AIIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

301/587-8202

Centimeter

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 mm

1 2 3 4 5

Inches

MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 2

BNL-NCS-60566
INFORMAL REPORT
LIMITED DISTRIBUTION

THE U.S. NUCLEAR DATA NETWORK

Summary of the Nineteenth Meeting
held at
Asilomar Conference Center
October 19, 1993

National Nuclear Data Center
Secretariat

Department of Nuclear Energy

Brookhaven National Laboratory
Associated Universities, Inc.
Upton, Long Island, New York 11973

Under Contract No. DE-AC02-76CH00016 with the

UNITED STATES DEPARTMENT OF ENERGY

DISCLAIMER

AGENDA
U.S. NUCLEAR DATA NETWORK MEETING
ASILOMAR CONFERENCE GROUNDS
MONTEREY, CALIFORNIA
OCTOBER 19, 1993

Chairman: M. R. Bhat

9:00-12:30		
	Welcome	J. M. Dairiki
	Opening Remarks	R. A. Meyer
	Relevance of Nuclear Data Evaluations for Research	
	High-spin Physics & Table of Superdeformed Bands	B. Singh
	High-spin Data File & Applications	J. D. Garrett
	Experimental Data File/Repository	J. K. Tuli
	Radioactive Decay & Applications	R. G. Helmer
	Electronic Access to Nuclear Data	
	ENSDF Online System	J. K. Tuli
	Accessing Level Schemes from ENSDF on Desktop Computers	C. A. Stone
	Expanding the Scope of the NSR File	L. P. Ekstrom
	ENSDAT Program: Online and on IBM/PC	R. R. Kinsey
12:30-1:30	L U N C H	
1:30-2:00		
	Report on the Cross Section Evaluation Working Group (CSEWG) Meeting	M. R. Bhat
	A Draft Proposal for a USNDN Program Advisory Council	
2:00-4:15		
	Discussion of Focus Groups	

4:15-5:00

Recommendations of Focus Groups

Recommendations of Focus Group 1	M. R. Bhat
Recommendations of Focus Group 2	J. A. Cizewski
Recommendations of Focus Group 3	J. Dairiki
Recommendations of Focus Group 4	J. K. Tuli

5:00-6:00

Publications: Table of Isotopes

Status of Book	R. B. Firestone
CD-ROM Version	J. Z. James
Interactive Version	F. Chu

Adjournment

<u>**Table of Contents**</u>

Table of Contents

Page

U. S. Nuclear Data Network Meeting

October 19, 1993

Attendees:

Y. A. Akovali (ORNL)
C. M. Baglin (LBL)
M. R. Bhat (BNL)
E. Browne (LBL)
R. M. Chasteler (Duke U.)
F. Chu (LBL)
J. A. Cizewski (Rutgers U.)
J. M. Dairiki (LBL)
L. P. Ekstrom (Lund U.)
R. B. Firestone (LBL)
J. D. Garrett (ORNL)
R. G. Helmer (INEL)
J. Z. James (LBL)
R. R. Kinsey (BNL)
M. J. Martin (ORNL)
R. A. Meyer (DOE)
L. D. Mumaw (San Jose State U.)
L. K. Peker (BNL)
C. W. Reich (INEL)
V. S. Shirley (LBL)
B. Singh (LBL)
C. A. Stone (San Jose State U.)
J. K. Tuli (BNL)
H. R. Weller (Duke U.)
S. L. Whetstone
J. Zipkin (LBL)

1. The following progress reports from the member centers of the USNDN were distributed prior to the meeting:

TUNL A=3-20 Data Project Activity Report 1993
(Attachment 1)
INEL Mass-chain Evaluation Project Activity Report for 1993
(Attachment 2)
1993 Isotopes Project Center Report
(Attachment 3)
Nuclear Data Project Activity Report
(Attachment 4)
The NNDC Activity Report (Parts A & B)
(Attachment 5)

2. The Formats & Procedures Subcommittee of the international Nuclear Structure & Decay Data Network (NSDD) met on the evening of October 18, 19 with M. J. Martin presiding. The minutes of its meeting are given in Attachment 6.

3. The nineteenth meeting of the U. S. Nuclear Data Network (USNDN) was held at the Asilomar Conference Center, October 19, 1993, with M. R. Bhat in the chair.

4. J. M. Dairiki welcomed the attendees and wished them a successful meeting. She also expressed the hope that the spirit of co-operation shown by the USNDN members at the Duke University last year was alive and well and would continue to guide the deliberations at this meeting.

5. In delivering his Opening Remarks, R. A. Meyer requested the attendees to listen in a "THINK MODE" and not react in a "DEFEND and RETREAT MODE". His comments were on three general topics: a. the Budget, b. Questions and Concerns, and c. Suggestions.

a. the Budget:

The budget was expected to be flat in uninflated dollars at best, but may be down by as much as about 10% in FY95. In the data programs, the cross- section measurements component has been too severely hit-down by about $2.3 M in FY94 from $7-8 M in FY91. The nuclear structure component has had a slight increase in dollars. If the budget drops further, then the following questions should be posed.

b. Questions & Concerns:

Has the present USNDN organization become too antiquated to compete for funds?

Has the present product become too antiquated?

Does it have too high a cost, e.g., FTE dollars per mass-chain?

Is the A-chain mentality in fact antiquated?

What should the organization and products of the structure component of the data network look like in the year 2000?

How can we get there?

Do we need a USNDN or an NSEWG?

What form of co-ordination is needed within the USNDN?

What form of interface do we need between the U. S. and international collaboration–the IAEA, the NEA DataBank?

Enormous effort and funds are put into the ENSDF; how do we make it a viable tool so that it will still be supported in the year 2000?

How can the DOE assure co-operation within the USNDN and avoid duplication?

Where do we want to go?

What is the minimum effort needed?

Who are our customers?

Where will the new information come from?

Is there information need for applied areas?

If so, what is the information, and who pays for it? Examples of applied uses are: decay heat calculations and safety issues where savings in real dollars are possible.

How do we re-structure ourselves?

What type of service centers can be most efficient and best serve customer needs while providing support for the data work?

What components are needed, e.g., development and use of advanced technology, data professional training and updating, customer service?

What aspects of the present effort need strengthening, and what will be eliminated to achieve that goal?

How to proceed?

c. Suggestions:

Think of today as a day for re-structuring and change the agenda accordingly. Present abstracts of reports in the morning and go to a think-tank mode in the afternoon. In the near term, a network co-ordinator is needed; and R. A. Meyer suggested that the network members nominate and elect a co-ordinator. He proposed J. M. Dairiki. This was declined by her, and as a counter proposal she suggested the formation of an executive council.

6. The network discussed changes in the agenda suggested by R. A. Meyer and others and adopted the agenda on page 1.

7. Relevance of Nuclear Data Evaluations for Research was the next general topic of discussion under which the following four papers were presented:

Evaluation of High-spin Nuclear Data for ENSDF and
Table of Superdeformed Nuclear Bands by B. Singh
This paper described the author's past and ongoing efforts to enter high-spin data into ENSDF. A draft report "Table of Superdeformed Nuclear Bands", has also been produced showing the rotational bands, and listing the gamma-ray transitions and the references. In addition to the superdeformed data, high-spin data for A=124 has also been entered into ENSDF. He reiterated the need for a depository of data, including additional experimental details and information which are often missing from published papers. (Attachment 7)

Proposal for Support of an Experimental High-spin Data File/
Data-Network Co-ordinator by J. D. Garrett
A proposal for the creation and maintenance of an experimental high-spin data file was presented and copies of the proposal were distributed. (Attachment 8)

Experimental Data File/Repository by J. K. Tuli
This was a brief presentation on the possibility of having and maintaining an experimental nuclear structure data file (XNSDF) which would include high-spin and other types of data.

Radioactive Decay & Applications by R. G. Helmer
This talk emphasized the two main difficulties with ENSDF found by applied users, viz., insufficient documentation and lack of or insufficient warnings where data are suspect. (Attachment 9) In addition, a proposal " A Plan for a Horizontal Evaluation of Decay Data" by R. G. Helmer, E. Browne, and M. Schmorak was also discussed. (Attachment 10)

8. Electronic Access to Nuclear Data was the next general topic under which the

following four papers were presented.

ENSDF Online System by J. K. Tuli
The NNDC online system, its user statistics, recent enhancements, future plans for improvements were presented in this talk. It was pointed out that the use of the online system was increasing exponentially and future technical advances such as data super highways and faster modes of data transmission augured well for this form of data access. (Attachment 11)

The MacNuclide Project by C. A. Stone
A status report on version 1.0 of the MacNuclide was presented with a computer demonstration and a discussion of future plans for this project. (Attachment 12)

Expanding the Scope of the Nuclear Structure Reference File by L. P. Ekstrom
Suggestions for extending the scope of literature coverage by the NSR and improvements in the file such as eliminating duplicate keynumbers for the same entry and introducing new selectors for topics of current interest were mentioned. Advantages of the availability of the file on CD-ROM and online were pointed out; and the need for both these forms of data access was emphasized. (Attachment 13)

ENSDAT: Evaluated Nuclear Structure Drawings and Tables by R. R. Kinsey
The availability of this program both online and on IBM/PC was discussed and plans for its enhancement were mentioned. Its usage online has shown much increase and the program has been found useful by evaluators in checking and correcting their evaluations. (Attachment 14)

9. A report on the October 5-7, 1993 meeting of the Cross Section Evaluation Working Group (CSEWG) held at Brookhaven and the CSEWG Strategy Session was given by M. R. Bhat. The purpose of the strategy session was to discuss the goals of CSEWG, its organization, users of its products and their needs, its role in co-operation with foreign evaluators with a view to formulate a strategy that would assure its long-term survival. (Attachment 15)

10. A draft proposal for a USNDN Program Advisory Council was next presented by M. R. Bhat (Attachment 16). The purpose of this proposal was to provide a mechanism for obtaining user input to the activities of the USNDN.

11. The attendees then broke up into four Focus Groups to come up with recommendations on these broad categories: Management/Organization, Marketing, User Needs, Tools and Others. These recommendations are given in Attachments 17-20.

12. Following the recommendations of the Focus Groups an Executive Committee of the USNDN was formed with the following members: J. M. Dairiki (Chair), M. R. Bhat, J. A. Cizewski and L. P. Ekstrom. The Executive Committee met with R. A. Meyer on the 19th and 23rd and had a luncheon meeting on the 21st.

13. The following three papers were presented related to the publication of the Table of Isotopes.

The *Table of Isotopes* by R. B. Firestone
A status report on the 8th edition of the Table of Isotopes was presented; it is expected

that the book will be sent to the publishers in 1994. (Attachment 21) In addition to the printed book, the contents of the book will also be available on a CD-ROM and as Electronic Table of Isotopes. Details of these two modes of electronic access were discussed in the following two presentations.

The *Isotopes CD-ROM* by J. Z. James
(Attachment 22)

Electronic Table of Isotopes (ETOI) by F. Chu
(Attachment 23)

14. The members of the U.S. Nuclear Data Network organized a hands-on exhibit called "Electronic Access to Nuclear Data" on October 20-22, 1993 at the Surf & Sand building. (Attachment 24)

15. The next USNDN meeting will be held in conjunction with the APS Division of Nuclear Physics Fall Meeting at Williamsburg, VA, October 26-29, 1994. The exact dates and other details will be decided at a later date.

Attachment 1

TUNL A = 3 - 20 DATA PROJECT
ACTIVITY REPORT 1993
to
UNITED STATES NUCLEAR DATA NETWORK

D.R. Tilley[1], H.R. Weller[2], C.M. Cheves[2] and R.M. Chasteler[2]

Triangle Universities Nuclear Laboratory, Duke Station, Durham, NC 27706

[1]Department of Physics, North Carolina State University, Raleigh, North Carolina, 27695
[2]Department of Physics, Duke University, Durham, North Carolina 27706

I. TUNL is responsible for data evaluations in the mass range A = 3 - 20. The current status of these evaluations is summarized below:

Nuclear Mass	Publication/Status	Comments
A = 3	Nucl. Phys. A474, 1 (1987)	TUNL
A = 4	Nucl. Phys. A541, 1 (1992)	TUNL/LANL
A = 5 - 10	Nucl. Phys. A490, 1 (1988)	U. Penn. (FAS)
A = 11 - 12	Nucl. Phys. A506, 1 (1990)	U. Penn. (FAS)
A = 13 - 15	Nucl. Phys. A523, 1 (1991)	U. Penn. (FAS)
A = 16 - 17	Nucl. Phys. A460, 1 (1986) Revision Accepted by Nucl. Phys.	U. Penn. (FAS) TUNL, 1993
A = 18 - 20	Nucl. Phys. A475, 1 (1987) New Evaluation begun	U. Penn. (FAS) TUNL, 1993

II. Related Activities

During the period since the 1992 Activities Report, TUNL has continued its coverage of the literature, compiling bibliographical listing for relevant experimental and theoretical work, utilizing the resources of the Triangle Area Libraries as well as Monthly Updates from NNDC, Current Contents on Diskette with Abstracts, and Physics Abstracts.

After the preliminary versions of the A = 16 and A = 17 reviews were distributed in preprint form in June 1992 and December 1992 respectively, TUNL began work on converting the material to ESP-LaTeX format for submission to Nuclear Physics and making the revisions based on responses received from recipients of the preliminary versions. During the past year TUNL also worked on computer techniques for making revisions to the large hand-drawn level diagrams for A = 5 - 20 supplied by Professor Fay Ajzenberg-Selove. Methods were developed for scanning the drawings and editing them using currently available graphics applications for the Macintosh. Drawings edited in this way were used for the A = 16 - 17 manuscript which was submitted to Nuclear Physics in July 1993.

Work on a new version of A = 18 - 20 has begun and a preliminary version for A = 18 will be issued as a preprint as soon as that part of the review is completed.

In addition to work on an update to A = 18 - 20 a high priority is being assigned to the entry of A = 5 - 20 data into ENSDF, and TUNL is working closely with Dr. Murray Martin of the Nuclear Data Project at ORNL. Dr. Martin has recently carried out level and decay data entry for A = 16 - 17 and is presently helping TUNL personnel to learn the procedures.

In September 1993 the project gained the services of Dr. Robert Chasteler whose responsibilities as a DOE-sponsored post doctoral research associate will be divided equally between the nuclear data project and the radiative capture research program at TUNL. Dr. Chasteler is expected to play a major role in developing new techniques for the TUNL project and in performing compiled data entry into ENSDF files.

This work is supported by the U.S. Department of Energy Director of Energy Research, Office of High Energy and Nuclear Physics, under Contract No. DE-FG05-91ER40619 (Duke University), Contract No. DE-FG05-88ER40441 (North Carolina State University

Attachment 2

INEL MASS-CHAIN EVALUATION PROJECT

ACTIVITY REPORT for 1993
to

NUCLEAR STRUCTURE EVALUATION WORKING GROUP

R. G. Helmer and C. W. Reich

Idaho National Engineering Laboratory
EG&G Idaho, Idaho Falls, Idaho 83415-2211

I. Mass-Chain Evaluations

The following summarizes our A-chain evaluation activity for the 1993 calendar year.

A-chains under our responsibility:	87, 153-163
A-chains submitted (to 10/15/93):	155, 159
A-chains expected to be submitted (after 10/15/93):	157
A-chains published (to 10/15/93):	154, 160
A-chains expected to be published (after 10/15/93):	None
Number of A-chains reviewed (to 10/15/93):	One
Number of A-chains expected to be reviewed (after 10/15/93):	None
Number of continuous evaluation (to 10/15/93):	None
Number of continuous evaluation anticipated (after 10/15/93):	None
Number of full-time evaluators:	0.7
Projection of activities for 1994:	submit 158, 163 publish 155, 159

The current status of the 12 A-chains for which we are responsible is as follows:

A-chain	Publication	Comments
87	NDS 62, 327 (1991)	By German group
153	NDS 60, 419 (1990)	Update form
154	NDS 69, 507 (1993)	Update form
155	NDS 50, 563 (1987)	Revision submitted
156	NDS 65, 65 (1992)	Update form
157	NDS 55, 71 (1988)	New evaluation started
158	NDS 56, 199 (1989)	
159	NDS 53, 507 (1988)	Revision submitted
160	NDS 68, 405 (1993)	
161	NDS 59, 1 (1990)	
162	NDS 64, 79 (1991)	
163	NDS 56, 313 (1989)	By NNDC group

As indicated the only A-chain over five years old has been submitted.

II. Related Activities

A. Beta-feeding distributions by total absorption spectrometry

A total absorption γ-ray spectrometer (TAGS) has been developed at the ^{252}Cf-based INEL ISOL facility to measure beta-feeding distributions for fission-product nuclides. In the last year the methodology for analysis of these spectra has been completely upgraded. As part of this upgrade, response functions for the large NaI(Tl) detector have been generated by Monte Carlo calculations for monoenergetic electrons emitted from the source for both singles and β-gated coincidence spectra. These functions simulate the response for electrons that scatter into the NaI(Tl) detector as well as bremsstrahlung photons produced in stopping the electrons. By convoluting these functions with a theoretical beta spectrum, this gives the response to each beta branch. The new analysis routine includes the calculation of the coincidence summing between each simulated beta branch spectrum and the summed γ response for all the following γ rays. With this addition, all physical phenomena of a decay scheme are modeled except the internal bremsstrahlung from the beta decay. Data have been collected on the β feeding distributions for a total of about 45 radionuclides.

B. ICRM Workshop on Evaluation of Decay Data

A small workshop on the evaluation of decay data was organized by the Non-Neutron Nuclear Data Working Group, A. L. Nichols chair, of the International Committee on Radionuclide Metrology (ICRM) and held in Idaho Falls, 5-7 October 1992. E. Browne and R. G. Helmer from the US Nuclear Data Network attended. The group discussed various, and conflicting, methodologies for the evaluation of discrepant data, especially for half-lives and γ-ray emission probabilities. A report on the work and conclusions of the Workshop was prepared by Dr. Nichols.

C. Energy of first-excited level in ^{229}Th

It has been known for many years that the first-excited state of ^{229}Th lies close to the ground state. Originally this energy was given as < 0.1 keV; later, Reich and Helmer reported a value of -1 ± 4 eV. Since the existence of a nuclear state at this very low energy is of considerable interest, measurements of its energy, half-life and modes of excitation and deexcitation are important. In an attempt to improve this level energy, we have measured over 175 γ-ray spectra with several combinations of radionuclides. In comparison with our earlier study, we have considered more γ rays in ^{229}Th, used more well-measured reference lines, used more detectors, used detectors with better low-energy resolution, more closely matched peak count rates, and specifically considered certain systematic errors. From this large set of measurements we have deduced a value of 3.5 ± 1.0 eV for the energy of this level. A report containing all of the measurement results has been issued and a manuscript describing the results has been prepared for publication.

D. Relevant Publications (Not including the NDS)

"The Level at a Few eV of Excitation in ^{229}Th," C. W. Reich and R. G. Helmer, invited paper presented at the Symposium on Nuclear Physics of Our Times, Sanibel Island, Florida, Nov. 17-21, 1992.

"γ-ray energies for calibration from the decay of ^{161}Tb, ^{172}Hf + ^{172}Lu, and ^{241}Am", R. G. Helmer, Nucl. Instr. and Meth. **A330**, 434 (1993).

"An Improvement in the Value of the Energy of the First Excited State in ^{229}Th", R. G. Helmer and C. W. Reich, U.S. DOE Report EGG-NRP-10693 (April 1993).

Attachment 3

October 4, 1993

TO: U.S. Nuclear Data Network

FROM: Edgardo Browne and Richard B. Firestone
Isotopes Project, Lawrence Berkeley Laboratory

RE: 1993 Isotopes Project Center Report

1. Mass-Chain Evaluation (V.S. Shirley, C.M. Baglin, B. Singh, E. Browne, R.B. Firestone). The Isotopes Project has permanent responsibility for evaluating 43 mass chains with A=81, 83, 89-93, 167-194, 206, 210-212, 215, 219, 223, and 227, and for converting data with A=23-26, and 33-44 from P. Endt's evaluations to ENSDF format. The project has accepted temporary responsibility for evaluating the following mass chains: A=76, 79, and 80 (from the Nuclear Data Project at Kuwait); and A=59 (from the Swedish Group at Lund). Table I shows the current evaluation status of mass chains assigned to the Isotopes Project.

The following summarizes the Isotopes Project 1993 mass-chain evaluation activity:

Number of mass-chain evaluations *submitted* to BNL between 1-1-93 and 10-15-93.	3 (A=168, 178, 179)
Number of mass-chain evaluations *expected* to be submitted to BNL between 10-15-93 and 12-31-93:	3 (A=76, 173, 185)
Number of mass-chain evaluations *published* between 1-1-93 and 10-15-93:	3 (A=81, 175, 177)
Number of mass-chain evaluations *expected* to be published between 10-15-93 and 12-31-93:	3 (A=59, 79, 93)
Number of continuous mass-chain evaluations *completed* between 1-1-93 and 10-15-93:	none
Number of continuous mass-chain evaluations *expected* to be completed between 10-15-93 and 12-31-93:	4 (A=181, 183, 187, 189)
Number of mass-chain evaluations *reviewed* between 1-1-93 and 10-15-93:	2

In addition, the Isotopes Project has collaborated with the McMaster group to evaluate and update reaction and adopted data sets for the existing data on superdeformed bands.

The Isotopes Project has dedicated about 2.0 full-time employees (FTE) to mass-chain evaluation in 1993.

Table I: Status of LBL Mass-Chain Assignment

Mass Chain	Status	Reference	Age[a]
23-26	In ENSDF (1992)	Nucl. Phys. **A521**,	
33-44	In ENSDF (1992)	1 (1990).	
59 (temporary, Sweden)	Published	NDS **69**, 733 (1993)	
76 (temporary, Kuwait)	In progress	NDS **42**, 233 (1984)	
79 (temporary, Kuwait)	Submitted 1992	NDS **37**, 393 (1982)	
80 (temporary, Kuwait)	Published	NDS **66**, 623 (1992)	
81	Published	NDS **69**, 267 (1993)	0
83	Published	NDS **66**, 281 (1992)	1
89	Published	NDS **58**, 351 (1989)	4
90	Published	NDS **67**, 579 (1992)	1
91	Published	NDS **60**, 835 (1990)	3
92	Published	NDS **66**, 347 (1992)	1
93	Published	NDS **70**, 1 (1993)	0
167	Published	NDS **58**, 871 (1989)	4
168	Submitted 1993	NDS **53**, 223 (1988)	1
169	Published	NDS **64**, 505 (1991)	2
170	Published	NDS **50**, 351 (1987)	6
171	Published	NDS **66**, 69 (1992)	1
172	Published	NDS **51**, 577 (1987)	6
173	Published	NDS **54**, 589 (1988)	5
174	Published	NDS **62**, 1 (1991)	2
175	Published	NDS **69**, 903 (1993)	0
176	Published	NDS **60**, 227 (1990)	3
177	Published	NDS **68**, 747 (1993)	0
178	Submitted 1993	NDS **54**, 199 (1988)	1
179	Submitted 1993	NDS **55**, 483 (1988)	1
180	Submitted 1992	NDS **52**, 127 (1987)	1
181	Published	NDS **62**, 101 (1991)	2
182	Published	NDS **54**, 307 (1988)	5
183	Published	NDS **65**, 589 (1992)	1
184	Published	NDS **58**, 243 (1989)	4
185	In progress	NDS **58**, 441 (1989)	4
186	Published	NDS **55**, 583 (1988)	5
187	Published	NDS **62**, 159 (1991)	2
188	Published	NDS **59**, 133 (1990)	3
189	Published	NDS **59**, 869 (1990)	3
190	Published	NDS **61**, 243 (1990)	3
191	Published	NDS **56**, 709 (1989)	4
192	Published	NDS **64**, 205 (1991)	2
193	Published	NDS **61**, 519 (1990)	3
194	Published	NDS **56**, 75 (1989)	4
206	Published	NDS **61**, 93 (1990)	3
210	Published	NDS **65**, 209 (1992)	1
211	Published	NDS **63**, 79 (1991)	2
212	Published	NDS **66**, 191 (1992)	1
215, 219, 223, 227	Published	NDS **65**, 669 (1992)	1
		Average	2.3

[a]Years since previous evaluation (=1 for submitted mass chains)

2. 8th Edition of the *Table of Isotopes* (R.B. Firestone, V.S. Shirley, J. Zipkin, and J.Z. James)

The first draft of the 8th edition has been completed (except for mass chains A=11-20,131 which are not yet up-to-date in ENSDF). Q-value data and proton/neutron separation energies have been updated with values provided by Audi and Wapstra from their 1993 evaluation (in press). Thermal cross-section information from BNL-325, updated natural abundances, nuclear moments from Raghavan, and references have also been added. We have also included the superdeformed band data recently updated in ENSDF by Balraj Singh and added information about recently discovered isotopes that are not yet in ENSDF. Mass chains through A=137 have been edited for consistency of presentation and scientific content. We are beginning to send completed mass chains to evaluators for their comments. The process of final layout for the 8th edition has been automated to allow interactive merging of tables and figures, on screen, with a VAX-4000 workstation. The book is projected to contain 3,000 pages and require two volumes.

In addition to the printed book we are preparing a computerized version on CD-ROM. This form of the book would not have the size constraints of the printed book and could thus contain far more information. The CD-ROM version will include the entire NSR reference file, the *Table of Superdeformed Nuclear Bands*, the ENSDF file and manual, nuclear charts, and extensive appendices. Each CD-ROM will be distributed with software to view the file with zoom capabilities, interactive bookmarks for quick access to subject matter, and hypertext links between related information. This software will be supported on Microsoft Windows, Macintosh, and UNIX operating systems. Most printers will be supported for preparing hard copy from the CD-ROM. A demonstration system containing over 15,000 pages is now available. Annual updates of the *Table of Isotopes* and related material on CD-ROM are planned, with updates of the printed book expected every few years.

3. Table of Superdeformed Nuclear Bands (B. Singh and R.B. Firestone)

Among the most exciting developments in nuclear physics has been the discovery of superdeformation in high-spin physics. The recent evolution of large detector arrays has led to an abundance of new data on this subject. Because very little of that data was in the ENSDF file and the demand for high-spin information is high, we initiated a horizontal evaluation of superdeformed band data. This evaluation is now up-to-date and includes 67 superdeformed bands from 37 nuclides. With publication tools developed to produce the *Table of Isotopes* we have produced the first draft of the *Table of Superdeformed Nuclear Bands*. This book contains adopted level data for each nucleus with superdeformed bands, the moment of inertia and induced moments for each band, and band level scheme drawings. Additional related data for actinide shape (fission) isomers have been included. The first draft has been distributed widely for comment, and we plan a general distribution in December.

We are continuing to update the superdeformed database and gratefully acknowledge the helpful advice of the LBL and MacMaster high-spin groups, suggestions from Gammasphere users, and prepublication data provided by various researchers. We have also begun to update additional high-spin data for ENSDF. Evaluation groups from the Peoples Republic of China and Sweden have offered to participate and this effort was endorsed at the IAEA/NSDD meeting in Geel, Belgium. We are strongly encouraging the participation of other evaluation and research groups in the horizontal evaluation of nuclear data.

4. Electronic *Table of Isotopes* (F. Chu and R.B. Firestone)

We have begun to develop an interactive version of the *Table of Isotopes* which we proposed at the 1990 and 1991 USNDN meetings. Our goal is to provide interactive access to nuclear data in an object-oriented environment on desktop computers. The Electronic *Table of Isotopes* (ETOI) currently supports level scheme drawings for all ENSDF datasets, nuclear bands, and decay schemes on Macintosh computers. The level schemes are scalable and scrollable in both vertical (energy) and horizontal (labels and γ rays) directions. Transitions can be shown from groups of levels or from selected levels which decay to the ground state. Nearly all data on ENSDF level, gamma, beta, alpha, and parent records are presented on the drawings. Complementary tabular data presentations are also being developed to provide more complete information including comments. File navigation tools are provided to rapidly select ENSDF data for display. Multiple windows can be created and saved for comparison.

The ETOI can display any data file which uses the ENSDF format. This makes it a useful tool for both evaluators preparing datasets and researchers analyzing experimental information. Future plans include printer support, selection of data by property, nuclear application software, and linkage of ENSDF to other data files including Nuclear Structure References (NSR), atomic masses, moments, and atomic data. We are developing an extended version of the ENSDF file for electronic publication. It will contain explicit linkage between related data, inverted indices, updated information, and standardized presentation. The ETOI will be available for beta testing by the end of this year. The first general distribution is targeted for late 1994. It will be available for both Microsoft Windows and Macintosh operating systems.

5. Evaluation Methodology and Computer Codes (C.M. Baglin and E. Browne).
A new IBM/PC version, by C.M. Baglin, of the computer program GABS (for normalizing decay schemes), is available as of August 1993. This version accepts "publication records" (PN) and produces correct results, which was not true for the previous version.

6. Nuclear Structure References (NSR) on Desktop Computers (P. Ekstrom, E. Browne, and Lorin Mumaw).
The Lund-Berkeley Collaboration has implemented the NSR file (produced by S. Ramavataram, Brookhaven National Laboratory) on IBM/PC and Macintosh computers, as a complement to the existing on-line system. Retrieval of information can be done using PAPYRUS (for the IBM/PC) or ENDNOTE (for the Macintosh) bibliographic database management systems, produced by Research Software Design, Inc., and Niles & Associates, Inc, respectively. The entire database requires about 150 Mbytes of memory, and may be distributed on compact disks (CD-ROM). This system will be especially useful for those who do not have on-line computer network access to NSR.
Lorin Mumaw, an undergraduate student from the Chemistry Department, San Jose State University, participated in the project during summer of 1993.

7. Research Publications.

1. *Half-lives of Microsecond Isomers in ^{151}Eu and ^{181}W*, B. Singh and H.W. Taylor, to be published in Journal of Applied Radiation and Isotopes.

2. *Electron-Capture Decay of ^{231}U*, E. Browne, I. Ahmad, K.E. Gregorich, S.A. Kreek, D.M. Lee, and D.C. Hoffman, to be published in Nuclear Instruments and Methods for Physics Research.

Attachment 4

NUCLEAR DATA PROJECT ACTIVITY REPORT

Asilomar, October 1993

This report covers the calendar year 1993.

The Nuclear Data Project is responsible for all mass chains in the region A≥200, excluding A=206, 210, 211, 212, 215, 219, 223, 227, 238, 240, 242, and 244. The effective number of mass chains in this region is ≈40. The number of full-time equivalent evaluators is 2.75.

1. MASS-CHAIN EVALUATIONS

Mass chains submitted (1/1/93 to 9/30/93)	203, 231, 234
Mass chains to be submitted (10/1/93 to 12/31/93)	201, 204, 208, 241
Mass chains published (1/1/93 to 9/30/93)	203, 205, 230, 235
Mass chains to be published (10/1/93 to 12/31/93)	207, 231
Continuous evaluations to be submitted (10/1/93 to 12/31/93)	243, 245

2. MASS-CHAIN EDITING

Mass chains reviewed (1/1/93 to 9/30/93)	59, 79, 81, 97, 99, 103, 105, 122, 123, 126, 154, 180, 196, 230
Mass chains to be reviewed (10/1/93 to 12/31/93)	113, 129, 140, 155, 159?

