Report

Committee on the Formal Investigation of Alleged Scientific Misconduct by LBNL Staff Scientist Dr. Victor Ninov

Dr. Murdock Gilchriese (LBNL)
Dr. Andrew Sessler (LBNL)
Dr. George Trilling (LBNL and UCB)
Dr. Rochus Vogt (Caltech and UC President's Council)

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Murdock Gilchriese
M.G. Gilchriese

Andrew M. Sessler
A. M. Sessler

George H. Trilling
G.H. Trilling

R.E. Vogt

Executive Summary

Experiments by the Heavy Element Group at the LBNL 88” cyclotron in 1999 led to the claimed observation of several alpha particle decay chains allegedly arising from the production and decay of an element with Z=118, (referred to subsequently as element-118). This work was reported in a PRL article published in 1999. Subsequent efforts at other institutions to confirm these observations failed. In further running at LBNL in 2001, one of the collaborators, Dr. Victor Ninov, claimed observation of a new element-118 event, but, within a few days, work by other collaborators showed that the data gave no basis for this claim. This history motivated a careful reexamination of the original LBNL data. The reexamination failed to reproduce the original results, and led to the appointment of a Technical Review Committee, chaired by Dr. G. Lynch, which studied all aspects of the analysis process that led to the original results. The Lynch Committee concluded that there was clear evidence of fabrication of data. The Lynch Committee Report was reviewed by Dr. Piermaria Oddone who recommended that the Laboratory initiate a review under its Integrity in Research Policy. This led to Dr. S. Loken’s Preliminary Inquiry, followed by the appointment of the Committee for the Formal Investigation of Alleged Scientific Misconduct (FIASM) by LBNL Staff Scientist Victor Ninov.

The FIASM Committee carefully examined the Lynch Committee Report and other evidence, interviewed the Lynch Committee, various members of the Heavy Element Group and others, and gave Dr. Ninov full opportunity to refute the allegations against him. On the basis of this review, the FIASM Committee draws the following conclusions:

1. The existing raw data files (original tapes or disk files copied from the tapes) show no evidence for any of the element-118 events originally claimed.

2. There is no evidence to suggest that the raw data files that exist now are any different from those that were produced in the course of the experiment. Thus one can assert that, with very high probability, the raw data files never contained the events claimed. This is given independent support by the failure of attempts elsewhere, with even higher luminosities, to confirm the LBNL observations.

3. Although the data analysis program used, GOOSY, has some known imperfections, there is no doubt that these were not the cause of finding the long decay chains that were the basis of the claimed discovery

4. There is convincing evidence, demonstrated in the Lynch Committee Report on the basis of existing analysis files, text files and journal files, that at least one of the 1999 element-118 decay chains, and the candidate decay chain in 2001,

were fabricated through alteration of some events and addition of others in the course of the analysis process. Here the term “events” refers to individual triggers from either a heavy nucleus or from alpha particles produced in successive decays, with an element-118 candidate consisting of a correlated chain of such events. This assertion is given independent support by a statistical analysis which shows less than 1% probability for the claimed distribution of decay times arising from the expected exponential time distributions.

5. There is clear evidence to conclude that Dr. Ninov has engaged in misconduct in scientific research by carrying out this fabrication. He was the only collaboration member doing analysis in 1999, and he was the one who announced both the 1999 chains and the initially claimed decay chain in 2001. If anyone else had done the fabrication, Dr. Ninov would almost surely have detected it.

6. In response to the FIASM Committee’s invitation to refute the conclusions of the Lynch Committee Report, and the opportunity to respond to a specific set of questions, the material provided by Dr. Ninov, although proclaiming his innocence, did not provide any substantive basis for changing the Committee’s conclusion as to his role in the fabrication of data.

7. In the FIASM Committee’s view, the BGS group failed in its responsibility to verify, with the required level of care, the experimental basis of what, if it had been correct, would have been an important discovery.

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I. Introduction

A Formal Investigation of Alleged Scientific Misconduct (FIASM) by Staff Scientist Dr. Victor Ninov, a member of the Berkeley-Gas-Filled-Separator (BGS) Group at the Lawrence Berkeley National Laboratory (LBNL), has been conducted, and this report represents the findings of the investigating committee appointed by Dr. Lee Schroeder, Director of the Nuclear Science Division at LBNL.

The FIASM Committee had the following members:

Dr. Murdock ("Gil") Gilchriese (LBNL)
Dr. Andrew Sessler (LBNL)
Dr. George Trilling (UC and LBNL)
Dr. Rochus ("Robbie") Vogt, Chair, (Caltech and UC President's Council)

I.1 Charge to the Committee

The Committee was charged to investigate alleged misconduct in scientific research by LBNL Staff Scientist Dr. Victor Ninov and to determine whether or not the alleged misconduct occurred (see App-14). The term "misconduct in scientific research" is defined by Laboratory policy as "fabrication, falsification, plagiarism, or other similar practices that occur in the course of proposing, conducting, or reporting research". The policy also states: "Not included in this definition are honest error or honest differences in interpretations of judgments of data" (see App-16). The allegations of scientific misconduct refer to events connected with attempts to synthesize element 118 in the 1999-2001 period, involving the Heavy Element Group at the LBNL 88" cyclotron.

I. 2 Brief history of events leading to the appointment of the FIASM Committee

- April 8-12, 1999: Run 013 on LBNL 88" cyclotron to attempt production of element 118 by the (86)Kr + (208)Pb reaction. Identification of three element-118 decay chains by Dr. Ninov, two of which were reported in the published paper.
- April 30-May 5, 1999: Run 015 on LBNL 88" cyclotron to produce element 118 by the (86)Kr + (208)Pb reaction. Identification of a third element-118 decay chain by Dr. Ninov, also reported in the published paper.

- May 1999: Presentations of element-118 results to LBNL 88” Cyclotron Council and to selected members of the LBNL Nuclear Science Division (NSD) senior staff.
- May 25, 1999: Submission of paper to Physical Review Letters: “Observation of Superheavy Nuclei Produced in the Reaction of (86)Kr with (208)Pb”, by Dr. Ninov (first author) and 14 co-authors.
- May 31, 1999: LBNL press release on the discovery of element 118.
- August 9, 1999: Element-118 paper appears in Physical Review Letters. (see **Ref-1/App-1**)
- Summer 1999: Gesellschaft fuer Schwerionenforschung (GSI), Germany, attempts to confirm the element-118 discovery with the (86)Kr + (208)Pb reaction, but finds no element-118 decay chains. (see **Ref-2**)
- Fall 1999: RIKEN Institute (Japan) conducts experiment with an (84)Kr + (208)Pb reaction, but finds no element-118 decay chain. (see **Ref-3**)
- February 2000: RIKEN Institute (Japan) attempts experiment with an (86)Kr + (208)Pb reaction, but finds no element-118 decay chains. (see **Ref-3)**
- Spring 2000: Further runs on the LBNL 88” cyclotron to reproduce the production and decay of element 118. No element-118 decays found.
- Summer and Fall 2000: Independent LBNL group, chaired by Dr. I-Yang Lee, studies the 1999 and 2000 experiments to produce element 118.
- January 25, 2001: I-Yang Lee Group issues its report: “Independent Study of the Synthesization of Element 118 at the LBNL 88-Inch Cyclotron (Draft 1.07)”. (see **App-2**)
- Fall/Winter 2000/01: Improvements to and tests of the element-118 search detector system and conduct of operations.
- April-May 2001: Further runs on LBNL 88” cyclotron to reproduce the production and decay of element 118. One element-118 decay chain in Run 045 reported by Dr. Ninov, but not confirmed in subsequent analyses.
- June 2001: “118 Review Working Group”, chaired by Dr. Darleane Hoffman (LBNL) examines and assesses all original data of the 1999-2001 experiments, is unable to identify any of the element-118 decay chains. (see **App-3**)
- June 19, 2001: NS Division Director Schroeder forms committee, chaired by Dr. Gerald Lynch, to review the element-118 program, resulting in: ”Report of the Committee for the Technical Review of the Element 118 Program”, on October 11, 2001. Among the findings is the statement: “The element 118 candidates that were reported from the 1999 and 2001 BGS experiments are not in the data, as it exists today”. (see **App-4a, App-4b**)
- July 27, 2001: LBNL issues press release retracting results of element-118 experiment. (see **App-5**)

- October 2001 *:* BGS group leader submits retraction of 9 August 1999 PRL paper to PRL. (see **App-6**)
- October 12, 2001: PRL declines publication of retraction because Dr. Ninov refuses to co-author the retraction. (see **App-7**)
- October 17, 2001: In a letter to Nuclear Science Division Director Schroeder, LBNL Deputy Director Oddone suggests that "…a review of this matter under the Laboratory's Integrity in Research Policy…" may be advisable. (see **App-8**)
- October 23, 2001: NSD Director Schroeder informs Dr. Ninov that ".questions relating to alleged misconduct in your research have come up…", and that a preliminary inquiry has been initiated. (see **App-9**)
- November 16, 2001: Dr. Stewart Loken (LBNL), after having conducted a preliminary inquiry, submits report: "Element 118 Preliminary Inquiry", concluding that "…data were fabricated by Dr. Ninov…." and that "…there should be a formal investigation under the provisions of the policy on Integrity in Research." (see **App-10, App-11**)
- November 21, 2001: NSD Director Schroeder places Dr. Ninov on indefinite paid leave. (see **App-12**)
- November 28, 2001: NSD Director Schroeder convenes a committee to conduct a Formal Investigation of Alleged Scientific Misconduct (FIASM). (see **App-13, App-14)**

I. 3 Documentation

The following documents were provided to the FIASM Committee at the beginning of its investigations:

- Physical Review Letters article of 9 August 1999: "Observation of Superheavy Nuclei Produced in the reaction of (86)Kr with (208)Pb", by V. Ninov, K.E. Gregorich, W. Loveland, A. Ghiorso, D.C. Hoffman, D.M. Lee, H. Nitsche, W.J. Swiatecki, U.W. Kirbach, C.A. Laue, J.L. Adams, J.B. Patin, D.A. Shaughnessy, D.A. Strellis, and P.A. Wilk. (**App-1/Ref-1**)
- Report, dated 01.25.01, by I-Yang Lee (chair), B. Fujikawa, L. Phair, K. Vetter, entitled: "Independent Study of the Synthesization of Element 118 at the LBNL 88-Inch Cyclotron (Draft 1.07)". (**App-2**)
- Memorandum, dated 06.15.01, from D. Hoffman, for the "118 Review Working Group", to L. Schroeder: "Status Report as of June 15, 2001". (**App-3**)
- Report, dated 10.11.01, by G. Lynch (chair), A. Macchiavelli, Ch. McParland, and D. Olson, entitled: "Report of the Committee for the Technical Review of the Element 118 Program". (**App-4b)**
- Letter, dated 10.17.01, from Pier Oddone to L. Schroeder, commenting on the Report of the Committee for the Technical Review of the Element 118 Program. (**App-8)**

- Letter, dated 10.23.01, from L. Schroeder to V. Ninov, transmitting the report of the Lynch Committee and the 10.17.01 letter by Deputy Director Oddone, and announcing the initiation of a preliminary inquiry on possible scientific misconduct. (**App-9**)
- Letter, dated 10.23.01, from L.Schroeder to S. Loken, requesting conduct of a preliminary inquiry on possible misconduct in scientific research. (**App-10)**
- Report, dated 11.16.01, by S. Loken to L. Schroeder on conclusion of "Element 118 Preliminary Inquiry". (**App-11**)
- Letter, dated 11.21.01, from L. Schroeder to V. Ninov, announcing decision to initiate FIASM and placing V. Ninov on Paid-Leave status. (**App-12)**
- Letter, dated 11.28.01, from L. Schroeder to V. Ninov, including charge to FIASM Committee and copy of S. Loken report on preliminary inquiry. (**App-13**)
- Letter, dated 11.28.01, from L. Schroeder to R. Vogt with charge to FIASM Committee. (**App-14**)
- Federal Policy on Research Misconduct, *Federal Register, Vol. 65, No. 235, December 6, 2000.* (**App-15)**
- Lawrence Berkeley National Laboratory Policy on Integrity in Research (RPM 2.05I). (**App-16)**

Additional documents used by the FIASM Committee during the course of its investigations:

- "The discovery of the heaviest elements", S. Hofmann and G. Muenzenberg, Rev. Mod. Phys., **72**, No. 3, July 2000. (**Ref-2**)
- "Search for a Z = 118 Superheavy nucleus in the reaction of Kr beam with Pb target at RIKEN", K. Morimoto et al., CP561, *Tours Symposium on Nuclear physics IV,* 2001. (**Ref-3**)
- "A new test for random events of an exponential distribution", K.H. Schmidt, Eur. Phys. J. A **8,** 141-145 (2000). (**Ref-4**)
- LBNL Press release of July 27, 2001: "Results of Element 118 Experiment retracted". (**App-5**)
- "Retraction: Observation of Superheavy Nuclei Produced in the Reaction (86)Kr with (208)Pb [Phys. Rev. Lett. 83, 1104 (1999)], submitted to PRL. (**App-6**)
- October 12, 2001: e-mail from PRL to K. Gregorich re retraction. (**App-7**)
- "New results on elements 111 and 112", preprint by S. Hofmann et al., GSI (Germany), December 20, 2001. (**App-17**)
- "Likelihood Calculation of the Spread of the Time Distributions of Events in the Reported Element 118 Decay Chains", K. Gregorich **(App-18)**

- “In re: TECHNICAL REVIEW OF ELEMENT 118 PROGRAM, STATEMENT OF VICTOR NINOV, Ph.D.”, dated February 1,2002. (**App-19**)
- e-mail from R. Vogt to Duane & Seltzer, attorneys to V. Ninov, asking for transmission of “10 questions” to V. Ninov , dated February 12, 2002. (**App-20**)
- e-mail from R. Seltzer, transmitting V. Ninov’s answers to “10 questions”, dated February 19, 2002. (**App-21)**

I. 4 FIASM Committee Meetings and Participants

- December 10, 2001: Teleconference
  Committee: M. Gilchriese, A. Sessler, G. Trilling, R. Vogt

- December 14, 2001: Meeting at LBNL
  Committee: M. Gilchriese, A. Sessler, G. Trilling, R. Vogt
  Staff: Patricia Oddone (LBNL)
  Invited Guests: K. Gregorich, D. Hoffman, I-Y. Lee, G. Lynch, A.Macchiavelli, Ch. McParland, V. Ninov, D. Olson, L. Schroeder, G. Woods

- January 9, 2002: Meeting at LBNL
  Committee: M. Gilchriese,A. Sessler, G. Trilling, R.Vogt
  Staff: Patricia Oddone
  Invited Guests: K. Gregorich, S. Loken, W. Loveland (by telephone), G. Lynch, A. Macchiavelli, V. Ninov (declined to attend), Ch. McParland, L. Schroeder

- January 24, 2002: Teleconference
  Committee: M. Gilchriese, A. Sessler, G. Trilling, R. Vogt

- February 6, 2002: Teleconference
  Committee: M. Gilchriese, A. Sessler, G. Trilling, R. Vogt
  Staff: P. Oddone

- February 11, 2002: Meeting at LBNL
  Committee: M. Gilchriese, A. Sessler, G. Trilling, R. Vogt
  Staff: P. Oddone
  Invited Guests: K. Gregorich, I-Y. Lee, W. Loveland (by telephone), V. Ninov (declined), L. Schroeder

- February 14, 2002: Teleconference
  Committee: M. Gilchriese, A. Sessler, G. Trilling, R. Vogt
  Staff: P. Oddone

- March 1, 2002: Teleconference
  Committee: M. Gilchriese, A. Sessler, G. Trilling, R. Vogt
  Staff: P. Oddone

- March 4, 2002: Meeting at LBNL
  Committee: M. Gilchriese, A. Sessler, G. Trilling, R. Vogt
  Staff: P. Oddone
  Invited Guests: G. Lynch

- March 21, 2002: Teleconference
  Committee: M. Gilchriese, A. Sessler, G. Trilling, R. Vogt
  Staff: P. Oddone

II. Committee Findings

Experiments performed by the LBNL BGS group in 1999 at the LBNL 88" cyclotron led to a PRL publication (App-1), reporting the discovery of three element-118 alpha-decay chains. Subsequent cyclotron runs in 2001 produced another claim of an element-118 decay chain. Attempts by the GSI group (Germany) and the RIKEN group (Japan) to reproduce and confirm these results failed to do so. Investigations at LBNL conducted in 2001 established the absence of the three claimed 1999 element-118 decay chains and of the single 2001 decay chain in the data. The 2001 Lynch Committee Report (App-4b) raised the issue of fabrication of data. The Lynch Committee Report was reviewed by Dr. Piermaria Oddone who recommended that the Laboratory initiate a review under its Integrity in Research policy. The Loken report (App-11) led ultimately to the appointment of this committee, charged with investigating whether Staff Scientist Victor Ninov engaged in scientific misconduct in connection with the claimed element-118 discovery.

In the following sections the Committee documents that the irregularities connected with the reported element-118 discoveries could not be explained by inadvertent errors, and

- that the existing raw data files do not contain the reported 1999 and 2001 element-118 decay chains (II.1),
- that the absence of the element-118 decay chains from the raw data files cannot be explained by their willful removal (II.2),
- that the absence cannot be explained by software failure (II.3),
- that in fact evidence was found in analysis files from 1999 and 2001 for the fabrication of element-118 decay chains (II.4),
- that the evidence from these findings convinces us that Staff Scientist Victor Ninov was responsible for the fabrication of these false events (II.5).

II. 1 Evidence that the present raw data files do not contain the claimed Z=118 events

Since, insofar as the Committee can tell, there seems to be no dispute on this point, we shall quote directly from the relevant inputs. Section 3 of the Darleane Hoffman Status Report (App-3) states: “Tom Ginter and Victor Ninov have now searched all of the 1999 data, and Larry Phair has searched targeted data files for the reported 118 decay chains. They have been unable to identify any of these decay chains.” Furthermore in Section 4, the same report states “The six-member element -118 decay chain seen in the preliminary analysis of the April-May 2001 experiment does not exist in the data. Additional analysis of all data is continuing”.

The Lynch Committee (App-4b), in its section 5, accepts the above conclusions, and adds that “since then, Kenneth Gregorich, using a C-program running in the Windows-98 environment, searched for the chains in all three runs, also with negative results.”

Given that Ninov was the individual who claimed to find all the interesting events, and that he, as well as several others, have been unable to find these events in the existing raw data files, we accept as true the first item in the Lynch Committee Report Executive Summary: “The element 118 candidates that were reported from the 1999 and 2001 BGS experiments are not in the data, as it exists today.”

II. 2 Evidence that the present raw data files have not been modified through the removal of real Z=118 events that were originally present

II.2.1 Data Integrity

We have investigated the possibility that the raw data files were altered to remove element-118 decay chains. The Lynch Committee also examined this possibility and “…found no evidence that original data tapes have been altered by the addition or deletion of events.” We requested additional checks of the integrity of the raw data tapes. These checks were performed by members of the Lynch Committee and their report is given in App-22.

The data tapes created by the BGS experiments were written by an online data acquisition system in a format specified by the GOOSY data analysis package. A description of the data format and references may be found in App-22. The data tapes were typically copied to disk for analysis. No backups (except the disk files) of the tapes written in 1999-2001 were created until the formation of the “118 Review Working Group” chaired by D. Hoffman in June 2001. Tapes 7 and 8 from the BGS Run 45 are missing. Tape 8 would have contained the postulated element-118 decay chain that was claimed to have been found on about May 7, 2001. The original data tapes from 1999-2001 were put under the custody of Claude Lyneis by mid-2001 and access restricted (they are locked up). Access to the data tapes was not controlled from the inception of the BGS runs in 1999 until mid-2001.

There is no evidence that alterations have been made to the original data tapes that have been checked by the Lynch Committee. The tapes and files supposedly containing the events found in 1999 have been examined. The disk file copied from the tape containing the event found in 2001 has been checked. A list of tapes/files examined in this analysis is given in App-22. The data appear to be internally consistent. In addition, some checks were performed to compare data on the existing tapes with analysis files (.LOG files) created from disk files (tape images) written in 1999. No differences were seen apart from the evidence of modification of LOG files discussed in section II.4.

The Lynch Committee and Ken Gregorich examined GOOSY log files recorded in April 1999 (see Appendix G of their report). The data for Run 13 were recorded on April 11-12, 1999. The first of the published element-118 decay chains was ascribed to raw data file T01F020142.LMD, which was recorded on April 11. The second, unpublished chain was ascribed to file T01F020146.LMD, also recorded on April 11, 1999. A GOOSY log file (SLOG_CA_R013.LOG;1) exists that shows the results of analysis of Run 13 data done from April 13 (starting at 18:57) until April 15 (ending at 15:05), 1999. The analysis of file T01F020142.LMD began at 09:17 on April 15. The analysis should have shown the first of the published events but did not. The analysis of file T01F020146.LMD began at 11:34 on April 15 and should have found the 2nd, unpublished, escape element-118 decay chain but did not. The GOOSY analysis was done using disk files rather than raw data tapes. Thus, if alteration of the raw data files occurred to remove real events, it would have had to occur between April 11 and the morning of April 15. Under the hypothesis that events were in fact deleted, the circumstances for the remaining two chains reported in 1999 would have necessarily been similar. First the chains would have to be found, data files (and eventually tapes) altered carefully and then the data files replaced on disk. It is apparent from the chronology given in the Lynch Committee Report (Section 5.4) and from testimony to our committee, that Ninov was the only individual analyzing the data on a daily basis. Ninov was creating the tape images on disk. It is highly unlikely that Ninov would not have noticed either duplicate data files (unaltered and altered would have to exist simultaneous at least for some time) or have been immediately concerned when continued analysis of data files on or after April 15 no longer showed evidence for the two decay chains from Run 13.

In addition, alteration of the original data tapes and files to remove real events, in a manner such as to escape detection of this alteration, would have required considerable knowledge of the GOOSY data formats, the tape-writing procedures, and the ability to find the real events. The evidence presented above also shows this would have had to be done within days or less of acquiring the raw data. Furthermore, testimony from members of the BGS group (Gregorich, Hoffman and Loveland) and from I-Y Lee indicates that only Dr. Ninov would have had the requisite skills and opportunity in 1999 to alter data tapes.

II.2.2 Indications from other experiments

An indirect indication that the claimed alpha decay chains were never on the raw data tapes arises from the fact that, at this time, other groups have sought and failed to confirm the published element-118 results, using integrated luminosities considerably larger than those on which the original results were based.
The total number of incident Kr ions in the exposure on which the PRL was based was, according to the published paper, 2.3 X 10^{18} (App-1/Ref-1). According to the report from the I-Y Lee Committee (App-2, Table 1), a more recent estimate reduces this to 1.6 X 10^{18} total Kr ions. Subsequently the GSI Group (Ref-2), using an exposure of 2.9 X 10^{18} Kr ions, found no candidate Z=118 events. The Riken Group (Ref-3), with an exposure of 2 X 10^{18} Kr ions, also found no candidates. The recoil separation technique used by the Riken Group was almost identical to that used in Berkeley, whereas the GSI Group used a different system based on velocity filtering. However both groups attempted to match the Berkeley conditions, such as beam energy, as closely as possible. The absence of a signal for an integrated total of 4.9 X 10^{18} Kr ions is in clear disagreement with the Berkeley claim of 1.6 X 10^{18} ions leading to four element-118 alpha chains (three published, one not published).

Since the observed production rate may be quite sensitive to incident energy, detector efficiencies, or other experimental conditions, the above observations, by themselves, do not conclusively rule out the possibility that there were real element-118 events on the Berkeley data tapes. However they are completely consistent with all the other evidence indicating that the Berkeley raw data never contained element-118 alpha chains. This conclusion was evidently convincing to the authors of the element-118 PRL, since, except for Ninov, they signed a retraction sent to PRL (but not accepted for publication because of Ninov's disagreement (see App-6, App-7)).

II. 3 Evidence that the claimed events did not arise from faulty software

The Lynch Committee Report (App-4b) in its Section 5.2, in its Appendix C, in the Conclusions (Item #3), and in the Executive Summary (Item #3) addresses the question as to whether, or not, the data analysis program, GOOSY, was working correctly. In fact it discusses that analysis program in some detail. It should be noted that GOOSY is not only used at LBNL, but in fact in other places as well. While GOOSY has some problems, there is no evidence that its corruption mechanisms played any role in producing the claimed decay chains, which look to be unique and robust events. In the case of the 2001 element-118 decay chain, according to the Lynch Committee Report, “there was no evidence of data corruption by the analysis routine either before or after the events purported to be part of that chain...”

All of these findings are given in the Lynch Committee Report Conclusion, Item #3, which we quote here: “We have verified that GOOSY is properly unpacking events from raw data files and presenting them to the user analysis code in the proper order. With the exception of those events constituting the 118 candidate in run 45 (2001), an analysis of event sequences found in raw data files and event analysis sequences shown in GOOSY log files show agreement between the tmp parameter present in both raw event data and user analysis routine output. It should be noted that the GOOSY analysis framework has been shown capable, on occasion, of corrupting data structures in the shared memory database. If present, this corruption is believed to be responsible for incorrect histograms, misaligned array indices and truncated arrays. However, in the above analysis, the fact that there was no evidence of such corruption either before or after the 118 candidate events suggests that this mechanism played no role in producing the events seen in the GOOSY log file. Furthermore, since the final analysis procedure used for identifying the 118 event chain consisted of examination of raw event data as printed by the same user code that produced these log file entries, with no additional analysis of the raw data, we see no evidence that this data was incorrectly presented to the user by GOOSY. And lastly, analysis of user codes used during the 2001 experiment shows no mechanism that could erroneously produce the reported robust event chains.” There is no claim by V. Ninov, and he was specifically asked by us on Dec 14, 2001, that the problems in the element-118 analysis resulted from failures in the computer programs.

The recent preprint from GSI (App-17) is also relevant in this regard. The authors found that, in a reexamination of 34 previously measured Z=110, 111, 112 decay chains, two appeared to have been spuriously created. They made great efforts to “track down” the problem and in the course of that investigation looked very carefully at GOOSY (which they also use). They conclude that explanation of the problem on the basis of errors in the computer program was ruled out. These results are consistent with the above, i.e., that GOOSY is not capable of producing false data chains, and the source of the spurious data lies somewhere other than in GOOSY (see further discussion in Section II.5.3).

II. 4 Evidence that some analysis files for both the 1999 and the 2001 data were fabricated

According to the Lynch Committee Report, Conclusion #4, “There is clear evidence that at least one of the 118 element decay chains published in 1999, and also the candidate in the 2001 data, were fabricated. This fabrication was performed by capturing the output of the data analysis program in a text editor and then systematically altering some events and inventing others in order to present data that would appear to be an element 118 decay chain….. In 2001, a run of GOOSY analysis output was inserted into the normal operational log. While most of the analysis output that appears in this inserted section is consistent with events found in the data file, there is a short sequence that is not. This sequence does not appear in subsequent GOOSY analysis runs documented in the same log file on either the same or subsequent days and is not found in the data file. This sequence was the basis of the confirming 118 event decay chain said to have been found in the 2001 experimental run”.

II.4.1 The 2001 event

We begin with a consideration of the Run 45 (2001) event because there is much more information available on its history.

Although the original data tape in which the alpha decay chain was supposedly contained seems to have disappeared, a disk file believed to be identical to that data tape exists and has been the subject of detailed comparisons with the corresponding GOOSY analysis log files. A printout of some relevant pieces of that analysis file is shown on Table II-1 (excerpted from Lynch Committee Report, App F), corresponding to analyses of the same data recorded at 12:54 and 15:03, on May 7, 2001. Explanations of the various entries in the file are given in Table II-2. In the 12:54 sequence, starting with an evaporation residue (event # 242625) there appears to be a decay chain of three alpha particles at the same location (strip 12, coordinate 351-357) and correlated in time (time differences dt of 0.137 ms, 18 ms, and 10.412 s), and with energies corresponding to expectations for element 118. These form the basis for the initially claimed event in 2001. However in the same area of data analyzed at 15:03, the evaporation residue (now at #242597) has just the same energy and tmp (microsecond clock) measurement, but is at a completely different position (strip 2, coordinate 397). The following entry, an alpha, bears some identical parameters (energy of 12.254 MeV, and coordinate 352) and others that differ (time difference dt of 932 ms and location at strip number 2) relative to the corresponding entry in the 12:54 sequence. There is no evidence at 15:03 for other members of the alpha-particle chain seen at 12:54. A further analysis of the same group of data at 15:27 also shows no alpha chains (App. A7 of Lynch

Committee Report). Indeed the 15:03 and 15:27 results agree with the information on the raw data disk, while the 12:54 results do not. They appear to have been fabricated through the modification of some analysis file entries and the addition of others. It may be worth mentioning another oddity in the 12:54 output in Table II-1. There are two entries for #242631 (one of the "118"-chain alpha events) with different values of tmp (the microsecond clock), and with both of these values differing from yet another value shown in printouts given to the Lynch Committee. Again this does not look like the effect of a normal analysis.

A further important observation in the Lynch Committee Report was based on the study of the timing of the events (see the values for "time"). In Table II-1, the times for event #242100 (before the interesting sequence) and #252649 (after the interesting sequence) are identical in the analyses done at 12:54 and 15:03, and remain so for events before #242100 and after #252649. Yet these times are not absolute: they represent a running sum based on the accumulation of time differences from all previous events. If the discrepancy in the region of the "interesting chain" were the result of a software problem, the time values for #252649 and beyond in the 12:54 and 15:03 analysis runs could not have agreed. Their agreement clearly indicates that the time values in the interesting chain did not come from the analysis program, but were produced separately and inserted into the output.

12:54:43	--	ER	ev:	242048	time:	7101.122	tmp:	1079	E(ch):	2006	pos:	1328	TOF:	1404		
12:54:43	--	ER-AL	ev:	242100	time:	7102.703	tmp:	14929	E(kev):	8171	pos:	1333	dt(ms):	1581.696	dx(ch):	6

12:54:43 Events making interesting decay chain

12:54:43	--	ER	ev:	242625	time:	7118.294	tmp:	8563	E(ch):	553	pos:	12357	TOF:	1593		
12:54:43	--	ER-AL	ev:	242626	time:	7118.294	tmp:	8700	E(kev):	12254	pos:	12352	dt(ms):	0.137	dx(ch):	-5
12:54:43	--	AL-mo	ev:	242626	time:	7118.294	tmp:	8700	E(keV):	12254	pos:	12352				
12:54:43	--	Al-da	ev:	242631	time:	7118.312	tmp:	15087	E(keV):	10722	pos:	12356	dt(s):	0.018	dx(ch):	4
12:54:43	--	AL-mo	ev:	242631	time:	7118.312	tmp:	11268	E(keV):	10722	pos:	12356				
12:54:43	--	Al-da	ev:	242744	time:	7128.724	tmp:	15087	E(keV):	8788	pos:	12351	dt(s):	10.412	dx(ch):	-5

12:54:43	--	ER	ev:	252649	time:	7411.835	tmp:	1244	E(ch):	432	pos:	1340	TOF:	1447		
12:54:43	--	ER-AL	ev:	252757	time:	7415.089	tmp:	6161	E(kev):	10558	pos:	1290	dt(ms):	3253.460	dx(ch):	-50
12:54:43	--	ER	ev:	256934	time:	7536.610	tmp:	5370	E(ch):	590	pos:	2696	TOF:	1380		
12:54:43	--	ER-AL	ev:	257031	time:	7539.281	tmp:	6513	E(kev):	8268	pos:	2734	dt(ms):	2671.478	dx(ch):	38
12:54:43	--	ER	ev:	261041	time:	7653.936	tmp:	8814	E(ch):	791	pos:	1661	TOF:	1369		
12:54:43	--	ER-AL	ev:	261167	time:	7657.852	tmp:	2684	E(kev):	10989	pos:	1673	dt(ms):	3915.082	dx(ch):	12
12:54:43	--	ER	ev:	268156	time:	7861.826	tmp:	9668	E(ch):	1013	pos:	14876	TOF:	1187		
12:54:43	--	ER-AL	ev:	268289	time:	7865.838	tmp:	11945	E(kev):	10110	pos:	14873	dt(ms):	4012.418	dx(ch):	-3
12:54:43	--	ER	ev:	271901	time:	7970.688	tmp:	7397	E(ch):	1924	pos:	1681	TOF:	1252		
12:54:43	--	ER-AL	ev:	272033	time:	7974.602	tmp:	5731	E(kev):	10903	pos:	1687	dt(ms):	3914.366	dx(ch):	6
12:54:43	--	ER	ev:	276364	time:	8101.191	tmp:	3345	E(ch):	998	pos:	32542	TOF:	1225		

15:03:44 Remains of apparent interesting chain seen at 12:54

15:03:41	$ANL	ER	ev:	237734	time:	6975.925	tmp:	14885	E(ch):	421	pos:	1581	TOF:	1528		
15:03:41	$ANL	ER-AL	ev:	237824	time:	6978.622	tmp:	14323	E(kev):	10067	pos:	1618	dt(ms):	2696.553	dx(ch):	36
15:03:42	$ANL	ER	ev:	239313	time:	7022.683	tmp:	3256	E(ch):	865	pos:	29659	TOF:	1287		
15:03:42	$ANL	ER-AL	ev:	239473	time:	7026.954	tmp:	9281	E(kev):	8232	pos:	29702	dt(ms):	4271.328	dx(ch):	43
15:03:42	$ANL	ER	ev:	239674	time:	7032.418	tmp:	477	E(ch):	713	pos:	25548	TOF:	1499		
15:03:42	$ANL	ER-AL	ev:	239801	time:	7035.825	tmp:	7706	E(kev):	7261	pos:	25577	dt(ms):	3406.307	dx(ch):	29
15:03:43	$ANL	ER	ev:	242048	time:	7101.122	tmp:	1079	E(ch):	2006	pos:	1328	TOF:	1404		
15:03:43	$ANL	ER-AL	ev:	242100	time:	7102.703	tmp:	14929	E(kev):	8173	pos:	1333	dt(ms):	1581.696	dx(ch):	6
15:03:44	$ANL	ER	ev:	242597	time:	7117.157	tmp:	8563	E(ch):	553	pos:	2397	TOF:	1593		
15:03:44	$ANL	ER-AL	ev:	242626	time:	7118.089	tmp:	4625	E(kev):	12254	pos:	2352	dt(ms):	932.137	dx(ch):	-45
15:03:46	$ANL	ER	ev:	247677	time:	7264.954	tmp:	6093	E(ch):	733	pos:	12176	TOF:	1224		
15:03:46	$ANL	ER-AL	ev:	247708	time:	7265.769	tmp:	566	E(kev):	8488	pos:	12181	dt(ms):	815.168	dx(ch):	6
15:03:49	$ANL	ER	ev:	252649	time:	7411.835	tmp:	1244	E(ch):	432	pos:	1340	TOF:	1447		
15:03:49	$ANL	ER-AL	ev:	252757	time:	7415.089	tmp:	6161	E(kev):	10559	pos:	1290	dt(ms):	3253.460	dx(ch):	-50

Table II-1

Table II-2: Explanation of Entries in Table II-1

1st column: time when analysis was done
2nd column: "- - " in entries at 12:54 and "$ANL" at entries at 15:03
(see explanation for this difference in the text)
3rd column: "ER" – evaporation residue, "ER-AL" – alpha from evap. residue
"AL-mo" – alpha leading to mother nucleus
"Al-da" – alpha leading to daughter nucleus
4th & 5th columns: "ev: event number" where every trigger is a separate event
6th & 7th columns: "time: seconds clock output"
8th & 9th columns: "tmp: microseconds clock output"
10th & 11th columns: "E(ch): energy in channel counts" for evaporation residues
"E(keV): energy in keV" for alphas
12th & 13th columns: "pos: position on strip (last 3 digits) and strip number"
14th & 15th columns: "dt(s): decay times"
16th & 17th columns: "dx(ch): position displacements in alpha decay

Note: For the format in the earlier files shown in Table II-3, the AL-mo and Al-da are replaced by AL-A and Al-B, and the time and event number are given in the reverse order.

Further evidence of such fabrication, based on other elements of the GOOSY analysis file is discussed in Appendix F of the Lynch Committee Report:

1) Page lengths are very regular (63 to 68 lines/page) except in 5 places, one of which is the region of the apparent chain at 12:54.

2) The processing time indicated in the log entries at 12:54 suggest that a 200MB file was read and analyzed in 5 seconds, and yet the computer and disks are not capable of processing data at 40 MB/s. This indicates that the program was not really analyzing data during that run.

3) Again referring to Table II-1, there is a format difference between the printouts for 12:54 and 15:03: the second column is"- -"at 12:54 and "$ANL" at 15:03. The Lynch Committee points out that "- -"appears in that column wherever a command to type the contents of another file into the log file is recorded.

There is clear evidence that the Run 45 "element-118 event" was fabricated.

II.4.2 The 1999 events

Referring again to Conclusion #4 of the Lynch Committee Report, we quote " In 1999, one such modified sequence was present in an e-mail sent to collaboration members and is accepted by the BGS Collaboration as representing the decay chain for the 3rd 118 event listed in the PRL publication". The previous discussion has treated the Run 45 event with considerable detail, even though it did not enter into the 1999 publication, because there is more information about the circumstances of that event. It is also of great interest to try to understand the events that went into the published PRL. The Lynch Committee Report discusses the analysis of the Run 15 event (the third event included in the publication) in some detail.

The original data tape is still available in this case, as are a text file (R015CH1.TXT) and two journal files (R015_CHAIN_LIS and NEW_CHAIN_LIS). Outputs from the journal files are shown in Tables II-3 and II-4 (see also Lynch Committee Report, App E). Additional information about the relevant events has been read from the original raw data tape (with the assistance of G. Lynch) and is shown in Table II-5. The output shown on Table II-5 differs from that shown in the journal files in that i) it includes a millisecond clock whose output is an essential ingredient, and ii) the energies are not in keV and need a constant multiplicative factor to become keV. This information allows one to follow the transition from the original data to the final claimed decay chain:

1) The R015_CHAIN_LIS (see Table II-3, last four lines) is fairly close to the original data (Table II-5), but there are some differences: a) the energies are different - - even without knowing the calibration factor to go to keV, the raw data energies are increasing with event no. while those in Table II-3 are decreasing, b) the time differences dt(s) in Table II-3 are wrong: using the millisecond clock the two time differences should be 0.139 s and 0.666 s respectively rather than 0.001 s. In addition, the event numbers are off by 1, but this difference is not of great significance. Note that the above time difference results are consistent with the tmp, the microsecond clock, which reads modulo 20 ms. If one adds 140 ms to the 21913 tmp and 800 ms to the 21937 tmp, the results are in agreement.

2) The next version, NEW_CHAIN_LIS (Table II-4, bottom) shows major differences: a) The first two entries (including the evaporation residue) have been added, b) the tmp values on the next two entries are changed (6115 to 5115 and 5054 to 6054), and c) event numbers are modified. These modifications begin to provide the basis for an apparent element-118 alpha chain.

3) The final version, R015CH1.TXT (Table II-4, top) which is the basis for a published event, is almost the same as NEW_CHAIN_LIS. The one further change is that the tmp value of the evaporation residue is changed from 4068 to 3758, giving it a finite alpha decay time.

This published decay chain is the third on Fig. II-1. The decay times shown for α_2, α_3, α_4, α_5 are exactly those obtained from taking tmp differences in Table II-4, and the energies are close (though not absolutely identical) to those in Table II-4. This still leaves the origin of α_1, α_6, α_7 unexplained. They do not seem to be on any analysis or journal files that have been located. It seems abundantly clear that the original data were edited to form the alpha decay chain that was the basis of the third event in the publication.

Content of file recovered from 5DKB100:[BGS.VNINOV]R015_CHAIN_LIS.TPU$JOURNAL;1

```
Tape label  :
File name   :
User name   :
Run ID      : run15
Experiment  : 459 86Kr + 450 208Pb
Created     : 3-May-99 11:10:04
Q1=1509 M1=338 M2=573 P=1.033
------------------- End of File Header ----------------------------------------
File input started from: VSCA::$5$DKA100:[BGS.RUN015]T02F05.LMD;1

ER   time:   0: 30: 56.  68    ev:    32242 tmp: 12226 Em(ch):   2662 pos:  9515 TOF:     5
ER-A time:   0: 30: 56.  88    ev:    32243 tmp: 14204 Ed(kev): 11325 pos:  9520 dt(ms):      1.400 dx(ch):   5
AL-B time:   0: 30: 56. 299    ev:    32245 tmp: 10261 E1(keV): 11011 pos:  9521
Al-A time:   0: 30: 56.  56    ev:    32252 tmp: 11035 E2(keV): 10503 pos:  9523 dt (s):      0.057 dx(ch): -17
AL-B time:   0: 30: 57. 176    ev:    32259 tmp:  3049 E1(keV): 10100 pos:  9518
Al-A time:   0: 30: 58. 831    ev:    32261 tmp:  8516 E2(keV):  9763 pos:  9525 dt (s):      0.655 dx(ch):  -5
Al-B time:   0: 30: 58. 831    ev:    32261 tmp:  8516 E2(keV):  9763 pos:  9525 dt (s):      0.655 dx(ch):  -5

ER   time:   0: 56: 46. 195    ev:   174295 tmp: 13924 Em(ch):   3364 pos:  7200 TOF:     0
ER-A time:   0: 56: 41. 278    ev:   174300 tmp:  7182 Ed(kev): 10886 pos:  7207 dt(ms):     83.000 dx(ch):   7
AL-A time:   0: 56:  8.   2    ev:   171460 tmp:  4613 E1(keV):  9778 pos:  7212
Al-B time:   0: 56:  4. 961    ev:   171542 tmp: 10529 E2(keV): 11085 pos:  7211 dt (s):      0.959 dx(ch): -11
AL-A time:   0: 56: 46. 565    ev:   174252 tmp: 10959 E1(keV):  9843 pos:  7214
Al-B time:   0: 56: 41. 278    ev:   174300 tmp:  7182 E2(keV): 10886 pos:  7207 dt (s):      0.713 dx(ch): -17

ER   time:   1: 47:  6. 868    ev:   392094 tmp:  3975 Em(ch):   1056 pos:  6211 TOF:     1
ER-A time:   1: 47:  6. 868    ev:   392097 tmp: 11025 Ed(kev): 12024 pos:  6227 dt(ms):      0.700 dx(ch):  16
Al-a time:   1: 47:  6. 868    ev:   392097 tmp: 11025 E2(keV): 12024 pos:  6227
AL-A time:   1: 47:  5.  92    ev:   392108 tmp:  1432 E1(keV):  9171 pos:  6225 dt (s):      0.846 dx(ch):   2

ER   time:   1: 19: 54. 746    ev:   379422 tmp:  1495 Em(ch):   2612 pos:  5643 TOF:    16
ER-A time:   1: 36: 30. 825    ev:   379427 tmp:  9427 Ed(kev): 10608 pos:  5661 dt(ms):     79.000 dx(ch):  19
AL-A time:   1: 19: 21. 174    ev:   379434 tmp: 14354 E1(keV): 10816 pos:  5584
Al-B time:   1: 19: 58.  78    ev:   379524 tmp: 14704 E2(keV): 12197 pos:  5576 dt (s):      0.904 dx(ch):  -8
AL-A time:   1: 19: 41. 725    ev:   379258 tmp:  4363 E1(keV):  9010 pos:  5643
Al-B time:   1: 36: 17.  87    ev:   379298 tmp: 10620 E2(keV): 10722 pos:  5641 dt (s):      0.362 dx(ch):  -3

AL-A time:   0: 14: 13. 979    ev:    21908 tmp:  6115 E1(keV): 11280 pos: 13131
Al-B time:   0: 14: 13. 980    ev:    21914 tmp:  5054 E2(keV): 10705 pos: 13133 dt (s):      0.001 dx(ch):   2
AL-A time:   0: 14: 13. 980    ev:    21914 tmp:  5054 E1(keV): 10705 pos: 13133
Al-B time:   0: 14: 13.     ev:    21937 tmp: 10973 E2(keV): 10150 pos: 13128 dt (s):      0.001 dx(ch):  -5
```

Table II-3

Content of 5DKB100:[BGS.VNINOV.GOOSY.CVC]R015CH1.TXT;8

```
ER   time:   0: 14: 13. 979    ev:    21906 tmp:  3758 Em(ch):   1256 pos: 13146 TOF:   1167
ER-A time:   0: 14: 13. 979    ev:    21907 tmp:  4068 E2(keV):  3260 pos: 13133 dt(ms):      0.310 dx(ch): -13

AL-A time:   0: 14: 13. 979    ev:    21907 tmp:  4068 E1(keV):  3260 pos: 13133
Al-B time:   0: 14: 13. 980    ev:    21908 tmp:  5115 E2(keV): 11280 pos: 13131 dt (s):      0.001 dx(ch):   8

AL-A time:   0: 14: 13. 979    ev:    21908 tmp:  5115 E1(keV): 11280 pos: 13131
Al-B time:   0: 14: 13. 980    ev:    21909 tmp:  6054 E2(keV): 10705 pos: 13133 dt (s):      0.001 dx(ch):   2

AL-A time:   0: 14: 13. 980    ev:    21909 tmp:  6054 E1(keV): 10705 pos: 13133
Al-B time:   0: 14: 13. 985    ev:    21917 tmp: 10973 E2(keV): 10150 pos: 13128 dt (s):      0.005 dx(ch):  -5

AL-A time:   0: 14: 13. 980    ev:    21909 tmp:  6054 E1(keV): 10705 pos: 13133
Al-B time:   0: 14: 13. 985    ev:    21917 tmp: 10973 E2(keV): 10150 pos: 13128 dt (s):      0.005 dx(ch):  -5
```

Content of file recovered from 5DKB100:[BGS.VNINOV]NEW_CHAIN_LIS.TPU$JOURNAL;1

```
SUC: GOOSY> sta in fi  VSCA::$5$DKA100:[BGS.RUN015]T04F020280.LMD;1/op/swa
------------------- File Header -----------------------------------------------
Tape label  :
File name   :
User name   :
Run ID      :
Experiment  :
Created     : 6-May-99 12:48:25
Q1=1509 M1=338 M2=573 p=1.027 torr B=1.395T
TACs in S(27) and S(29) 120ns=770ch in s(27)
------------------- End of File Header ----------------------------------------

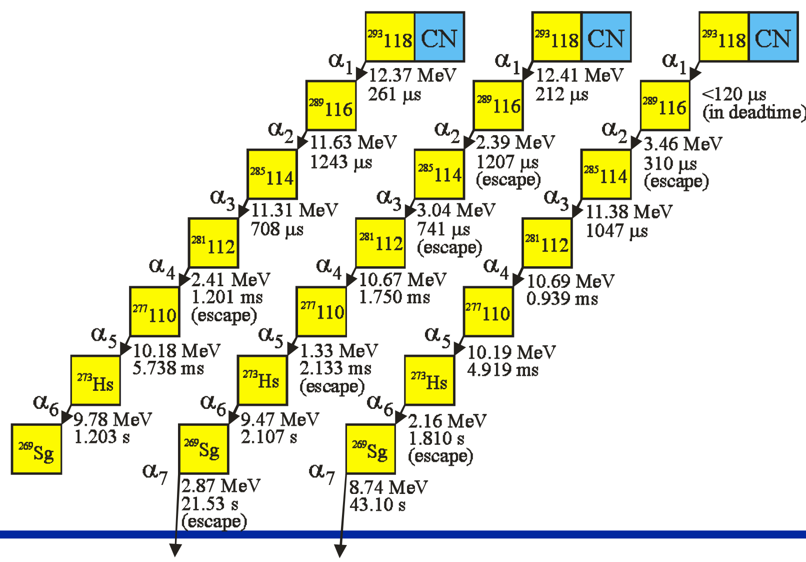

ER   time:   0: 14: 13. 979    ev:    21906 tmp:  4068 Em(ch):   1256 pos: 13146
ER-A time:   0: 14: 13. 980    ev:    21908 tmp:  4068 E2(keV):  3260 pos: 13133 dt (s):      0.001 dx(ch): -13
AL-A time:   0: 14: 13. 979    ev:    21907 tmp:  4068 E1(keV):  3260 pos: 13125
Al-B time:   0: 14: 13. 980    ev:    21908 tmp:  5115 E2(keV): 11280 pos: 13133 dt (s):      0.001 dx(ch):   8
AL-A time:   0: 14: 13. 979    ev:    21908 tmp:  5115 E1(keV): 11280 pos: 13131
Al-B time:   0: 14: 13. 980    ev:    21909 tmp:  6054 E2(keV): 10705 pos: 13133 dt (s):      0.001 dx(ch):   2
AL-A time:   0: 14: 13. 980    ev:    21909 tmp:  6054 E1(keV): 10705 pos: 13133
Al-B time:   0: 14: 13. 985    ev:    21917 tmp: 10973 E2(keV): 10150 pos: 13128 dt (s):      0.005 dx(ch):  -5
```

Table II-4

ev. no.	sec clock	ms clock	tmp	energy	position
21907	853	1011	6115	2300	13131
21913	853	1150	5054	2550	13133
21936	853	1816	10973	2722	13128

Table II-5

Fig. II-1: 1999 Element-118 Decay Chains



II.4.3 Event Statistics

In this section we discuss the distribution of alpha decay times for the claimed events and help confirm – not with certainty, since the arguments are statistical, but with good probability – that the chains were fabricated. This analysis is included because it is independent of arguments previously given.

A quantitative analysis of the decay times was developed by H.K.Schmidt in 2000 (Ref-4). In his paper he develops a statistical test of random decay which compares the observed decay times with an exponential decay. Most simply, there should – for a number of events – be an appropriate spread of observed decay times. He applies the test to element-110 data and finds that the five events are spread as one might expect (Ref-4, Fig 1). However, when he applies the test to the reported element-118 data, he finds that “the assumption that these events originate from radioactive decays is statistically rejected with an error probability of less than 5%”.

Subsequently, Darleane Hoffman, Wladyslaw Swiatecki, and Ken Gregorich all independently (private communication) made statistical studies of the element-118 data with similar conclusions. A more detailed analysis of the purported element-118 chains has been made by Gregorich. This analysis is very similar to Schmidt’s, but goes beyond his general technique, being specifically tailored to simulate the statistics of the LBNL measurement. We summarize Gregorich’s result here and present his analysis in App-18.

From the analysis described in App-18, only 0.82% of a million random trials resulted in decay time distributions more clustered than the claimed element-118 data. That is, there is only one chance in 100 that real element-118 data would give rise to the kind of decay-time distribution claimed.

II.5 Evidence that the individual who fabricated the analysis files was Victor Ninov

In this section, we combine the factual information, previously delineated and described in considerable detail, to conclude that element-118 decay chains were fabricated by Victor Ninov. We first present our evidence (Section II.5.1), consider the possibility of another perpetrator (Section II.5.2), discuss the relevance of the recent GSI preprint (Section II.5.3), and comment on some of Victor Ninov’s inputs relevant to this discussion (Section II.5.4).

II.5.1 Evidence implicating Ninov

In the previous sections, we have given compelling evidence that the claimed element-118 decay chains are not now and never were in the raw data tapes. We have further shown through analysis of journal files (Section II.4.2) the details of how, in the process of analysis, some of the data were modified and other output was fabricated outright to produce the Run-15 decay chain. Indeed, the statistical analysis of Section II.4.3 shows only a small probability that real decay chains would have produced the observed distribution of decay times.

According to the testimony of collaboration members who spoke to our committee, Victor Ninov was, in 1999, the only individual in the collaboration familiar with the GOOSY data analysis program. It was he who announced to the collaboration the observation of the decay chains, and it was he who sent W. Loveland an email with a printout (Lynch Committee Report, Appendix B4) purportedly showing evidence for the Run-15 decay chain, using data whose successive massaging steps have been discussed in detail in Section II.4.2.

Another element of the evidence is based on the study of a GOOSY log file (Section II.2.1 and Lynch Committee Report, Appendix G) showing an analysis of Run 13 at which two decay chains, one published and one not published, were alleged by Ninov to have been discovered. The GOOSY log file should have shown the two decay chains, but, in fact, did not show either one. Yet the GOOSY log file was made during the period between April 13 and April 15, 1999, only two days after the data were recorded. It was therefore known by whoever made that file, as early as April 15, 1999, and well before the publication, that the chains did not exist. Since Ninov was the only person familiar with GOOSY at the time, the evidence is overwhelming that Ninov made the log file in question. Yet he was the individual who presented the Run-13 chains to the collaboration, justified entirely by his hand-written notes. Indeed no one, to the Committee's knowledge, has yet found an actual analysis printout from that period showing evidence for the purported decay chains.

We now consider Run 45 in 2001. As discussed in Section II.4.1 and more extensively in Section 5.3.2 of the Lynch Committee Report (App-4b), the GOOSY log file from the May 7, 2001 (12:54) analysis shows clear evidence of editing and of the modification and fabrication of entries in the region of the purported decay chain. Again Ninov was the individual who claimed discovery of this chain, using the edited output as the basis for that claim. At this time, however, others in the collaboration were familiar with GOOSY, and the "discovery" was soon shown to have no basis in the raw data.

II.5.2 Could there be another explanation?

Although the evidence linking Ninov to the fabrication of the element-118 decay chains is very strong, one needs to ask whether some very unlikely combination of circumstances, or a different perpetrator, could have conspired to make him appear guilty of a transgression of which he was in fact innocent. Given that Ninov was the only person in 1999 able to run GOOSY (as per repeated testimony from many), another perpetrator is very unlikely. For example, since Ninov was the expert on GOOSY, it is unreasonable to believe that, in the Run-15 massaging of data, someone else could have prepared the file showing part of a element-118 chain and that Ninov could have picked up the output of these machinations, without noticing that they had occurred. Furthermore, since this output contained only information on α_2, α_3, α_4, and α_5, Ninov also needed to look back at the raw data to obtain the information on α_1, α_6, and α_7 which he presented. Such a look at the raw data would have immediately disclosed the fabrications.

Also, we now know that by April 15, 1999 there was a GOOSY file showing the absence of the claimed Run-13 element-118 chains. If that file was made by any of the co-authors not in on the fabrication, they would immediately have questioned the existence of these chains. That file must have been made by the perpetrator himself and, since no one else could run GOOSY, it must have been by Ninov.

In short, it is very difficult to reconcile all these circumstances on any basis other than with Ninov being the fabricator of the claimed Z=118 decay chains.

II.5.3 Relevance of the recent GSI preprint

The recent preprint from GSI (App-17) provides further perspective into the situation at LBNL. The GSI authors have gone back and reanalyzed all their data on heavy elements (Z = 110, 111, 112), and found that two decay chains published back in 1995 and 1996, with Ninov as a participant and a co-author, were not present in the raw data, although they were in the text files used in their analysis. To quote their 2001 preprint "For reasons not yet known to us the contents of these text files had been modified for the case of the two events so that event chains were spuriously created." They rule out an explanation based on errors in the computer program (as noted in Section II.3), and conclude "we cannot rule out human error in the analysis of these two events." Since the evidence for the fabrication at LBNL of apparently robust alpha decay chains, discussed in Section II.4, goes far beyond what can be explained by human error, there is nothing in what we know of the GSI experience that offers an alternative to, or puts into question, our conclusions concerning the LBNL element-118 situation and Ninov's role in it.

II.5.4 Ninov's responses to the allegations

Ninov was invited to submit a written response to the conclusions reached in the Lynch Committee Report, and provided the Committee with a written statement entitled "In re: Technical Review of Element 118 Program – Statement of Victor Ninov, Ph.D." (App-19). Subsequently he responded in writing to a set of ten questions from the Committee (App-20, App-21). A detailed discussion of Ninov's responses is given in Chapter III. Here it suffices to state that these responses add nothing that refutes the investigation or conclusions of our committee or the Lynch Committee, or that indicates that anyone other than Ninov was responsible for the fabrication.