As part of the revised review procedure, the Editor-in-Chief sees each mass chain reviewed by other evaluators prior to the mass chain being returned to the author(s). Comments are added to those of the reviewer, if needed, based just on a reading of the manuscript. This procedure gives the author(s) all the suggested changes at the same stage, and has resulted in significantly fewer changes being required at the Galley stage. The Editor-in-Chief continues to be responsible for resolving problems arising from differences of opinion between the author(s) and the reviewer.

3. LOW-MASS DATA

Adopted level, gamma and decay data for A = 13-20 were entered into ENSDF. The A = 16, 17 data are those of the TUNL center, to be published in 1993.

4. OTHER ACTIVITIES

The following papers involved NDP staff members.

a. "Test of Predicted Deformation-Driving Effect in ^{173}Re," N. R. Johnson, et al., Nucl. Phys. **A556**, 347c (1993).
b. "Search for Population of Superdeformed States in ^{194}Pb Using ^{194}Bi β^+ Decay," M. A. Stoyer, et al., Phys. Rev. **C47**, 76 (1993).
c. "Search for Low-Spin Superdeformed States in Nuclei," C. R. Bingham, et al., Nucl. Instrum. Methods Phys. Res. **B79**, 309 (1993).
d. "Alpha-Decay Branching Ratio for ^{188}Pb," J. D. Richards, et al., Bull. Am. Phys. Soc. **37**, 1658 (1992).
e. "Lifetimes of High-Spin States in ^{173}Re," J. C. Wells, et al., Bull. Am. Phys. Soc. **38**, 1014 (1993).
f. "Observation of Fine Structure in ^{190}Pb," J. D. Richards, et al., to be submitted to Phys. Rev.

Attachment 5

The NNDC Activity Report

M. R. Bhat

September 15, 1993

Part A: Mass-chain Evaluations, NDS Publication, Online Access & Other Services

I. Mass-chain Evaluations

A-chains assigned to the NNDC: 45–50, 57, 58, 65–71, 72*, 73*, 94–97, 99, 136–148, 150, 152, 165, 199, 211(T), 212(T). Total: 39+2(T)

(* Temporary assignment to Taiwan). (T: Temporary assignment to NNDC).

A-chains submitted for publication (1/1/93–9/15/93): 140, 136, 131

A-chains expected to be submitted (9/16/93–12/31/93): 47, 68, 199

A-chains published in the NDS (1/1/93–9/15/93): 46, 48, 65, 70, 71, 73, 95, 96, 138, 145

A-chains expected to be published in the NDS (9/16/93–12/31/93): 97, 99

Number of A-chains reviewed (1/1/93–9/15/93): 8

Number of continuous evaluations completed (1/1/93–9/15/93): None

Number of continuous evaluations anticipated (9/16/93–12/31/93): 45, 48, 50, 66

Total number of full-time evaluators: 1.75

Projections of activities for 1994:

It is planned to evaluate the following A-chains: 49, 58, 69, 137, 144, and 45, 48, 50, and 66 in the continuous mode.

Total number of full-time evaluators: 1.75

Please see Table 1 for the current status of the A-chains assigned to the NNDC.

II. Nuclear Data Sheets (NDS) Publication

No. of A-chains sent to the publisher (1/1/93–9/15/93): 24 = 5 + 19(u)
(u)= published in up-date mode.

No. of A-chains expected to be published in 1993: 33

No. of issues of Nuclear Structure References (NSR) expected to be published: 1

There are at present 28 A-chains in the NDS production pipe-line. The processing statistics for the A-chains published in 1993 showing the time spent in various stages of publication are given in Table 2.

A new NDS production code has been in use since the January, 1993 issue. It has the following features:

- Output is a PostScript file for ease of production and greater portability.
- Larger character sizes result in improved readability.
- Intermixing of drawings and tables.
- Organization of all material by daughter nuclides.
- Simpler skeleton scheme.
- Stacking of gammas in band drawings, thus reducing the width of the drawing.
- Automatic generation of abstract, tables, drawings, references, and index pages.

III. The NNDC Online Data Service

The number of retrievals in 1993 have already surpassed those of 1992 by a substantial amount ($\approx$ 11%) as can be seen in Table 3. The NSR database continued to be the most popular with $\approx$ 35% of the retrievals and NUDAT, the second most with $\approx$ 23% as of September 9, 1993. The total time the users have spent on the retrievals was 3215 hours to date this year.

The service had 835 active users as of September 9^{th}, an increase of $\approx$ 67% since last year. Of these, $\approx$ 68% are from the United States and Puerto Rico; the rest are from Australia, Brazil, Canada, Chile, Croatia, Czech Republic, Hungary, India, Israel, Japan, Mexico, New Zealand, Poland, Romania, Russia, Singapore, Slovenia, South Africa, South Korea, Thailand, Venezuela, and Western Europe. Foreign users accounted for about 13% of the retrievals to date this year. INTERNET is still the dominant method of reaching the NNDC computer.

Several new features have been added to the service and other improvements have been made in the last year. These include

1. ENDF and ENSDF analysis and checking codes and associated documentation are now available through the CODES option of the service and an anonymous account.
2. The ENDF data base now contains the JEF-2 evaluated nuclear data library. This file is produced as a cooperative effort of several Western European countries coordinated through the Nuclear Energy Agency Data Bank, Paris, France.

3. The output from all data base retrieval programs operating in the non-video mode has been improved and standardized.
4. The network transmission of files, codes and documentation has been enhanced such that the network transmission parameters are saved after a successful transmission. The user may also define a default file transmission address which is different from the default electronic mail address.
5. Single references can be retrieved in the RETRIEVE option without first creating a keynumber list in the BROWSE/EXTRACT option.
6. Two additional output file formats have been provided for CSISRS.
7. Neutron thermal scattering law data in the ENDF data base can now be accessed.
8. The older purely graphical display of selected ENSDF data sets in PLOT has been replaced by an option which produces full tabular and graphical displays in almost publication quality output.

The NEW_FEATURES option of the service provides further information on these improvements and other recent improvements. Future improvements being considered include the addition of an atomic masses files, an ENDF plotting option within PLOT, a string search capability within NSR, and on-line access to CSISRS, ENDF, and ENSDF manuals and documentation and installation of higher speed modems (9600 or 14400 bps).

The entire NNDC online system, which was installed in 1992, is now available at the IAEA Nuclear Data Section, Vienna. The system is also being considered for installation at Gatchina.

IV. Nuclear Structure References (NSR)

The list of 80 journals scanned regularly for the NSR file is given in the Recent References issue of the Nuclear Data Sheets. In addition, secondary references which appear in: (i) laboratory reports from all important US and foreign laboratories, (ii) important conferences, (iii) conference papers published in Nuclear Physics and other journals, (iv) secondary references and private communications used by mass-chain evaluators are coded and entered into the NSR.

In 1993, a tape of secondary source entries was received from the RIKEN Data Center, Japan. These entries were checked and merged into the NSR. We expect to receive a similar tape of secondary references from Gatchina, Russia. Monthly and four-monthly distribution of NSR retrievals are being transmitted to the various data centers on schedule.

V. The Evaluated Nuclear Structure Data File (ENSDF)

The ENSDF is now being updated by archiving new evaluations as soon as they are published in the NDS. A six-monthly update to ENSDF was distributed to the network in February and August 1993. The current status of the mass-chains for A>44 in the ENSDF is shown in Fig.1; which also shows those A-chains that are being evaluated and/or that have been submitted for publication.

VI. ENSDF Related Codes

The ENSDF analysis and checking codes continue to be maintained and improved. The current status of these codes is given in Table 4. The programs ENSDAT (R. R. Kinsey, BNL), ALPHAD (ORNL), and an MS-DOS version of GABS (C. M. Baglin, LBL) were added to the distribution this year and significant improvements were made in the codes FMTCHK and GTOL. ANSI and VAX versions of the codes are now available online and a set of 3.5-in high density diskettes have been prepared for the MS-DOS versions. A more detailed report on the status and availability of these codes was distributed in June 1993 to the NSDD evaluators.

VII. User Services

The NNDC provides many services to the NSDD network evaluators and others on a routine basis; at present they are:

(i) Monthly NSR updates to all evaluation centers for the A-chains assigned to them.

(ii) Complete NSR and ENSDF retrievals at the start of an evaluation are sent only to those who cannot access online the NSR or the ENSDF from the NNDC or the NEA Data Bank, Saclay; others have to do their own retrievals.

(iii) Copies of references to evaluators (with help from the NDP for older references).

(iv) ENSDF updates are sent twice a year. The NNDC will no longer send the complete ENSDF; only six monthly updates are sent.

(v) NSR updates are sent once in four months.

(vi) Special retrievals from the NSR and the ENSDF. Requests for these specialized retrievals are satisfied on a case-by-case basis. Users are encouraged to take advantage of the full potential of the NNDC online retrieval system; if their needs cannot be satisfied by the system then only the requests are satisfied.

(vii) Maintain the ENSDF physics processing codes and send corrections and updates.

A-Chain Status in ENSDF (A>44)

Center - ALL

23-SEP-93

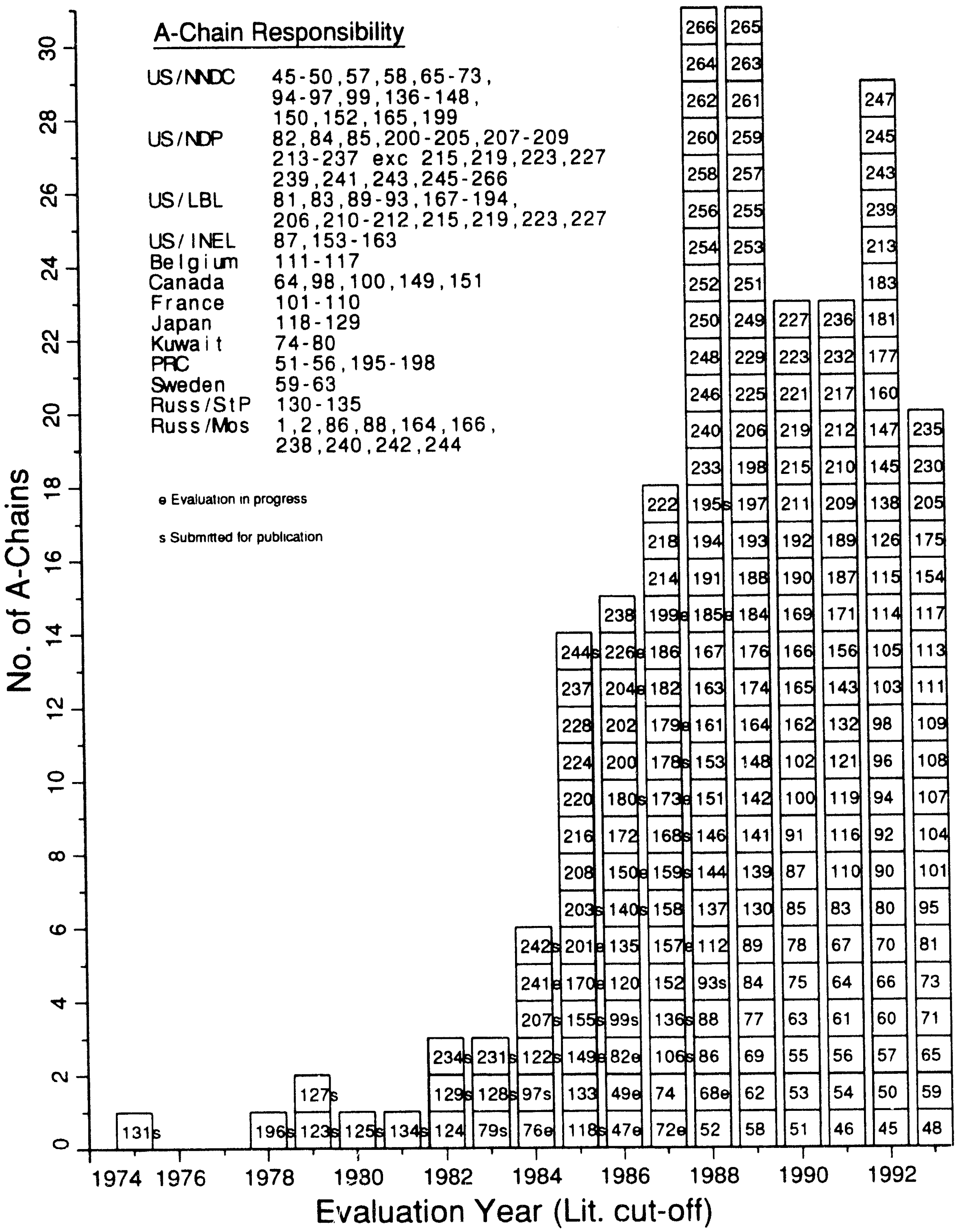


Fig. 1

Table 1
Status of A-chains Assigned to the NNDC
September 15, 1993

Mass-chain	Last Published	Present Status
45	NDS **65**, 1 (1992)	1992 continuous update done
46	NDS **68**, 271 (1993)	
47	NDS **48**, 1 (1986)	Being evaluated
48	NDS **68**, 1 (1993)	
49	NDS **48**, 569 (1986)	Being evaluated
50	NDS **61**, 1 (1990)	1992 continuous update done
57	NDS **67**, 195 (1992)	
58	NDS **61**, 189 (1990)	
65	NDS **69**, 209 (1993)	
66	NDS **61**, 461 (1990)	1992 continuous update done
67	NDS **64**, 875 (1991)	
68	NDS **55**, 1 (1988)	Being evaluated
69	NDS **58**, 1 (1989)	
70	NDS **68**, 117 (1993)	
71	NDS **68**, 579 (1993)	
72	NDS **56**, 1 (1989)	Done by Taiwan
73	NDS **69**, 857 (1993)	Done by Taiwan
94	NDS **66**, 1 (1992)	
95	NDS **68**, 635 (1993)	
96	NDS **68**, 165 (1993)	
97	NDS **46**, 607 (1985)	New evaluation submitted
99	NDS **48**, 663 (1986)	New evaluation submitted
136	NDS **52**, 273 (1987)	New evaluation submitted
137	NDS **59**, 767 (1990)	
138	NDS **69**, 69 (1993)	
139	NDS **57**, 337 (1989)	
140	NDS **51**, 395 (1987)	New evaluation submitted
141	NDS **63**, 573 (1991)	
142	NDS **63**, 647 (1991)	
143	NDS **64**, 429 (1991)	
144	NDS **56**, 607 (1989)	
145	NDS **68**, 997 (1993)	
146	NDS **60**, 953 (1990)	
147	NDS **66**, 705 (1992)	
148	NDS **59**, 393 (1990)	
150	NDS **48**, 345 (1986)	New evaluation submitted
152	NDS **58**, 93 (1989)	
165	NDS **65**, 439 (1992)	
199	NDS **53**, 331 (1988)	Being evaluated
211(T)	NDS **63**, 79 (1991)	
212(T)	NDS **66**, 171 (1992)	

T : Temporary assignment to NNDC
Average literature-cut-off age of A-chains on permanent assignment: 3.6 yrs
Average age of A-chains including those in the pipeline: 2.9 yrs

Table 2

NDS Processing Statistics for 1993

NDS Vol/No	NDS Date	A	Pages	Received	Elapsed Time (months) NNDC	Evaluator	Review	Editor-in-Chief	Date on Shelf	Total Elapsed Time (months)
68/1	01/93	48(u)	115	12/31/91	4.33	4.70	3.43	0.47	03/22	14.7
		70(u)	47	03/31/92	1.03	3.20	4.47	1.07	03/22	11.7
		96(u)	106	09/27/91	4.57	6.97	4.27	0.27	03/22	17.9
68/2	02/93	46(u)	40	12/30/91	1.90	10.17	1.87	0.27	04/29	16.0
		103(u)	93	05/19/92	3.10	0.67	5.37	0.27	04/29	11.3
		160	173	12/16/91	4.90	5.00	4.37	0.40	04/29	16.5
68/3	03/93	71(u)	56	06/11/92	2.77	2.40	4.13	0.33	06/04	11.8
		95(u)	112	08/24/92	2.63	1.17	3.13	0.27	06/04	9.4
		177	139	07/27/92	2.97	2.43	2.27	0.43	06/04	10.3
68/4	04/93	54(u)	48	06/02/92	4.30	1.30	4.60	0.37	06/25	12.8
		105(u)	62	05/18/92	4.03	0.83	5.87	0.30	06/25	13.2
		145(u)	82	10/25/90	4.27	20.30	5.20	0.37	06/25	32.0
69/1	05/93	60(u)	67	12/01/92	2.33	0.97	2.27	0.13	07/01	7.0
		138	86	12/28/92	1.27	0.57	2.70	0.27	07/01	6.1
		230	54	08/03/92	3.53	5.57	0.27	0.27	07/01	11.0
69/2	06/93	65(u)	58	12/28/92	2.37	1.97	1.87	0.23	08/01	7.1
		81(u)	107	12/03/91	3.10	9.90	5.77	0.67	09/01	21.0
		235(u)	54	11/03/92	2.03	1.70	4.10	0.43	08/01	9.0

Table 2
(Cont'd.)

NDS Processing Statistics for 1993

					Elapsed Time (months)					Total
NDS Vol/No	NDS Date	A	Pages	Date Received	NNDC	Evaluator	Review	Editor-in-Chief	Date on Shelf	Total Elapsed Time (months)
69/3	07/93	126(u)	77	08/27/92	2.40	4.07	4.97	0.47	10/93	13.6
		154(u)	172	08/05/92	3.73	3.43	5.10	0.37	10/93	14.3
		205(u)	53	12/03/92	2.80	2.73	2.83	0.33	10/93	10.4
69/4	08/93	59(u)	123	08/22/91	3.13	16.90	4.17	0.43	11/93	26.4
		73(u)	45	04/19/93	1.23	1.87	.97	0.33	11/93	6.5
		175	116	07/09/93	1.03		0.00	0.70	11/93	3.9
70/1	09/93	93(u)	83	12/30/92	1.77	4.53	2.07	0.54	11/93	10.2
		97(u)	88	08/28/92	2.95	3.77	5.93	0.31	11/93	14.3
		203(u)	43	03/17/93	1.66	1.31	2.93	0.43	11/93	7.6
70/2	10/93	125	98	06/11/92	1.90	7.13	7.93	0.26	03/94	20.7
		207(u)	71	11/16/92	2.30	7.90	1.87	0.00	03/94	15.5
		231(u)	49	04/29/93	2.76	0.33	3.21	0.34	03/94	10.1
70/3	11/93	79(u)	93	12/21/92	2.21	2.39	6.97	0.30	03/94	14.5
		123	100	08/27/92	2.54	7.00	5.87	0.26	03/94	18.3

Table 3: On-Line Access Statistics 1986-1993

Year	1986	1987	1988	1989	1990	1991	1992	1993[a]
Runs	648	1275	2264	3374	5436	10142	15079	19011
Retrievals	1621	4263	8748	8406	12067	22183	29927	33200
NSR	814	2521	5022	3253	5613	11517	13050	11517
ENSDF	142	863	1303	850	1256	2807	3626	4596
NUDAT	536	815	1492	1841	2204	4021	6710	7562
CINDA	129	60	285	522	187	371	458	266
ENDF	—	4	187	150	1019	1525	2846	4196
CSISRS	—	—	459	1649	1623	1384	1613	3006
MIRD	—	—	—	121	53	40	141	345
PLOT	—	—	—	11	39	69	218	523
PHYSCO	—	—	—	9	65	172	96	70
X-RAY	—	—	—	—	8	277	1169	527
CODES	—	—	—	—	—	—	—	592

[a]Through September 9.

Table 4: Status of ENSDF Analysis and Checking Codes (September 9, 1993)

Code	Function	Version[a] No./Date	MS-DOS	Documentation
ADDGAM	Adds γ's to adopted data set.	1(3) 930414	Yes	No (See "Read Me" file)
ALPHAD	Calculates α HF's and theoretical $T^{\alpha}_{\frac{1}{2}}$'s	1.2 930421	Yes	No (See "Read Me" file)
DELTA	Analyzes angular correlation data.	1.01 930415	Yes	LUNFD/(NFFR-3048) 1-27
ENSDAT	Produces tables and drawings	3.23[b] 930624	Yes	No (See "Read Me" file)
FMTCHK	ENSDF format checking.	8.1a 930513	Yes	No (See "Read Me" file)
GABS	Calculates absolute ΔI_{γ}'s.	VIIa 930827	Yes	Yes
GAMUT	Creates adopted levels, gammas from source data sets.	[c,d] 8809	No	LBL-26024
GTOL	Determines level energies from a least-squares fit to E_{γ}'s & feedings.	6.1 930712	Yes	BNL-NCS-23375/R LUNFD/(NFFR-3049) 1-27
HSICC	Interpolates internal conversion coefficients.	11(10) 930803	Yes	Nucl. Data A4, 1 Nuclear Data Tables A9, 119 BNL-NCS-23375/R
LOGFT	Calculates log ft.	7(14) 930903	Yes	Nucl. Data Tables A10, 206
NSDFLIB	Support subprograms for many codes	4(12) 930401	Yes	Yes
PANDORA	Physics check of ENSDF data sets. Aids with adopted gammas & XREF.	6.0a 930809	Yes	Yes
PREND	Constructs level schemes from ENSDF data sets.	2.4a[d] 930810	No	Yes
RADLST	Calculates atomic & nuclear radiations. Checks energy balance.	5.5 881005	No	BNL-NCS-52142
RULER	Calculates reduced transition probabilities.	1.16a 930806	Yes	Yes
SPINOZA	Physics check of an ENSDF data set.	1(4)[d] 930809	No	Yes
TREND	Tabular display of ENSDF data.	6.13b 930806	Yes	No (See "Read Me" file)

[a]Please check with the NNDC as to more recent versions.
[b]MS-DOS only.
[c]Program as received from the author.
[d]Program contains VAX extensions of ANSI-standard FORTRAN 77.

The NNDC Activity Report

M. R. Bhat

September 15, 1993

Part B: International Network Coordination

I. Evaluation of A-chains

In the calender year 1992, the members of the Nuclear Structure & Decay Data (NSDD) network submitted for publication a total of 30 A-chains; of these the U.S. contributed 18. The total number of A-chains submitted for publication in 1993 to date is 20; of these 9.5 are from the U.S. (Table 1).

Ammenah Farhan of the Nuclear Data Project at the Kuwait Institute of Scientific Research (KISR) has begun evaluation of A=74 with 0.4 FTE evaluation support. M. M. King of the National Tsing Hua University, Taiwan continues her participation in the network and submitted A=73 for publication. Wen-Tsae Chou has joined this group to give a total of 0.3 FTE evaluators.

At present, a subset of the evaluated data for A=5–44 published in the journal Nuclear Physics are coded for entry into the ENSDF by the NNDC, the Nuclear Data Project at ORNL, Grenoble and LBL. The status of this work is shown in Table 2. The TUNL group has finished evaluation of A=16, 17 and these have been accepted for publication in Nuclear Physics. The evaluated data are being coded into the ENSDF. The NNDC continues to help in the conversion of references from the Ajzenberg-Selove format to the standard NSR format for A=3–20.

Table 3 shows the average age of the mass-chains on permanent assignment to the different data centers in the NSDD network based on the literature cut-off date. Column 3 gives the average age for the evaluations published and merged into the ENSDF; column 4 shows the average age if the evaluations in the previous column are replaced by the corresponding new ones in the publication pipeline. The last column shows the age of the oldest mass-chain not being evaluated or submitted for publication. The grand average age of all A-chains in ENSDF is 4.5 years.

II. NSDD Meeting

The tenth meeting of the NSDD network was held at the Central Bureau for Nuclear Measurements (CBNM), Geel, Belgium from November 9-13, 1992.

At this meeting, the average age of the mass-chain evaluations in the ENSDF as determined from the literature cut-off dates was 4.7 years and 15% of the mass-chains that were not being evaluated or had not been submitted for publication were older than 5 years. The need for re-evaluating these older mass-chains as soon as possible was stressed especially in view of the publication of the 8th edition of the Table of Isotopes. It was also decided that the network should give priority to evaluations in regions of current research interest and where there are new data. The exact procedure for implementing this proposal is to be formulated at a later date. Given the diverse backgrounds and expertise of the network members, it was stressed that the quality control of new evaluations before merging them into the ENSDF was essential. Thus, processing, checking and detailed reviews of new mass-chains could not be de-emphasized or eliminated.

At this meeting, it was decided that the Formats & Procedures Subcommittee of the USNDN should be renamed as the Formats & Procedures Subcommittee of the NSDD network. Ammenah Farhan (Kuwait) was appointed as a representative of the non-US members in this subcommittee. The proposal that in the future, there be only one Recent References issue per year of the Nuclear Data Sheets containing all the references added during the previous year was supported.

Table 1
Mass-chain Evaluations for 1993 (A>44)
September 1993

Lab	No. of Evaluators	Mass-chains Projected for Completion (Month/A)	Evaluations in Continuous Mode	Mass-chains Submitted for Publication
BNL (USA)	1.75	1/140;6/47;7/49;9/68,199;12/137,136	45,48,50,66	140,136,131 (half)
INEL (USA)	0.8	5/159;6/155;10/157		159,155
LBL (USA)	2.0	6/168;9/178,179;10/76,173	92,80,187.189,210	168,178
NDP (USA)	2.6	3/203:4/234;6/208,201,231;7/241;10/204, 228-224-220-216;12/200		203,231,234
Kuwait U. (Kuwait)	0.4	11/74	77	
CEA (France)	0.5	12/116	101,104,107,108, 109,111,113,114, 115,117	
Ghent U. (Belgium)	0.5	10/106		106
JAERI (Japan)	1.5	3/124,127,128,129;9/120	124,127,128,129	118,129,128,127
CAJaD (Russia)*	2.0	4/88;12/242		242,244
LIYaF (Russia)	0.66	3/134;6/131		134,131 (half)
McMaster U. (Canada)	0.5	6/149		
Lund U. (Sweden)	0.0			
CNDC (PRC)	~0.5	12/195		195
Jilin University (PRC)	0.4	12/52		
Nat'l Tsing Hua U. (Taiwan)	0.3	3/73;12/72		73

*No response; repeat of 1992 projection.

Table 2 Coding of A=5-44 into ENSDF September 15, 1992		
Data Center	A-range	Status
NNDC	5–12	Coded & merged into ENSDF
NDP	13–26	A=13-20 coded and being checked
Grenoble	27–32	A=21,22,27-32 coded & merged into ENSDF
LBL	33–44	A=23-26,33-44 coded & merged into ENSDF

Table 3
Age of Mass-chain Evaluations on Permanent Assignment
Based on Literature Cut-off Date
September 15, 1993

Group	Total (Outdated@)	Average Age(yrs) (ENSDF*)	Average Age(yrs) (ENSDF+New Eval#)	Maximum Age(yrs)%
BNL	39(1)	3.6	2.9	5.9
INEL	12(3)	4.3	3.2	6.1
LBL	43(5)	3.8	3.2	7.6
NDP	58(11)	5.1	4.4	8.3
TUNL	18(10)	5.8	5.1	7.4
Holland	24(0)	3.3	3.3	3.3
KISR(Kuwait)	7(1)	5.5	4.1	6.6
CEA(France)	10(0)	1.8	1.1	3.2
Ghent(Belgium)	7(1)	1.6	1.6	5.3
JAERI(Japan)	12(2)	8.7	2.8	11.3
CAJaD(Russia)	10(3)	5.9	4.4	6.8
LIYaF(Russia)	6(2)	8.6	3.8	8.7
McMaster(Canada)	5(1)	4.0	4.0	5.2
Lund(Sweden)	5(0)	2.2	2.2	4.1
CNDC(PRC)	10(0)	4.8	2.8	4.8

@A-chains older than 5 yrs & not being evaluated or submitted for publication
* Published and merged into ENSDF
# ENSDF replaced by new evaluations submitted for publication
%Age of oldest A-chain not being evaluated or submitted for publication

Attachment 6

MINUTES OF THE FORMATS AND PROCEDURES SUBCOMMITTEE

October 18-19, 1993

The numbering system refers to the numbered items in the **TOPICS FOR DISCUSSION** agenda (attachment 1)

1. Balraj Singh described a method for allowing an evaluator to include, in a single data set, Iγ, Eγ etc., data from more than one experiment, or several sets of data from the same experiment. His suggestion involves use of an XREF-type continuation G record. BNL will look into the feasibility of allowing for such an option. It should be noted that the same end result could be achieved by creating separate data sets for each of the experiments (or for each set of experimental conditions) for which data were available. Akovali and Ekstrom pointed out that in much of the newer several-fold coincidence experiments, Iγ singles are not obtained. This is likely to be the situation in the future. Firestone pointed out that the same procedure could be used for decay data sets. Helmer emphasized that we need to tell the reader when several sets of data are available, and in the case of Iγ values be sure to state clearly what the quoted Iγ values are.

2. Balraj Singh discussed the need for more consistency in the way $J\pi$ and γ character assignments from in-beam experiments are treated by evaluators. Balraj was asked to prepare a set of guidelines for the treatment of $\gamma(\theta)$ data from in-beam experiments. This problem is not new, but it is still serious. This request is a repeat of an action item first proposed for Balraj at the 1988 USNDN meeting at BNL, following discussion of an agenda item proposed by him for that meeting.

3., 4. Balraj Singh suggested that the NSR scanning procedure should include review articles, such as those appearing in *Annual Reviews of Nuclear Science*, *Reports on Progress in Physics*, and *Physics Reports*. At present only *Reviews of Modern Physics* is scanned regularly. Balraj pointed out that these general articles would be of value as a resource tool to graduate students. This agenda item led to several comments on the importance of the NSR file, and to the need for more complete coverage, on a timely basis, of the secondary source material, especially conference proceedings. An additional problem was pointed out. Many libraries are responding to budget cuts by deleting subscriptions to peripheral journals (peripheral from the librarians' point of view), many of which are important to the evaluation effort. This trend is likely to continue, and BNL will perhaps need to make use of those repository libraries that are still a viable source for these materials. At the same time BNL will look into the possibility of expanding the coverage of recent references, including the possible need for more manpower for this crucially important part of the evaluation effort.

5. Balraj Singh recommended that GTOL be modified so that the evaluators can specify default options for ΔEγ and ΔIγ. This option would allow the evaluator to specify ΔEγ or ΔIγ, for example, in cases where no uncertainties are given by the authors, but where the evaluator feels that he/she can arrive at reasonable estimates of these quantities. There are several obvious advantages to assigning uncertainties at this stage rather than entering such assigned uncertainties explicitly on the Eγ or Iγ entries in the source data set. The subcommittee endorsed this proposal, and BNL will make the necessary modifications.

6. Murray Martin recommended that the HSICC program be modified so that the α_i output values for L=3 and L=4 multipole transitions are reduced to (0.975 *10)*α_i for E3 and M3 transitions, and to (0.975 *5*)α_i for E4 and M4 transitions. This recommendation is based on the specific recommendation of Nemeth et al., in *Nuclear Instruments and Methods* **A286**, 601 (1990), although the deviation of experimental values with theory for these multipoles was first pointed out by Raman et al., in *Phys. Rev.* C7, 2531 (1973). The subcommittee endorsed this proposal, and BNL will make the modifications.

7. Eddie Browne raised the question of how the network should incorporate the evaluations from the individual metrology centers. Evaluators have already been informed of the published results from the Coordinated Research Program (CRP) of the IAEA (91BaZS and 86LoZT) and evaluators have been encouraged to make use of these evaluations whenever possible. In this connection, Helmer volunteered to offer advice on the use of any of the values recommended by the CRP if evaluators have specific questions. In addition to these evaluations, Browne points out that evaluations are carried out by members of the International Committee on Radionuclide Metrology (ICRM). In particular he has provided a list of the radionuclides being evaluated in the UK. For information on these nuclides (listed in attachment 2), the evaluators should contact Dr. Alan Nichols. Nichol's address is included in the attachment.

8. Eddie Browne discussed a proposal suggesting the formal use in ENSDF of procedures presented in "Techniques for evaluating discrepant data" by M. U. Rajput and T. D. MacMahon in *Nucl. Instrum. and Methods in Phys. Research* **A312**, 289 (1992). No specific recommendation was proposed, but evaluators are encouraged to familiarize themselves with the techniques presented, and to make use of them when appropriate.

9. Dick Helmer recommended that the drawing program be modified so that complex decay schemes can be presented with uniform level spacings. With the present proportional spacing scheme, it is difficult to correlate the $J\pi$ and E(level) labels with the associated levels. The question of whether such drawings should be used just for checking, or also for publication, was raised, but no decision was reached. BNL will look into the possibility of preparing decay schemes with uniformly spaced levels, and evaluators will then have a chance to evaluate the usefulness of such schemes and to provide input on whether or not they should be used in the publication. Discussion of the above proposal led to two drawings-related points. Singh suggested that the in-beam drawings should show inter-band transitions in the "slanted-arrow" style used in several publications. He pointed out that a program designed by David Radford (Chalk River) contained such a capability. Tuli suggested that an alternative approach to modifying the drawing program, in either of the above cases, would be to give the information in tabular form. BNL will contact Radford and check into the feasibility of using his program.

10. Shaheen Rab questioned whether the statement on the inside of the front cover of the *Nuclear Data Sheets* which states "A Journal Devoted to Compilations and Evaluations of Experimental and Theoretical Results in Nuclear Physics" is misleading in that we do not evaluate theoretical results, and do not include them in as complete a sense as we do the experimental results. The consensus of the subcommittee was that, while the statement may be somewhat misleading, we do include enough theory results (shell model, Nilsson model, etc.,) to justify retaining the above statement.

11. Jag Tuli reiterated the need for a reevaluation of the criteria used to decide on which mass chains should be updated for publication. There are too many cases where mass chains with little new information are being recycled. Bhat pointed out that this question had been raised at the Geel meeting, where it had been recommended that the F&P subcommittee come up with a system for ranking mass chains in terms of a combination of their outdatedness and the amount of significant new data. Ekstrom raised the question of whether we should give up the concept of Center assignments. Reich pointed out that there is the potential of a loss of efficiency whenever evaluators work on new (to them) mass chains, especially in new mass regions. Tuli suggested that the subcommittee should first decide whether it can agree in principle with the above-mentioned ranking criterion, and then if so, proceed with such a ranking. The subcommittee endorsed the idea, and Singh agreed to prepare an initial list of the mass chains that, based on cutoff date and the amount of significant new data, should be given first priority for evaluation.

12. Jag Tuli pointed out that there are inconsistencies in the way continuous evaluations are being prepared. He will send out a memo to all evaluators stressing the importance of such evaluations, and the procedures to be followed. In particular the need for an internal review prior to submission will be stressed.

MEETING OF THE FORMATS AND PROCEDURES SUBCOMMITTEE OF THE NSDD

October 18-19, 1993 - Asilomar

TOPICS FOR DISCUSSION

1. Discussion of a method to allow for incorporation within a single data set of data (mainly Iγ) from several experiments. An example is the incorporation of several sets of Iγ data within a single (HI,xnγ) data set. (Balraj Singh)

2. Jπ and γ character assignments in in-beam data sets. (Balraj Singh)

3. Need for inclusion in NSR of review articles such as those that appear in *Annual Review of Nuclear Science* or *Reports on Progress in Physics*, and *Physics Reports*. (Balraj Singh)

4. Journal subscriptions and Conference Proceedings. Problems with subscriptions, especially for new journals, and with scanning of conference proceedings. (Balraj Singh)

5. Recommendation that GTOL be modified to allow for variable ΔEγ and ΔIγ to be specified by the evaluator as options. (Balraj Singh)

6. Recommendation that HSICC be modified so that the α_i for L=3 and L=4 multipole transitions are given as (0.975 *10*)α_i for E3 and M3, and as (0.975 *5*)α_i for E4 and M4. See Nemeth et al., *Nuclear Instruments and Methods* **A286**, 601 (1990) (See attachment 1). This recommendation would apply to internal conversion coefficients of either Hager Selzer or of Rosel. Note, however, the paper of Band et al., in the *Bulletin of the Russian Academy of Sciences* **56** #11, 1745 (1992), where they discuss errors in the conversion coefficients calculated by Rosel. The errors are especially large (up to 30%) for magnetic transitions for all $p_{1/2}$-, $d_{3/2}$-, and $f_{5/2}$-shells for Z≥70. (see attachment 2) (Murray Martin)

7. Formal use (in ENSDF) of data evaluated by members of the International Committee on Radionuclide Metrology (ICRM). (Eddie Browne)

8. Formal use of procedures presented in "Techniques for evaluating discrepant data", by M. U. Rajput and T. D. MacMahon, in *Nucl. Instrum. and Methods in Phys. Research* A312, 289 (1992). (Eddie Browne)

9. Recommendation that the drawings be modified so that the levels are uniformly spaced all the way across the drawing. This makes the level, Jπ, and energy more easily associated, at the expense of the vertical proportionality of the energy. The central portion of the enclosed sample drawing (attachment 3) is very difficult to use. (Dick Helmer)

10. On the inside of the front cover of *Nuclear Data Sheets*, it states "A Journal Devoted to Compilations and Evaluations of Experimental and Theoretical Results in Nuclear Physics". Do we really compile and evaluate theoretical results? The statement should perhaps be modified. (Shaheen Rab)

11. Other Topics

UK Evaluations of Activation Product Decay Data

Nuclide	Nuclide	Nuclide	Nuclide	Nuclide	Nuclide
H-3	Cl-38	Co-55	Nb-95m	Sn-125	Eu-155
He-6	Cl-38m	Co-56	Mo-93	Sn-125m	Tb-157
He-8	Ar-37	Co-57	Mo-93m	Sn-126	Dy-157
Li-8	Ar-39	Co-58	Mo-99	Sb-122	Dy-159
Li-9	Ar-41	Co-58m	Tc-99	Sb-122m	Hf-174
Be-7	Ar-42	Co-60	Tc-99m	Sb-124	Hf-175
Be-8	K-38	Co-60m	Ru-103	Sb-124m	Hf-181
Be-10	K-38m	Ni-57	Rh-102	Sb-124n	Ta-179
Be-11	K-40	Ni-59	Rh-102m	Sb-125	Ta-180
B-12	K-42	Ni-63	Rh-103m	Sb-129	Ta-180m
B-13	K-43	Ni-65	Rh-104	Sb-129m	Ta-182
C-14	K-44	Cu-62	Rh-104m	Te-125m	Ta-182m
C-15	Ca-41	Cu-64	Ag-107m	Te-129	Ta-182n
N-13	Ca-45	Cu-66	Ag-108	Te-129m	W-181
N-16	Ca-47	Zn-63	Ag-108m	I-125	W-185
O-19	Ca-49	Zn-65	Ag-109m	I-126	W-185m
F-18	Sc-44	As-74	Ag-110	Xe-125	W-187
F-20	Sc-44m	Se-75	Ag-110m	Xe-125m	Au-198
Ne-23	Sc-46	Br-79m	Cd-109	Xe-127	Au-198m
Na-22	Sc-46m	Br-80	Cd-111m	Xe-127m	Hg-197
Na-24	Sc-47	Br-80m	Cd-113	Cs-134	Hg-197m
Na-24m	Sc-48	Br-82	Cd-113m	Cs-134m	Hg-203
Na-25	Sc-49	Br-82m	In-111	Cs-135	Tl-204
Na-26	Sc-50	Kr-79	In-111m	Cs-135m	Pb-204
Mg-27	Sc-50m	Kr-79m	In-113m	Cs-136	Pb-204m
Mg-28	Ti-45	Sr-85	In-114	Cs-136m	Bi-207
Al-26	Ti-51	Sr-85m	In-114m	Cs-137	Th-228
Al-26m	V-48	Sr-89	In-114n	Ba-133	Th-231
Al-28	V-49	Sr-90	In-115	Ba-133m	Np-239
Al-29	V-52	Y-88	In-115m	Ba-137m	Am-241
Al-30	V-53	Y-89m	In-116	Ce-139	Am-243
Si-31	V-54	Y-90	In-116m	Ce-139m	
Si-32	Cr-49	Y-90m	In-116n	Pm-145	
P-32	Cr-51	Zr-89	Sn-113	Sm-145	
P-33	Cr-55	Zr-89m	Sn-113m	Sm-146	
P-34	Mn-54	Zr-93	Sn-117m	Sm-151	
S-35	Mn-56	Zr-95	Sn-119m	Eu-152	
S-37	Fe-53	Nb-93m	Sn-121	Eu-152m	
Cl-34	Fe-53m	Nb-94	Sn-121m	Eu-152n	
Cl-34m	Fe-55	Nb-94m	Sn-123	Eu-154	
Cl-36	Fe-59	Nb-95	Sn-123m	Eu-154m	

Nuclide	Nuclide	Nuclide	Nuclide
Hg-206	Po-216	Pa-234	Am-241
Tl-206	Po-218	Pa-234m	Am-242
Tl-206m	At-215	Pa-235	Am-242m
Tl-207	At-217	U-232	Am-243
Tl-207m	At-218	U-233	Am-244
Tl-208	At-219	U-234	Am-244m
Tl-209	Rn-217	U-235	Am-245
Tl-210	Rn-218	U-235m	Am-246
Pb-205	Rn-219	U-236	Am-246m
Pb-209	Rn-220	U-237	Cm-241
Pb-210	Rn-222	U-238	Cm-242
Pb-211	Fr-221	U-239	Cm-243
Pb-212	Fr-223	U-240	Cm-244
Pb-214	Ra-223	Np-236	Cm-245
Bi-210	Ra-224	Np-236m	Cm-246
Bi-210m	Ra-225	Np-237	Cm-247
Bi-211	Ra-226	Np-238	Cm-248
Bi-212	Ra-228	Np-239	Cm-249
Bi-212m	Ac-225	Np-240	Cm-250
Bi-212n	Ac-227	Np-240m	Bk-249
Bi-213	Ac-228	Np-241	Bk-250
Bi-214	Th-227	Pu-236	Cf-249
Bi-215	Th-228	Pu-237	Cf-250
Po-209	Th-229	Pu-238	Cf-251
Po-210	Th-230	Pu-239	Cf-252
Po-211	Th-231	Pu-240	Cf-253
Po-211m	Th-232	Pu-241	Es-253
Po-212	Th-233	Pu-242	
Po-212m	Th-234	Pu-243	
Po-212n	Th-235	Pu-244	
Po-213	Pa-231	Pu-245	
Po-214	Pa-232	Pu-246	
Po-215	Pa-233	Am-240	

Dr. Alan L. Nichols
AEA Technology
Environmental & Process Engineering
404 Harwell
Didcot
Oxfordshire
OX11 ORA
United Kingdom

Tel ++0235 434113
fax ++0235 436285

Attachment 7

EVALUATION OF HIGH-SPIN NUCLEAR DATA FOR ENSDF

and

TABLE OF SUPERDEFORMED NUCLEAR BANDS

U.S. NUCLEAR DATA NETWORK MEETING

Asilomar, California

October 19, 1993

Balraj Singh
McMaster University
Hamilton, Ontario Canada

High-spin Physics Data and ENSDF for $A > 45$

Nuclear Structure Data from In-beam Gamma-ray Spectroscopy through (HI,xn gamma) reactions.

Such experiments started thirty years ago (Morinaga and Gugelot: Nucl. Phys. 46, 210 (1963)). Since the mid-eighties, with the discovery of superdeformation in nuclei, this field has become one of the most important topics of research in nuclear physics.

A large amount of data generated with detector arrays of the late eighties and early nineties is not yet in the ENSDF. Until about two months ago, except for 152Dy, no data for the superdeformed bands was in ENSDF.

Modern detector arrays GAMMASPHERE, EUROGAM and GASP (with a detection limit of ~ 0.01 of the reaction channel) are accumulating new data very rapidly.

The volume of new data in this field is obviously quite large and perhaps more than in any other field of nuclear spectroscopy which is included in ENSDF.

If ENSDF is to remain a useful database for research in high-spin spectroscopy, data in this file need to be more current than at the present time. One should perhaps aim at a yearly update rather than a four year interval.

In the ENSDF, there is also a lack of consistency in the presentation of these data:

a. Multipolarity and Spin-parity assignments
b. Labeling of rotational bands
c. Gamma-ray intensities

Access of complete data to the evaluators is also limited in many ways.

Do the researchers in the field use NDS or ENSDF ?

Some impressions from the International High-spin meeting in Ottawa.

Local colleagues at McMaster and Chalk River.

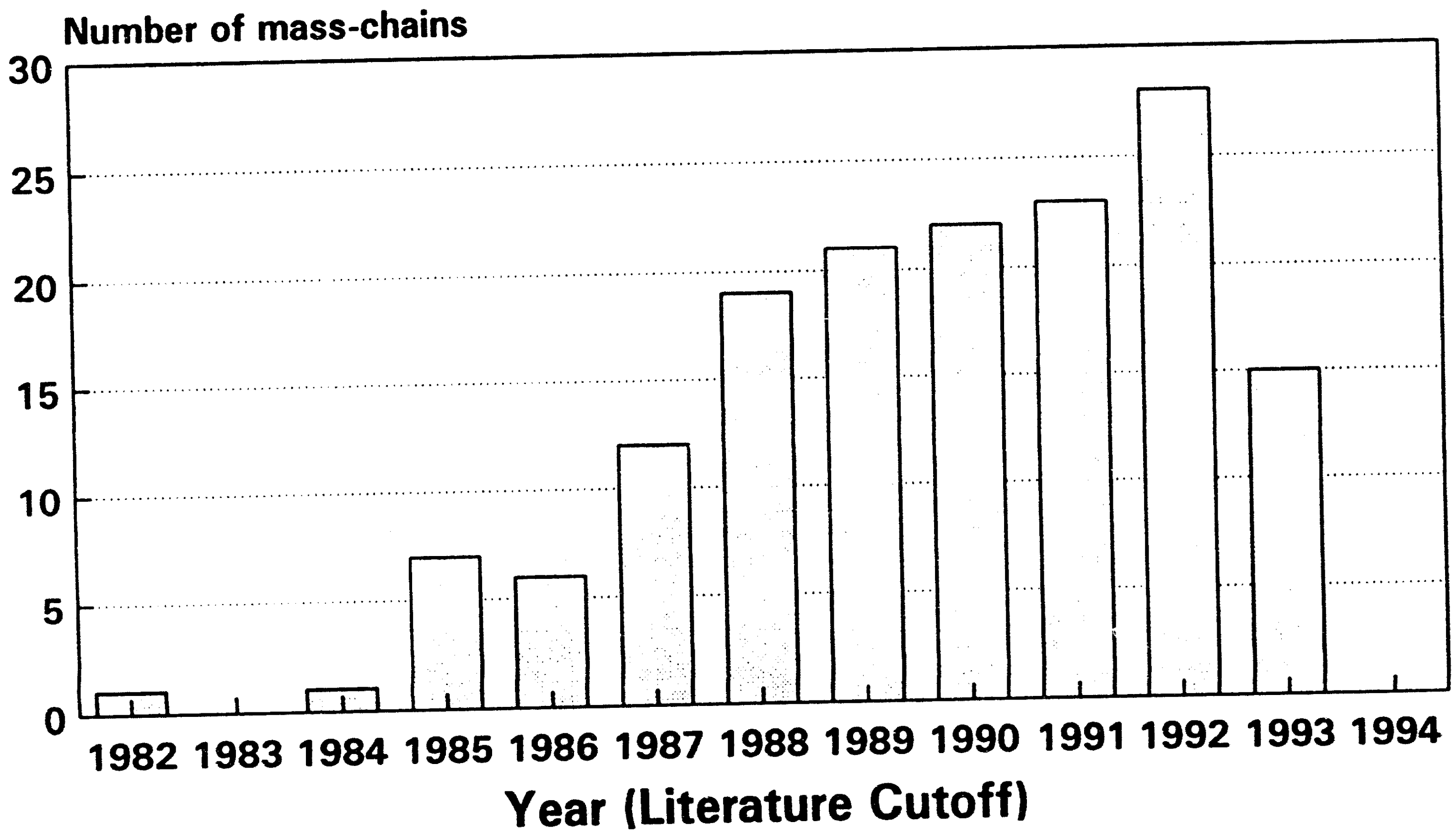
How are the data used?

Initial planning of the experiments.

Competing reactions, through gamma-rays.

Systematics of neighboring nuclides.

Mass-chain status (A=45-247)



Present status of the ENSDF for A=45-246:

65 mass chains (82-89).
About 30 mass chains are in the mass regions where large deformations have been reported.

45 mass chains (90-91)

43 mass chains (92-93)

48 mass chains (submitted for publication or under revision) (92-94)

It is perhaps possible to carry out the task within the presently available resources.

A team of three or four persons within the US NDN and international NSDD could take the responsibility. This team should be in active contact with the research community.

A=124 as an example: took about two weeks.

Update relevant high-spin data sets, first for those mass chains which lie in the regions of reported superdeformation and then for those for which the data are more than three years old. This will be about 3 person-year effort.

Some assistance from summer students could be used when data to be entered do not require much evaluation. This could save a lot of evaluators' time for other tasks.

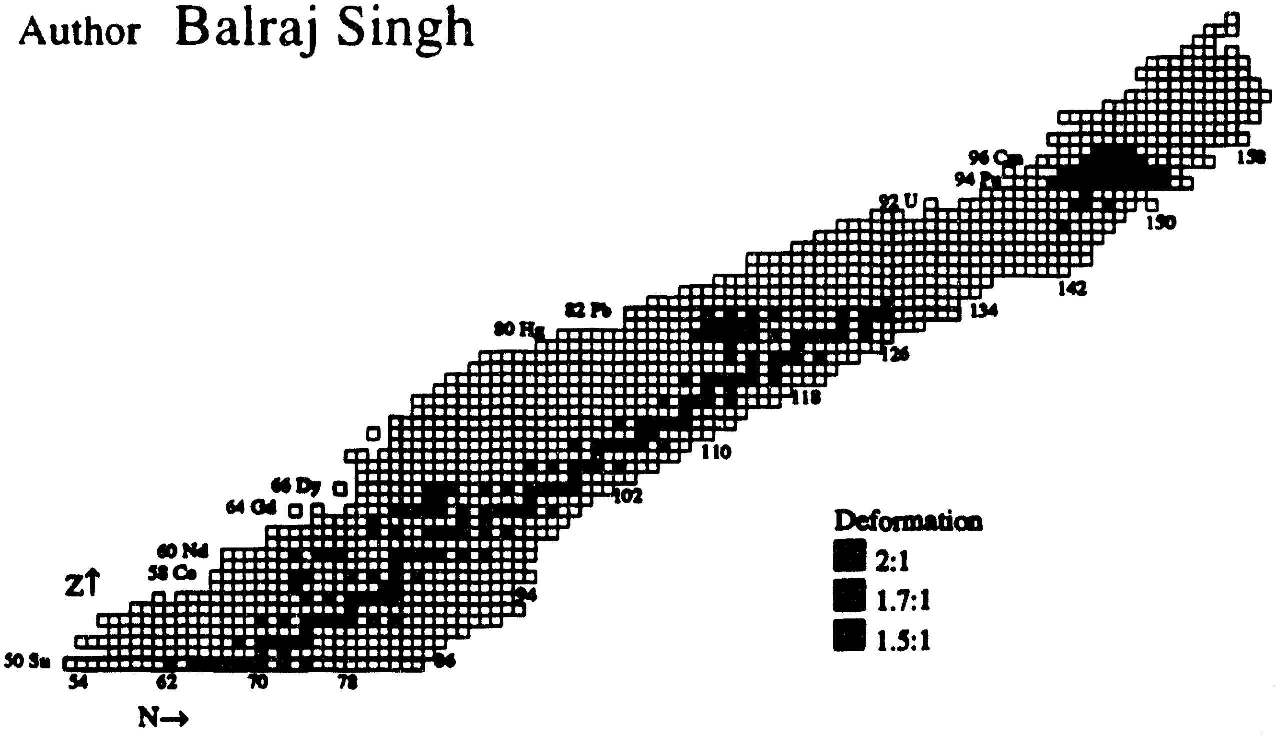
With another 2 person year effort, all data could be brought to a yearly update level. The maintenance of this file then could be done by two or three persons working part-time.

The high-spin data sets prepared this way should be included into ENSDF after some independent review.

Table of Superdeformed Nuclear Bands

Edited by Richard B. Firestone

Author Balraj Singh



Since the observation (in 1986) of discrete set of gamma transitions in 152Dy described as due to a superdeformed minimum in the second potential well of the nucleus, an intensive research at several laboratories has focused on finding other mass regions exhibiting large deformations.

The data on other nuclides have been accumulating very rapidly during the last six years or so.

As a part of our commitment to keep the nuclear structure data as current as possible for the purpose of ENSDF, NDS and TOI, we were prompted to include the data on SD bands on a priority basis.

Prior to starting the project in Sept. 92, no SD data were present in ENSDF, except that for 152Dy.

For each nuclide where SD data were available, two data sets were retrieved from the main ENSDF: the "Adopted Levels, Gammas" data set and the "(HI,xn gamma)" or any other reaction data set containing data on high-spin spectroscopy.

These two data sets were revised to include available data on SD bands: gamma-ray energies, relative intensities, level spins, moments, half-lives etc.

First compilation was completed in April 93 and a draft copy of this report was sent to several laboratories in June 93. The data in this booklet were presented in the style of Table of Isotopes.

It also contained some calculated quantities such as static and dynamic moments of inertia for SD bands. Complete bibliographic information, experimental as well as theoretical, for SD bands was also provided.

This booklet also contained data on fission isomers. These data were taken from ENSDF.

Assignment of a SD band to a nucleus

Gamma-ray energies, uncertainties

Gamma-ray Intensities

Spin assignments

Half-life and Quadrupole moments

Moments of Inertia

BASIS OF J-ASSIGNMENTS:

- Deexcitation of SD bands to known yrast levels with the assumption of a small number of (ΔJ = 1,2) transitions

- Use of rotational model formulae:

$$E(J) = AJ(J+1) + BJ^2(J+1)^2 + CJ^3(J+1)^3$$

$$\hbar(J+\frac{1}{2}) = 2\alpha\omega + \frac{4}{3}\beta\omega^3$$

(Becker et al. Phys. Rev. C41, R9(1990)
Phys. Rev. C46, 889(1992)

- $E(J) = a\left[\sqrt{1+bJ(J+1)}-1\right]$

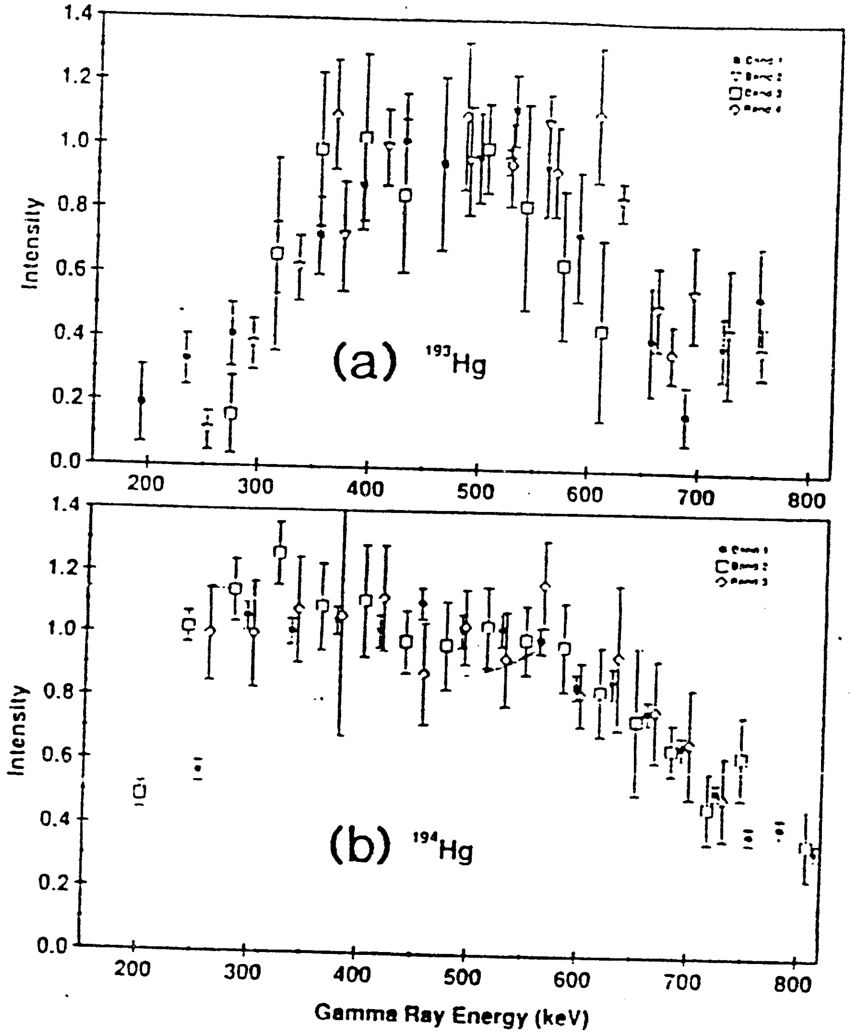
Wu et al. Phys. Rev. C45, 261(1992)

A second revision was done this August and a new booklet is being prepared for circulation. About a month ago, the revised data sets were also included in ENSDF. Fission isomer data were also revised somewhat.

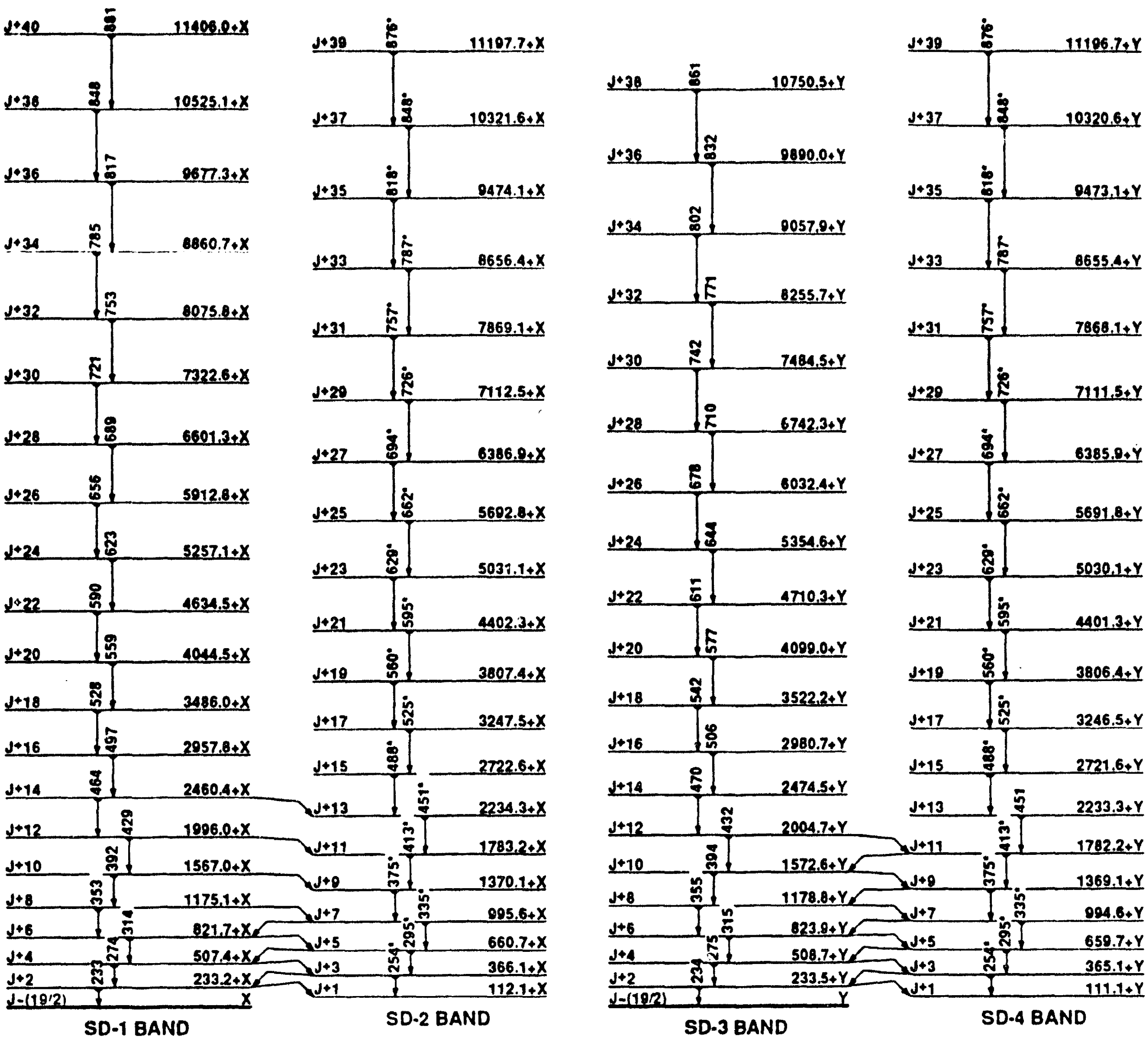
The recent version will contain data on 67 SD bands in 36 nuclides in A=190, 150, 130 regions. It will also contain data on 43 fission isomers in 33 nuclides. Bibliography for SD structures and fission isomers is presented separately.

The new detector arrays (Gammasphere, Eurogam and Gasp) are generating new data on SD bands very fast. In the 1993 Daresbury annual report, there are many additional SD bands reported from the Eurogam data: 3 each in 152Dy and 150Gd, 5 in 149Gd, 4 in 133Pr and 2 in 132Ce.