III Discussion of Victor Ninov Responses

Victor Ninov was interviewed by Stewart Loken (App 11), and appeared before our committee on December 14, 2001. Ninov declined invitations to meet with our committee on January 9, 2002 and February 6, 2002. Our committee asked that he respond to the Lynch Committee Report and he prepared a written statement (App-19). Subsequently Ninov responded to a set of written questions from our committee (App-20, App-21). In this section we address these verbal and written responses, and find that they do not change our earlier conclusion that Victor Ninov fabricated element-118 decay chains.

III.1 Comments to Stewart Loken

In Ninov's interview with Stewart Loken (App-11), he is quoted as claiming that the original data tapes were modified to remove real element-118 decay chains, perhaps by someone angry at the large amount of beam time given to the BGS group. The existence of such jealousy was strongly denied by I-Yang Lee, Director of the 88" Cyclotron, when he appeared before our committee. Even if such jealousy existed, it appears to be a rather implausible motivation for so drastic a step as modifying raw data. Furthermore here is no evidence that the original data tapes were modified (see Section II.2.1).

III.2 Appearance on December 14, 2001

It should be emphasized that the December 14, 2001 occasion was an initial appearance, more a "get to know each other" session than a detailed discussion of allegations and responses. We expected to have further face-to-face discussions with Dr. Ninov, but this was not realized. Ninov asserted to us that the original data tapes had been modified, as he had said earlier to Loken. Now, however, he gave a different motivation for this action, suggesting that one or more collaboration members got "cold feet" (because other groups had not confirmed the element-118 discovery), and hence removed the relevant decay chains from the raw data. Aside from the utter implausibility of that motive, and the strong evidence that raw data were not modified, one need only point out the evidence (Section II.4) that as early as April 15, 1999 the Run-13 raw data did not contain the claimed decay chains, long before the issue of non-confirmation arose.

A more plausible defense would be a claim that someone other than Ninov had edited and fabricated the decay chains. If that were the case, it seems to us that Ninov, having been duped, would have every interest in helping to clear up the problem. In particular:
1)Ninov would likely not have made his claims about modification of raw data tapes,
2) He would have had no reason to contest the retraction of the element-118 PRL,
3) He would have made every effort to fully cooperate with our committee in determining who might have done the fabrication, something that did not happen.

III.3 Ninov's Statement of February 1, 2002

The Statement is presented in App-19 and has been carefully scrutinized by our committee. There is nothing in this document that refutes any of the detailed findings that we have made above that clearly show that Ninov was the person that fabricated data. The 1999 element-118 events are implied to be real in Ninov's statement. Yet he seems to accept that there was fabrication (as described in II.4) but attributes it to someone else. He states that his files were readily available to other members of the BGS group since his password, or passwords, were widely known. Indeed our investigation has found that other members of the BGS group could have accessed files in his area. However, there is no evidence that anyone other than Ninov was responsible for the fabrication. He expresses "surprise" that the decay chains were never checked by anyone else (a view that we also share). He dismisses the 2001 data and its history by simply observing the loss of the original data tape for reasons unknown to him (or us), ignoring the fact that the missing tape had been copied onto a disk file. In our investigation, we have assumed that the loss of this tape was an accidental event. In sum, then, there is nothing specific in his statement that in any manner refutes the detailed evidence presented in the Lynch Committee Report (which he had in hand).

There are some remarks in Ninov's statement which are unwarranted. The assertion that Figs 1-4 of the I-Yang Lee Report (App-2) are "off by orders of magnitude" is misleading. The figures are based on the theory of Smolanczuk, whose prediction is orders of magnitude higher than the supposedly-observed cross sections, and was one of the drivers for conducting the 1999-2001 cyclotron runs. The statement "It is not very difficult with basic computer knowledge to manipulate the raw data", implying it was easy to alter the raw data to remove real events in undetectable fashion has not been substantiated by the investigation of our committee or by the Lynch Committee (see II.2.1).

III.4 Ninov Response to Committee Questions

Our committee submitted a set of ten written questions for Ninov's responses (App-20, App-21). The questions, responses, and our comments on the responses are given in App-23. In developing the Committee's comments on Ninov's responses, we were greatly helped by Gerald Lynch, and his inputs are folded in with ours. In sum, Ninov denies his role in fabricating data, but his responses provide no substantive basis for altering our conclusions.

IV Comments on BGS Group Practices

The Committee's investigations revealed disturbing weaknesses in the operations and dynamics of the BGS Group.

The Committee finds it incredible that not a single collaborator checked the validity of Ninov's conclusions of having found three element-118 decay chains by tracing these events back to the raw data tapes. While it has been claimed that only Ninov had the expertise in the analysis software, it took no special expertise to go back and check the raw data for the claimed alpha chains. The claim of an important discovery demanded no less.

The group failed to generate and maintain proper documentation of the experiment. Such practice should be part of any scientific effort.

When the I-Yang Lee Committee, in its report of January 25, 2001, listed first under its recommendations: "Complete the independent analysis of both old and new data sets", such an analysis seems not to have been performed until the "118 Review Working Group" under Dr. Darleane Hoffman was convened in June 2001. Given that there was concern over the BGS group's and other groups' inability to confirm the element-118 discovery, such delay seems excessive.

It is customary in the performance of scientific experiments to designate a lead person (usually a Principal Investigator or a Spokesperson) with clearly defined authority and responsibilities. During the events under discussion, responsibility seemed to have been loosely divided between two principals, Drs. Gregorich and Ninov, and the rest of the collaborating scientists, with the result that no one seems to have properly carried out those leadership responsibilities.

The BGS group attempted to retract the 1999 PRL paper but has been prevented from doing so by the refusal of Dr. Ninov to sign the retraction. The BGS group, however, has been slow to document (e.g., in a preprint) the (re) analysis of the 1999-2001 data, which could have been done even in the absence of a formal retraction. The management of the LBNL Nuclear Science Division should have more actively encouraged this approach.

It is regrettable that raw data tapes, including one which contained the alleged 2001 element-118 event, were lost. However, our conclusions are unaffected by the loss of these tapes.

V Concluding Remarks

Science in the US has thrived and has contributed immensely to the nation's welfare, but it could do this only because the public and its representatives have given it generous support. Scientific research requires, for its very health—to say nothing of continued support and respect—continuous vigilance so as to ensure its integrity. It is exactly in this vein that the present investigation of alleged misconduct was carried out. The issues investigated by this committee were highly technical and needed to be addressed by technical experts. The public often will find it difficult to form judgments on such technical issues and, in the end, has to rely on the judgment and integrity of the scientific community.

The Committee found it a difficult duty to sit in judgment of one of its colleagues, for his very professional reputation has been at stake in this investigation. We have made every effort to be objective and fair, to discover whether the findings discussed in this report were due to human error or to scientific misconduct. Unfortunately, we received less cooperation from our colleague, against whom allegations of misconduct had been raised, than we wished. Nevertheless, we are confident that the judgment arrived at is fair, and we believe sufficiently documented as to be understood by others. Ours was not a formal judicial proceeding; it was an investigation conducted by scientific peers to find the truth to the best of their ability. We regret that our findings revealed intentional fabrication of data amounting to scientific misconduct instead of honest error or honest differences in interpretation of scientific data.

We have carefully reviewed the purported discovery of element 118 in 1999 and the attempts to reproduce this "discovery" in 2000 and 2001. The details of our examination constitute most of this report (Section II), some of it based on our own study, and much of it based upon the technical considerations of the Lynch Committee Report, but always after careful examination and personal questioning of the authors of that report. We find clear and convincing evidence that the data in 1999, upon which the reported discovery was based, were fabricated. We have studied the manner in which data may have been fabricated and, most particularly, who could have done that fabrication. We find clear and convincing evidence that Victor Ninov was responsible for the fabrication and that he engaged in scientific misconduct.

We have paid careful attention (Section III) to the inputs from Victor Ninov and find that they do not alter our conclusion that he was the one who fabricated data.

We have also examined the BGS Group practices (Section IV) and find it incredible that no one in the Group, other than Ninov, examined the original data to confirm the purported discovery of element 118. We are also concerned over the lack of proper documentation of the experiment, as well as by a number of other deficiencies.

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Glossary

BGS: Berkeley Gas-Filled Separator
Caltech: California Institute of Technology
FIASM: Formal Investigation of Alleged Scientific Misconduct
GSI: Gesellschaft fuer Schwerionenforschung mbh, Darmstadt, Germany
LBNL: Lawrence Berkeley National Laboratory, also “the Laboratory”
.LIS files: This extension is the usual default for files that are to by typed to a terminal or printed.
.LOG files: Data analysis using GOOSY software package (see http://www-gsi-vms.gsi.de/goodoc/GM_ANAL.ps) creates files called SLOG xx yy.LOG that record commands executed and command output during an analysis session. These files are recorded automatically during an analysis session.
PRL: Physical Review Letters
.TPU$JOURNAL or journal files: A text editor under the VMS computer system used by the BGS group could automatically generate a “journal” file during editing sessions. The journal file is a record of all work done during the session. In the event of a user error or system crash, the journal file can be used to recover work that had not been saved. The journal file is deleted when you exit the editor with an exit command or a quit command. When the editor is left involuntarily (or if the normal exit procedure is not used), the journal file is saved. The edited file can be recreated by recovering the journal file. Every command typed and every line of data entered will be re-done.
.TXT files: These files are plain text files
UC: University of California
UCB: UC Berkeley

Appendices

App-1: PRL Paper of August 9, 1999

See next 4 pages attached.

Observation of Superheavy Nuclei Produced in the Reaction of ^{86}Kr with ^{208}Pb

V. Ninov,[1] K. E. Gregorich,[1] W. Loveland,[2] A. Ghiorso,[1] D. C. Hoffman,[1,3] D. M. Lee,[1] H. Nitsche,[1,3] W. J. Swiatecki,[1] U. W. Kirbach,[1] C. A. Laue,[1] J. L. Adams,[1,3] J. B. Patin,[1,3] D. A. Shaughnessy,[1,3] D. A. Strellis,[1] and P. A. Wilk[1,3]

[1]*Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720*

[2]*Department of Chemistry, Oregon State University, Corvallis, Oregon 97331*

[3]*Department of Chemistry, University of California, Berkeley, California 94720*

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Following a prediction by Smolańczuk [Phys. Rev. C **59**, 2634 (1999)], we searched for superheavy element formation in the bombardment of ^{208}Pb with 449-MeV ^{86}Kr ions. We have observed three decay chains, each consisting of an implanted heavy atom and six subsequent α decays, correlated in time and position. In these decay chains, a rapid (ms) sequence of high energy α particles ($E_\alpha \geq 10$ MeV) indicates the decay of a new high-Z element. The observed chains are consistent with the formation of $^{293}118$ and its decay by sequential α-particle emission to $^{289}116$, $^{285}114$, $^{281}112$, $^{277}110$, ^{273}Hs ($Z = 108$) and ^{269}Sg ($Z = 106$). The production cross section is $2.2^{+2.6}_{-0.8}$ pb.

PACS numbers: 25.70.Jj, 27.90.+b

The synthesis of new heavy nuclei has fundamental interest for nuclear physics and chemistry. The heaviest nuclei provide a laboratory to test our ideas of nuclear structure at the limits of large numbers of protons in the nucleus. For over 25 years, scientists have sought to find or synthesize superheavy nuclei at or near the region $Z = 114$ and $N = 184$ [1], although some calculations suggest that the region of maximum stability may be near $Z = 120$ or $Z = 126$ [2,3].

The synthesis of elements 110–112 [4–7] and element 114 [8] has invigorated this quest. However, it has proven difficult to proceed beyond element 112 [9] using the so-called "cold fusion" approach [10] of bombarding Pb or Bi target nuclei to produce heavy compound nuclei at low excitation energies. The usual extrapolations of existing data on the synthesis of elements 110–112 indicate that to reach still heavier elements will require orders of magnitude increases in accelerator beam currents and new target technologies.

However, the recent prediction of Smolańczuk [11] indicates that the cold fusion reaction of ^{86}Kr with ^{208}Pb should produce superheavy nuclei ($^{293}118$ and its decay products) with an evaporation residue (EVR) cross section of 670 pb. This would represent a dramatic increase in cross section. His predicted decay sequence [12] for the products of the ^{208}Pb(^{86}Kr, n)$^{293}118$ reaction is shown in Table I.

We have studied this reaction at the 88-Inch Cyclotron of the Lawrence Berkeley National Laboratory, using the Berkeley gas-filled separator [13]. A schematic diagram of the separator is shown in Fig. 1. A ^{86}Kr^{19+} beam produced with the Advanced Electron Cyclotron Resonance source [14] was accelerated to 459 MeV[ΔE(FWHM) = 2.3 MeV] at an average current of $\sim$300 particle nanoamperes (1.9×10^{12} ions/s). It went through the 0.1 mg/cm^2 carbon entrance window of the separator and struck a ^{208}Pb target placed 0.5 cm downstream from the window. The targets were 300–450 μg/cm^2 thick (sandwiched between 40 μg/cm^2 C on the upstream side and 10 μg/cm^2 C on the downstream side) [15]. Nine of them were mounted on a wheel that was rotated at 400 rpm. The beam energy at the center of the target was 449 MeV [16]. The beam intensity was monitored by two silicon detectors (mounted at ± 30 deg with respect to the incident beam) that detected elastically scattered beam particles from the target. During the first experiment (8–12 April 1999), a dose of 0.7×10^{18} ions was delivered to the target and two correlated EVR-α-particle decay chains were observed. During the second experiment (30 April–05 May 1999), a dose of 1.6×10^{18} ions was delivered and one correlated EVR-α-particle decay chain was observed.

The EVRs ($E \sim 131$ MeV) were separated spatially in flight from beam particles and transfer reaction products by their differing magnetic rigidities in the gas-filled separator. The separator consists of three magnets, a vertically focusing quadrupole magnet followed by a strong horizontally focusing gradient dipole magnet and a flat field dipole magnet. The separator is filled with helium gas at a pressure of 1 torr. We have estimated the magnetic rigidity ($B\rho$) to be 2.11 Tm [17]. The optimal magnetic field setting was obtained by scaling the values from the measured focal plane EVR distributions for the

TABLE I. Predicted [12] decay sequence for $^{293}118$.

$^{A}Z_N$	Q_α (MeV)	T_α
$^{293}118_{175}$	12.23	31 μs–310 μs
$^{289}116_{173}$	11.37	960 μs–9.6 ms
$^{285}114_{171}$	11.18	800 μs–8.0 ms
$^{281}112_{169}$	11.00	610 μs–6.1 ms
$^{277}110_{167}$	10.77	620 μs–6.2 ms
$^{273}_{108}$Hs$_{165}$	9.69	120 ms–1.2 s
$^{269}_{106}$Sg$_{163}$	8.35	8.0 min–80 min
$^{265}_{104}$Rf$_{161}$	SF	41 min

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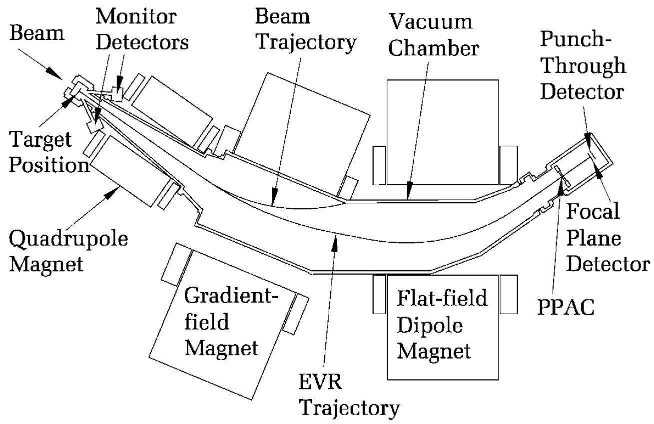

FIG. 1. Schematic diagram of the Berkeley gas-filled separator as configured for this experiment.

analog reaction of 459-MeV ^{86}Kr + ^{116}Cd with estimated $B\rho$ of 1.50 Tm.

The efficiency of the separator for transport and implantation of EVRs was estimated by studying the ^{86}Kr + ^{116}Cd reaction to make α-particle emitting $^{194-198}$Po isotopes. By comparing the measured Po implantation rates with predicted EVR production cross sections [18], we estimate a separator efficiency of ~75%. This efficiency agrees with Monte Carlo simulations of ion trajectories through the separator.

In the focal plane region of the separator, the EVRs passed through a 10 cm × 10 cm parallel plate avalanche counter (PPAC) [19] that recorded the time, ΔE, and x, y positions of the particles. In the first experiment, the PPAC was placed ~3 cm from the focal plane detector while in the second experiment, the PPAC was ~29 cm from the focal plane detector. In the second experiment, the time of flight of the EVRs between the PPAC and the focal plane detector was measured. In both experiments, the PPAC was used to distinguish (99.1% efficiency) between particles hitting the focal plane detector that were beam related and events due to the decay of implanted atoms.

After passing through the PPAC, the recoils were implanted in a 16-strip, 300-μm thick passivated ion implanted silicon detector at the focal plane that had an active area of 80 mm × 35 mm. The strips were position sensitive in the vertical (35 mm) direction. The position resolution along each strip was measured to be 0.58 mm for recoil-α correlations in the ^{86}Kr + ^{116}Cd reaction. The energy response of each strip of the focal plane detector was calibrated using implanted recoils. An average energy resolution of 30 keV for 5–9 MeV α particles was measured for this detector. The focal plane detector had an estimated efficiency of 60% for the detection of full energy 12 MeV α particles following implantation of a ^{293}118 nucleus to a calculated depth of 14 μm. A second silicon strip "punch-through" detector was installed behind this detector to reject particles passing through the primary detector. In the first experiment, a 50 mm × 50 mm detector was used that did not back the entire focal plane detector, while in the second experiment a detector was used that backed the full focal plane detector.

In the first experiment, with a beam current of ~300 particle nanoamperes of ^{86}Kr striking a ^{208}Pb target, the average total counting rate ($E \geq 0.5$ MeV) in the focal plane detector was ~50 s^{-1}. A modification of the beam stop reduced this rate to ~15–20 s^{-1} in the second experiment. The number of particles with energies, $4 \leq E \leq 13$ MeV, was 0.5 s^{-1}. In Fig. 2, the low energy spectrum recorded in the focal plane detector during the entire second experiment is displayed under several conditions. In Fig. 2(a), we show the ungated spectrum.

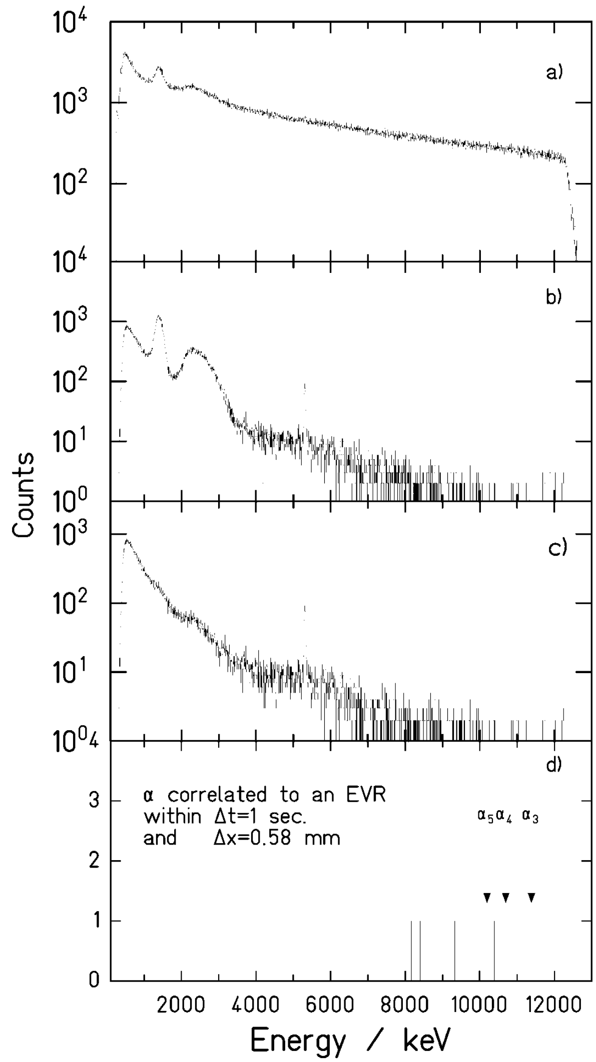

FIG. 2. The α-particle energy spectrum recorded during the entire second experiment. (a) The ungated singles spectrum. (b) The spectrum after applying the PPAC veto. (c) The effect of adding the veto of the punch-through detector to the total veto. (d) The spectrum of all events with $8.1 \leq E \leq 13.0$ MeV correlated in position to an implant, satisfying the veto requirements, which occurred within 1 s of implantation. The arrows indicate members of the decay chain observed in this second experiment.

In Fig. 2(b), the spectrum after applying the PPAC veto is shown. In Fig. 2(c), we display the effect of adding the veto of the "punch-through" detector to the total veto. Finally, in Fig. 2(d), we show the spectrum of all events with $8.1 \leq E \leq 13.0$ MeV satisfying both requirements, which were correlated in position and time (within 1 s) with an implanted recoil. Note that 3 of the 16 counts shown in Fig. 2(d) are part of a single decay chain.

We have observed three decay chains consisting of an implanted heavy atom correlated in position and time with six subsequent α decays for the reaction of 449-MeV ^{86}Kr with ^{208}Pb. This corresponds to a production cross section of $2.2^{+2.6}_{-0.8}$ pb. The observed correlations are shown in Fig. 3 in terms of the predicted decay sequences for ^{293}118. For the third observed chain, we have chosen to indicate the presence of a "missing" α particle. This first α-particle decay could have been missed because it occurred within the 120-μs dead time (after recoil implantation) of the data acquisition system. Based upon the sequences shown in Fig. 3, the half-lives [20] of the decay chain members are ^{293}118, 120^{+180}_{-60} μs; ^{289}116, 600^{+860}_{-300} μs; ^{285}114, 580^{+870}_{-290} μs; ^{281}112, 890^{+1300}_{-450} μs; ^{277}110, $3.0^{+4.7}_{-1.5}$ ms; and ^{273}Hs, $1.2^{+1.7}_{-0.6}$ s. For the first decay chain, the positions (mm) in strip 11 for the implant and subsequent α decays are 13.3, 13.1, 13.2, 13.2, 12.7, 13.2, and 13.1. The positions (mm) for the second chain (strip 9) and the third chain (strip 13) are 3.5, 3.5, 3.0, 3.3, 3.3, 4.0, 3.8, 3.8 and 5.2, 5.2, 5.1, 5.2, 5.0, 5.3, 5.1, respectively. All positions of the members of each chain agree within the uncertainties expected from the calibrations. Given the small number of events in the energy region of interest [Fig. 2(d), the probability of a chance correlation causing these decay chains is negligible. Chance correlations do limit our ability to unambigiously assign correlations involving α decay and fissionlike decays with lifetimes greater than 20 min, i.e., decays at the end of the observed chains.

The energies of the observed α particles and their lifetimes agree remarkably well with the predictions of Smolańczuk [12]. The overall agreement supports the proposed assignments, and there are no known nuclei that exhibit the observed decay pattern. Thus this observation must be taken as evidence for the formation of new nuclei with very high Z. We considered the possibility that the completely fused system deexcited by emitting an α particle or proton instead of a neutron. Statistical model considerations suggest that the ratio of Γ_n/Γ_α would be proportional to $\exp\{-[S_n - (B_\alpha - Q_\alpha)]/T\}$, where S_n is the neutron separation energy, B_α is the Coulomb barrier for α emission, Q_α is the energy released in removing an α particle from the nucleus, and T is the nuclear temperature. Substituting in these relationships appropriate values of the binding energies [12] and barriers [21] gives $\Gamma_n/\Gamma_\alpha \sim 60$ and $\Gamma_n/\Gamma_p \sim 2000$, indicating that neutron emission is the most probable deexcitation path. Since the excitation energy of the completely fused system is 13 MeV [11], emission of two neutrons is energetically forbidden.

In Fig. 4, we compare our measured values of the α-particle energies with the predictions of several modern mass models. The best agreement with our observations is obtained with Smolańczuk's prediction. The finite range droplet model [22] and the Thomas-Fermi model [23] predict appropriate values of the decay energies for the decay of ^{293}118, ^{289}116, and ^{273}Hs ($Z = 108$), but fail for $Z = 106$, and especially, $Z = 114$. The empirical mass model of Liran and Zeldes [24] is not suitable for extrapolation into this region.

We have presented evidence for the first synthesis of new superheavy elements [^{293}118 and its decay products ^{289}116, ^{285}114, ^{281}112, ^{277}110, ^{273}Hs ($Z = 108$) and ^{269}Sg ($Z = 106$)]. Our results show the unexpected viability of the cold fusion approach to the synthesis of superheavy nuclei using projectiles heavier than ^{70}Zn [9]. The production cross section may be explained by the idea of "unshielded fusion" where, with heavier projectiles, the optimal bombarding energy for the $1n$ deexcitation channel is above the Coulomb barrier.

We gratefully acknowledge the operations staff of the 88-Inch Cyclotron for providing intense, steady beams

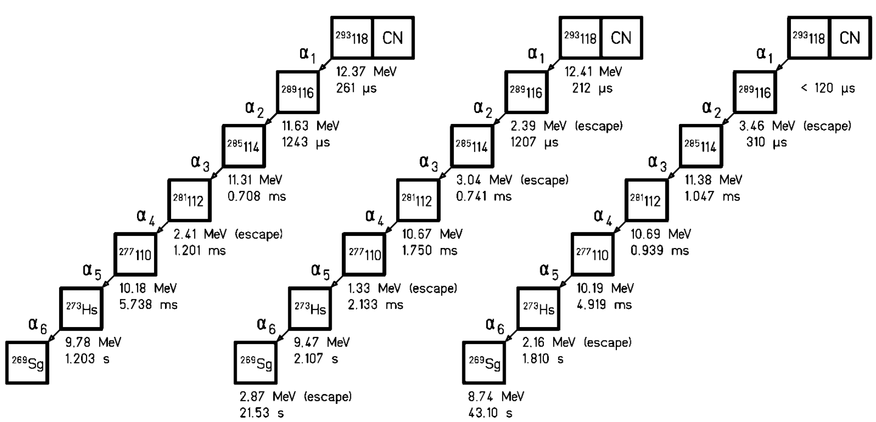

FIG. 3. Observed decay chains for the reaction of 449-MeV ^{86}Kr with ^{208}Pb. The "escape" α particles are those α-particles emitted toward the front of the detector that deposit only a fraction of their energy in the detector.

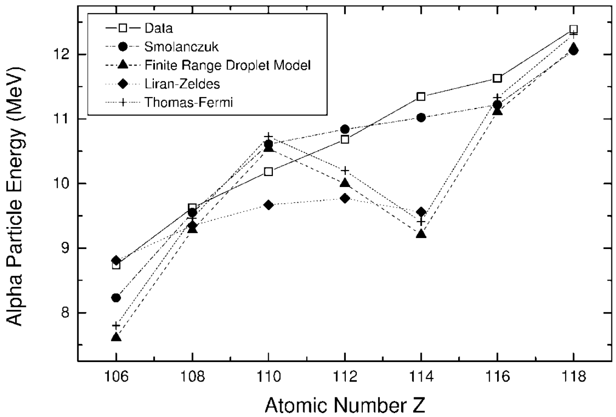

FIG. 4. Comparison of the α-particle energies observed in this work with the predictions of various mass models for the $N - Z = 57$ nuclei.

of ^{86}Kr. We thank B. Lommel and W. Thalheimer of Gesellschaft für Schwerionenforschung for providing the carbon entrance windows and the lead targets. We thank N. Kurz and H. Essel for help in setting up the data acquisition system. We thank G. Münzenberg, S. Hofmann, and F. Hessberger for their support. We gratefully acknowledge R. Smolańczuk for helpful discussions and continuous theoretical support. We thank M. Steiner, J. Yurkon, and D. J. Morrissey at Michigan State University for lending the PPACs. Financial support was provided by the Office of High Energy and Nuclear Physics, Nuclear Physics Division and the Office of Energy Research, Office of Basic Energy Sciences, Chemical Sciences Division of the U.S. Department of Energy, under Contract No. DE-AC03-76SF00098 and Grant No. DE-FG06-88ER40402.

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App-2: I-Yang Lee Group Report (January 25, 2001) – 19 pages

See next 19 pages attached.

Independent Study of the Synthesization of Element 118 at the LBNL 88-Inch Cyclotron (DRAFT 1.07)

I-Yang Lee[1] (Chair), Brian Fujikawa, Larry Phair, and Kai Vetter
Nuclear Science Division
Lawrence Berkeley National Laboratory

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[1] iylee@lbl.gov

Experiment	Start Date	Stop Date	Integrated $^{86}Kr^{19+}$ ions	Energy (MeV)	Number of Element 118 Candidates
"old" run 1	4/8/1999	4/12/1999	0.8×10^{18}	459	2
"old" run 2	4/30/1999	5/5/1999	1.6×10^{18} †	459	1
"new" run 3	4/2000	5/2000	2×10^{18}	459	0
"new" run 4	3/2000	4/2000	1×10^{18}	464	0

Table 1: Summary of the element 118 searches with the Berkeley gas-filled separator at the Lawrence Berkeley National Laboratory Berkeley 88-Inch Cyclotron. *Comments:* †*A more recent estimate is smaller than this published value. The estimate is* 0.8×10^{18}

1 Introduction

Smolańczuk[1] predicted that significant amounts of element 118 (in particular $^{293}118$) can be synthesized through the cold fusion reaction

$$^{86}\mathrm{Kr} +^{208} \mathrm{Pb} \rightarrow^{294} 118^{*} \rightarrow^{293} 118 + \mathrm{n} \tag{1}$$

with a 670 pb cross section. A group of physicists and chemists from the Lawrence Berkeley National Laboratory Nuclear Science Division, the University of California Chemistry Department, and the Oregon State University Chemistry Department [1] studied this reaction at the Lawrence Berkeley National Laboratory Berkeley 88-Inch Cyclotron using the Berkeley gas-filled separator (BGS). This study was carried out in two separate experiments which we will call the "old" experiment and the "new" experiment. The "old" experiment and the "new" experiment had slightly different running conditions which will be discussed below. The "old" experiment had two beam periods: run 1 from 4/8/1999 to 4/12/1999 and run 2 from 4/30/1999 to 5/5/1999. The "new" experiment also had two beam periods: run 3 from 4/2000 to 5/2000 and run 4 from 3/2000 to 4/2000. A summary of each experiment is given in Tab. 1. The "old" experiment resulted in the observation of three events that were consistent with element 118 with a production cross section of $2.2^{+2.6}_{-1.2}$ pb [2]. No element 118 candidates were observed in the "new" experiment, although about three events were expected assuming a 2.2 pb cross section.

Although it is possible that no element 118 candidates were observed in the "new" experiment due to a statistical fluctuation, this is unlikely since the probability of this happening is less than 5%[2]. It is even more unlikely that the observation of three element 118 candidates in the "old" experiment was caused by a statistical fluctuation of the background - this probability is less than 10^{-19} [3]. Therefore, it is clear that the results of the "new" experiment are not consistent with the "old" experiment. Possible explanations for this inconsistency include:

[1]We will refer to this group as the "Berkeley Superheavy Element Group".

[2]The probability of observing zero events given an expectation of three is equal to $e^{-3} = 0.05$.

- Element 118 was not synthesized in the "new" experiment because of one or more the following reasons.
  1. The isotopic composition of the beam was not ^{86}Kr in the "new" experiment.
  2. The beam energy on target did not overlap the excitation function for the cold fusion reaction (Eqn. 1) in the "new" experiment.
  3. The integrated ^{86}Kr ions on target was overestimated in the "new" experiment.
  4. The areal density of the ^{208}Pb target was overestimated in the "new" experiment.
- Element 118 was synthesized, but not detected in the "new" experiment because one or more of the following reasons.
  1. The acceptance for element 118 in the BGS was overestimated in the "new" experiment.
  2. An inefficiency was introduced by a change in the data acquisition.
  3. An inefficiency was introduced by a change in the data analysis method.
- Element 118 was not synthesized nor detected in the "old" experiment. The element 118 candidates were actually one or more of the following.
  1. An isotope other than element 118 was synthesized because the beam was not ^{86}Kr and/or the target was not ^{208}Pb.
  2. Non-statistical background, for example periodic electronic noise introduced by switching power supplies.
  3. "False" or "bad" events introduced by the data acquisition hardware or software.
  4. "False" or "bad" events from an error in the data analysis code or method.

This report summarizes the results of an independent[3] investigation of these issues made by a group[4] consisting of I-Yang Lee (chair), Brian Fujikawa, Larry Phair, and Kai Vetter. This group was assisted by Ken Gregorich, Victor Ninov, Tom Ginter, and Phil Wilk who are active members of the Berkeley Superheavy Element Group. A number of issues have been raised in our discussions and most of them have been resolved. This report is organized as follows. Section two addresses the issue of experimental conditions. Section three address issues related to the data acquisition. Section four discusses the statistical interpretation of the data. Section five summarizes the results of this investigation. Finally section six makes some recommendations for actions to be taken to resolve the inconsistencies between the "old" and "new" experiments and to future element 118 searches.

Setting	Value in “old” experiment	Value in “new” experiment
Frequency (MHz)	15.5540	15.5551
Main magnet	1749.0	1746.38
Dee voltage (kV)	71.4	68.5
Trim coil 1	-555.5	-306.3
Trim coil 2	-269.5	-312.3
Trim coil 3	-139.7	-129.8
Trim coil 4	47.4	-28.5
Trim coil 6	112.1	114.5
Trim coil 8	121.5	125.5
Trim coil 10	-50.0	-48.5
Trim coil 12	-219.8	-221.5
Trim coil 14	-659.2	-660.2
Trim coil 15	-1997.4	-2013.0

Table 2: Typical 88-Inch Cyclotron settings for the “old” and “new” experiments.

2 Experimental Conditions

2.1 Beam

2.1.1 Isotopic Composition of the Beam

The Cyclotron settings, taken from the 88-Inch Cyclotron log book, for the “old” and “new” experiments is shown in Tab. 2 and the possible ions that can be accelerated with these settings is shown in Tab. 3. According to the Cyclotron RF frequency, the only possible beam is ^{86}Kr. The nearest possible candidate is ^{77}Se which is offset by -10.5 kHz. It is highly unlikely that there is much Se in the ion source - certainly not enough to produce micro-amperes of beam. Therefore we are confident that the isotopic composition of the beam was ^{86}Kr for both the “old” and “new” experiments.

2.1.2 Beam Energy

The absolute energy of the 88-Inch Cyclotron beam was checked with the $^{86}\mathrm{Kr} + ^{120}\mathrm{Sn}$ excitation function in July 1999, in between the “old” and “new”experiments. The measured excitation function agrees with GSI data to within ±2 MeV. The 88-Inch Cyclotron settings for both experiments were nearly the same as shown in Tab. 2. According to Dave Clark, the absolute energy of the 88-Inch Cyclotron beam is accurate to within ±0.8% and the reproducability is within ±0.3%. However, energy losses of the beam in the entrance window

[3]Independent of the Berkeley Superheavy Element Group

[4]not part of the Berkeley Superheavy Element Group

Ion	Abundance (%)	E/M	M/Q	Energy (MeV)	Freq. (MHz)	ΔF (kHz)
$^{80}Kr^{18+}$	2.25	5.54	4.44	442.80	15.8385	283.30
$^{80}Se^{18+}$	49.60	5.54	4.44	442.80	15.8385	283.30
$^{40}Ar^{9+}$	99.60	5.54	4.44	221.40	15.8369	281.70
$^{40}Ca^{9+}$	96.94	5.54	4.44	221.40	15.8368	281.60
$^{120}Sn^{27+}$	32.40	5.54	4.44	664.10	15.8349	279.70
$^{49}Ti^{11+}$	5.50	5.52	4.45	270.00	15.8033	248.10
$^{107}Ag^{24+}$	51.84	5.50	4.45	588.50	15.7873	232.10
$^{58}Fe^{13+}$	0.28	5.50	4.46	318.60	15.7802	225.00
$^{58}Ni^{13+}$	61.27	5.50	4.46	318.60	15.7796	224.40
$^{116}Sn^{26+}$	14.70	5.50	4.46	637.10	15.7755	220.20
$^{67}Zn^{15+}$	4.10	5.49	4.46	367.20	15.7613	206.10
$^{134}Xe^{30+}$	10.40	5.48	4.46	734.10	15.7554	200.10
$^{76}Se^{17+}$	9.00	5.48	4.47	415.80	15.7473	192.00
$^{76}Ge^{17+}$	7.80	5.48	4.47	415.80	15.7468	191.60
$^{94}Zr^{21+}$	17.33	5.46	4.47	512.90	15.7268	171.50
$^{112}Sn^{25+}$	1.00	5.45	4.48	610.00	15.7112	156.00
$^{130}e^{29+}$	4.10	5.44	4.48	707.10	15.7000	144.80
$^{139}La^{31+}$	99.91	5.44	4.48	755.70	15.6951	139.90
$^{54}Cr^{12+}$	2.36	5.41	4.49	291.60	15.6466	91.40
$^{54}Fe^{12+}$	5.80	5.41	4.49	291.60	15.6464	91.20
$^{63}Cu^{14+}$	63.17	5.41	4.49	340.20	15.6464	91.10
$^{72}Ge^{16+}$	27.40	5.41	4.50	388.80	15.6458	90.60
$^{90}Zr^{20+}$	51.45	5.41	4.50	486.00	15.6455	90.20
$^{45}Sc^{10+}$	100.00	5.40	4.50	243.00	15.6442	89.00
$^{36}Ar^{8+}$	0.34	5.40	4.50	194.40	15.6430	87.80
$^{117}Sn^{26+}$	7.70	5.40	4.50	631.60	15.6419	86.70
$^{27}Al^{6+}$	100.00	5.40	4.50	145.70	15.6396	84.40
$^{144}Sm^{32+}$	3.10	5.40	4.50	777.20	15.6385	83.30
$^{18}O^{4+}$	0.20	5.39	4.50	97.10	15.6298	74.60
$^{9}Be^{2+}$	100.00	5.38	4.51	48.50	15.6082	53.00
$^{122}Sn^{27+}$	4.60	5.36	4.51	653.20	15.5779	22.70
$^{86}Kr^{19+}$	17.30	5.34	4.52	459.00	15.5552	0.00
$^{77}Se^{17+}$	7.60	5.34	4.52	410.40	15.5447	-10.50
$^{136}Xe^{30+}$	8.90	5.32	4.53	723.40	15.5259	-29.30
$^{59}Co^{13+}$	100.00	5.32	4.53	313.20	15.5155	-39.70
$^{118}Sn^{26+}$	24.30	5.31	4.53	626.30	15.5109	-44.30
$^{109}Ag^{24+}$	48.16	5.31	4.54	577.70	15.5007	-54.50
$^{50}Ti^{11+}$	5.40	5.30	4.54	264.60	15.4915	-63.80
$^{50}Cr^{11+}$	4.35	5.30	4.54	264.60	15.4911	-64.20
$^{50}V^{11+}$	0.25	5.30	4.54	264.60	15.4907	-64.50
$^{91}Zr^{20+}$	11.27	5.29	4.55	480.70	15.4751	-80.10
$^{132}Xe^{29+}$	26.90	5.28	4.55	696.50	15.4646	-90.70
$^{82}Kr^{18+}$	11.60	5.27	4.55	432.10	15.4567	-98.50
$^{82}Se^{18+}$	81.92	5.27	4.55	432.10	15.4561	-99.10
$^{41}K^{9+}$	6.73	5.27	4.55	216.00	15.4548	-100.40
$^{114}Sn^{25+}$	0.70	5.26	4.56	599.40	15.4387	-116.50
$^{73}Ge^{16+}$	7.80	5.26	4.56	383.50	15.4334	-121.90
$^{64}Ni^{14+}$	0.91	5.24	4.57	334.90	15.4047	-150.50
$^{64}Zn^{14+}$	48.60	5.24	4.57	334.90	15.4044	-150.80
$^{96}Zr^{21+}$	2.78	5.24	4.57	502.30	15.4021	-153.10
$^{32}S^{7+}$	95.02	5.24	4.57	167.40	15.4009	-154.30
$^{128}Xe^{28+}$	1.91	5.24	4.57	669.60	15.3991	-156.20
$^{119}Sn^{26+}$	8.60	5.22	4.57	621.10	15.3817	-173.50
$^{55}Mn^{12+}$	100.00	5.21	4.58	286.30	15.3652	-190.10
$^{78}Kr^{17+}$	0.35	5.20	4.58	405.20	15.3473	-207.90
$^{124}Sn^{27+}$	5.60	5.19	4.59	642.70	15.3290	-226.20
$^{92}Zr^{20+}$	17.17	5.17	4.60	475.50	15.3087	-246.50
$^{46}Ti^{10+}$	8.00	5.17	4.60	237.70	15.3086	-246.60
$^{115}Sn^{25+}$	0.40	5.17	4.60	594.20	15.3058	-249.40
$^{23}Na^{5+}$	100.00	5.17	4.60	118.80	15.2998	-255.40
$^{60}Ni^{13+}$	26.10	5.14	4.61	308.10	15.2600	-295.20

Table 3: List of possible ions that can be accelerated given the 88-Inch Cyclotron tune.

and the target need to be considered. The entrance window and the target will be discussed in section 2.2.

2.1.3 Beam Intensity

The beam intensity for both the “old” and “new” experiments were measured with two PIN diode charged particle detectors placed at $\pm 30°$ relative to the beam direction. These detectors measured the intensity of Rutherford scattered ions off of the target. The robustness of measuring the beam intensity with this method is questionable since the PIN diode detectors have a tendancy to fail after being hit by $\approx 10^9$ heavy ions. The beam intensity for the “new” experiment was measured with a Faraday Cup in addition to the Rutherford detectors. Gregorich and Ninov report that there is a 30% uncertainty on the relative beam current when using the Rutherford detectors alone and there is a 20% uncertainty on the relative beam current when using both the Rutherford detectors and the Faraday Cup.

Run 1 had recorded 0.8×10^{18} ^{86}Kr ions on target and Run 2 had recorded 1.6×10^{18} ions. Gregorich and Ninov report that the Rutherford PIN diode detectors had failed during Run 2 (see above) and the actual intensity is estimated to be 0.8×10^{18} ^{86}Kr ions on target. Since the beam intensity in the “new” experiment was measured by both the Rutherford detectors and the Faraday Cup, we can conclude that the relative beam current is known to 20%. There is some indication that the beam intensity in Run 2 of the “old” experiment was overestimated. This means that the element 118 production cross section is actually larger than the published value and the there is a bigger disagreement between the results of the “old” experiment and the “new” experiment.

2.1.4 Alignment of the Beam and Target

There are strong indications that the beam is properly aligned with respect to the target. The beam “burn” spot can be seen on the window after the run. In addition, the window frame would melt if 20% or more of the beam were to hit the frames. No melting was observed. It is estimated that at least 90% of the beam hits the target. Ken Gregorich has made a Monte Carlo study of the effects of the position and the incident angle of the beam on the position of the recoil at the detector. The beam was shifted by 1 cm to the left and 1 cm to right. The incident angle was varied to the maximum allowable value constrained by the beam pipe. No significant changes in the x-y scatter plots of the recoil profiles were observed.

2.2 Target

2.2.1 Isotopic Composition of the Target

Different target samples were used for the “old” and “new” experiments. The “old” experiment used targets with a nominal ^{208}Pb enrichment of 99.89%. The “new” experiment used

	Material	Nominal Thickness (μg/cm^2)	Stopping Power (MeV/μg/cm^2)	Energy Loss (MeV)
Entrance Window	Carbon	50-100	0.044	2.2-4.4
Upstream Target Backing	Carbon	35-40	0.045	1.6-1.8
Target	^{208}Pb	300-450	0.017	5.1-7.6

Table 4: Nominal values for the energy loss of the ion beam (459 MeV initial energy) in the entrance window, the upstream foil, and the target.

targets with a nominal ^{208}Pb enrichments of 89.9% and 99.4%. Gregorich and Ninov reported that the isotopic enrichment of the targets from the "old" experiment was confirmed by mass spectrometry. At the time of this writing, no tests were done on the targets from the "new" experiments and the enrichment was only determined from the supplier's assay. Although this is very unlikely, it is possible that the targets from the "new" run do not have the nominal enrichment.

2.2.2 Entrance Window Thickness

According to the publication [2] describing the results of the "old" experiment, the carbon entrance window thickness was 100 μg/cm^2. Gregorich and Ninov report that the carbon window has an initial nominal thickness of 50-65 μg/cm^2 in the "new" experiment. The stopping power of 459 MeV ^{86}Kr ions in carbon is 0.044 MeV/μg/cm^2 [4, 5]. Consequently, a window thickness of 100 μg/cm^2 corresponds to a energy loss of 4.4 MeV and a window thickness of 50 μg/cm^2 corresponds to a energy loss of 2.2 MeV. Gregorich and Ninov report that the window becomes thinner during the run from the beam. Although, the windows and targets are changed every 3-4 days, it is expected that there can be a ≈ 2 MeV variation in beam energy due to window damage.

2.2.3 Target Thickness

The ^{208}Pb targets, which have nominal thicknesses of 300-450 μg/cm^2, is sandwiched between two carbon foils. The upstream carbon foil had a nominal thickness of 40 μg/cm^2 and the downstream foil had a nominal thickness of 10 μg/cm^2. Note that the downstream foil does not affect the energy of the beam on target. The target thicknesses have been measured by Rutherford backscattering and by alpha energy loss. These two techniques give measured thicknesses which agree to within 20%. There is the possibility that the targets become thinner or can have quaility degradation due to melting during the experiment. The target thickness can be monitored from the Rutherford scattering rates during the experiment with the beam intensity monitor (see section 2.1.3). Ninov reported that there was no indication of a decreasing target thickness from the beam intensity monitor detectors, however, no quantitative data was given. Degradation of the target quality can be determined

Sample	Position	Layer	Thickness ($\times 10^{15}$atoms/cm^2)	Composition	RBS Pb Thickness (μg/cm^2)	αE-loss Thickness (μg/cm^2)
Broken piece (GSI) post-beam	1	1	150	C		
		2	1060	Pb	363	302
		3	1800	C		
	2	1	100	C		
		2	250	$C_{0.6}Pb_{0.4}$		
		3	1000	Pb	377	346
		4	1700	C		
	3	1	150	C		
		2	890	Pb	305	324
		3	1900	C		
#45 (LBNL) post-beam	1	1	300	C		
		2	1260	Pb	430	452
		3	2500	C		
	2	1	220	C		
		2	1350	Pb	462	439
		3	2500	C		
	3	1	240	C		
		2	1040	Pb	356	419
		3	2500	C		

Table 5: The target thicknesses as measured by Rutherford Backscattering (RBS) and α energy loss measurements are listed for a sampling of different targets.

by comparing the width of the alpha energy loss distribution before and after the experiment, but this has not been done.

The stopping power from Ref. [4, 5] and the average energy losses for ^{208}Pb target and carbon foils are given in Tab. 4. We have calculated the element 118 production yield using the excitation function from Smolańczuk[6] and taking into consideration the beam energy, the entrance window thickness, and target thickness. Details of this calculation is given in Appendix A. The results of these calculations for various running conditions are shown in Fig. 1, Fig. 2, Fig. 3, and Fig. 4. These plots show that with realistic pertubations in beam energy, entrance window thickness, and target thickness, the beam energy in the target still overlaps with a significant portion of the exicitation function and that there is less than a 50% reduction in the element 118 production yield. However, the actual excitation function may be narrower than that given by Ref. [6]. If this were the case, then the effect of beam energy, entrance window thickness, and target thickness will be much greater.

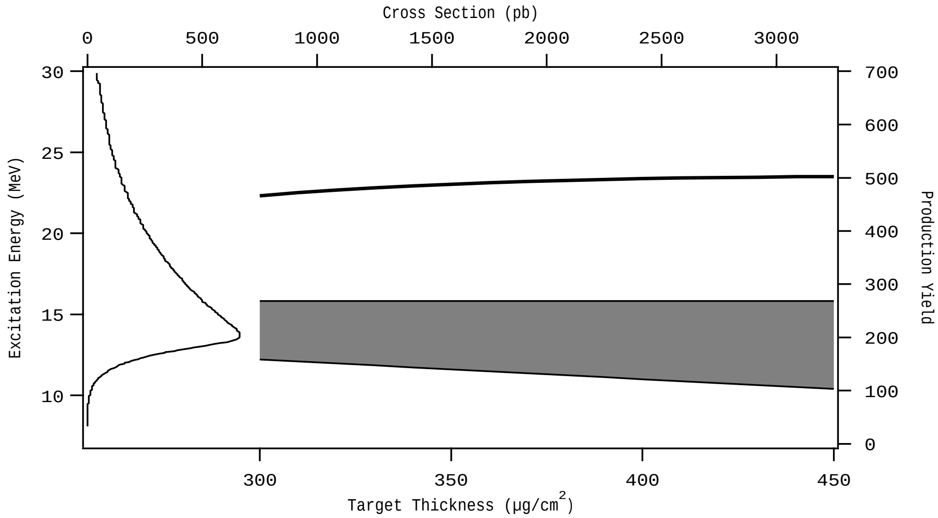

Figure 1: Calculation of the Element 118 production yield for 10^{18} $^{86}Kr^{19+}$ ions on target. The solid line is the production yield as a function of target thickness. The shaded band represents the range of excitation energy spanned by the target. The curve on the left is the theoretical excitation function from Smolańczuk [6]. The calculation was made for a 459 MeV ion beam which passes through a 100 μg/cm^2 thick carbon entrance window and a 40 μg/cm^2 thick upstream carbon foil.

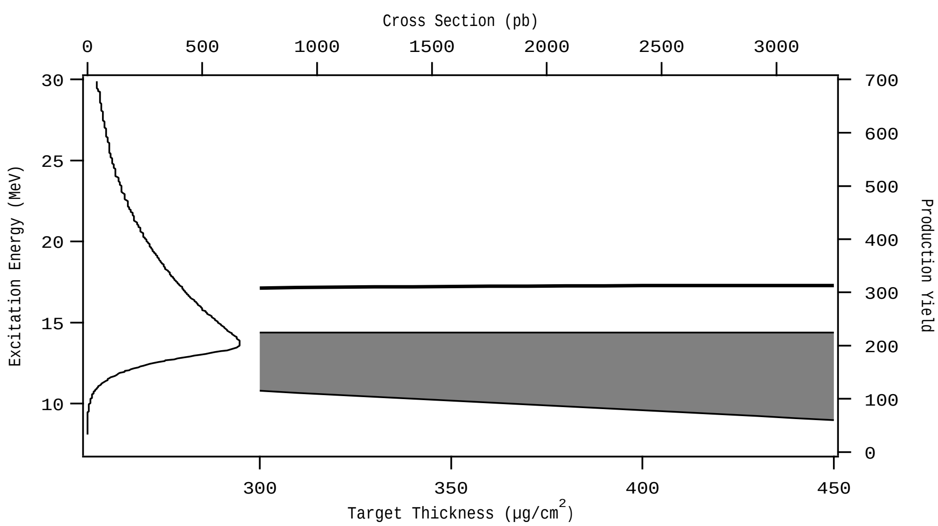

Figure 2: Element 118 production yield calculation. The same as Fig. 1 except the ion beam energy is 457 MeV.

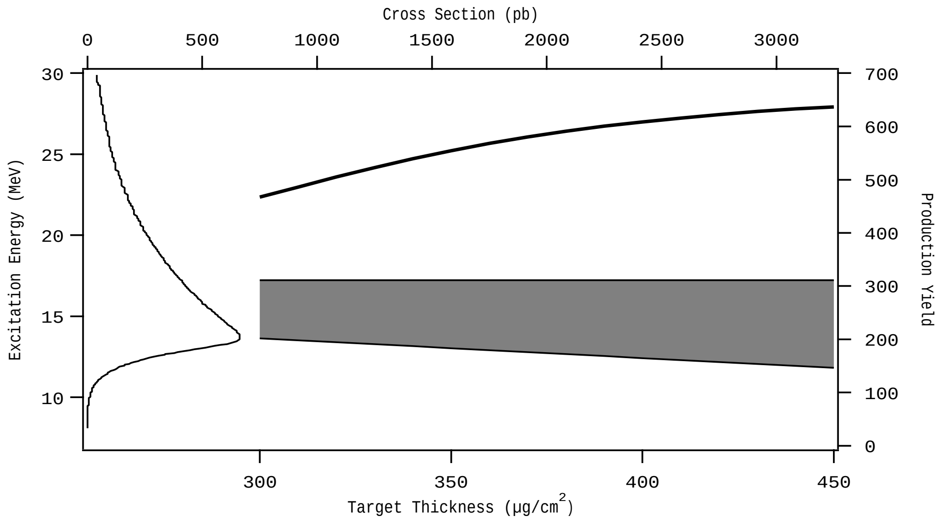

Figure 3: Element 118 production yield calculation. The same as Fig. 1 except the ion beam energy is 461 MeV.

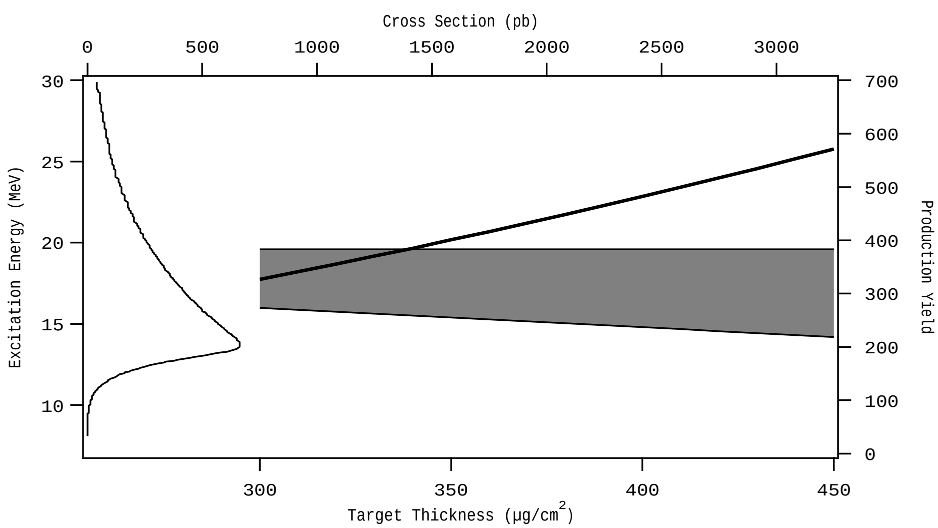

Figure 4: Element 118 production yield calculation. The same as Fig. 1 except the ion beam energy is 461 MeV and the thickness of the entrance window is 25 μg/cm^2.

	Upper Coil		Lower Coil		
Current [A]	Voltage [V]	Resistance [Ω]	Voltage [V]	Resistance [Ω]	Total [Ω]
49	7.31	0.1492	7.66	0.1563	0.3055
98	14.77	0.1507	15.47	0.1579	0.3086
147	22.34	0.1520	23.41	0.1593	0.3112
196	29.67	0.1514	31.12	0.1588	0.3102
245	37.24	0.1520	39.00	0.1592	0.3118
294	44.72	0.1521	46.98	0.1598	0.3119
343	54.22	0.1528	54.90	0.1600	0.3128
392	60.0	0.1531	62.80	0.1602	0.3133
441	67.6	0.1533	70.80	0.1605	0.3138
490	75.4	0.1539	79.00	0.1612	0.3151

Table 6: Results of BGS magnet 1 measurements. Resistance changes about 3% from 50 A to 490 A. Double bridge readings: total resistance: 0.2961 Ω. (upper coil: 0.14433 Ω; lower coil: 0.15173 Ω (5% difference between both coils)).

2.3 Detection Efficiency

The acceptance of the BGS is dependent upon the trajectories of the recoil ions in the BGS. The recoil ion trajectories in the BGS is calculated from the BGS magnetic field map and the charge state of the recoil ions.

2.3.1 BGS Magnetic Field

The field is varied by changing the current in the coil. The current is measured using a shunt across the coil. Fields were set according to the $B(I)$ curves obtained from field calculations. To check for possible short in the coil, current vs voltage curves for the M1 and M2 magnets were made by Gudrun Kleist. The results are shown in Tab. 6 and Tab. 7. The numbers indicate that the resistance of the coils is 0.28 ohms agreeing with the design value. In the experiment carried out so far, only M2 has a Hall probe and the magnetic field can be measured independently. Between the "old" runs and the "new" runs, a 10 ohm filter was inserted in parallel in M2. This reduced the current in the coil by 3%. The M2 Hall probe showed a 3% reduction in the magnetic field. This corresponds to an overall 1.5% reduction in the total bending power of the BGS. However, a ^{86}Kr $+^{120}$ Sn calibration showed that the current has to be increase by 4.5% in order to bring the recoiling residues back to the center of the detector. Since the magnet current was not increased for the ^{86}Kr $+^{208}$ Pb experiment, and if the correction should have been the same as for ^{86}Kr $+^{120}$ Sn, then only about 1/4 of the Z=118 recoil nuclei are expected to hit the detector. Except for the ^{86}Kr $+^{120}$ Sn calibration, the other reactions show the expected 1.5% shift as shown in Tab. 8.

	Upper Coil		Lower Coil		
Current [A]	Voltage [V]	Resistance [Ω]	Voltage [V]	Resistance [Ω]	Total [Ω]
75	10.4	0.1389	10.4	0.1389	0.2778
151	21.1	0.1396	21.1	0.1397	0.2793
226	31.6	0.1399	31.6	0.1398	0.2797
299	42.1	0.1408	42.1	0.1409	0.2817
377	53.0	0.1406	53.0	0.1406	0.2812
453	63.9	0.1411	64.0	0.1413	0.2824
528	74.9	0.1419	74.9	0.1419	0.2828
604	86.1	0.1426	86.1	0.1426	0.2852
679	97.5	0.1436	97.5	0.1436	0.2872
755	110.1	0.1458	110.1	0.1458	0.2916

Table 7: Results of BGS magnet 2 measurements. Resistance changes about 5% from 75 A to 755 A. Double bridge readings: total resistance: 0.2848 Ω (upper coil: 0.1424 Ω; lower coil: 0.1424 Ω (no difference between both coils)).

Reaction	Product	Bρ [Tm]	Bρ(00)/Bρ(99)
^{51}V +^{208}Pb	^{257}Db	2.0	1.015
^{51}V +^{154}Sm	^{203}At	1.5	1.015
^{86}Kr+^{120}Sn	^{204}Rn	1.5	1.045†
^{64}Ni+^{120}Sn	^{178}Pt	1.5	1.015

Table 8: Comparison of measured BGS rigidities in 1999 and 2000. *Comments:* †*This result is not understood. This measurement was in October 2000. The Hall probe reproduced the ratio of 1.045. The ratio should be 1.03 according to the magnet current values.*

2.3.2 Recoil charge state

The gas composition in the BGS will affect the charge state of the recoil ion in the BGS. The helium gas in the BGS can be contaminated with air from a possible leak or from isobutane from possible a leak in the PPACs The recoil would then have a different average charge state and a different rigidity. There was such a leak during run 2 of the "old" experiment. From the observed pressure rise in the BGS because of the leaking isobutane, Gregorich has estimated the contamination to be about 10% which will change the rigidity by an unknown amount. If the shift is in the same direction as Nitrogen, then the position of the one event observed in run 2 is in the direction opposite that of the calculated rigidity change. However, this result could be due to statistical fluctuation, or the rigidity change is less than calculated.

Reaction	Product	Bρ [Tm]	Efficiency (measured)	Efficiency (calculated)	Method
^{40}Ar+^{208}Pb	^{245}Fm	2.0	1.1	0.4	σ; SHIP at GSI
^{16}O +^{208}Pb	^{222}Th	1.6	0.08	0.1	σ; Munich (in beam)
^{22}Ne+^{238}U	^{256}No	2.0	N.A.†	$\simeq$0.06	σ; DUBNA
^{64}Ni+^{120}Sn	^{178}Pt	1.5	0.4	0.7	σ; ANL
^{22}Ne+^{197}Au	^{214}Ac	1.6	0.08	0.09	catcher foil
^{12}C +^{197}Au	^{206}At	1.6	0.02	0.02	catcher foil
^{26}Mg+^{181}Ta	^{204}At	1.6	0.13	0.12	catcher foil
^{25}Mg+^{181}Ta	^{203}At	1.6	0.09	0.12	catcher foil

Table 9: Measured BGS efficiencies ϵ for various reaction systems. The efficiencies with Carbon, Neon and Magnesium beams were direct measurements with catcher foils at the BGS. These numbers agree very well with the calculated transmission of the BGS. The other results are based on cross-section values measured at the given facilities. They agree within a factor of two with the expected values. *Comments:* †*Not avaliable due a problem with the data acquisition.*

2.3.3 Efficiency estimates

With correct field settings, the efficiency of the BGS has been measured using a number of reactions covering a wide range of beam-target mass asymmetry. The results are shown in Tab. 9. For future runs, the rigidity and the efficiency of BGS will be measured before the experiment using a reaction with a known cross section such as $^{86}\mathrm{Kr} + ^{116}\mathrm{Cd}$. In addition, the purity of He will be measured using a residual gas analyzer.

3 Data Acquisition

The two experiments were carried out using entirely different detector systems and electronics systems. However, the GSI/MBS/GOOSY system was used for both experiments. A schematic diagram of the electronics in the "new" experiment is given in Fig. 5.

3.1 "False" Events

It is possible for "false" or "bad" events of unphysical origin to be mistaken for element 118 candidates. Each event is tagged by a time stamp and no out of sequence events have been observed. The makes the possibility that a "bad" event can be the produced from a faulty readout very unlikely.

A completely independent analysis of the data from the "old" using a program written from "scratch" has been unsuccessful so far. The failure is due to an incomplete understanding of the tape format. However, there is no such problem in the "new" experiment and so

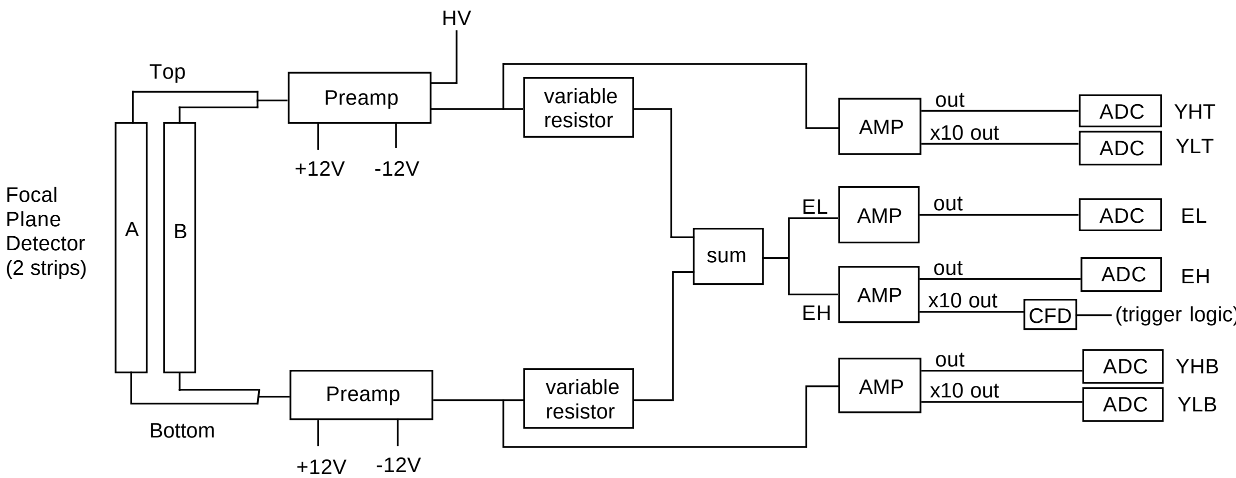

Figure 5: A schematic diagram of the electronics readout from the "new" run.

we were able to read and analyze these tapes.

Upon close inspection of the data from the "new" experiment, we found events where every strip in a given detector "fires" (non-zero data words read). Detector 1 showed more of these events ($\sim$1 per few minutes) than detector 2 ($\sim$1 per hour). In these events at least one of the strips produced a large (greater than one quarter of full scale) ADC value. These events are probably due to particles hitting the detector guard rings. Ninov confirmed that no such events were observed in the three 118 events from the "old" run. Gregorich and Ninov also reported that the data stream contains some events due to cross talk. These events have valid data in one ADC channel with near pedestal "data" in the neighboring ADC channel. A proper analysis will remove the guard ring and the cross talk events. It is highly unlikely that these events could mimic Z=118 candidates.

3.2 Non-statistical Background?

We tested the event α multiplicity distribution of data from the "new" experiment. From our analysis, events with 1-α, 2-α, 3-α, and higher are observed in a 500 ms window for a given strip. The yields follow a Poisson distribution. Requiring the particles to strike within a few mm of "target-like" recoils reduced dramatically the observed background. With this spatial cut, no random 4-α or higher chains were observed within a 500 ms window in the data from the "new" experiment. Therefore it is unlikely that a non-statistical background could produce a element 118 candidate.

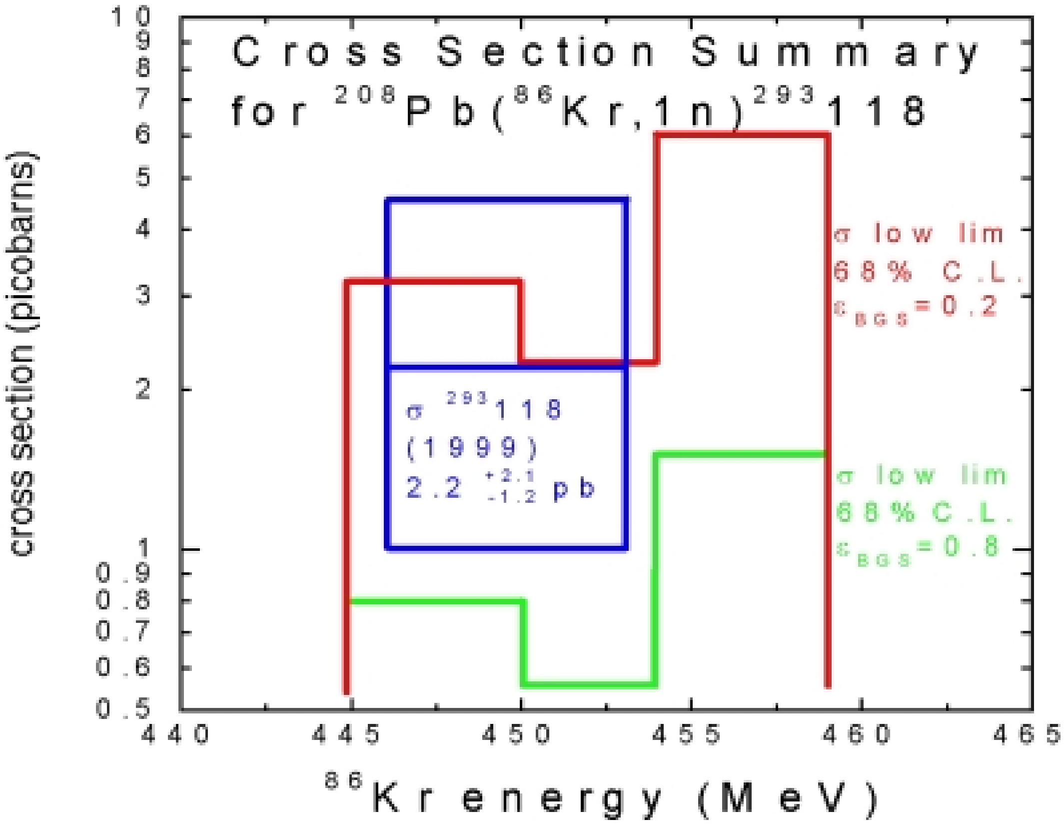

Figure 6: Summary of the cross sections from the ^{86}Kr +^{208} Pb experiments. The box shows the 68% confidence limits from the 1999 experiments with the most probable cross section identified by the central line. The lower curve shows the upper limit in the 2000 experiments for two overlapping energy ranges, assuming a BGS efficiency of 80%. An efficiency of 20% (due to shifts in the recoil positions) results in the upper curve.

3.3 Data analysis method

To check the data analysis method, Tom Ginter is performing an independent analysis of the data. So far, a detailed analysis of the data from "new" experiment has not been completed and no work has been done on the data from the "old" experiment.

3.4 Software error in DAQ code

We inquired about software errors in the DAQ code, such as overwriting memory, accessing unallocated memory, etc. Ninov points out that the DAQ code has been sufficiently tested and exercised at GSI so this is unlikely. This is very difficult to test.

4 Statistical Interpretation

To determine the production cross section from the observed number of events requires the time integrated beam flux, target thickness, BGS and detector efficiencies. Based on previous discussions, the comparison of the results from the two runs are shown in Fig. 6.

4.1 Is the distribution of lifetimes sufficiently random?

A paper from a GSI group [7], analyzed the decay time of the three 118 events and concluded that the time distribution is not random enough. However, they combined the three times (alpha2-alpha3-alpha4) from the three events and performed the analysis on the 9 data points. However, if the analysis is carried out on the three data points of the same decay from the three events, the results are consistent with statistical distribution.

5 Conclusions

So far, the most likely reason for the difference between the two experiments is the magnet settings. However, this discrepancy of 4.5% in the current is not understood. The plan is to do a series of calibration runs. The Berkeley Superheavy Element Group will measure the rigidity using the primary beam, the BGS with no gas, and a phosphor. They will also re-measure the $^{86}\mathrm{Kr} + ^{120}\mathrm{Sn}$ reaction using pure He and He plus N_2 gas in the BGS. The final calibration will use the reaction $^{64}\mathrm{Ni} + ^{208}\mathrm{Pb}$ to produce element 110. It has the rigidity closest to 118, but still has a reasonable cross section (15pb). Only after this rigidity question is resolved, will they repeat the 118 search again.

6 Recommendations

Based upon our analysis, we make the following recommendations:

1. Complete the independent analysis of both old and new data sets.

2. The magnetic field should be monitored continually. Hall probes with sufficient accuracy and stability should be installed in M1 and M2 for this purpose.

3. The coil resistances should be checked periodically. Since the origin of the 4.5 % shift remains unclear, we recommend checking the coil resistances (reproducing the voltage vs current correlation) every few months to check that this is not the source of the problem.

4. The beam energy and the absolute bending power of the BGS should be determined accurately. This information is important for other laboratories to confirm the BGS results.

5. The purity of the He gas in the BGS should be monitored. This could be done with a residual gas analyzer.

6. A well defined calibration run should occur before and after each experiment. If the calibration runs produce little long-lived background, one could consider calibrations during the experiment as well.

7. In future runs, the beam intensity should be measured with a Faraday cup and Rutherford detectors. To extend the lifetime of the PIN diode detector, a mask has been placed in front of the detectors. Ghiorso has recommended measuring the beam intensity with a calorimeter. The calorimeter technology has not been used since the 1950's and should be tested. Measuring beam intensity with an external induction coil should also be considered.

8. We recommend a test of the isotopic purity of the targets as well as a target thickness and uniformity measurement before and after running.

A Element 118 Production Yield

The element 118 production yield for a 100% enriched target is equal to:

$$\mathrm{Y} = \left(\frac{\mathrm{Q}}{\mathrm{Ze}}\right)\left(\frac{\mathrm{N_A}}{\mathrm{A}}\right)\int_{\mathrm{E_i}}^{\mathrm{E_f}} \mathrm{dE}\left(\frac{\mathrm{dE}}{\mathrm{dx}}\right)^{-1}\sigma(\mathrm{E}) \tag{2}$$

where $\frac{\mathrm{Q}}{\mathrm{Ze}}$ is the integrated $^{86}\mathrm{Kr}^{19+}$ ions on target, $\mathrm{N_A}$ is Avogodro's number, A is the atomic weight of the target, $\mathrm{E_i}$ is the energy of the ion as it enters the target, $\mathrm{E_f}$ is the energy of the ion as it exits the target, dE/dx is the stopping power in mass units, and $\sigma(\mathrm{E})$ is the excitation function for $^{86}\mathrm{Kr} +^{208}\mathrm{Pb} \rightarrow^{293} 118 + \mathrm{n}$. The final ion energy is determined by solving:

$$\int_{\mathrm{E_i}}^{\mathrm{E_f}} \mathrm{dE}\left(\frac{\mathrm{dE}}{\mathrm{dx}}\right)^{-1} - \delta\mathrm{x} = 0 \tag{3}$$

where δx is the target thickness. Note that for thin targets, $\mathrm{E_f} \cong \mathrm{E_i} - \left(-\frac{\mathrm{dE}}{\mathrm{dx}}\right)(\delta\mathrm{x})$. The ion beam passes through a carbon entrance window and an upstream carbon foil before entering the target. Eqn. 3 can be used estimate the energy loss in the entrance window and the upstream foil. The nominal values for the energy loss in the entrance window, upstream foil, and target are given in Tab. 4. The stopping power for the these calculations are taken from SRIM [4, 5]. Note that the above formulas ignore straggling and multiple scattering which are expected to have minimal effects on the yield. The excitation function is taken from a calculation by Smolańczuk [6]. The amplitude of this excitation function is known to be inconsistent with experiment by more than two orders of magnitude [2]. However, we assume that the shape is correct and we use this excitation function as a reference that can be scaled. Calculations of the production yields are shown in Fig. 1 through Fig. 4.

References

[1] R. Smolańczuk, Phys. Rev. **C 59**, 2634 (1999).

[2] V. Ninov, *et al.*, Phys. Rev. Lett. **83**, 1104 (1999).

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[6] R. Smolańczuk, Phys. Rev. **C 61**, 011601R (1999).

[7] K.-H. Schmidt, Eur. Phys. J. **A 8**, 141 (2000).

App-3: Hoffman Group Report (June 18, 2001)

See next 18 pages attached.

To: Lee Schroeder
From: Darleane C. Hoffman for the "118 Review Working Group"
Subject: Status Report as of June 15, 2001

1. Introduction

As requested and agreed at a meeting held on Friday, June 8, 2001, I have overseen the formation of a "118 Review Working Group". Its mission has been to examine and assess as quickly as possible all of the original data from the 1999-2001 experiments relevant to the original observation of 118 decay chains in April and May 1999 and the failure to find the 118 decay chain originally thought to be in the 2001 experiments. The chronology of these experiments is given in **Attachment 1**.

When I agreed to organize this effort, it was understood that we would have short daily meetings beginning June 11 and extending through June 15 to coordinate and expedite the efforts. All Heavy Element Nuclear & Radiochemistry Group and all BGS experiments were cancelled to allow Ken Gregorich and Victor Ninov to devote their total attention to this review. At the end of the week a status report was to be prepared for you.

We have held daily coordination meetings. The minutes which were taken and transcribed by Tom Ginter (postdoctoral fellow) and approved by all at the subsequent daily meeting are appended. (**Attachment 2**.) These served not only as a record of participation, but also as a method for organizing the tasks to be done and for checking them off as they were accomplished.

2. Status

A. Backup of Tapes

One of the first major tasks was to back up all of the original data tapes from the 118 runs in 1999. This included: 2 tapes from BGS-Run 13, April, 1999 which contained 2 of the 3 events reported in 1999; 4 tapes from BGS-Run 15, May, 1999 which contained the other 118 chain reported; 10 of the 12 tapes from the "confirmation experiment", BGS-Run 45, April-May, 2001. Data tapes 7 and 8 from BGS-Run 45 are still missing although tape 8 had been transferred to disk. (Tape 7 contained only calibration and testing data, but Tape 8 would have contained the possible 118 event.)

Copying the tapes proved to be a more formidable and longer process than originally anticipated but all have now been copied and the originals are secured. A directory of the contents of the original and copies are stored with each set of tapes. The 1999 duplicates have now been copied to disks and are available for analysis. The 2001 data have been similarly copied. See Tables 1 and 2 for detailed matrices of the data tapes copied and the status of analysis.

B. Data Analysis Methods

Initially, only the files that Victor Ninov indicated contained interesting decay chains were examined, but now all of the data from the April & May 1999 experiments have been analyzed independently by Tom Ginter and Victor Ninov. Larry Phair has analyzed only the portion of the data that was thought by Victor to contain the two reported 118 decay chains and the partial unpublished chain from the April, 1999 experiment. (See the summary given in Table I.) His analysis is independent of the BGS acquisition and analysis system which utilizes a VMS platform. By modifying previously developed PC based software, his approach was to look for alpha-decay chains of 4 members or more within 200 ms with energies between ~0.25 and ~12.5 MeV within any given detector strip. In addition, at least 3 of the relative time intervals were required to be 6 ms or less. None of the candidate chains identified in this way had the characteristics of the previously reported 118 decay chains.

Tom Ginter's analysis was developed within the context of the BGS data acquistion and analysis system. His code searched for 4 events (~0.25 to ~12.5 MeV) within a given detector strip within a time interval of 18 ms. Some 200 candidate chains were found. Upon visual inspection, none of these chains corresponded to those identified in 1999. Ginter's and Phair's results were shown to produce similar results for commonly analyzed data from 1999 and the element 110 decay chain described below.

Victor Ninov used a procedure similar to his original analysis method. This involves keeping a buffer of potential high energy alpha decays (7-13.5 MeV). When a high energy alpha is observed, the buffer is checked for alpha decays correlated within 1.6 mm in a given strip and within a 1-second time interval. A list of such correlations was used to identify interesting correlation chain candidates for more detailed analysis.

Again, no events corresponding to the element 118 decay chains he identified in the1999 experiments could be found.

C. 110 event, Tom Ginter and Larry Phair independently searched for the $^{271}110$ decay chain identified in an October 2000 experiment. This consisted of a recoil and three correlated alpha decays. They verified that it was the same as in Victor Ninov's original analysis. Ken Gregorich checked the raw data at the location indicated by their analyses and it ***does show*** this element 110 event decay chain.

3. Summary

Tom Ginter and Victor Ninov have now searched all of the 1999 data and Larry Phair has searched targeted data files for the previously reported 118 decay chains. They have been unable to identify any of these 118 decay chains.

4. Plan for next week

Detailed investigations of the April-May, 1999 and 2001 data and analysis will be continued in an attempt to understand the origin of the previously identified element 118 decay chains.

4. Response to Inquiries

After much discussion, we came to a consensus that the following statement expresses what our response to inquiries from outside should be until an official NSD or LBNL position is developed.

> ***"The six-member element 118 decay chain seen in the preliminary analysis of the April-May, 2001 experiment does not exist in the data. Additional analysis of all our data is continuing."***

***Working Group Composition and Additional Participants**

The working group consisted of Ken Gregorich, Victor Ninov, Tom Ginter, Larry Phair, I.-Y. Lee, Claude Lyneis, and Darleane Hoffman. We owe a debt of thanks to Postdoctoral fellow Ralf Sudowe, recent graduate Philip Wilk, graduate students C. M. Folden III and Josh Patin of the Heavy Element Nuclear and Radiochemistry Group and Dr. J. P. Omtvedt and Liv Stavsetra of the University of Oslo SISAK group. Prof. Walter Loveland, Oregon State University consulted with us by phone and e-mail and sent disk drives.

Minutes of Meeting to Discuss Questions Regarding 118 Work

Date: June 8, 2001
Attendees:
- Ginter, Tom
- Gregorich, Ken
- Hoffman, Darleane
- Lee, I-Yang
- Lyneis, Claude
- Ninov, Victor
- Nitsche, Heino
- Phair, Larry
- Schroeder, Lee

Start of meeting: 9:15 am

Experiments Discussed

Three different experiments to measure 118 were discussed -- the two discovery experiments in 1999 and a confirmation experiment in 2001. These experiments were referred to as the "1999 Run 1 experiment", the "1999 Run 2 experiment", and the "2001 experiment". The 1999 Run 1 experiment is BGS Run 13. The 1999 Run 2 experiment is BGS Run 15. The 2001 experiment is BGS Run 45. The 1999 Run 1 experiment contains two of the three events reported in the 1999 publication; it also contains one partial event that was not published. The 1999 Run 2 experiment contains the third event reported in the 1999 publication. The 2001 experiment contains a possible event confirming the 1999 results.

Data Tapes

The status of the data tapes was discussed. The 1999 Run 1 experiment data is on two tapes. Claude has the two original data tapes in his possession. The 1999 Run 2 experiment data is on 5 tapes. Claude has the first four original data tapes in his possession. The fifth tape, which contains background runs and calibration data, is missing. The 2001 experiment data is on 12 tapes. Tapes 7 and 8 are missing. Claude has the original copies of the remaining 10 tapes. A full copy of Tape 8 is on the computer disk. Claude has a copy of Tape 8 made from the data on the computer disk. Tape 8 contains the possible 2001 event confirming the 118 result. Tape 7 is thought not to contain important data.

It was decided that working copies of all of these tapes should be made as soon as possible for use in scanning the data to minimize the possibility of data loss from the original tapes.

Data Evaluation Status

For the 2001 experiment Walt Loveland tried to use Tom's GOOSY analysis code to search for the 118 event which had been identified. He was not successful. He also worked with Joshua Patin to find the event and was unsuccessful. When he tried to use Victor's code to look for the event, an error was discovered in the code. These problems had prompted a re-examination of the 118 events from 1999.

The search for the 1999 events has thus far been confined to three files from the 1999 Run 1 experiment which are indicated on a handwritten summary of the one partial and two full events. For each event, this summary gives an event number, but it is not clear how the counting was done to arrive at the event number. Larry has been searching for the events based on their time fingerprints but has so far not had success in locating them. His search is based on a code he has written that does not rely on GOOSY or the VMS operating system. Ken also has been unable to locate the events within the three files by looking at the raw data based on the event numbers. Tom is also looking for the events within the three files based on their time fingerprints using a modified version of his GOOSY analysis code.

Larry and Tom requested that the parameter list they are using to search the 1999 Run 1 experiment data be double-checked. Ken and Victor agreed to provide a verified list.

Data Evaluation Plan

It was agreed that the following steps will be taken to evaluate the 1999 data:

- Larry and Tom will compare the results of their codes to make sure that they come up with identical lists of events meeting their search criteria and to make sure that they understand any events that do not appear on both lists.
- The search for the 118 events will be extended to all data files from the 1999 Run 1 and 2 experiments.
- Larry and Tom will test their codes on the file containing the 110 event to check their ability to find events with long alpha-decay chains.
- Victor will start trying to locate the 1999 118 events.

Other Topics

Ken has been looking at the log files generated by the analysis code when it was used in the 2001 experiment to locate the confirming event. Inconsistencies in these log files seem to indicate a problem with the analysis code being used.

There was a discussion of whether it is possible for a faulty analysis code to corrupt data files. The consensus was that this should be unlikely. Even if such corruption is possible, the fact that only copies of the data files are analyzed should prevent any data loss.

Claude and Lee arrived at the meeting and were briefed about the previous discussions.

Lee pointed out that his confidence in the 118 result has been shaken. He said that clearing up the questions regarding the 118 work is the highest priority of the Nuclear Science Division -- especially in light of the review of the low energy research facilities scheduled for late summer. He cancelled further heavy element and BGS experimental work until the 118 questions are adequately addressed. He pointed out that computing resources are available for us to call on within the lab.

In general discussion it was agreed that more disk space on the VMS cluster is needed immediately.

It was agreed that meetings should be held regularly coordinate the effort to address the questions regarding the 118 work. The next meeting was scheduled to take place at 8:30 am on Monday, June 11.

There was a discussion of the schedule for upcoming heavy element and BGS experiments.

Close of meeting: 10:45 am

Minutes of Meeting to Discuss Questions Regarding 118 Work

Date: June 11, 2001
Attendees:
Ginter, Tom
Gregorich, Ken
Hoffman, Darleane
Lee, I-Yang
Lyneis, Claude
Ninov, Victor
Phair, Larry (had to leave early for NSD staff meeting)

Start of meeting: 8:30 am

Data Storage

Darleane spoke with Walt Loveland over the weekend and arranged for him to ship a disk drive to be used on the VMS cluster. The drive should arrive on Tuesday, June 12. The drive will be used to store data copied from the tapes from the 1999 Run 1 and 2 experiments; it will also provide space for Victor to pull files from backup tapes back onto the system.

Joshua Patin and Cody Folden are copying tapes. So far a copy has been made of tape R13T01. They will print out a directory of the contents of the original and copy tapes to be included with the tapes.

Parameter Lists for 1999 Run 1 and 2 experiments

Ken and Victor said that the parameter list Larry and Tom have been using in their sorts of the 1999 Run 1 data is correct. There are still some questions about a few of the parameters, but these are not important for locating the 118 chains.

Ken and Victor will make a parameter list for 1999 Run 2. They will copy a file from this run onto the VMS system to aid them in compiling the list.

Results of Searches for the 118 chains

Tom reported on his and Larry's attempt to locate the 118 chains in three files from the 1999 Run 1 experiment. The three files they examined were T01F020142, T01F020146, and T02F010168. File T01F020142 contains the full chain from strip 11, file T01F020146 contains the partial chain from strip 14 (not published), and file T02F010168 contains the full chain from strip 9.

Tom and Larry's codes use equivalent but not identical search strategies for locating the chains. Tom's code lists chains of at least four events occurring within any strip inside a time interval of 18 ms. No requirements are placed on the position of the events within the strip, and events are listed with low energy (high gain) ADC values between 30 and 4000 channels. Larry's code searches for pairs of events separated by 6 ms or less. It generates a listing if at least three such pairs occur within a strip within a 200 ms time interval. Again, no requirements are placed on the position of events within a strip. Events are listed with low energy (high gain) ADC values between 30 and 3800 or 4000 channels.

Both codes did not generate any listings consistent with the time fingerprints, decay chain lengths, and strip numbers of the 118 events. Both codes did, however, generate listings arising from random correlations and the very unrestricted nature of the searches. Larry and Tom compared their listings and found that their codes located the same series of events -- typically about five to ten listings per file. Each code also generated listings of event series that the other code did not see. In all cases Larry and Tom were able to understand the listings not common to both programs in terms of the differences in their search parameters.

Victor reported that he had searched one of the files by listing high energy events from the high gain (low energy) branch that were not in coincidence with signals from the PPAC. He said that he did seem to be finding events from the 118 decay chain, but that he needed more time to check the times associated with these events. Ken requested that Victor give him event numbers so that he could look at the raw data if Victor became more confident about the events he found.

Note Collection

Ken will be maintaining a loose-leaf binder to collect any papers generated documenting the search for the chains.

Plans for the Day

- Victor will continue with his search of the three files from the 1999 Run 1 experiment.
- Ken will update notes. He will also look at the raw data for any promising events that Victor finds.
- Tom will look over the tape copying.

Next Meeting

The next meeting was scheduled for Tuesday, June 12, 2001 at 8:00 am.

Close of meeting: 9:15 am

Minutes of Meeting to Discuss Questions Regarding 118 Work

Date: June 12, 2001
Attendees:
- Ginter, Tom
- Gregorich, Ken
- Hoffman, Darleane
- Lee, I-Yang
- Lyneis, Claude
- Ninov, Victor
- Phair, Larry
- Schroeder, Lee

Start of meeting: 8:00 am

Matrix Summary

Darleane requested that the group maintain a matrix chart to track the progress of checking the data files. The matrix would chart things such as who has looked at what files and what they have found. Ken agreed to be in charge of keeping this record.

Disk Drive

The disk drive from Walt Loveland is expected to arrive today. It has a capacity of 36 Gbytes, which should be enough room to hold all of the data. The data we have copied will be put onto this disk once it arrives.

Time Stamps

There was a brief discussion of time stamps. At least three types of time stamps appear in the data: 1) at the operating system level in the file header; 2) at the mbs front end level in the GOOSY-formatted file header; and 3) at the mbs front end level in each GOOSY-formated buffer header. It is not yet clear how the times in these different stamps are related to each other.

Comments from Lee

Lee reported that he had informed the lab upper management of the 118 status. He said that they expressed concern, especially in light of the upcoming DOE review of the low energy experimental facilities. The management wants a final answer on the status of the 1999 events as soon as possible. It was agreed that the group should be able to have an answer by Friday. Lee requested a chronology of the BGS runs. It was agreed that the BGS schedule from the web would be included in the documentation of the group's work.

Parameter List

Ken has made a parameter list for the 1999 Runs 1 and 2 experiments.

Larry pointed out that Mike Rowe has a parameter list from March 1999. This list confirms the parameter assignments in Ken's list, and it will be included in the documentation.

Update on Data Analysis

Larry is working on his analysis code to be able to search for the 110 chain in a file from the October 2000 run.

Victor said that the potential events he mentioned in the last meeting turned out not to be significant. He said that his strategy is now to search through all the data files without preconceptions on where the chains are located.

Next Meeting

The next meeting was scheduled for Wednesday, June 13 at 1 pm.

Close of meeting: 8:45 am

Minutes of Meeting to Discuss Questions Regarding 118 Work

Date: June 13, 2001
Attendees:
    Ginter, Tom
    Gregorich, Ken
    Hoffman, Darleane
    Lyneis, Claude
    Ninov, Victor

Start of meeting: 1:00 pm

Disk Drives

The disk drive that arrived on June 12 from Walt Loveland did not work. Victor set up 12 Gbytes of free disk space on old drives that he thinks should be reliable enough to last through the current work. Walt is having another disk shipped to us from the manufacturer. It was scheduled to arrive at Darleane's house today but has not yet arrived.

Documentation

It was decided that a written summary of the group's efforts with supporting documentation should be generated by Friday so that it can be available for Lee on Monday. Lee will be getting a verbal update from Claude on Friday, and it should be possible to get any written information to him then if he needs it. Ken will prepare the summary.

Data Status

Joshua Patin has made copies of the first four tapes of the 2001 experiment. He hopes to be finished copying the remaining 2001 data tapes tomorrow. Yesterday, Tom copied the two data tapes from the 1999 Run 1 experiment onto the disk space made available by Victor. He will copy the four tapes from the 1999 Run 2 experiment onto the disk today.

110 Event

Larry and Victor and Tom were each able to pick out the 110 event with their three analysis codes. Ken was able to see the event in the raw data using the GOOSY event number supplied by the others. The event consists of an implant followed by three α-decays. No escape or α-decay for 104 (rutherfordium) has been located in the data.

<u>1999 Data Search</u>

Victor has examined the T01F01 files from the 1999 Run 1 experiment and does not find any chains. Tom confirmed that the versions of the files just copied to disk generated the same printouts with his code as the three files he had examined earlier. Larry and Tom had only just started examining files and have not seen any chains. They plan to start by scanning the files adjacent to the three files they have already examined. Tom requested assistance in running his code to look at the data.

<u>Next Meetings</u>

The next meetings were scheduled for June 14 at 8:30 am and June 15 at 8:30 am.

Close of meeting: 13:45 am

Minutes of Meeting to Discuss Questions Regarding 118 Work

Date: June 14, 2001
Attendees:
Ginter, Tom
Gregorich, Ken
Hoffman, Darleane
Lyneis, Claude
Ninov, Victor

Start of meeting: 8:30 am

Data Status

Four tapes from the 2001 experiment remain to be copied. The tape copying should be finished today.

The 1999 Run 2 experiment tapes (Tapes 1-4) have been copied to disk.

Plans for Tomorrow's Report

Details of tomorrow's report were discussed. The report is intended to serve as a status report, not a final report. It will describe the efforts of this group, which will be referred to as the "118 Review Working Group". The report will include a chronology of experiments, the minutes of the working group's meetings over the past week, the composition of the group, a summary of findings and accomplishments, and a list of items the group still wants to examine.

1999 Data Search

Victor finished running the data from the 1999 Run 1 experiment. He reported that, although there are things he wants to examine more closely, he did not see anything that resembles what he saw in 1999. He also mentioned that he is worried about the byte shift that shows up in the file headers.

Tom reported that with help from others in the Heavy Element Group he is examining the 1999 data by running his code to generate a separate log file for each computer file of the data. The group has mostly finished scanning the 1999 Run 1 experiment, but no one has had a chance to go through the log files to look for events.

Run 016 Analysis Code

Ken had looked at the analysis code used for BGS Run 16, a run from summer 1999 to measure the excitation function of Kr on Sn. (This run was the first BGS run after the 1999 Run 2 experiment.) He believes there is no way for the code to mix parameter numbers from different events. He would like to examine the log files generated by the code if they still exist.

Next Meeting

The next meeting is scheduled for June 15 at 8:30 am.

Close of meeting: 9:15 am

Minutes of Meeting to Discuss Questions Regarding 118 Work

Date: June 15, 2001
Attendees:

Ginter, Tom
Gregorich, Ken
Hoffman, Darleane
Lyneis, Claude
Ninov, Victor
Phair, Larry

Start of meeting: 8:30 am

Disk Drives

The 18 Gbyte disk drive shipped by Walt Loveland arrived yesterday. Also, two 36 Gbyte drives were purchased locally yesterday. Victor will test and install all three drives today.

Data Status

Joshua Patin finished copying the data tapes from the 2001 run. Victor will begin organizing all 118 data (from 1999, 2001, and 2000) on the new disk drives.)

1999 Data Search

Victor finished searching the data from the 1999 Run 2 experiment and did not see anything resembling the third published 118 chain. He was using the same analysis code he used earlier in the week to search the 1999 Run 1 data. He wants to rerun this code on some of the data to make sure the output of the code is repeatable. Victor plans to retrieve the 1999 version of his code to search the data.

With help from others in the Heavy Element Group, Tom finished his search of the data from the 1999 Runs 1 and 2 experiments. The search, which was targeted to locate the published chains, was unable to find them. Jon Petter Omtvedt supplied a particularly helpful code to pull information out of the log files generated from the data scan. This information provides a quality check that each data file was scanned properly and a consistency check of technical details regarding the data format in the files and the clock and time stamp information imbedded in the data.

Larry completed a scan of the data in the files adjacent to the file thought to contain the first event from the 1999 Run 1 experiment. He did not find the published chains.

2001 Data

Ken spent more time looking at the log files from the scan where the 2001 event was found. He was not able to construct how this chain could come out of the raw data. He sees indications that the sorting code was doing some funny mixing of the data parameters or information in the events. There was a discussion of how a data file could become modified or corrupted. Ken and Victor do not think the data file is changing, but that the mixing observed is more likely an artifact of the analysis code or a problem with the pointers in the data base.

1999 Analysis Code Log Files

Victor mentioned that he was not able to do frequent backups of the VMS cluster in 1999 because of time constraints. His practice is from time-to-time to clean up log files generated by the analysis code. It is not clear if the log files were cleaned up before the system was backed up.

Status Report Preparation

The status report of the group's work this week was discussed.

Planning for Next Week

It was agreed that the next step should be to try to understand how the 1999 decay chains were generated.

Close of meeting: 10:15 am

App4a: Charge to Lynch Committee

See next 2 pages attached.

June 19, 2001

To: Gerry Lynch (Phys. Div)
Doug Olson (NSD)
Augusto Machiavelli (NSD)
Chuck McParland (NERSC)

From: Lee S. Schroeder (NSD)

Re: Technical Review of the "118" Program—Data Collection, Analysis and Associated Methodology

Thank you for agreeing to serve on this very important review committee. As you know, it is imperative to the scientific reputation of the Nuclear Science Division and its members, that a resolution of the uncertainties now surrounding the 1999 and subsequent experiments (2000 and 2001) on the production of the so-called 'superheavy' elements, be resolved. In particular, the production of element 118 and its subsequent decay to other superheavy elements (i.e., 118→116→114→…..). After the initial experiments and publication of those results in Phys. Rev. Letters, subsequent experiments, both at the 88-Inch Cyclotron and elsewhere, have not confirmed the initial findings. Indeed, the results of recent work by the "118 Review Working Group (see confidential enclosure)" has not been able to reestablish the previously reported 118 decay chains. The next phase of understanding the exact nature and status of the 1999 data is a more in-depth review by an expert group outside the BGS research group and collaborators.

Charge to the Committee:

1) examine the methodology used, from data collection through analysis chains, for all the 118 experiments: original 1999 runs, 2000 and 2001

2) identify, where possible, all aspects of the analysis processes that could lead to misinterpretation of the data (i.e., the apparent observation of highly correlated alpha particles signaling the decay of a heavy nucleus), and

3) in the area of "lessons learned," provide recommendations on improvements to the data collection, data reduction and analysis which can be incorporated into the procedures of the BGS group in future experiments.

In carrying out this review, I believe that you will want to meet/interview most (if not all) members of the local BGS group and their collaborators, as well as familiarize yourself with the full BGS and its detectors. In addition, you will want to have discussions with 88-Inch Operations and Scientific management and myself. You can expect full cooperation in these matters.

I would appreciate periodic updates on the status of your review. I hope that this can be carried out in a relatively brief time frame. I would appreciate your report by July 3rd, before the lab shutdown for the July 4th holiday.

App-4b: Lynch Committee Report (October 11, 2001)

See next 59 pages attached.

Report of the Committee for the Technical Review of the Element 118 Program

Gerald Lynch, Augusto O. Macchiavelli, Charles McParland, and Douglas Olson

October 11, 2001

1. Charge

On June 19, 2001 Lee Schroeder formed this committee to review the element 118 program, with the charge to:

a. examine the methodology used, from data collection through analysis chains, for all the 118 experiments: original 1999 runs, 2000 and 2001,
b. identify, where possible, aspects of the analysis that could lead to misinterpretation of the data (i.e. the apparent observation of highly correlated alpha particles signaling the decay of a heavy nucleus), and
c. in the area of "lessons learned", provide recommendations on improvements to the data collection, data reduction and analysis which can be incorporated into the procedures of the BGS group in future experiments.

2. Executive Summary

The committee has, as per its charge, investigated the circumstances and methodology surrounding the collection and analysis of data associated with the element 118 search experiment performed by the BGS group at the LBNL 88" Cyclotron. Our findings are based on numerous interviews, examination of data analysis programs and their respective output listings, and examination of files present on the BGS VMS computer system used for data analysis on all experimental runs of the element 118 search. While it is difficult to document the chronology of all activities associated with this experimental program over the past three years, the committee has been able to reconstruct and document a number of important findings pertaining to the analysis of data from these experiments. The committee has reached the following conclusions:

1. The element 118 candidates that were reported from the 1999 and 2001 BGS experiments are not in the data, as it exists today.

2. We have found no evidence that original data tapes have been altered by the addition or deletion of events. Internal consistency checks of a number of data tapes have shown no obvious signs of their having been modified. Furthermore, examination of data analysis listings created in 1999 and 2001 shows them to be consistent with the existing data files (except as noted in conclusion 4).

3. We have verified that the GOOSY analysis framework is properly unpacking events from raw data files and presenting them to the user analysis code in the proper order. We further believe that, given the nature of the data analysis process and the simplicity of those sections of the analysis code used for displaying experiment results, data analysis programming errors played no role in misleading experimenters by accidentally generating the reported, robust and internally consistent, decay chains.

4. We have found clear evidence that at least one of the 118 element decay chains published in 1999 and the single 2001 candidate decay chain were fabricated. This fabrication was performed by systematically altering data analysis results in order to construct credible 118 element decay chains.

5. Procedures used by the collaboration prior to publication of the 1999 PRL article failed to uncover the above discrepancies. Although suitable programs to display raw event data were available, there was no attempt to retrace handwritten listings of candidate events back to their original data files.

3. The Situation

The Heavy Elements group using the Berkeley Gas filled Separator (BGS) at the LBNL 88” Cyclotron has reported the observation of element 118 candidates. Three of these candidates, two from run 13 and one from run 15, were published in 1999 [V. Ninov et al., Phys. Rev. Lett. 83, 1105 (1999)]. Another candidate was observed in run 45 this year. The following table summarizes some of the element 118 run information.

Run	Date	
13	April 1999	3 chains reported – 2 published
15	May 1999	1 chain reported and published
-	February-May 2000	no chains reported
45	April-May 2001	one chain reported

In all instances, data acquisition was performed using the MBS data acquisition package (developed at GSI), and data analysis was carried out using the GOOSY software package (also developed at GSI) running on the BGS/VMS cluster. Since these packages share a common data format, examination of MBS data files by the GOOSY analysis framework is a straight forward operation. Careful examination of the original data files has failed to substantiate the reported candidates. No alpha chains like the ones reported are now found in the data, though the element 110 candidate that was reported in the year 2000 is still clearly seen in the data.

In these experiments, the team relied on Victor Ninov to do the analysis of the data. In the 1999 runs it seems that no one else looked for decay chains in the raw data. The chains that were published in 1999 and the one that was considered in 2001 came to the attention of the other members of the experimental team when Victor Ninov reported finding them in the data.

During the week of June 8 a number of meetings were held by a group of scientists from the 88" cyclotron to reexamine the 1999-2001 experiments that reported observation of alpha decay chains from element 118. A confidential report of that investigation was made by Darleane Hoffman on June 15, concluding that: "The six-member element 118 decay chain seen in the preliminary analysis of the April-May 2001 experiment does not exist in the data." It does not make such an assertion for the 1999 decay chains.

For the 2001 run a log file made by the analysis program has been saved. On May 7 at 12:54 the log file records the recoil and three full-energy alphas that were observed in the chain, but when this section of the data file was investigated by the same program at 15:03 two of these alphas are not there.

It is believed that all of the original data tapes from the 1999 run are accounted for and undamaged. Two of the data tapes from the 2001 run are missing, one of which is the tape that has the element 118 candidate. A disk file that has these data does exist and the data on it agree with what was recorded in the May 7 log file at 15:03.

4. Procedures

The committee was addressed by Lee Schroeder and Ken Gregorich gave a technical introduction. We talked at length with Ken Gregorich and Victor Ninov, had meetings with Larry Phair, I.Y. Lee, Tom Ginter, Darleane Hoffman, and Mike Rowe, and spoke with Walter Loveland. Everyone with whom we interacted was very cooperative.

Ken Gregorich gave us the parameter lists for the data tape structure for all of the runs and also some screen dumps of interesting sections of the log file. This material is described in Appendix A. We also received from Victor Ninov a copy of the log file that was produced by the analysis program in the runs of this year.

Much time was spent investigating the one 2001 candidate, simply because there is more information available about it. The proposed decay chain for this candidate is shown in Appendix B. In the 1999 data more attention was paid to the one candidate from run 15 than to the two or three from run 13 because the record that we have for this candidate has a few numbers that should be unchanged from what is on the tape, whereas the record for the run 13 candidates has only derived numbers. These records are shown in Appendix B. No examination was done of the element 110 event because it has no reproducibility problems.

Two members of the committee (C.M and D.O.) delved into the programs used in the analysis of the data, and wrote and ran programs to check if the GOOSY system that is used by the experiment was misbehaving. Details of this investigation are in Appendices C and D.

The committee also suggested checks that could be done to try to understand the problem. Ken Gregorich and Victor Ninov did some of these checks.

Following a backup procedure of the BGS-VMS cluster carried out on Friday July 27^{th}, committee members did extensive searches of the VMS disks in an attempt to uncover records concerning the reported chains. Some files were found that shed light on how some of the information was obtained for the published chain in run 15 and the reported chain in this year's data. This is detailed in Appendix E. In addition, regular and physical image backups were made of these disks. So far no use has been made of those backups. Appendix F illustrates some sections of the run 45 log file that enter into our findings and conclusions.

After we reached our conclusions, we had two long sessions with Ken Gregorich and Victor Ninov to see if there was pertinent information that we had not taken into account. Our conclusions remained unchanged.

Later Ken Gregorich informed us of significant analysis that he had done on a log file from run 13 that he had found. This analysis is presented in appendix G.

5. Findings

Before the committee started Tom Ginter, Victor Ninov, and Larry Phair had looked for all or some of the events in the 1999 data and did not find them. Tom Ginter used his own GOOSY-based data analysis code while Larry Phair used a completely different IDL-based program in his search. Since then Ken Gregorich, using a C-program running in the Windows-98 environment, searched for the chains in all three runs, also with negative results.

5.1 Analysis Process

Analysis of 1999 experimental data leading to the publication was carried out by Victor Ninov with user-written analysis programs running within the GOOSY software package. While similar versions of this code are available, an exact copy does not exist.

Victor Ninov described the general procedure that he uses for analysis of the data. This procedure is to run a GOOSY-based analysis program once or twice and find heavy element decay chain candidate by looking for high-energy alpha particles. After identifying candidates he looks through the data again, displaying the raw data for events in the region of the decay chain candidates. These individual events are examined in order to determine if there are additional alpha-decay events in which the alpha particle escapes the focal plane detector leaving a low energy signal. In the 2001 data these escape alpha particles may deposit the remainder of their energy in other detectors, which permits reconstructing the full energy of the alpha particle. These events are also examined in order to finalize the energy calibration, converting from raw detector channels to energy. The description of the complete decay sequence of events is constructed from these listings of individual events.

We were told that during analysis of the 1999 runs, the original data file was only examined two or three times. Energy calibrations were performed manually and candidate events were hand copied by Victor Ninov to two sheets of paper (see Appendix B). Discussions concerning experimental results and alternative explanations never prompted a re-examination of the original data files. All questions appear to have been resolved by reference to two pages of information that were derived from the results of the original data analysis session.

No suitable element 118 decay chains were found in the 2000 data. A single interesting decay chain was reported by Victor Ninov in the 2001 data. While the events that constitute this decay chain were also hand copied to paper (see Appendix B), a detailed record of analysis activity and user code debugging information exists in the form of a GOOSY log file (see Appendix F). It should be noted that information logged from user-supplied analysis routines is subject to changes. As mentioned, we have a reasonably close version of the analysis code used for 2001 data analysis, but there is no way of correlating the exact code version responsible for each portion of the GOOSY log file.

The log file from May 7, 2001 shows, through user code printouts, a potential decay chain at 12:54pm in the data file T08F020591.LMD. This decay chain does not appear later in the log file around 3:04pm, May 7, when the same file is processed again.

Despite this discrepancy, we were told that the general impression was that a valid decay chain had been found (see Appendix A7). This impression continued for about a week, until Walter Loveland failed to reproduce the results. It is not clear who was responsible for running GOOSY at the 12:54 PM and 3 PM sections, though Victor Ninov was clear that he did not know about the 3 PM section.

We carried out an investigation of the internal consistency of this GOOSY analysis log file and compared some features related to run 45 (tape 8, file 2) to data found in the disk copy of the original data file (T08F020591.LMD). Details of these investigations are given in appendices D and F. The result is that the log file we received appears to have been modified from the original produced by GOOSY.

In the analysis code from run 45 provided by Victor Ninov there is an error in how the time of an event, and therefore the time difference between events, is calculated (see Appendix D). This error often makes the time differences that are entered into the log file to be too small. The result is that sequential events that have a time difference of greater than 65 milliseconds could appear to have a time difference of only microseconds. However, this effect, by itself, did not give rise to the decay chain seen at 12:54pm on May 7. For this particular case, the 137 microsecond time difference between an apparent evaporation residue deposit and an alpha decay does not agree with the procedure used in the code to calculate time. The incorrect algorithm would give a correct time difference between events 242625 and 242626 of 50.5 milliseconds rather than the 137 microseconds shown in the log file. This discrepancy indicates that this section of the log file was not directly the output of running the analysis code.

5.2 GOOSY

Extensive tests were made to check if the event handling by GOOSY could possibly corrupt the events. A detailed description of these tests can be found in Appendix C. In general, these tests were designed to verify that GOOSY properly unpacked events from the data file and presented them in the proper order and without additions or deletions to the user-supplied analysis program. This was particularly important in view of the significance of calculated sub-event numbers (present only in the 2001 data) to correlate raw events found in data files with those reported by the GOOSY analysis code. No evidence was found that the GOOSY analysis framework performed these tasks incorrectly.

The above tests also allowed us to verify the correct formatting and integrity of data files by the front-end MBS data acquisition program. These checks were performed using an independent Perl-based program and were only performed on the T08F020591.LMD data file (run 45). All data structures within the file appeared in compliance with the published GOOSY data format specification.

Ken Gregorich investigated the internal consistency of the event and sub-event lengths for all data from runs 13, 15 and 45 and found no discrepancies. This also indicates that the MBS and GOOSY framework were behaving reliably for writing the data.

However, some GOOSY-related problems were discovered. The GOOSY analysis framework makes extensive use of a database located in a shared memory global section. From time to time, not readily apparent to the user, data structures located in this shared memory section become corrupted. This often results in program failures due to VMS memory access violations. Unfortunately, these seemingly random failures are the only operational indication of shared memory corruption. Since all GOOSY components, including the display processor, share data stored in this global section, there has been some concern that a corrupted global section could cause GOOSY to behave unreliably and report incorrect analysis results.

Victor Ninov was able to perform a sequence of GOOSY operations that yielded incorrect results. He used an analysis code that, for the first run, accessed shared memory in a known, incorrect manner. The immediate result was a corruption of some portion of the GOOSY database, followed by a VMS program access violation and subsequent program abort of one or more GOOSY components. On the next run, with a now corrected user program, GOOSY apparently ran normally but yielded an incorrect histogram of position data.

This demonstration did show that GOOSY is capable of producing incorrect histograms when operated with a previously corrupted database. This behavior was described to us as inconsistent and irreproducible and its ultimate effect on GOOSY-displayed histograms was therefore difficult to predict. However, it should be pointed out that the primary event analysis procedure for all reported 118 event chains is based on single raw event data listings produced by the GOOSY user analysis routine. Within the user analysis routine, these raw data event listings are produced via simple print statements with little or no manipulation or analysis occurring between the presentation of raw event data by the GOOSY framework and its subsequent printout to the log file. We have found runs whose analysis log entries correspond exactly with events found in the raw data file. In addition to demonstrating its ability to operate without database errors, these error-free analysis runs show that the GOOSY framework correctly unpacks events and presents them to the user routine without corruption. In our analysis of the single 118 decay chain in 2001 data, we have seen no evidence of data corruption by the user analysis routine either before or after the events purported to be part of that chain, thus suggesting that the GOOSY corruption mechanism played no role in producing the events seen in the log file. Furthermore, we have seen no additional data corruption and/or user analysis routine mechanisms that could plausibly produce the unique and robust 118 event chains as reported.

Other members of the BGS collaboration have dealt with these GOOSY shared memory section problems. Tom Ginter stated that he has experienced little of this behavior in using GOOSY for data analysis. He is aware that the data definitions used in the compiled analysis code must match exactly those defined in the GOOSY database or else the database may get corrupted. By being careful to maintain the correspondence between the analysis code and the database Tom Ginter has experienced reliable behavior of GOOSY.

Mike Rowe has also encountered database corruptions in using GOOSY. His procedure for reliable operation requires a clean start (i.e. reloading the global section) every time program changes are made. He described an incident where the layout of data in an array differed in its appearance between that seen within the user analysis program and the view presented by GOOSY command-line utilities. The cause of this discrepancy was never determined.

Based on our interviews, the GOOSY acquisition and analysis package used at the 88" Cyclotron has been solely supported by Victor Ninov. Support for both the VMS operating system and its PL/1 compiler are tenuous at best since the demise of Digital Equipment Corporation (DEC). Support for existing DEC computing hardware is limited to the used computer market. There is no support for either DEC hardware or the VMS operating system at LBNL.

The user-supplied analysis program used within the GOOSY analysis package must be written using the PL/1 programming language. There is no VMS PL/1 programming language reference manual at the 88" Cyclotron. It is not clear that one can be purchased. All coding appears to be based on alterations of existing user analysis programs and, when necessary, referring to an IBM PL/1 language reference manual. This IBM manual has no specific information about compiler implementation and defaults on the BGS VMS cluster.

5.3 Attempts at a Resolution

5.3.1 Other Analyses

Larry Phair performed an independent analysis of the 2000 data. There was some difficulty in obtaining a valid parameter list for this, as well as 1999, data files. This was eventually resolved between Larry Phair, Mike Rowe, and Victor Ninov.