We intend to update this information on a continuous basis, although, there are some problems in revising files, retrieved each time from ENSDF.



Proc. Conf. at Strasbourg (1991) p 67



$^{193}_{80}$Hg Nuclear Bands

Data from Joyce, et al
Physical Review Letter 71, 2176 (October 1993)

$^{195}_{81}$Tl

Δ:−28240 *130* S_n:(9320) S_p:3280 *140* Q_{EC}:2840 *140*

Populating Reactions and Decay Modes

A ^{197}Au(α,6nγ) E=76 MeV (63Di10, 74Ne16, 76Di14, 77CoZM, 77LiZG, 77LiZJ, 78Li10)

B ^{161}Ta(^{18}O,4nγ):sd (91Az04, 91Ch36, 91Sa12)

Levels and γ-ray branchings:

0, 1/2$^+$, 1.16 *5* h, *[AB]*, %EC+%β$^+$=100, μ=+1.58 *4*

383.66 *12*, 3/2$^+$, *[ABC]* γ_0**383.64** *12* (†$_\gamma$100) M1+E2: δ=1.8$^{+4}_{-3}$

482.63 *17*, 9/2$^-$, 3.6 *4* s, *[AC]*, %IT=100 γ_{384}**98.97** *12* (†$_\gamma$100) E3

777.55 *17*, (5/2$^+$), *[B]* γ_{384}**393.7** *3* (†$_\gamma$100.0 *89*) γ_0**777.6** *2* (†$_\gamma$71.1 *89*)

811.1 *6*, *[B]* γ_{384}**427.4** *5* (†$_\gamma$100)

876.69 *19*, 11/2$^-$, *[AC]* γ_{483}**394.21** *12* (†$_\gamma$100) M1(+E2): δ=0.42 *13*

1079.7 *8*, *[B]* γ_{384}**696.0** *8* (†$_\gamma$100)

1173.79 *20*, 9/2$^-$,11/2$^-$, *[C]* γ_{483}**691.17** *15* (†$_\gamma$100) M1

1190.12 *19*, 13/2$^-$, *[AC]* γ_{877}**313.22** *12* (†$_\gamma$50 *3*) M1+E2: δ=0.38 *10* γ_{483}**707.67** *15* (†$_\gamma$100 *6*) E2

1267.0 *3*, (1/2$^+$,3/2$^+$,5/2$^+$), *[B]* γ_{384}**883.4** *3* (†$_\gamma$100) (E2)

1285.3 *4*, *[B]* γ_{778}**507.8** *3* (†$_\gamma$100) γ_{384}**994.3** *8*(?) (†$_\gamma$100)

1360.95 *22*, 11/2$^-$, *[C]* γ_{483}**878.40** *16* (†$_\gamma$100) M1(+E2)

1378.07 *8*, *[B]*

1410.68 *20*, 11/2$^-$,13/2$^-$, *[C]* γ_{1174}**236.60** *23* (†$_\gamma$1.12 *11*) M1 γ_{877}**534.11** *14* (†$_\gamma$=44.9) M1 γ_{483}**928.02** *16* (†$_\gamma$100 *15*) (E2)

1434.7 *7*, *[B]* γ_{384}**1051.0** *8* (†$_\gamma$100)

1484.04 *21*, 13/2$^-$, *[AC]* γ_{1190}**294.2** *5* (†$_\gamma$65 *48*) γ_{877}**607.64** *15* (†$_\gamma$100 *11*) M1+E2: δ=0.66 *19* γ_{483}**1000.92** *18* (†$_\gamma$16.6 *14*)

1612.7 *9*, (3/2$^+$,5/2$^+$,7/2$^+$), *[B]* γ_{778}**835.2** *8* (†$_\gamma$100) M1

1616.42 *21*, 9/2$^-$,11/2$^-$,13/2$^-$, *[C]* γ_{1174}**442.74** *14* (†$_\gamma$100 *10*) M1 γ_{877}**739.47** *23* (†$_\gamma$47 *8*) γ_{483}**1133.73** *21* (†$_\gamma$98.9 *11*)

1618.74 *20*, 15/2$^-$, *[AC]* γ_{1190}**428.44** *13* (†$_\gamma$100 *6*) M1+E2: δ=0.34 *6* γ_{877}**742.19** *15* (†$_\gamma$93 *6*) E2

1648.6 *5*, *[B]* γ_{1285}**346.0** *5*(?) (†$_\gamma$7.9 *52*) γ_{778}**871.0** *5* (†$_\gamma$100 *13*)

1687.9 *7*, *[B]* γ_{1435}**253.2** *5* (†$_\gamma$29 *12*) γ_{384}**1304.2** *8* (†$_\gamma$100 *15*)

1725.26 *23*, (13/2)$^+$, *[C]* γ_{877}**848.66** *16* (†$_\gamma$100 *25*) E1(+M2) γ_{483}**1242.24** *32* (†$_\gamma$11.3 *25*)

1843.7 *10*, *[B]* γ_{384}**1461.1** *8* (†$_\gamma$100)

1844.8 *4*, *[B]* γ_{1649}**196.1** *5* (†$_\gamma$73 *14*) γ_{1267}**578.0** *5* (†$_\gamma$36 *18*) γ_{778}**1067.0** *8* (†$_\gamma$100 *18*)

1924.46 *22*, 17/2$^-$, *[AC]* γ_{1619}**305.67** *15* (†$_\gamma$58 *6*) M1+E2: δ=0.11$^{+3}_{-4}$ γ_{1190}**734.43** *15* (†$_\gamma$100 *25*) E2

1944.61 *21*, 13/2$^-$, *[C]* γ_{1619}**325.85** *14* (†$_\gamma$10.6 *13*) M1+E2 γ_{1411}**534.1** (†$_\gamma$=8.39) γ_{1190}**754.73** *32* (†$_\gamma$13 *3*) M1 γ_{877}**1067.88** *17* (†$_\gamma$100 *6*) M1(+E2)

1991.47 *22*, 11/2$^-$,13/2$^-$, *[C]* γ_{1361}**630.58** *14* (†$_\gamma$100 *8*) M1(+E2) γ_{1190}**801.26** *17* (†$_\gamma$62 *6*) M1

2011.5 *3*, 17/2$^-$, *[AC]* γ_{1619}**392.8** *5* (†$_\gamma$100 *47*) (M1+E2): δ=0.11$^{+3}_{-4}$ γ_{1190}**821.3** *3* (†$_\gamma$82 *47*) E2

2023.5 *3*, 11/2$^-$,13/2$^-$,15/2$^-$, *[C]* γ_{1484}**539.50** *15* (†$_\gamma$100) M1 γ_{1484}**549.0** *5*(?) (†$_\gamma$65 *59*)

2033.7 *5*(?), *[C]* γ_{1190}**843.2** *5* (†$_\gamma$100)

2037.1 *3*, 15/2$^+$, *[AC]* γ_{1619}**418.5** *3* (†$_\gamma$20 *3*) (E1) γ_{1484}**552.9** *3* (†$_\gamma$24 *4*) (E1) γ_{1190}**847.1** *5* (†$_\gamma$100 *35*) (E1) γ_{877}**1161.6** *5*(?)

2115.1 *5*(?), *[C]* γ_{1484}**630.58** *14* (†$_\gamma$100 *8*)

2145.1 *3*, (11/2,13/2,15/2)$^+$, *[C]* γ_{1725}**419.81** *16* (†$_\gamma$100) M1

2212.9 *4*, 17/2$^+$, *[A]* γ_{2037}**175.7** *3* (†$_\gamma$100) M1+E2: δ=0.13 *5*

2361.9 *4*, (11/2,13/2,15/2) γ_{1484}**877.9** *3* (†$_\gamma$2.1 *7*)

2367.9 *5*(?), *[C]* γ_{1619}**748.8** *5* (†$_\gamma$100)

2470.1 *3*, 19/2$^-$, *[A]* γ_{2012}**458.7** *3* (†$_\gamma$100 *13*) M1+E2: δ=0.75 *15* γ_{1924}**545.7** *3* (†$_\gamma$21 *5*) M1+E2: δ=0.57 *16* γ_{1619}**851.3** *3* (†$_\gamma$17 *8*) E2

2529.6 *4*, 19/2$^+$, *[A]* γ_{2213}**316.8** *3* (†$_\gamma$100 *12*) M1+E2: δ=0.21 *4* γ_{2037}**492.6** *3* (†$_\gamma$16 *5*) E2

2581.5 *5*(?), *[C]* γ_{2115}**466.4** *5* (†$_\gamma$32 *14*) γ_{1190}**1391.0** *5* (†$_\gamma$100 *32*)

2587.4 *3*, 21/2$^-$, *[A]* γ_{2470}**117.3** *5* (†$_\gamma$26 *9*) (M1+E2) γ_{2012}**575.8** *3* (†$_\gamma$42 *6*) E2 γ_{1924}**663.1** *3* (†$_\gamma$100 *11*) E2

2840.7 *5*, 21/2$^+$, *[A]* γ_{2530}**311.4** *5* (†$_\gamma$100 *31*) M1+E2: δ=0.23 *5* γ_{2213}**627.7** *3* (†$_\gamma$50 *8*) E2

2861.1 *4*, 23/2$^-$, *[A]* γ_{2587}**273.7** *3* (†$_\gamma$100) M1(+E2)

3059.8 *4*, 25/2$^-$, *[A]* γ_{2861}**198.8** *3* (†$_\gamma$100 *25*) (M1+E2) γ_{2587}**472.3** *3* (†$_\gamma$64 *21*) E2

3157.1 *5*, 27/2($^-$), *[A]* γ_{3060}**97.3** *3* (†$_\gamma$100) (M1+E2)

3201.9 *5*, 23/2$^+$, *[A]* γ_{2841}**361.1** *3* (†$_\gamma$69 *8*) M1+E2: δ=0.23 *4* γ_{2530}**672.3** *5* (†$_\gamma$<100) E2

3513.9 *5*, 25/2$^+$, *[A]* γ_{3202}**312.3** *5* (†$_\gamma$70 *22*) M1+E2: δ=0.27 *6* γ_{2841}**673.2** *5* (†$_\gamma$<100) (E2)

3729.6 *5*, 27/2$^+$, *[A]* γ_{3514}**215.8** *3* (†$_\gamma$100 *10*) M1(+E2) γ_{3202}**527.6** *3* (†$_\gamma$60 *12*) E2

3885.3 *6*, 29/2($^+$), *[A]* γ_{3730}**155.7** *3* (†$_\gamma$100) (M1+E2)

4002.8 *8*, 31/2($^+$), *[A]* γ_{3885}**117.5** *5* (†$_\gamma$100) (M1+E2)

4174.8 *9*, 33/2($^+$), *[A]* γ_{4003}**172.0** *3* (†$_\gamma$100) (M1+E2)

4393.3 *9*, 35/2($^+$), *[A]* γ_{4175}**218.5** *3* (†$_\gamma$100) (M1+E2)

X, J=(29/2), *[B]*

330.1+x, J+2, *[B]* γ_0**330.1** $\mathfrak{I}^{(1)}$=96.9, $\mathfrak{I}^{(2)}$=99.8, ħω=0.175

700.3+x, J+4, *[B]* γ_{330+x}**370.2** $\mathfrak{I}^{(1)}$=97.2, $\mathfrak{I}^{(2)}$=107.0, ħω=0.194

1107.9+x, J+6, *[B]* γ_{700+x}**407.6** $\mathfrak{I}^{(1)}$=98.1, $\mathfrak{I}^{(2)}$=108.4, ħω=0.213

1552.4+x, J+8, *[B]* γ_{1108+x}**444.5** $\mathfrak{I}^{(1)}$=99.0, $\mathfrak{I}^{(2)}$=105.3, ħω=0.232

2034.9+x, J+10, *[B]* γ_{1552+x}**482.5** $\mathfrak{I}^{(1)}$=99.5, $\mathfrak{I}^{(2)}$=110.2, ħω=0.250

2553.7+x, J+12, *[B]* γ_{2035+x}**518.8** $\mathfrak{I}^{(1)}$=100.2, $\mathfrak{I}^{(2)}$=111.7, ħω=0.268

3108.3+x, J+14, *[B]* γ_{2554+x}**554.6** $\mathfrak{I}^{(1)}$=101.0, $\mathfrak{I}^{(2)}$=123.1, ħω=0.285

3695.4+x, J+16, *[B]* γ_{3108+x}**587.1** $\mathfrak{I}^{(1)}$=102.2, $\mathfrak{I}^{(2)}$=116.6, ħω=0.302

4316.8+x, J+18, *[B]* γ_{3695+x}**621.4** $\mathfrak{I}^{(1)}$=103.0, $\mathfrak{I}^{(2)}$=126.2, ħω=0.319

4969.9+x, J+20, *[B]* γ_{4317+x}**653.1** $\mathfrak{I}^{(1)}$=104.1, $\mathfrak{I}^{(2)}$=121.6, ħω=0.335

5655.9+x, J+22, *[B]* γ_{4970+x}**686.0** $\mathfrak{I}^{(1)}$=105.0, $\mathfrak{I}^{(2)}$=133.3, ħω=0.350

6371.9+x, J+24, *[B]* γ_{5656+x}**716.0** $\mathfrak{I}^{(1)}$=106.1

Y, J=(31/2), *[B]*

350.7+y, J+2, *[B]* γ_0**350.7** $\mathfrak{I}^{(1)}$=96.9, $\mathfrak{I}^{(2)}$=102.0, ħω=0.185

740.6+y, J+4, *[B]* γ_{351+y}**389.9** $\mathfrak{I}^{(1)}$=97.5, $\mathfrak{I}^{(2)}$=105.0, ħω=0.204

1168.6+y, J+6, *[B]* γ_{741+y}**428.0** $\mathfrak{I}^{(1)}$=98.1, $\mathfrak{I}^{(2)}$=106.1, ħω=0.223

1634.3+y, J+8, *[B]* γ_{1169+y}**465.7** $\mathfrak{I}^{(1)}$=98.8, $\mathfrak{I}^{(2)}$=105.8, ħω=0.242

2137.8+y, J+10, *[B]* γ_{1634+y}**503.5** $\mathfrak{I}^{(1)}$=99.3, $\mathfrak{I}^{(2)}$=108.1, ħω=0.261

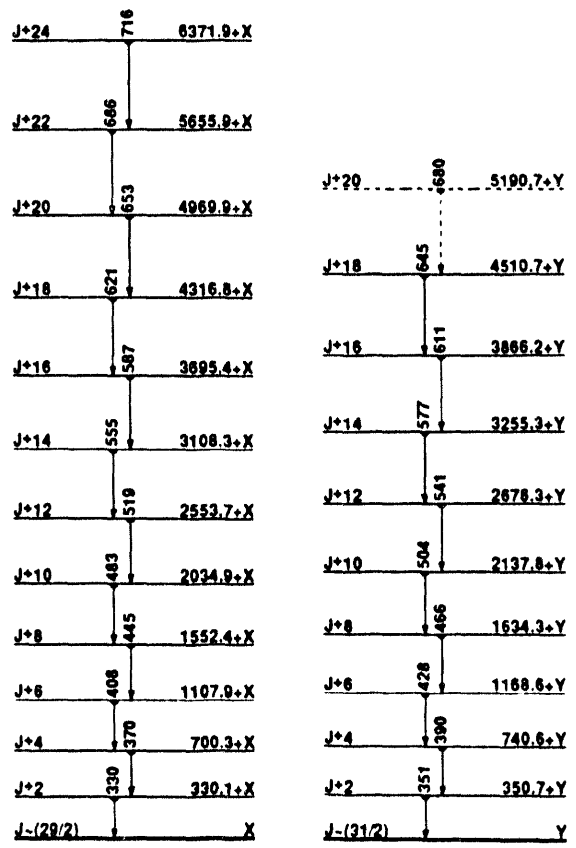
2678.3+y, J+12, *[B]* γ_{2138+y}**540.5** $\mathfrak{I}^{(1)}$=99.9, $\mathfrak{I}^{(2)}$=109.6, ħω=0.279

3255.3+y, J+14, *[B]* γ_{2678+y}**577.0** $\mathfrak{I}^{(1)}$=100.5, $\mathfrak{I}^{(2)}$=118.0, ħω=0.297

3866.2+y, J+16, *[B]* γ_{3255+y}**610.9** $\mathfrak{I}^{(1)}$=101.5, $\mathfrak{I}^{(2)}$=119.0, ħω=0.314

4510.7+y, J+18, *[B]* γ_{3866+y}**644.5** $\mathfrak{I}^{(1)}$=102.4, $\mathfrak{I}^{(2)}$=112.7, ħω=0.331

5190.7+y (?), J+20, *[B]* γ_{4511+y}**680.0**(?) $\mathfrak{I}^{(1)}$=102.9



SD-1 BAND [α=+] [91AZ04] **SD-2 BAND [α=-] [91AZ04]**

$^{195}_{81}$Tl Rotational Bands

Table 1
Superdeformed Band Summary

Nuclide	Band	E_γ-range (N_γ)	J-range	%-feeding	Q[a]	Principal References
^{130}La	SD-1	762-1412 (9)	(16)-(34)	10		89Go13
^{131}Ce	SD-1	592-1732 (16)	(17/2)-(81/2)	5	5.5(5)	88Lu01,90He12,93MuAA
^{132}Ce	SD-1	809-2030 (17)	(18)-(52)	5	8.0(7)	87Ki02,90Di01
^{133}Nd	SD-1[b]	345-1631 (18)	(17/2)-(89/2)	20	6.0(7)	87Wa18,92Mu09,93BaAA
^{134}Nd	SD-1	591-1473 (13)	(10)-(36)	5		87Be32,87Wa18
^{135}Nd	SD-1[b]	546-1449 (14)	(25/2)-(81/2)	10	7.4(10)[c]	87Be57,90Di01,93WiAA
^{136}Nd	SD-1	718-1480 (12)	(16)-(40)	2		87Be32
^{137}Nd	SD-1	635-1431 (14)	(25/2)-(81/2)	13	4.0(5)	87Wa18,92Mu09
^{142}Sm	SD-1	800-1603 (14)	(29)-(57)	0.5(1)		93Ha03
^{143}Eu	SD-1	484-1743 (22)	(37/2)-(125/2)	1.1	13(1)	93At01
^{146}Gd	SD-1	826-1447 (13)	(33)-(59)	0.65(19)	12(2)	90He14,91Rz01,92HaZR
	SD-2	807-1532 (14)	(32)-(60)	0.39(12)	8(2)	92StZu
^{147}Gd	SD-1	697-1516 (17)	(55/2)-(123/2)	0.87(19)		91Zu01,92HaZR
	SD-2	731-1559 (16)	(61/2)-(125/2)	0.57(15)		
^{148}Gd	SD-1	652-1580 (18)	(27)-(63)	1.30(15)		88De10,92HaZR
	SD-2	788-1437 (14)	(32)-(60)	0.62(20)		
^{149}Gd[d]	SD-1	618-1733 (22)	(51/2)-(139/2)	2.5	17(2)	88Ha02,90Ha31,93FlAA
	SD-2	877-1506 (14)	(71/2)-(127/2)	1.0		
	SD-3	896-1485 (12)	(77/2)-(125/2)	0.3		
^{150}Gd	SD-1	780-1494 (17)	(30)-(64)	1.0	17(3)	90By01,91Fa07
	SD-2	770-1378 (14)	(33)-(61)	0.3		
^{150}Tb	SD-1	598-1486 (18)	(21)-(57)	1.0		89De10,90Ha31
^{151}Tb	SD-1	728-1535 (18)	(61/2)-(133/2)	1.0		90By01,92Mu10,93BeAA
	SD-2	647-1494 (19)	(57/2)-(133/2)	0.3		
^{151}Dy	SD-1	522-1490 (20)	(51/2)-(131/2)	1.3		88Ra19,92Mu10
^{152}Dy	SD-1	602-1449 (19)	(22)-(60)	1.47(7)	18(3)	91Be12,92Sm01
^{153}Dy	SD-1	810-1406 (14)	(71/2)-(127/2)	0.25		89Jo04
	SD-2	816-1388 (13)	(71/2)-(123/2)	0.18		
	SD-3	895-1410 (12)	(77/2)-(125/2)	0.13		
^{191}Au	SD-1	229-678 (13)	(19/2)-(71/2)	0.15		93VoAA
^{189}Hg	SD-1	366-708 (10)	(29/2)-(69/2)	0.5		92Be18
^{190}Hg	SD-1	360-812 (14)	(14)-(42)		18(3)	91Dr04,93CaAA
^{191}Hg	SD-1	351-754 (12)	(29/2,31/2)-(77/2,79/2)	2.0	18(3)	90Ca18,89Mo08
	SD-2	292-699 (12)	(25/2)-(73/2)	1.0	~18	
	SD-3	312-708 (12)	(27/2)-(75/2)	0.8		
^{192}Hg	SD-1	215-874 (20)	(8)-(48)	2.0	20(2)	92La07,90Mo16,93HaAA
^{193}Hg	SD-1	233-881 (20)	(19/2)-(99/2)	1.6	[e]	93JoAA,90He09,90Cu05
	SD-2[f]	254-876 (19)	(21/2)-(97/2)	2.1		
	SD-3	234-860 (19)	(19/2)-(95/2)	0.9		
	SD-4[f]	254-876 (19)	(21/2)-(97/2)	2.1		
	SD-5	291-831 (16)	(27/2,29/2)-(91/2,93/2)	1.1		
	SD-6	240-858 (17)	J-J+34			
^{194}Hg	SD-1	254-843 (18)	(10)-(46)	7.0		92ShZR,90St12,90Be11,90Ri05
	SD-2	262-793 (16)	(11)-(43)			

Table 1 (cont.)
Superdeformed Band Summary

Nuclide	Band	E_γ-range (N_γ)	J-range	%-feeding	Q[a]	Principal References
^{191}Tl	SD-1	378-633 (8)	J-J+16	0.4		92PiZR,92YuZY
	SD-2	318-656 (10)	J-J+20	0.4		
^{192}Tl	SD-1	358-629 (8)	J-J+16	0.9		92Li21
	SD-2	378-637 (8)	J-J+16	0.5		
	SD-3	376-641 (8)	J-J+16	1.1		
	SD-4	357-619 (8)	J-J+16	0.7		
	SD-5	381-642 (8)	J-J+16	0.5		
	SD-6	406-634 (7)	J-J+14	0.3		
^{193}Tl	SD-1	228-678 (13)	(19/2)-(71/2)	0.5		90Fe07
	SD-2	248-685 (13)	(21/2)-(73/2)	0.5		
^{194}Tl	SD-1	268-704 (13)	(12)-(38)	1.5		91Az03,90St11
	SD-2	209-686 (14)	(9)-(37)	1.0		
	SD-3	241-718 (14)	(10,11)-(38,39)	0.9		
	SD-4	220-703 (14)	(9,10)-(37,38)	0.6		
	SD-5	188-628 (13)	(8,9)-(34,35)	0.6		
	SD-6	207-613 (12)	(9,10)-(33,34)	0.8		
^{195}Tl	SD-1	330-716 (12)	(29/2)-(77/2)	0.5		91Az04
	SD-1	351-680 (10)	(31/2)-(71/2)	0.25		
^{192}Pb	SD-1	263-636 (11)	(10,11)-(32,33)			91He11,93Pl01[g]
^{194}Pb	SD-1	170-705 (15)	(6)-(36)	1.0	20(3)	90Hu10,90Br10,93Wi02
^{196}Pb	SD-1	171-620 (12)	(6)-(30)			91Wa14
^{198}Pb	SD-1?	304-553 (7)	(12)-(26)			91Wa14

a) Transistion or intrinsic quadrupole moment in eb.

b) Linking transitions to normal states have been reported by 93LuAA (for ^{133}Nd) and 93WiAA (for ^{135}Nd).

c) Q=1.4 eb reported for first member of SD band (93WiAA).

d) Five additional excited SD bands have been reported by 93FlAA.

e) g_k(intrinsic) = -0.61(11) (93JoAA).

f) Unresolved bands.

g) Report non-observation of SD bands in ^{192}Pb.

Table II

Summary of Fission (Shape) Isomers

Nuclide	E(Isomer)[a]	J^{π}	$t_{1/2}$	%IT[b]	Q_0	Selected References
^{236}U	2750 10[c,d]	(0+)	120 ns 2	87(6)	32(5)	78Gu02,80MeAA,89Ma57,90Ma59
^{238}U	2557.6 5[c,d]	0+	298 ns 18	~95	29(3)	69La14,79Ul01,82Go02,92St05
	2557+Y		≥ 1 ns			89Me40
^{237}Np	2800 400		45 ns 5	e)		73Wo03,77Mi09
^{235}Pu	3000 200		25 ns 5			69Me11,70Bu02,78SoZP,89SoZZ
^{236}Pu	~3000	(0+)	37 ps 4		37^{+14}_{-8}	74MeYP,77Me08
	4000 200		34 ns 8			69La14,71Br39
^{237}Pu	~2600		85 ns 15		f)	69La14,79Gu03,82Ra04
	~2900		1.1 μs 1			70Po01,73Va16,79Gu03
^{238}Pu	~2400		0.6 ns 2			73Li01,74MeYP
	~3500	(0+)	6.0 ns 15			70Bu02,71Br39,73Na35,92DeZZ
^{239}Pu	3100 200[c]	(5/2+)	7.5 μs 10		36(4)	70Po01,77Ha01,79Ba02
	~3300[d]	(9/2-)	2.6^{+40}_{-12} ns			77GoZH,80Gu20
^{240}Pu	~2800[c]	(0+)	3.7 ns 3			71Br39,72Sp06,73Be10,86De04
^{241}Pu	~2200		21 μs 3			70Po01,70Ga10,73Be05
	~2300		32 ns 5			69La14,81Gu04
^{242}Pu	~2200		3.5 ns 6			74Me10,75Me28
	2200+Y		28 ns			69La14,70Po01
^{243}Pu	1700 300		45 ns 15			69La14,70Vi05,80Bj02
^{244}Pu	X		0.40 ns 10			74MoYC
^{245}Pu	2000 400		90 ns 30			71Au06,80Bj02
^{237}Am	~2400		5 ns 2			70Po01,71Br39,73Br38
^{238}Am	~2500		35 μs 10			67Bo23,72Br35,73Fl03
^{239}Am	2500 200	(7/2+)	163 ns 12		g)	69La14,72Br35,85Ra28
^{240}Am	3000 200		0.94 ms 4		32.7(20)[h]	71Br39,79Be46,85Jo04
^{241}Am	~2200		1.5 μs 6			69La14,72Br35,73Be04
^{242}Am	2200 80		14.0 ms 10			62Po09,63Pe27,85Ku18,92Ba67
^{243}Am	2300 200		5.5 μs 5			70Po01,72Wo07,87Gu03
^{244}Am	2800 400		0.90 ms 15			68Bj04,69Bo25,72Wo07
	2800+Y		~6.5 μs			69SiZZ
^{245}Am	2400 400		0.64 μs 6			72Wo07,73Br38,80Bj02
^{246}Am	~2000		73 μs 10			72Wo07,83Po14
^{240}Cm	~2000		10 ps 3			76Sl01
	~3000		55 ns 12			76Sl01,78Ul01
^{241}Cm	~2300		15.3 ns 10			69Me11,71Br39,72Vy07
^{242}Cm	1900 200		40 ps 15			75Me28,76Sl01
	~2800		0.18 μs 7			71Re11,71Br39,73Br38
^{243}Cm	1900 300		42 ns 6			69Me11,71Re11,80Bj02
^{244}Cm	~2200		≤5 ps			69Me11,71Re11,80Bj02,80MeAA
	~3500		>100 ns			69MeZX,80MeAA,89Ha40
^{245}Cm	2100 300		13.2 ns 18			71Br39,72Wo07,80Bj02
^{242}Bk	X		9.5 ns 20			72Wo07
	X+Y		0.60 μs 10			72Wo07
^{243}Bk	~2200?[i]		5 ns ?			72Ga42,72Vy07
^{244}Bk	X		0.82 μs 6			72Ga42,72Wo07
^{245}Bk	~1560		2 ns 1			71Re11,72Ga42,72We09

a) Systematics of fission isomers suggest X = 1600-2000; Y ≤ 1000.
b) %SF (^{236}U isomer) = 13(6), %SF (^{238}U isomer) ~5. In all other isomers, only SF decay has been observed.
c) Rotational bands built on this state are shown in the figures.
d) Deexcitation to normal states is shown in the figures.
e) Some evidence of isomeric decay is reported.
f) g-factor = -0.45 (3).
g) g-factor = 0.74 (5).
h) Q_0 = 29.0 (13) (85Jo04).
i) Questionable existence.

Attachment 8

PROPOSAL FOR SUPPORT OF AN EXPERIMENTAL HIGH-SPIN DATA FILE / DATA-NETWORK COORDINATOR

We propose to establish a new staff position with responsibility for the development and maintenance of a high-spin data file (HSDF). The creation of the file will proceed in two phases. In Phase I, a two-year post doctoral position would be created to demonstrate the feasibility of the project and to develop the File. In Phase II a staff position would be established to provide for continuity of file maintenance, and to coordinate the input/output activities among the high-spin research centers. The successful candidates for these positions would be hired within the Physics Division of the Oak Ridge National Laboratory, and the work would be coordinated through the Nuclear Data Project (M. J. Martin, Director) and the Nuclear Structure Group (J. D. Garrett, Group Leader) of that Division. The estimated cost to the Department of Energy for Phase I would be $30,000 per year, in FY 1993 dollars. In addition, $25,000 in capital funds is requested in the first year for acquisition of a work station for graphics analysis. The estimated cost to the Department of Energy for Phase II would be $150,000 per year, in FY 1993 dollars.

NEED FOR A CENTRALIZED HIGH-SPIN DATA FILE

Of increasing importance for the nuclear structure research community is the creation of a data file for experimental data on the frontier areas of nuclear structure physics. This need has been stated in the report of the National Research Council Panel on Nuclear Data Compilations held at Oak Ridge in October, 1991. Based on input to that panel from members of the nuclear structure research community, the panel recommended that the Nuclear Data Network investigate with the nuclear structure community:

a) the possibility of providing to the nuclear science community, via the Data Network, the data currently residing in the partial high-spin data files of several centers in this country and in Europe;

b) a method of maintaining an up-to-date high-spin data file; and

c) a technique for providing the data from such a file to interested users either interactively on line, or in a tabular format that can be used directly for computing additional quantities of scientific interest.

The two areas that this proposal addresses are the management of data from the studies of high-spin states and from the study of nuclides far from stability that will be produced by the several radioactive beam facilities presently being developed, such as the RIB facility at ORNL.