Two independent analyses of the 1999 data were carried out by Larry Phair and Tom Ginter. These were performed using different programs. Larry Phair and Tom Ginter found a number of chain candidates with their loose selection criteria. A careful comparison of the candidates found in their searches agreed, boosting the confidence that they were done correctly.

Based on the analysis carried out by Tom Guinter, Larry Phair and, more recently, by Ken Gregorich, one can conclude that the chains published in PRL are not present in the data. Furthermore, analysis by Ken Gregorich shows no evidence for any interesting decay chains in the 2001 data.

5.3.2 The Run 45 event

In the 2001 data the chain of alphas that was first reported is not in the data that are on disk, but the implant and the first alpha seem to be there. The alpha has the same event number (242626) and energy as was recorded in the first observation, but has different time and positions. The implant has the same energy, time of flight, and one of the times (the one called tmp) is the same, but the event number (242597) and positions are different. Also, the actual time difference between the real events 242597 and 242626 is 2.6 seconds rather than 137 microseconds that was first reported.

The information that we have about the single 118 candidate from run 45 in 2001 primarily comes from the GOOSY analysis log file (Appendix F) covering the period of time from April 22, 2001 to May 22, 2001. This file was originally created by the GOOSY program as SLOG_A607_R045.LOG, and was supplied to us electronically as R045.SLOG. The first recorded access of the file containing this decay chain began by commanding GOOSY to skip over 242620 sub-events in file T08F020591.LMD. The suspected implant event occurs at sub- event 242626. In the data stream of the 2001 experiment, sub-events are not tagged with explicit IDs; they must be calculated by counting from the beginning of each data file. As far as we are able to determine, there is no way, a priori, of determining the sub-event number of a particular sub-event using the online version of the GOOSY analysis program. This is due to data stream sampling by the analysis program. Accurate event IDs can only be determined by offline analysis of the data file with a suitable program (e.g. the 118 GOOSY user analysis code) that counts events and assigns them sequential IDs.

Several GOOSY-related listings were provided to the committee. One was a screen dump of portions of the GOOSY log file covering the analysis on 7 May, 2001 (12:54) containing the 118 decay chain. (see Appendix A4). An additional screen dump (Appendix A5) shows the results of a subsequent analysis of the same data file that shows no evidence of the element 118 decay chain. A reconstructed list of the interesting portions of the GOOSY log file were collected together, along with narrative comments, and given to the committee (Appendix A7). We were also given copies of the handwritten reconstruction of the 2001 decay chain (Appendix B1) and the GOOSY-generated event data supporting that reconstruction (Appendix B, B2).

Careful comparison of these listings and the GOOSY log file (R045.SLOG) revealed some discrepancies. The file "untitled" (Appendix B2) appears to provide the event data supporting the candidate decay chain. Although this file includes the escape alphas, it agrees with the screen dump listing purporting to show the decay chain (A4). However, while the tmp values for event 242631 shown on the A4 listing and the supporting data for the decay chain diagram (B2) agree, they are different from those values found in both the narrative listing (A7) and the GOOSY log file itself (R045.SLOG). Furthermore, we noted this event appears to have two different tmp values as shown in the narrative listing (A7). It was also discovered that the four lines following event 242744 in the screen dump listing (A4) are not present in the GOOSY log file during that same analysis session (i.e. starting at 12:54 on 7 May 2001). This suggests that the VMS LSE editor window shown in A4 depicts an edited version of the log file. It was found that the display presented to us in support of the 2001 decay chain could be reproduced by inserting four lines from a subsequent GOOSY analysis (one starting at 15:27, 7 May 2001) at an appropriate place in the listing for that done at 12:54 earlier that same day.

These inconsistencies raised the question about the possible existence of other copies of the original GOOSY log file. This was discussed with Ken Gregorich. In searching the BGS/VMS cluster accounts, he noticed that the copy of the log file previously distributed to the committee by email (R045.SLOG) had disappeared. This situation prompted a management decision to backup all the relevant accounts in the cluster on Friday July 27th. This backup was performed by Everett Harvey, with the help of BGS personnel.

While searching for other copies of the log file, Ken Gregorich also found a copy of a log file associated with run 13 in one of the VAX machines. As mentioned earlier Gregorich's analysis of this log file is presented in Appendix G.

Following these activities, members of the committee proceeded to search extensively through all BGS directories for other versions of the log file. A copy of the log file was found on a scratch disk. This copy is identical to the one that had been mailed to us earlier. In addition an edited version of the 12:54 section of the log file was found in [LOVELAND.GOOSY.NINOV]TEST.LIS;3 that contained GOOSY analysis output that appeared almost identical to that found in the GOOSY log file starting at 12:54. Further examination of this file showed that it lacked the time stamps and line formatting present in GOOSY log files. The actual analysis output information, while substantially identical to that found in the

GOOSY log file at 12:54, contained a different tmp value for event 242631. When compared to the screen dump listing given us at the start of our investigations, this analysis output listing (TEST.LIS;3) was substantially the same as that found in the screen dump A4. It contained the same, but *incorrect*, tmp value for event 242631; but, it did not have the four artificially inserted lines of event listing found in the screen dump listing (A4).

We have been led to believe that the section of the log file at 12:54 on May 7, 2001 was the result of GOOSY analysis that was done at that time (see Appendix A7). This is not the case. Judging by the format of this section and the time that it took to be inserted in the log file, it is clear that this section was not the result of analysis done at that time, but was made earlier and copied into the log file at 12:54. (Details of this can be found in Appendix F.) This could have been done using a GOOSY command file ([LOVELAND.GOOSY.NINOV]STAFI.GCOM;1) that does a type command for TEST.LIS (see Appendix E). STAFI.COM was created at 10:49 on May 7.

Not only is it clear that the 12:54 section (with the evidence for the reported decay chain) was copied into the log file, we also see that this file (TEST.LIS) was edited before it was copied. That the file was edited is strongly suggested by the fact that the contents agree with the raw data for all events except the ones that form the reported chain. Manifestations of this editing are that the two tmp values for event 242631 are changed and are not self-consistent and that the time values for events 242625 through 242744 (see Appendix F) are not consistent with time values for the following events. Another suspicious fact, pointed out by Ken Gregorich, is that the last alpha in the chain has a correlation time of 10.4 seconds. On the basis of the alpha-alpha correlations seen in the 12:54 section, it is probable that an upper limit of about 5 seconds had been set in the analysis program to report such correlations.

A file named [VNINOV]SLOG_A607_R045_LOG.TPU$JOURNAL;1 dated May 13, 2001 at 12:58:52 was found on the VMS disk. This shows that a file called SLOG_A607_R045.LOG was being looked at with the TPU editor. This occurs at a time when, based on the content of R045.SLOG, it appears that the GOOSY system was shutdown and this would cause the file to not be locked so that it could be edited. The file name SLOG_A607_R045.LOG follows that standard GOOSY naming convention for the "system log" file and is very likely the original name of the file that R045.SLOG was derived from. Based upon the number of lines per page (see Appendix F) it is apparent that R045.SLOG has been modified from the original form generated by the GOOSY logging system. However, we have not determined that this particular TPU$JOURNAL file from May 13 is a evidence for modifying the log file. Ken Gregorich states that simply looking at the log file in an editor is a sensible activity in light of the work on May 13 in trying to reproduce the element 118 decay chain candidate reported on May 7.

5.3.3 The Run 15 event

The information that we have about the published candidate from run 15 is mostly contained in a file called event4.txt (see Appendix B). It has a format that is consistent with that of the GOOSY log file and contains evidence for the implant and four alphas. If the 1999 data have a similar behavior to what is seen for the 2001 event, then we might see the implant for the chain reported in run 15. With Ken Gregorich's help a search was made for events for which the tmp parameter (a measure of the time in microseconds, modulo 20,000) agreed with those listed in event4.txt. This search did not find any events consistent with that listing. A similar search for the time of flight of the implant was negative. This provided evidence that not only is the reported chain of alphas not present in the run 15 data, neither is the implant. However, we did find later that there is an event in the raw data that has the same tmp value, strip, and position as the last event in event4.txt.

Although we did not find the chain corresponding to the candidate published from run 15, we were able to associate some of the events that are listed in event4.txt with the raw data on tape with the help of two journal files :
[VNINOV]R015_CHAIN_LIS.TPU$JOURNAL;1 and
[VNINOV]NEW_CHAIN_LIS.TPU$JOURNAL;1 (see Appendix E) , made in May 1999. Files of this type are made when the TPU editor ends improperly. Therefore they cannot be expected to represent the final form of the file that is being edited, but they contain useful information nevertheless. These files have been recovered to produce the original files that were being edited.
NEW_CHAIN.LIS has information that is close to what is in event4.txt. Events 21909 and 21937 and the last two occurrences of 21908 are identical. Event 21907 has only a small difference in the energy. The implant has a different tmp value. So it looks as though NEW_CHAIN.LIS was an early form of event4.txt. Only the last four lines in R015_CHAIN.LIS are relevant to the event that was published. Three events that are here have the same time, energy, and position as events in event4.txt, but there are significant differences. The tmp for event 21908 is changed from 6115 to 5115. The tmp for event 21914 is changed from 5054 to 6054, and the event number is changed to 21909. The event number of 21937 is changed to 21917.

The events in R015_CHAIN.LIS can be found in file T04F020280.LMD on the run 15 tapes. Using the event counting that Ken Gregorich employed to do his search, events with the same time, tmp values, and strip numbers are on this tape at event numbers 21807, 21913, and 21936, that is, one event number from the values in R015_CHAIN.LIS. As far as we can see there are no events on the tape that correspond to the implant nor the first alpha that are in event4.txt. So we have the data tape that contains this candidate, and what was reported misrepresents the information that is there.

A file named [VNINOV.GOOSY.CVC]R015CH1.TXT;8 dated May 21, 1999 was found on disk and is listed in Appendix E. This file is almost identical to the event data content of the event4.txt file. The main difference is that there are some numbers which are inconsistent between the two listings of some events in event4.txt while the repeated numbers in R015CH1.TXT;8 are identical. These cases are the value for pos in event 21907 and the values for pos and time in event 21908.

The situation that we see here is that R015_CHAIN.LIS agrees with what is on tape except that the energies have been changed. Three of the five events on NEW_CHAIN.LIS have the same times and energies as events in R015_CHAIN.LIS, but two of them have different values of the microsecond clock, and two of them have event numbers that are a little different. In addition, NEW_CHAIN.LIS has two events that are not seen in the real data. NEW_CHAIN.LIS is very close to what was in event4.txt, which is close to what was published. R015CH1.TXT has internally consistent numbers while event4.txt has some internally inconsistent numbers.

5.4 Reconstructed Chronology

Following the findings above, we will attempt to reconstruct a possible chronology of events happening at the times of runs 13, 15 and 45. When listed, times refer to the VMS system clock running on the BGS cluster.

BGS Run 13 April 1999

11 April 1999	---	Fist hint of 118 decay chain reported by Victor Ninov.
15 April 1999	9:17:38	GOOSY analysis of events in the T01F020142.LMD file recorded in SLOG_CA_R013.LOG;1

15 April 1999	11:34:37	GOOSY analysis of events in the T01F020146.LMD file recorded in SLOG_CA_R013.LOG;1
15 April 1999	"before lunch"	Victor Ninov discusses chains with Ken Gregorich

BGS Run 15 May 1999

6 May 1999	17:46:46	R015_CHAIN.LIS being edited under VNINOV account, as shown by the journal file in the home directory.
7 May 1999	20:46:19	NEW_CHAIN.LIS being edited under same account.
12 May 1999	9:51:38	e-mail sent by V. Ninov to W.Loveland with event4.txt.
21 May 1999	14:41:30	R015CH1.TXT;8 file created
27 May 1999		Manuscript received by PRL.

BGS Run 45 May 2001

22 Apr 2001	04:25:47	First entry in SLOG_A607_R045.LOG .
5 May 2001	03:45:50	Data from the detector recorded for file T08F020591.LMD.
7 May 2001	10:04:24	Last entry in SLOG_A607_R045.LOG before 10 -11:49 gap.
7 May 2001	10:39:06	TEST.LIS being edited under VNINOV account as evidenced by journal file in home directory
7 May 2001	10:48:50	STAFI.GCOM being edited under same

		account. A copy of this file exists in [LOVELAND.GOOSY.NINOV] with a time of 10:49:55.

According to Ken Gregorich's records, a confirmation chain is discussed for the first time at about 11 am.

7 May 2001	11:49:57	First entry in SLOG_A607_R045.LOG since 10 AM.
7 May 2001	12:05:05	Skip to event 242620 on data file.
7 May 2001	12:54:50	Contents of TEST.LIST appears in SLOG_A607_R045.LOG, probably by executing STAFI.GCOM.
13 May 2001	10:56:18	Walter Loveland copies [VNINOV.GOOSY.CVC] to [LOVELAND.GOOSY.NINOV]
13 May 2001	12:58:52	Log file being edited as evidenced by SLOG_A607_R045_LOG.TPU$JOURNAL file in [VNINOV] directory.
13 May 2001	12:58	Short page length in log file.
22 May 2001	17:04:46	Last entry in SLOG_A607_R045.LOG
23 May 2001	09:12: 37	Creation of R045.SLOG.

6. Comments and Observations

Several practices appeared surprising and noteworthy in light of the uniqueness and importance of the claimed discovery of element 118 decay chains.

A major difference between the 1999 and the 2001 analysis processes is that in 2001 several people tried to check the candidate soon after it was reported, whereas this was not done in 1999. As far as we can determine, the 1999 events were looked at no more than three times and never re-examined again until this year. In spite of Victor Ninov's experience in these types of experiments, it is questionable that no attempt was made to cross examine the 1999 event chains This is particularly surprising given the fact that Victor Ninov raised concerns about the data integrity during the "maiden voyage" of BGS.

The BGS data analysis has been done in a way that makes it difficult or impossible to check what was done. Much of the analysis, especially in 1999, was done by hand. In fact, the only record available of their discovery is contained on two handwritten pieces of paper. When Victor Ninov was asked to reproduce some or all of the graphs in Figure 2 of the PRL publication, approximate versions of graphs A, B, and C were ultimately produced. But, Figure 2D was described as being produced "by hand" and could not be reproduced by any existing analysis program.

There was little if any attention paid to documentation of 1999 data handling and analysis leading to publication of the PRL article. This documentation should have included log files of the analysis, the source code used for the analysis, printouts of the complete events included in the decay chains, a record of the calibration used, a record of the parameters used to control the data analysis and a record of the "parameter list" for the raw data format. In fact, there are no known accurate copies of user analysis code used during either the 1999 or 2001 runs. It is not uncommon that at times of hectic debugging activities, logbook records tend to be relegated to a secondary role. This would somewhat justify the procedures followed during run 13. However, given the unique nature of the potential discovery made in that experiment, a more detailed set of procedures and records were called for in subsequent runs.

From discussions with a number of experimenters at the 88" Cyclotron, there was (and is) much confusion and some uneasiness about how the GOOSY analysis package (as differentiated from the GOOSY data acquisition software) performs its functions. This has resulted in uncertainty and, in some cases, outright superstition about the causes and frequency of GOOSY-generated errors.

Victor Ninov is familiar with many of these GOOSY failure modes and database corruption mechanisms. Yet, he appears willing to continue to use a corrupted GOOSY database until the analysis finally crashes or exhibits grossly incorrect behavior. A reliable procedure would be to create a new GOOSY database at the first sign of any incorrect behavior.

7. Conclusions

Based on the findings presented in section 4, all members of the committee have reached the following conclusions.

1. The element 118 candidates that were reported from the 1999 and 2001 BGS experiments are not in the data, as it exists today.

2 We have found no evidence that original data tapes have been altered by the addition or deletion of events. For data tapes recorded in 1999, this conclusion is based primarily on their correct formatting and internal consistency as demonstrated by recent independent re-analysis, as well as the agreement between the file R015_CHAIN_LIS.TPU$JOURNAL;1 dated May 6, 1999 with the current content of the data tapes. For data recorded in 2001, in particular run 45 tape 8, we have a further independent verification of proper data format and correlations between this recent independent re-analysis and listings found in the still extant GOOSY analysis log from April/May 2001.

3 We have verified that GOOSY is properly unpacking events from raw data files and presenting them to the user analysis code in the proper order. With the exception of those events constituting the 118 candidate in run 45 (2001), an analysis of event sequences found in raw data files and event analysis sequences shown in GOOSY log files shows agreement between the tmp parameter present in both raw event data and user analysis routine output. It should be noted that the GOOSY analysis framework has been shown capable, on occasion, of corrupting data structures in the shared memory database. If present, this corruption is believed to be responsible for incorrect histograms, misaligned array indices and truncated arrays. However, in the above analysis, the fact that there was no evidence of such corruption either before or after the 118 candidate events suggests that this mechanism played no role in producing the events seen in the GOOSY log file. Furthermore, since the final analysis procedure used for identifying the 118 event chain consisted of examination of raw event data as printed by the same user code that produced these log file entries, with no additional analysis of the raw data, we see no evidence that this data was incorrectly presented to the user by GOOSY. And lastly, analysis of user codes used during the 2001 experiment shows no mechanism that could erroneously produce the reported robust event chains.

4 There is clear evidence that at least one of the 118 element decay chains published in 1999, and also the candidate in the 2001 data, were fabricated. This

fabrication was performed by capturing the output of the data analysis program in a text editor and then systematically altering some events and inventing others in order to present data that would appear to be an element 118 decay chain. In 1999, one such modified sequence was present in an e-mail sent to collaboration members and is accepted by the BGS collaboration as representing the decay chain for the 3rd 118 event listed in the PRL publication. In 2001, a run of GOOSY analysis output was inserted into the normal operational log. While most of the analysis output that appears in this inserted section is consistent with events found in the data file, there is a short sequence that is not. This sequence does not appear in subsequent GOOSY analysis runs documented in the same log file on either the same or subsequent days and is not found in the data file. This sequence was the basis of the confirming 118 event chain said to have been found in the 2001 experimental run.

5 Procedures used by the collaboration prior to publication of the 1999 PRL article failed to uncover the above discrepancies. Although suitable programs to display raw event data were available, there was no attempt to retrace the handwritten event parameters of candidate events back to the original data files. By 2001, the collaboration review process was capable of discovering these discrepancies.

8. Recommendations

1 The main recommendation is that the internal review process for publishing new results needs to be improved. Whenever a new discovery is made, in particular with an experimental setup that is under development, it is essential that independent analyses should be carried out. These, analyses should not only try to reproduce the result, but also check its consistency when reasonable changes are made in the cuts or selections.

2 Efforts should be made to keep up a more detailed set of records and documentation during the course of an experiment, both on- and off-line. Analysis procedures should be repeatable and, in particular, the programs that are used to get the final results should be saved in a code management system such as CMS or CVS.

3 There are circumstances under which GOOSY seems to corrupt its database and present inaccurate histogram output. While these circumstances are likely to be due to programmer and/or operator error, the program does not always give adequate indication that errors have occurred. This situation should not be tolerated. If the analysis continues to be GOOSY-based, efforts should be increased to fix this defect, perhaps by writing automatic diagnostic tools to detect and report when its database has been corrupted. Continued reliance on the GOOSY analysis package without professional software support for either program enhancements or user training and assistance is not recommended. Alternatives to replace this analysis package should be explored.

4 The BGS is perceived as an important facility in the low-energy program of the NSD. During the course of the investigation it became clear that the technical operation of the instrument (mechanical, electronics, and data acquisition aspects) relies heavily on the efforts of two persons, Ken Gregorich and Victor Ninov. To reduce the possibility of repeating incorrect results, the Heavy Elements group should strive to obtain more institutional support and should see to it that staff members become more involved in all aspects of the experiment.

A Appendix – Run45 analysis materials

The following pages are copies of material given to this committee by the BGS group in June 2001.

Contents

Parameter List for BGS RUN013 April, 1999

Strip#	EL	YLT	EH	YHT
1	85	69	1	52
2	86	70	2	53
3	87	71	3	54
4	88	72	4	55
5	89	73	5	56
6	90	74	6	57
7	91	75	7	58
8	92	76	8	59
9	93	77	9	60
10	94	78	10	61
11	95	79	11	62
12	96	80	12	63
13	97	81	13	64
14	98	82	14	65
15	99	83	15	66
16	100	84	16	67

EL=low energy EH=high energy
YLT=low-E position YHT=high-E position

18 Ruth East
19 Ruth West
20 Punchthru
21 Punchthru
22 Punchthru
23 Punchthru
24 Punchthru
25
26
27
28 PPAC L
29 PPAC R
30 PPAC U
31 PPAC D
32 PPAC L+R
33 PPAC U+D

109 us chop
110 us
111 ms
112 s
113 scaler
114 scaler
115 pattern U

param	Make	Model	camac N
1-16	Phillips	7164	3
18-33	Phillips	7164	5
35-50	Phillips	7164	7
52-67	Phillips	7164	9
69-76	Silena	4418	11
77-84	Silena	4418	12
85-92	Silena	4418	13
93-100	Silena	4418	14
101-108	Silena	4418	16

param	Make	Model	camac N
109	LeCroy	2250B	17
110-114	LeCroy	2551	18
115	GSI	patternUnit	19

Parameter List for BGS RUN015, May 1999

Strip#	EL	YLT	EH	YHT
1	85	69	1	52
2	86	70	2	53
3	87	71	3	54
4	88	72	4	55
5	89	73	5	56
6	90	74	6	57
7	91	75	7	58
8	92	76	8	59
9	93	77	9	60
10	94	78	10	61
11	95	79	11	62
12	96	80	12	63
13	97	81	13	64
14	98	82	14	65
15	99	83	15	66
16	100	84	16	67

EL=low energy EH=high energy

YLT=low-E position YHT=high-E position

18 Ruth East
19 Ruth West
20 PPAC L+R
21 PPAC U+D
22 PPAC L
23 PPAC R
24 PPAC U
25 PPAC D
26
27 PPAC TAC
28
29 PPAC TAC
30 Punchthru
31 Punchthru
32 Punchthru
33 Punchthru

109 us chop
110 us
111 ms
112 s
113 scaler
114 scaler
115 pattern U

param	Make	Model	camac N
1-16	Phillips	7164	3
18-33	Phillips	7164	5
35-50	Phillips	7164	7
52-67	Phillips	7164	9
69-76	Silena	4418	11
77-84	Silena	4418	12
85-92	Silena	4418	13
93-100	Silena	4418	14
101-108	Silena	4418	16

param	Make	Model	camac N
109	LeCroy	2551	17
110-114	LeCroy	2551	18
115	GSI	patternUnit	19

strip#	EL	EH	YLT	YHT	YLB	YHB
1	32	64	96	128	160	192
2	33	65	97	129	161	193
3	34	66	98	130	162	194
4	35	67	99	131	163	195
5	36	68	100	132	164	196
6	37	69	101	133	165	197
7	38	70	102	134	166	198
8	39	71	103	135	167	199
9	40	72	104	136	168	200
10	41	73	105	137	169	201
11	42	74	106	138	170	202
12	43	75	107	139	171	203
13	44	76	108	140	172	204
14	45	77	109	141	173	205
15	46	78	110	142	174	206
16	47	79	111	143	175	207
17	48	80	112	144	176	208
18	49	81	113	145	177	209
19	50	82	114	146	178	210
20	51	83	115	147	179	211
21	52	84	116	148	180	212
22	53	85	117	149	181	213
23	54	86	118	150	182	214
24	55	87	119	151	183	215
25	56	88	120	152	184	216
26	57	89	121	153	185	217
27	58	90	122	154	186	218
28	59	91	123	155	187	219
29	60	92	124	156	188	220
30	61	93	125	157	189	221
31	62	94	126	158	190	222
32	63	95	127	159	191	223

EL=low energy   YLT=low-E pos top   YLB=low-E pos bottom
EH=high energy   YHT=high-E pos top   YHB=high-E pos top

scalers:	MSW	LSW
us chopper	2	1
us since start acq	4	3
ms since start acq	6	5
sec since start acq	8	7
min since start acq	10	9
us since MBS start	12	11
ms since start MBS	14	13
sec since start MBS	16	15
min since start MBS	18	17
pulses since start MBS2	20	19
beam dumps since start	22	21
unused scaler	24	23
unused scaler	26	25
unused scaler	28	27
user bit 1	29	

TOF-324 ?

A3

TMP = 1508? ...ST BETWEEN BLOCKS 1000 - 140000

200

A4

DIGITAL Language-Sensitive Editor

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```
ER-AL  ev:  215359 time:  6322.476 tmp:  16150 E(kev):  11828 pos:   1698 dt(ms):   1087.464 dx(ch):  38
ER     ev:  220796 time:  6479.401 tmp:  15325 E(ch):     462 pos:  10337 TOF:  1494
ER-AL  ev:  220803 time:  6479.578 tmp:  14691 E(kev):  10846 pos:  10383 dt(ms):    177.225 dx(ch):  46
ER     ev:  235952 time:  6923.710 tmp:  11798 E(ch):    1020 pos:  10175 TOF:  1246
ER-AL  ev:  236011 time:  6925.535 tmp:  10076 E(kev):   8983 pos:  10141 dt(ms):   1824.867 dx(ch): -33
ER     ev:  235919 time:  6922.657 tmp:   3354 E(ch):    1103 pos:  10131 TOF:  1224
ER-AL  ev:  236011 time:  6925.535 tmp:  10076 E(kev):   8983 pos:  10141 dt(ms):   2878.312 dx(ch):  11
ER     ev:  237734 time:  6975.925 tmp:  14885 E(ch):     421 pos:   1581 TOF:  1528
ER-AL  ev:  237824 time:  6978.622 tmp:  14323 E(kev):  10064 pos:   1618 dt(ms):   2696.553 dx(ch):  36
ER     ev:  239313 time:  7022.683 tmp:   3256 E(ch):     865 pos:  29659 TOF:  1287
ER-AL  ev:  239473 time:  7026.954 tmp:   9281 E(kev):   8233 pos:  29702 dt(ms):   4271.328 dx(ch):  43
ER     ev:  242048 time:  7101.122 tmp:   1079 E(ch):    2006 pos:   1328 TOF:  1404
ER-AL  ev:  242100 time:  7102.703 tmp:  14929 E(kev):   8171 pos:   1333 dt(ms):   1581.696 dx(ch):   6
ER     ev:  242625 time:  7118.294 tmp:   8563 E(ch):     553 pos:  12357 TOF:  1593
ER-AL  ev:  242626 time:  7118.294 tmp:   8700 E(kev):  12254 pos:  12352 dt(ms):      0.137 dx(ch):  -5
AL-mo  ev:  242626 time:  7118.294 tmp:   8700 E(keV):  12254 pos:  12352
Al-da  ev:  242631 time:  7118.312 tmp:   6768 E(keV):  10722 pos:  12356 dt( s):      0.018 dx(ch):   4
AL-mo  ev:  242631 time:  7118.312 tmp:   6768 E(keV):  10722 pos:  12356
Al-da  ev:  242744 time:  7128.724 tmp:  15087 E(keV):   8788 pos:  12351 dt( s):     10.412 dx(ch):  -5
AL-mo  ev:  243153 time:  7133.392 tmp:   1548 E(keV):   4681 pos:   1384
Al-da  ev:  243162 time:  7133.714 tmp:   6158 E(keV):   1377 pos:   1403 dt( s):      0.322 dx(ch):  19
AL-mo  ev:  243241 time:  7135.887 tmp:  10607 E(keV):   1280 pos:   3174
Al-da  ev:  243244 time:  7135.979 tmp:   8608 E(keV):   1001 pos:   3160 dt( s):      0.092 dx(ch): -13
ER     ev:  252649 time:  7411.835 tmp:   1244 E(ch):     432 pos:   1340 TOF:  1447
ER-AL  ev:  252757 time:  7415.089 tmp:   6161 E(kev):  10558 pos:   1290 dt(ms):   3253.460 dx(ch): -50
ER     ev:  256934 time:  7536.610 tmp:   5370 E(ch):     590 pos:   2696 TOF:  1380
ER-AL  ev:  257031 time:  7539.281 tmp:   6513 E(kev):   8268 pos:   2734 dt(ms):   2671.478 dx(ch):  38
ER     ev:  261041 time:  7653.936 tmp:   8814 E(ch):     791 pos:   1661 TOF:  1369
ER-AL  ev:  261167 time:  7657.852 tmp:   2684 E(kev):  10989 pos:   1673 dt(ms):   3915.082 dx(ch):  12
ER     ev:  268156 time:  7861.826 tmp:   9668 E(ch):    1013 pos:  14876 TOF:  1187
ER-AL  ev:  268289 time:  7865.838 tmp:  11945 E(kev):  10110 pos:  14873 dt(ms):   4012.418 dx(ch):  -3
ER     ev:  271901 time:  7970.688 tmp:   7397 E(ch):    1924 pos:   1681 TOF:  1252
ER-AL  ev:  272033 time:  7974.602 tmp:   5731 E(kev):  10903 pos:   1687 dt(ms):   3914.366 dx(ch):   6
```

OK

OK

OK

OK

241695

241750

242801

252276

NEXT TIME THROUGH DIF

A5

DIGITAL Language-Sensitive Editor

File Edit View Search Source Show Options Navigate

```
15:03:41 $ANL  ER     ev:  237734 time:   6975.925 tmp:  14885 B(ch):     421 pos:   1581 TOF:  1528
15:03:41 $ANL  ER-AL  ev:  237824 time:   6978.622 tmp:  14323 B(kev):  10067 pos:   1618 dt(ms):        2696.553 dx(ch):   36
15:03:42 $ANL  ER     ev:  239313 time:   7022.683 tmp:   3256 B(ch):     865 pos:  29659 TOF:  1287
15:03:42 $ANL  ER-AL  ev:  239473 time:   7026.954 tmp:   9281 B(kev):   8232 pos:  29702 dt(ms):        4271.328 dx(ch):   43
15:03:42 $ANL  ER     ev:  239674 time:   7032.418 tmp:    477 B(ch):     713 pos:  25548 TOF:  1499
15:03:42 $ANL  ER-AL  ev:  239801 time:   7035.825 tmp:   7706 B(kev):   7261 pos:  25577 dt(ms):        3406.307 dx(ch):   29
15:03:43 $ANL  ER     ev:  242048 time:   7101.122 tmp:   1079 B(ch):    2006 pos:   1328 TOF:  1404
15:03:43 $ANL  ER-AL  ev:  242100 time:   7102.703 tmp:  14929 B(kev):   8173 pos:   1333 dt(ms):        1581.696 dx(ch):    6
15:03:44 $ANL  ER     ev:  242597 time:   7117.157 tmp:   8563 B(ch):     553 pos:   2397 TOF:  1593
15:03:44 $ANL  ER-AL  ev:  242626 time:   7118.089 tmp:   4625 B(kev):  12254 pos:   2352 dt(ms):         932.137 dx(ch):  -45
15:03:46 $ANL  ER     ev:  247677 time:   7264.954 tmp:   6093 B(ch):     733 pos:  12176 TOF:  1224
15:03:46 $ANL  ER-AL  ev:  247708 time:   7265.769 tmp:    566 B(kev):   8488 pos:  12181 dt(ms):         815.168 dx(ch):    6
15:03:49 $ANL  ER     ev:  252649 time:   7411.835 tmp:   1244 B(ch):     432 pos:   1340 TOF:  1447
15:03:49 $ANL  ER-AL  ev:  252757 time:   7415.089 tmp:   6161 B(kev):  10559 pos:   1290 dt(ms):        3253.460 dx(ch):  -50
15:03:51 $ANL  ER     ev:  256934 time:   7536.610 tmp:   5370 B(ch):     590 pos:   2696 TOF:  1380
15:03:51 $ANL  ER-AL  ev:  257031 time:   7539.281 tmp:   6513 B(kev):   8268 pos:   2734 dt(ms):        2671.478 dx(ch):   38
15:03:52 $ANL  ER     ev:  257805 time:   7560.883 tmp:  13613 B(ch):     335 pos:  15575 TOF:  1447
15:03:52 $ANL  ER-AL  ev:  257890 time:   7563.488 tmp:  10084 B(kev):   7575 pos:  15559 dt(ms):        2605.012 dx(ch):  -16
15:03:53 $ANL  ER     ev:  259848 time:   7620.040 tmp:  13380 B(ch):     589 pos:   1368 TOF:  1479
15:03:53 $ANL  ER-AL  ev:  259858 time:   7620.362 tmp:  16793 B(kev):   7265 pos:   1329 dt(ms):         321.261 dx(ch):  -39
15:03:53 $ANL  ER     ev:  261041 time:   7653.936 tmp:   8814 B(ch):     791 pos:   1661 TOF:  1369
15:03:53 $ANL  ER-AL  ev:  261167 time:   7657.852 tmp:   2684 B(kev):  10988 pos:   1673 dt(ms):        3915.082 dx(ch):   12
15:03:54 $ANL  ER     ev:  261672 time:   7672.811 tmp:  12358 B(ch):    1078 pos:  25144 TOF:  1246
15:03:54 $ANL  ER-AL  ev:  261673 time:   7672.871 tmp:  12179 B(kev):   7743 pos:  25150 dt(ms):          59.820 dx(ch):    7
15:03:56 $ANL  ER     ev:  267358 time:   7838.486 tmp:   5596 B(ch):     849 pos:  15281 TOF:  1182
15:03:56 $ANL  ER-AL  ev:  267366 time:   7838.630 tmp:   7999 B(kev):   7332 pos:  15284 dt(ms):         143.647 dx(ch):    3
15:03:57 $ANL  ER     ev:  268156 time:   7861.826 tmp:   9668 B(ch):    1013 pos:  14876 TOF:  1187
15:03:57 $ANL  ER-AL  ev:  268289 time:   7865.838 tmp:  11945 B(kev):  10110 pos:  14873 dt(ms):        4012.418 dx(ch):   -3
15:03:58 $ANL  ER     ev:  269917 time:   7913.769 tmp:    480 B(ch):     433 pos:   2362 TOF:  1553
15:03:58 $ANL  ER-AL  ev:  269966 time:   7915.236 tmp:    966 B(kev):   7072 pos:   2342 dt(ms):        1467.075 dx(ch):  -20
15:03:59 $ANL  ER     ev:  271901 time:   7970.688 tmp:   7397 B(ch):    1924 pos:   1681 TOF:  1252
15:03:59 $ANL  ER-AL  ev:  272033 time:   7974.602 tmp:   5731 B(kev):  10904 pos:   1687 dt(ms):        3914.366 dx(ch):    6
15:04:01 $ANL  ER     ev:  276364 time:   8101.191 tmp:   3345 B(ch):     998 pos:  32542 TOF:  1225
```

2001

THIRD TIME

A6

DIGITAL Language-Sensitive Editor

File Edit View Search Source Show Options Navigate

```
15:27:04 $ANL ER-AL ev: 242217 time: 7106.466 tmp:  5320 E(kev):  1259 pos: 22612 dt(ms): 4063.211 dx(ch):  -5
15:27:04 $ANL ER    ev: 242148 time: 7104.311 tmp: 15057 E(ch):   1166 pos:  1425 TOF:   1476
15:27:04 $ANL ER-AL ev: 242265 time: 7108.046 tmp: 17523 E(kev):  1145 pos:  1387 dt(ms): 3734.755 dx(ch): -38
15:27:04 $ANL ER    ev: 242163 time: 7104.799 tmp:   569 E(ch):   1561 pos: 25640 TOF:   1284
15:27:04 $ANL ER-AL ev: 242288 time: 7108.733 tmp: 14123 E(kev):   907 pos: 25662 dt(ms): 3933.528 dx(ch):  22
15:27:04 $ANL ER    ev: 242280 time: 7108.483 tmp:  5838 E(ch):   1694 pos: 18771 TOF:   1238
15:27:04 $ANL ER-AL ev: 242302 time: 7109.175 tmp:  5115 E(kev):   819 pos: 18775 dt(ms):  691.948 dx(ch):   4
15:27:04 $ANL ER    ev: 242285 time: 7108.631 tmp: 15472 E(ch):    806 pos: 27452 TOF:   1465
15:27:04 $ANL ER-AL ev: 242312 time: 7109.431 tmp:  1466 E(kev):   613 pos: 27502 dt(ms):  799.914 dx(ch):  49
15:27:04 $ANL ER    ev: 242231 time: 7106.821 tmp:  9067 E(ch):   1575 pos:  8278 TOF:   1155
15:27:04 $ANL ER-AL ev: 242372 time: 7111.023 tmp:  5273 E(kev):   790 pos:  8307 dt(ms): 4201.519 dx(ch):  29
15:27:04 $ANL ER    ev: 242262 time: 7107.952 tmp: 12878 E(ch):   2069 pos: 28221 TOF:   1160
15:27:04 $ANL ER-AL ev: 242406 time: 7111.899 tmp:  5651 E(kev):  1188 pos: 28235 dt(ms): 3947.014 dx(ch):  14
15:27:04 $ANL ER    ev: 242329 time: 7109.844 tmp:  6918 E(ch):    660 pos: 29410 TOF:   1392
15:27:04 $ANL ER-AL ev: 242473 time: 7113.744 tmp:  7988 E(kev):  4778 pos: 29372 dt(ms): 3899.599 dx(ch): -38
15:27:04 $ANL ER    ev: 242528 time: 7115.462 tmp:  5891 E(ch):   2541 pos:  6371 TOF:   1357
15:27:04 $ANL ER-AL ev: 242534 time: 7115.603 tmp:  6031 E(kev):  1347 pos:  6380 dt(ms):  141.389 dx(ch):   9
15:27:04 $ANL ER    ev: 242597 time: 7117.157 tmp:  8563 E(ch):    553 pos:  2397 TOF:   1593
15:27:04 $ANL ER-AL ev: 242626 time: 7118.089 tmp:  4625 E(kev): 12255 pos:  2352 dt(ms):  932.137 dx(ch): -45
15:27:04 $ANL ER    ev: 242597 time: 7117.157 tmp:  8563 E(ch):    553 pos:  2397 TOF:   1593
15:27:04 $ANL ER-AL ev: 242673 time: 7119.361 tmp: 11011 E(kev):  3738 pos:  2403 dt(ms): 2203.867 dx(ch):   6
15:27:05 $ANL ER    ev: 242784 time: 7122.448 tmp: 11686 E(ch):   2273 pos: 25302 TOF:   1337
15:27:05 $ANL ER-AL ev: 242815 time: 7123.450 tmp:  6883 E(kev):  1371 pos: 25278 dt(ms): 1001.442 dx(ch): -24
15:27:05 $ANL AL-mo ev: 242867 time: 7125.042 tmp: 13545 E(keV):  3232 pos:  2888
15:27:05 $ANL Al-da ev: 242882 time: 7125.495 tmp: 13349 E(keV):  1445 pos:  2855 dt( s):    0.453 dx(ch): -33
15:27:05 $ANL ER    ev: 242817 time: 7123.527 tmp:  9574 E(ch):   2145 pos: 29296 TOF:   1244
15:27:05 $ANL ER-AL ev: 242957 time: 7127.676 tmp:  7634 E(kev):  1024 pos: 29260 dt(ms): 4149.446 dx(ch): -36
15:27:05 $ANL ER    ev: 242964 time: 7127.912 tmp: 11176 E(ch):    381 pos: 28246 TOF:   1249
15:27:05 $ANL ER-AL ev: 243040 time: 7130.142 tmp:  7560 E(kev):  1375 pos: 28232 dt(ms): 2230.120 dx(ch): -14
15:27:05 $ANL AL-mo ev: 243153 time: 7133.392 tmp:  1548 E(keV):  4680 pos:  1384
15:27:05 $ANL Al-da ev: 243162 time: 7133.714 tmp:  6158 E(keV):  1377 pos:  1403 dt( s):    0.322 dx(ch):  19
15:27:05 $ANL AL-mo ev: 243241 time: 7135.887 tmp: 10607 E(keV):  1280 pos:  3174
15:27:05 $ANL Al-da ev: 243244 time: 7135.979 tmp:  8608 E(keV):  1003 pos:  3160 dt( s):    0.092 dx(ch): -13
```

Offline analysis of the 118 event on May 7, 2001:
The first time through the file an interesting correlation was observed. It consisted of a recoil followed by three alpha particles at a position near the center of strip 12.

```
12:54:43  --  ER     ev:  239313 time:   7022.683 tmp:  3256 E(ch):     865 pos: 29659 TOF:   1287
12:54:43  --  ER-AL  ev:  239473 time:   7026.954 tmp:  9281 E(kev):   8233 pos: 29702 dt(ms):     4271.328 dx(ch):  4
12:54:43  --  ER     ev:  242048 time:   7101.122 tmp:  1079 E(ch):    2006 pos:  1328 TOF:   1404
12:54:43  --  ER-AL  ev:  242100 time:   7102.703 tmp: 14929 E(kev):   8171 pos:  1333 dt(ms):     1581.696 dx(ch):  (
12:54:43  --  ER     ev:  242625 time:   7118.294 tmp:  8563 E(ch):     553 pos: 12357 TOF:   1593
12:54:43  --  ER-AL  ev:  242626 time:   7118.294 tmp:  8700 E(kev):  12254 pos: 12352 dt(ms):        0.137 dx(ch):  -
12:54:43  --  AL-mo  ev:  242626 time:   7118.294 tmp:  8700 E(keV):  12254 pos: 12352
12:54:43  --  Al-da  ev:  242631 time:   7118.312 tmp: 15087 E(keV):  10722 pos: 12356 dt( s):        0.018 dx(ch):
12:54:43  --  AL-mo  ev:  242631 time:   7118.312 tmp: 11268 E(keV):  10722 pos: 12356
12:54:43  --  Al-da  ev:  242744 time:   7128.724 tmp: 15087 E(keV):   8788 pos: 12351 dt( s):       10.412 dx(ch):  -
12:54:43  --  ER     ev:  252649 time:   7411.835 tmp:  1244 E(ch):     432 pos:  1340 TOF:   1447
12:54:43  --  ER-AL  ev:  252757 time:   7415.089 tmp:  6161 E(kev):  10558 pos:  1290 dt(ms):     3253.460 dx(ch):  -5
```

A few hours later, there is another run through the data where the recoil has a different event number and is in strip 2. Note that the position of the recoil within the strip has moved from .357 to .397.

```
15:03:43 $ANL  ER     ev:  242048 time:   7101.122 tmp:  1079 E(ch):    2006 pos:  1328 TOF:   1404
15:03:43 $ANL  ER-AL  ev:  242100 time:   7102.703 tmp: 14929 E(kev):   8173 pos:  1333 dt(ms):     1581.696 dx(ch):   6
15:03:44 $ANL  ER     ev:  242597 time:   7117.157 tmp:  8563 E(ch):     553 pos:  2397 TOF:   1593
15:03:44 $ANL  ER-AL  ev:  242626 time:   7118.089 tmp:  4625 E(kev):  12254 pos:  2352 dt(ms):      932.137 dx(ch): -45
15:03:46 $ANL  ER     ev:  247677 time:   7264.954 tmp:  6093 E(ch):     733 pos: 12176 TOF:   1224
15:03:46 $ANL  ER-AL  ev:  247708 time:   7265.769 tmp:   566 E(kev):   8488 pos: 12181 dt(ms):      815.168 dx(ch):   6
```

A third run through the data looks similar

```
15:27:04 $ANL  ER     ev:  242528 time   7115.462 tmp:  5891 E(ch):    2541 pos:  6371 TOF:   1357
15:27:04 $ANL  ER-AL  ev:  242534 time   7115.603 tmp:  6031 E(kev):   1347 pos:  6380 dt(ms):      141.389 dx(ch):   9
15:27:04 $ANL  ER     ev:  242597 time   7117.157 tmp:  8563 E(ch):     553 pos:  2397 TOF:   1593
15:27:04 $ANL  ER-AL  ev:  242626 time   7118.089 tmp:  4625 E(kev):  12255 pos:  2352 dt(ms):      932.137 dx(ch):  ·45
15:27:04 $ANL  ER     ev:  242597 time   7117.157 tmp:  8563 E(ch):     553 pos:  2397 TOF:   1593
15:27:04 $ANL  ER-AL  ev:  242673 time   7119.361 tmp: 11011 E(kev):   3738 pos:  2403 dt(ms):     2203.867 dx(ch):   6
15:27:05 $ANL  ER     ev:  242784 time   7122.448 tmp: 11686 E(ch):    2273 pos: 25302 TOF:   1337
15:27:05 $ANL  ER-AL  ev:  242815 time   7123.450 tmp:  6883 E(kev):   1371 pos: 25278 dt(ms):     1001.442 dx(ch):  ·24
```

In the following pages, these log files are compared with the data either from a binary dump, of from a printout of the raw parameters using the

mutil type file

command

MBS assigns unique event numbers to all events. Victor's event numbers are actually counting subevents. When a second event occurs before the preceding one is fully read out, it is buffered in the ADC and the scalers and is then read out as a second subevent in a single "event". This is done by tricking MBS into believing that it is reading out a second crate. Thus, Victor's event numbers are greater than the MBS event numbers by the number of extra subevents which have occurred. When looking for the 118 event in the 201 experiments, in 12dkb100:[scratch.run045]T08F020591, Victor reset his event counter at the beginning of the analyzing that file. The first event in that file was assigned MBS event number 18525898. In the region of the 118 chain, there had been 350 extra subevents, thus

V=MBS-18525898+350 = MBS-18525548
MBS=V+1852898-350 = V+18525548

Where V is Victor's event number, and MBS is the MBS-assigned event number

An event which has most of the characteristics of the implant is at MBS=18768145/V=242597, whereas the first run through the analysis indicated MBS=18768173/V=242625, a difference of 28 events. Note that this event has TMP(param1)=8563, EH(2)(param65)=553, and TOF(param324)=1593. These are the same as the recoil, except the event is in strip 2, rather than strip 12 as indicated in the first run through the data in the log file. The second and third runs through the data in the log file have this event at the proper event number and strip number and proper TMP.

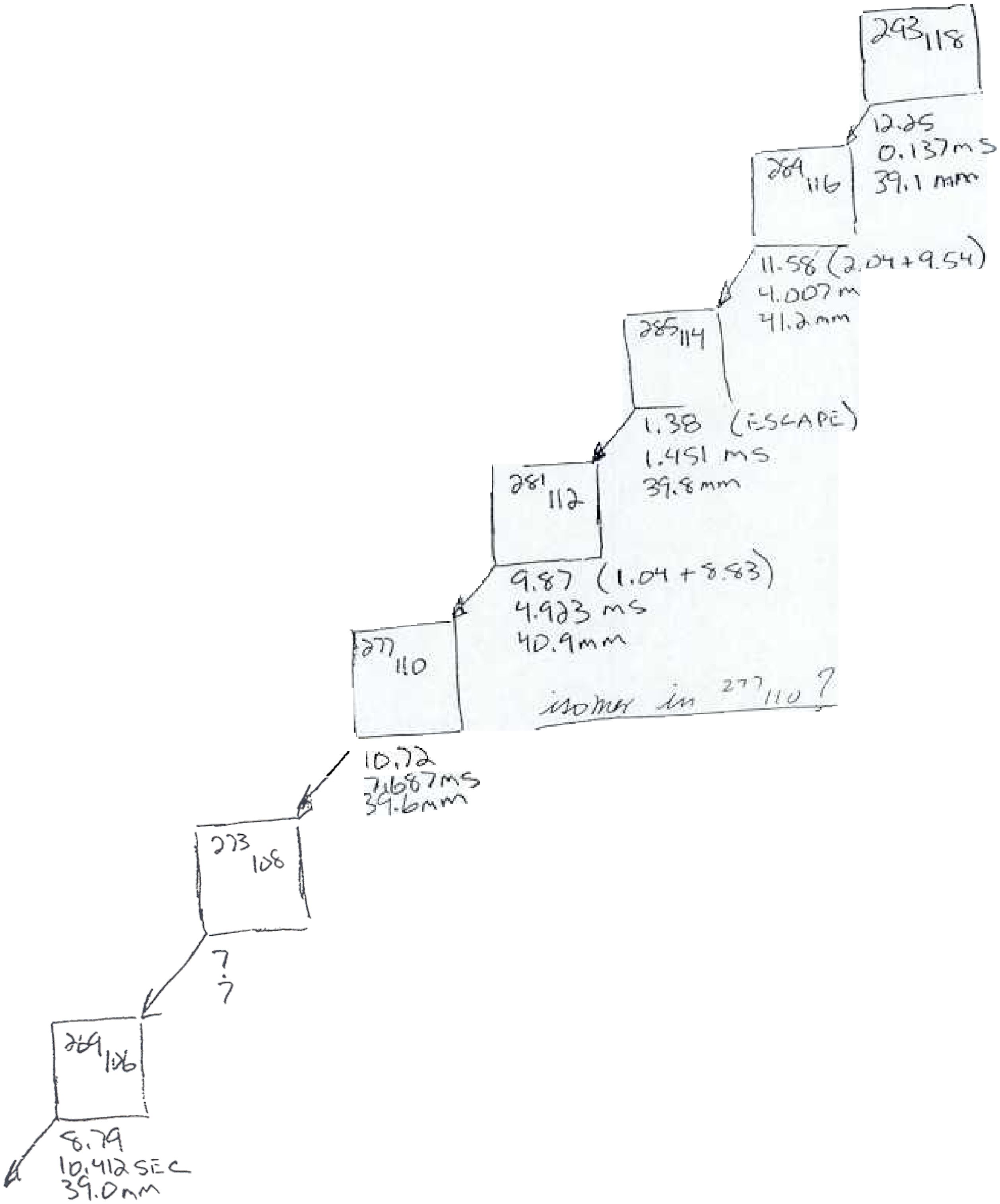
```
==================== Event 16  ============================================
Type =    10, Subtype =    1, Length =    158, Trigger =  1, Event =    18768145
Type =    10, Subtype =    1, Length =    150, Crate =    0, ID =    1, Ctrl =  9
1        :8563     2        :0        3        :12789    4        :12740
5        :30684    6        :406      7        :26638    8        :0
9        :444      10       :0        11       :46365    12       :41518
13       :39429    14       :10540    15       :35480    16       :10
17       :11519    18       :0        19       :22429    20       :786
21       :43321    22       :55273    23       :62978    24       :95
25       :38769    26       :170      27       :6554     28       :120
29       :0        30       :0        33       :4095     65       :553
96       :136      97       :2038     98       :79       128      :80
129      :244      160      :193      161      :2677     162      :116
193      :364      224      :127      225      :145      226      :94
227      :93       228      :117      229      :85       230      :144
231      :100      232      :165      233      :139      234      :129
235      :101      236      :70       237      :118      238      :35
239      :72       257      :97       259      :97       320      :613
336      :152      321      :1078     337      :186      322      :1299
338      :107      323      :1635     339      :181      324      :1593
340      :180      325      :125      341      :91
343      :142      31       :0                 :
```

B Appendix – Decay chain documentation for 2001 and 1999 events

The following pages are copies of material given to this committee in June 2001.

Contents

- B1 – hand drawn figure of the 118 decay chain candidate from run45 (2001).
- B2 – "Untitled, page 1", text similar to that resulting from GOOSY data analysis with numbers in support of the figure in B1.
- B3 – handwritten page showing three candidates for118 decay chain sequences from 1999. The first and third sequences shown on this page were used in the PRL article
- B4 – "event4.txt, page 1", printed text is part of an e-mail message sent to Walter Loveland by Victor Ninov on May 12, 1999 containing numbers in support of the 4th element 118 decay chain sequence from 1999 (3rd chain in the publication).


293 118
12.25
0.137 ms
39.1 mm
289 116
11.58 (2.04+9.54)
4.007 m
41.2 mm
285 114
1.38 (ESCAPE)
1.451 ms
39.8 mm
281 112
9.87 (1.04+8.83)
4.923 ms
40.9 mm
277 110
isomer in 277 110 ?
10.72
7.1687 ms
39.6 mm
273 108
?
?
269 106
8.79
10.412 SEC
39.0 mm

B

```
ER     ev:  242625 time:   7118.294 tmp:  8563 E(ch):     553 pos:  12357 TOF:   1593
ER-AL  ev:  242626 time:   7118.294 tmp:  8700 E(kev):  12254 pos:  12352 dt(ms)          0.137 dx(ch)
AL-mo  ev:  242626 time:   7118.294 tmp:  8700 E(keV):  12254 pos:  12352
Al-da  ev:  242627 time:   7118.298 tmp: 12707 E(keV):   2037
pos:  12371 dt( s):       0.004 dx(ch):   19
       PATTERN: 00000100000000000000000000000000  dE+E(kev):  11519 EHB(ch):  0
Al-mo  ev:  242627 time:   7118.298 tmp: 12707 E(keV):   2037 pos:  12371
Al-da  ev:  242628 time:   7118.300 tmp: 14158 E(keV):   1377 pos:  12358 dt( s)          0.002 dx(ch):   -13
        PATTERN: 00000000000000000000000000000000  dE+E(kev):      0 EHB(ch):  0
Al-mo  ev:  242628 time:   7118.300 tmp: 14158 E(keV):   1377 pos:  12358 dt( s)          0.002 dx(ch):   -13
Al-da  ev:  242629 time:   7118.305 tmp: 19081 E(keV):   1041 pos:  12368 dt( s)          0.005 dx(ch):    10
        PATTERN: 00000000001000000000000000000000  dE+E(kev):   9870 EHB(ch):  0
Al-da  ev:  242631 time:   7118.312 tmp:  6768 E(keV):  10722 pos:  12356 dt( s)          0.018 dx(ch):     4
AL-mo  ev:  242631 time:   7118.312 tmp:  6768 E(keV):  10722 pos:  12356
Al-da  ev:  242744 time:   7128.724 tmp: 15087 E(keV):   8788 pos:  12351 dt( s)         10.412 dx(ch):    -5
```


B2

(1) 3

plantation
35 : 43 ~~TØ4 FØ2014~~

(17, −3)		0.261 ms
11.7	(+2)	1.243 ms
11.3	(−1)	0.708 ms
2.3	(+12)	1.201 ms
10.1	(+1)	5.738 ms
9.8	(−4)	1.200 sec

Sta: 11-04-99 03 40

143 starts at 5 27

strip 11 16

no fission

ent. p ble
f afte 7 m

Sta 1 4 99 12 19 50
46 TØ FØ2014

(2) 80 / 14 471 ev: 32076

12.0	(21/6)	0.190 ms
11.4	(−1)	0.936 ms
1.3	(+16)	1.125 ms
3.1	(+6)	1.740 ms
2.3	(−2)	1.503 sec
~~1.2~~	~~(+12)~~	~~13.879 sec~~

2

too long

(3) 560 909 ?

start 0 7 37
683 23 58
TØ2 FØ1016

(bad y pos
) 0 2 2 m

strip 9

2 1 s
2 9 +8 0 74 ms
7 750 ms
+8) ~~21 231 m~~ 1
9 4 13 2 sec

B3

tota dose 3 x 4 p b for 10 eff

estimated det effic y 25

all α erg sh has an uncer y of 40 k

from p p) had been
for th events

parameter pg 162 124

Walt,

event4.txt

this what ew've got for the moment. Oganessian was yesterday and the day before here ate thelab, so that I have still have to go through the last day of data. Have fun and see you soon.
cheers victor

```
                                                                           Δt
ER   time:  0: 14: 13. 979   ev:  21906 tmp:  3758 Em(ch):  1256
pos: 13146 TOF:   1167
--More--
 ER-A time:   0: 14: 13. 979   ev:  21907 tmp:  4068 E2(keV):  3260    310 μs
pos: 13133 dt(ms):     0.310 dx(ch): -13
AL-A time:  0: 14: 13. 979   ev:  21907 tmp:  4068 E1(keV):  3260
pos: 13125
Al-B time:  0: 14: 13. 980   ev:  21908 tmp:  5115 E2(keV): 11280    1047 μs
pos: 13133 dt (s):     0.001 dx(ch):  8
AL-A time:  0: 14: 13. 979   ev:  21908 tmp:  5115 E1(keV): 11280    X
pos: 13131
Al-B time:  0: 14: 13. 980   ev:  21909 tmp:  6054 E2(keV): 10705    939 μs
pos: 13133 dt (s):     0.001 dx(ch):  2
AL-A time:  0: 14: 13. 980   ev:  21909 tmp:  6054 E1(keV): 10705
pos: 13133
Al-B time:  0: 14: 13. 985   ev:  21917 tmp: 10973 E2(keV): 10150    4919 μs
pos: 13128 dt (s):     0.005 dx(ch): -5
```

1.980 esc   1.810 s
8.670 α   43.1 se

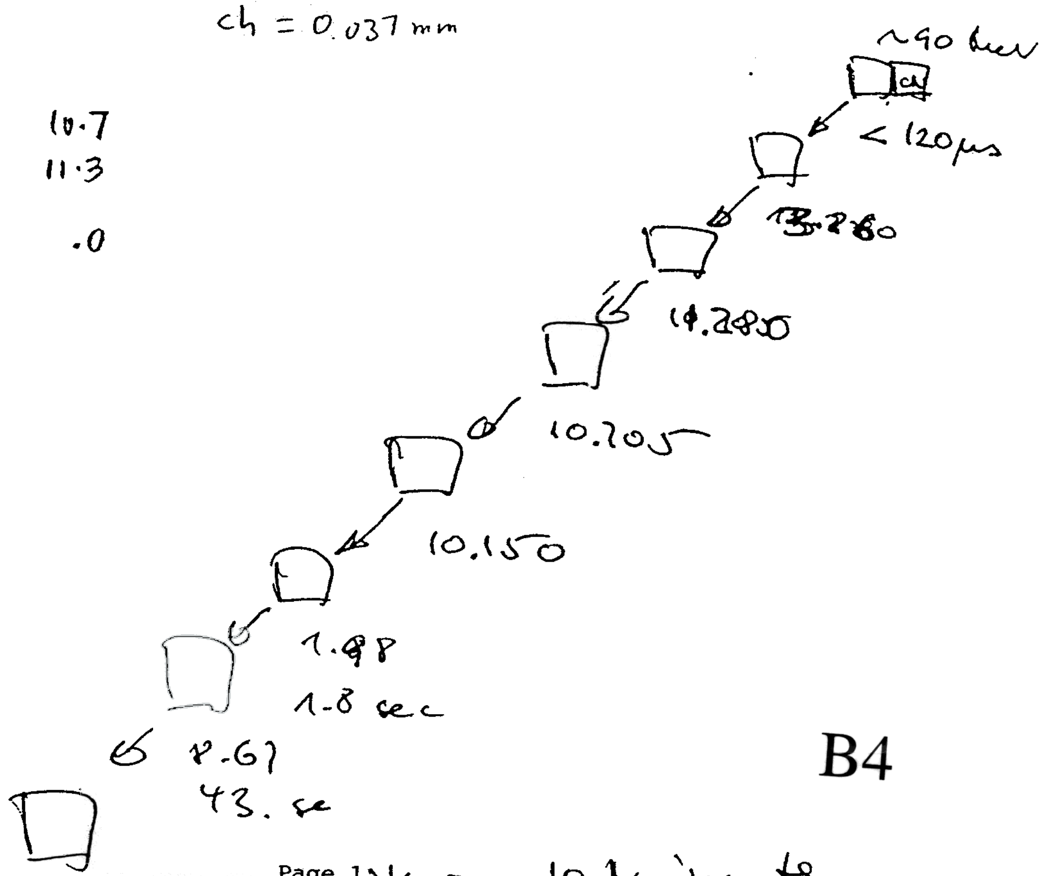
960 ch = 35 mm

ch = 0.037 mm

10.7
11.3
.0

11.3

11.5 ± 0.2



B4

no fission within 10 minutes

C Appendix - GOOSY

GOOSY is a sophisticated data analysis environment capable of integrating complex user analysis routines into its general data handling and display framework. It was developed at GSI and relies on operating system features unique to the Digital Equip. VAX/VMS operating system and its associated hardware. Its most notable architectural feature is the use of multiple processes for reading, unpacking, analyzing and displaying experimental data. One of these processes can be user-developed code tailored to the analysis needs of the current experiment. These processes communicate through a single shared region of memory called the GOOSY database. The correct behavior of each of these components depends on synchronized access to this database by all participating GOOSY processes. It further depends on all GOOSY processes having an identical, up-to-date image of what data structures are stored in the database and where they are located.

Since most experiments integrate their own analysis routines into the GOOSY system, there is usually a through debugging process by which the combined set of GOOSY and experimenter-supplied code is integrated into a trusted, working system. During this process, there are occasions when GOOSY's database and global section (i.e. VMS shared memory) become corrupted. The result is usually a program memory access violation and one or more of the GOOSY processes being aborted. The cause is typically a user programming error and, once corrected, GOOSY appears to run correctly.

However, execution errors also occur during normal operation. The end result is that the source of such errors, either user code or GOOSY code, is often not understood and, lacking access to GOOSY software support, is not pursued. Furthermore, the cause, indication and correct remedial actions surrounding these errors have taken on the quality of an "urban legend". GOOSY thus takes on the specter of a monolithic, undecipherable program that experimenters trust (and hope) is doing the right thing.

When execution problems do occur, some users reload and reinitialize the GOOSY database. Others, in particular the experiment in question, go through this process sporadically and infrequently (e.g. several weeks or longer). Although the problem appears to go away, there is no real understanding of the underlying problem or failure mechanism. Given the ultimate reliance on this software package for publication quality data analysis, this attitude seems incongruous. Furthermore, when analyzing data from such low statistics experiments as these, dependence on an analysis software package that not fully understood and, to a noticeable extent, not universally trusted is particularly odd.

As noted earlier, GOOSY is a large and complex collection of code. When not functioning properly, it is capable of presenting users with questionable results. While its dependence on a shared memory, multi-process software architecture is not a fault, the complexity of such a design creates a certain "fragility" that both increases the likelihood of programming errors and obscures their origin. GOOSY is no longer being actively developed by GSI, and its required operating environment, the DEC VMS hardware and operating system, has a dubious future. This lack of global support resources is compounded by the fact that there are no local computing professionals charged with the responsibility of maintaining the existing GOOSY software base and insuring its proper operation. While it is not the purpose of this review committee to explore alternate models for providing software support and resources for experimenters at the 88" Cyclotron, it is clear that lack of effective support for the GOOSY analysis program, both at LBNL and within the global community, has contributed to the present situation.

D Appendix - Committee analysis of 2001 Run45

- Integrity tests performed on Run 45 Tape 8 File 591 (C. McParland)
- Various investigations carried out on data from the 2001 run. (D.Olson)

Integrity tests performed on Run 45 Tape 8 File 591 (C. McParland)

Several tests were performed to ascertain the integrity and accuracy with which GOOSY presented its events to the user-supplied data analysis routine. Since Run 45 Tape 8 was still missing, these tests were performed on a disk file believed to be identical to that used for the original analysis in early May 2001. Tests were performed on this run and file because, as described above, an extensive GOOSY log file remained that partially documented the use and behavior of the GOOSY analysis package between April 24 and May 18, 2001. Log files for other data analysis sessions were no longer available.

An independent Perl program was written that, based on GOOSY data format documents, unpacked and reconstructed events from Run 45 Tape 8 File 591. It was found that the overall structure of the data file was correct and internally consistent. In particular, all physical buffers were of the correct size with no intervening gaps in buffer IDs. All events had increasing event IDs without intervening gaps and with increasing VMS-style time stamps. Sub-events were properly contained within events and buffer spanning behavior appeared correct. All buffer and event IDs were correct and consistent with GOOSY documents.

Each experiment event (sub-events in GOOSY parlance) contains a microsecond scaler that is reset every 20 milliseconds. This scaler is present in all events and, although it only exhibits values between 0 and 20000, it provides locally unique data tag among events near each other in the data stream. If an event passes certain cuts in Victor Ninov's GOOSY-based analysis program, this scaler value, along with a locally calculated sub-event number is printed in a diagnostic message. This scaler value, labeled "tmp", is output directly without any manipulation and, thus, represents, to a reasonable extent, the contents of the event delivered by the GOOSY analysis framework to Victor Ninov's analysis code. These diagnostic lines are captured in the GOOSY log file mentioned earlier. By comparing the microsecond scaler and sub-event numbers found in the log file with those found and calculated in our independent Perl event unpacking program, we are able to verify that, during these analysis sessions, the GOOSY framework correctly presented data to the Victor Ninov's analysis routine. This test only verifies the correspondence between log and data file for those events selected for inclusion in the GOOSY log file by Victor Ninov's analysis program. However, since one of there fields, notably the sub-event counter, is incremented manually by Victor Ninov's analysis routine each time GOOSY presents a new sub-event, any additions or deletions of sub-events at the GOOSY framework level would be immediately apparent.

The correspondence of these value pairs at approximately a dozen locations distributed throughout the file and spanning at least five different instances of a GOOSY analysis of Run 45 Tape 8 File 591 showed, for the most part, the expected, correct behavior. Namely, the calculated sub-event number and scaler value from the GOOSY log file was identical to the scaler value found in the event of the same calculated sub-event number extracted by our unpacking program.

In a single GOOSY analysis run (7 May, 2001 12:54 PM), several events appeared in the log file that could not be found, through examination, in the original disk data file. Within this run, events following these few erroneous events, appear consistent with data in the original disk file.

Various investigations carried out on data from the 2001 run. (D. Olson)

Glossary:

MBS event – an event as recorded from a trigger of the BGS detector. In the 2001 data this may consist of one or more "sub-events".
sub-event – corresponds to a single instance of a detector trigger. The electronics used with BGS in 2001 has a capability to buffer the digitized output of the ADC's and scalers for those triggers that occur within a time interval starting with the previous trigger which is longer than the digitization deadtime, reported to be about 15 microseconds, and the readout time, reported to be about 100 microseconds (and probably depends upon total MBS event size).
buffer – an 8 KB block in the raw data output stream, on tape and on disk, which is a low level container holding events
GOOSY – the data acquisition, online and offline analysis framework from GSI

1. There was a partially successful attempt to compare the view of the raw data from the particular data file, T08F020591.LMD, which showed the interesting decay chain in the Run45 log file at 12:54:43pm on May 7, 2001. These three views are: a) data as it appears in a perl script written by Chuck McParland that reads the raw data file and decodes the buffer, MBS event (and sub-event) structure of the data, b) data as listed using the GOOSY "type file" command which is a relatively low level utility that simply dumps the contents of a data file to an ascii file, and c) the data as it appears in Victor Ninov's analysis routine running in the context of a full GOOSY data analysis session.
I was able to compare the views (a) and (b) for the entire file of about 700K events. This comparison showed agreement for all data values except in three MBS events (#'s 18921204, 18986690, 19198830). In these three events the GOOSY "type file" format reported errors with the length of sub-events and then produced a hex dump of some amount of data which is less than or equal to the remainder of the MBS event. The first of these incidents occurs at sub-event count 396130. It should be noted that the apparent interesting decay chain observed in this file occurs at sub-event count of 242625. Since the GOOSY "type file" facility is rarely used, I would attribute the discrepancy to a piece of the GOOSY code which was not updated for some newer data format capabilities and that is very likely not used for the normal data analysis path in GOOSY, and so would not contribute to any corruption of the data analysis.
Victor Ninov tried several times to produce a complete listing for the file of view (c), in which the raw data values are printed out from within his analysis routine in GOOSY. The largest number of sub-events Victor Ninov was able to print out was 5477 and then the program would crash for one reason or another. However, these 5477 sub-events agreed completely with the views (a) and (b).

2. It was noticed that the time calculation used the analysis code that Victor Ninov provided to the committee is in error. This is supposed to be the analysis code that was used for the Run45 data (May 2001). D. Olson investigated the effects of this error. The time of an event is derived from 24-bit scalers which are fed by oscillators with periods of one second, one millisecond and one microsecond. The scalers are read by the MBS data acquisition code and written to the data stream as a 32 bit value as two 16 bit words. The analysis code uses the least significant 16 bit word of the microsecond scaler to calculate the time. This 16 bit value cycles every 65 milliseconds (65536 microseconds to be precise) and any events which are sequential in time but greater than 65 milliseconds apart will appear to have a time difference which is less than the actual time difference and the apparent time difference could be as low as zero or one microsecond. From the Run45 log file it is apparent that this time calculation was being used during the analysis on May 7, 2001. The correct way to calculate time is to use both 16 bit words of the microsecond clock, which will make a counter that cycles about every hour. A comparison of the correctly calculated time with the incorrect calculation was done for data file T08F020591.LMD, and it is clear that this incorrect time calculation, by itself, did not cause the appearance of the interesting decay chain at 12:54pm on May 7.

E Appendix – Files found in search of disks on VMS cluster

A complete directory listing of all files on the BGS group computer cluster was made on August 3, 2001. An excerpt from that listing that show files and directories relevant to this report is shown below.

```
Directory $5$DKB100:[BGS.LOVELAND.GOOSY]
NINOV.DIR;1                27/36      13-MAY-2001 10:56:17.99  (RWE,RWE,RE,RE)
Directory $5$DKB100:[BGS.LOVELAND.GOOSY.NINOV]
STAFI.GCOM;1                1/18       7-MAY-2001 10:49:55.31  (RWED,RWED,RE,RE)
TEST.LIS;3                 77/90       7-MAY-2001 14:20:21.13  (RWED,RWED,RE,RE)
Directory $5$DKB100:[BGS.VNINOV]
NEW_CHAIN_LIS.TPU$JOURNAL;1
                            7/18       7-MAY-1999 20:46:19.23  (RWED,RWED,RWED,RE)
R015_CHAIN_LIS.TPU$JOURNAL;1
                           18/18       6-MAY-1999 17:46:45.59  (RWED,RWED,RWED,RE)
SLOG_A607_R045_LOG.TPU$JOURNAL;1
                            1/18      13-MAY-2001 12:58:52.11  (RWED,RWED,RE,RE)
STAFI_GCOM.TPU$JOURNAL;1
                            1/18       7-MAY-2001 10:48:50.33  (RWED,RWED,RE,RE)
TEST_LIS.TPU$JOURNAL;1
                            1/18       7-MAY-2001 10:39:06.85  (RWED,RWED,RE,RE)
Directory $5$DKB100:[BGS.VNINOV.GOOSY.CVC]
R015CH1.TXT;8               2/18      21-MAY-1999 14:41:30.34  (RWED,RWED,RWED,RE)
Directory $6$DKB500:[BGS.TEST]
R045.SLOG;1            22931/22960    23-MAY-2001 09:12:37.60  (RWED,RWED,RE,RE)
```

Content of 5DKB100:[BGS.VNINOV.GOOSY.CVC]R015CH1.TXT;8

```
ER   time:   0: 14: 13. 979    ev:    21906 tmp:  3758 Em(ch):   1256 pos: 13146 TOF:   1167
ER-A time:   0: 14: 13. 979    ev:    21907 tmp:  4068 E2(keV):  3260 pos: 13133 dt(ms):      0.310 dx(ch): -13

AL-A time:   0: 14: 13. 979    ev:    21907 tmp:  4068 E1(keV):  3260 pos: 13133
Al-B time:   0: 14: 13. 980    ev:    21908 tmp:  5115 E2(keV): 11280 pos: 13131 dt (s):      0.001 dx(ch):   8

AL-A time:   0: 14: 13. 979    ev:    21908 tmp:  5115 E1(keV): 11280 pos: 13131
Al-B time:   0: 14: 13. 980    ev:    21909 tmp:  6054 E2(keV): 10705 pos: 13133 dt (s):      0.001 dx(ch):   2

AL-A time:   0: 14: 13. 980    ev:    21909 tmp:  6054 E1(keV): 10705 pos: 13133
Al-B time:   0: 14: 13. 985    ev:    21917 tmp: 10973 E2(keV): 10150 pos: 13128 dt (s):      0.005 dx(ch):  -5

AL-A time:   0: 14: 13. 980    ev:    21909 tmp:  6054 E1(keV): 10705 pos: 13133
Al-B time:   0: 14: 13. 985    ev:    21917 tmp: 10973 E2(keV): 10150 pos: 13128 dt (s):      0.005 dx(ch):  -5
```

Content of file recovered from 5DKB100:[BGS.VNINOV]NEW_CHAIN_LIS.TPU$JOURNAL;1

```
SUC: GOOSY> sta in fi  VSCA::$5$DKA100:[BGS.RUN015]T04F020280.LMD;1/op/swa
------------------- File Header ----------------------------------------------
Tape label  :
File name   :
User name   :
Run ID      :
Experiment  :
Created     : 6-May-99 12:48:25
Q1=1509 M1=338 M2=573 p=1.027 torr B=1.395T
TACs in S(27) and S(29) 120ns=770ch in s(27)
------------------- End of File Header ----------------------------------------


ER   time:   0: 14: 13. 979    ev:    21906 tmp:  4068 Em(ch):   1256 pos: 13146
ER-A time:   0: 14: 13. 980    ev:    21908 tmp:  4068 E2(keV):  3260 pos: 13133 dt (s):      0.001 dx(ch): -13
AL-A time:   0: 14: 13. 979    ev:    21907 tmp:  4068 E1(keV):  3260 pos: 13125
Al-B time:   0: 14: 13. 980    ev:    21908 tmp:  5115 E2(keV): 11280 pos: 13133 dt (s):      0.001 dx(ch):   8
AL-A time:   0: 14: 13. 979    ev:    21908 tmp:  5115 E1(keV): 11280 pos: 13131
Al-B time:   0: 14: 13. 980    ev:    21909 tmp:  6054 E2(keV): 10705 pos: 13133 dt (s):      0.001 dx(ch):   2
AL-A time:   0: 14: 13. 980    ev:    21909 tmp:  6054 E1(keV): 10705 pos: 13133
Al-B time:   0: 14: 13. 985    ev:    21917 tmp: 10973 E2(keV): 10150 pos: 13128 dt (s):      0.005 dx(ch):  -5
```

Content of file recovered from 5DKB100:[BGS.VNINOV]R015_CHAIN_LIS.TPU$JOURNAL;1

```
Tape label  :
File name   :
User name   :
Run ID      : run15
Experiment  : 459 86Kr + 450 208Pb
Created     : 3-May-99 11:10:04
Q1=1509 M1=338 M2=573 P=1.033
------------------- End of File Header ----------------------------------------
File input started from: VSCA::$5$DKA100:[BGS.RUN015]T02F05.LMD;1

ER   time:   0: 30: 56.  68    ev:    32242 tmp: 12226 Em(ch):   2662 pos:  9515 TOF:     5
ER-A time:   0: 30: 56.  88    ev:    32243 tmp: 14204 Ed(kev): 11325 pos:  9520 dt(ms):      1.400 dx(ch):   5
AL-B time:   0: 30: 56. 299    ev:    32245 tmp: 10261 E1(keV): 11011 pos:  9521
Al-A time:   0: 30: 56.  56    ev:    32252 tmp: 11035 E2(keV): 10503 pos:  9523 dt (s):      0.057 dx(ch): -17
AL-B time:   0: 30: 57. 176    ev:    32259 tmp:  3049 E1(keV): 10100 pos:  9518
Al-A time:   0: 30: 58. 831    ev:    32261 tmp:  8516 E2(keV):  9763 pos:  9525 dt (s):      0.655 dx(ch):  -5
Al-B time:   0: 30: 58. 831    ev:    32261 tmp:  8516 E2(keV):  9763 pos:  9525 dt (s):      0.655 dx(ch):  -5

ER   time:   0: 56: 46. 195    ev:   174295 tmp: 13924 Em(ch):   3364 pos:  7200 TOF:     0
ER-A time:   0: 56: 41. 278    ev:   174300 tmp:  7182 Ed(kev): 10886 pos:  7207 dt(ms):     83.000 dx(ch):   7
AL-A time:   0: 56:  8.   2    ev:   171460 tmp:  4613 E1(keV):  9778 pos:  7212
Al-B time:   0: 56:  4. 961    ev:   171542 tmp: 10529 E2(keV): 11085 pos:  7211 dt (s):      0.959 dx(ch): -11
AL-A time:   0: 56: 46. 565    ev:   174252 tmp: 10959 E1(keV):  9843 pos:  7214
Al-B time:   0: 56: 41. 278    ev:   174300 tmp:  7182 E2(keV): 10886 pos:  7207 dt (s):      0.713 dx(ch): -17

ER   time:   1: 47:  6. 868    ev:   392094 tmp:  3975 Em(ch):   1056 pos:  6211 TOF:     1
ER-A time:   1: 47:  6. 868    ev:   392097 tmp: 11025 Ed(kev): 12024 pos:  6227 dt(ms):      0.700 dx(ch):  16
Al-a time:   1: 47:  6. 868    ev:   392097 tmp: 11025 E2(keV): 12024 pos:  6227
AL-A time:   1: 47:  5.  92    ev:   392108 tmp:  1432 E1(keV):  9171 pos:  6225 dt (s):      0.846 dx(ch):   2

ER   time:   1: 19: 54. 746    ev:   379422 tmp:  1495 Em(ch):   2612 pos:  5643 TOF:    16
ER-A time:   1: 36: 30. 825    ev:   379427 tmp:  9427 Ed(kev): 10608 pos:  5661 dt(ms):     79.000 dx(ch):  19
AL-A time:   1: 19: 21. 174    ev:   379434 tmp: 14354 E1(keV): 10816 pos:  5584
Al-B time:   1: 19: 58.  78    ev:   379524 tmp: 14704 E2(keV): 12197 pos:  5576 dt (s):      0.904 dx(ch):  -8
AL-A time:   1: 19: 41. 725    ev:   379258 tmp:  4363 E1(keV):  9010 pos:  5643
Al-B time:   1: 36: 17.  87    ev:   379298 tmp: 10620 E2(keV): 10722 pos:  5641 dt (s):      0.362 dx(ch):  -3

AL-A time:   0: 14: 13. 979    ev:    21908 tmp:  6115 E1(keV): 11280 pos: 13131
Al-B time:   0: 14: 13. 980    ev:    21914 tmp:  5054 E2(keV): 10705 pos: 13133 dt (s):      0.001 dx(ch):   2
AL-A time:   0: 14: 13. 980    ev:    21914 tmp:  5054 E1(keV): 10705 pos: 13133
Al-B time:   0: 14: 13.     ev:    21937 tmp: 10973 E2(keV): 10150 pos: 13128 dt (s):      0.001 dx(ch):  -5
```

Content of 5DKB100:[BGS.LOVELAND.GOOSY.NINOV]STAFI.GCOM;1

```
$ ty test.lis
```

F Appendix - Run45 GOOSY log file

There exists a log file produced by GOOSY that spans Victor Ninov's analysis session from April 22, 2001 until May 22, 2001. This log file is one of the log files that GOOSY produces automatically and it contains some part of the record of a data analysis session. Some lines of the file are generated by the GOOSY system itself and some lines are from print statements in Victor Ninov's analysis code. Victor Ninov provided this log file to the committee on June 21, 2001.
Excerpts from this log file are shown below. Sections of the log file which have been omitted are indicated with a line consisting of 3 dots (...).
There are comments included for this appendix at the places where the data file (T08F020591.LMD) is opened. The set of events that comprise the interesting decay chain are indicated with a border, first at 12:54:43. When this file is processed again later at 15:03:44 the two events that seem to be the same as those at 12:54 are indicated with a border.
One aspect of this log file is that before this file has been analyzed the operator appears to have knowledge of the location of the interesting decay chain which starts are event number 242625 at 12:54:43. This is indicated by the sequence of operations where the first time the file is opened the first 5 events are processed. The second time the file is opened the analysis skips to event number 242620 and then steps through the next 13 events one at a time.

This committee carried out an analysis of the internal consistency of this file and found a number of features indicating that this file has been modified from it's original form as written by the GOOSY logging service. These aspects are:
1. The page length is very regular at 63 to 68 lines per page (as measured by awk) with 64 lines per page being the dominant number, except at 5 places in the file. One of these places is at the May 7, 10:00am break in the file where a page has 23 lines. Another place is at the start of 12:54pm May 7 analysis run. This indicates that the log file was modified after it was first produced by GOOSY.

- Page 37642, 23 lines (start of gap at 10:00am on May 7)
- Page 37910, 76 lines (start of 12:54pm May 7 run)
- Page 69879, 37 lines (May 13, 12:58:02 it appears that the GOOSY session was restarted following this page.)
- Page 86464, 50 lines (page break between May 13 and May 22)
- Page 86538, 74 lines (9:48am May 22, GOOSY has many buffer errors trying to open & read T08F020591.LMD,

Also notice that the page length and content of the log file at the end of the 12:54pm run (12:54:46, 14:20:24) is consistent with normal GOOSY output.
These features are consistent with a scenario where the times indicated around 12:54pm on May 7 are actually the times with these lines were written into the log file and that some parts of the log file before 12:54pm on May 7 were deleted at some time after 12:54pm on May 7.

2. Considering the amount of time it took to process data for a number of cases ranges from 2 to 30 buffers/second. For the 12:54pm run it processed 2441 buffer/second. Also, at 12:05:05pm on May 7 it takes 10 seconds to skip 242620 events (and 4095 buffers) while at 12:54pm it takes 5 seconds to process the entire file (12208 buffers and at least 721901 events). If the log entries at 12:54pm indicate the actual processing of the data file at that time then this would mean that the 200 MB file was read and processed in 5 seconds. It could be proved that the computer and disks used are not capable of reading data at 40 MB/sec. This indicates that the program was not really analyzing data during this run.

3. There is an example in the log on May 2 where a command is recorded that seems to type the contents of another file into the log file (15:13:59 -- $ ty T5_F06.LIS;1). An excerpt from this section of the log file is given on a following page. There are two important aspects to the format of the output following this command. A) The second column which is usually "$ANL" for the printout from the analysis code is instead "- -". B) There are no trailing spaces following the last printable character on the lines. It is the case that the listing during the 12:54pm run on May 7 has both these characteristics.

4. A comparison of the "time" values in the log file with those derived from the raw data file, T08F020591.LMD, was carried out and described in Appendix D. The "time" value is effectively a running sum value reflecting an accumulation of values from all previous events in a data file. The values of "time" in the run45 log file agree with those in the raw data file except for the 12:54 section of the log file events 242625 through 242744. The "time" values for earlier and later events in the 12:54 section of the log file, as well as for all events in the 15:01 to 15:34 section of the file, when this data is processed again, agree with the values from the raw data. This discrepancy at 12:54 for events 242625 – 242744 is significant because if this was caused by some coincidental software problem that happened also to produce an apparent element 118 decay chain, then the "time" values for events following 242744 should not agree with those in the 15:01 – 15:34 section of the log file. This indicates that the "time" values for events 242625 – 242744 at 12:54 did not come from the analysis program and so must have been produced separately and then inserted into the analysis output.

Here, on May 2, a file was copied into the log file with a ty(pe) command.

```
2-MAY-2001 12:22

12:22:19 $DBM     R$TIME_RUTH : 7.8000000E+01
12:22:19 $DBM     R$E_RUTH : 5.8026500E+06
15:13:59  --   $ ty T5_F06.LIS;1
15:13:59  --   ER     ev:  626263 time:   16501.603 tmp:  2772  EH(ch) :   500 pos: 14317 TOF:  2488
15:13:59  --   ER-AL  ev:  626266 time:   16501.609 tmp:  9589  Ed(kev): 10289 pos: 14319 dt(ms):      6.817 dx(ch):    1
15:13:59  --   AL-mo  ev:  626266 time:   16501.610 tmp:  9589  E1(keV): 10289 pos: 14319
15:13:59  --   Al-da  ev:  626282 time:   16501.879 tmp: 19497  E2(keV):  9568 pos: 14318 dt(s):       0.270 dx(ch):   -1
15:13:59  --
15:13:59  --   ER     ev: 2144857 time:   57138.980 tmp:  1506  Em(kev):   500 pos:  9528 TOF:  2475
15:13:59  --   ER-AL  ev: 2144858 time:   57138.982 tmp:  1856  Ed(kev): 10291 pos:  9531 dt(ms):      0.350 dx(ch):    3
15:13:59  --   AL-mo  ev: 2144858 time:   57138.982 tmp1:  1856 E1(keV): 10291 pos:  9531
15:13:59  --   Al-da  ev: 2144973 time:   57142.973 tmp2: 11831 E2(keV):  8923 pos:  9531 dt(s):       3.990 dx(ch):   -0
15:13:59  --   AL-da  ev: 2144973 time:   57142.972 tmp2: 11831 E2(keV):  8923 pos:  9531
15:13:59  --   Al-gd  ev: 2145024 time:   57144.176 tmp3: 17076 E3(keV):  8867 pos:  9528 dt(s):       1.205 dx(ch):   -2
15:13:59  --
15:13:59  --   ER     ev: 2438717 time:   66795.046 tmp:   5798 Em(kev):   490 pos:  4348 TOF:  2468
15:13:59  --   ER-AL  ev: 2438719 time:   66795.047 tmp:   7901 Ed(kev):  2115 pos:  4336 dt(ms):      2.103 dx(ch):  -12
15:13:59  --   AL-mo  ev: 2438719 time:   66795.048 tmp1:  7901 E1(keV):  2115 pos:  4336
15:13:59  --   Al-da  ev: 2438724 time:   66795.273 tmp2: 17273 E2(keV):  9478 pos:  4336 dt(s):       0.229 dx(ch):   -0
15:13:59  --   AL-da  ev: 2438724 time:   66795.277 tmp2: 17273 E2(keV):  9478 pos:  4336
15:13:59  --   Al-gd  ev: 2438976 time:   66804.227 tmp3:  9491 E3(keV):  2914 pos:  4331 dt(s):       8.952 dx(ch):   -4
15:13:59  --
15:13:59  --   22-Oct-94 15:50
15:13:59  --   File input started from: SHIP$ROOT:[NASE.LMDATA.R168]T6_F006.LMD;
15:13:59  --   AL     ev:   27508 time:     893.057 tmp: 16723 E(keV):   8099 pos:  8376                    PU: 0000000100000000
15:14:00  --
15:14:00  --   AL     ev:   65130 time:    1626.955 tmp: 14808 E(keV):   9157 pos:  8227                    PU: 0000000110000000
```

First instance of openning data file T08F020591.LMD. Processed 5 events.

Second instance of openning data file T08F020591.LMD. Skip to event 242620 and step through 13 events one at a time.

```
11:59:35  --   cre proc anl45 $anl prio=2
11:59:37 $SVR  HVR connected from AXP612::R045____$ANL(GN_XX_PRCTRL)
11:59:45 $DBM  cle spec *
11:59:47  --   >set member db:[data]ipar.r(1) 1
11:59:50  --   >set member db:[data]ipar.r(29) 1
12:00:00 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=5/op/swa
12:00:01 $ANL  ------------------ File Header ------------------------------------------------
12:00:01 $ANL  Tape label  : R45T08
12:00:01 $ANL  File name   : T08F020591.LMD
12:00:01 $ANL  User name   : bgs
12:00:01 $ANL  Run ID      : Run045
12:00:01 $ANL  Experiment  : 86-Kr(19+)
12:00:01 $ANL  Created     : 05-May-01 03:45:50
12:00:01 $ANL  Q1:1633 M1:382 M2:584 M2HallProbe:6.862
12:00:01 $ANL  E=457 MeV
12:00:01 $ANL  new targets: 208-Pb(40C-500Pb-3C)
12:00:01 $ANL  new window
12:00:01 $ANL  M1HallProbe:7.84
12:00:01 $ANL  ------------------ End of File Header -----------------------------------------
12:00:01 $ANL  File input started from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:00:01 $ANL  initialization done, buffer, event, time counters reseted :
12:00:04 $ANL  Processed buffers: 1, events : 5, skipped : 0
12:00:04 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:02:04 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=5/swa
12:02:04 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:02:13 $ANL  Processed buffers: 2, events : 10, skipped : 0
12:02:13 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:04:33 $DBM  cle spec *
12:04:36  --   >set member db:[data]ipar.r(1) 1
12:05:05 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 skip_ev=242620/op/swa
12:05:05 $ANL  Input file closed:
12:05:05 $ANL  Number of processed buffers: 2
12:05:05 $ANL  ------------------ File Header ------------------------------------------------
12:05:05 $ANL  Tape label  : R45T08
12:05:05 $ANL  File name   : T08F020591.LMD
12:05:05 $ANL  User name   : bgs

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12:05:05 $ANL  Run ID      : Run045
12:05:05 $ANL  Experiment  : 86-Kr(19+)
12:05:05 $ANL  Created     : 05-May-01 03:45:50
12:05:05 $ANL  Q1:1633 M1:382 M2:584 M2HallProbe:6.862
12:05:05 $ANL  E=457 MeV
12:05:05 $ANL  new targets: 208-Pb(40C-500Pb-3C)
12:05:05 $ANL  new window
```

```
12:05:05 $ANL  M1HallProbe:7.84
12:05:05 $ANL  ------------------- End of File Header ----------------------------------------
12:05:05 $ANL  File input started from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:05:15 $ANL  Processed buffers: 4095, events : 242620, skipped : 0
12:05:15 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:08 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
12:12:08 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:10 $ANL  initialization done, buffer, event, time counters reseted :
12:12:10 $ANL  Processed buffers: 4096, events : 242621, skipped : 0
12:12:10 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:17 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
12:12:17 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:19 $ANL  Processed buffers: 4096, events : 242622, skipped : 0
12:12:19 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:22 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
12:12:22 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:24 $ANL  Processed buffers: 4096, events : 242623, skipped : 0
12:12:24 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:29 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
12:12:29 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:30 $ANL  Processed buffers: 4096, events : 242624, skipped : 0
12:12:30 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:32 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
12:12:32 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:34 $ANL  Processed buffers: 4096, events : 242625, skipped : 0
12:12:34 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:36 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
12:12:36 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:37 $ANL  Processed buffers: 4096, events : 242626, skipped : 0
12:12:38 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:39 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
12:12:39 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:40 $ANL  Processed buffers: 4096, events : 242627, skipped : 0
12:12:40 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:42 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
12:12:42 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:43 $ANL  Processed buffers: 4096, events : 242628, skipped : 0
12:12:43 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:52 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
12:12:52 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:53 $ANL  Processed buffers: 4096, events : 242629, skipped : 0
12:12:53 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:55 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
12:12:55 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:56 $ANL  Processed buffers: 4096, events : 242630, skipped : 0
12:12:56 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:12:59 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
```

```
12:12:59 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:13:00 $ANL  Processed buffers: 4096, events : 242631, skipped : 0
12:13:00 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:13:20 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
12:13:20 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:13:22 $ANL  Processed buffers: 4096, events : 242632, skipped : 0
12:13:22 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1

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12:13:24 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
12:13:24 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:13:26 $ANL  Processed buffers: 4096, events : 242633, skipped : 0
12:13:26 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:26:46 $DSP  dis sp s(335)
12:27:07 $DSP  dis sp s(334)
12:27:10  --   >set member db:[data]ipar.r(1) 1
12:27:15  --   >set member db:[data]ipar.r(5) 0
12:27:20  --   >set member db:[data]ipar.r(29) 0
12:27:23 $DBM  cle spec *
12:27:34 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 /op/swa
12:27:34 $ANL  Input file closed:
12:27:34 $ANL  Number of processed buffers: 4096
12:27:34 $ANL  ------------------- File Header ------------------------------------------------
12:27:34 $ANL  Tape label  : R45T08
12:27:34 $ANL  File name   : T08F020591.LMD
12:27:34 $ANL  User name   : bgs
12:27:34 $ANL  Run ID      : Run045
12:27:34 $ANL  Experiment  : 86-Kr(19+)
12:27:34 $ANL  Created     : 05-May-01 03:45:50
12:27:34 $ANL  Q1:1633 M1:382 M2:584 M2HallProbe:6.862
12:27:34 $ANL  E=457 MeV
12:27:34 $ANL  new targets: 208-Pb(40C-500Pb-3C)
12:27:34 $ANL  new window
12:27:34 $ANL  M1HallProbe:7.84
12:27:34 $ANL  ------------------- End of File Header -----------------------------------------
12:27:34 $ANL  File input started from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:27:34 $ANL  initialization done, buffer, event, time counters reseted :
12:27:40 $DSP  dis sp s(334)
12:27:43 $DSP  dis sp s(334) bi=8
12:28:01 $DSP  dis sp s(335) bi=8
12:28:35 $DSP  dis spe s(324)
12:32:34 $DSP  dis spe s(330)
12:32:34 $DSP  Spectrum *::BGS:[$SPECTRUM]S(330) in frame 1 is empty
12:32:36 $DSP  dis spe s(331)
12:32:36 $DSP  Spectrum *::BGS:[$SPECTRUM]S(331) in frame 1 is empty
12:32:37 $DSP  dis spe s(332)
```

Third instance of openning file T08F020591.LDM. Process entire file.

```
12:32:44 $DSP  dis spe s(333)
12:32:48 $DSP  dis spe s(332)
12:33:44 $ANL  Input file closed: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:33:44 $ANL  Number of processed buffers: 12208
12:45:39 $DSP  dis spe s(332)
12:45:44 $DSP  dis spe s(333)
12:45:49 $DSP  ex
12:45:49 $DSP  To fire cursor press      : LEFT B
12:45:49 $DSP  To stop cursor input press: MIDDLE
12:46:09 $DBM  sh con el(3)
12:46:16 $DBM  cle spec *
12:46:27  --   >set member db:[data]ipar.r(1) 1
12:46:29  --   >set member db:[data]ipar.r(5) 1
12:46:51 $DBM  set con win el(3) 1200,8000
12:46:51 $DBM  Limits for condition window *::BGS:[$CONDITION]EL(3) :
12:46:51 $DBM       Dimension 1   1200.              8000.
12:48:03  --   >set member db:[data]ctrl.r$dt_al_max 500
12:54:10 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 /op/swa
12:54:38 $ANL  stop in fi
12:54:41  --   >
12:54:41  --   ------------------ File Header -----------------------------------------------
12:54:41  --   Tape label  : R45T08
12:54:41  --   File name   : T08F020591.LMD
12:54:41  --   User name   : bgs
12:54:41  --   Run ID      : Run045
12:54:41  --   Experiment  : 86-Kr(19+)
12:54:41  --   Created     : 05-May-01 03:45:50
12:54:41  --   Q1:1633 M1:382 M2:584 M2HallProbe:6.862
12:54:41  --   E=457 MeV
12:54:41  --   new targets: 208-Pb(40C-500Pb-3C)
12:54:41  --   new window
12:54:41  --   M1HallProbe:7.84
12:54:41  --   ------------------ End of File Header ----------------------------------------
12:54:41  --   File input started from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
12:54:41  --   SUC: GOOSY>
12:54:41  --   correlation is active ;

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12:54:41  --   initialization done, buffer, event, time counters reseted :
12:54:41  --   ER     ev:     2081 time:        66.617 tmp:    939 E(ch):     365 pos:  22355 TOF:   1396
12:54:41  --   ER-AL  ev:     2155 time:        68.765 tmp:   8201 E(kev):  12114 pos:  22370 dt(ms):       2148.058 dx(ch):    15
12:54:41  --   ER     ev:     2636 time:        83.983 tmp:  18443 E(ch):     404 pos:   1552 TOF:   1565
12:54:41  --   ER-AL  ev:     2779 time:        88.978 tmp:   6707 E(kev):  11109 pos:   1579 dt(ms):       4994.502 dx(ch):    26
12:54:41  --   ER     ev:     2958 time:        94.832 tmp:  17098 E(ch):     379 pos:   1598 TOF:   1564
12:54:41  --   ER-AL  ev:     3068 time:        98.150 tmp:  17903 E(kev):  11188 pos:   1570 dt(ms):       3318.336 dx(ch):   -29
12:54:41  --   ER     ev:     9177 time:       287.554 tmp:  19732 E(ch):    1450 pos:   1741 TOF:   1218
```

4th instance of openning T08F020591.LMD. Open is followed immediately by a stop. Why does the analysis run? Is log file corrupt?

```
12:54:41  --  ER-AL  ev:     9321 time:      291.539 tmp:  18644 E(kev):   8490 pos:   1708 dt(ms):       3984.891 dx(ch):   -33
12:54:41  --  ER     ev:    21662 time:      661.467 tmp:  13434 E(ch):     410 pos:  27503 TOF:   1430
12:54:41  --  ER-AL  ev:    21769 time:      664.475 tmp:  10478 E(kev):  10003 pos:  27496 dt(ms):       3007.897 dx(ch):    -7
12:54:41  --  ER     ev:    42317 time:     1267.049 tmp:   4385 E(ch):    1074 pos:   9762 TOF:   1240
12:54:41  --  ER-AL  ev:    42395 time:     1269.546 tmp:   9263 E(kev):   8881 pos:   9794 dt(ms):       2496.463 dx(ch):    32
...
12:54:42  --  ER     ev:   200522 time:     5890.603 tmp:  16738 E(ch):    2068 pos:  16332 TOF:   1196
12:54:42  --  ER-AL  ev:   200635 time:     5893.821 tmp:   2437 E(kev):  10136 pos:  16365 dt(ms):       3217.987 dx(ch):    33
12:54:42  --  ER     ev:   207560 time:     6094.392 tmp:  10968 E(ch):    2352 pos:   9735 TOF:   1161
12:54:42  --  ER-AL  ev:   207664 time:     6097.416 tmp:   3013 E(kev):  10142 pos:   9698 dt(ms):       3023.973 dx(ch):   -37
12:54:42  --  ER     ev:   209312 time:     6145.273 tmp:  15414 E(ch):     363 pos:  18865 TOF:   1228
12:54:42  --  ER-AL  ev:   209333 time:     6145.929 tmp:   4356 E(kev):   8241 pos:  18825 dt(ms):        656.076 dx(ch):   -40
12:54:42  --  ER     ev:   209355 time:     6146.451 tmp:  18459 E(ch):    2378 pos:  10263 TOF:   1029
12:54:42  --  ER-AL  ev:   209487 time:     6150.395 tmp:   8386 E(kev):  11374 pos:  10296 dt(ms):       3944.714 dx(ch):    34
12:54:42  --  ER     ev:   212614 time:     6242.201 tmp:   1125 E(ch):     861 pos:   3390 TOF:   1344
12:54:42  --  ER-AL  ev:   212692 time:     6244.552 tmp:    531 E(kev):  12347 pos:   3346 dt(ms):       2350.984 dx(ch):   -44
12:54:42  --  ER     ev:   215325 time:     6321.388 tmp:    452 E(ch):     348 pos:   1659 TOF:   1503
12:54:42  --  ER-AL  ev:   215359 time:     6322.476 tmp:  16150 E(kev):  11828 pos:   1698 dt(ms):       1087.464 dx(ch):    38
12:54:42  --  ER     ev:   220796 time:     6479.401 tmp:  15325 E(ch):     462 pos:  10337 TOF:   1484
12:54:42  --  ER-AL  ev:   220803 time:     6479.578 tmp:  14691 E(kev):  10846 pos:  10383 dt(ms):        177.225 dx(ch):    46
12:54:42  --  ER     ev:   235952 time:     6923.710 tmp:  11798 E(ch):    1020 pos:  10175 TOF:   1246
12:54:42  --  ER-AL  ev:   236011 time:     6925.535 tmp:  10076 E(kev):   8983 pos:  10141 dt(ms):       1824.867 dx(ch):   -33
12:54:42  --  ER     ev:   235919 time:     6922.657 tmp:   3354 E(ch):    1103 pos:  10131 TOF:   1224
12:54:42  --  ER-AL  ev:   236011 time:     6925.535 tmp:  10076 E(kev):   8983 pos:  10141 dt(ms):       2878.312 dx(ch):    11
12:54:42  --  ER     ev:   237734 time:     6975.925 tmp:  14885 E(ch):     421 pos:   1581 TOF:   1528
12:54:42  --  ER-AL  ev:   237824 time:     6978.622 tmp:  14323 E(kev):  10064 pos:   1618 dt(ms):       2696.553 dx(ch):    36
12:54:43  --  ER     ev:   239313 time:     7022.683 tmp:   3256 E(ch):     865 pos:  29659 TOF:   1287
12:54:43  --  ER-AL  ev:   239473 time:     7026.954 tmp:   9281 E(kev):   8233 pos:  29702 dt(ms):       4271.328 dx(ch):    43
12:54:43  --  ER     ev:   242048 time:     7101.122 tmp:   1079 E(ch):    2006 pos:   1328 TOF:   1404
12:54:43  --  ER-AL  ev:   242100 time:     7102.703 tmp:  14929 E(kev):   8171 pos:   1333 dt(ms):       1581.696 dx(ch):     6
12:54:43  --  ER     ev:   242625 time:     7118.294 tmp:   8563 E(ch):     553 pos:  12357 TOF:   1593
12:54:43  --  ER-AL  ev:   242626 time:     7118.294 tmp:   8700 E(kev):  12254 pos:  12352 dt(ms):          0.137 dx(ch):    -5
12:54:43  --  AL-mo  ev:   242626 time:     7118.294 tmp:   8700 E(keV):  12254 pos:  12352
12:54:43  --  Al-da  ev:   242631 time:     7118.312 tmp:  15087 E(keV):  10722 pos:  12356 dt( s):          0.018 dx(ch):     4
12:54:43  --  AL-mo  ev:   242631 time:     7118.312 tmp:  11268 E(keV):  10722 pos:  12356
12:54:43  --  Al-da  ev:   242744 time:     7128.724 tmp:  15087 E(keV):   8788 pos:  12351 dt( s):         10.412 dx(ch):    -5
12:54:43  --  ER     ev:   252649 time:     7411.835 tmp:   1244 E(ch):     432 pos:   1340 TOF:   1447
12:54:43  --  ER-AL  ev:   252757 time:     7415.089 tmp:   6161 E(kev):  10558 pos:   1290 dt(ms):       3253.460 dx(ch):   -50
12:54:43  --  ER     ev:   256934 time:     7536.610 tmp:   5370 E(ch):     590 pos:   2696 TOF:   1380
12:54:43  --  ER-AL  ev:   257031 time:     7539.281 tmp:   6513 E(kev):   8268 pos:   2734 dt(ms):       2671.478 dx(ch):    38
12:54:43  --  ER     ev:   261041 time:     7653.936 tmp:   8814 E(ch):     791 pos:   1661 TOF:   1369
12:54:43  --  ER-AL  ev:   261167 time:     7657.852 tmp:   2684 E(kev):  10989 pos:   1673 dt(ms):       3915.082 dx(ch):    12
12:54:43  --  ER     ev:   268156 time:     7861.826 tmp:   9668 E(ch):    1013 pos:  14876 TOF:   1187
12:54:43  --  ER-AL  ev:   268289 time:     7865.838 tmp:  11945 E(kev):  10110 pos:  14873 dt(ms):       4012.418 dx(ch):    -3
12:54:43  --  ER     ev:   271901 time:     7970.688 tmp:   7397 E(ch):    1924 pos:   1681 TOF:   1252
12:54:43  --  ER-AL  ev:   272033 time:     7974.602 tmp:   5731 E(kev):  10903 pos:   1687 dt(ms):       3914.366 dx(ch):     6
12:54:43  --  ER     ev:   276364 time:     8101.191 tmp:   3345 E(ch):     998 pos:  32542 TOF:   1225
```

Events making interesting decay chain.

```
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12:54:43  --   ER-AL  ev:   276511 time:       8105.499 tmp:  12581 E(kev):   8023 pos:  32522 dt(ms):       4307.771 dx(ch):   -20
12:54:43  --   ER     ev:   279197 time:       8183.834 tmp:  19072 E(ch):     436 pos:   2200 TOF:   1402
12:54:43  --   ER-AL  ev:   279261 time:       8185.739 tmp:     79 E(kev):   8744 pos:   2154 dt(ms):       1904.562 dx(ch):   -46
12:54:43  --   ER     ev:   279165 time:       8182.838 tmp:  15862 E(ch):     767 pos:   4688 TOF:   1373
12:54:43  --   ER-AL  ev:   279270 time:       8186.017 tmp:  17234 E(kev):   9698 pos:   4699 dt(ms):       3178.849 dx(ch):    11
12:54:43  --   ER     ev:   283664 time:       8311.476 tmp:   8711 E(ch):     446 pos:   8745 TOF:   1363
12:54:43  --   ER-AL  ev:   283797 time:       8315.207 tmp:  11169 E(kev):  11453 pos:   8774 dt(ms):       3730.809 dx(ch):    29
12:54:43  --   ER     ev:   283817 time:       8315.780 tmp:   6083 E(ch):     937 pos:  16734 TOF:   1216
12:54:43  --   ER-AL  ev:   283935 time:       8319.262 tmp:  19266 E(kev):   8293 pos:  16712 dt(ms):       3482.089 dx(ch):   -22
12:54:43  --   ER     ev:   288732 time:       8459.085 tmp:   6878 E(ch):    2076 pos:  15573 TOF:    948
12:54:43  --   ER-AL  ev:   288737 time:       8459.246 tmp:  18756 E(kev):   8502 pos:  15563 dt(ms):        160.801 dx(ch):   -10
12:54:43  --   ER     ev:   289596 time:       8483.879 tmp:  11039 E(ch):    1991 pos:   1675 TOF:   1255
12:54:43  --   ER-AL  ev:   289721 time:       8487.596 tmp:   4638 E(kev):   9924 pos:   1682 dt(ms):       3716.961 dx(ch):     6
...
12:54:46  --   ER     ev:   711043 time:      20662.862 tmp:  17962 E(ch):     432 pos:  24202 TOF:   1195
12:54:46  --   ER-AL  ev:   711098 time:      20664.610 tmp:   9285 E(kev):   8923 pos:  24185 dt(ms):       1747.752 dx(ch):   -17
12:54:46  --   ER     ev:   712128 time:      20693.774 tmp:   6328 E(ch):    1097 pos:   3581 TOF:   1305
12:54:46  --   ER-AL  ev:   712236 time:      20697.148 tmp:   1238 E(kev):   8236 pos:   3576 dt(ms):       3373.273 dx(ch):    -5
12:54:46  --   ER     ev:   721752 time:      20973.081 tmp:  13301 E(ch):     528 pos:   1494 TOF:   1548
12:54:46  --   ER-AL  ev:   721901 time:      20977.536 tmp:   1273 E(kev):   8136 pos:   1445 dt(ms):       4455.419 dx(ch):   -49
12:54:46  --   Input file closed: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1

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12:54:46  --   Number of processed buffers: 12208
14:20:24 $ANL  ---C$EXECM:GN_R045____$ANL(2080142D):AL612(*****):- 7-MAY-01 14:20:24.90
14:20:24 $ANL  %GOOCMD-E-ILLPAR, Unknown named parameter or qualifier 'skipe_ev='
14:21:06 $ANL  ---C$EXECM:GN_R045____$ANL(2080142D):AL612(*****):- 7-MAY-01 14:21:06.74
14:21:06 $ANL  %GOOCMD-E-ILLPAR, Unknown named parameter or qualifier 'skipe_ev=242620'
14:21:11 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 skip_ev=242620/op/swa
14:21:11 $ANL  Input file closed:
14:21:11 $ANL  Number of processed buffers: 12160
14:21:11 $ANL  ------------------- File Header -----------------------------------------------
14:21:11 $ANL  Tape label  : R45T08
14:21:11 $ANL  File name   : T08F020591.LMD
14:21:11 $ANL  User name   : bgs
14:21:11 $ANL  Run ID      : Run045
14:21:11 $ANL  Experiment  : 86-Kr(19+)
14:21:11 $ANL  Created     : 05-May-01 03:45:50
14:21:11 $ANL  Q1:1633 M1:382 M2:584 M2HallProbe:6.862
14:21:11 $ANL  E=457 MeV
14:21:11 $ANL  new targets: 208-Pb(40C-500Pb-3C)
14:21:11 $ANL  new window
14:21:11 $ANL  M1HallProbe:7.84
```

Open T08F020591.LMD 5th time. Skip to event 242620 and step through 5 events.

```
14:21:11 $ANL  ------------------- End of File Header -----------------------------------------
14:21:11 $ANL  File input started from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
14:21:21 $ANL  Processed buffers: 4095, events : 242620, skipped : 0
14:21:21 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
14:56:14  --   >set member db:[data]ipar.r(29) 1
14:56:24 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
14:56:24 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
14:56:25 $ANL  Processed buffers: 4096, events : 242621, skipped : 0
14:56:25 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
14:57:53 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
14:57:53 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
14:57:55 $ANL  Processed buffers: 4096, events : 242622, skipped : 0
14:57:55 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
14:57:58 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
14:57:58 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
14:58:00 $ANL  Processed buffers: 4096, events : 242623, skipped : 0
14:58:00 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
14:58:03 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
14:58:03 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
14:58:04 $ANL  Processed buffers: 4096, events : 242624, skipped : 0
14:58:04 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
14:58:05 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 ev=1/swa
14:58:05 $ANL  File input resumed from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
14:58:07 $ANL  Processed buffers: 4096, events : 242625, skipped : 0
14:58:07 $ANL  File input stopped from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
15:00:02 $DBM  sh con el(2)
15:00:28 $DBM  sh con el(4)
15:00:34 $DBM  set con win el(3) 0,0
15:00:34 $DBM  Limits for condition window *::BGS:[$CONDITION]EL(3) :
15:00:34 $DBM       Dimension 1   0.0                0.0
15:00:45 $DBM  set con win el(4) 9000,7000
15:00:45 $DBM  Limits for condition window *::BGS:[$CONDITION]EL(4) :
15:00:45 $DBM       Dimension 1   7000.              9000.
15:00:48 $DBM  cle spec *
15:00:50  --   >set member db:[data]ipar.r(1) 1
15:01:01  --   >set member db:[data]ipar.r(29) 0
15:01:10 $ANL  sta in fi $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1 /op/swa
15:01:10 $ANL  Input file closed:
15:01:10 $ANL  Number of processed buffers: 4096
15:01:10 $ANL  ------------------- File Header ------------------------------------------------
15:01:10 $ANL  Tape label  : R45T08

 7-MAY-2001 15:01

15:01:10 $ANL  File name   : T08F020591.LMD
15:01:10 $ANL  User name   : bgs
15:01:10 $ANL  Run ID      : Run045
```

Open T08F020591.LMD for 6th time.

Remains of apparent interesting chain seen at 12:54.