Nearly all nuclear physics groups active in high-spin research maintain a computerized data file of the level schemes deduced from their own experiments. Furthermore, several of those groups have also made an effort to produce data files for specific mass regions that address the needs of their own research program. The earliest effort to establish a comprehensive compilation of high-spin data in deformed nuclei was started at the Niels Bohr Institute in late 1984. Already in 1985 and 1986 two scientific papers, describing the use of gauge space routhians, were published based on analyses using that data file (see Appendix). The Niels Bohr Institute data file was subsequently exported to several other laboratories (e.g., Lund, Stockholm, Uppsala, Cologne, Liverpool, Oak Ridge, University of Tennessee, Argonne, and StonyBrook) by the various guests who used it at the Niels Bohr Institute. Each export, however, produced a separate data file which then evolved on its own, and attempts to standardize the diverging data files have not been successful, due mainly to the lack of a single person devoted to this task. Furthermore, the recent explosion of data on high-spin states, associated with the advent of sizeable arrays of Compton-suppressed germanium detectors, has made it nearly impossible for any of the individual groups to maintain a comprehensive file for even a limited number of nuclides in the deformed region. The recent start of the scientific programs associated with EUROGAM and GASP, and the first GAMMASPHERE experiments scheduled for early 1993, herald yet another dramatic increase in the amount of high-spin data. In addition, the funding in the U.S., Europe, and Japan, of facilities for the production of intense beams of radioactive ions promises to increase by about 50% the number of isotopes for which experimental data exists, and by perhaps 100% the number of isotopes for which high-spin data exists.

In order to keep abreast of such developments it is essential that a high-spin data file be in place prior to operation of the new state-of-the-art facilities. This point is emphasized in "National Nuclear Data Needs of the 1990's", a report to the Nuclear Science Advisory Committee by the Subcommittee on Nuclear Data Needs. In the section of the report concerning the needs for high-spin physics connected with these new facilities it is stated that "It is crucial that appropriate technology be utilized to compile, evaluate, and disseminate this large body of nuclear data in a rapid and efficient manner. ... Such data compilation efforts are in progress at several institutions; unfortunately, much of this work is being performed outside the well-established nuclear data community and suffers from lack of central coordination."

By incorporating into one file the data presently available only in fragmented sources (segments of data files, lab and conference reports, etc.,), and maintaining this file, a single-source base of continuously updated data can be made available to the research community.

FRAMEWORK AND FEATURES OF THE PROPOSED HIGH-SPIN DATA FILE

The existing Evaluated Nuclear Structure Data File, ENSDF, is the logical computer-based system to use for the proposed HSDF. The on-line access requests for data from this file are growing at a rapid rate, indicating increased awareness and use of the file. Documented requests directed to ENSDF over the past three years are 850 in 1989, 1256 in 1990, and 2807 in 1991. ENSDF has a structure that can easily accommodate the additional high-spin data. The recommendation of the Formats and Procedures Subcommittee of the U. S. Nuclear Data network is that the High-Spin Data File be set up as an auxiliary file within ENSDF.

The purpose of the High-Spin Data File is to maintain an accurate and current computerized listing of high-spin data, and to provide these data in a convenient format for use in a variety tasks. Such tasks include comparison with nuclear models, calculation of secondary quantities of scientific interest (e.g., moments of inertia of "identical bands", level spacing distributions that can distinguish between "ordered" and "chaotic" nuclear motion, and residual interactions), simulations of the continuum of nuclear states, and literature searches. Examples of uses of the existing High-Spin Data Files appearing in scientific publications are given in Appendix A, and three recent uses are highlighted in Appendix B.

This auxiliary file would contain high-spin nuclear structure information provided directly by the researchers. The data under consideration can be conveniently divided into two categories, primary-source data and secondary-source data. The first category includes data that have been peer reviewed and published. The second category includes unevaluated data from sources such as laboratory reports, conferences, and theses. For completeness, it will be very useful to have in this file the published data that are not already in ENSDF, but it is the collection of the secondary-source material that will be of the most value. In the case of published papers, HSDF could act as a repository for backup data that were not included in the publication. The data in either the primary- or secondary-source category would be provided by the authors and reformatted, where necessary, by the HSDF coordinator for entry into the auxiliary file. The standardized file format will allow the research community efficient access to, and extraction of, the data. At the same time, the format in which the data can be provided will not be so rigid as to inhibit the researchers' participation in the system. The minimum requirements for inclusion in the file would be that the data consist of gamma-ray energies and excitation energies assigned to a specific nuclide. As much additional data, such as gamma-ray intensities, gamma-ray character, spins and parities, lifetimes, static moments, intrinsic configurations as a researcher wishes to provide can easily be included in the file. The mass-chain evaluators would also be able to use these data, incorporating them into the individual mass-chain evaluations as these mass chains are updated. The single-source ENSDF-compatible nature of these data would save evaluators considerable time in preparing their mass chains, and conversely, would allow the extensive set of analysis, checking, and output programs designed for ENSDF to be available for users of HSDF. The data-base management aspects of HSDF will be coordinated with the U. S. Nuclear Data Network to ensure compatibility with ENSDF, and to maximize the usefulness of the File to present and future users.

ROLE OF THE HIGH-SPIN DATA FILE COORDINATOR

The role of the coordinator would be to establish and manage the high-spin data file. During the initial phase, the coordinator would spend nearly full time developing the system, and would work closely with the Nuclear Data Network and the existing High-Spin Data Files. Thereafter, the coordinator's time would be spent managing the File and using the File for systematic nuclear structure studies. The coordinator would interact with the data producers to ensure that the file will satisfy their needs, and to assist them in transferring their data to HSDF. The coordinator would also assist nuclear structure researchers in accessing and obtaining information from the HSDF. The data transfer process would likely require some reformatting, and management of the file would involve development of some data format checking codes and of auxiliary data manipulating programs as needed.

To effectively carry out the coordinator role, the candidate would need to be an experienced nuclear structure researcher who has familiarity with modern computational techniques and with the existing data files, and who has good contacts with the major groups producing the data. The coordinator will have high visibility within the research community, and once the feasibility of the project is demonstrated, and the file is established, it will be essential for the maximum effective use of the file that the coordinator position be a permanent one so that long-range continuity can be provided in the liaison between the file and the researchers. Such continuity will also allow the coordinator to take full advantage of the software and hardware developments associated with the ORNL supercomputer center. A permanent coordinator position will eliminate the need for periodic retraining, and will provide the degree of confidence in the system needed to maximize the researchers' use of the system. Maintenance of the file as a current up-to-date research tool with continually expanding and diverse input/output requirements is expected to absorb a major fraction of the coordinator's time. The remaining time will be devoted to use of the file for systematic nuclear structure studies. This aspect of the coordinator's role will allow the coordinator to keep abreast of new developments in the field as they arise, and to help ensure that the output capabilities of the file keep pace with the needs of the researchers.

The specifications of the coordinator position will necessitate extensive travel, especially in the first year, in order to establish and maintain close contact with the researchers and the data-base personnel. In particular, it will be very important that the coordinator attend the major high-spin and nuclei-far-from-stability conferences, as well as meetings of the Nuclear Data Network.

JUSTIFICATION FOR SITING THE COORDINATOR POSITION AT ORNL

ORNL has a preeminent data evaluation group, the Nuclear Data Project, and a leading experimental program in high-spin physics. These are the two most important assets for development of a data file that addresses the needs of the research community and meshes with the existing data file ENSDF. In addition, a Radioactive-Beam Facility, to be constructed at ORNL, will provide new data from nuclides never before produced. Furthermore, the recently established Nuclear Structure Theory Research Group, coordinated jointly by ORNL and the University of Tennessee, will provide complementary theory expertise. Indeed, this group, with its sizeable guest program, promises to provide the most significant nuclear structure theory effort in the U. S. An additional important resource is the ORNL Supercomputer Center which is available to provide expertise as needed in interactive on-line access to data files. One of the major initiatives of the supercomputer Center is the development of modern data-base software for distributed computing environments. Although the present project does not need the resources of a parallel supercomputer, the new software is expected to provide standard interfaces to modern visualization and graphics packages. ORNL provides a visualization support group that will help develop the needed software interface. This will be particularly useful for data-base systems running on work stations. Taken together, these organizations would provide a stimulating environment within which the coordinator position described above could function most effectively.

At present, the most complete operational high-spin data file in existence is the ORNL/UTK data file. The history of high-spin data files at Oak Ridge National Laboratory started in the fall of 1986 when a version of the Copenhagen Data File was set up at ORNL and the University of Tennessee. The use of this data file has continually grown since that time. In 1989 the ORNL-UT High-Spin Data File was modified by adding a keyword input format to make it compatible with the Cologne High-Spin Data File being used in several German and Scandinavian Laboratories. During 1990 and 1991 a serious effort was made to make this data file as complete as possible for all deformed nuclei. It is estimated that the existing ORNL-UT High-Spin Data File represents a total effort of about eight man years. Much of the recent data-entry effort has utilized student participants in the ORNL Science and Engineering Research Semester and University of Tennessee Science Alliance.

The file itself, and the several years of hands-on experience developing and working with it, would provide a valuable starting point for development of the complete system being proposed.

COST-PHASE I (DOE + ORNL)

Salary + fringe benefits + travel + overhead

ORNL Physics Division support	$30,000
DOE matching funds	$30,000
Total	$60,000
One-time capital cost request for a graphics analysis computer work station	$ 25,000

COST-PHASE II (DOE)

Salary + fringe benefits + travel + overhead	$150,000

APPENDIX A. BIBLIOGRAPHY OF EXAMPLES OF USES OF THE EXISTING HIGH-SPIN DATA FILES

- Identical Bands and the Varieties of Rotational Behavior
  J.-Y. Zhang, R.F. Casten, W.-T.Chou, D.S. Brenner, N.V. Zamfir, P. von Brentano

- Identical Bands at Normal Deformation: Criteria and Challenges
  Jing-ye Zhang, Lee L. Riedinger

- Identical Bands in Normally Deformed Nuclei
  C. Baktash, J.D. Garrett, D. Winchell, and A. Smith, Phys. Rev. Lett. 69, 1500 (1992)

- Ordered Nuclear Motion in "Cold" Rotating Nuclei
  J.D. Garrett, J.R. German, L. Courtney, and J.M. Espino, in Future Directions in Nuclear Physics with 4π Gamma Detection Systems of the New Generation, ed. by J. Dudek and B. Haas (AIP, 1992, New York), p. 345

- Observation of Diabolical Points for Rapidly Rotating Nuclei
  J.-Y. Zhang and J.D. Garrett, Phys. Rev. Lett. **62**, 693 (1989)

- Empirical Estimates of Proton-Neutron Residual Interactions
  J.-Y. Zhang, J.D. Garrett, R.F. Casten, D.S. Brenner, C. Wesselborg, C.H. Yu, and M. Carpenter, Nucl. Phys. **A520**, 251c (1990).

  J.-Y. Zhang, R.F. Casten, and D.S. Brenner, Phys. Lett. **227B**, 1 (1989).

  J.D. Garrett, J. Nyberg, C.H. Yu, J.M. Espino, and M.J. Godfrey, in Contemporary Topics in Nuclear Structure Physics, ed. R.A. Casten, et al. (World Scientific, 1988, Singapore) pg. 699.

- Simulations of the Gamma Ray Continuum
  I.Y. Lee, C. Baktash, J.R. Beene, M.L. Halbert, D.C. Hensley, N.R. Johnson, F.K. McGowan, M.A. Riley, and D.G. Sarantites, Phys. Rev. **C46**, 597 (1992)

- Moments of Inertia of Rapidly-Rotating Nuclei
  J.M. Espino and J.D. Garrett, Nucl. Phys. **A492**, 205 (1989).

  D.F. Winchell, D.O. Ludwigsen, and J.D. Garrett, Phys. Lett. **B289**, 267 (1992).

- The Routhian in Gauge Space
  J.D. Garrett, in Proceedings of the Niels Bohr Centennial Conference on Nuclear Structure, ed. R.A. Broglia, G.B. Hagemann, and B. Herskind (North Holland, 1985, Amsterdam) pg. 111.

  J.-Y. Zhang, J.D. Garrett, J.C. Bacelar, and S. Frauendorf, Nucl. Phys. **A453**, 104 (1986).

- Signature Splitting in Rapidly-Rotating Nuclei
  S. Shastry, J.C. Bacelar, J.D. Garrett, G.B. Hagemann, B. Herskind, and J. Kownacki, Nucl. Phys. **A470**, 253 (1987).

APPENDIX B. DESCRIPTION OF THREE TYPICAL USES OF HIGH-SPIN DATA FILES

For illustration, three recent uses of existing high-spin data files are briefly described.

Identical Bands in Normally Deformed Nuclei:

The existing data files for normally-deformed nuclei have allowed a quick negative answer to the suggestion that the observed superdeformed identical bands are the result of special symmetries associated with superdeformed nuclear shapes. In fact the three most comprehensive of the several recent discussions of identical bands in normally-deformed nuclei (J.-Y. Zhang, et al.Phys. Rev. Lett. 69, 1160 (1992); C. Baktash, et al., ibid. 1500; and J.-Y.Zhang, et al., ibid. 3448) all utilized a version of the existing high-spin data files. Although it is well established that identical bands in neighboring nuclei are not unique to superdeformed shapes, the physical basis of identical bands, indeed the question of the microscopic composition of the moments of inertia of deformed nuclei, remains an open question.

Level Repulsion and Chaos in the Nuclear Quantum System:

A recent analysis of the level-spacings of nuclear states with the same spin and parity in "cold" rotating nuclei shows a Poisson distribution (often associated with ordered behavior, see J.D. Garrett, et al. in Future Directions in Nuclear Physics with 4pi Gamma Detection Systems of the New Generation (AIP, 1992, New York) p. 345). However, even at low excitation energies where the average spacing is about 300 keV, significant deviations from the Poisson distribution are observed for small spacings. Such deviations are attributed to the level repulsion associated with the mixing of closely-spaced states with the same quantum numbers. For deformed rare-earth nuclei this mixing apparently becomes increasingly important for separations less than about 60 keV, providing for the first time quantitative information on the transition from "order" to "chaos" in the nuclear quantum system.

Simulations of the Gamma-Ray Continuum:

Due to the large number of gamma-decay paths at high spin and at high excitation energies above the yrast configuration, discrete gamma-ray transitions cannot be resolved. To extract quantitative nuclear structure information from the continuum of gamma-rays associated with this region of excitation energy and angular momentum, it is often useful to simulate the continuum by taking known bands from neighboring nuclei available from the high-spin data files, (see e.g., I.Y. Lee et al., Phys. Rev. C46, 597 (1992)). Such simulations should become even more important for the analysis of higher-fold gamma-ray coincidence continuum data, which are becoming available with the new generation of gamma-ray detector arrays.

113Sn β- DECAY

MAJOR γ'S - FOR ASSAY OF THE AMOUNT OF 113SN PRESENT, THE ONLY γ RAY USUALLY OF INTEREST IS AT 391 KEV. THE Iγ(255) IS USED TO VARIFY THE NUCLIDE IDENTIFICATION AND TO DECMPOSE ANY COMPLEX PEAK AT THIS ENERGY.

COMPLETENESS - THE FOLLOWING DECAY SCHEME INCLUDES ALL OF THE KNOWN LEVELS IN 113IN BELOW THE Q(EC) VALUE OF 1039 KEV, EXCEPT ONE AT 1024 KEV. THE J^{π} OF ALL LEVELS ARE KNOWN FROM ATOMIC-BEAM MEASUREMENTS, L TRANSFER VALUES, AND/OR γ MULTIPOLARITIES (SEE NDS). THE UNOBSERVED β BRANCH TO THE 1024 LEVEL IS 2ND FORBIDDEN FOR WHICH THE LOGFT SHOULD BE 11.9 - 13.6 (73RA10) AND THE CORRESPONDING β BRANCH SHOULD THEN BE LT 1.0E-07% OF THE DECAYS. AS NOTED IN THE SCHEME, THE β BRANCH TO THE GROUND STATE IS EXPECTED TO BE AP 1.0E-13% OF THE DECAYS. THE OBSERVED γ RAYS REPRESENT ALL OF THE EXPECTED γ TRANSITIONS BETWEEN THE LEVELS, THEREFORE, IS CONCLUDED THAT, FOR ALL PRACTICAL PURPOSES, THE CURRENT DECAY SCHEME IS COMPLETE.

113Sn β- DECAY (Continued)

NORM - The Iγ(391) will be determined from the total feeding of the ground state which involves only the 391 and 646 γ's.

CAUTION - The 391-keV level in 113In has a half-life of 1.6 hours, so in some situations the 391-keV γ ray may not be in equalibrium with the 113Sn parent.

NOTE - Due to the long half-life of the 391-keV level, the activity of this level is slightly larger than that of the 113Sn parent. For a level half-life of 1.6580(5) hours (??//??), the relative activities are

{[Activity of 391 level] / [Activity of 113Sn]} =

{[T(113Sn)] / [T(113Sn) - T(391 level)]} = 1.00060.

SN113 BETA 25. 0.853

0	0.0	0.0
391	98.	0.0
647	2.	0.0
1029	0.00099	0.0
0	0.0	0.0

2	1	391.7	64.89	0.541	0.43
3	2	255.0	1.85	0.046	0.039
3	1	646.7	0.000004	0.04	0.03
4	3	382.9	0.00003		
4	2	638.0	0.00097	0.0013	0.0011

152Eu EC and β- DECAY (13.506 Y)

MAJOR γ's - For the assay of 152EU and for the efficiency calibration of Ge detectors, there are 10 strong γ's that should be considered; these are at 121, 244, 344, 411, 444, 778, 964, 1085, 1112, and 1408 keV. The data for these γ's are especially good because their relative intensities (or emission probabilities) were the object of an international intercomparison which was sponsored by the Beta- and Gamma-ray Spectrometry Working Group of the International Committee on Radionuclide Metrology (ICRM) and involved 26 participants. This set of data was unique in that the ICRM evaluator had available not only each set of results, but also the detector efficiency calibration data. Therefore, he was able to suggest many adjustments and corrections in order to improve the consistency of the decay data used by the participants. All of the ICRM information was made available to this evaluator who in 1988 combined it with the results from nine other studies, and the results were included in the IAEA report 91Ba?? (IAEA-TECDOC-619). The evaluation for the IAEA report involved a total of 25 γ's which included, in addition to the ten listed above, those at 295, 367, 488, 563, 586, 678, 688, 867, 919, 1005, 1089, 1212, 1299, 1457, and 1528 keV. The relative intensities for the remaining γ's have been taken from the NDS.

152EU EC AND β- DECAY (13.506 Y) (CONTINUED)

NORM - THE NORMALIZATION OF THE RELATIVE γ INTENSITIES HAS BEEN ACCOMPLISHED BOTH BY MEASUREMENTS OF THE γ-EMISSION RATES FOR SOURCES OF KNOWN ACTIVITY AND BY SETTING THE FEEDING OF THE GROUND STATES TO 100%. THESE TWO NORMALIZATION FACTORS ARE P_γ(1408) = 20.85% 8 FROM THE ICRM MEASUREMENTS AND 20.83% 21 FROM SETTING THE GROUND-STATE FEEDING TO 100% AS DONE IN THE IAEA DOCUMENT. THE MAJOR COMPONENT IN THE LATTER UNCERTAINTY IS THAT OF α(121), WHICH IS TAKEN TO BE 3%. THE EXCELLENT AGREEMENT BETWEEN THESE TWO NORMALIZATIONS DEMONSTRATES THE CORRECTNESS AND COMPLETENESS OF THIS DECAY SCHEME.

CALIB - THE DATA FOR THE γ'S AT 121, 244, 344, 411, 444 (DOUBLET), 778, 964 (DOUBLET), 1085, 1112, AND 1408 KEV ARE OF SUFFICIENT QUALITY TO USE FOR ENERGY AND EFFICIENCY CALIBRATIONS.

NOTE - THE γ PEAKS AT 443.9, 564, AND 964 KEV ARE DOUBLETS, SO TOTAL VALUE GIVEN IN THE COMMENTS, OR THE SUM OF THE TWO Iγ VALUES MUST BE USED IN ANY ASSAY.

152Eu EC AND β- DECAY (13.506 Y) (CONTINUED)

ENERGIES - THE γ ENERGIES FOR THE 25 LINES EVALUATED FOR THE IAEA DOCUMENT HAVE BEEN TAKEN FROM , , AND ; OTHER VALUES ARE FROM THE NDS.

NOTE - 152Eu DECAYS BY BOTH β- AND EC DECAY SO THE γ DATA ARE IN TWO TABLES AND THERE ARE TWO DECAY SCHEME DRAWINGS.

NOTE - THERE ARE OVER 120 γ'S IN THIS DECAY, SO THE ASSAY OF OTHER NUCLIDES IN THE PRESENCE OF 152EU MAY BE DIFFICULT DUE TO THE MANY POSSIBLE INTERENCES.

SEE NDS FOR HALF-LIFE MEASUREMENTS AND J^{π} ARGUMENTS. SEE NDS FOR LIST OF ALL MEASUREMENTS.

SEE NDS FOR ORIGIN OF γ MULTIPOLARITIES AND δ VALUES.

EU-152	BETA-	40.	0.928	
0.	0.	0.0		
344.28	8.2	0.0		
615.42	0.0	0.0		
755.40	0.94	0.0		
930.58	0.30	0.0		
1047.51	0.0	0.0		
1109.18	0.29	0.0		
1123.19	13.8	0.0		
1282.28	0.023	0.0		
1318.37	0.18	0.0		
1433.98	2.40	0.0		
1550.18	0.0	0.0		
1605.63	0.10	0.0		
1643.42	1.78	0.0		
1692.38	0.020	0.0		
0.0	0.0	0.0		
15 2	1348.09	0.0169	0.0	0.0
15 4	937.0	0.0031	0.0	0.0
14 2	1299.15	1.63	0.0	0.0
14 5	712.85	0.094	0.0	0.0
14 7	534.24	0.0430	0.0	0.0
14 8	520.23	0.049	0.0	0.0
1411	209.49	0.0044	0.0	0.0
13 1	1605.62	0.0075	0.0	0.0
13 2	1261.35	0.0327	0.0	0.0
13 3	990.20	0.0309	0.0	0.0
13 5	674.678	0.0190	0.0	0.0
13 6	558.1	0.0040	0.0	0.0
13 7	496.38	0.0046	0.0	0.0
12 2	1206.09	0.0150	0.0	0.0
12 4	794.78	0.0246	0.0	0.0
11 2	1089.77	1.7	0.0	0.0
11 4	678.62	0.459	0.007	0.006
11 5	503.39	0.15	0.0	0.0
11 7	324.789	0.075	0.0	0.0
10 2	974.09	0.0144	0.0	0.0
10 3	703.233	0.0035	0.0	0.0
9 4	526.88	0.0131	0.0	0.0
9 5	351.66	0.0090	0.0	0.0
9 7	172.1	0.0004	0.0	0.0
8 2	778.90	12.91	0.0	0.0

Attachment 10

A Plan for a Horizontal Evaluation of Decay Data

R. G. Helmer

Idaho National Engineering Laboratory
EG&G Idaho, Inc., P. O. Box 1625
Idaho Falls, Idaho, 83415-2219

E. Browne

Lawrence Berkeley Laboratory
Bldg. 50A, MS 6102
Berkeley, California 94720

M. Schmorak

Nuclear Data Project, Bldg. 6000, MS 371
P. O. Box 2008
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831

Background

From 4-7 November 1992, two groups held meetings to assess the status of, and recommend changes in, the scope of work related to the evaluation of the nuclear structure and decay data that appear in the Evaluated Nuclear Structure Data File, ENSDF, and the related publication in Nuclear Data Sheets, NDS. These groups were the US Nuclear Data Network, NDN, which is composed of five evaluation centers in this country, and Nuclear Structure Evaluation Working Group, NSEWG, an advisory panel recently constituted by the US Department of Energy, DOE.

"Horizontal Evaluations" was a topic of discussion at these meetings. Specific items in this category included: a unified compilation and evaluation of all α-decay data; the Table of Isotopes; and decay data. This latter topic, the one of interest here, was introduced in a draft report prepared by C. M. Lederer entitled "How to Revitalize the Nuclear Data Compilation and Evaluation Program" [1] and in the center report from the Idaho National Engineering Laboratory, INEL, presented by R. G. Helmer [2]. This topic was subsequently discussed by C. W. Reich in a summary presentation to the NSEWG panel.[3] In the Lederer report, the "horizontal evaluation of decay data" was used to indicate the use of data from other excitation modes to produce "adopted" ENSDF decay data sets, whereas the current ENSDF policy is to include only experimental decay data sets. In contrast, the INEL discussion of horizontal evaluation of decay data pointed out the need to do in-depth evaluation of selected decay data for those radionuclides that are important for various applications.

As result of these presentations and the related discussion, Dr. Jolie Cizewski, NSEWG chair, requested the authors prepare a document describing what should be done in this area and for whom it would be useful. It is the concept of in-depth evaluation of selected decay data needed for applied work that is discussed in this document. The suggested procedure would be implemented outside the current ENSDF evaluation activity, but the evaluated data would be available to and very likely adopted by the ENSDF evaluators.

In the following, we describe the problem, and suggest a goal and a methodology for achieving it. We conclude with a brief review of the authors' qualifications.

The Problem

Although the decay schemes of many radionuclides of interest in applied work have been studied for many years, the readily available evaluated data often do not meet the needed precision. The quantities generally needed are the half-lives and the γ-emission probabilities (photons per 100 decays), P_γ, of the important γ rays. The lack of precision in the existing published data arises, in part, because these quantities are not easy to measure and a precise knowledge of them is often not needed for an understanding of the corresponding nuclear physics. On the other hand, there are highly specialized groups working in nuclear metrology, such as the Radioactivity Group at the National Institute of Science and Technology, NIST, in the U. S., the Physikalisch-Technische Bundesanstalt, PTB, in Germany, the Laboratoire Primaire des Rayonnements Ionisants, LPRI (formerly known as Laboratoire de Métrologie des Rayonnements Ionisants, LMRI) in France, the National Physical Laboratory, NPL, in the United Kingdom, and the Central Bureau for Nuclear Measurements, CBNM, in Belgium. These laboratories are involved in the precise measurement of half-lives and photon emission probabilities, but often publish their results in internal reports of limited dissemination, or do not publish at all. Consequently, these results are often not included in the standard evaluations such as ENSDF.

Half-lives and P_γ values are needed where quantitative assay of radionuclide content in samples is determined by γ-ray spectroscopy. Such assays represent a major use of nuclear decay data and are carried out routinely in such areas as fission- and fusion-reactor research and technology (i.e., nuclear reactors, fuel fabrication and reprocessing plants, and waste storage areas), monitoring and analysis of environmental samples, medical applications using radioisotopes for diagnosis or therapy, and industrial processes.

Despite the large amount of effort expended on decay-scheme studies over the years, many of the needed data are still not adequate for various uses, as shown in tables 1 and 2 for the decay of ^{234m}Pa (1.2 m) and ^{144}Ce (284 d). The decay data for ^{234m}Pa are important because this radionuclide is a member of the ^{238}U decay chain, and the observed intensity of the 1001-keV γ ray is often used to determine the amount of ^{238}U present in samples. Neither ^{238}U nor its ^{234}Th daughter emit γ rays that are generally useful for assay due to their low energies and low emission probabilities. This problem was called to the attention of one of the authors (Helmer) when he received a call recently from a spectroscopist from another laboratory who obtained inconsistent results from different methods of assaying for ^{238}U.

The solution was simple. As shown in table 1, "recent" measurements (reported in 1986, 1990, and 1992) give values around 0.84% which differ significantly from the values of 0.65% in the Table of Radioactive Isotopes and 0.59% in the most recent NDS. Use of these recent values solved the problem which had precipitated the telephone call. It is somewhat disturbing to see that this new suggested value represents a 42% increase in P_γ(1001) from the NDS value, which implies a substantial decrease in the amount of ^{238}U present in samples assayed using the old values. Unfortunately, the Gunnink value, see table 1, has never been published in a reviewed journal and the methodology used to obtain it was not well documented in the laboratory report. Consequently, evaluators generally excluded it from consideration. The last three values in table 1 were all measured in response to the problem of getting consistent results for ^{238}U assays.

The decay data for ^{144}Ce are important because it is a fission product with a 5% chain yield, and is present in old unseparated fission products. A problem with the data for this radionuclide came to attention of R. G. Helmer because the Radiation Measurement Laboratory, RML, at the INEL observed two problems with its γ-ray spectral analysis results that involved the $P_\gamma(80)/P_\gamma(133)$ ratio. The first problem was that for samples containing ^{144}Ce, the analysis program would determine the amount of ^{144}Ce from the 133-keV peak but, due to the use of a low value for this ratio, this amount of ^{144}Ce would not account for all of the 80-keV peak. Therefore, in order to account for the additional intensity, the analysis program would indicate that ^{133}Xe or ^{131}I, which have γ rays at 80 keV, could be present in the sample. The second problem occurred in the use of the measured intensities of the 80- and 133-keV peaks from a pure ^{144}Ce-^{144}Pr sources to determine the detector efficiency for two sample geometries, large volume liquid and point. These measurements were not successful because the $P_\gamma(80)/P_\gamma(133)$ ratio was too low. (This ratio had been generated from the information in the Table of Radioactive Isotopes and thus ultimately from ENSDF). The author was asked to investigate these two problems.

The author found a solution, sufficient to meet the immediate needs, by contacting the radionuclide metrology laboratories in the U. S. and Germany, NIST and PTB, respectively, and an evaluator in the United Kingdom (A. L. Nichols). As indicated in table 2, these contacts provided two more precise values which have not been published. Subsequent discussions also disclosed that the NCRP Handbook had used data from two additional references. Although a future evaluator must still consult with NIST and PTB about the uncertainties for their values and then determine how to weight the unpublished values, any new $P_\gamma(80)/P_\gamma(133)$ value should be higher, and thus presumably better, than the value currently in the NDS. This change in the ratio eliminated the two analysis problems.

In addition to the evaluation of P_γ values, consideration needs also to be given to the evaluation of half-lives. It is well known that the various measurements of half-lives for some isotopes give quite discrepant results; the usual examples are ^{137}Cs and ^{90}Sr. Because evaluators have different methods of dealing with discrepant data, they have reached different conclusions about the adopted value for these half-lives; this difference shows up most strikingly in the uncertainties that they assign. For these two radionuclides, such uncertainties differ by as much as a factor of 20. This variation is illustrated in table 3 where the evaluated half-lives for these two radionuclides and ^{154}Eu, for which the data are consistent, are given for several different averaging methods. For the first two method the values are weighted according to the uncertainties assigned by the measurer. In the last three methods the uncertainties are modified during the evaluation process. For ^{137}Cs the uncertainties range from 0.02 to 0.21 years, even excluding the weighted mean and its internal uncertainty of 0.01 years,

The evaluation of discrepant data is of sufficient interest that the Working Group on Non-Neutron Nuclear Data of the International Committee on Radionuclide Metrology, ICRM, recently held a workshop at the INEL on this topic (Helmer, the local coordinator, and Browne attended). The report on the workshop will be available early in 1993, and the contents will be useful in documenting the methodology to be used in future half-life evaluations.