```
15:01:10 $ANL  Experiment  : 86-Kr(19+)
15:01:10 $ANL  Created     : 05-May-01 03:45:50
15:01:10 $ANL  Q1:1633 M1:382 M2:584 M2HallProbe:6.862
15:01:10 $ANL  E=457 MeV
15:01:10 $ANL  new targets: 208-Pb(40C-500Pb-3C)
15:01:10 $ANL  new window
15:01:10 $ANL  M1HallProbe:7.84
15:01:10 $ANL  ------------------- End of File Header ----------------------------------------
15:01:10 $ANL  File input started from: $12$DKB100:[SCRATCH.RUN045]T08F020591.LMD;1
15:01:10 $ANL  initialization done, buffer, event, time counters reseted :
15:01:11 $ANL  ER     ev:     1278 time:         42.009 tmp:   5314 E(ch):     370 pos:   7328 TOF:   1455
15:01:11 $ANL  ER-AL  ev:     1399 time:         45.767 tmp:  18815 E(kev):   7408 pos:   7306 dt(ms):       3757.213 dx(ch):   -22
15:01:11 $ANL  ER     ev:     1360 time:         44.726 tmp:  12652 E(ch):    1293 pos:  30585 TOF:   1173
...
15:03:36 $ANL  ER     ev:   228676 time:       6711.341 tmp:   9028 E(ch):     670 pos:   1466 TOF:   1538
15:03:36 $ANL  ER-AL  ev:   228796 time:       6714.788 tmp:  13423 E(kev):   7086 pos:   1427 dt(ms):       3446.508 dx(ch):   -39
15:03:40 $ANL  ER     ev:   235952 time:       6923.710 tmp:  11798 E(ch):    1020 pos:  10175 TOF:   1246
15:03:40 $ANL  ER-AL  ev:   236011 time:       6925.535 tmp:  10076 E(kev):   8983 pos:  10141 dt(ms):       1824.867 dx(ch):   -33
15:03:40 $ANL  ER     ev:   235919 time:       6922.657 tmp:   3354 E(ch):    1103 pos:  10131 TOF:   1224
15:03:40 $ANL  ER-AL  ev:   236011 time:       6925.535 tmp:  10076 E(kev):   8983 pos:  10141 dt(ms):       2878.312 dx(ch):    11
15:03:41 $ANL  ER     ev:   237734 time:       6975.925 tmp:  14885 E(ch):     421 pos:   1581 TOF:   1528
15:03:41 $ANL  ER-AL  ev:   237824 time:       6978.622 tmp:  14323 E(kev):  10067 pos:   1618 dt(ms):       2696.553 dx(ch):    36
15:03:42 $ANL  ER     ev:   239313 time:       7022.683 tmp:   3256 E(ch):     865 pos:  29659 TOF:   1287
15:03:42 $ANL  ER-AL  ev:   239473 time:       7026.954 tmp:   9281 E(kev):   8232 pos:  29702 dt(ms):       4271.328 dx(ch):    43
15:03:42 $ANL  ER     ev:   239674 time:       7032.418 tmp:    477 E(ch):     713 pos:  25548 TOF:   1499
15:03:42 $ANL  ER-AL  ev:   239801 time:       7035.825 tmp:   7706 E(kev):   7261 pos:  25577 dt(ms):       3406.307 dx(ch):    29
15:03:43 $ANL  ER     ev:   242048 time:       7101.122 tmp:   1079 E(ch):    2006 pos:   1328 TOF:   1404
15:03:43 $ANL  ER-AL  ev:   242100 time:       7102.703 tmp:  14929 E(kev):   8173 pos:   1333 dt(ms):       1581.696 dx(ch):     6
15:03:44 $ANL  ER     ev:   242597 time:       7117.157 tmp:   8563 E(ch):     553 pos:   2397 TOF:   1593
15:03:44 $ANL  ER-AL  ev:   242626 time:       7118.089 tmp:   4625 E(kev):  12254 pos:   2352 dt(ms):        932.137 dx(ch):   -45
15:03:46 $ANL  ER     ev:   247677 time:       7264.954 tmp:   6093 E(ch):     733 pos:  12176 TOF:   1224
15:03:46 $ANL  ER-AL  ev:   247708 time:       7265.769 tmp:    566 E(kev):   8488 pos:  12181 dt(ms):        815.168 dx(ch):     6
15:03:49 $ANL  ER     ev:   252649 time:       7411.835 tmp:   1244 E(ch):     432 pos:   1340 TOF:   1447
15:03:49 $ANL  ER-AL  ev:   252757 time:       7415.089 tmp:   6161 E(kev):  10559 pos:   1290 dt(ms):       3253.460 dx(ch):   -50
```

G Appendix – Ken Gregorich analysis of a Run 13 log file

The contents of one of the Ws-Ftp log files in Ken Gregorich's computer indicates that SLOG_CA_R013.LOG;1 file was copied from vscn::BGS$ROOT:[VNINOV.GOOSY] to Gregorich's computer at 13:49 on July 24, 2001. The contents of the Ws_ftp log file is below.

```
101.06.07 14:48 A C:\My Documents\Word Docs\118\R45.SLOG;2 <-- vscn BGS$ROOT:[GREGORICH] R45.SLOG;2
101.06.13 10:41 A C:\My Documents\Word Docs\118\DUMP110.TXT;2 <-- vscn BGS$ROOT:[GREGORICH] DUMP110.TXT;2
101.06.13 15:15 A C:\My Documents\Word Docs\118\X$ANALR016.PPL;15 <-- csa7 BGS$ROOT:[LOVELAND.GOOSY] X$ANALR016.PPL;15
101.06.14 15:22 A C:\My Documents\Word Docs\118\DUMP120.TXT;2 <-- csa7 BGS$ROOT:[BGS] DUMP120.TXT;2
101.06.14 15:40 A C:\My Documents\Word Docs\118\DUMPFIRST.TXT;1 <-- csa7 BGS$ROOT:[GREGORICH] DUMPFIRST.TXT;1
101.06.14 17:08 A C:\My Documents\Word Docs\118\EVENT2001.TXT;2 <-- csa7 BGS$ROOT:[GREGORICH] EVENT2001.TXT;2
101.07.24 13:49 A C:\My Documents\Word Docs\118\SLOG_CA_R013.LOG;1 <-- vscn BGS$ROOT:[VNINOV.GOOSY] SLOG_CA_R013.LOG;1
101.07.24 13:50 A C:\My Documents\Word Docs\118\R012_CAL.DAT;10 <-- vscn BGS$ROOT:[VNINOV.GOOSY] R012_CAL.DAT;10
101.07.24 13:50 A C:\My Documents\Word Docs\118\GLOG_CA_R013.LOG;1 <-- vscn BGS$ROOT:[VNINOV.GOOSY] GLOG_CA_R013.LOG;1
101.07.24 13:51 A C:\My Documents\Word Docs\118\CLOG_CA_R013.LOG;1 <-- vscn BGS$ROOT:[VNINOV.GOOSY] CLOG_CA_R013.LOG;1
101.07.24 15:36 B C:\My Documents\Word Docs\118\SLOG_A607_R045_LOG.TPU$JOURNAL;1 <-- csa7.lbl.gov BGS$ROOT:[VNINOV]
SLOG_A607_R045_LOG.TPU$JOURNAL;1
101.07.24 15:40 B C:\My Documents\Word Docs\118\SLOG_A607_R045_LOG.TPU$JOURNAL;1 <-- csa7.lbl.gov BGS$ROOT:[VNINOV]
SLOG_A607_R045_LOG.TPU$JOURNAL;1
```

SLOG_CA_R013.LOG; was sent to Augusto Macchiavelli on July 25, 2001. It is interesting to note that the analysis shown in SLOG_CA_R013.LOG;1 was performed on the vsca computer, and the log file was recovered from the vscn computer (vax4000s) whereas the other analyses were performed on the DEC alphas.

Ken Gregorich performed some detailed analysis on SLOG_CA_R013.LOG;1 on September 17, 2001. The first ^{86}Kr + ^{208}Pb experiment (run013) was carried out from April 8-12, 1999. SLOG_CA_R013.LOG;1 has entries starting from 08:55 on April 13, 1999 until 15:04 on April 15, 1999. Entries from 18:18 on April 13, 1999 until 18:39 on April 13, 1999 show a search for recoil-alpha correlations. From 18:18:03 until 18:21:11, the analysis appears to be displaying the time intervals between the recoils and alphas in milliseconds, even though the output format indicates seconds. At 18:30:03, a new version of the analysis is loaded which corrects this problem. The parameter lists shown at 17:45:52 and 18:34:52 show the ER_AL_MAX (the maximum recoil alpha timeinterval) set to 100 seconds and 1000 seconds, respectively. The maximum recoil-alpha time intervals shown in the listings are near 6 seconds, indicating that the high rate of recoil-like events is filling the allocated size of the recoil buffer, preventing the listing of longer recoil-alpha time intervals.

At 18:56:06, a new parameter listing shows the ER_AL_MAX set to 0.1 seconds, turning off the display of most of the recoil-alpha correlations. At 18:56:31, DT_AL_MAX is set to 0.9 (seconds) enabling display of alpha-alpha correlations out to daughter lifetimes of 0.9 seconds. At 19:07:42, the energy limits are set to CHANNELS 2000-3800 (approximately 7-13.5 MeV), and listings of alpha-alpha correlations follow. Gregorich performed an analysis, comparing the list of alpha-alpha correlations in SLOG_CA_R013.LOG;1 to events found in new analyses of the data. Spot checks of individual events in the alpha-alpha correlations in SLOG_CA_R013.LOG;1 indicated that the analysis in SLOG_CA_R013.LOG;1 presented the events accurately. In addition, Gregorich performed an alpha-alpha correlation analysis, using his Windows-based C program using gating conditions similar to those in the later half of SLOG_CA_R013.LOG;1. He found that the alpha-alpha correlation analysis in SLOG_CA_R013.LOG;1 was performing correctly.

The alpha-alpha correlation analysis in SLOG_CA_R013.LOG;1 covers times from 18:57 until 20:21 on April 13, 1999, 09:59 until 10:09 on April 14, 1999 and 08:53 until 15:05 on April 15 1999. Beginning at 09:17:38 on April 15, the T01F020142.LMD file was analyzed. This is the file which should have contained the first of the published chains, shown at the top of Appendix B3. While it should be prominent, this chain does not appear in the analysis begun at 09:17:38. Beginning at 11:34:37, the T01F020146.LMD file was analyzed. This is the file which should have contained the unpublished chain shown at the center of Appendix B3. The $^{293}118$ – $^{289}116$ alpha-alpha correlation should be in the listing from this sort, and it is absent.

CONCLUSION: Analysis was performed on April 15, 1999, showing the ABSENCE of two of the subsequently reported element 118 decay chains.

App-5: LBNL Press Release of July 27, 2001

See next 2 pages attached.

Results of Element 118 Experiment Retracted

The team of Berkeley Lab scientists that announced two years ago the observation of what appeared to be Element 118 – heaviest undiscovered transuranic element at the time – has retracted its original paper after several confirmation experiments failed to reproduce the results.

A technical committee of experts from the Laboratory's physics, supercomputing, and nuclear science divisions is reviewing the data and methodology from that 1999 result. Subsequent re-analyses of the original data with different software codes have been unsuccessful in observing atomic decay patterns, or chains, which would confirm the existence of element 118.

In a brief statement submitted to Physical Review Letters, the same publication in which the original results were announced, the research team stated: "In 1999, we reported the synthesis of element 118 in the (lead-krypton) reaction based upon the observation of three decay chains, each consisting of an implanted heavy atom and six sequential high-energy alpha decays, correlated in time and position. Prompted by the absence of similar decay chains in subsequent experiments, we (along with independent experts) re-analyzed the primary data files from our 1999 experiments. Based on these re-analyses, we conclude that the three reported chains are not in the 1999 data. We retract our published claim for the synthesis of element 118."

"Science is self-correcting," Berkeley Lab Director Charles Shank said. "If you get the facts wrong, your experiment is not reproducible. In this case, not only did subsequent experiments fail to reproduce the data, but also a much more thorough analysis of the 1999 data failed to confirm the events. There are many lessons here, and the lab will extract all the value it can from this event."

The original experiment and two confirmation runs were performed at the Laboratory's 88-inch cyclotron, utilizing a newly installed device called the Berkeley Gas-Filled Separator (BGS). In the experiment, targets of lead were bombarded with an intense beam of high-energy krypton ions. The detected sequence of decay events for elements 118 and 116, if observed, would be consistent with theories that have suggested an “island of stability” for nuclei.

In addition to the confirmation tests at Berkeley, scientists at the GSI laboratory in Germany and the RIKEN lab in Japan were unable to duplicate the original reported results.

Shank said that, in retracting the paper, the experimenters are taking responsibility to clear the record. “The path forward is to learn from the mistakes and to strengthen the resolve to find the answers that nature still hides from us,” he added.

July 27, 2001

##

App-6: Retraction Notice of 9 August 1999 Paper Submitted to PRL

See next 1 page attached.

Retraction: Observation of Superheavy Nuclei Produced in the Reaction of ^{86}Kr with ^{208}Pb [Phys. Rev. Lett. 83, 1104 (1999)]

V. Ninov, K. E. Gregorich, W. Loveland, A. Ghiorso, D. C. Hoffman, D. M. Lee, H. Nitsche, W. J. Swiatecki, U. W. Kirbach, C. A. Laue, J. B. Patin, D. A. Shaughnessy, D. A. Strellis, and P. A. Wilk

(Published)

DOI: PACS numbers: 25.70.Jj, 27.90.+b, 99.10.+g

In our Letter, we reported the synthesis of element 118 in the ^{208}Pb(^{86}Kr, n) reaction based upon the observation of three decay chains, each consisting of an implanted heavy atom and six sequential high-energy alpha decays, correlated in time and position. Prompted by the absence of similar decay chains in subsequent experiments [1–4], we (along with independent experts) reanalyzed the primary data files from our 1999 experiments. Based on these reanalyses, we conclude that the three reported chains are not in the 1999 data.

We retract our published claim for the synthesis of element 118.

[1] S. Hofmann and G. Münzenberg, Rev. Mod. Phys. **72**, 733 (2000).
[2] K. Morimoto *et al.*, in *Tours Symposium on Nuclear Physics IV, Tours, 2000*, AIP Conf. Proc. No. 561 (AIP, New York, 2001), p. 354.
[3] C. Stodel *et al.*, in Ref. [2], p. 344.
[4] K. E. Gregorich *et al.* (to be published).

ACC. CODE **LGE802** AUTHOR **ninov** AIP ID **009138PRL**

App-7: Rejection of Retraction Notice by PRL

See next 2 pages attached.

Subject: Your_manuscript LGE802 Ninov re/author list
Date: Fri, 12 Oct 2001 17:24:02 -0400 (EDT)
From: Physical Review Letters <prl@ridge.aps.org>
To: kegregorich@lbl.gov
CC: lsschroeder@lbl.gov

Dr. Ken Gregorich
MS 88
Lawrence Berkeley Laboratory
Univ. of California
Berkeley, CA 94720
kegregorich@lbl.gov

Re: LGE802
Retraction: Observation of superheavy nuclei produced in the reaction of ^{86}Kr with ^{208}Pb [L $\bf{83}$, 1104 (1999)]
By: V. Ninov, K.E. Gregorich, W. Loveland, A. Ghiorso, et al.

Dear Dr. Gregorich:

Thank you for your email message of 02 October. You agreed that we publish the Retraction/Erratum with the original author list. As you know, we are quite willing to do that. However, we also received a request from the first author, Dr. Ninov, that his name be removed from the author list. As you probably know, we don't publish papers if there is dissent between the authors about the contents. I have discussed the issue with the senior PRL editors including Dr. Sandweiss. It was decided that PRL will publish the Erratum under the following three conditions:

1) The author list must be complete. Normally, we prefer the original author list, in the exact original order; but in this case we would accept a purely alphabetical list and, if you wish, a designated first author. It can be a different person than on the original Letter.

2) Please add the name of J.L. Adams who is presently missing from the list of authors.

3) You may modify the Retraction/Erratum to clarify the reasons that lead to the retraction of the original Letter. Please feel free to insert an appropriate qualifying statement as you see fit. I understand that there may be dissent regarding the conditions under

which the reanalysis of the original data did or did not reveal the original three decay events. We would be quite happy to publish such information to the extent that readers might find it useful for planning their own experiments.

I would appreciate it if you shared the above information with Dr. Ninov.

For your information, I will be at the DNP Meeting in Maui next week. Please feel free to discuss this matter with me in person.

In any event, please let us know how you wish to proceed. You may send us a revised Retraction/Erratum via the usual channels.

I hope the above information is useful. We will wait for your response before we process the Retraction/Erratum further.

Sincerely,

Christopher Wesselborg
Assistant Editor
Physical Review Letters
Email: prl@aps.org
Web: http://prl.aps.org/

App-8: Letter from Piermaria Oddone to L. Schroeder (October 17, 2001)

See next 2 pages attached.

BERKELEY LAB

OFFICE OF THE
DEPUTY DIRECTOR

October 17, 2001

To: Lee Schroeder

From: Pier Oddone

Subject: Report of the Committee for the Technical Review of the Element 118 Program

As you are aware, I have been closely following the work of the Committee for the Technical Review of the Element 118 Program. This committee was appointed by you in June of this year to look into the issues surrounding the inability of our research scientists and others to reproduce the observation of element 118 which was announced and published in Physical Review Letters in 1999. The committee report was issued on October 11, 2001.

The committee has completed a careful and detailed review of the methodology used to collect and analyze the data for the runs in 1999 as well as for the runs in 2000 and 2001.

In its fourth conclusion of the Executive Summary the committee states: "We have found clear evidence that at least one of the 118 element decay chains published in 1999 and the single 2001 candidate decay chain were fabricated. This fabrication was performed by systematically altering data analysis results in order to construct credible 118 element decay chains." [Section 2, paragraph 5]

Based upon my discussions and interactions with the committee and after reviewing their report, it is my opinion that there is sufficient evidence in the report to support the committee's conclusion that the element 118 chains were fabricated. Furthermore, the findings of the committee would support the conclusion that staff scientist Victor Ninov was responsible for the fabrication. Some key findings that support these conclusions are the following:

1. The research group relied on Victor Ninov for the analysis of the data. For all the event chains in question, it was Victor Ninov who reported to have found them to the rest of his colleagues. The committee found that: "In these experiments, the team relied on Victor Ninov to do the analysis of the data. In the 1999 runs it seems that no one else looked for decay chains in the raw data. The chains that were published in 1999 and the one that was considered in 2001 came to the attention of the other members of the experimental team when Victor Ninov reported finding them in the data." [Section 3, paragraph 3]

2. The committee's investigation of the chain reported in 2001 by Victor Ninov shows that the chain does not exist in the data tapes today, nor did it exist only hours after the chain was reported by Victor Ninov. The output of the analysis program, called a log file, which was run only hours after the chain was reported, does not show the chain. The committee states: "This decay chain does not appear later in the log file around 3:04pm, May 7, when the same file is processed again." [Section 5.1, paragraph 5] The log file, however, contains an earlier section at 12:54pm, May 7, that contains very strong evidence of an attempt to modify the log file to make it appear as if the analysis program had actually produced the reported chain. The committee's investigation presents

clear evidence that this apparent chain in the 12:54pm section of the log file was not the product of the analysis program but was copied into the log file to make it appear as if the chain existed in the data. The committee states: "Not only is it clear that the 12:54 section (with the evidence for the reported decay chain) was copied into the log file, we also see that this file (*TEST.LIS*) was edited before it was copied." [Section 5.3.2 paragraph 9]

3. Victor Ninov's records for such an important discovery in 1999 are so meager that they fall outside the normally accepted standards for scientific research. The committee states: "The BGS data analysis has been done in a way that makes it difficult or impossible to check what was done. Much of the analysis, especially in 1999, was done by hand. In fact, the only record available of their discovery is contained on two handwritten pieces of paper" [Section 6, paragraph 3]. Despite this difficulty, the committee has found evidence of fabrication by obtaining files that the computer system automatically saved when editing sessions terminated abnormally. For one of the events in 1999, referred to as the Run 15 event, these files show that, starting with some events in the raw data, events have been modified and added to in order to make a complete element 118 decay chain before being reported out by Victor Ninov to the collaboration. [chronology in Section 5.4] The committee states: "This fabrication was performed by capturing the output of the data analysis program in a text editor and then systematically altering some events and inventing others in order to present data that would appear to be an element 118 decay chain." [Section 7, paragraph 5]

4. Corroborating evidence for fabrication during the 1999 data analysis of Run 13 was provided to the committee by Ken Gregorich and is contained in Appendix G. A log file of the analysis program (called *SLOG_CA_R013.LOG;1*) shows both that the reported chains were not there and that the analysis program was operating correctly. "Gregorich performed an analysis, comparing the list of alpha-alpha correlations in *SLOG_CA_R013.LOG;1* to events found in new analyses of the data. Spot checks of individual events in the alpha-alpha correlations in *SLOG_CA_R013.LOG;1* indicated that the analysis in *SLOG_CA_R013.LOG;1* presented the events accurately." [Appendix G, paragraph 4] So if the decay chains were real, they should have been prominent in the output of the analysis program contained in the log file. Gregorich states, "This is the file which should have contained the first of the published chains, shown at the top of Appendix B3. While it should be prominent, this chain does not appear in the analysis begun at 09:17:38." [Appendix G, paragraph 5] So while Victor Ninov was reporting the decay chains to the rest of the group, the underlying analysis done at the time did not show the reported chains. Gregorich states in his conclusion, "Analysis was performed on April 15, 1999, showing the ABSENCE of two of the subsequently reported element 118 decay chains." [Appendix G, paragraph 6] The reconstructed chronology shows Victor Ninov reporting the decay chains to his colleagues during the same time period. [Section 5.4, BGS Run 13 Chronology]

In view of the above, I believe that you should initiate a review of this matter under the Laboratory's Integrity in Research Policy. These procedures will provide Victor Ninov with an opportunity to address the findings of the committee and the conclusions they support. Please let me know if you have any questions or wish to discuss this matter.

c: C. V. Shank
S. M. Benson

App-9: Letter from L. Schroeder to V. Ninov (October 23, 2001)

See next page attached.

ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
Lee S. Schroeder
Nuclear Science Division
Bldg. 50 Room 4052D ? M/S: 50-4049
Tel: (510) 486-7890 Fax: (510) 486-6003
Email: LSSchroeder@lbl.gov

October 23, 2001

To: Victor Ninov
Nuclear Science Division
MS 88

From: Lee S. Schroeder

Subject: Preliminary Inquiry

As you are aware, I have had a technical committee investigating aspects of the element II 8 program. Their study has been concluded and provided to myself and the appropriate Deputy Directors of the Berkeley Lab.

This is to notify you that questions relating to alleged misconduct in your research h ave come up. I am enclosing a copy of the report of the Committee for the Technical Review of the Element II 8 Program and a letter of October 17, 2001 to me from Deputy Director, Dr. Pier Oddone. In his letter, Dr. Oddone states that it is his opinion that there is sufficient evidence in the report to support the committee's conclusion of fabrication and that their findings also would support the conclusion that you were responsible for the fabrication.

The Laboratory is required to look into such matters in accord with its policy on Integrity in Research that I am enclosing for your information (RPM 2.051).

The policy provides for a two-step process: preliminary inquiry and, if warranted, formal investigation. A preliminary inquiry has been initiated in th is case. Its purpose is to seek to separate allegations deserving of further investigation from unjustified or mistaken allegations in order to determine whether there is sufficient credible evidence of scientific misconduct to warrant a formal investigation. To accomplish this end, I have appointed Dr. Stewart Loken, (ext. 7474) to review the facts and make a recommendation as to whether to proceed to the second, formal investigation stage. Dr. Loken will meet with you and, in addition, if you so choose, y ou may submit a written response.

If you have any questions about this process, please feel free to contact me or Deputy Director Benson, who has overall responsibility for the policy on Integrity in Research.

CC: Stewart Loken
Deputy Director Benson
Deputy Director Oddone

App-10: Letter from L. Schroeder to S. Loken (October 23, 2001)

See next 2 pages attached.

ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
Lee S. Schroeder
Nuclear Science Division
Bldg. 50 Room 4052D• M/S: 50-4049
Tel: (510) 486-7890 Fax: (510) 486-6003
Email: LSSchroeder@lbl.gov

October 23, 2001

To: Stewart Loken
Physics Division
MS 50-4049

From: Lee S. Schroeder

Subject: Preliminary Inquiry

Thank you for agreeing to conduct a preliminary inquiry to examine a question of misconduct in scientific research pursuant to the enclosed LBNL policy on Integrity in Research (RPM 2.05I). This is the first stage of the process for resolving allegations of this nature, and is required to be confidential and completed in an expeditious manner. The only purpose of the inquiry is to determine whether there is sufficient credible evidence of research misconduct to warrant a formal investigation. If a formal investigation is warranted, that investigation will form the basis for the ultimate determination that misconduct did or did not occur.

The preliminary inquiry should be conducted in an objective and fair manner and should seek to separate allegations deserving of further investigation from unjustified or mistaken allegations. Your determination of whether there is sufficient evidence to warrant a formal investigation requires an objective assessment of the credibility of the available information from documents and witnesses. You should request whatever documents and ask whatever questions are necessary to make your determination.

The allegations in this case stem from the enclosed Report of the Committee for the Technical Review of the Element 118 Program and the enclosed letter from Dr. Pier Oddone. The 118 review committee concluded, among other things, that:

> "There is clear evidence that at least one of the 118 element decay chains published in 1999, and also the candidate in the 2001 date, were fabricated. This fabrication was performed by capturing the output of the data analysis program in a text editor and then systematically altering some events and inventing others in order to present date that would appear to be an element 118 decay chain"

In his letter Dr. Oddone states that, in his opinion, there is sufficient evidence in the report to support the committee's conclusion of fabrication and that the findings of the committee also would support the conclusion that staff scientist Victor Ninov was responsible for the fabrication.

In regard to any interview you may wish to conduct, arrangement can be made through my office or directly with the individuals you wish to interview. I have also enclosed a copy of my letter to Victor Ninov informing him of these allegations.

Your written report, which is to be submitted within 25 working days, should state your findings of fact, the evidence on which your findings are based, and your recommendations as whether a formal investigation is warranted.

Please let me know if you have any questions.

CC: Deputy Director Benson
Deputy Director Oddone

App-11: Loken Report (November 16, 2001)

See next 3 pages attached.

BERKELEY LAB

PHYSICS DIVISION

16 November 2001

To: Lee Schroeder
From: Stewart C. Loken
Subject: Element 118 Preliminary Inquiry

This is in response to your request that I conduct a preliminary inquiry into the possibility of scientific misconduct related to the Element 118 Program. Under the LBNL policy on Integrity in Research (RPM 2.05I), the preliminary inquiry is to determine whether there is sufficient credible evidence of research misconduct to warrant a formal investigation.

Process:
I have reviewed the following documents:

- *The Report of the Committee for the Technical review of the Element 118 Program,* Gerald Lynch, Augusto O. Macchiavelli, Charles McParland, and Douglas Olson, October 11, 2001.
- *Observation of Superheavy Nuclei Produced in the Reaction of ^{86}Kr with ^{208}Pb*, V. Ninov, K. E. Gregorich, W. Loveland, A. Ghiorso, D. C. Hoffman, D. M. Lee, H. Nitsche, W. J. Swiatecki, U. W. Kirbach, C. A. Laue, J. L. Adams, J. B. Patin, D. A. Shaughnessy, D. A. Strellis, and P. A. Wilk, pp. 1104-1107, 9 August 1999.
- *Independent Study of the Synthesization of Element 118 at the LBNL 88-Inch Cyclotron (Draft 1.07)*, I-Yang Lee, Brian Fujikawa, Larry Phair, and Kai Vetter, January 25, 2001.
- *Report on the Investigation of the Element 118 Experiments*, Darlene Hoffman et al., June 15, 2001
- Memo from Pier Oddone to Lee Schroeder, October 17, 2001.
- Memo from Lee Schroeder to Victor Ninov, October 23, 2001.

I have met with the following people:

- Gerald Lynch
- Augusto Macchiavelli
- Charles McParland
- Douglas Olson
- Ken Gregorich
- Victor Ninov
- Darlene Hoffman
- Heino Nitsche
- Claude Lyneis
- I-Yang Lee

I have spoken by telephone with:

- Walter Loveland
- Michael Rowe

ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY
ONE CYCLOTRON ROAD | BERKELEY, CALIFORNIA 94720 | TEL: 510.486.5421 | FAX: 510.486.6003

Analysis:

The are a number of key points that emerge from reading of the report of the Technical Review Committee (G. Lynch et al.) and from discussions with the principals in the experiment.

The most important conclusion is that the data were fabricated. The committee states this in its executive summary:
We have found clear evidence that at least one of the 118 element decay chains published in 1999 and the single 2001 candidate decay chain were fabricated. This fabrication was performed by systematically altering data analysis results in order to construct credible 118 element decay chains.

In Section 7, paragraph 5, the committee adds:
This fabrication was performed by capturing the output of the data analysis program in a text editor and then systematically altering some of the events and inventing others in order to present data that would appear to be an element 118 decay chain.

This conclusion was reached following detailed analysis of the experiment log files that led to the decay chains included in the published paper. In some cases, the committee was able to recover journal files from sessions of the VAX editor showing that log files were, in fact modified in the way their report describes.

The committee notes that there are no data to support the publication of the decay chains. In Section 7, Paragraph 2 they state:
The element 118 candidates that were reported from the 1999 and 2001 BGS experiments are not in the data, as it exists today.

The report also concludes that the primary data tapes show no evidence that they have been altered. In appendix D, the committee describes a detailed analysis of Run 45 Tape 8 File 591. It concludes:
It was found that the overall structure of the data file was correct and internally consistent. In particular, all physical buffers were of the correct size with no intervening gaps in buffer Ids. All events had increasing event Ids without intervening gaps and with increasing VMS-style time stamps.

It is clear from the committee report and from conversations with members of the team that Victor Ninov was the only person doing 1999 analysis. In Section 3, Paragraph 3, the report states:
In these experiments, the team relied on Victor Ninov to do the analysis of the data. In the 1999 it seems that no one else looked for decay chains in the raw data. The chains that were published in 1999 and the one that was considered in 2001 came to the attention of the other members of the experimental team when Victor Ninov reported finding them in the data.

This observation is corroborated by interviews with members of the team. Ninov also served as the manager of the VAX cluster on which the analysis was done. In the committee's study of the Run 15 event described in Section 5.3.3, the journal files showing modification of the events were in a VAX directory belonging to the account of [VNINOV]. Victor Ninov appears to have been the only person who had the opportunity and the expertise to fabricate the events leading to the 1999 publication.

A crucial piece of information, the file, SLOG_CA_R013.LOG;1, was given to the committee by Ken Gregorich on July 25, 2001. In appendix G, the committee states:

This file was copied from the directory vscn::BGS$ROOT:[VNINOV.GOOSY] to Gregoririch's computer at 13:49 on July, 2001.

The name of the directory, *[VNINOV.GOOSY]* indicates that it belonged to V. Ninov. The file shows an analysis that was carried out on a different VAX system from the one used for most of the analysis in 1999. They note:

It is interesting to note that the analysis shown in SLOG_CA_R013.LOG;1 was performed on the vscn computer, and the log file was recovered from the vscn computer (vax4000s) whereas the other analyses were performed on the DEC alphas.

The report goes on to say:

Gregorich performed an analysis comparing the list of alpha-alpha correlations in SLOG_CA_R013.LOG;1 to events found in new analyses of the data. Spot checks of individual events in the alpha-alpha correlations in SLOG_CA_R013.LOG;1 indicated that the analysis in SLOG_CA_R013.LOG;1 presented the events accurately.

That analysis is described in Appendix G of the committee's report, which states:

CONCLUSION: Analysis was performed on April 15, 1999, showing the ABSENCE of two of the subsequently reported element 118 decay chains.

At the same time that this analysis was done on April 15, 1999, Victor Ninov was claiming the existence of the event shown in appendix B3 of the report of the committee.

Comments by Victor Ninov:

Victor Ninov still declares that the discovery was real and should not be retracted. He agrees that the log files were modified but says that the modification did not put the published events into those files. He says that the primary data tapes were also modified to eliminate the element 118 events shown in the log files. He also claims that people in other experiments at the 88 were angry that the BGS Program was getting so much beam time and that some unidentified person made the changes to disrupt and discredit the experiment. He claims that the tapes could have been changed by anyone with knowledge of the analysis program. These claims contradict the evidence presented by the Technical Committee. In particular, there is no evidence to support his contention that the primary tapes or disk files of the primary data have been altered.

It is important to note that Victor never suggested the possibility that the data had been altered during the analysis of the 1999 data or during the preparation of the publication. According to all team members, Victor Ninov was the person who brought the analysis program to Berkeley and was the undisputed expert on the analysis program. It is highly likely that Victor would have detected any modifications to files and would have seen that the data were fabricated had the modifications been done by anyone else.

Conclusion:

There exists clear and compelling evidence that data related to the reported discovery of Element 118 were deliberately fabricated to produce a result that is not supported by the primary data from the experiment. In addition, there is clear evidence that the data were fabricated by Victor Ninov and presented by him to his collaborators as evidence for the discovery. Based on this analysis, there is no question that there should be a formal investigation under the provisions of the policy on Integrity in Research.

App-12: Letter from L. Schroeder to V. Ninov (November 21, 2001)

See next page attached.

Lee S. Schroeder, Director
Nuclear Science Division
(510) 486-7890
lsschroeder@lbl.gov

November 21, 2001

To: Victor Ninov
Nuclear Science Division
MS 88

From: Lee S. Schroeder

Re: Formal Investigation—Paid Leave

The preliminary inquiry into the alleged question of scientific misconduct has been concluded. A copy of the report containing the recommendation to proceed to a formal investigation is enclosed. I will be appointing a committee to conduct a formal investigation into the allegation that you have engaged in scientific misconduct. You will be hearing from the committee in the near future. As in my letter of October 23, 2001, for your information I am enclosing the Laboratory's policy on Integrity in Research (RPM 2.05I).

In addition, it is my view that while the formal investigation is being undertaken, it would be best for all parties, including the Laboratory, yourself and the heavy element group, if you were not present at the Berkeley Laboratory during this period. It is therefore my decision to place you on paid leave beginning today, November 21, 2001, and continuing until further notice.

If you need to return to the Laboratory during this leave for any reason, please call me so that we may discuss your request. Also, if you have any other questions regarding this leave or the issues related to it, please let me know.

cc: Deputy Sally M. Benson

App-13: Letter from L. Schroeder to V. Ninov (November 28, 2001)

See next page attached.

Lee S. Schroeder, Director
Nuclear Science Division
(510) 486-7890
lsschroeder@lbl.gov

November 28, 2001

To: Victor Ninov
729 North Tuxedo
Stockton, CA 95204

From: Lee S. Schroeder

Re: Formal Investigation—Committee Letter and Documents

Enclosed is a copy of the letter sent to the chair of the committee charged with conducting the formal investigation into your alleged misconduct in scientific research surrounding element 118. For your information I am also enclosing Stewart Loken's report, as well as documents he gathered in his preliminary inquiry.

I expect that the formal investigation will begin in the very near future. I anticipate that the chair of the committee will be in contact with you at that time.

I remind you that should you need to return to the Laboratory for any reason during this period, please call me (510-486-7890) so that we may discuss your request. Again, if you have any questions regarding your leave, issues related to it or the upcoming formal investigation, please let me know.

cc: Deputy Sally M. Benson
Committee chair: Prof. Robbie Vogt

App-14: Letter from L. Schroeder to R. Vogt (November 28, 2001)

See next 2 pages attached.

Lee S. Schroeder, Director
Nuclear Science Division
(510) 486-7890
lsschroeder@lbl.gov

November 28, 2001

To: Prof. Robbie Vogt
MS 103-33
California Inst. of Technolgy
Pasadena, California 91125

From: Lee S. Schroeder

Re: Formal Investigation of Alleged Scientific Misconduct

This is to confirm that you have agreed to serve as chair of a committee to conduct a formal investigation into alleged misconduct in scientific research by LBNL staff scientist Dr. Victor Ninov. Other members of the committee are: Dr. Gil Gilchriese (LBNL), Dr. Andrew Sessler (LBNL) and Prof. George Trilling (UCB Physics and LBNL). I am enclosing a copy of the preliminary inquiry report from Dr. Stewart Loken and the several documents that were provided and reviewed by him in reaching his conclusions and recommendations.

The formal investigation is to be conducted in a confidential and expeditious manner in accordance with the Laboratory's policy on Integrity in Research (RMP 2.05I, copy enclosed). The charge to your committee is to determine whether or not the alleged scientific misconduct occurred. You should be aware, however, that the decision to initiate an investigation does not represent any presumption that research misconduct has taken place. Rather, it reflects only a judgment that a thorough, formal investigation to examine the facts and circumstances is warranted. The term "misconduct in scientific research' is defined by Laboratory policy as "fabrication, falsification, plagiarism, or other similar practices that occur in the course of proposing, conducting, or reporting research." It does not include honest error or honest differences in interpretations or judgments of data.

The committee is to conduct its investigation in an objective and fair manner based upon all available information from documents and interviews and, at its discretion, may seek the advice of experts or others to assist its investigation. You should feel free to request whatever documents you may need and ask whatever questions you believe are necessary to your determination. Your task is a difficult one and a careful, focused, and objective review is essential.

The investigation should be completed in 45 working days or less and contain sufficient discussion of the allegations and information reviewed to provide a basis for your findings and any recommendations.

cc: Sally Benson
Pier Oddone
Committee members (Gilchriese, Sessler, Trilling)

App-15: Federal Policy on Research Misconduct

See next 5 pages attached.

reference the ''Tokeland Cow Dip Pit CERCLA Site'' and EPA Docket No. CERCLA–10–97–0043 and should be addressed to Ms. Shillcutt at the above address.

FOR FURTHER INFORMATION CONTACT: Jennifer Byrne, Assistant Regional Counsel, EPA Region 10, Office of Regional Counsel, 1200 Sixth Avenue, Seattle, Washington 98101, telephone number (206) 553–0050.

Dated: November 21, 2000.

Charles E. Findley,

Acting Regional Administrator, Region 10.

[FR Doc. 00–30909 Filed 12–5–00; 8:45 am]

BILLING CODE 6560–50–U

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Executive Office of the President; Federal Policy on Research Misconduct; Preamble for Research Misconduct Policy

AGENCY: Office of Science and Technology Policy.

ACTION: Notification of Final Policy.

SUMMARY: The Office of Science and Technology Policy (OSTP) published a request for public comment on a proposed Federal research misconduct policy in the October 14, 1999 **Federal Register** (pp. 55722–55725). OSTP received 237 sets of comments before the public comment period closed on December 13, 1999. After consideration of the public comments, the policy was revised and has now been finalized. This notice provides background information about the development of the policy, explains how the policy has been modified, and discusses plans for its implementation.

EFFECTIVE DATE: December 6, 2000.

FOR FURTHER INFORMATION CONTACT: Holly Gwin, Office of Science and Technology Policy, Executive Office of the President, Washington, DC 20502. Tel: 202–456–6140; Fax: 202–456–6021; e-mail: hgwin@ostp.eop.gov.

SUPPLEMENTARY INFORMATION: Advances in science, engineering, and all fields of research depend on the reliability of the research record, as do the benefits associated with them in areas such as health and national security. Sustained public trust in the research enterprise also requires confidence in the research record and in the processes involved in its ongoing development. For these reasons, and in the interest of achieving greater uniformity in Federal policies in this area, the National Science and Technology Council (NSTC) initiated discussions in April 1996 on the development of a research misconduct policy. The Office of Science and Technology Policy (OSTP) provided leadership and coordination. The NSTC approved the proposed draft policy in May 1999, clearing the way for the October 14, 1999 **Federal Register** notice. Public comments in response to that notice have been reviewed. The purpose of this notice is to provide information about the policy as it has now been finalized.

This policy applies to federally-funded research and proposals submitted to Federal agencies for research funding. It thus applies to research conducted by the Federal agencies, conducted or managed for the Federal government by contractors, or supported by the Federal government and performed at research institutions, including universities and industry.

The policy establishes the scope of the Federal government's interest in the accuracy and reliability of the research record and the processes involved in its development. It consists of a definition of research misconduct and basic guidelines for the response of Federal agencies and research institutions to allegations of research misconduct.

The Federal agencies that conduct or support research will implement this policy within one year of the date of publication of this notice. An NSTC interagency research misconduct policy implementation group has been established to help achieve uniformity across the Federal agencies in implementation of the research misconduct policy. In some cases, this may require agencies to amend or replace extant regulations addressing research misconduct. In other cases, agencies may need to put new regulations in place or implement the policy through administrative mechanisms.

The policy addresses research misconduct. It does not supersede government or institutional policies or procedures for addressing other forms of misconduct, such as the unethical treatment of human research subjects or mistreatment of laboratory animals used in research, nor does it supersede criminal or other civil law. Agencies and institutions may address these other issues as authorized by law and as appropriate to their missions and objectives.

Summary of Comments

The Office of Science and Technology Policy received 237 comments on the proposed Federal Research Misconduct Policy. Letters were signed by individuals, and by representatives of universities, university associations, Federal agencies, and private entities. Comments are available for review. Comments that resulted in a modification of the policy are summarized below. A section that addresses other questions raised by the comments follows the summary of modifications.

Uniform Federal Policy

Issue: Many comments recommended various mechanisms to ensure uniform implementation of this policy.

Response: An NSTC research misconduct policy implementation group has been formed to foster uniformity among the agencies in their implementation of the policy.

Section I: Research Misconduct Defined

Issue: A number of comments suggested that the definition of fabrication be modified to read as follows: ''Fabrication is making up data or results and recording or reporting them.'' (Italicized words are suggested addition.) This change is to clarify that the raw data collected or generated in the research process can be fabricated just as can the results of the research.

Response: This change was accepted.

Issue: A number of commenters interpreted the definition of plagiarism to imply that using material gathered during the peer review process was acceptable as long as it is cited.

Response: The policy is intended to address the problem of reviewers who take material from the peer review process and use it without attribution. This constitutes plagiarism. We have deleted the phrase ''including those obtained through confidential review of others' research proposals and manuscripts'' to avoid any appearance of condoning a breach of confidentiality in the peer review process.

Issue: Despite general support for the rationale for the phrase ''does not include honest error or honest differences of opinion,'' several comments requested various clarifications.

Response: This phrase is intended to clarify that simple errors or mere differences of judgment or opinion do not constitute research misconduct. The phrase does not create a separate element of proof. Institutions and agencies are not required to disprove possible ''honest error or differences of opinion.'' The phrase has been retained, with the deletion of the second ''honest'' of the phrase as redundant.

Issue: A number of comments raised questions about what fields of research are included in the definition of research. For example, some readers were unsure about the applicability of the policy as written to medicine or the social sciences.

Response: The policy applies to research funded by the Federal agencies. In order to be responsive to specific inquiries about what fields of research are covered by the policy, an illustrative, non-exclusive list of selected fields of research is now included in the policy itself.

Section II: Findings of Research Misconduct

Issue: Several comments stressed the need for greater precision in the phrase ''significant departure from accepted practices of the scientific community.''

Response: This phrase is intended to make it clear that behavior alleged to involve research misconduct should be assessed in the context of community practices, meaning practices that are generally understood by the community but that may not be in a written form. For clarification purposes and in order to be more comprehensive, the term ''scientific community'' has been modified to read ''relevant research community.'' The policy is not intended to ratify those ''accepted practices'' but rather to indicate that these may vary among different communities.

Issue: Several comments requested clarification regarding the level of intent that is required to be shown in order to reach a finding of research misconduct.

Response: Under the policy, three elements must be met in order to establish a finding of research misconduct. One of these elements is a showing that the subject had the requisite level of intent to commit the misconduct. The intent element is satisfied by showing that the misconduct was committed ''intentionally, or knowingly, or recklessly.'' Only one of these needs to be demonstrated in order to satisfy this element of a research misconduct finding.

Section III: Responsibilities of Federal Agencies and Research Institutions

Issue: Some comments indicated that this section could be incorrectly construed to require appeal of the agency misconduct finding back to the institution.

Response: The policy has been clarified to affirm that each agency should establish an appeals process for persons found by the agency to have engaged in research misconduct. The subject of the agency finding cannot appeal the agency decision back to the institution, although some institutions do offer an appeal of the institutional finding at the institutional level.

Section IV: Guidelines for Fair and Timely Procedures

Issue: The comments indicated some uncertainty about to whom the actions section applied.

Response: The actions delineated are those that may be taken by the Federal agencies if research misconduct has been shown to have occurred. The section has thus been renamed ''Agency Administrative Actions.''

Issue: The suggestion was made that publications based on false or fabricated data, or including such data, should be required to be officially withdrawn.

Response: Correction of the research record has been added to the list of possible actions to be taken if a researcher is found to have engaged in research misconduct.

Issue: The suggestion was made that safeguards for informants and subjects of allegations be made more explicit.

Response: More explicit safeguards have been added to the policy for both informants and subjects.

Other Comments

Several comments and clarifications are addressed in the following question and answer format rather than through modification of the policy.

Will agencies be required to announce the details of their implementation plans? Yes. Agencies will announce the details of their implementation plans, including those plans that do not require formal rulemaking.

What types of misconduct are covered by this policy? This policy is limited to addressing misconduct related to the conduct and reporting of research, as distinct from misconduct that occurs in the research setting but that does not affect the integrity of the research record, such as misallocation of funds, sexual harassment, and discrimination. This policy does not limit agencies or research institutions from addressing these other issues under appropriate policies, rules, regulations, or laws. In addition, should the behavior associated with research misconduct also trigger the applicability of other laws (including criminal law) this policy is not intended to limit agencies or research institutions from pursuing these matters under separate authorities.

Does this policy address misrepresentation of a researcher's credentials or publications? Yes, misrepresentation of a researcher's qualifications or ability to perform the research in grant applications or similar submissions may constitute falsification or fabrication in proposing research.

Are authorship disputes covered by this policy? Authorship disputes are not covered by this policy unless they involve plagiarism.

Does research misconduct include the mistreatment of human subjects or animals in research? This policy addresses activity that occurs in the course of human subjects or animal research that involves research misconduct as defined by the policy. Thus, falsification, fabrication, or plagiarism that occurs during the course of human or animal research is addressed by this policy. However, other issues concerning the ethical treatment of human or animal subjects are covered under separate procedures and are not affected by this policy.

Why doesn't the policy provide immunity for research misconduct investigative committees? Providing immunity to research misconduct investigative committees and other participants in institutional and agency research misconduct proceedings would require significant statutory or regulatory initiatives which will be explored separately from this policy.

Aren't there circumstances when omission of data or results is appropriate? A number of commenters suggested that there are circumstances when it may be appropriate to omit data in reporting research results. It is not the intent of this policy to call accepted practices into question. However, the omission of data is considered falsification when it misleads the reader about the results of the research.

Does this policy supersede institutional policies regarding research misconduct? Non-federal research institutions have authority to establish policies for research and employee misconduct that serve their own institutional purposes. However, the Federal research misconduct policy (as implemented by the agencies) provides the relevant guidance to institutions for purposes of Federal action.

Does this policy supersede other agency policies, procedures, rules, and regulations? Agencies must comply with all relevant Federal personnel policies and laws in responding to allegations of research misconduct. However, personnel actions may not adequately protect the public from the consequences of falsified, fabricated or plagiarized research. For example, Federal personnel policies may permit termination of an employee who commits research misconduct, but may not address the problem of research misconduct or seek to prevent it from recurring. The administrative actions available under the Federal research misconduct policy, such as debarment from federal funding, supervision and certification of research, and correction of the literature, are designed to specifically address the problems raised by research misconduct.

Must all three elements in the Finding of Research Misconduct section be present for there to be a finding of research misconduct? Yes.

Who makes the final determination about whether or not there is a finding of research misconduct? The Federal agency will make the final decision about whether to make an agency finding of research misconduct. However, within its own internal jurisdiction, a non-Federal research institution may establish policies and take actions as appropriate to its needs and as consistent with other relevant laws.

Shouldn't the burden of proof be more stringent, e.g., require "clear and convincing evidence" to support a finding of research misconduct? While much is at stake for a researcher accused of research misconduct, even more is at stake for the public when a researcher commits research misconduct. Since "preponderance of the evidence" is the uniform standard of proof for establishing culpability in most civil fraud cases and many federal administrative proceedings, including debarment, there is no basis for raising the bar for proof in misconduct cases which have such a potentially broad public impact. It is recognized that non-Federal research institutions have the discretion to apply a higher standard of proof in their internal misconduct proceedings. However, when their standard differs from that of the Federal government, research institutions must report their findings to the appropriate Federal agency under the applicable Federal government standard, i.e., preponderance.

Why don't the Federal agencies conduct all inquiries and investigations? Research institutions are much closer to what is going on in their own institutions and are in a better position to conduct inquiries and investigations than are the Federal agencies. While the Federal agencies could have taken on the task of investigating all allegations of research misconduct, or established a separate agency for this purpose, this would have involved a substantial new Federal bureaucracy, which is not thought desirable. An agency may take steps, as appropriate, should a research institution demonstrate a lack of commitment to the policy's guidelines.

How will a lead agency be identified? If more than one Federal agency has jurisdiction over allegations of research misconduct, those agencies should work together to designate a lead agency.

What criteria will be used for selecting the research institution that will handle the response to the allegation of research misconduct? In most cases, agencies will rely on the researcher's home institution to respond to allegations of research misconduct. However, in cases where the subject has switched institutions, it may be more appropriate for the institution where the alleged research misconduct occurred to respond to the allegation. The institution where the questioned research was conducted may have better access to the evidence and witnesses and therefore will have the capability to undertake a more efficient and thorough response.

Shouldn't the policy be more explicit about time lines for a response to allegations of misconduct? In establishing reasonable time lines the Federal agencies must balance the interests of concluding the process expeditiously while ensuring it has been conducted fairly and thoroughly. This will allow flexibility for the research institutions while at the same time ensuring that the process does not extend for an unreasonably long period. Research institutions should have the option to request reasonable extensions of agency timelines in individual cases.

What can informants or subjects of allegations expect with regard to confidentiality? The policy strives for confidentiality for all involved to the extent consistent with a fair and thorough process and as allowed by law, including applicable Federal and state freedom of information and privacy laws.

Should the policy punish informants who act in bad faith or individuals who harass informants? The principal aim of this policy is to communicate to the research community those behaviors that constitute research misconduct and to take actions where research misconduct is found to have occurred. As employers and managers of the research, non-Federal research institutions may adopt policies to address the consequences of false, malicious, or capricious allegations and to respond to retaliation against informants. Agencies may also address this issue in their implementation of this policy.

How should the "seriousness" of the research misconduct be evaluated and how will this relate to any actions taken? In determining what action to take, agencies should fully consider the level of intent of the misconduct, the consequences of the behavior, and other aggravating and mitigating factors.

Next Steps

The Federal agencies have up to one year from the date of publication of this notice to implement the policy. An interagency implementation group has been established under the auspices of the National Science and Technology Council to assist agencies in their implementation process and to strive for the highest level of uniformity possible and as appropriate in their implementation plans.

Federal Policy on Research Misconduct [1]

I. Research [2] Misconduct Defined

Research misconduct is defined as fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results.

- Fabrication is making up data or results and recording or reporting them.
- Falsification is manipulating research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.[3]
- Plagiarism is the appropriation of another person's ideas, processes, results, or words without giving appropriate credit.
- Research misconduct does not include honest error or differences of opinion.

II. Findings of Research Misconduct

A finding of research misconduct requires that:

- There be a significant departure from accepted practices of the relevant research community; and
- The misconduct be committed intentionally, or knowingly, or recklessly; and
- The allegation be proven by a preponderance of evidence.

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[1] No rights, privileges, benefits or obligations are created or abridged by issuance of this policy alone. The creation or abridgment of rights, privileges, benefits or obligations, if any, shall occur only upon implementation of this policy by the Federal agencies.

[2] Research, as used herein, includes all basic, applied, and demonstration research in all fields of science, engineering, and mathematics. This includes, but is not limited to, research in economics, education, linguistics, medicine, psychology, social sciences, statistics, and research involving human subjects or animals.

[3] The research record is the record of data or results that embody the facts resulting from scientific inquiry, and includes, but is not limited to, research proposals, laboratory records, both physical and electronic, progress reports, abstracts, theses, oral presentations, internal reports, and journal articles.

III. Responsibilities of Federal Agencies and Research Institutions [4]

Agencies and research institutions are partners who share responsibility for the research process. Federal agencies have ultimate oversight authority for Federally funded research, but research institutions bear primary responsibility for prevention and detection of research misconduct and for the inquiry, investigation, and adjudication of research misconduct alleged to have occurred in association with their own institution.

• *Agency Policies and Procedures.* Agency policies and procedures with regard to intramural as well as extramural programs must conform to the policy described in this document.

• *Agency Referral to Research Institution.* In most cases, agencies will rely on the researcher's home institution to make the initial response to allegations of research misconduct. Agencies will usually refer allegations of research misconduct made directly to them to the appropriate research institution. However, at any time, the Federal agency may proceed with its own inquiry or investigation. Circumstances in which agencies may elect not to defer to the research institution include, but are not limited to, the following: the agency determines the institution is not prepared to handle the allegation in a manner consistent with this policy; agency involvement is needed to protect the public interest, including public health and safety; the allegation involves an entity of sufficiently small size (or an individual) that it cannot reasonably conduct the investigation itself.

• *Multiple Phases of the Response to an Allegation of Research Misconduct.* A response to an allegation of research misconduct will usually consist of several phases, including: (1) an *inquiry*—the assessment of whether the allegation has substance and if an investigation is warranted; (2) an *investigation*—the formal development of a factual record, and the examination of that record leading to dismissal of the case or to a recommendation for a finding of research misconduct or other appropriate remedies; (3) *adjudication*—during which recommendations are reviewed and appropriate corrective actions determined.

[4] The term "research institutions" is defined to include all organizations using Federal funds for research, including, for example, colleges and universities, intramural Federal research laboratories, Federally funded research and development centers, national user facilities, industrial laboratories, or other research institutes. Independent researchers and small research institutions are covered by this policy.

• *Agency Follow-up to Institutional Action.* After reviewing the record of the investigation, the institution's recommendations to the institution's adjudicating official, and any corrective actions taken by the research institution, the agency will take additional oversight or investigative steps if necessary. Upon completion of its review, the agency will take appropriate administrative action in accordance with applicable laws, regulations, or policies. When the agency has made a final determination, it will notify the subject of the allegation of the outcome and inform the institution regarding its disposition of the case. The agency finding of research misconduct and agency administrative actions can be appealed pursuant to the agency's applicable procedures.

• *Separation of Phases.* Adjudication is separated organizationally from inquiry and investigation. Likewise, appeals are separated organizationally from inquiry and investigation.

• *Institutional Notification of the Agency.* Research institutions will notify the funding agency (or agencies in some cases) of an allegation of research misconduct if (1) the allegation involves Federally funded research (or an application for Federal funding) and meets the Federal definition of research misconduct given above, and (2) if the institution's inquiry into the allegation determines there is sufficient evidence to proceed to an investigation. When an investigation is complete, the research institution will forward to the agency a copy of the evidentiary record, the investigative report, recommendations made to the institution's adjudicating official, and the subject's written response to the recommendations (if any). When a research institution completes the adjudication phase, it will forward the adjudicating official's decision and notify the agency of any corrective actions taken or planned.

• *Other Reasons to Notify the Agency.* At any time during an inquiry or investigation, the institution will immediately notify the Federal agency if public health or safety is at risk; if agency resources or interests are threatened; if research activities should be suspended; if there is reasonable indication of possible violations of civil or criminal law; if Federal action is required to protect the interests of those involved in the investigation; if the research institution believes the inquiry or investigation may be made public prematurely so that appropriate steps can be taken to safeguard evidence and protect the rights of those involved; or if the research community or public should be informed.

• *When More Than One Agency is Involved.* A lead agency should be designated to coordinate responses to allegations of research misconduct when more than one agency is involved in funding activities relevant to the allegation. Each agency may implement administrative actions in accordance with applicable laws, regulations, policies, or contractual procedures.

IV. Guidelines for Fair and Timely Procedures

The following guidelines are provided to assist agencies and research institutions in developing fair and timely procedures for responding to allegations of research misconduct. They are designed to provide safeguards for subjects of allegations as well as for informants. Fair and timely procedures include the following:

• *Safeguards for Informants.* Safeguards for informants give individuals the confidence that they can bring allegations of research misconduct made in good faith to the attention of appropriate authorities or serve as informants to an inquiry or an investigation without suffering retribution. Safeguards include protection against retaliation for informants who make good faith allegations, fair and objective procedures for the examination and resolution of allegations of research misconduct, and diligence in protecting the positions and reputations of those persons who make allegations of research misconduct in good faith.

• *Safeguards for Subjects of Allegations.* Safeguards for subjects give individuals the confidence that their rights are protected and that the mere filing of an allegation of research misconduct against them will not bring their research to a halt or be the basis for other disciplinary or adverse action absent other compelling reasons. Other safeguards include timely written notification of subjects regarding substantive allegations made against them; a description of all such allegations; reasonable access to the data and other evidence supporting the allegations; and the opportunity to respond to allegations, the supporting evidence and the proposed findings of research misconduct (if any).

• *Objectivity and Expertise.* The selection of individuals to review allegations and conduct investigations who have appropriate expertise and have no unresolved conflicts of interests help to ensure fairness throughout all phases of the process.

• *Timeliness.* Reasonable time limits for the conduct of the inquiry, investigation, adjudication, and appeal phases (if any), with allowances for extensions where appropriate, provide confidence that the process will be well managed.

• *Confidentiality During the Inquiry, Investigation, and Decision-Making Processes.* To the extent possible consistent with a fair and thorough investigation and as allowed by law, knowledge about the identity of subjects and informants is limited to those who need to know. Records maintained by the agency during the course of responding to an allegation of research misconduct are exempt from disclosure under the Freedom of Information Act to the extent permitted by law and regulation.

V. Agency Administrative Actions

• *Seriousness of the Misconduct.* In deciding what administrative actions are appropriate, the agency should consider the seriousness of the misconduct, including, but not limited to, the degree to which the misconduct was knowing, intentional, or reckless; was an isolated event or part of a pattern; or had significant impact on the research record, research subjects, other researchers, institutions, or the public welfare.

• *Possible Administrative Actions.* Administrative actions available include, but are not limited to, appropriate steps to correct the research record; letters of reprimand; the imposition of special certification or assurance requirements to ensure compliance with applicable regulations or terms of an award; suspension or termination of an active award; or suspension and debarment in accordance with applicable government-wide rules on suspension and debarment. In the event of suspension or debarment, the information is made publicly available through the List of Parties Excluded from Federal Procurement and Nonprocurement Programs maintained by the U.S. General Services Administration. With respect to administrative actions imposed upon government employees, the agencies must comply with all relevant federal personnel policies and laws.

• *In Case of Criminal or Civil Fraud Violations.* If the funding agency believes that criminal or civil fraud violations may have occurred, the agency shall promptly refer the matter to the Department of Justice, the Inspector General for the agency, or other appropriate investigative body.

VI. Roles of Other Organizations

This Federal policy does not limit the authority of research institutions, or other entities, to promulgate additional research misconduct policies or guidelines or more specific ethical guidance.

Barbara Ann Ferguson,

Assistant Director for Budget and Administration, Office of Science and Technology Policy.

[FR Doc. 00–30852 Filed 12–5–00; 8:45 am]

BILLING CODE 3170–01–P

FEDERAL COMMUNICATIONS COMMISSION

Notice of Public Information Collection(s) Being Reviewed by the Federal Communications Commission

November 27, 2000.

SUMMARY: The Federal Communications Commission, as part of its continuing effort to reduce paperwork burden invites the general public and other Federal agencies to take this opportunity to comment on the following information collection(s), as required by the Paperwork Reduction Act of 1995, Public Law 104–13. An agency may not conduct or sponsor a collection of information unless it displays a currently valid control number. No person shall be subject to any penalty for failing to comply with a collection of information subject to the Paperwork Reduction Act (PRA) that does not display a valid control number. Comments are requested concerning (a) whether the proposed collection of information is necessary for the proper performance of the functions of the Commission, including whether the information shall have practical utility; (b) the accuracy of the Commission's burden estimate; (c) ways to enhance the quality, utility, and clarity of the information collected; and (d) ways to minimize the burden of the collection of information on the respondents, including the use of automated collection techniques or other forms of information technology.

DATES: Written comments should be submitted on or before January 5, 2001. If you anticipate that you will be submitting comments, but find it difficult to do so within the period of time allowed by this notice, you should advise the contact listed below as soon as possible.

ADDRESSES: Direct all comments to Judy Boley, Federal Communications Commission, Room 1–C804, 445 12th Street, SW, DC 20554 or via the Internet to *jboley@fcc.gov.*

FOR FURTHER INFORMATION CONTACT: For additional information or copies of the information collection(s), contact Judy Boley at 202–418–0214 or via the Internet at *jboley@fcc.gov.*

SUPPLEMENTARY INFORMATION:

OMB Control No.: 3060–0951.

Title: Service of Petitions for Preemption, 47 CFR 1.1204(b) Note and 1.1206(a) Note 1.

Form No.: N/A.

Type of Review: Extension of a currently approved collection.

Respondents: Individuals or households; businesses or other for-profit, not-for-profit institutions and state, local or tribal government.

Number of Respondents: 125.

Estimated Time Per Response: 15 minutes.

Frequency of Response: On occasion reporting requirement and third party disclosure requirement.

Total Annual Burden: 30 hours.

Total Annual Cost: N/A.

Needs and Uses: These provisions supplement the procedures for filing petitions seeking Commission preemption of state and local government regulation of telecommunications services. They require that such petitions, whether in the form of a petition for rulemaking or a petition for declaratory ruling, be served on all state and local governments. The actions for which as cited as a basis for requesting preemption. Thus, in accordance with these provisions, persons seeking preemption must serve their petitions not only on the state or local government whose authority would be preempted, but also on other state or local governments whose actions are cited in the petition.

OMB Control No.: 3060–0937.

Title: Establishment of a Class A Television Service, MM Docket No. 00–10.

Form No.: N/A.

Type of Review: Extension of a currently approved collection.

Respondents: Businesses or other for-profit.

Number of Respondents: 1,000 respondents; 19,370 responses.

Estimated Time Per Response: .166 hours to 52 hours.

Frequency of Response: Recordkeeping requirement, on occasion and quarterly reporting requirement and third party disclosure requirement.

Total Annual Burden: 396,251 hours.

Total Annual Cost: $2,284,000.

Needs and Uses: The Community Broadcasters Protection Act directed the Commission to make Class A television licensees subject to the same operating requirements as that of full-service broadcast stations. The Commission has

App-16: LBNL Policy on Integrity in Research

See next 5 pages attached.

Lawrence Berkeley National Laboratory
Regulations and Procedures Manual (RPM)
Section 2.05 I

I. INTEGRITY IN RESEARCH

1. General

Integrity of the research enterprise is crucial to the search for new knowledge. All individuals involved in scientific research at the Laboratory have an obligation to create an environment that encourages absolute intellectual honesty. Open communication, an emphasis on quality (not quantity) of research and publications, rigorous peer review, appropriate supervision of personnel, maintenance of accurate and detailed research procedures and results, and suitable assignment of credit and responsibility for research and publications are all necessary to foster intellectual honesty.

Conduct or activities that fall short of the basic ethical principles inherent in the research process undermine the scientific enterprise in ways that go far beyond the waste of public funds. Although uncommon relative to the large body of scientific literature, violations of accepted standards occur. As an institution engaged in research, the Laboratory has a responsibility for dealing with allegations of such misconduct fairly, effectively, and expeditiously. In accomplishing this, however, it is important not to create an atmosphere that discourages openness and creativity. Moreover, as is noted in the definition below, it is particularly important to distinguish misconduct in scientific research from the honest error and ambiguities of interpretation that are inherent in the scientific process and normally corrected by further research.

2. Purpose

This policy provides (a) the basis for uniform procedures for dealing with instances of alleged “misconduct in scientific research,” as that term is defined below, and (b) the authority for the administration of such procedures.

3. Definition

“Misconduct in scientific research” is defined for purposes of this policy as “fabrication, falsification, plagiarism, or other similar practices that occur in the course of proposing, conducting, or reporting research.” Not included in this definition are honest error or honest differences in interpretations of judgments of data.

4. Policy

It is the policy of the Laboratory to provide an environment that promotes integrity, to require the highest ethical standards from all individuals involved in scientific research, and to inquire into and, if necessary, investigate and resolve promptly and fairly all instances of alleged misconduct in scientific research. Any individual found to have engaged in such misconduct may be subject to disciplinary or corrective action in accordance with applicable Laboratory policies and procedures.

5. Applicability

These policies and procedures apply to all instances of alleged misconduct in scientific research at the Laboratory and to all individuals involved in such research (e.g., scientists, graduate students, and administrative and technical staff).

6. Authority

The Deputy Director for Operations (DDO) has overall responsibility for the development of this policy and the procedures for its implementation. The division director in whose program area the misconduct is alleged to have occurred (the cognizant division director) is responsible for enforcing this policy and carrying out its procedures.

7. Procedures for Handling Allegations of Misconduct in Scientific Research

a.Reporting Alleged Misconduct

Allegations or information concerning suspected misconduct in scientific research should be reported to a division director. The individual reporting such information must be informed of the scope of the policy and the procedures regarding such allegations and the process that will occur. The individual will also be informed that such matters will be treated confidentially but that the information provided, including his or her name, will be a matter of record and may be disclosed to the person accused of misconduct or to others with a need to know or a legal right to receive such information. Within five working days after receipt of such a report, the information will be forwarded to the cognizant division director (hereafter division director) for action.

b.Preliminary Inquiry

(1) Within ten working days after receipt of information or a report concerning suspected misconduct, the division director will appoint one or more individuals to conduct a preliminary inquiry to review the allegations and information available and to recommend whether a formal investigation should be undertaken. The inquiry will be conducted in an objective and fair manner for the purpose of separating allegations deserving of further investigation from unjustified or mistaken allegations. Within the same ten-day period, the division director will inform the individual alleged to have engaged in the misconduct (respondent) and the DDO of the allegation or information, the name(s) of the individual(s) who will conduct the preliminary inquiry, and the process to be followed.

(2) Within 25 working days after the appointment of individual(s) to conduct the preliminary inquiry, these individual(s) will submit a report to the division director recommending whether a formal investigation should be conducted. This report will contain sufficient discussion of the allegations and information reviewed to provide a basis for the recommendation.

(3) The division director will consider the preliminary inquiry report and, after consulting the DDO, decide whether a formal investigation should be undertaken. Within ten working days after receipt of the preliminary report, the decision of the division director and the preliminary report will be provided to the respondent and the DDO. If no formal investigation will be undertaken, the decision of the division director will also be provided to the individual who made the allegations.

c.Formal Investigation

(1) Within ten working days after the date of the decision to conduct a formal investigation, the division director will appoint a three-member ad hoc committee, none of whom may have served in the preliminary inquiry review, and will inform the respondent and the DDO of the nature of the allegation or information to be investigated, the names of the members of the investigating committee, and the process to be followed.

(2) The charge to the ad hoc committee will be to make findings on whether the respondent has engaged in misconduct in scientific research and to recommend what action, if any, is appropriate under the circumstances. The committee will conduct its investigation in an objective and fair manner and provide the respondent the opportunity to respond to the allegations being investigated. The committee, at its discretion, may seek the advice of experts or others to assist its investigation.

(3) Within 45 working days after its appointment, the investigating committee will report its findings and recommendations to the division director. This report will contain sufficient discussion of the allegations and information reviewed to provide a basis for the findings and recommendations. Within five working days after receipt of the committee's report, the division director will provide a copy to the respondent, who will be given ten working days to comment in writing.

(4) The division director will consider the findings and recommendations in the report and any response by the respondent and, in consultation with the DDO and the Human Resources Department, decide what action, if any, must be taken. Within 30 working days after receipt of the report of the committee, the decision of the division director will be provided to the respondent. If the decision is to take disciplinary action against the respondent, the applicable provisions of the RPM will be followed.

8. General Provisions

a.The respondent will be informed of the right to be represented at any stage during the preliminary inquiry or formal investigation.

b.The respondent is expected to cooperate fully during a preliminary inquiry or formal investigation. Failure to do so without good cause may result in disciplinary or corrective action in accordance with applicable Laboratory policies and procedures.

c.No individual who has made a good-faith allegation of misconduct in scientific research will be subject to reprisal or retaliation.

d.Individuals who have made bad-faith allegations of scientific misconduct may be subject to disciplinary or corrective action in accordance with applicable Laboratory policies and procedures.

e.In addition to Laboratory disciplinary or corrective action, a respondent found to have engaged in misconduct in scientific research may be subject to actions by cognizant funding agencies.

f.The division director will ensure that those appointed to undertake inquiries and investigations are free from any conflicts of interest that would interfere with their ability to be fair and objective. The DDO, in consultation with the division director, has the final authority to decide questions or issues regarding conflicts of interest.

g.The time limits set forth in this policy may be extended for good cause as determined by the DDO.

h.All notices, reports, and recommendations referred to in this policy will be in writing.

i.The matters dealt with under this policy will be treated confidentially to the extent practicable and in accordance with applicable law.

j.The DDO will provide the cognizant funding agencies with any information required by applicable regulations.

k.At any stage in this process, the division director, in consultation with the DDO, may agree with the respondent to resolve the matters under review. Any such resolution will be in writing.

l.The division director, on receipt of the information or report(s) called for under this policy or at any stage of this process, has the right to seek clarification or additional information or to institute further inquiry or investigation.

App-17: GSI Preprint of December 20, 2001

See next 11 pages attached.

EPJ manuscript No.
(will be inserted by the editor)

New results on elements 111 and 112*

S. Hofmann[1], F.P. Heßberger[1], D. Ackermann[1], G. Münzenberg[1], S. Antalic[2], P. Cagarda[2], B. Kindler[1], J. Kojouharova[1], M. Leino[3], B. Lommel[1], R. Mann[1], A.G. Popeko[4], S. Reshitko[1], S. Śaro[2], J. Uusitalo[3], and A.V. Yeremin[4]

[1] Gesellschaft für Schwerionenforschung (GSI), D–64220 Darmstadt, Germany, email: S.Hofmann@gsi.de
[2] Department of Nuclear Physics, Comenius University, SK–84248 Bratislava, Slovakia
[3] Department of Physics, University of Jyväskylä, FIN–40351 Jyväskylä, Finland
[4] Flerov Laboratory of Nuclear Reactions, JINR, RU–141 980 Dubna, Russia

Submitted: 20 December 2001

Abstract. Experiments on the synthesis and identification of the nuclei $^{272}111$ and $^{277}112$ were performed in order to confirm previous results. Three additional decay chains were measured in the reaction ^{64}Ni + ^{209}Bi → $^{273}111$*. The study revealed considerably improved data on the decay chain originating from $^{272}111$. One additional chain was measured in the reaction ^{70}Zn + ^{208}Pb → $^{278}112$*. The decay properties of the chain starting at $^{277}112$ are in excellent agreement with the second chain of the first experiment down to ^{265}Sg, where the new chain ends by a previously unknown spontaneous-fission branch. A re-analysis of all data on elements 110, 111, and 112 measured at GSI since 1994 (a total of 34 decay chains was investigated) revealed that for 2 chains (second chain of $^{269}110$ measured in 1994 and first chain of $^{277}112$ measured in 1996) the results of the new analysis differed from the previous one. In all other cases the earlier data are exactly reproduced.

PACS. 21.10.Dr Binding energies and masses – 23.60.+e Alpha decay – 25.70.-z Low and intermediate energy heavy-ion collisions – 25.85.Ca Spontaneous fission – 27.90.+b 220 ≤ A

1 Introduction

Criteria that must be satisfied in order for the discovery of a new element to be recognized were established by the 1992-report of IUPAC's Transfermium Working Group (TWG) [1]. These criteria served as a guide for the new report of IUPAC/IUPAP's Joint Working Party (JWP) [2] which treated the discovery of the elements 110, 111, and 112. These reports will probably also be the basis for the work of similar committees in the future.

One criterion of more general nature is the reproducibility of an experimental result, and the TWG suggested that no new element should be officially recognized until the data have been reproduced. However, a need for repetition could be waived in those cases where the data are of such nature that no reasonable doubt is possible and a repetition of the experiment would imply an unreasonable burden.

Concerning our results on element 110, 111, and 112 obtained at the GSI UNILAC in Darmstadt, the JWP report concluded that element 110 was convincingly identified in the 1994 SHIP experiment [3,4]. However, when the same criteria were applied to the results for elements 111 and 112 [5,6], which we identified by three and two decay chains, respectively, internal redundancy was found to be insufficient to warrant certitude of identification.

The cross-section for the synthesis of $^{272}111$ was 3.5 pb and 1.0 pb for $^{277}112$. The latter value allows for detection of one nucleus per week using the presently available techniques. The half-lives are within a range of a few hundred microseconds which is ideal for detection using recoil separators. Therefore it seemed to us not to be an unreasonable burden to repeat the two experiments in order to certify the previously measured data.

2 Experimental procedure

We performed the measurements aiming at new data on the synthesis and the decay of $^{277}112$ and $^{272}111$ in the year 2000. The irradiations took place from May 3 – 29 and October 16 – 29, respectively. The reactions were the same as in our first experiments, ^{70}Zn + ^{208}Pb → $^{278}112$* and ^{64}Ni + ^{209}Bi → $^{273}111$*. A summary of the experimental conditions is given in Tab. 1. First results from the Z = 112 experiment were already published in Ref. [7].

The nuclei were identified by position and time correlation analysis which allows to establish genetic relations of the nuclei within a decay chain. The data were measured by using position-sensitive Si detectors. Details of

* This paper is dedicated to our former department leader P. Armbruster on the occasion of his 70th birthday.

Table 1. Summary of previous and present irradiations performed to synthesize element 111 and 112. E_{proj} is the beam energy in front of the target, E^* is the calculated excitation energy of the compound nucleus for reactions in the middle of the target thickness. The compilation of Ref. [10] was used for projectile and target mass and the calculations of Ref. [11] for the mass of the compound nucleus. The 'observed events' are decay chains which were assigned to the one neutron evaporation channel by generic correlation to known daughter nuclei. Also given are the results from short irradiation of a ^{207}Pb target with ^{64}Ni [12] after the element 111 run and of a UF_4 target with ^{70}Zn after the element 112 run.

Date	Time /day	Target Isotope	Thickness μg/cm^2	Beam Isotope	E_{proj} /MeV	Compound nucleus	E^* /MeV	Ion dose /10^{18}	Observed events	σ/pb
01.12.-06.12.1994	5.0	^{209}Bi	450	^{64}Ni	316.1	^{273}111	9.4	1.0	0	<2.9
06.12.-12.12.1994	5.8				318.1		11.0	1.1	1	$1.7^{+3.3}_{-1.4}$
12.12.-18.12.1994	5.9				320.0		12.5	1.1	2	$3.5^{+4.6}_{-2.3}$
16.10.-29.10.2000	13				320.0		12.5	2.2	3	$2.5^{+2.5}_{-1.4}$
29.10.-06.11.2000	7.3	^{207}Pb	435		317.0	^{271}110	14.0	1.3	8	13 ± 5
26.01.-18.02.1996	24	^{208}Pb	450	^{70}Zn	343.8	^{278}112	10.1	3.4	1[a]	$0.5^{+1.1}_{-0.4}$
03.05.-22.05.2000	19		450		346.1		12.0	3.5	1	$0.5^{+1.1}_{-0.4}$
22.05.-29.05.2000	7		426		343.8		10.1	1.2	0	<2.6
29.05.-01.06.2000	3	$^{238}UF_4$	305		370.3	^{308}122	18.6	0.6	0	<7.2

[a] see Chapter 2.

the experimental set-up and the analysis procedure are given elsewhere [4,7–9].

The targets were prepared by evaporation of lead or bismuth deposited in layers of 450 μg/cm^2 on carbon backing foils of 40 μg/cm^2. The target layers were then covered by evaporation of a 10 μg/cm^2 thick carbon layer to protect the targets from sputtering and to enhance radiative cooling. At a distance of 16 cm behind the target a carbon foil of 60 μg/cm^2 thickness was mounted for equilibration of the ionic charge state. Before the reaction products were implanted into the Si detector, they passed through three time-of-flight detectors each consisting of two carbon foils. The total thickness of these carbon foils amounted to 190 μg/cm^2.

In extension of our electronic set-up we installed a circuit for the Z = 111 run, which allowed to switch off the beam within 50 μs after an implanted residue was detected by coincidence of energy and time-of-flight signal. In a subsequent time window of 10 ms a preset number of α particles (in this experiment one) was required which then prolonged the beam-off period up to the expected measurable end of the decay chain. In our experiment 10 minutes were chosen, thus making provision for the detection of a possible α decay of ^{252}Md, $T_{1/2}$ = 2.3 min. This improvement considerably reduced the background during the period of α decays and allowed for the safe detection of signals from long lived decays. The circuit was prepared already in May for the Z = 112 experiment, but not yet used since the trigger conditions could not be set properly, mainly due to the use of degrader foils in front of the Si detector. No degrader foils were used in the Z = 111 experiment.

Behind the stop detector we mounted a second Si detector. This detector was of the same type as the stop detector, however, the detector strips were galvanically connected so that three energy sensitive segments were formed. In the analysis, the signals from the detector were used to identify and reject protons of about 11-MeV energy. The protons leave in the stop detector (thickness 300 μm) energy-loss signals of about 1.9 MeV with a distribution of about 0.5-MeV width (FWHM). This is the same range in which also the signals from escaping α particles are measured. Therefore, an efficient suppression of the protons reduces considerably the probability for chance correlations in those cases, when escaping α particles are not stopped in the back detectors and the device for switching off the beam cannot be used.

We suppose that the protons are emitted from reactions with carbon nuclei of the target backing, cover foil and/or the charge equilibration foil. The protons have a high magnetic rigidity, and a part of them passes SHIP and is focused in the right-end side of the detector (see Fig. 3 in Ref. [4]). At beam currents of 2.0 × 10^{12} /s the counting rate of these protons is 0.4 /s.

Preceding the main irradiation we tested the experimental set-up using reactions of higher cross-section. In the case of element 111 we chose the reaction ^{64}Ni + ^{208}Pb, which has a cross-section for the 1n channel of 15 pb at E^* = 12.1 MeV. During 3 days we measured 3 decay chains of ^{271}110, which were in agreement with the previous result [4]. In one case we even observed the α decay of ^{255}Md at the end of the chain. The nucleus ^{255}Md has an α branching of 8 %. It is produced by electron capture of ^{255}No. Our measured α energy was 7.32 MeV and the lifetime 19 min, both values are in agreement with the literature data for the decay of that nucleus [13].

During the same irradiation period we used the ^{64}Ni beam also for an investigation of the even-even nucleus

$^{270}110$ using a ^{207}Pb target (see Tab. 1). The results obtained were published in Ref. [12]. From that data we received useful information for the comparison of the $^{277}112$ decay chain with the results from theoretical studies (see Chapter 4.2).

In the case of the element 112 run (^{70}Zn beam) we used for testing purposes a ^{50}Ti beam and chemical compounds of ^{208}Pb as target. Subsequent to the main experiment we used the ^{70}Zn beam also to irradiate a $^{238}UF_4$ target (see Tab. 1). In that reaction the compound nucleus would be $^{308}_{186}122$. This nuclide is located near the predicted closed neutron shell N = 184, where shell effects could result in relatively high cross-sections. In that irradiation, however, we did not observe any decay chain which could be attributed to a superheavy element. The upper cross-section limit obtained was 7.2 pb.

In order to prove consistency of the results from the earlier analysis and the presently used one, we also reanalyzed all our data measured since 1994. In the course of that work we reviewed a total of 34 decay chains, four of $^{269}110$, eight of $^{270}110$, thirteen of $^{271}110$, six of $^{272}111$ and three of $^{277}112$. In two cases (second chain of $^{269}110$ measured in 1994 and first chain of $^{277}112$ measured in 1996) we found inconsistency between the original raw data, stored in binary files on magnetic tape (which were used for re-analysis), and the event-by-event text files (which were used at the time as the basis for the assignment). For reasons not yet known to us the contents of these text files had been modified for the case of the two events so that event chains were spuriously created.

The data, which were assigned to the second event chain of $^{269}110$ at the time, were taken from a text file. These data consisted of an implanted residue succeeded by three α decays within 375 ms [3]. However, the data which was re-analyzed from the binary raw data file, revealed only one α decay with $E_\alpha = 10.53$ MeV (this is the same energy as α_2 of the earlier analysis) subsequent to an implanted nucleus after 20 μs (the electronic dead time is 15 μs), but not after 201 μs as in the case of α_1 of the chain.

The first decay chain assigned to $^{277}112$ consisted of five α decays subsequent to an implanted nucleus [6]. The new analysis of the binary raw data file revealed agreement with the 1996 event-by-event text file only in the case of the event α_1, an α decay with 11.65-MeV energy. It was preceded by an implanted nucleus at 11 s (but not at 400 μs as deduced in 1996). This sequence of two correlated events fits perfectly to the transfer product ^{212}Po.

An explanation for the disagreement between the original raw data (fully consistent with the present re-analysis) and the extracted text file data (showing the disagreement just discussed) on the basis of errors in the computer program was ruled out, because all neighboring single events and all other decay chains measured at the time were exactly reproduced by the new analysis. We cannot exclude, for example, human error in the analysis of these two events. But to reiterate: all other events, a total of 32 decay chains, are exactly reproduced in the re-analysis.

3 Element 111

3.1 Results

The new results on the decay of $^{272}111$ are in full agreement with the data measured previously. In our first experiment in 1994 we studied the reaction $^{64}Ni + ^{209}Bi \rightarrow {}^{273}111^*$ at three different beam energies. The energy values and the results of the experiment are listed in Tab. 1.

The cross-section maximum could not be definitely determined from the data due to the large statistical error bars and few number of data points. However, taking into account the trend set by the previously measured excitation functions for the synthesis of nuclei of lighter elements [4], we concluded that the maximum yield should be close to an excitation energy of 12 MeV. In order to improve the statistical accuracy at that energy, we chose the already measured data point at 320-MeV beam energy also in the confirmation experiment.

During an irradiation time of 13 days we collected a beam dose of 2.2×10^{18} ions. A total of 3 decay chains was measured, from which, in agreement with the first result, a cross-section of 2.5 pb was deduced. The efficiency of SHIP was estimated to be 40 %, the same value was used in our first experiment. The mean cross-section value from both experiments at 320-MeV beam energy (5 events at 3.3×10^{18} projectiles) is $(2.9^{+1.9}_{-1.3})$ pb.

The newly measured decay chains are plotted in Fig. 1. The decay data of the three new chains are compared with those from the first experiment and with literature data on ^{260}Db and ^{256}Lr [13–15] in Fig. 2. The results are discussed in the following.

3.2 Discussion

The trigger for the switching off the beam worked properly. All three chains were measured in full length during beam-off periods. The 10 minutes beam-off trigger was activated only in one case without detection of a decay chain.

The implantation energies are grouped around the mean value of 39.2 MeV. The individual energy values are given in Fig. 1. The signals were calibrated using a fraction of projectiles which hit the detector due to low ionic charge states. No corrections for nuclear stopping or recombination effects were applied.

We compare now the measured energies with those calculated for a fusion process, taking into account the energy loss in the target, in the various carbon foils and in a detector dead layer of 11.6 $\mu g/cm^2$ Si. For the two extreme cases of reactions at the front side and at the end of the target, we get kinetic energies of the evaporation residues of 54.5 and 58.7 MeV, respectively, when they enter the active detector material. The energy losses of projectiles and the heavy residues were calculated using the computer program SRIM-2000 [16]. For the residues the extrapolation $dE/dx(^{272}111) = dE/dx(^{238}U)$ at the same E/A value as the residue was applied, because uranium is the heaviest element included in SRIM.

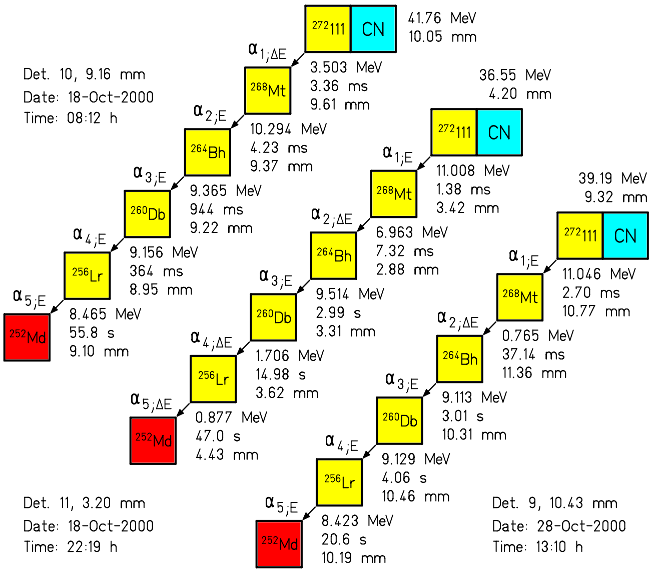

Fig. 1. Three decay chains and decay data measured during an experiment aiming at the confirmation of element 111.

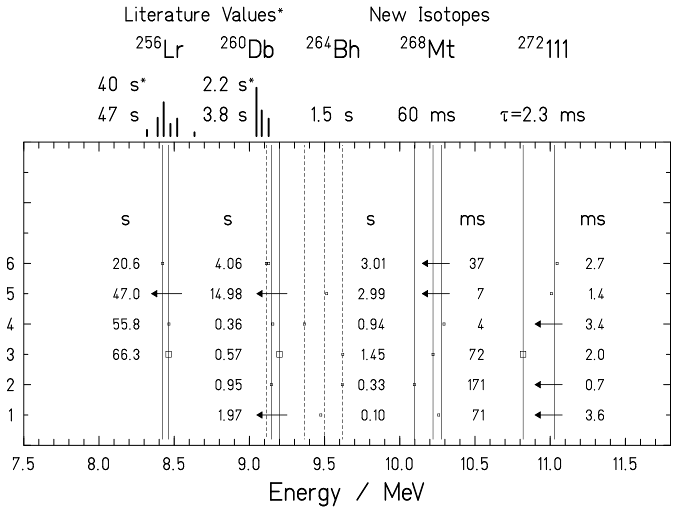

Fig. 2. Comparison of α-decay data from the six events which were assigned to the decay of ^{272}111. The event chains are chronologically ordered and numbered from 1 to 6. The size of the data points reflects the detector resolution, small dots stand for $\alpha's$ stopped in the main detector, larger squares for escape $\alpha's$ stopped in the back detectors and arrows for escape $\alpha's$ delivering only a ΔE signal from the main detector. Vertical lines are drawn at energies of single data points or at the mean energy values of decays which have the same energy within the detector resolution. Data points assigned to ^{264}Bh are marked by dashed lines for better distinction from the ^{260}Db data. Also given are the individual and mean values of lifetimes (not half-lives). Above the upper abscissa the α spectra and lifetimes deduced from literature (marked by an asterisk) are plotted for the decays of ^{260}Db and ^{256}Lr.

The difference of the mean values of implantation energies from measurement and calculation is 17.4 MeV (31 %) which seems a reasonable fraction for the sum of various pulse height defects. An amount of 9.4 % of signal loss due to vacancies and phonons is determined by SRIM for ^{238}U ions in Si. If that data is correct, then the remainder of 12.1 MeV (21.6 %) must be due to recombination effects.

The width of the measured implantation energies from 36.5 to 41.8 MeV is in reasonable agreement with the limits set by the target thickness and additional statistical fluctuations.

The chains were measured from detector strip number 10, 11 and 9 (in order of their appearance) which are located at 7.5, 12.5 and 2.5 mm right from the center of the 80 mm wide detector. The mean vertical positions were at 9.16, 3.20 and 10.43 mm, respectively, measured from the bottom of the 35 mm long detector strips. The position distribution close to the center of the detector evidences the correct setting of the SHIP electromagnetic field values and proper estimate of the ionic charge state of the residues.

All signals, which were assigned to a decay chain, had identical strip number and the vertical positions were distributed around the mean value according to the detectors position resolution of ± 150 μm for α particles of about 10-MeV energy. The mean values were calculated from the more accurate data of the fully stopped α particles, marked with letter E in Fig. 1, except in the case of α_2 of chain two, which was also used because of the high energy loss value of 6.96 MeV. In all cases the vertical position was calculated from the signals of the bottom connector, which had the higher amplitude and hence higher accuracy. The redundant signals from the top connector resulted in complementary values. The positions from low energy escape α's and high energy implantations deviate up to 1 mm from the mean values, because of decreasing position resolution at decreasing energy and signal processing in a different branch of low amplification, respectively.

We conclude from the implantation signals and position measurement that the three measured sequences of signals arise from correlated events. They show all characteristic properties of decay chains of implanted fusion products.

The first three α decays of the chains, which were assigned to the new nuclei ^{272}111, ^{268}Mt and ^{264}Bh, are grouped at energies of 11.0, 10.2 and 9.4 MeV, respectively (see Fig. 2). The α decays of ^{260}Db and ^{256}Lr are located at 9.05 and 8.45 MeV. The trend of decreasing energy by about 0.7 MeV per α decay along a decay chain was also observed for the neighboring decay chains of ^{266}Mt, ^{269}110, ^{270}110 and ^{271}110. This is a result of the smoothly varying potential energy landscape below neutron number 162. The trend is broken when N = 162 is crossed, as it is in the case of the ^{277}112 decay chain (see Sect. 4).

Each of the nuclei in the decay chain of ^{272}111 decays by transitions of more than one energy. In particular, we measured two transitions from $^{272}111$ itself, at least two from ^{268}Mt and four from ^{264}Bh. Three and six different energies are known from ^{260}Db and ^{256}Lr, respectively.

A commensurate condition for a convincing assignment of the decay chains is the agreement of the data for the decay of known daughter nuclei with literature values. However, this condition must not necessarily be fulfilled, which could occur, e.g., in the case of incompletely known decay schemes of the daughter nuclei.

In the case of dubnium we measured three α's which were fully stopped in the detector. Their energies are 9.146, 9.156 and 9.129 MeV (from chain 2, 4 and 6) with a mean value of 9.144 MeV. The relative error bar for each of the single energies is determined by the detector resolution of 20 keV (FWHM) and amounts to $\sigma = 8.5$ keV. However, the absolute uncertainty is affected by the calibration procedure. In our case α decays were used from evaporation residues of reactions with ^{142}Ce and ^{150}Nd targets and the ^{64}Ni beam. We estimate an absolute uncertainty of $\sigma =$ 20 keV.

Ghiorso et al. [14] assigned three α lines to the decay of ^{260}Db with energies and intensities of 9.06 (55 %), 9.10 (25 %) and 9.14 MeV (20 %). The accuracy of the energy was estimated to be 0.02 MeV. From a second experiment on the decay of ^{260}Db, Bemis et al. [15] reported values of 9.041 (48 %), 9.074 (25 %) and 9.120 MeV (17 %) for the α decay and a 9.6 % spontaneous fission branch. The α energies were accurate within ± 0.014 MeV for the first two lines and within ± 0.017 MeV for the last line, however, the values are systematically smaller by about 0.020 MeV than in the first experiment. Our energy of 9.144 MeV is in agreement within the given accuracy with the third high energy line of the literature data.

A slightly different, 56 keV higher energy was measured from chain 3 in the 1994 experiment. However, the energy value of 9.200 MeV was determined from an escape event stopped in the back detector. For such events the energy resolution is only 40 keV (FWHM). Therefore this transition is still in agreement with the other three decays measured at higher accuracy.

Two of the α particles from the ^{260}Db decay escaped from the detector (chain 1 and 5). However, from the energy loss signal we could determine the lifetimes of 1.97 and 14.98 s, respectively. Together with the lifetimes of the other four decays we determine an arithmetic mean value of $(3.8^{+2.6}_{-1.1})$ s, from which a half-life of $(2.6^{+1.8}_{-0.8})$ s follows. The literature values for the half-life are (1.6 ± 0.3) s [14] and (1.52 ± 0.13) s [15]. The data are in agreement, although we notice that the relatively long lifetime measured in chain 5 shifts our mean value upwards.

A statistical analysis as worked out by Schmidt at al. [17] for an exponential distribution shows that the upper limit for a confidence level of 68 % is at 5.8 times the true value in the case of one event, which means in our incident a limit at 12.7 s for the lifetime using the most accurate half-life of 1.52 s. On the average each 6th decay must be even beyond that limit. In addition, the lifetimes of the other members of the chain do not show any peculiarity which would justify the assignment to an isomeric state. Therefore we consider the 14.98 s decay to be a statistical fluctuation in the decay of ^{260}Db.

Six α transitions are known from the decay of ^{256}Lr, $T_{1/2} = 28$ s [13] (see Fig. 2). In our first experiment only one decay was measured. The other two could not be unambiguously correlated due to long lifetimes. An energy of 8.463 MeV was determined from the energy loss and residual energy of that escape event (chain 3). In the new experiment we measured almost the same energy (8.465 MeV) from chain 4, but now with better accuracy from a fully stopped α particle. Another different α energy of 8.423 MeV was measured from chain 6. The same precision of the energy measurement holds as already discussed in the case of ^{260}Db. The two energies agree with the known transitions of 8.475 (13.3 %) and 8.430 MeV (37 %) [13], both energies given with an accuracy of ± 0.015 MeV.

One decay of ^{256}Lr was detected as an escape event with a lifetime of 47 s. The arithmetic mean of the lifetimes from the four measured decays is 47 s, the half-life is (33^{+33}_{-11}) s in agreement with the literature value.

We conclude that in all of the six measured decay chains the energies and lifetimes of the 4th and 5th α decay are in agreement with literature data on the decay of ^{260}Db and ^{256}Lr. Especially high precision and completeness was obtained in the case of chain 4 and 6 of the confirmation experiment. The chains end for being detectable after the α decay of ^{256}Lr due to the large electron capture branch of ^{252}Md ($b_{EC} > 50$ % [13]) and the long half-life of ^{252}Fm ($T_{1/2} = 25.4$ h).

As a consequence of the discussion presented before, we assign the α transitions preceding ^{260}Db to the previously unknown nuclei ^{264}Bh, ^{268}Mt and $^{272}111$. The arithmetic mean values of the lifetimes determined from the six decay chains are 1.5 s, 60 ms and 2.3 ms, respectively, resulting in half-lives of $(1.0^{+0.7}_{-0.3})$ s, (42^{+29}_{-12}) ms and $(1.6^{+1.1}_{-0.5})$ ms. The distribution of the individual lifetimes is in agreement with statistical fluctuations (see discussion before), although a possible existence of isomeric levels cannot be excluded. A candidate for the decay of an isomer could be the 171 ms, $E_\alpha = 10.097$ MeV transition of ^{268}Mt in chain 2, which has a relatively long lifetime and also an energy different from the three other decays by 0.16 MeV.

Analogous is the situation in the nucleus ^{264}Bh. There, the α energies are spread across a range from 9.11 MeV (chain 6) to 9.62 MeV (chain 2 and 3). Similar wide energy and lifetime distributions were measured previously in the case of the neighboring odd-odd isotope ^{262}Bh [18]. In that case, however, there was clear evidence for an isomeric state deduced from the higher number of 29 measured events. The feeding of both the isomer ($T_{1/2} = 8.0$ ms) and the ground-state (102 ms) by the α decay of ^{266}Mt was established later [19]. Despite a wide energy distribution of the ^{266}Mt α decays from 10.5 to 11.7 MeV based on 14 events, the lifetimes could be described by one common value corresponding to $T_{1/2} = 1.7$ ms. However, as discussed in Ref. [19], the existence of isomers with similar half-life in ^{266}Mt could not be excluded. Guided by a theoretical study of Ćwiok et al. [20] and the correspondence of the experimental data, we conclude that an analog level structure exists in the case of ^{268}Mt and ^{264}Bh as in the two neutrons lighter isotopes ^{266}Mt and ^{262}Bh.

For the decay of ^{272}111 redundancy in the α energies was measured in two cases (chain 5 and 6). The mean energy value is 11.027 MeV. Compared with the previously measured energy of 10.820 MeV (chain 3), a 210-keV difference of the Q_α values results. In this context the coincidence of the ^{272}111 α decay from chain 1 with a signal of (155.0 $\pm$ 0.8) keV energy in the Ge detector is especially interesting (see discussion in [5]). The energy of 155 keV is close to the predicted $K_{\alpha 1}$ X-ray energy of meitnerium ($E_{K\alpha 1}$ = 151.7 keV) [21]. If the low energy α transition populates a level at 207 keV in ^{268}Mt, then the transition energy from that level would be sufficient to eject one of the K electrons which are bound by an energy of 177 keV [21]. Unfortunately, we failed to measure if the ^{272}111 α particle in chain 1 belongs also to the low energy group, because that α particle escaped from the detector.

At the limit of belonging together are the three α decay energies of ^{268}Mt from chain 1, 3 and 4. They are grouped at a mean energy value of 10.258 MeV. An argument that the origin of the 10.221-MeV α decay (chain 3) is different from the other two is the fact that this transition was in coincidence with a 93-keV signal in the Ge detector. Therefore, we tentatively split the three transitions into two groups consisting of the transition measured from chain 3 at 10.221 MeV and the two transitions from chain 1 and 4 at a mean energy value of 10.276 MeV.

In the case of ^{264}Bh the energies from chain 2 and 3 and from chain 1 and 5 agree well within the detector resolution. The mean values are 9.619 and 9.494 MeV, respectively.

Our conclusion of the recent Z = 111 experiment is that our first results are confirmed and that the new data reveal considerably improved information on the decay pattern of the chains starting at ^{272}111.

4 Element 112

4.1 Results

The experiment for confirmation of the synthesis of element 112 was performed in May 2000 (see Tab. 1). Using the same reaction as in the first experiment, ^{70}Zn + ^{208}Pb $\rightarrow$ ^{278}112*, we measured one additional chain of ^{277}112. The decay properties are in agreement with the second chain of the first experiment down to ^{265}Sg, where the new chain ends by a previously unknown spontaneous-fission branch.

In our first experiment we chose a beam energy of 343.8 MeV, which resulted in a 10.1-MeV excitation energy of the compound nucleus. A beam dose of 3.4 $\times$ 10^{18} was collected during the 24 days experiment. The cross-section which resulted on the basis of one decay chain was 0.5 pb.

The beam energy had been chosen according to a measured trend of cross-section maxima into the direction of lower excitation energy with increasing element number [4]. In the new experiment we chose a slightly higher beam energy which resulted in 12.0-MeV excitation energy in order to determine the trend of the cross-section at varying beam energy. Arguments for increasing instead of decreasing the beam energy resulted from theoretical studies which predicted the cross-section maximum at E* = 12.6 MeV [22] or even a sharp increase up to about 100 pb at E* = 14 MeV [23].

During the 19 days experiment in May 2000 we collected a beam dose of 3.5 $\times$ 10^{18} ions. A Cross-section of 0.5 pb was deduced from the only one decay chain observed, using the same efficiency of 45 % as in the first experiment. The measured decay data are shown together with our assignment in Fig. 3. A comparison between half-lives and Q_α values from both chains is presented in Fig. 4.

The decay chain starts with an implantation signal from detector strip 16 at an energy of 24.1 MeV. This energy is lower than the implantation energies in the element-111 run, because we used degrader foils in front of the Si detector in order to stop a part of the low energetic background of projectiles. Another reason was to avoid high amplitude signals which cause tailing and make an exact α-energy measurement more difficult in the case of lifetimes shorter than 500 μs. The degrader was composed of a 3-μm-thick Mylar foil and an Al wedge-shape degrader of 1.1 μm thickness on the left side (there the background has higher energy, but is deflected more by the last SHIP dipole magnet due to higher charge states, see Fig. 1 in Ref. [7]) and 0.5 μm on the right side (where strip 16 is located). The foils of the time-of-flight detectors were the same as described before, however, the thickness of the charge equilibration foil was only 30 μg/cm^2 carbon in this run.

We tried to reproduce the measured implantation energy using SRIM-2000 for the calculation of the energy loss of projectiles and fusion products. We obtained a kinetic energy of 41.8 MeV for the ^{277}112 ion when entering the active detector material. This value differs from the measured one by 17.7 MeV or 42 %. Taking into account larger uncertainties of energy-loss values due to the relatively thick degrader foils and a relatively increased contribution from nuclear stopping at lower kinetic energy as in the element 111 run (which was performed without degrader foils) a pulse-height defect of 42 % seems reasonable.

The implantation signal was in coincidence with signals from all three time-of-flight detectors. Subsequent to implantation three α particles were measured with full energy in the stop detector. The fourth α escaped. The energy-loss signal of 0.2 MeV was relatively low due to the location of the parent nucleus close to the detector surface. All α events occurred during the 5.5-ms beam-on intervals, however, none of the time-of-flight detector signals was in coincidence, which indicates that the pulses from the Si detector were caused by radioactive decays. No signal from the γ detector was in coincidence neither with the implantation nor with the α particles.

Finally, a high energy event of 153 MeV was measured in the stop detector. This value is given without any correction for energy deficit. The event occurred 6.2 ms after the beginning of the 14.5-ms beam-off period and, there-

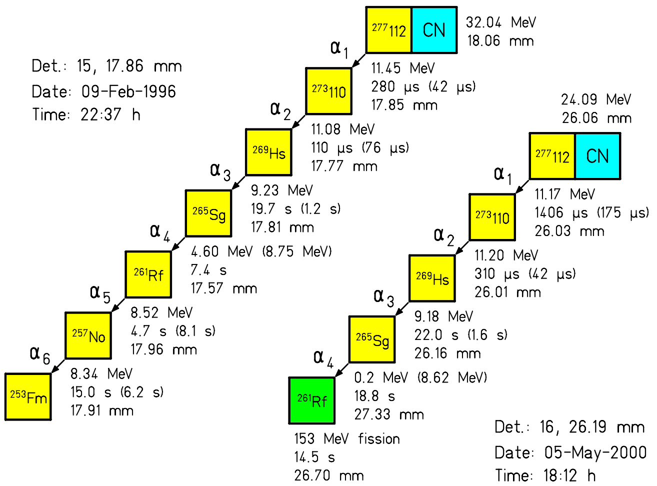

Fig. 3. Decay chains attributed to the decay of $^{277}112$ produced in reactions $^{70}Zn + ^{208}Pb$. The newly measured chain is plotted on the lower right side of the figure. The previously measured chain from our 1996 experiment [6] is also plotted for better comparison. The lifetimes given in brackets were obtained from calculations using the WKB method (see text). In the case of escape α particles the energies were calculated from the lifetimes. The results are given in brackets.

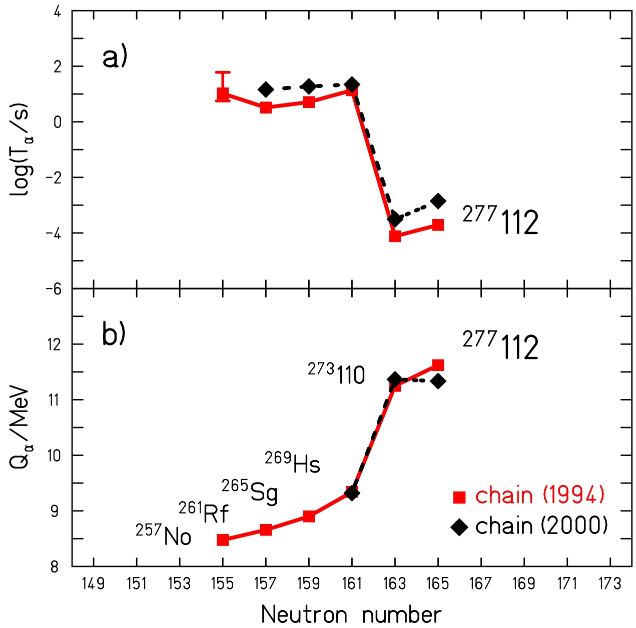

Fig. 4. Systematics of the decay chains of $^{277}112$: upper part, measured half-lives; lower part, Q_α values. An example of the error bar of the half-lives is shown in one case. It reflects the statistical uncertainty in the case of one event and demonstrates the agreement between the lifetime measurements for each of the nuclei of the decay chains.

fore, must be assigned to a radioactive decay. No high energy signal was measured from the back detectors, but there was a 2.3-MeV signal from back-detector segment 6 in coincidence within a time window of 1 μs. This segment is located closest to strip 16 of the stop detector. The low energy signal could be due to the residual energy of a fission fragment, but electrons and a cascade of γ rays emitted during the fission process are another possible explanation. From the Ge detector we received a coincident signal of (1857 ± 6) keV. The sum of information obtained from that high energy event identifies it as a spontaneous fission event. The relatively high energy measured in the stop detector indicates that most of the fission energy was deposited there.

All signals from the stop detector were tagged by a logic signal which identifies them to originate from detector strip number 16. This strip is located at the border of the detector, 35–40 mm on the right side from the center. The vertical positions are grouped around a mean value of 26.19 mm from the bottom of the strip within a position window set by the detector resolution. The mean value was calculated from both the bottom and top signals from all events except the escaped α from which only the top signal was above the discriminator level.

The measured time intervals between the detector signals are given in Fig. 3. The first two α decays are on the order of one millisecond, the subsequent two and the fission event on the order of few tens of seconds. This is still short relative to the intervals arising from background events if the position information is included. Therefore the origin of the correlated event chain by chance is unlikely. During the whole experiment no other similar chain was observed.

4.2 Discussion

The decay chain of $^{277}112$ is located in a region of the chart of nuclei, where the decay properties of the daughter nuclei were not studied in SHIP experiments before. The reason is that those nuclei can be directly produced only in reactions using actinide targets for which SHIP has a low transmission of only a few percent.

At the time of our first experiment (1996) no literature data was available for comparison with the decay properties of the daughter and granddaughter nuclei $^{273}110$ and ^{269}Hs. Today, the data on these nuclei is still scarce and incomplete. Only one work was published dealing with the synthesis of the daughter nucleus $^{273}110$ [24] and only recently a paper was submitted on the decay of the granddaughter ^{269}Hs [25]. Therefore we begin the discussion with presenting the available information on the decay properties of nuclei at the lower end of the decay chain, aiming to work out a consistent picture of the decay properties of nuclei relevant to the decay chain of $^{277}112$.

The measurable end of the decay chain is set by the long living nuclide ^{253}Fm which decays dominantly by electron capture ($T_{1/2} = 3.0$ d, $b_{EC} = 88$ %) [13]. It is populated by the α decay of ^{257}No ($T_{1/2} = 25$ s, $b_\alpha \approx 100$ %).

Three α lines were measured from the decay of ^{257}No studied in the reaction ^{13}C + ^{248}Cm which produced ^{257}No directly in a 4n evaporation channel [26]. The energies of the transitions were 8.22, 8.27 and 8.32 MeV with relative intensities of 55, 26 and 19 %, respectively.

The decay of ^{257}No was observed again subsequent to the α decay of ^{261}Rf. This nucleus was first identified by Ghiorso et al. [27] using the reaction ^{18}O + ^{248}Cm $\rightarrow$ ^{266}Rf*. An α line at (8.28 $\pm$ 0.02) MeV was measured superimposed on the α lines of the daughter decay. A half-life of (65 $\pm$ 10) s was obtained for the mother activity. A new half-life of (78^{+11}_{-6}) s, based on a greater number of decays, was published in Ref. [28].

Recently, the decay of ^{261}Rf and ^{262}Rf was reinvestigated by Lazarev et al. [29] using the reaction ^{22}Ne + ^{244}Pu $\rightarrow$ ^{266}Rf*. Using a α–α–correlation method the previously obtained data on the decay of ^{261}Rf were confirmed. From 69 measured correlations no α particle energy was greater than 8.4 MeV neither from the parent nor from the daughter decay.

For the neighboring spontaneously fissioning isotope ^{262}Rf an upper limit for α decay of 3 % was measured. This value is in agreement with the more restrictive 0.8 % limit measured by Lane et al. [30]. In the latter paper also the presently most accurate half-life value of (2.1 $\pm$ 0.2) s was presented, and a previously measured half-life of 47 ms [31] was considered as a candidate for a spontaneously fissioning K isomer.

Both isotopes, ^{261}Rf and ^{262}Rf, were observed as α decay daughter products from the corresponding parent nuclei of seaborgium (Z = 106). The experiments were performed at the Dubna gas-filled separator [32] and at GSI using chemical separation by ARCA [33] and OLGA [34]. Alpha decays with energies in the range from 8.6 to 9.0 MeV were assigned to ^{265}Sg and ^{266}Sg. The two isotopes were distinguished by the decay properties of the daughter nuclei known at the time, α decay of ^{261}Rf and spontaneous fission of ^{262}Rf.

Four decay chains were measured by Lazarev et al. [24] in the reaction ^{34}S + ^{244}Pu $\rightarrow$ ^{277}110*, which were assigned with different significance to the decay of ^{273}110. In the chain which was given the highest weight the decays of ^{269}Hs and ^{261}Rf were missed, however, the measured data are not in contradiction (taking into account the resolution of 120-keV FWHM for that chain) to the data measured in our experiment down to the decay of ^{265}Sg, although the combined lifetimes measured in [24] for the decay of ^{269}Hs – ^{265}Sg (158 s) and ^{261}Rf – ^{257}No (384 s) were unusually long.

In a very recent paper Türler et al. [25] reported on three and two decay chains, which they had assigned to ^{269}Hs and the new isotope ^{270}Hs, respectively. The nuclei were produced in reactions ^{26}Mg + ^{248}Cm $\rightarrow$ ^{274}Hs* and transported in a He/O_2-carrier gas in form of volatile HsO_4 molecules into a cryo thermochromatography detector system which was built from two arrays of PIN diodes facing each other at a distance of 1.6 mm. The results on the decay of ^{269}Hs fully confirm the data which we obtained from the decay of ^{277}112.

The following conclusions can be drawn from that work, from the previous studies discussed above and from our decay chains assigned to ^{277}112.

1. *Decay of* ^{269}Hs: One component of the α decay has an energy of 9.18 MeV, determined from our new chain. The uncertainty of the α energy is $\pm$0.02 MeV given by possible systematic deviations and a detector resolution of 20 keV FWHM. This transition likely populates an excited level in ^{265}Rf as indicated by the 60 keV higher energy measured in the 1996 chain. The energies measured in Ref. [25] were 9.18, 8.88 and 9.10 MeV with an uncertainty of typically $^{+0.07}_{-0.03}$ MeV. The asymmetric error bar is caused by possible energy loss in the gas between the detector arrays. The energy loss could be even more than 40 keV in the case that α particles are emitted under shallow angles to the detector surface. The half-life deduced from our work is (14^{+26}_{-6}) s (arithmetic mean of two events). This value is long enough to secure survival of collection and transport time needed in the chemical experiment [25]. There, ^{269}Hs was the parent nucleus and its half-life could not be measured. We notice that the data on the decay of ^{269}Hs from our work are in agreement with the results obtained by Türler et al., which proved by chemical means, that the measured nucleus belongs to element 108.

2. *Decay of* ^{265}Sg: In our experiment the α particles from the decay of ^{265}Sg escaped from the detector, however, their lifetime could be measured from the energy loss signals. From the two events we determine a half-life of (9^{+17}_{-4}) s. An estimate of the α particle energies can be obtained using the WKB method and a potential barrier given by Igo [35]. From the individual lifetimes we determine α energies of 8.75 MeV and 8.62 MeV, respectively. Decay energies between 8.6 and 9.0 MeV were measured for this nuclide [32,34], and a half-life of ($7.4^{+3.3}_{-2.7}$) s was deduced [34]. In the recent work by Türler et al. [25] α energies of 8.69, 8.90 and 8.68 MeV were measured and individual lifetimes of 4.4, 17.1 and 9.3 s, respectively. We notice that also the data from the decay chains of ^{277}112, which were assigned to ^{265}Sg, agree with the data from the other experiments.

3. *Decay of* ^{261}Rf: The literature data on the decay of this nucleus are E_α = 8.28 MeV and $T_{1/2}$ = 78 s (τ = 112 s). In our experiments we measured for the decays of this chain member an α particle with an energy of 8.52-MeV and a lifetime of 4.7 s (old chain), and a spontaneous fission event with a lifetime of 14.5 s (new chain). The α energy of 8.52 MeV and spontaneous fission was not observed in experiments, in which ^{261}Rf was produced as evaporation residue. Also not the short lifetime of 9.6 s deduced from our chains. However, in the recent experiment by Türler et al. [25] these observations were confirmed. Two α decays with an energy of 8.50 MeV each and one fission event were measured from the decay chains of ^{269}Hs with lifetimes of 2.4, 0.8 and 7.9 s, respectively.

In experiments which produced ^{261}Rf as daughter of the evaporation residue ^{265}Sg (a total of 21 decays are cited in the literature [32–34]), an 8.52 MeV α decay was measured only in one case [33]. This decay, however, occurred with a lifetime of 142 s and could not be definitely assigned to the decay chain of ^{265}Sg [36]. In few other cases it could be possible that due to the previously unknown fission branch of ^{261}Rf, α–fission correlations were erroneously assigned to the decay sequence ^{266}Sg–^{262}Rf.

Summarizing the data from our experiments on ^{277}112, that on ^{269}Hs from Ref. [25] and the previously obtained literature data, we conclude that two levels exist in ^{261}Rf with half-lives of $(78^{+11}_{-\ 6})$ s and $(4.2^{+3.4}_{-1.3})$ s, which decay by emission of 8.28-MeV α particles in the first case and by emission of 8.52-MeV α's and by spontaneous fission with a branching of about 40 % in the latter case. The α energy of 8.52 MeV fits better into the systematic of ground-state α energies [37]. Therefore we tentatively assign the 4.2-s level to the ground-state, whereas the 78-s level could be a higher spin isomeric state, because it is preferably produced in heavy-ion fusion reactions.

4. *Decay of* ^{257}No: The α decay of this isotope was measured in the first experiment with E_α = 8.34 MeV and τ = 15.0 s. These data are in agreement with the literature data (see before). In the work by Türler et al. [25] α decay of ^{257}No was measured only in one of the two cases subsequent to α decay of ^{261}Rf. The non-observation of the ^{257}No α decay in 1 from a total of 3 cases, although its energy and lifetime should be easily detectable, is indication for an electron capture branch. Such a decay channel would populate the 5.5-h ^{257}Md which has an α/EC ratio of 15/85 [13]. The decay of ^{257}Md could probably not be observed in Ref. [25]. In previous work [26,27,29] the ^{257}Md α lines at 7.0 MeV were covered by intense background lines.

A calculation of the electron capture half-life for ^{257}No is difficult, because of its low Q_β value [38]. However, a logarithmic interpolation of the EC half-lives of ^{255}No and ^{259}No results in $T_{1/2,EC} = 42$ min and thus $b_{EC} \approx 1$ % for the decay of ^{257}No. Considering the experimental result we conclude that ^{257}No has an EC branch probably near the middle between 1 and 30 %.

So far, we discussed in detail the data which were measured in our work in the reaction ^{70}Zn + ^{208}Pb $\rightarrow$ $^{278}112^*$ and the results which were obtained in other experiments on lighter nuclei performed up to the study of ^{269}Hs. We showed, that our assignment of the data measured for the second chain in the 1996 experiment [6] and the results and interpretation deduced from the new decay chain measured in 2000 [7], were fully confirmed by independent investigations. The agreement of our decay chains with literature data up to the decay of ^{269}Hs proves the assignment of the two preceding α decays to the nuclei ^{273}110 and ^{277}112. Other possible evaporation residues as starting points of the decay chain were already discussed and excluded in Ref. [6].

The first two α decays of the new chain have energies of 11.17 and 11.20 MeV, respectively, which are succeeded by an α of only 9.18 MeV, an energy step by about 2 MeV. Correspondingly, the lifetime increases by about five orders of magnitude between the second and third α decay. This decay pattern is in agreement with the one observed for the chain in our first experiment (see Fig. 4). It was explained as the result of a local minimum of the shell correction energy at neutron number N = 162 which is crossed by the α decay of ^{273}110 [39,40].

Recently, Ćwiok et al. [41] performed a Hartree-Fock-Bogoliubov calculation with Skyrme-Sly4 interaction and a zero-range pairing in order to calculate the low-energy quasiparticle states of nuclei along the ^{277}112 decay chain. The calculations clearly provide evidence for high or low spin isomeric states near the ground state in both ^{277}112 and ^{273}110. Due to the large single particle energy gap at N = 162, the low spin levels $1/2^+$ and $3/2^+$ are shifted upwards to higher energy by about 1 MeV in ^{269}Hs. Therefore the Q_α values of the favorite transitions from the low spin state in ^{273}110 is reduced by that amount of energy. The population of an excited level at about 1 MeV seems unusual if compared with α-decay properties in the region of lighter elements. There, however, the ground-state Q_α values are on the order of about 6 MeV, whereas in the case of ^{273}110 they are almost twice as high.

Beyond N = 162 the predicted Q_α values of the favored transitions between the low and high spin levels are almost equal. This result is in line with our experimental data, if we tentatively assign the measured α decays to transitions between the high spin states. Search for low spin isomeric states as predicted theoretically remains as a task for future experiments.

Support for the quality of the model was obtained recently by a convincing description of a high spin K isomer which was observed experimentally in ^{270}110 at an excitation energy of 1.13 MeV with a half-life of 6.0 ms [12]. In that nucleus the same single particle levels for the neutrons are responsible for the low-energy level-scheme as in the case of the nuclei at the upper part of the decay chain from ^{277}112.

We also calculated the α-decay probabilities using the WKB method and a potential barrier given by Igo [35]. This model reproduces the α-decay probabilities of even-even nuclei in the region of heavy elements within a factor of two. The result for the lifetime of each individual transition within the ^{277}112 decay chains, assuming Δl = 0 transitions, is given in brackets in Fig. 3. Some of the transitions are reproduced accurately, others reveal hindrance factors of about 10 on the average. In order to explain these hindrance factors solely by centrifugal barrier, Δl values of about 4 - 6 are needed. However, another more likely reason to explain the hindrance factors is strong configuration mixing as suggested by the theoretical description.

A cross-section of $(0.5^{+1.1}_{-0.4})$ pb was measured for the new data point at 12.0-MeV excitation energy. This value fits well into the systematic of cross-sections. A cross-section increase with increasing beam energy as predicted by theoretical investigations [22,23] was not observed.

During our experiment we also decreased for a period of 7 days the energy of the ^{70}Zn beam to the previously used value of 343.8 MeV. No further event was measured at a beam dose of 1.2×10^{18}. A new mean value for the cross-section of $(0.4^{+0.9}_{-0.3})$ pb follows for the data point at 10.1-MeV excitation energy (1 event at 4.6×10^{18} projectiles).

5 Summary and outlook

Two experiments were carried out in 2000, which resulted in the detection of three additional decay chains of ^{272}111 and one more decay chain of ^{277}112. The reaction ^{64}Ni + ^{209}Bi was used for the synthesis of element 111 and ^{70}Zn + ^{208}Pb for element 112. These were the same reactions as used in our first experiments. The new data are in full agreement with the results obtained in 1994 from three decay chains measured of ^{272}111 and with the second chain of ^{277}112 measured in 1996. The quality of the data was improved and new, previously not known decay properties were measured. The decay data of daughter nuclei of the chains was compared in detail with literature data available until October 2001. The agreement of our data with the data on the daughter nuclei obtained independently from other experiments, results in an unambiguous assignment of the parent nuclei to ^{272}111 and ^{277}112, respectively.

Part of the data was also compared with the results from theoretical calculations. The decay properties are in agreement with structure calculations of nuclei near N = 162 and Z = 108–110. For these nuclei a local minimum of the shell-correction energy was calculated, which results from a low single-particle level density at large quadrupole plus hexadecapole deformation.

We performed a re-analysis of our data measured since 1994 in order to confirm the previously obtained results and to prove consistency with the presently used computer programs. In the course of this work we reviewed 34 decay chains, four of ^{269}110, eight of ^{270}110, thirteen of ^{271}110, six of ^{272}111 and three of ^{277}112. In two cases (second chain of ^{269}110 measured in 1994 and first chain of ^{277}112 measured in 1996) we found inconsistency of the data, which led to the conclusion, that for reasons not yet known to us, part of data used for establishing these two chains were spuriously created. In all other cases the previously obtained data are exactly reproduced.

The measured cross-sections were on a level of 1 pb. Beam times of several weeks were necessary for the detection of few events, although beam currents and detection sensitivity had been continuously improved in recent years. The results presented in this paper and recent work in Dubna on element 114 and 116 [42] demonstrates, that further investigation of superheavy nuclei is promising. However, systematic work on an extremely low cross-section level is mandatory. At the UNILAC, which was our working horse for now 25 years, a further increase of the sensitivity is not easily possible. The reasons are that the duty factor of 28 % cannot be increased and that necessary long beam times cannot be arranged due to the multifold use of the accelerator also as injector of beams into the high energy facility SIS. A possible solution might be the construction of a high current accelerator dedicated to heavy element research delivering beams of 100 % duty factor. With such a machine, improved target technology, a separator upgrade with respect to higher transmission and further background suppression, a detailed investigation of the properties of superheavy nuclei will become feasible.

6 Acknowledgement

We are much indebted to the UNILAC staff for making all efforts to provide our experiments with intense and stable beams over periods of several weeks. We are also grateful to H.G. Burkhard and H.J. Schött for taking care of the mechanical devices and electrical components at SHIP and to W. Hartmann, J. Klemm, J. Steiner of the GSI target laboratory for preparation of the target wheels. Many thanks also to the colleagues from the department of experimental electronics and data acquisition. We are particularly grateful for fruitful discussions with N.V. Antonenko, E.A. Cherepanov, S. Ćwiok, V.Yu. Denisov, W. Greiner, P.H. Heenen, M.G. Itkis, P. Möller, A.K. Nasirov, W. Nazarewicz, W. Nörenberg, Yu.Ts. Oganessian, W. Scheid, R. Smolanczuk and A. Sobiczewski.

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App-18: Likelihood Calculation of the Spread of the Time Distributions of Events in the Reported Element 118 Decay Chains (K. Gregorich).

In the table below:

Column 1 is the Z of the chain members
Column 2 is the time units for the values in columns 3-7
Column 3 are lifetimes of events in the first chain from 1999.
Column 4 are lifetimes of the 1999 “escape chain.”
Column 5 are lifetimes of events in the second chain from 1999.
Column 6 are lifetimes of events in the third chain from 1999.
Column 7 are lifetimes of events in the 2001 chain

Note that in the escape chain from 1999 (column 4), the decay of element 116 was not observed. This is presumably because it occurred during the 120 microsecond deadtime of the 1999 data acquisition system. A lifetime of 60 microseconds was assumed, and the element 114 lifetime was adjusted accordingly. Also, for the third chain from 1999 (column 6) the element-118 decay was not observed for the same reason. Again, a lifetime of 60 microseconds was assumed, and the element-116 lifetime was adjusted accordingly.

In Columns 8 and 9, for each Z in the decay chains, 100000 sets of four decay lifetimes (three for the Z=106) were generated by choosing random values from an exponential distribution. For each of these random distributions, an average lifetime was calculated. A Likelihood function was applied to each distribution of four randomly generated lifetimes, giving a “probability” that the random distribution fits an exponential distribution with the corresponding average lifetime. The values in Columns 8 and 9 are the fraction of randomly generated distributions that have likelihood values larger than that for the set “observed” lifetimes. A value less than 50% indicates that the experimental lifetimes are more closely clustered than the randomly generated lifetimes. A value greater than 50% indicates that the experimental lifetimes are less closely clustered than the randomly generated lifetimes.

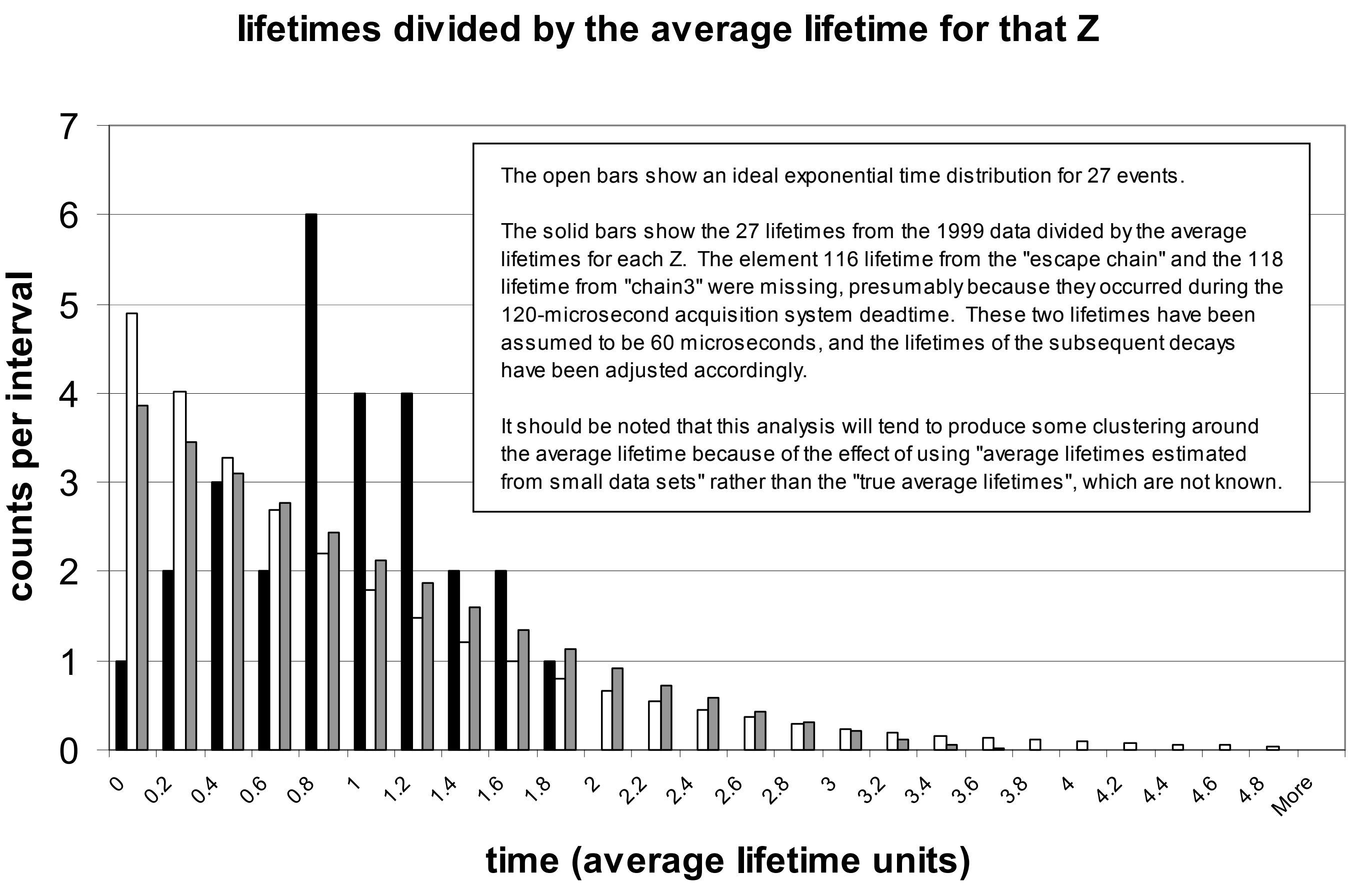
Column 8 considers the four chains from 1999.
Column 9 considers all five chains from 1999 and 2001.

For comparison, if these likelihood values were normally distributed, one standard deviation would extend from 15.9% to 84.1%, two standard deviations would extend from 2.3% to 97.7%.

col. 1	col. 2	col. 3	col. 4	col. 5	col. 6	col. 7	col. 8	col. 9
Z	units	1999	1999	1999	1999	2001	1999	1999+
		chain1	esc	chain2	chain3			2001
118	us	261	190	212	60	137	16.9%	8.0%
116	us	1243	60	1107	250	4007	72.1%	85.6%
114	us	708	876	741	1047	1451	0.6%	1.0%
112	us	1201	1125	1750	939	4923	1.9%	22.1%
110	us	5738	1740	2133	4919	7687	16.4%	13.8%
108	ms	1203	1503	2107	1810	N/A	1.4%	N/A
106	ms	N/A	13879	21530	43100	10412	23.8%	20.0%

To assess the probability that the total set of 27 measured lifetimes for the element 118 chains from 1999 are representative of exponential decay, all of the 27 lifetimes were analyzed in the following way:
1) For each Z, the average lifetime was determined.
2) For each Z, the individual lifetimes were divided by the respective average.
3) The resulting 27 normalized lifetimes were used to create an experimental likelihood value that they come from an exponential distribution.
4) A MonteCarlo simulation was run for 1,000,000 trials.
5) For each trial, six sets of four lifetimes and one set of three lifetimes were chosen from an exponential distribution.
6) For each set, the average lifetime was determined.
7) For each set, the individual lifetimes were divided by the respective average.
8) Each trial, the resulting 27 normalized lifetimes were used to create a theoretical likelihood value.
9) The experimental likelihood from step 4 was compared to the distribution of 1,000,000 theoretical likelihood values from step 8.

Only 0.82% of the 1,000,000 trials resulted in lifetime distributions that are more closely clustered than the lifetimes from the 1999 element 118 experiments.



Graphical Representation of Reported Lifetimes Compared to Ideal Exponential Decay Distribution.

App-19: V. Ninov Statement (February 1, 2002)

See next 5 pages attached.

In re: TECHNICAL REVIEW OF ELEMENT 118 PROGRAM

STATEMENT OF VICTOR NINOV, Ph. D.

1. Summary of My Position.

I stand by the integrity of my research and my interpretations of the data in May 1999. I have always been circumspect and cautious in my interpretations of any data. I have always and continue to hold myself to the highest standards of conduct during experiments and in analysis and interpretation of experimental data.

My review of the Report of the Committee headed by Dr. Gerald Lynch contains numerous errors, the most fundamental of which concerns the files found in my directory. The Committee ignored the fact that, for a considerable period of time, my account was used as a group account. Furthermore my directories were always open to everybody and my password was generally available. Hence many people were using files and programs placed in my directories and it would have been possible for any of them to intentionally, or negligently, manipulate the data in the files. Additionally, many people could have done so because it is not necessary to use GOOSY to analyze data, a fact of which the Lynch committee appears to be unaware. The data are independent from the platform since they are recorded on a UNIX computer. Hence the data can be reviewed or manipulated on any PC, Macintosh or UNIX computer. The only information one needs is the data structure and that is readily available on the web.

Although I have had suspicions about it, I do not have proof of how the data in the files came to be changed. Given my open policy concerning my files, there is no way for me now explain how the text files in question came to be in my directory.

2. A narrative of the events of the last two years

I have chosen this narrative form for clarity and also so the committee can see how events unfolded for me. Since I am not guilty of any academic crimes, I was slow to understand what was happening around me and to realize that my integrity was under assault. This made me slow to come to my own defense. It also never occurred to me to keep a diary record of events. Consequently, all dates are approximate.

1997-1998: At the time of my arrival at the NSD in late 1996, I was already a co-discoverer of numerous elements. I was anxious to enjoy an open scientific exchange such as that which had characterized my positive experiences as a researcher in Europe. Consequently, from the time of my arrival to the present, I have never locked my office or kept my passwords secret. All of my colleagues have always had easy access to my directories and files. Hence, a large community of scientists always had access to my research.

Spring, 1999: Robert Smolanczuk, a Polish theoretician on a fellowship at LBL, had suggested an increase in cross section for heavy element production using the magic lead and the semi magic krypton as a target projectile combination. The GSI had recently provided us with some new equipment and the group agreed to run an experiment with it to test his theories. We did so despite my concern that our equipment was not sufficiently de-bugged. We completed the experiment that resulted in interesting observations. I was excited and puzzled by the data. The Q-alpha values were close to Smolanczuk's theoretical prediction. Before I discussed it with the group, I discussed the results with my former colleagues at the GSI. I did this because some members of my own research group were inexperienced. They were also trained by me and, therefore, would only see the data through my eyes. The senior members had a greater degree of expertise. Walter Loveland had co-authored a textbook on heavy elements[1] with G.T. Seaborg. He is also a seasoned experimentalist and instructs graduate students in his home institution in on-line and off-line analysis.[2] Ken Gregorich had worked within the heavy element group led by A. Ghiorso and D. Hoffman for a long time.

However, neither one was expert in the technology that I now brought to the NSD from the GSI. Thus, for my own intellectual comfort, I preferred to confer with experienced longtime GSI colleagues in order to be sure of what I thought I was observing. I asked F.P. Heßberger (a leading international heavy element expert) to review the data and I discussed it with Gottfried Münzenberg (director of the Nuclear Physics and Nuclear Chemistry department of the GSI and my mentor). The essential question I wrestled with was if there was enough information to indicate a synthesis of a new element without an unambiguous proton number identification (Z - defined by IUPAC/IUPAP rules). They agreed with me that there was not enough but also concurred that there was enough to claim the "interesting observations" noted in the *PRL* article based on the theory of Smolanczuk.

Emboldened, I showed the data to my own group. I did not tell them I had already consulted the GSI as I did not want to belittle or offend anyone. I now expected Loveland and Gregorich to review the data to their own satisfaction since they were certainly able to do so and were deeply involved in the project. However, they apparently did not. It was particularly surprising that Loveland did not do so. As the chronology of the BGS experiments indicates (attached to the Lynch Report), he had already completed an experiment of his own on the apparatus and so was certainly able to tackle this.

Detecting, interpreting or manipulating the data was certainly within the skills of Loveland, Gregorich and a number of others. Indeed, anybody with basic computer and programming knowledge could detect or manipulate the signals. In 1999 I had restricted myself to a simple printout of all anti-coincident events in a certain energy range (typically between 8 and 12 MeV or in channels 2000-3000). To spot the interesting events is not really a task that has to be done by a computer, especially when one wants to look at their history. After spotting interesting sequences, a careful analysis on the raw data is performed. If there is a sequence of two or more events occurring in the same detector, the analysis is forced to go a few tenths of events before the interesting event occurred and then the raw, unpacked data are displayed. The decay sequence is reconstructed by analyzing event-by-event the list mode data until a time where background events may produce a random signal in the detector. This analysis may extend up to several minutes after the interesting event occurred, depending on the total counting rate in the detector and the decay mode of interest. All the relevant data such as event number and relative times since the beginning of the file are stored in a text file and made available to anybody interested.

In the weeks following the "interesting observations," the article for *PRL* was drafted. I insisted that the article should be cautious in its claim about discovering element 118. Without an unambiguous identification of the proton number, such a thing was impossible. However, despite my caution, the press office released the story to the public at the same time as the article with more cautionary language was sent to *PRL* for peer review.

Fall 1999: Following the *PRL* article, we committed ourselves to a series of experiments to try to replicate the results of May 1999. We improved the detector system, the data acquisition system and made extensive tests of the separator.

The Lynch report has since made much of the failings of our data acquisition system, GOOSY. In doing so, it joined a lively ongoing debate over this software comparable to debates about the superiority of Windows versus UNIX or Word versus WordPerfect. It was the Lynch committee's inexperience in the field that let it get sidetracked by this interesting but irrelevant issue. The software is used by several of the leading researchers in the field all of whom recognize that it is not error free but that it is the most robust analytical tool available for the research of nuclei far from stability. The committee did not need to do its own analysis of GOOSY from scratch. All the known errors are well documented and are available on the GOOSY news web site. Indeed, the committee did not even have to go that far if it had wanted to get a full statistical analysis of the software's history. I had posted a great deal of the available information to the BGS website which can be accessed through the LBL home page.

February 2000: We started a series of experiments. These were unsuccessful in repeating the 1999 results. This triggered an investigative committee headed by I-Y Lee to try to determine why we had failed. Neither Lee nor any of the committee was experienced in the field of heavy elements. However, I took an interest in their project in the hope that outsiders might be able to suggest something we had not considered. I saw several drafts of this report including the one that appears in the Lynch report. It quickly became clear that the committee was crippled by its lack of expertise. It added little to the information with which I provided them and added numerous interpretive mistakes. As an example of its failings, figures 1 to 4 are off by orders of magnitude and the labeling "production yield" is incorrect and misleading for heavy element production.

April 2001: We began an experiment to try to repeat the events of May 1999. I was not disheartened by news from Europe that researchers at the GSI and Ganille had failed to repeat our results. I was in contact and am friendly with all the principal researchers on those teams and we had discussed the strengths and weaknesses of their experimental setup. We, that is, the European researchers and myself, were encouraged by what they had learned and we all looked forward to future experiments.

In our own experiment, late in our scheduled beam time, the data showed one interesting event (the integrity of which is now challenged.) However, the original data tape disappeared. Whether that was the result of carelessness, malfeasance, or custodial enthusiasm, I do not know, but disappear it did. By the end of the experiment, no other event had occurred.

We had reached the end of our scheduled beam time and exhausted our meager supply of lead targets. Suddenly I. Y. Lee arrived and told us that that he had secured an extension of several additional days of beam time for us to continue in the hope that we might achieve another event. I told him that that was pointless as we had no targets left and so the experiment was over. He and Gregorich over-rode me. I was stunned. Over my strong objections, I was obliged to carry out a worthless exercise. For several days we bombarded krypton on carbon (carbon is the backing of the target), a process guaranteed to produce nothing.

June 2001: A discussion of whether the group should retract its 1999 findings was in full swing. I was under the impression this discussion was taking place only within the group. I was strongly opposed on the grounds that:

a) we had repeated the experiment even though we could not now claim it as the data was missing
b) our own and the research of other groups only advanced our knowledge of the performance of the separator, the detector system and the electronics
c) our targets had been of a steadily deteriorating quality
d) it was usual for it to take a long time to repeat heavy element experiments due to statistical fluctuations.

I then felt, and still believe, that the best course of action was to host a workshop for all interested researchers to present their work and pool our collective knowledge on this subject.

3. **Conclusion**.

As you can see from the foregoing, at no time did I knowingly engage in any form of misrepresentation of data or scientific misconduct. Although I may have inadvertently done something that contributed to the corruption of the data, I have never intentionally altered, invented, fabricated, corrupted, deleted, or concealed data or experimental observations, or otherwise taken any action that would result in falsifying experimental data or findings of any kind. I stand by the integrity of my research.

DATED: February 1, 2002

VICTOR NINOV, Ph. D.

[1] Glenn T. Seaborg and Walter D. Loveland, *The Elements Beyond Uranium* (New York: Wiley John & Sons, 1990).

[2] Walter Loveland, "Personal Homepage," www.chem.orst.edu/personalhomepage/loveland.htm (January 4, 2002).

App-20: R. Vogt e-mail to V. Ninov Attorneys (Duane & Seltzer)

See next 2 pages attached.

Vogt, Robbie

From: Vogt, Robbie
Sent: Tuesday, February 12, 2002 3:57 PM
To: 'rpd@dnai.com'; 'ess@dnai.com'
Cc: 'MGGilchriese@lbl.gov'; 'AMSessler@lbl.gov'; 'GHTrilling@lbl.gov'; 'PLOddone@lbl.gov'
Subject: Dr. Victor Ninov

Dear Sirs,

As I indicated in a recent discussion with Mr. Duane, our committee would like to submit some questions to Dr. Ninov. Please forward the attached questions to him for his comments. In order to meet the schedule under which our committee is operating, which already once has been extended to accommodate Dr. Ninov, we require Dr. Ninov's response within one week.

Thank you,

Robbie Vogt

Questions to
Dr.Ninov_02.12.02..

Questions to Dr. Ninov

Please indicate whether you concur with the following, and if not, please explain:

1. The present raw data files do not contain the published (PRL) three element-118 decay chains.
2. There is no evidence that the 1999 raw data files have been modified through a removal of the three 1999 decay chains.
3. The files R015_CHAIN_LIS.TPU$JOURNAL;1, NEW_CHAIN_LIS.TPU$JOURNAL;1 and R015CH1.TXT;8 were produced by Victor Ninov.
4. Five days after the file NEW_CHAIN_LIS.TPU$JOURNAL;1 was created on May 7,1999, in an e-mail to Dr. Loveland, Victor Ninov provided evidence for an element-118 decay chain on the basis of essentially the output that was on that file.
5. Victor Ninov agrees that the analysis as shown in the content of SLOG_CA_R013.LOG;1 demonstrates that by April 15,1999 two of the reported element-118 decay chains were not present in the data.
6. Victor Ninov reanalyzed the Run 013 and 015 data after May 7, 1999 to confirm the existence and properties of the published events.
7. There is no reason to suspect that the 1999 analysis was corrupted by GOOSY or any other software failure, affecting the 1999 conclusions.
8. The 2001 Run 45 decay chain was first observed by Victor Ninov about 1254, May 7, 2001.
9. In order to remove the 2001 Run 45 decay chain, the raw-data disk would have to have

been modified between the time of 1254 and 1502 on May 7, 2001.

10. There is no reason to believe that the existing disk record of the missing 2001 raw data tape, that should contain the event under discussion, is invalid.

App-21: Duane & Seltzer e-mail to R. Vogt (February 19, 2001)

See next 3 pages attached.

Vogt, Robbie

From: Gene Seltzer [ess@dnai.com]
Sent: Tuesday, February 19, 2002 1:41 PM
To: vogt@institute.caltech.edu
Cc: AMSessler@lbl.gov; MGGilchriese@lbl.gov; GHTrilling@lbl.gov
Subject: Responses to Questions; Dr. Ninov

Victor's ordeal3.doc (25 KB) ATT79196.txt (80 B)

Dear Dr. Vogt: Attached are Dr. Ninov's responses to your questions/statements. Please let me know if there is any further assistance we can provide....Eugne Seltzer

Questions to Dr. Ninov

Please indicate whether you concur with the following, and if not, please explain:

1. The present raw data files do not contain the published (PRL) three element-118 decay chains.

Answer: The present raw data from run 13,15 as analyzed in 2001 do not contain the four decay chains observed 1999.

2. There is no evidence that the 1999 raw data files have been modified through a removal of the three 1999 decay chains.

Answer: In the file headers of Run13 I recognized some peculiarities. They were never examined further. It never occurred to me until the summer of 2001 to examine the data files for corruption or manipulation. It is not very difficult with basic computer knowledge to manipulate the raw data.

3. The files R015_CHAIN_LIS.TPU$JOURNAL;1, NEW_CHAIN_LIS.TPU$JOURNAL;1 and R015CH1.TXT;8 were produced by Victor Ninov.

Answer: I did NOT produce the files the Lynch committee found in my directory. My account was used as a group account at that time and so many users had access to it.

4. Five days after the file NEW_CHAIN_LIS.TPU$JOURNAL;1 was created on May 7,1999, in an e-mail to Dr. Loveland, Victor Ninov provided evidence for an element-118 decay chain on the basis of essentially the output that was on that file.

Answer: I cannot imagine that I sent the e-mail to W. Loveland with erroneous data. Maybe the Lynch committee remembers how long it took me to discover the errors.

5. Victor Ninov agrees that the analysis as shown in the content of SLOG_CA_R013.LOG;1 demonstrates that by April 15,1999 two of the reported element-118 decay chains were not present in the data.

Answer: So far, I have only seen an ftp protocol submitted by Ken Gregorich to the Lynch committee. The last Run evaluated on the VAX cluster was Run 10. Afterwards I was working on the Alpha Cluster. Hence the Log file should be SLOG_AXP605_R013.LOG. Furthermore I did a very simple printout of anticoincident events not using any automated searches.

6. Victor Ninov reanalyzed the Run 013 and 015 data after May 7, 1999 to confirm the existence and properties of the published events.

Answer: I reanalyzed the run15 in 2001 with no positive result.

7. There is no reason to suspect that the 1999 analysis was corrupted by GOOSY or any other software failure, affecting the 1999 conclusions

Answer: There is no reason to suspect that GOOSY is not working properly. I cannot exclude an error on my side completely.

8. The 2001 Run 45 decay chain was first observed by Victor Ninov about 1254, May 7, 2001.

Answer: This is not correct. I was done with my analysis by noon and not 12.54. I continued around 4pm with running the calibration files for the backward detectors.

9. In order to remove the 2001 Run 45 decay chain, the raw-data disk would have to have been modified between the time of 1254 and 1502 on May 7, 2001.

Answer: This is not necessarily the case, since one week passed after reanalyzing the same file.

10. There is no reason to believe that the existing disk record of the missing 2001 raw data tape, that should contain the event under discussion, is invalid.

Answer: The disk record seemed to me be alright when I analyzed it on May 7th.

App-22: Integrity of the Raw Data Tapes

> We requested that members of the Lynch Committee perform additional checks of the integrity of the raw data tapes as they now exist. Their reply is given below.

Reply from Lynch committee:

"(a) Data tapes produced by the BGS group for the element-118 search experiment are written by the MBS data acquisition package[1] in a format which can be read and analyzed with the GOOSY online/offline data analysis package.

(b) A description of the GOOSY data formats are in
http://www-gsi-vms.gsi.de/goodoc/GM_BUFFER.ps./
The BGS data acquisition uses the event type 10, subtype 1 as shown in that manual. Data files are made up of a sequence of GOOSY buffers and the first buffer in a file is the File Header Buffer. The data buffers written by the BGS are type 10,1. Each buffer has a header that contains timestamp and length information, and this is followed by a number of events that contain size and length information. The size and length information stored in the buffers and events allow one to make some internal consistency checks of the data files that could detect if the files are grossly corrupted. The event information consists of a set of (parameter number, value) pairs where the parameter number identifies which electronics channel is encoded in the value portion of the pair. Part of the experiment documentation is the parameters lists that map parameter number from the event data to each detector element ADC or TDC, or scaler channel, etc. Some internal consistency checks can be performed on the event data themselves. The parameters numbers can only fall within a certain range, the scalers which count oscillators form clock signals that increment monotonically from one event to the next, etc.

(c) The data files that we checked last year were from the 2001 data set. They were already sitting on disk and had been copied from the tapes at some time previously from a tape that has since been lost. These have been checked again. Also some original raw data tapes from 1999 have been tested this year. For these, the internal consistency of the files was checked and verified based upon internal size & length information of the buffers and events.

Ken Gregorich checked the internal consistency for all data files from runs 13, 15 and 45 and found no discrepancies.

Scans of 118 data files were based on the "GOOSY Data Formats" document (Version 1.0 May 20, 1992). This document appears as an appendix to several GOOSY manuals and can be found at http://www-gsi-vms.gsi.de/anal/home.html.

[1] Information on the latest version of MBS is available at http://daq.gsi.de/. Data was taken at BGS using some previous version or versions.

In scanning data files from 1999 and 2001 experimental runs, the following checks were performed by Chuck McParland:

-From the file header (first block), print out VMS format time value, tape label, file name, and file creation time in text format.

-For the first, and all subsequent, data buffers:

-Check that all buffers have the correct length value for data contained in the buffer. That is, verify data length following the fixed length header present in every data buffer (8168 16-bit words).
-Assemble binary value for VMS format time found in each buffer and verify that it increases in each buffer starting at the first buffer and continuing until the last.
-Verify that each buffer is of correct type and sub-type (10 and 1).
-Verify that the buffer number field increases by one starting at the second data buffer and continuing until the last.

-Events found within each buffer are checked as follows:

-Verify that all events have the proper type and sub-type (10 and 1).
-Verify that the length of each event (or event fragment) does not exceed the physical size of the buffer.
-Verify that each event number field increases by one starting at the second event and continuing until the last.

-Sub-events found within each buffer are checked as follows:

-Verify that all sub-events have the proper type and sub-type (10 and 1).
-Verify that the length of each sub-event (or sub-event fragment) does not exceed the physical size of the buffer.
Note: sub-events do not contain number fields and, therefore, cannot be verified to be complete or in order.

The following is a brief summary of our analysis of the structure of data files from both 1999 and 2001 data runs. Our primary concern was to verify the correct structure and formatting of data files as described by the GOOSY Data Format document. It should be pointed out that, given the nature of most data acquisition systems, it is possible to encounter occasional events that violate the expected format; but the overall structure of resulting data files should be correct and consistent.

Four data files from the 2001 experiment were examined. They are:
Run 45, T02F030532.LMD
Run 45, T08F010590.LMD
Run 45, T08F020591.LMD supposed to contain "Chain 2001"
Run 45, T10F010620.LMD .
For tape 8, copies of these files were found on disk and, since the data tape from which they originated is still missing, all analysis was limited to these copies.

With the exception of several events that appeared to have illegal lengths, these files passed all verification tests described above.

Similar tests were performed on six files obtained from data tapes taken during 1999.
They are:
Run 13, T01F020142.LMD supposed to contain "Chain 1 1999"
Run 13, T01F020146.LMD supposed to contain "Escape Chain 1999"
Run 13, T02F010157.LMD
Run 13, T02F010168.LMD supposed to contain "Chain 2 1999"
Run 15, T02F020260.LMD.
These files also passed the same verification tests with, again, one file showing several events with illegal lengths. However, in these 1999 files, the VMS formatted time present in each data buffer failed to properly increment between subsequent data buffers. Furthermore, occasional VMS format times of 0 appeared in one of the files.
During discussions with members of the BGS group, it was mentioned that a major upgrade of their data acquisition system took place after the 1999 runs.

It was also noticed that the VMS format file present in the file header (i.e. first block of each data file) of 1999 files was set to 0. Subsequent examination of 2001 data files showed the same value.

d) The fact that data files are verified to be internally consistent is not proof that the files have not been altered, it merely indicates that if some files have been altered, it was done carefully. In order to carry out the process of modifying the data files to change the physics content of the events (add 118 chains, remove 118 chains, etc.), one would effectively have to combine the analysis program with the buffer writing portion of the data acquisition program and probably make some adjustments so that the timestamps included in the file header and buffer headers are reproduced reasonably. One would have to change the timestamps to indicate a consistent time, rather than the time at which the files were re-written.

e) The most direct evidence that the data have not been altered from the original form is in comparison of the present content of the data with some additional files which were generated at the time the data were first analyzed, and which retain some values from the data at that time.

For the 2001 data many tests were made to check if the data file on disk agrees with the R045.SLOG GOOSY log file. The only differences that were seen were in the vicinity of the reported chain in the 12:54 May 7 section of the log file. Everything else agrees, including the other two sections of the log file that cover the events near the reported chain.

There is a GOOSY analysis log file (SLOG_CA_R013.LOG) from the run13 data and a relevant editor journal file (R015_CHAIN_LIS.TPU$JOURNAL) from the run15 data analysis. The values in the run13 log file were recorded on 15 April 1999 between 11:34am and 11:38am. The timestamp on the run15 journal file is 6 May 1999 at 5:46pm. Values from the run13 log file from analysis of the raw data file T01F020146.LMD were compared with values from the same data file that was re-copied to disk from the original data tape on 31 Jan. 2002. Values from the run15 journal file were compared to values from the data file T04F020280.LMD copied again to disk from the original data tape on 31 Jan. 2002. These data files are the ones purported to contain the events that made up one of the 118 decay chains from run13 and the events from the 118 decay chain from run15. There are only a few values from a few events recorded in the run13 log and run15 journal files so it was not possible to make a comparison of the entire data files as they existed in 1999 and as they exist today. However, the events that are recorded are significant in that they show that the two relevant 118 decay chains that were published in fact did not exist in the data on 15 April 1999 and 6 May 1999. Also what is on the tapes now is very nearly the same as what was on them then. The following page shows details of the comparisons described above.

The comparisons described below were carried out by D. Olson on 2 Feb 2002 using the two data files (T01F020146.LMD, T04F020280.LMD) which were copied from the original data tapes to disk on 31 Jan 2002 by Ken Gregorich. This is followed by a comparison carried out by D. Olson on 3 Mar 2002 of the data file T01F020142.LMD copied to disk by Ken Gregorich in February 2002 with values recorded in the run13 log file.

Underlined values have been verified by re-examination of the data file freshly copied from tape. In case of energies verified means the values seem close but not necessarily identical since we don't have the energy calibration.
Courier font indicates text copied from run13 log file.
The text below is the complete record of analysis of the T01F020146.LMD file on 15 Apr 1999.
We could not verify the "time:" values because we do not know how they were calculated. We could verify the strip number , which is the first two digits of the position. We were also able to verify the vertical position, which is the last three digits.

15-APR-1999 10:40

10:40:47 $ANL Number of processed buffers: 15258
11:34:34 -- >set member db:[data]ipar.r(1) 1
11:34:37 $ANL sta in fi 5DKA100:[BGS.RUN013]T01F020146.LMD;1 /op/swa
11:34:37 $ANL ------------------- File Header --
11:34:37 $ANL Tape label :
11:34:37 $ANL File name : T01F020146.LMD
11:34:37 $ANL User name :
11:34:37 $ANL Run ID :
11:34:37 $ANL Experiment :
11:34:37 $ANL Created : 11-Apr-99 12:19:50
11:34:37 $ANL new ppac
11:34:37 $ANL q1=1498,m1=335,m2=566, p=1 Torr
11:34:37 $ANL ------------------- End of File Header ---
11:34:37 $ANL File input started from: 5DKA100:[BGS.RUN013]T01F020146.LMD;1
11:35:33 $ANL AL-A time 625.341 ev: 30308 tmp: 22988 E1(keV): 2379 pos: 15860
11:35:34 $ANL Al-B time: 625.735 ev: 30327 tmp: 2400 E2(keV): 2286 pos: 15858 dt (s) 0.394 dx(ch): -2

11:36:15 $ANL AL-A time: 1615.488 ev: 49995 tmp: 8729 E1(keV): 3056 pos: 11985
11:36:15 $ANL Al-B time: 1616.333 ev: 50016 tmp: 33231 E2(keV): 2154 pos: 11964 dt (s) 0.845 dx(ch): -21
11:37:53 $ANL Input file closed: 5DKA100:[BGS.RUN013]T01F020146.LMD;1
11:37:53 $ANL Number of processed buffers: 5688

The section below is from Run15 journal file r015_chain_lis.tpu$journal. A comparison is made of values in this journal file with the values in the data file T04F020280.LMD. The minutes:seconds portion of the time corresponds to the 1 second scaler (parameter number 112). We don't know the energy calibration., but because the calibration is the same for all events in the same strip, we know that at least two of the energies are inconsistent. Using the millisecond scaler (# 111) for the clock, the delta T (dt (s)) below should be 0.139 for ev: 21914 and 0.666 for ev: 21937. These are printed in outline to indicate they are verified to NOT match the data.

AL-A time: 0: 14: 13. 979 ev: 21908 tmp: 6115 E1(keV): 11280 pos: 13131
Al-B time: 0: 14: 13. 980 ev: 21914 tmp: 5054 E2(keV): 10705 pos: 13133 dt (s) 0.001 dx(ch): 2
AL-A time: 0: 14: 13. 980 ev: 21914 tmp: 5054 E1(keV): 10705 pos: 13133
Al-B time: 0: 14: 13. ev: 21937 tmp: 10973 E2(keV): 10150 pos: 13128 dt (s):0.001 dx(ch): -5

The run13 GOOSY log file, SLOG_CA_R013.LOG, contains information for 52 events from analysis of the raw data file T01F020142.LMD carried out on 15 Apr 1999. The listing for these 52 events is shown below. For each event and using the value for ev in the log file to find the corresponding event in the raw data file, I compared the values for tmp, E1 or E2 and strip number, which is the 1000's digits of the pos value. For each of the 52 events the values for tmp and E1/E2 match exactly. For all but 3 events the strip numbers matches. For the 3 events, ev = 157339, 157367, 50982, the strip number based on the raw data is 3 while the log file shows strip 4. It is possible that this slight discrepancy resulted from a bug in the analysis code but since there are no decay chain sequences in this log file listing this discrepancy has no significance. There was no comparison made of the other parameters in the log file, time, relative position (pos modulo 1000), dt, dx.

09:18:28 $ANL AL-A time: 1317.177 ev: 27522 tmp: 25815 E1(keV): 3515 pos: 10332
09:18:28 $ANL Al-B time: 1317.606 ev: 27557 tmp: 8693 E2(keV): 3158 pos: 10331 dt (s): 0.429 dx(ch): -2
09:19:13 $ANL AL-A time: 1695.900 ev: 55428 tmp: 38125 E1(keV): 2413 pos: 4735
09:19:13 $ANL Al-B time: 1696.718 ev: 55478 tmp: 59901 E2(keV): 2236 pos: 4758 dt (s): 0.818 dx(ch): 23
09:19:47 $ANL AL-A time: 1991.986 ev: 76634 tmp: 6707 E1(keV): 3135 pos: 14887
09:19:47 $ANL Al-B time: 1992.022 ev: 76637 tmp: 10327 E2(keV): 3620 pos: 14865 dt (s): 0.036 dx(ch): -23

09:20:24 $ANL AL-A time: 2305.874 ev: 99169 tmp: 15527 E1(keV): 2092 pos: 15560
09:20:24 $ANL Al-B time: 2306.167 ev: 99191 tmp: 44801 E2(keV): 2756 pos: 15583 dt (s): 0.293 dx(ch): 23
09:20:29 $ANL AL-A time: 2356.784 ev: 102834 tmp: 6523 E1(keV): 3264 pos: 16671
09:20:29 $ANL Al-B time: 2357.019 ev: 102855 tmp: 29990 E2(keV): 3170 pos: 16668 dt (s): 0.235 dx(ch): -3
09:20:39 $ANL AL-A time: 2433.986 ev: 108467 tmp: 46675 E1(keV): 3661 pos: 16172
09:20:39 $ANL Al-B time: 2434.648 ev: 108515 tmp: 52874 E2(keV): 2887 pos: 16184 dt (s): 0.662 dx(ch): 12
09:20:43 $ANL AL-A time: 2476.855 ev: 111504 tmp: 13589 E1(keV): 2109 pos: 12311
09:20:43 $ANL Al-B time: 2477.598 ev: 111555 tmp: 27857 E2(keV): 2375 pos: 12286 dt (s): 0.743 dx(ch): -25
09:20:56 $ANL AL-A time: 2589.456 ev: 119470 tmp: 53637 E1(keV): 2198 pos: 12377
09:20:56 $ANL Al-B time: 2589.579 ev: 119477 tmp: 6002 E2(keV): 3216 pos: 12388 dt (s): 0.123 dx(ch): 11
09:21:57 $ANL AL-A time: 3137.251 ev: 156578 tmp: 53113 E1(keV): 3512 pos: 15401
09:21:57 $ANL Al-B time: 3137.909 ev: 156629 tmp: 58945 E2(keV): 2675 pos: 15387 dt (s): 0.658 dx(ch): -14
09:21:58 $ANL AL-A time: 3146.758 ev: 157339 tmp: 43847 E1(keV): 2854 pos: 4291
09:21:58 $ANL Al-B time: 3147.073 ev: 157367 tmp: 15330 E2(keV): 2818 pos: 4308 dt (s): 0.315 dx(ch): 16
09:22:02 $ANL AL-A time: 3179.220 ev: 159762 tmp: 50062 E1(keV): 3727 pos: 10278
09:22:02 $ANL Al-B time: 3179.832 ev: 159820 tmp: 51219 E2(keV): 2822 pos: 10256 dt (s): 0.612 dx(ch): -22
09:23:02 $ANL AL-A time: 3675.644 ev: 196933 tmp: 12529 E1(keV): 2973 pos: 6872
09:23:02 $ANL Al-B time: 3676.011 ev: 196960 tmp: 49157 E2(keV): 3356 pos: 6884 dt (s): 0.367 dx(ch): 12
09:23:59 $ANL AL-A time: 4163.501 ev: 232375 tmp: 18230 E1(keV): 3269 pos: 11739
09:23:59 $ANL Al-B time: 4163.536 ev: 232380 tmp: 21726 E2(keV): 3446 pos: 11754 dt (s): 0.035 dx(ch): 16
09:24:32 $ANL AL-A time: 4460.582 ev: 252295 tmp: 26350 E1(keV): 3653 pos: 6404
09:24:32 $ANL Al-B time: 4461.200 ev: 252327 tmp: 28122 E2(keV): 2169 pos: 6412 dt (s): 0.618 dx(ch): 8
09:25:13 $ANL AL-A time: 4835.071 ev: 276786 tmp: 35171 E1(keV): 2607 pos: 7764
09:25:13 $ANL Al-B time: 4835.642 ev: 276826 tmp: 32362 E2(keV): 2185 pos: 7780 dt (s): 0.571 dx(ch): 16
09:25:17 $ANL AL-A time: 4874.539 ev: 279632 tmp: 21983 E1(keV): 3509 pos: 4658
09:25:17 $ANL Al-B time: 4874.714 ev: 279650 tmp: 39499 E2(keV): 3572 pos: 4642 dt (s): 0.175 dx(ch): -16
09:26:29 $ANL AL-A time: 5493.511 ev: 324359 tmp: 59156 E1(keV): 2129 pos: 16443
09:26:29 $ANL Al-B time: 5493.787 ev: 324389 tmp: 26759 E2(keV): 2927 pos: 16459 dt (s): 0.276 dx(ch): 16
09:26:52 $ANL AL-A time: 5693.746 ev: 338724 tmp: 42692 E1(keV): 3256 pos: 15329
09:26:52 $ANL Al-B time: 5694.358 ev: 338765 tmp: 43928 E2(keV): 3383 pos: 15308 dt (s): 0.612 dx(ch): -21
09:27:10 $ANL AL-A time: 5849.946 ev: 349889 tmp: 2680 E1(keV): 2605 pos: 9258