So far, we have discussed the need for the half-life and the P_γ values for the strong γ-ray lines. These quantities are used by anyone who assays the radionuclide content of samples by means of γ-ray spectrometry. However, because of the possibility of interference between a weak line of one radionuclide and the strong line (from which the activity is to be determined) of another, the P_γ values of the weak lines are also important. This is illustrated by the above example of ^{144}Ce where its 80-keV line can interfere with the principal line from ^{133}Xe.

Another need for the data for all of the γ rays is that for measurements made in large-solid-angle geometries (the source very near to the detector), corrections should be made for the influence of coincidence summing. Currently, in almost all cases, this correction is ignored in applied spectrometry; often simply because it is inconvenient to make it. With the current availability of high-speed small computers, it is expected that in the future these corrections will be routinely made in applied analyses. To make this correction it is necessary to include in the decay data file (i) the energies of the levels fed in the β or α decay; (ii) the intensity of the β^+, β^-, electron capture, or α feeding of each level; (iii) the placement for each γ ray (i.e., the initial and final levels); and (iv) the total and K-shell internal-conversion coefficients for each γ ray. With these data the coincidence summing between the γ rays and the K x-rays, as well as between two γ rays, can be computed.

The Product

The product of a specialized horizontal evaluation of decay data for applied work should be a collection of well-evaluated decay schemes that are of interest in applied γ-ray spectrometry. This evaluation should include all the existing measured data, be of high quality and well documented, so it can be accepted as the authoritative source for these data. Its establishment as the authoritative data file will require good dissemination and availability.

This collection of data should be made available as a computer data file as well as in printed form. The printed form should include a discussion of the evaluation methodology used since this will be necessary in establishing the authoritativeness of the results. The computer file will be a useful mode for the distribution of the results to potential users. Although the printed document may, or may not, be up-dated and reissued regularly, the computer file could be reissued regularly.

The horizontal evaluation discussed here are not needed for most of the over 2000 known radionuclides. Such evaluations should be limited to those radionuclides with significance in applied work. Table 4 lists the 214 radionuclides included in the decay-data library used in the INEL Radiation Measurements Laboratory; this list provides a first approximation to the number of radionuclides that would be considered in a horizontal evaluation. Some of these nuclides will not need a new evaluation, but additional radionuclides for medical and other applications will need to be added. Thus, it seems reasonable to assume that an initial horizontal evaluation may involve at least 250 nuclides.

Methodology

The horizontal evaluation of decay data envisioned here should involve the steps given below.

1. Develop a list of radionuclides to be included, in consultation with groups working in applied γ-ray spectrometry.

2. Produce a computer file containing the measured half-lives and γ-ray emission probabilities.

3. Ascertain the status of the existing evaluations for these radionuclides and thereby determine the level of evaluation needed for each one.

4. Contact all of the metrology laboratories to inquire about unpublished data and contact data evaluation groups about any evaluation work in progress on these radionuclides.

5. Establish a uniform methodology for the evaluation of half-lives, γ-ray energies, emission probabilities, conversion coefficients, multipolarities, and α- and β-decay properties. Document procedures for analyzing discrepant data and determining the recommended values and their uncertainties.

6. Evaluate all existing experimental decay data, the related theoretical information (e.g., internal-conversion coefficients and fluorescence yields), and the information from other population modes of the daughter levels. Construct the evaluated decay schemes. Identify the major contributions to the uncertainties in the P_γ values and inconsistencies in the decay schemes. For the weak γ rays of many radionuclides, the data from ENSDF should be sufficient, after adjustment for consistency with the evaluated values for the strong γ rays. Adopted data from ENSDF may also be used.

7. For each decay scheme, consult with (a) the ENSDF evaluator for the corresponding A-chain, (b) other evaluation groups (e.g., AEA, United Kingdom; LPRI, France; PTB, Germany), and (c) metrology measurement laboratories to see if they have any suggestions for improvement. Make the unpublished data available to the compilers of the Nuclear Structure References, NSR, bibliographic database.

8. Contact groups who might be willing to make new and more precise measurements of half-lives and P_γ values where this would be especially useful.

9. Develop a data format for circulation of the periodically updated computer data file. This format needs to able to accommodate the data used for applications and be easily converted for use in commercial analysis programs.

10. Produce the evaluated decay data in publication form and generate the associated computer file. Provide evaluated data to ENSDF evaluators and other interested groups as listed in item 7.

11. Publicize the existence of the evaluated data. Request and encourage users to communicate with the authors any questions about, or problems with, the evaluations. Request suggestions from users regarding other radionuclides that should be included in any subsequent publication or update of the computer file.

12. Provide regular updates of the computer file, ascertain the usefulness of the evaluations, and decide on subsequent revisions and distributions.

Background of Authors

The following brief summary of the authors' backgrounds is included to indicate their credentials for preparing this plan and carrying out the outlined evaluation effort.

- all three are experienced evaluators of decay and nuclear structure data for ENSDF and the Nuclear Data Sheets;

- Helmer was a participant in data measurement and evaluation for two IAEA Coordinated Research Programs [5,6];

- Helmer has had regular professional contact with members of the decay data evaluation groups at LPRI (France) and AEA Technology (United Kingdom);

- Helmer was chairman of the Gamma- and Beta-Ray Spectrometry Working Group of ICRM, 1985 to 1991, and in 1991 was elected an associate member of ICRM;

- Helmer is a co-author of a book entitled Gamma- and X-Ray Spectrometry with Semiconductor Detectors (1988).

- Schmorak is experienced in evaluation of α-decay data;

- Browne has studied the problem of the proper assignment of uncertainties to P_γ values in the normalization process [7];

- Browne and Helmer are experienced in metrology measurements of γ-ray energies and emission probabilities;

- Browne is a principal author of the Table of Isotopes, 7th ed., John Wiley & Sons, Inc. (1978) and co-author of the Table of Radioactive Isotopes, John Wiley & Sons (1986).

Schedule

No detailed cost estimate is included; however, we would suggest that the initial evaluation effort might extend over a period of about two years, with updating and expanded coverage extending beyond that.

References

1. C. M. Lederer, draft of article, distributed to NSEWG and NDN members (November 1992).

2. R. G. Helmer, report distributed to NSEWG and NDN members (November 1992).

3. C. W. Reich, oral report to NSEWG and NDN meeting, notes provided to J. Cizewski (November 1992).

4. Extracted by R. G. Helmer from material presented by D. MacMahon at the ICRM evaluation workshop (October 1992).

5. "Decay Data of the Transactinium Nuclides", IAEA Technical Reports Series No. 261 (IAEA, Vienna, 1986).

6. "X-ray and gamma-ray standards for detector calibration", IAEA-TECDOC-619 (September 1991).

7. E. Browne, Nucl. Instr. and Meth. **A249**, 461 (1986) and Nucl. Instr. and Meth. **A265**, 541 (1988).

Table 1

P_γ for 1001-keV γ from ^{234m}Pa (1.2 m)

		P_γ(1001) %
Adopted values		
NDS **40** (1983)		0.59(8)
Table of Radioactive Isotopes		0.65(9)
Measurements		
Bjørnholm	1963	0.59
Gunnink	1971 lab report	0.83
Moss	1986	0.834(7)
Scott	1990	0.839(5)
Siemon	1992	0.845(21)

Table 2

P_γ Ratio for ^{144}Ce (284 d) Decay

Adopted values	$P_\gamma(80)/P_\gamma(133)$	From
NDS **56** 1989	0.123(5)	84Da13
Table of Radioactive Isot.	0.103(10)	
NCRP Handbook 1984	0.135(7)	77Ge12,81Yo02
NDS **27** 1979	0.102(10)	76Ch33
Other values listed in NDS		
NDS **56** and NDS **27**	none	
Values from other references listed in NDS 56 (1989)		
70An15	0.148(12)	
70Fa03	0.143(14)	
70Po09	0.16(1)	
Other values (quoted in 70Po09, 76Ch33, or NCRP Handbook)		
Geiger (from CE) 1960	0.148	
Løvhøiden 1965	0.22(4)	
Mangal 1969	0.22(2)	
Rao 1976	0.150(4)	
77Ge12	0.134(8)	
Yoshizawa 1981	0.136(4)	
Unpublished		
PTB	0.140(4)	
NIST	0.1379(7) •	

• This is probably not the entire uncertainty.

Table 3

Evaluation of half-lives (all values are in years). Data are from D. MacMahon [4].

Method	^{90}Sr	^{137}Cs	^{154}Eu
Weighted mean	28.56(2)	30.10(1)	8.593(4)
Bayesian	28.56(14)	30.10(3)	8.593(1)
IAEA-CRP	28.60(17)	29.93(21)	8.593(4)
Normalized residual	28.83(5)	30.06(3)	8.593(4)
Rajeval	28.80(3)	30.10(2)	8.593(4)
Number of measurements	9	18	5

Table 4

Radionuclides included in library for RML.

Nuclide	Half-life
^{7}Be	53 d
^{19}O	26 s
^{20}F	11 s
^{22}Na	2.6 y
^{24}Na	14 h
^{26}Al	720 ky
^{27}Mg	9.4 m
^{28}Al	2.2 m
^{31}Si	2.6 h
^{37}S	5.0 m
^{38}Cl	37 m
^{40}K	1.2 Gy
^{41}Ar	1.8 h
^{42}K	12 h
^{46}Sc	83 d
^{47}Ca	4.5 d
^{47}Sc	3.3 d
^{48}Sc	1.8 d
^{49}Ca	8.7 m
^{51}Ti	5.7 m
^{51}Cr	27 d
^{52}V	3.7 m
^{54}Mn	312 d
^{55}Fe	2.7 y
^{56}Mn	2.5 h
^{56}Co	77 d
^{57}Co	271 d
^{58}Co	70 d
^{59}Fe	44 d
^{60}Co	5.2 y
^{64}Cu	12 h
^{65}Ni	2.5 h
^{65}Zn	244 d
^{66}Cu	5.1 m
^{69}Zn	13 h
^{70}Ga	21 m
^{71}Zn	3.9 h
^{72}Ga	14 h
^{75}Ge	1.3 h
^{75}Se	119 d
^{76}As	1.0 d
^{77}Ge	11 h
^{80}Br	17 m
^{82}Br	1.4 d
^{83}Br	2.3 h
^{84}Br	31 m
^{85}Kr	4.4 h
^{85}Kr	10 y
^{85}Sr	64 d
^{86}Rb	18 d
^{87}Kr	1.2 h
^{88}Kr	2.8 h
^{88}Rb	17 m
^{88}Y	106 d
^{89}Kr	3.1 m
^{89}Rb	15 m
^{90}Kr	32 s
^{90}Y	3.1 y
^{91}Sr	9.5 h
^{91}Y	49 m
^{91}Y	58 d
^{92}Sr	2.7 h
^{92}Y	3.5 h
^{92}Nb	10 d
^{93}Y	10 h
^{93}Nb	13 y
^{94}Y	18 m
^{94}Nb	20 ky
^{95}Y	10 m
^{95}Zr	64 d
^{95}Nb	3.6 d
^{95}Nb	34 d
^{97}Zr	16 h
^{97}Nb	1.2 h
^{98}Nb	51 m
^{99}Mo	2.7 d
^{99}Tc	6.0 h
^{101}Mo	14 m
^{101}Tc	14 m
^{103}Ru	39 d
^{103}Rh	56 m
^{103}Pd	16 d
^{105}Ru	4.4 h
^{105}Rh	1.4 d
^{105}Rh	45 3
^{106}Rh	29 s
^{108}Ag	127 y
^{109}Pd	13 h
^{109}Cd	1.2 y
^{110}Ag	249 d
^{113}Sn	115 d
^{115}Cd	2.2 d
^{115}Cd	44 d
^{115}In	4.4 h
^{116}In	54 m
^{117}Sn	13 d
^{122}Sb	2.7 d
^{123}Sn	129 d
^{123}Te	119 d
^{124}Sb	60 d
^{125}Sn	9.6 d
^{125}Sb	2.7 y
^{125}Te	58 d
^{126}Sb	12 d
^{127}Sb	3.8 d

Table 4 continued

Nuclide	Half-life	Nuclide	Half-life	Nuclide	Half-life
^{127}Te	9.3 h	^{141}Ce	32 d	^{188}Re	16 h
^{127}Te	109 d	^{142}Ba	10 m	^{191}Os	15 d
^{127}Xe	36 d	^{142}La	1.5 h	^{192}Ir	73 d
^{128}I	24 m	^{142}Pr	19 h	^{194}Ir	19 h
^{129}Te	1.1 h	^{143}Ce	1.3 d	^{197}Pt	18 h
^{129}Te	33 d	^{144}Ce	284 d	^{197}Hg	2.6 d
^{129}I	15 My	^{144}Pr	7.2 m	^{198}Au	2.6 d
^{130}I	12 h	^{144}Pr	17 m	^{199}Pt	30 m
^{131}Te	1.2 d	^{145}Pr	5.9 h	^{199}Au	3.1 d
^{131}Te	25 m	^{147}Nd	10 d	^{203}Hg	46 d
^{131}I	8.0 d	^{147}Pm	2.6 y	^{208}Tl	3.0 m
^{131}Xe	11 d	^{149}Nd	1.7 h	^{210}Pb	22 y
^{131}Ba	11 d	^{152}Eu	9.3 h	^{212}Pb	10 h
^{132}Te	3.2 d	^{152}Eu	13 y	^{212}Bi	1.0 h
^{132}I	2.2 h	^{153}Sm	1.9 d	^{214}Pb	26 m
^{133}I	20 h	^{153}Gd	241 d	^{214}Bi	19 m
^{133}Xe	2.1 d	^{154}Eu	8.8 y	^{226}Ra	1.6 ky
^{133}Xe	5.2 d	^{155}Sm	22 m	^{228}Ac	6.1 h
^{133}Ba	10 y	^{155}Eu	4.9 y	^{228}Th	1.9 y
^{134}I	52 m	^{156}Eu	15 d	^{229}Th	7.3 ky
^{134}Cs	2.0 y	^{160}Tb	72 d	^{232}Th	14 Gy
^{135}I	6.5 h	^{165}Dy	2.3 h	^{232}U	68 y
^{135}Xe	9.1 h	^{166}Ho	1.2 ky	^{233}Pa	27 d
^{135}Xe	15 m	^{169}Yb	32 d	^{234}Th	24 d
^{136}Cs	13 d	^{170}Tm	128 d	^{234}Pa	1.1 m
^{137}Xe	3.8 m	^{171}Er	7.5 h	^{234}U	245 ky
^{137}Cs	30 y	^{175}Yb	4.1 d	^{235}U	703 My
^{138}Xe	14 m	^{175}Hf	70 d	^{238}Pu	87 y
^{138}Cs	32 m	^{177}Lu	6.7 d	^{239}Np	2.3 d
^{139}Xe	39 s	^{177}Lu	160 d	^{239}Pu	24 ky
^{139}Cs	9.2 m	^{180}Hf	5.5 h	^{240}Pu	6.5 ky
^{139}Ba	1.4 h	^{180}Ta	8.1 h	^{241}Pu	14 y
^{139}Ce	137 d	^{181}Hf	42 d	^{241}Am	432 y
^{140}Ba	12 d	^{182}Ta	115 d	^{243}Am	7.3 ky
^{140}La	1.6 d	^{183}Ta	5.1 d	^{244}Cm	18 y
^{141}Ba	18 m	^{185}Os	93 d		
^{141}La	3.9 h	^{187}W	23 h		

Online-Service Statistics

(Sep. 30, 1993)

- Users:

  No. of accounts=879 (71% US)

  No. of names=1153 (74% US)

- Retrievals:

  No. of retrievals=35319 in 20842 runs

  NSR=12373

  NUDAT=8359

  ENSDF=4941

AIIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

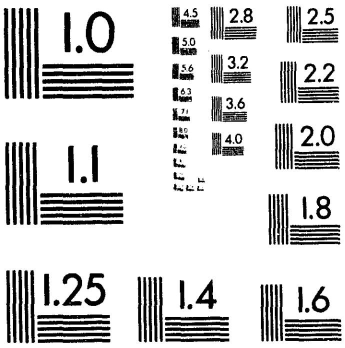
301/587-8202

Centimeter

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 mm

1 2 3 4 5

Inches



MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

Online-Service Statistics

(Sep. 30, 1993)

- Retrievals:

  ENDF=4466

  CSISRS=3288

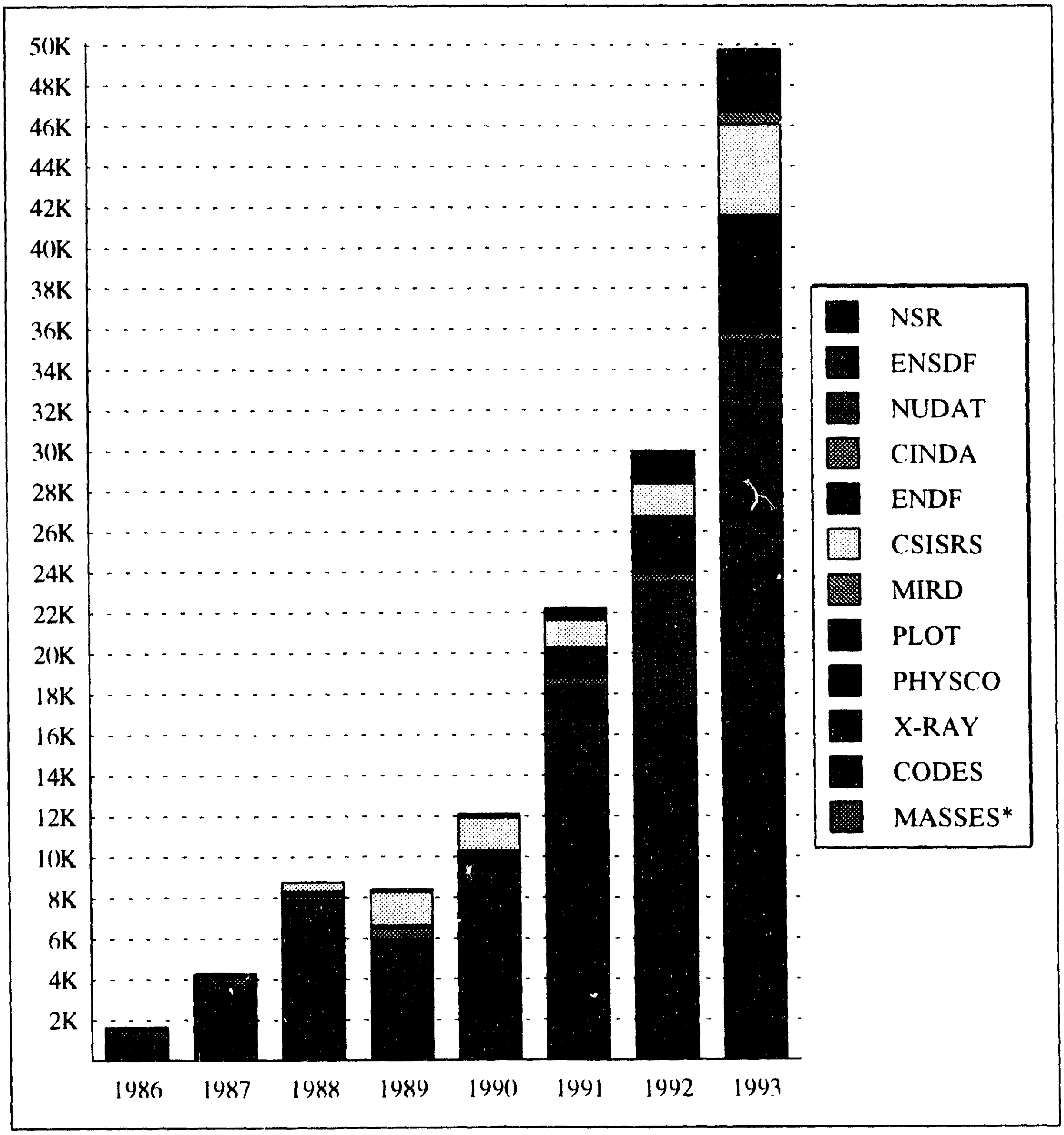
  PLOT=592

  XRAY=576

  MIRD=358

  PHYSCO=83

NNDC On-Line Data Service Retrievals 1986-1993



** Added November, 1993*

Online-Service Enhancements

- Short term
  - Wapstra Masses
  - Reaction Q value

- Long term
  - Reexamine human engineering aspects of user interface

Online-Service

- ACCESS
  NNDC MAJOR FOCAL POINT FOR
  INFORMATION DISSEMINATION
  ACCESS 24 HOURS A DAY
  SEVEN DAYS A WEEK
  VERY LITTLE DOWN TIME

Online-Service Prospects

- Huge Govt. Investment in
  Information Super-highways
  New Technology to extend transmission rate
  from Mega-byte/sec to Giga-byte/sec
  via ATM (Asynchronous Transfer Mode)

Online-Service Prospects

- Investments by Utilities
  (Baby Bells, Cable and Power Cos.) in
  Multi-media (Video, Voice, Data)
  developments to Bring info to our homes

Online-Service Prospects

- Experiments with ATM
  at BNL, Grumman, Stony Brook,
  NYNEX
  Areas of Medical, Video tele-conferencing

ENSDF - Retrievals

- **ENSDF**

  -From Archive or in Review

  -By Z (element name), A, or ZA

  -Specific experiment

  -Output as computer file,

  -Decay/Level Scheme, Tabular

- **NUDAT**

  -From ENSDF, Wallet Cards, ENDF

  -By Z (element name), A, or ZA

  -Levels or Gammas or Both

  -Many Retrieval Criteria

Attachment 12

The MacNuclide Project

Craig A. Stone
Department of Chemistry
San Jose State University, San Jose, CA 95192-0101

We completed the first release version of MacNuclide during this last year. Capabilities in version 1.0 now include simple data base searching, capabilities of combining results of several searches using boolean logic, calculations of Q-values for any reaction and separation energies for any emitted particle. Custom nuclide charts can be automatically generated using a new feature that chooses optimum ranges of values for a selected nuclear property, searches for nuclides that fall within these ranges, and then applies the results of the searches to the chart. Multiple charts can now be created and saved to disk. Properties of a nuclide are displayed by clicking on the box for a particular nuclide in the chart. An interactive skeleton level scheme displays basic properties and provides a method of accessing additional information. Neutron, proton, and nucleon numbers are changed by clicking on the appropriate number and adding or subtracting a value. Clicking on the decay arrow displays a list of functions such as "Move To Daughter" and "Display Daughters", providing relational information about the nuclide. To the right of the skeleton level scheme is a tabular listing of all properties known about the ground state and any isomeric states for that nuclide. We intend to distribute MacNuclide through a software publisher and the target release date is January 1.

We have begun to develop features for the second version of MacNuclide. A systematics editor is under construction and will display any collection of nuclides as a series of level schemes. Isomeric states, Q-values, separation energies, and level data input from text files can be currently displayed in these systematics. Clicking on a nuclide within this systematics plot displays the full level scheme for that nuclide. We are in the process of importing the ENSDF data base into MacNuclide. Information on excited states and their decay will be first supported by existing level scheme and systematics displays. Levels and transitions can be colored or hidden to emphasize certain features. Some advanced features will include logical grouping of levels both within a nuclide and across several nuclides, and a "rubber banding" function to create a custom grouping of levels or transitions. We plan to have incremental releases of MacNuclide as these features are implemented.

Attachment 13

Expanding the Scope of the Nuclear Structure Reference file

U.S. Nuclear Data Network Meeting

Asilomar Conference Grounds

19 October 1993

Peter Ekström

Lund, Sweden

What?

Why now?

How?

On-line/CD-ROM

FTP updates

Keywording/selectors

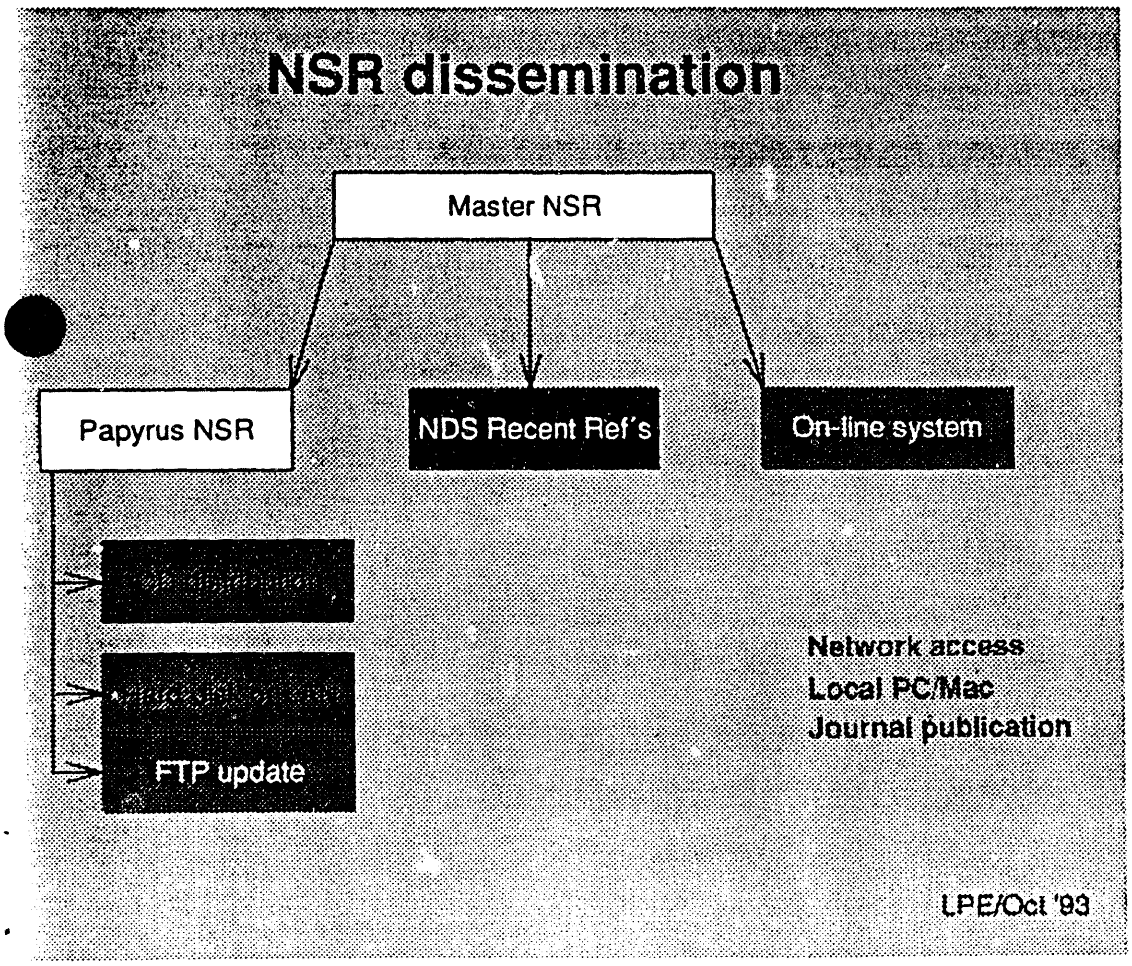
What?

What do we want to achieve with the NSR?

- **A *good* product that is recognised as such**
- **A *useful* product**
- **A *widely used* product**

Why now?

- New distribution media available
- The need for *one* master file



Basic assumptions

- Recognise that the foundation of science is published work and that effort spent in making this more accessible is a good investment
- The professional scanning/keywording makes the NSR unique in science
- The need for one master NSR for several distribution media

Conclusion:

Consider putting more resources into the NSR

Why new distribution media?

- Greater flexibility
- Greater choice

will lead to

- Greater use

Use of the file

- For mass-chain evaluation
- To obtain up-to-date information on nuclides or reactions (updating NDS) for:
  - Planning experiments
  - Referee reports
  - Comparison with theory

Note that the importance of the NSR is proportional to the outdatedness of ENSDF

Not possible today:

- Searches on topics not entered
- Searches on topics (words) without selectors
- Locating a paper with little information (J Bloggs wrote a good paper in Phys. Rev. about a year ago)
- Making reference lists/publication lists with flexible formats
- On-line decoding of key numbers from ENSDF-PC/Mac applications

How?

Structure of the file

- Essentially unchanged since the 1960's
- Card-images
- Field identifiers

No absolute need to restructure the file since there is virtually no cross-referencing (as *is* the case for ENSDF).

Stricter checking

- Reference field (volume, issue, page number) in a stricter format
    - Consistent journal names and abbreviations
    - Consistent use of separators

      Nucl. Phys. A222, 111 (1988)

      Nucl. Phy. A222 111(1988)
- Consistent author names (virtually impossible)
    - Transcription of names (Russian, Chinese etc.)
    - Inconsistency of names
- Check that the same article is not entered twice (with different Keynos)

What to do?

- Filter program and manual editing (analogous with FMTCHK for ENSDF)
- Scan for duplicates before adding a reference (note that once a Keyno has been published the reference can not be deleted)

CD-ROM/On-line access

Both means of dissemination have advantages - both means should be used

On-line system

- \+ Easy to keep up to date
- \+ Requires only terminal with network access
- – Difficult to use
  - High threshold to learn syntax
  - Network knowledge required
  - Authorisation required
- – Sometimes slow/sometimes down

CD-ROM distribution with commercial software

- \+ Easy to use
- – Requires PC/Mac
- – Slow if run directly from CD-ROM
  - Copy to hard disc or LAN (see below)
- – Difficult to keep up to date
  - FTP network update

Access via Local Area Network (LAN)

Required: Any LAN system with file/disk service, e.g.

DEC PathWorks, Novell Netware, Windows for Workgroups ....

- \+ Easy to use

References/subjects included

Coverage for properties of nuclei, decays and reactions is almost 100% for published articles.

These subjects are also very well keyworded.

Missing subjects

- General theory (Phys. Rev C, Nucl. Phys A, approx. 20%)
- Experimental methods and apparatus (NIM A, approx 100%)
- Applications

First • a good start

What to do?

- Include *all* articles in core nuclear physics journals
  - Only include Reference, Authors, Title and Keyno (many examples already)
  - Include abstract

    New major topic THEORY

    Abstract field
- To compensate for this extra work discontinue the keywording of abstracts like BAPSA - they never contain any useful information anyway

Introduce new selectors

Recently introduced selectors

- SUP-DEF
- HYP-DEF

are not entered consistently.

Introduce new keywords as a subject is evaluated or becomes of major interest (as was done for superdeformation).

Keywording/selectors

- 14989 references from ≥ 1988
  Papyrus to search Title and Keyword abstract

SELECTOR: *SUP-DEF*

	Selector	No Selector	Sum
Selector	255		255
superdeform*	255	8	263

- SELECTOR: *SPALLATION*

	Selector	No Selector	Sum
Selector	6		6
spallation	6	13	19

- SELECTOR: *TWO-B--DECAY*

	Selector	No Selector	Sum
Selector	147		147
Double beta decay	98	16	114
2 beta decay	56	4	60
two beta decay	6	0	6
beta beta decay	28	8	36
Sum	137	21	158

+ Relatively easy to keep up to date

Possibly nationwide with Al Gore´s computer superhighways?

ENSDAT

Evaluated Nuclear Structure Drawings And Tables

- Input is a text file in the ENSDF format.
- Output is a PostScript file.
- Tables and drawings are shown together for each dataset processed.
- Layout of the tables and drawings is automatic.
- All keynumbers used are listed (PC) or used to create reference pages (NNDC-VAX).

PROS

- Easy to use.
- Typeset quality output.
- All codes are translated and the text is edited to be in upper and lower case.

CONS

- Must have access to a Postscript printer or display.
- A PostScript emulater must be 100% PostScript (GhostScript will not do).

TO DO LIST

- Provide output compatible with GhostScript if possible.
- Reduce the size of the output file.

Attachment 15

Cross Section Evaluation Working Group (CSEWG)

Organized: 1966

Purpose: Provide evaluated nuclear reaction data for reactor development & other applications

Membership: Data measurers, evaluators & testers from National Labs., Industry & Academic Institutions

Product: ENDF/B, Versions I-VI, Processing & Other Codes

Methodology: 1. Evaluations based on microscopic data, 2. Data testing, which points out improvements needed and suggest 3. New measurements which lead to step 1 and a repetition of the cycle.

CSEWG Strategy Session
(Oct. 6, 1993)

Questions asked in order to develop a long-term CSEWG:

What are the goals of CSEWG? Is it still viable? Should it be re-organized?

Who are the users? Are their needs being met? Should CSEWG develop a closer association with them? How best to market CSEWG & ENDF/B-VI?

What is the role of CSEWG in foreign evaluation co-operation?

Conclusion: Evolve to survive

Attachment 16

A Draft Proposal

For A

USNDN Program Advisory Council

1. **Membership:**

   To be formed by about 5-7 persons designated by the sponsoring agency who will become members of an expanded USNDN for the duration of their tenure.

2. **Scope:**

   a. Provide user input to the USNDN for more effective use of nuclear structure and decay data evaluated by the NSDD/USNDN.

   b. Scrutinize, approve or suggest proposals to the USNDN to provide better user services.

   c. Co-ordinate proposals approved by the USNDN/Advisory Council, set completion goals, and assign projects to USNDN members to avoid duplication of effort.

   d. Monitor A-chain evaluations and projects assigned to the USNDN members in a collegial manner to provide the funding agency an annual progress report.

Attachment 17

Recommendations of Focus Group 1

October 19, 1993

M. R. Bhat
L. P. Ekstrom
R. G. Helmer
J. Z. James
B. Singh
J. Zipkin

1. Marketing:

A. Provide pre-processed ENSDF in a form suitable for:

i. Nuclear medicine

ii. Activation analysis

iii. Assay of radioactive materials by utilities/enviornmental users

2. Tools/products:

B. Obtain user feedback on a continuing basis

C. For basic research provide:

i. High spin data

ii. Adopted properties in a convenient form

3.Management/Re-Organization:

A. Executive Committee: We approve the formation of an Executive Committee as proposed by J. Dairiki

B. User group: We approve the formation of a User Group-the membership, scope have to be determined.

Recommendations of Focus Group 2

October 19, 1993

J. A. Cizewski
R. B. Firestone
J. D. Garrett
M. J. Martin
L. K. Peker
C. A. Stone
H. R. Weller

Management/Organization:

This focus group approves the concept of an executive committee to solve the leadership vacuum and to stimulate interactions with the broader community. This group did feel that in the long term a single strong leader is needed, who is accepted and supported by the network and the users.

Users' Needs:

While it is relatively straightforward to identify the basic nuclear structure users, answers to the questions- who constitute the larger community of users and what are its needs- remain to be studied. It was suggested that lists of contacts in the "applied" communities be generated. The Executive Committee would collate these lists and co-ordinate the contacts. The Executive Committee would also generate recommendations to start to address these needs in the "short term".

Recommendations of Focus Group 3

October 19, 1993

Y. A. Akovali
R. M. Chasteler
F. Chu
J. M. Dairiki
R. R. Kinsey
L. D. Mumaw
V. S. Shirley

1. User needs:

Who are our present users? Those known to us are primarily nuclear physics/ nuclear structure users.

How to identify potential users and determine their needs? We need to go out to users; to society meetings, etc. with a product tailored to that particular community.

2. Tools/products:

We need focussed development for a particular user community with easy, immediate access.

We also need a true data base with electronic accessibility; including level schemes on screen. We should also explore possibilities of video conferencing.

3. Marketing:

We need a product to show and a distribution system for products. We need to insure that the Network and the individual evaluators get proper credit for products/data. We could consider hiring a professional marketing agency to determine the market. It was also suggested that we could use a page insert in the Nuclear Data Sheets, Table of Isotopes, and Physics Today to inform users of new products/developments. We should work with publishers to identify market, users and issues.

4.Management Organization:

We recommend:

A. Formation of an Executive Committee of 4 people to assume the leadership of the network for the next year. The Committee should be composed of 3 people from the data centers plus the chairman of the users' group (could have rotating/staggered terms). It is important that all data centers have input/communication with the Executive Committee.

B. Formation of a Users' Group of 8-10 persons who are representatives from different societies/organizations (which remain to be identified). This group will meet annually to provide advice to the Executive Committee. Suggested names for this group included:

NUDE–Nuclear Users Data Exchange

RUN– Representatives of Users of Nuclear Data

Recommendations of Focus Group 4

October 19, 1993

C. M. Baglin
E. Browne
C. W. Reich
J. K. Tuli
S. L. Whetstone

1. Tools Needed:

A. Data Bases:

- We will continue to need computerized data bases, e.g., ENSDF, NSR, and derived data bases, e.g., NUDAT. These should be regularly updated and maintained, at least at current levels.
- We should explore the need for data bases for applied users, e.g., radiobiological and environmental data bases which will satisfy the needs of the medical, health physics, and environmental sciences. The radiobiological data base, for example, could show the human organs affected by the biological half-lives of ingested radioactive material.
- Data bases should be accessible both via computer networks and table-top computers.
- Search capability for these data bases is needed. The current capabilities should be strengthened.
- We should endeavor to have a better human-engineered interface for access to the data bases.

B. Software:

- Present programs which work on these data bases should be maintained.
- Software which could use data bases to derive quantities for specific applications should be developed.

- We should have good quality manuals for software produced by the network.

2. **Products/services:**

   - We should have the capability to view the data on-screen and in published form.
   - Evaluations in the ENSDF should continue to be published in the Nuclear Data Sheets.

3. **Others:**

   - Publicity: A professionally designed brochure in color advertising the network's products and services should be developed.
   - Improving currency: We should identify nuclides with new information and code this information into the ENSDF. High-priority effort should be directed at bringing new high-spin data into the ENSDF.
   - Applied users: We should identify special groups and their needs, e.g., in Nuclear Medicine, Health Physics, Reactor clean up, and others who will benefit from our services.

The *Table of Isotopes*

R.B. Firestone, V.S. Shirley, F. Chu, J. Zipkin
and J.Z. James

Isotopes Project, Lawrence Berkeley Laboratory
October 19, 1993

Progress on three Formats:

- Printed 8th edition for 1994
- Enhanced CD-ROM yearly updates
- Electronic *Table of Isotopes* for the future

8th Edition of the *Table of Isotopes*

- First draft completed - Summer, 1993
- Second drafts for A=1-146
- Limited updating

  1993 Audi-Wapstra Masses
  Superdeformed Bands
  Revised natural abundances
  Thermal Neutron Cross-sections
  Raghavan moments
  Delayed-particle data
  Updated isotope list

- Standardization of presentation

  Nuclear band names
  Consistent parent/level properties
  Numbers and limits
  Decay scheme properties

Publication Considerations

- 3000 pages require two volumes

  Option 1: two volumes by mass number
  Option 2: decay and reaction volumes

- Completion in 1994

$^{100}_{37}$Rb Option 1 (All data)

Δ:(−46700) S_n:(3800) Q_{β^-}:(13100)

Populating Reactions and Decay Modes

Fission (78Ko29, 79Az01, 79Pe01, 82Kr11, 83Ly01, 83Ly03, 83Ly06, 84LyZW, 86RaZG, 86Wa17)

Levels:

0, 51 8 ms, %β^-=100, %β^-n=6 3, %β^-2n=?

γ(^{100}Sr) from ^{100}Rb (51 ms) β^- decay:

129.2 5 (†γ100), **288.4** 5 (†γ36).

γ(^{99}Sr) from ^{100}Rb (51 ms) β^-n decay:

90.5 (†γ28), **120.8**(u) (†γ15).

γ(^{98}Sr) from ^{100}Rb (51 ms) β^-2n decay:

144.6(?).

$^{100}_{38}$Sr

Δ:−59780 160 S_n:5640 210 S_p:16090 200 Q_{β^-}:7520 140

Populating Reactions and Decay Modes

A ^{100}Rb β^- decay (78Ko29, 79Az01, 79Pe01, 80JuZY, 82Kr11, 83Ly01, 83Ly03, 83Ly06, 84Pa19, 86Wa17)

B ^{101}Rb β^-n decay (88PIZZ)

Levels and γ-ray branchings:

0, 0^+, 202 3 ms, [A], %β^-=100, %β^-n=0.73 3

129.2 5, (2^+), 5.15 20 ns, [A] γ_0**129.25** (†γ100)

417.6 7, (4^+), [A] γ_{129}**288.45** (†γ100)

γ(^{100}Y) from ^{100}Sr (202 ms) β^- decay < for Iγ% multiply by 0.22 1 >

10.683 (†γ44 4) E1, **65.463** (†γ69 5) M1(+E2):δ<0.1, **66.06** (†γ1.11 15), **88.503** (†γ6.4 3), **95.914** (†γ3.68 25), **95.944** (†γ3.13 16), **99.203** (†γ5.75 25), **107.43** 11 (†γ0.48 7), **114.865** (†γ0.88 6), **127.65** 11 (†γ0.13 2), **181.173** (†γ2.46 12), **195.013** (†γ15.9 7), **204.118** (†γ0.26 4), **233.774** (†γ1.84 10), **240.648**(?) (†γ0.77 7), **256.634** (†γ2.01 10), **276.906** (†γ0.94 9), **285.118** (†γ0.39 6), **288.73** (†γ0.04 1), **299.035** (†γ5.6 4), **299.706** (†γ1.10 7), **309.686** (†γ3.75 22), **311.62** 19 (†γ0.28 6), **365.314** (†γ3.22 17), **376.987** (†γ1.58 11), **384.55** 14 (†γ0.42 7), **407.438** (†γ0.52 6), **466.466** (†γ2.61 17), **473.33** 15 (†γ0.80 12), **484.778** (†γ1.41 12), **505.098** (†γ1.04 9), **518.676** (†γ3.07 17), **526.728** (†γ0.36 6), **539.648** (†γ0.71 9), **550.45** 19 (†γ0.33 6), **562.08** 18 (†γ0.13 3), **564.567** (†γ0.96 7), **581.266** (†γ1.65 10), **602.959** (†γ2.00 17), **622.47** 11 (†γ0.78 9), **633.04** 10 (†γ0.39 4), **655.87** 11 (†γ0.44 7), **657.849** (†γ1.01 10), **665.458** (†γ0.92 9), **723.336** (†γ3.4 3), **762.066** (†γ2.9 3), **861.02** 11 (†γ1.81 20), **873.90** 14 (†γ0.44 9), **875.45** 11 (†γ1.56 17), **898.504** (†γ86 4), **951.46** 16 (†γ0.38 6), **963.854** (†γ100 4), **964.578** (†γ3.2 3), **969.02** 21 (†γ0.26 6), **1003.04** 11 (†γ1.15 22), **1069.246** (†γ2.97 22), **1073.318** (†γ2.04 12), **1183.90** 17 (†γ0.36 10), **1240.12** 14 (†γ1.54 16), **1241.66** 19 (†γ0.87 15), **1280.08** 17 (†γ0.71 17), **1302.89** 16 (†γ0.54 7), **1313.70** 10 (†γ1.25 9), **1379.25** 15 (†γ1.88 22), **1401.24** (†γ0.77 20), **1623.78** 10 (†γ2.12 13), **1689.61** 25 (†γ0.57 16).

$^{100}_{39}$Y

Δ:−67300 80 S_n:5160 100 S_p:12380 150 Q_{β^-}:9310 70

Populating Reactions and Decay Modes

A ^{100}Sr β^- decay (78Ko29, 81DeYV, 83Mu19, 84Pa19, 85IaZZ, 85Mu07, 86Pe04, 86Wa17, 86Wo01, 87Wo07, 89WaZV)

B ^{101}Sr β^-n decay (86Wa17, 88PIZZ)

Levels and γ-ray branchings:

0, 1^-,2^-, 735 7 ms, [A], %β^-=100, %β^-n=0.81 4

0+x, (3,4,5), 0.94 3 s, %β^-=100

10.70 2, 1^+, [A] γ_0*10.683* (†γ100) E1

76.15 3, $(2)^+$, 72 7 ps, [A] γ_{11}*65.463* (†γ100) M1(+E2): δ<0.1

99.16 2, [A] γ_{11}*88.503* (†γ100 5) γ_0*99.203* (†γ90 4)

172.03 4, (3^+), [A] γ_{76}*95.944* (†γ100)

194.98 2, (1^+), [A] γ_{99}*95.914* (†γ23 2) γ_0*195.013* (†γ100 5)

309.83 3, [A] γ_{195}*114.865* (†γ16 1) γ_{76}*233.774* (†γ33 2) γ_{11}*299.035* (†γ100 7) γ_0*309.686* (†γ67 4)

355.75 4, [A] γ_{99}*256.634* (†γ100)

376.07 3, [A] γ_{310}*66.06* (†γ34 5) γ_{195}*181.173* (†γ76 4) γ_{172}*204.118* (†γ8 1) γ_{99}*276.906* (†γ29 3) γ_{76}*299.706* (†γ34 2) γ_{11}*365.314* (†γ100 5)

483.58 5, [A] γ_{376}*107.43* 11 (†γ92 13) γ_{356}*127.65* 11 (†γ25 4) γ_{195}*288.73* (†γ8 2) γ_{172}*311.62* 19 (†γ54 12) γ_{99}*384.55* 14 (†γ81 14) γ_{76}*407.438* (†γ100 12)

698.71 8, [A] γ_{172}*526.728* (†γ58 10) γ_{76}*622.47* 11 (†γ100 12)

734.03 6, [A] γ_{172}*562.08* 18 (†γ14 1) γ_{76}*657.849* (†γ30 3) γ_{11}*723.336* (†γ100 9)

776.24 5, [A] γ_{310}*466.466* (†γ100 7) γ_{195}*581.266* (†γ63 4)

827.97 8, [A] γ_{195}*633.04* 10 (†γ89 9) γ_{172}*655.87* 11 (†γ100 16)

849.45 8, [A] γ_{376}**473.33** 15 (†γ100 15) γ_{310}**539.648** (†γ89 11)

860.60 4, [A] γ_{484}**376.987** (†γ100 7) γ_{376}**484.778** (†γ89 8) γ_{356}**505.098** (†γ66 6) γ_{310}**550.45** 19 (†γ21 4) γ_{195}**665.458** (†γ58 6)

861.19 6, [A] γ_{99}**762.066** (†γ100 10) γ_0**861.02** 11 (†γ62 7)

974.60 4, 1^+, [A] γ_{99}**875.45** 11 (†γ1.6 2) γ_{76}**898.504** (†γ86 4) γ_{11}**963.854** (†γ100 4)

1045.70 13, [A] γ_{172}**873.90** 14 (†γ100 20) γ_{76}**969.02** 21 (†γ59 14)

1146.33 9, [A] γ_{861}**285.118** (†γ100 15) γ_{195}**951.46** 16 (†γ97 15)

1149.46 9, [A] γ_{76}**1073.318** (†γ100)

1340.74 6, [A] γ_{776}**564.567** (†γ30 2) γ_{376}**964.578** (†γ100 9) γ_{99}**1241.66** 19 (†γ27 5)

1379.16 4, (1^+), [A] γ_{861}**518.676** (†γ100 6) γ_{776}**602.959** (†γ65 6) γ_{376}**1003.04** 11 (†γ37 7) γ_{310}**1069.246** (†γ97 7) γ_{195}**1183.90** 17 (†γ12 3) γ_{99}**1280.08** 17 (†γ23 6) γ_{76}**1302.89** 16 (†γ18 2) γ_0**1379.25** 15 (†γ61 7)

1389.85 11, [A] γ_{1149}**240.648**(?) (†γ62 6) γ_{76}**1313.70** 10 (†γ100 7)

1412.14 14, [A] γ_{172}**1240.12** 14 (†γ100 10) γ_{11}**1401.24** (†γ50 13)

1699.99 10, [A] γ_{76}**1623.78** 10 (†γ100 6) γ_{11}**1689.61** 25 (†γ27 8)

γ(^{100}Zr) from ^{100}Y (0.94 s) β^- decay:

118.65(?) (†γ52) E2, **212.53** 19 (†γ100) E2, **331** 1(?) (†e7.4 15) E0, **351.960** 12 (†γ33 4), **665.85**(?) (†γ13 3), **878.15**(?) (†γ18 3), **1096.75**(?) (†γ4 2), **1195.55**(?) (†γ52).

γ(^{100}Zr) from ^{100}Y (735 ms) β^- decay < for Iγ% multiply by 0.73 10 >

118.597 (†γ21.1 12) E2, **212.53** 19 (†γ100 6) E2, **244.80** 8 (†γ0.75 6), **314.33** (†γ0.09 3), **317.82** (†γ0.20 4), **331.13** 5 (†e16 5) E0, **351.960** 12 (†γ1.73 11), **416.01** 11 (†γ0.34 4), **496.88** 13 (†γ1.19 17), **512.60** 7 (†γ0.24 7), **547.377** (†γ2.8 4), **611.60** 11 (†γ0.68 7), **616.677** (†γ9.4 6), **631.848** (†γ1.1 1), **643.43** 12 (†γ0.58 8), **665.987** (†γ10.6 6) (M1+E2):δ=+1.0 3, **741.997** (†γ6.0 4), **754.54** 23 (†γ0.39 9), **832.64** 10 (†γ0.90 7), **865.058** (†γ3.2 2), **878.548** (†γ5.5 4), **885.18** 11 (†γ0.99 9), **908.09** 12 (†γ0.62 7), **919.34** (†γ0.19 5), **978.37** 12 (†γ0.95 9), **983.598** (†γ1.7 2), **1038.68** 12 (†γ0.83 15), **1059.51** 7 (†γ8.7 6), **1082.338** (†γ3.4 3), **1109.13** (†γ1.0 3), **1110.53** (†γ1.0 3), **1185.83**(?) (†γ0.36 7), **1196.087** (†γ5.0 3), **1228.998** (†γ2.1 2), **1329.64** (†γ0.27 7), **1441.23** (†γ0.45 9), **1476.53** 14 (†γ1.74 18), **1551.42** (†γ1.12 13), **1595.16** 17 (†γ2.4 3), **1608.0**(?) (†γ1.5), **1637.03** (†γ0.64 10), **1670.83**(u) (†γ0.83 11), **1725.44** 16 (†γ0.93 15), **1750**(u?) (†γ1.0), **1807.92** (†γ1.6 3), **1814.96** (†γ0.29 9), **1891.82** (†γ2.3 3), **1937.93** (†γ0.97 12), **2017.03** (†γ1.04 10), **2182.35** (†γ0.43 11), **2240.52** (†γ1.80 16), **2375.3** 10 (†γ0.21 11), **2396.23** (†γ1.26 14), **2439.39** 18 (†γ9.1 7), **2469.63**(u) (†γ1.45 14), **2480.17** 17 (†γ4.7 4), **2515.13** 14 (†γ8.4 5), **2557.84** (†γ0.56 9), **2600.95** 18 (†γ6.1 4), **2633.73** (†γ1.10 14), **2692.64** (†γ0.32 9), **2719.23** (†γ1.09 13), **2728.05** (†γ0.48 12), **2738.65** (†γ0.33 10), **2770.43** (†γ7.8 6), **2846.22** (†γ5.8 4), **2932.13** (†γ3.7 3), **2980.85**(u) (†γ0.42 10), **3359.24** (†γ1.14 14), **3571.84** (†γ0.87 11), **3743.95** (†γ0.66 11), **3956.85** (†γ0.74 10), **4075.84** (†γ0.52 9), **4288.16** (†γ0.23 7).

γ(^{99}Zr) from ^{100}Y (735 ms) β^-n decay:

121.828 (†γ1.28 14).

$^{100}_{40}$Zr

Δ:−76610 40 S_n:6890 50 S_p:13680 80 Q_{β^-}:3335 25

Populating Reactions and Decay Modes

A ^{100}Y β^- decay (735 ms) (77Kh03, 78Kh01, 78Se03, 79Bo26, 80Wo09, 81Al25, 81DeYV, 83Mu19, 84Pa19, 85IaZZ, 85Mu07, 86Wa17, 86Wo01, 87Kr02, 89Lh01, 89Ma47, 89Oh05, 89WaZV, 89Wo05, 90Ma01)

B ^{100}Y β^- decay (0.94 s) (77Kh03, 77Pl01, 79Bo26, 86Wo01)

C ^{252}Cf SF decay (66WaZX, 70Ch11, 70Jo20, 71Ch44, 71Ho29, 72ClZN, 72Ho08, 72Wi15, 73Kh05, 74ClZX, 74JaYY, 74KhZV, 74Su04, 80ChZM, 83MaYT, 87BoZN)

D ^{101}Y β^-n decay

Levels and γ-ray branchings:

0, 0^+, 7.1 4 s, [ABC], %β^-=100

212.530 9, 2^+, 0.58 4 ns, [ABC], μ=0.44 10 γ_0*212.53* 19 (†γ100) E2

331.13 5, 0^+, 5.53 13 ns, [AB] γ_{213}*118.597* (†γ100 6) E2 γ_0*331.13* 5 (†e75 24) E0

564.486 15, (4^+), 37 4 ps, [ABC] γ_{213}*351.960* 12 (†γ100)

829.20 6, 0^+, [A] γ_{213}*616.677* (†γ100)

878.57 4, (2^+), [AB] γ_{564}*314.33* (†γ9 3) γ_{331}*547.377* (†γ26 4) γ_{213}*665.987* (†γ100 6) (M1+E2): δ=+1.0 3 γ_0*878.548* (†γ52 4)

1062.4 5, (6^+), [C] γ_{564}*497.95* (†γ100)

1196.16 4, (2^+), [A] γ_{879}*317.82* (†γ4.0 8) γ_{564}*631.848* (†γ22 2) γ_{331}*865.058* (†γ64 4) γ_{213}*983.598* (†γ34 4) γ_0*1196.087* (†γ100 6)

1294.85 5, $(2^-,3,4^+)$, [A] γ_{879}*416.01* 11 (†γ10 1) γ_{213}*1082.338* (†γ100 9)

1408.0 5(?), [B] γ_{213}*1195.5* 5(?) (†γ100)

1427.8 5(?), [B] γ_{331}*1096.7* 5(?) (†γ100)

1441.44 7, $(1,2^+)$, [A] γ_{331}*1110.53* (†γ48 15) γ_{213}*1228.998* (†γ100 10) γ_0*1441.23* (†γ21 4)

$^{100}_{37}$Rb Option 2 (Decay)

Δ:(−46700) S_n:(3800) Q_{β^-}:(13500)

Populating Reactions and Decay Modes

Fission (78Ko29, 79Az01, 79Pe01, 82Kr11, 83Ly01, 83Ly03, 83Ly06, 84LyZW, 86RaZG, 86Wa17)

Levels:

0, 51 *8* ms, %β⁻=100, %β⁻n=6 *3*, %β⁻2n=?

γ(¹⁰⁰Sr) from ¹⁰⁰Rb (51 ms) β⁻ decay :
129.25 (Iγ100), ***288.45*** (Iγ36).

γ(⁹⁹Sr) from ¹⁰⁰Sr (51 ms) β⁻n decay :
90.5 (Iγ28), ***120.8***(u) (Iγ15).

γ(⁹⁸Sr) from ¹⁰⁰Rb (51 ms) β⁻2n decay :
144.6(?).

$^{100}_{38}$Sr

Δ:−60220 *130* S_n:6120 *180* S_p:16580 *170* Q_{β^-}:7080 *100*

Populating Reactions and Decay Modes

A ¹⁰⁰Rb β⁻ decay (78Ko29, 79Az01, 79Pe01, 80JuZY, 82Kr11, 83Ly01, 83Ly03, 83Ly06, 84Pa19, 86Wa17)

B ¹⁰¹Rb β⁻n decay (88PlZZ)

Levels and γ-ray branchings:

0, 0⁺, 202 *3* ms, *[A]*, %β⁻=100, %β⁻n=0.73 *3*

γ(¹⁰⁰Y) from ¹⁰⁰Sr (202 ms) β⁻ decay < *for Iγ% multiply by 0.22 1*>
10.683 (Iγ44 *4*) E1, ***65.463*** (Iγ69 *5*) M1(+E2):δ<0.1 , ***66.06*** (Iγ1.11 *15*), ***88.503*** (Iγ6.4 *3*), ***95.914*** (Iγ3.68 *25*), ***95.944*** (Iγ3.13 *18*), ***99.203*** (Iγ5.75 *25*), ***107.43*** *11* (Iγ0.48 *7*), ***114.865*** (Iγ0.88 *6*), ***127.65*** *11* (Iγ0.13 *2*), ***181.173*** (Iγ2.46 *12*), ***195.013*** (Iγ15.9 *7*), ***204.118*** (Iγ0.26 *4*), ***233.774*** (Iγ1.84 *10*), ***240.648***(?) (Iγ0.77 *7*), ***256.634*** (Iγ2.01 *10*), ***276.906*** (Iγ0.94 *9*), ***285.118*** (Iγ0.39 *6*), ***288.73*** (Iγ0.04 *1*), ***299.035*** (Iγ5.6 *4*), ***299.706*** (Iγ1.1 *07*), ***309.686*** (Iγ3.75 *22*), ***311.62*** *19* (Iγ0.28 *6*), ***365.314*** (Iγ3.22 *17*), ***376.987*** (Iγ1.58 *11*), ***384.55*** *14* (Iγ0.42 *7*), ***407.438*** (Iγ0.52 *6*), ***466.466*** (Iγ2.61 *17*), ***473.33*** *15* (Iγ0.80 *12*), ***484.778*** (Iγ1.41 *12*), ***505.098*** (Iγ1.04 *9*), ***518.876*** (Iγ3.07 *17*), ***526.728*** (Iγ0.36 *6*), ***539.648*** (Iγ0.71 *9*), ***550.45*** *19* (Iγ0.33 *6*), ***562.08*** *18* (Iγ0.13 *3*), ***564.567*** (Iγ0.96 *7*), ***581.266*** (Iγ1.65 *10*), ***602.959*** (Iγ2.00 *17*), ***622.47*** *11* (Iγ0.78 *9*), ***633.04*** *10* (Iγ0.39 *4*), ***656.87*** *11* (Iγ0.44 *7*), ***657.849*** (Iγ1.01 *10*), ***665.458*** (Iγ0.92 *9*), ***723.336*** (Iγ3.4 *3*), ***762.066*** (Iγ2.9 *3*), ***861.02*** *11* (Iγ1.81 *20*), ***873.90*** *14* (Iγ0.44 *9*), ***875.45*** *11* (Iγ1.56 *17*), ***898.504*** (Iγ86 *4*), ***951.46*** *16* (Iγ0.38 *6*), ***963.854*** (Iγ100 *4*), ***964.578*** (Iγ3.2 *3*), ***969.02*** *21* (Iγ0.26 *6*), ***1003.04*** *11* (Iγ1.15 *22*), ***1069.246*** (Iγ2.97 *22*), ***1073.318*** (Iγ2.04 *12*), ***1183.90*** *17* (Iγ0.36 *10*), ***1240.12*** *14* (Iγ1.54 *16*), ***1241.66*** *19* (Iγ0.87 *15*), ***1280.08*** *17* (Iγ0.71 *17*), ***1302.89*** *16* (Iγ0.54 *7*), ***1313.70*** *10* (Iγ1.25 *9*), ***1379.25*** *15* (Iγ1.88 *22*), ***1401.24*** (Iγ0.77 *20*), ***1623.78*** *10* (Iγ2.12 *13*), ***1689.61*** *25* (Iγ0.57 *16*).

$^{100}_{39}$Y

Δ:−67300 *80* S_n:5160 *80* S_p:12410 *150* Q_{β^-}:9310 *70*

Populating Reactions and Decay Modes

A ¹⁰⁰Sr β⁻ decay (78Ko29, 81DeYV, 83Mu19, 84Pa19, 85IaZZ, 85Mu07, 86Pe04, 86Wa17, 86Wo01, 87Wo07, 89WaZV)

B ¹⁰¹Sr β⁻n decay (86Wa17, 88PlZZ)

Levels and γ-ray branchings:

0, 1⁻,2⁻, 735 *7* ms, *[A]*, %β⁻=100, %β⁻n=0.81 *4*

0+x, (3,4,5), 0.94 *3* s, %β⁻=100

γ(¹⁰⁰Zr) from ¹⁰⁰Y (0.94 s) β⁻ decay :
118.65(?) (Iγ52) E2, ***212.53*** *19* (Iγ100) E2, ***331*** *1*(?) (Iγ7.4 *15*) E0, ***351.960*** *12* (Iγ33 *4*), ***665.85***(?) (Iγ13 *3*), ***878.15***(?) (Iγ18 *3*), ***1096.75***(?) (Iγ4 *2*), ***1195.55***(?) (Iγ5 *2*).