```
09:27:10 $ANL  Al-B time:   5850.593 ev:   349935 tmp:  7348 E2(keV):  2021 pos:  9274 dt (s):      0.647 dx(ch):  16
09:27:42 $ANL  AL-A time:   6173.528 ev:   368933 tmp: 20827 E1(keV):  2599 pos: 13402
09:27:42 $ANL  Al-B time:   6173.985 ev:   368974 tmp:  6609 E2(keV):  2367 pos: 13381 dt (s):      0.457 dx(ch): -21
09:28:36 $ANL  AL-A time:   6652.846 ev:   401555 tmp: 59092 E1(keV):  2042 pos: 14399
09:28:36 $ANL  Al-B time:   6652.911 ev:   401558 tmp:  5541 E2(keV):  2400 pos: 14421 dt (s):      0.065 dx(ch):  22
09:29:31 $ANL  AL-A time:   7147.994 ev:   434698 tmp: 13881 E1(keV):  2140 pos:  6492
09:29:31 $ANL  Al-B time:   7148.196 ev:   434710 tmp: 34049 E2(keV):  2185 pos:  6475 dt (s):      0.202 dx(ch): -18
09:29:48 $ANL  AL-A time:   7300.530 ev:   444907 tmp: 27523 E1(keV):  3102 pos: 16089
09:29:48 $ANL  Al-B time:   7300.612 ev:   444913 tmp: 35741 E2(keV):  2892 pos: 16106 dt (s):      0.082 dx(ch):  17
09:31:11 $ANL  AL-A time:   8032.043 ev:   495029 tmp: 38781 E1(keV):  3207 pos: 15815
09:31:11 $ANL  Al-B time:   8032.143 ev:   495046 tmp: 48831 E2(keV):  3357 pos: 15818 dt (s):      0.100 dx(ch):   2
09:31:25 $ANL  AL-A time:   8135.884 ev:   503349 tmp: 42871 E1(keV):  3707 pos: 12361
09:31:25 $ANL  Al-B time:   8136.079 ev:   503367 tmp:  2451 E2(keV):  2026 pos: 12352 dt (s):      0.195 dx(ch):  -9
09:31:35 $ANL  AL-A time:   8281.404 ev:   509809 tmp:  1328 E1(keV):  2292 pos:  4608
09:31:35 $ANL  Al-B time:   8282.350 ev:   509892 tmp: 35925 E2(keV):  2180 pos:  4623 dt (s):      0.946 dx(ch):  16
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App-23: Committee's "10 Questions", Ninov's Answers, and Committee's Comments

Dr. Ninov responded in writing to the questions from the Committee of February 12, 2002 (App-20) on February 19, 2002 (App-21). Below we give the questions (numbered) from the Committee, Ninov's response (**Answer**) and the Committee's subsequent comments on his answers (**Comment**). In developing its comments on Ninov's answers, the Committee was greatly helped by Gerald Lynch, and his comments are folded in below.

Dr. Ninov was asked to indicate whether he concurs with the following, and if not, to please explain.

1. The present raw data files do not contain the published (PRL) three element-118 decay chains.

Answer: The present raw data from run 13,15 as analyzed in 2001 do not contain the four decay chains observed 1999.

Comment: Ninov and the Committee agree.

2. There is no evidence that the 1999 raw data files have been modified through a removal of the three 1999 decay chains.

Answer: In the file headers of Run13 I recognized some peculiarities. They were never examined further. It never occurred to me until the summer of 2001 to examine the data files for corruption or manipulation. It is not very difficult with basic computer knowledge to manipulate the raw data.

Comment: Ninov's answer is not a direct response either agreeing or not. Lynch reports, "Chuck McParland did find that the VMS time on the header is zero in the 1999 files. We have no idea if this is what Victor is referring to. This defect is on all 1999 files that Chuck looked at. Chuck did not find other problems. So we cannot say any more about this without more specific information."

3. The files R015_CHAIN_LIS.TPU$JOURNAL;1, NEW_CHAIN_LIS.TPU$JOURNAL;1 and R015CH1.TXT;8 were produced by Victor Ninov.

Answer: I did NOT produce the files the Lynch committee found in my directory. My account was used as a group account at that time and so many users had access to it.

Comment: This is a direct denial. All the evidence that the Committee has marshaled indicates that Ninov produced these files.

4. Five days after the file NEW_CHAIN_LIS.TPU$JOURNAL;1 was created on May 7,1999, in an e-mail to Dr. Loveland, Victor Ninov provided evidence for an element-118 decay chain on the basis of essentially the output that was on that file.

Answer: I cannot imagine that I sent the e-mail to W. Loveland with erroneous data. Maybe the Lynch committee remembers how long it took me to discover the errors.

Comment: This is a direct denial of something for which there is documented evidence. To quote Lynch, "The page in appendix B4 was given to us by Victor or Ken at the first meeting that we had with them. It was from a page that was in a logbook that was kept at Bldg. 88. The part of this page that is computer printout was sent by Victor to Walter Loveland on May 12,1999 at 9:51 AM. Last August Walter found the letter in a backup and sent it to Ken, who forwarded it to us on August 12."

5. Victor Ninov agrees that the analysis as shown in the content of SLOG_CA_R013.LOG;1 demonstrates that by April 15,1999 two of the reported element-118 decay chains were not present in the data.

Answer: So far, I have only seen an ftp protocol submitted by Ken Gregorich to the Lynch committee. The last Run evaluated on the VAX cluster was Run 10. Afterwards I was working on the Alpha Cluster. Hence the Log file should be SLOG_AXP605_R013.LOG. Furthermore I did a very simple printout of anticoincident events not using any automated searches.

Comment: Ninov response is not relevant to the Committee statement.

6. Victor Ninov reanalyzed the Run 013 and 015 data after May 7, 1999 to confirm the existence and properties of the published events.

Answer: I reanalyzed the run15 in 2001 with no positive result.

Comment: The Committee statement is about 1999 and the Ninov response is about 2001, with the Ninov response neither supporting nor denying the Committee statement.

7. There is no reason to suspect that the 1999 analysis was corrupted by GOOSY or any other software failure, affecting the 1999 conclusions

Answer: There is no reason to suspect that GOOSY is not working properly. I cannot exclude an error on my side completely.

Comment: Ninov agrees with Committee findings.

8. The 2001 Run 45 decay chain was first observed by Victor Ninov about 12:54, May 7, 2001.

Answer: This is not correct. I was done with my analysis by noon and not 12:54. I continued around 4pm with running the calibration files for the backward detectors.

Comment: Ninov flags a time difference of 54 minutes, but does not deny the essence of the Committee's statement. According to Lynch, "The 2001 chain was not first observed at 12:54 on May 7, 2001. That is when the section of the log file that has evidence for the chain was copied into the log file. This section was probably produced earlier that day."

9. In order to remove the 2001 Run 45 decay chain, the raw-data disk would have to have been modified between the time of 12:54 and 15:02 on May 7, 2001.

Answer: This is not necessarily the case, since one week passed after reanalyzing the same file.

Comment: Ninov disagrees, but the Committee feels confident that it is correct, for to quote Lynch, "There are two times here, 12:54 and 15:02. Victor questions the 15:02 because it was not until a week later that someone looked again at the data and saw that the chain was not there. But we regard the 15:02 as a firm number because, although no one acknowledges looking at the data at that time, the log file tells us that someone did, and the chain was not there then. As I said before, the 12:54 is not a firm number. The evidence that the 12:54 section was copied into the log file is beyond a reasonable doubt. If one were to argue that the information in this section is correct, one would argue that GOOZY was run at an earlier time and the results captured and then copied into the log file at 12:54. Since a file that could have done the copy was made at 10:59 that morning, it seems likely the the evidence for the chain was available before that."

10. There is no reason to believe that the existing disk record of the missing 2001 raw data tape, that should contain the event under discussion, is invalid.

Answer: The disk record seemed to me be alright when I analyzed it on May 7th

Comment: Ninov and the Committee agree.