γ(¹⁰⁰Zr) from ¹⁰⁰Y (735 ms) β⁻ decay < *for Iγ% multiply by 0.73 10*>
118.59 *7* (Iγ21.1 *12*) E2, ***212.53*** *19* (Iγ100 *6*) E2, ***244.808*** (Iγ0.75 *6*), ***314.33*** (Iγ0.09 *3*), ***317.82*** (Iγ0.20 *4*), ***331.13*** *5* (Iγ16 *5*) E0, ***351.960*** *12* (Iγ1.73 *11*), ***416.01*** *11* (Iγ0.34 *4*), ***496.88*** *13* (Iγ1.19 *17*), ***512.60*** *7* (Iγ0.24 *7*), ***547.37*** *7* (Iγ2.8 *4*), ***611.60*** *11* (Iγ0.68 *7*), ***616.67*** *7* (Iγ9.4 *6*), ***631.84*** *8* (Iγ1.1 *1*), ***643.43*** *12* (Iγ0.58 *8*), ***665.98*** *7* (Iγ10.6 *6*) (M1+E2):δ=+1.0 *3*, ***741.99*** *7* (Iγ6.0 *4*), ***754.54*** *23* (Iγ0.39 *9*), ***832.64*** *10* (Iγ0.90 *7*), ***865.05*** *8* (Iγ3.2 *2*), ***878.54*** *8* (Iγ5.5 *4*), ***885.18*** *11* (Iγ0.99 *9*), ***908.09*** *12* (Iγ0.62 *7*), ***919.34*** (Iγ0.19 *5*), ***978.37*** *12* (Iγ0.95 *9*), ***983.59*** *8* (Iγ1.7 *2*), ***1038.68*** *12* (Iγ0.83 *15*), ***1059.51*** *7* (Iγ8.7 *6*), ***1082.33*** *8* (Iγ3.4 *3*), ***1109.13*** (Iγ1.0 *3*), ***1110.53*** (Iγ1.0 *3*), ***1185.83***(?) (Iγ0.36 *7*), ***1196.08*** *7* (Iγ5.0 *3*), ***1228.99*** *8* (Iγ2.1 *2*), ***1329.64*** (Iγ0.27 *7*), ***1441.23*** (Iγ0.45 *9*), ***1476.53*** *14* (Iγ1.74 *18*), ***1551.42*** (Iγ1.12 *13*), ***1595.16*** *17* (Iγ2.4 *3*), ***1608.0***(?) (Iγ1.5), ***1637.03*** (Iγ0.64 *10*), ***1670.83***(u) (Iγ0.83 *11*), ***1725.44*** *16* (Iγ0.93 *15*), ***1750***(u?) (Iγ1.0), ***1807.92*** (Iγ1.6 *3*), ***1814.96*** (Iγ0.29 *9*), ***1891.82*** (Iγ2.3 *3*), ***1937.93*** (Iγ0.97 *12*), ***2017.03*** (Iγ1.04 *10*), ***2182.35*** (Iγ0.43 *11*), ***2240.52*** (Iγ1.80 *16*), ***2375.3*** *10* (Iγ0.21 *11*), ***2396.23*** (Iγ1.26 *14*), ***2439.39*** *18* (Iγ9.1 *7*), ***2469.33***(u) (Iγ1.45 *14*), ***2480.17*** *17* (Iγ4.7 *4*), ***2515.13*** *14* (Iγ8.4 *5*), ***2557.84*** (Iγ0.56 *9*), ***2600.95*** *18* (Iγ6.1 *4*), ***2633.73*** (Iγ1.10 *14*), ***2692.84*** (Iγ0.32 *9*), ***2719.23*** (Iγ1.09 *13*), ***2728.05*** (Iγ0.48 *12*), ***2738.65*** (Iγ0.33 *10*), ***2770.43*** (Iγ7.8 *6*), ***2846.22*** (Iγ5.8 *4*), ***2932.13*** (Iγ3.7 *3*), ***2980.85***(u) (Iγ0.42 *10*), ***3359.24*** (Iγ1.14 *14*), ***3571.84*** (Iγ0.87 *11*), ***3743.95*** (Iγ0.66 *11*), ***3956.85*** (Iγ0.74 *10*), ***4075.84*** (Iγ0.52 *9*), ***4288.16*** (Iγ0.23 *7*).

$^{100}_{40}$Zr

Δ:−76610 *40* S_n:6910 *40* S_p:13690 *40* Q_{β^-}:3335 *25*

Populating Reactions and Decay Modes

A ¹⁰⁰Y β⁻ decay (735 ms) (77Kh03, 78Kh01, 78Se03, 79Bo26, 80Wo09, 81Al25, 81DeYV, 83Mu19, 84Pa19, 85IaZZ, 85Mu07, 86Wa17, 86Wo01, 87Kr02, 89Lh01, 89Ma47, 89Oh05, 89WaZV, 89Wo05, 90Ma01)

B ¹⁰⁰Y β⁻ decay (0.94 s) (77Kh03, 77Pl01, 79Bo26, 86Wo01)

C ²⁵²Cf SF decay (66WaZX, 70Ch11, 70Jo20, 71Ch44, 71Ho29, 72ClZN, 72Ho08, 72Wi15, 73Kh05, 74ClZX, 74JaYY, 74KhZV, 74Su04, 80ChZM, 83MaYT, 87BoZN)

D ¹⁰¹Y β⁻n decay

Levels and γ-ray branchings:

0, 0⁺, 7.1 *4* s, *[ABC]*, %β⁻=100

γ(¹⁰⁰Nb) from ¹⁰⁰Zr (7.1 s) β⁻ decay < *for Iγ% multiply by 1.0*>
103.71 (Iγ0.67 *6*), ***197.05***(?) (Iγ<0.1), ***253.41*** (Iγ0.21 *3*), ***303.21*** (Iγ0.22 *3*), ***400.48*** *4* (Iγ19.2 *8*), ***498.03*** (Iγ0.72 *8*), ***504.25*** *4* (Iγ31 *4*), ***695.0***(?), ***703.32*** (Iγ0.36 *5*).

$^{100}_{41}$Nb

Δ:−79940 *30* S_n:5680 *30* S_p:9460 *30* Q_{β^-}:6245 *25*

Populating Reactions and Decay Modes

A ¹⁰⁰Zr β⁻ decay (7.1 s) (69WiZX, 70Ei02, 72Tr08, 76Ah06, 77Pl01, 78Si02, 79Bo26, 81Al25, 81DeYV, 82VoZP, 84Pa19, 86LhZX, 89Lh01, 89WaZV)

B Fission (80MoZJ, 86LhZX)

C ¹⁰⁰Mo(t,³He) (79Aj03, 80KeZP, 85Wa04)

Levels and γ-ray branchings:

0, 1⁺, 1.5 *2* s, *[AC]*, %β⁻=100

480 *80*, (4⁺,5⁺), 2.99 *11* s, *[B]*, %β⁻=100

γ(¹⁰⁰Mo) from ¹⁰⁰Nb (2.99 s) β⁻ decay < *for Iγ% multiply by 0.974*>
159.51 (Iγ5.5 *9*) E2, ***461.33*** (Iγ6.6 *8*), ***528.263*** *18* (Iγ9.0 *17*), ***535.666*** *14* (Iγ100.0 *23*), ***543.02*** (Iγ6.5 *14*), ***600.51*** (Iγ67.0 *17*), ***635.74*** (Iγ4.6 *18*), ***638.74*** (Iγ7.2 *18*), ***695.0*** (Iγ0.71 *15*) E0, ***707.65*** (Iγ4.7 *17*), ***710.84*** (Iγ5.3 *14*), ***768.92*** (Iγ9.1 *19*), ***928.52*** (Iγ7.3 *20*), ***952.46*** (Iγ4.6 *32*), ***966.54*** (Iγ19.9 *17*), ***1063.92*** (Iγ5.2 *10*), ***1071.53*** (Iγ5.9 *13*), ***1280.62*** (Iγ24.5 *16*).

γ(¹⁰⁰Mo) from ¹⁰⁰Nb (1.5 s) β⁻ decay < *for Iγ% multiply by 1.00 13*>
159.51 (Iγ8.8 *5*) E2, ***3271*** (Iγ0.12 *5*), ***368.65*** (Iγ0.13 *3*), ***4001*** (Iγ0.16 *10*), ***440.91*** (Iγ1.07 *5*), ***4711*** (Iγ0.10 *6*), ***513.22*** (Iγ0.20 *5*), ***528.263*** *18* (Iγ9.1 *2*) E2+M1:δ=+4.4 $^{+15}_{-9}$, ***535.666*** *14* (Iγ45.7 *1*), ***543.51*** (Iγ0.42 *3*), ***573.62*** (Iγ0.29 *4*), ***600.51*** (Iγ0.55 *5*), ***622.52*** (Iγ1.5 *3*), ***695.0*** (Iγ1.14 *17*) E0, ***768.71*** (Iγ3.4 *3*), ***856.33*** (Iγ0.40 *16*), ***913.25*** (Iγ0.19 *9*), ***928.31*** (Iγ2.5 *1*) M1+E2:δ=−0.27 *2*, ***969.11*** (Iγ2.6 *3*), ***1022.53*** (Iγ4.9 *6*), ***1063.71*** (Iγ3.3 *2*), ***1071.72*** (Iγ0.49 *8*), ***1125.82*** (Iγ0.31 *6*), ***1257.06*** (Iγ0.90 *8*), ***1281.85*** (Iγ0.14 *4*), ***1362.5*** *10* (Iγ0.10 *7*), ***13911*** (Iγ0.07 *3*), ***13971*** (Iγ0.10 *7*), ***14321*** (Iγ0.06 *5*), ***1441.52*** (Iγ0.27 *6*), ***1501.91*** (Iγ4.4 *3*), ***1550.53*** (Iγ0.68 *9*), ***1598.73*** (Iγ0.21 *5*), ***1653.92*** (Iγ1.23 *10*), ***1665.74*** (Iγ0.28 *5*), ***18711*** (Iγ0.33 *6*), ***1906.65*** (Iγ0.39 *14*), ***2434.65*** (Iγ1.39 *11*), ***2526.94*** (Iγ0.34 *5*), ***2534.64*** (Iγ0.81 *9*).

$^{100}_{42}$Mo

%:9.63 *3*

Δ:−86185 *6* S_n:8289 *6* S_p:11146 *12*

σ_γ:0.199 *3* b

Populating Reactions and Decay Modes

A ¹⁰⁰Nb β⁻ decay (1.5 s) (67Hu09, 69WiZX, 70Ei02, 72He37, 72Tr08, 75Kh05, 76Ah06, 78Si02, 79Bo26, 81DeYV, 82VoZP, 83Ke09, 84BuZS, 84Pa19, 87Me06, 89OhZY, 89WaZV, 90Ma01)

B ¹⁰⁰Nb β⁻ decay (2.99 s) (72He37, 76Ah06, 79Bo26, 80KeZP, 84BuZS, 87Me06)

C ⁹⁶Zr(⁷Li,p2nγ) (86Ho25)

D ⁹⁹Mo(t,p), ⁹⁹Mo(t,pγ) (73Ta06, 81Fl06, 84De17, 87Es01, 88Ca16, 88Ch29)

E ¹⁰⁰Mo(γ,γ) (71Mo26, 73Mo30, 74Wo05, 79Mo19, 81Sc10)

F ¹⁰⁰Mo(n,n') (73La06, 74Mc02, 74Mc13, 75Si17, 75Sm04, 76FeZI, 77Fe01, 78LaZM, 79Ra02, 80Ei01, 81Ko15, 82SmZU, 83Bh01, 85Ti08, 87Ko05, 87Ko06)

G ¹⁰⁰Mo(n,n'γ) (74Mc02, 78AhZX, 83Mo11, 84Ke09)

H ¹⁰⁰Mo(p,p') (71Hi08, 71Lu07, 71Si11, 72AnZP, 72Aw03, 72DiZR, 72Si05, 73InZY, 73NaZS, 73Ta03, 75Bu04, 75RaYL, 77Re04, 82Ce04, 82Sa19,

$^{100}_{37}$Rb Option 2 (Structure)

Δ:(−46700) S_n:(3800) Q_{β^-}:(13500)

Populating Reactions and Decay Modes

Fission (78Ko29, 79Az01, 79Pe01, 82Kr11, 83Ly01, 83Ly03, 83Ly06, 84LyZW, 86RaZG, 86Wa17)

Levels:

0, 51 *8* ms, %β^-=100, %β^-n=6 *3*, %β^-2n=?

$^{100}_{38}$Sr

Δ:−60220 *130* S_n:6120 *180* S_p:16580 *170* Q_{β^-}:7080 *100*

Populating Reactions and Decay Modes

A ^{100}Rb β^- decay (78Ko29, 79Az01, 79Pe01, 80JuZY, 82Kr11, 83Ly01, 83Ly03, 83Ly06, 84Pa19, 86Wa17)

B ^{101}Rb β^-n decay (88PIZZ)

Levels and γ-ray branchings:

0, 0$^+$, 202 *3* ms, *[A]*, %β^-=100, %β^-n=0.73 *3*

129.2 *5*, (2$^+$), 5.15 *20* ns, *[A]* γ_0*129.2 5* (I_γ100)

417.6 *7*, (4$^+$), *[A]* γ_{129}*288.4 5* (I_γ100)

$^{100}_{39}$Y

Δ:−67300 *80* S_n:5160 *80* S_p:12410 *150* Q_{β^-}:9310 *70*

Populating Reactions and Decay Modes

A ^{100}Sr β^- decay (78Ko29, 81DeYV, 83Mu19, 84Pa19, 85IaZZ, 85Mu07, 86Pe04, 86Wa17, 86Wo01, 87Wo07, 89WaZV)

B ^{101}Sr β^-n decay (86Wa17, 88PIZZ)

Levels and γ-ray branchings:

0, 1$^-$,2$^-$, 735 *7* ms, *[A]*, %β^-=100, %β^-n=0.81 *4*

0+x, (3,4,5), 0.94 *3* s, %β^-=100

10.70 *2*, 1$^+$, *[A]* γ_0*10.68 3* (I_γ100) E1

76.15 *3*, (2)$^+$, 72 *7* ps, *[A]* γ_{11}*65.46 3* (I_γ100) M1(+E2): δ<0.1

99.16 *2*, *[A]* γ_{11}*88.50 3* (I_γ100 *5*) γ_0*99.20 3* (I_γ90 *4*)

172.03 *4*, (3$^+$), *[A]* γ_{76}*95.94 4* (I_γ100)

194.98 *2*, (1$^+$), *[A]* γ_{99}*95.91 4* (I_γ23 *2*) γ_0*195.01 3* (I_γ100 *5*)

309.83 *3*, *[A]* γ_{195}*114.86 5* (I_γ16 *1*) γ_{76}*233.77 4* (I_γ33 *2*) γ_{11}*299.03 5* (I_γ100 *7*) γ_0*309.69 6* (I_γ87 *4*)

355.75 *4*, *[A]* γ_{99}*256.63 4* (I_γ100)

376.07 *3*, *[A]* γ_{310}*66.0 6* (I_γ34 *5*) γ_{195}*181.17 3* (I_γ76 *4*) γ_{172}*204.11 8* (I_γ8 *1*) γ_{99}*276.90 6* (I_γ29 *3*) γ_{76}*299.70 6* (I_γ34 *2*) γ_{11}*365.31 4* (I_γ100 *5*)

483.58 *5*, *[A]* γ_{376}*107.43 11* (I_γ92 *13*) γ_{356}*127.65 11* (I_γ25 *4*) γ_{195}*288.73* (I_γ8 *2*) γ_{172}*311.62 19* (I_γ54 *12*) γ_{99}*384.55 14* (I_γ81 *14*) γ_{76}*407.43 8* (I_γ100 *12*)

698.71 *8*, *[A]* γ_{172}*526.72 8* (I_γ58 *10*) γ_{76}*622.47 11* (I_γ100 *12*)

734.03 *6*, *[A]* γ_{172}*562.08 18* (I_γ4 *1*) γ_{76}*657.84 9* (I_γ30 *3*) γ_{11}*723.33 6* (I_γ100 *9*)

776.24 *5*, *[A]* γ_{310}*466.46 6* (I_γ100 *7*) γ_{195}*581.26 6* (I_γ63 *4*)

827.97 *8*, *[A]* γ_{195}*633.04 10* (I_γ89 *9*) γ_{172}*655.87 11* (I_γ100 *16*)

849.45 *8*, *[A]* γ_{376}*473.33 15* (I_γ100 *15*) γ_{310}*539.64 8* (I_γ89 *11*)

860.60 *4*, *[A]* γ_{484}*376.96 7* (I_γ100 *7*) γ_{376}*484.77 8* (I_γ89 *8*) γ_{356}*505.09 8* (I_γ66 *6*) γ_{310}*550.45 19* (I_γ21 *4*) γ_{195}*665.45 8* (I_γ58 *6*)

861.19 *6*, *[A]* γ_{99}*762.06 6* (I_γ100 *10*) γ_0*861.02 11* (I_γ62 *7*)

974.60 *4*, 1$^+$, *[A]* γ_{99}*875.45 11* (I_γ1.6 *2*) γ_{76}*898.50 4* (I_γ86 *4*) γ_{11}*963.85 4* (I_γ100 *4*)

1045.70 *13*, *[A]* γ_{172}*873.90 14* (I_γ100 *20*) γ_{76}*969.02 21* (I_γ59 *14*)

1146.33 *9*, *[A]* $\gamma_{861.2}$*285.11 8* (I_γ100 *15*) γ_{195}*951.46 16* (I_γ97 *15*)

1149.46 *9*, *[A]* γ_{76}*1073.31 8* (I_γ100)

1340.74 *6*, *[A]* γ_{776}*564.56 7* (I_γ30 *2*) γ_{376}*964.57 8* (I_γ100 *9*) γ_{99}*1241.66 19* (I_γ27 *5*)

1379.16 *4*, (1$^+$), *[A]* $\gamma_{860.6}$*518.67 6* (I_γ100 *6*) γ_{776}*602.95 9* (I_γ65 *6*) γ_{376}*1003.04 11* (I_γ37 *7*) γ_{310}*1069.24 6* (I_γ97 *7*) γ_{195}*1183.90 17* (I_γ12 *3*) γ_{99}*1280.08 17* (I_γ23 *6*) γ_{76}*1302.89 16* (I_γ18 *2*) γ_0*1379.25 15* (I_γ61 *7*)

1389.85 *11*, *[A]* γ_{1149}*240.64 8*(?) (I_γ62 *6*) γ_{76}*1313.70 10* (I_γ100 *7*)

1412.14 *14*, *[A]* γ_{172}*1240.12 14* (I_γ100 *10*) γ_{11}*1401.24* (I_γ50 *13*)

1699.99 *10*, *[A]* γ_{76}*1623.78 10* (I_γ100 *6*) γ_{11}*1689.61 25* (I_γ27 *8*)

$^{100}_{40}$Zr

Δ:−76610 *40* S_n:6910 *40* S_p:13690 *40* Q_{β^-}:3335 *25*

Populating Reactions and Decay Modes

A ^{100}Y β^- decay (735 ms) (77Kh03, 78Kh01, 78Se03, 79Bo26, 80Wo09, 81Al25, 81DeYV, 83Mu19, 84Pa19, 85IaZZ, 85Mu07, 86Wa17, 86Wo01, 87Kr02, 89Lh01, 89Ma47, 89Oh05, 89WaZV, 89Wo05, 90Ma01)

B ^{100}Y β^- decay (0.94 s) (77Kh03, 77PI01, 79Bo26, 86Wo01)

C ^{252}Cf SF decay (66WaZX, 70Ch11, 70Jo20, 71Ch44, 71Ho29, 72ClZN, 72Ho08, 72Wi15, 73Kh05, 74ClZX, 74JaYY, 74KhZV, 74Su04, 80ChZM, 83MaYT, 87BoZN)

D ^{101}Y β^-n decay

Levels and γ-ray branchings:

0, 0$^+$, 7.1 *4* s, *[ABC]*, %β^-=100

212.530 *9*, 2$^+$, 0.58 *4* ns, *[ABC]*, μ=0.44 *10* γ_0*212.531 9* (I_γ100) E2

331.13 *5*, 0$^+$, 5.53 *13* ns, *[AB]* γ_{213}*118.59 7* (I_γ100 *6*) E2 γ_0*331.13 5* (I_γ75 *24*) E0

564.486 *15*, (4$^+$), 37 *4* ps, *[ABC]* γ_{213}*351.960 12* (I_γ100)

829.20 *6*, 0$^+$, *[A]* γ_{213}*616.67 7* (I_γ100)

878.67 *4*, (2$^+$), *[AB]* γ_{564}*314.3 3* (I_γ9 *3*) γ_{331}*547.37 7* (I_γ26 *4*) γ_{213}*665.98 7* (I_γ100 *6*) (M1+E2): δ=+1.0 *3* γ_0*878.54 8* (I_γ52 *4*)

1062.4 *5*, (6$^+$), *[C]* γ_{564}*497.9 5* (I_γ100)

1196.16 *4*, (2$^+$), *[A]* γ_{879}*317.8 2* (I_γ4.0 *8*) γ_{564}*631.84 8* (I_γ22 *2*) γ_{331}*865.05 8* (I_γ84 *4*) γ_{213}*983.59 8* (I_γ34 *4*) γ_0*1196.08 7* (I_γ100 *6*)

1294.85 *5*, (2$^-$,3,4$^+$), *[A]* γ_{879}*416.01 11* (I_γ10 *1*) γ_{213}*1082.33 8* (I_γ100 *9*)

1408.0 *5*(?), *[B]* γ_{213}*1195.5 5*(?) (I_γ100)

1427.8 *5*(?), *[B]* γ_{331}*1096.7 5*(?) (I_γ100)

1441.44 *7*, (1,2$^+$), *[A]* γ_{331}*1110.5 3* (I_γ48 *15*) γ_{213}*1228.99 8* (I_γ100 *10*) γ_0*1441.2 3* (I_γ21 *4*)

1676.6(?), (8$^+$), *[C]* γ_{1062}*614.2*(?)

1807.59 *5*, (1,2$^+$), *[A]* γ_{1295}*512.60 7* (I_γ10 *3*) γ_{1196}*611.60 11* (I_γ28 *3*) γ_{829}*978.37 12* (I_γ40 *4*) γ_{331}*1476.53 14* (I_γ73 *8*) γ_{213}*1595.16 17* (I_γ100 *13*) γ_0*1807.9 2* (I_γ67 *13*)

1938.13 *5*, (1,2$^+$), *[A]* γ_{1441}*496.88 13* (I_γ14 *2*) γ_{1295}*643.43 12* (I_γ6.7 *9*) γ_{1196}*741.99 7* (I_γ69 *5*) γ_{879}*1059.51 7* (I_γ100 *7*) γ_{829}*1109.1 3* (I_γ11 *3*) γ_{331}*1608.0*(?) (I_γ1 *7*) γ_{213}*1725.44 16* (I_γ10.7 *18*) γ_0*1937.9 3* (I_γ11.1 *13*)

2182.92 *9*, (1,2$^+$), *[A]* γ_{1938}*244.80 8* (I_γ100 *8*) γ_0*2182.3 5* (I_γ57 *15*)

2692.76 *9*, (1,2$^+$), *[A]* γ_{1938}*754.54 23* (I_γ8 *2*) γ_{1808}*885.18 11* (I_γ21 *2*) γ_{879}*1814.9 6* (I_γ6 *2*) γ_{213}*2480.17 17* (I_γ100 *9*) γ_0*2692.6 4* (I_γ7 *2*)

2727.4 *2*, (1,2$^+$), *[A]* γ_{1808}*919.3 4* (I_γ15 *4*) γ_{331}*2396.2 3* (I_γ100 *11*) γ_0*2728.0 5* (I_γ38 *10*)

2770.66 *8*, (1,2$^+$), *[A]* γ_{1938}*832.64 10* (I_γ9.9 *8*) γ_{1577}*1185.8 3*(?) (I_γ4.0 *8*) γ_{1441}*1329.6 4* (I_γ3.0 *8*) γ_{879}*1891.8 2* (I_γ25 *3*) γ_{331}*2439.39 18* (I_γ100 *8*) γ_{213}*2557.8 4* (I_γ6.2 *10*) γ_0*2770.4 3* (I_γ86 *7*)

2846.26 *7*, (1,2$^+$), *[A]* γ_{1938}*908.09 12* (I_γ7.4 *8*) γ_{1808}*1038.68 12* (I_γ9.9 *18*) γ_{1295}*1551.4 2* (I_γ13.3 *13*) γ_{829}*2017.0 3* (I_γ12.4 *12*) γ_{331}*2515.13 14* (I_γ100 *6*) γ_{213}*2633.7 3* (I_γ13.1 *17*) γ_0*2846.2 2* (I_γ69 *5*)

2932.02 *13*, (1,2$^+$), *[A]* γ_{1295}*1637.0 3* (I_γ10.5 *16*) γ_{331}*2600.95 18* (I_γ100 *7*) γ_{213}*2719.2 3* (I_γ18 *2*) γ_0*2932.1 3* (I_γ61 *5*)

3069.7 *2*, (1,2$^+$), *[A]* γ_{829}*2240.5 2* (I_γ100 *9*) γ_{331}*2738.6 5* (I_γ18 *6*)

3571.8 *3*, (1,2$^+$), *[A]* γ_{1196}*2375.3 10* (I_γ18 *9*) γ_{213}*3359.2 4* (I_γ100 *12*) γ_0*3571.8 4* (I_γ76 *10*)

3956.7 *4*, (1,2$^+$), *[A]* γ_{2771}*1185.8 3*(?) (I_γ45 *9*) γ_{213}*3743.9 5* (I_γ89 *15*) γ_0*3956.8 5* (I_γ100 *14*)

4288.4 *4*, (1,2$^+$), *[A]* γ_{213}*4075.8 4* (I_γ100 *17*) γ_0*4288.1 6* (I_γ44 *13*)

$^{100}_{41}$Nb

Δ:−79940 *30* S_n:5680 *30* S_p:9460 *30* Q_{β^-}:6245 *25*

Populating Reactions and Decay Modes

A ^{100}Zr β^- decay (7.1 s) (69WiZX, 70Ei02, 72Tr08, 76Ah06, 77PI01, 78St02, 79Bo26, 81Al25, 81DeYV, 82VoZP, 84Pa19, 86LhZX, 89Lh01, 89WaZV)

B Fission (80MoZJ, 86LhZX)

C ^{100}Mo(t,^{3}He) (79Aj03, 80KeZP, 85Wa04)

Levels and γ-ray branchings:

0, 1$^+$, 1.5 *2* s, *[AC]*, %β^-=100

0+x, *[BC]*

34.3+x *10*, *[BC]* γ_{0+x}*34.3* (I_γ100) (M1)

101.7+x(?), *[C]* γ_{34+x}*67.1* (I_γ100) γ_{0+x}*101.9* (I_γ100)

131+x *10*

210+x *15*(?), *[BC]* γ_{102+x}*106.6*(?) (I_γ3) γ_{34+x}*173.3* (I_γ100)

348+x *15*

392.8+x(?), *[BC]* γ_{210+x}*185.4* (I_γ100) γ_{34+x}*358.6* (I_γ74) γ_{0+x}*392.8* (I_γ56)

400.48 *4*, 1$^+$, 0.19 *23* ns, *[AC]* γ_0*400.48 4* (I_γ100)

410+x *15*, *[C]*

450+x *20*, *[C]*

520+x *20*, *[C]*

565+x *10*, *[C]*

595+x *20*(?), *[C]*

680+x *20*, *[C]*

720+x *20*(?), *[C]*

784+x *20*, *[C]*

820+x *20*, *[C]*

Table of Isotopes on CD-ROM

- Regular updates (yearly)
- Expanded Coverage

  More complete nuclear data
  NSR
  Table of Super Deformed Bands
  ETOI

- ACROBAT (Adobe, Inc.) Viewer

  Windows/Macintosh/Unix
  Bookmarks
  Hypertext links
  Navigational and display aids

- >19,000 page demonstration version

  Table of Isotopes (first draft)
  NSR (1910-1992
  Table of Superdeformed Bands
  Nuclear Charts
  Table of Skeleton Schemes
  ENSDF and ENDF/B-VI files
  ENSDF and ENDF manuals
  ACROBAT Reader software

Electronic *Table of Isotopes*

- Complete Nuclear Data Presentation

  Level-scheme drawings

  Decay schemes
  Nuclear Bands

  Tables of all properties
  ENSDF applications

- Multiplatform

  Macintosh
  Windows
  Unix

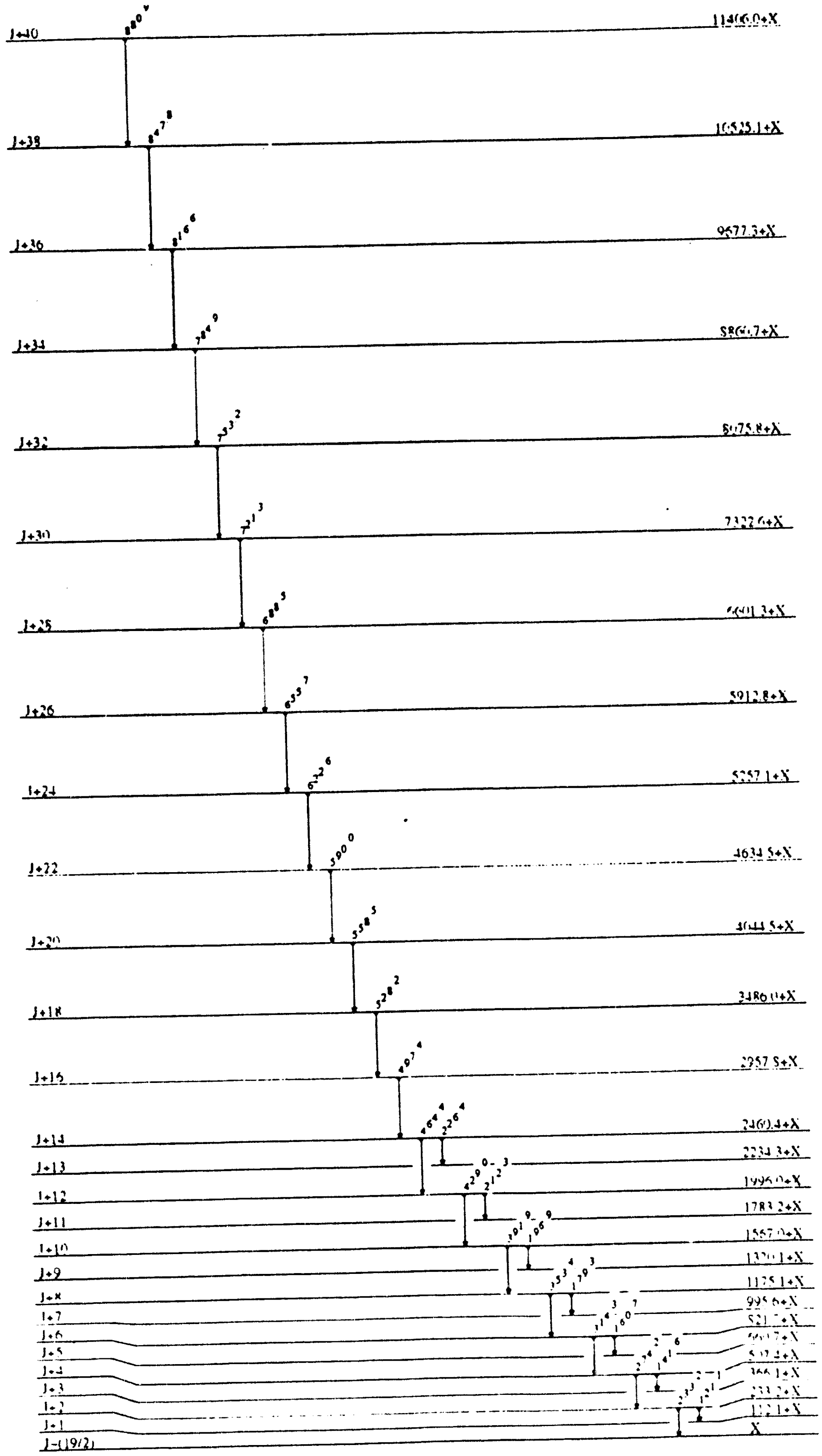
- Easy to use

  Graphical user interface
  Multiple windows
  Rapid, random access to data

- Editable

  User/evaluator ENSDF editor
  Modernized ENSDF file structures
  Easy output for user applications

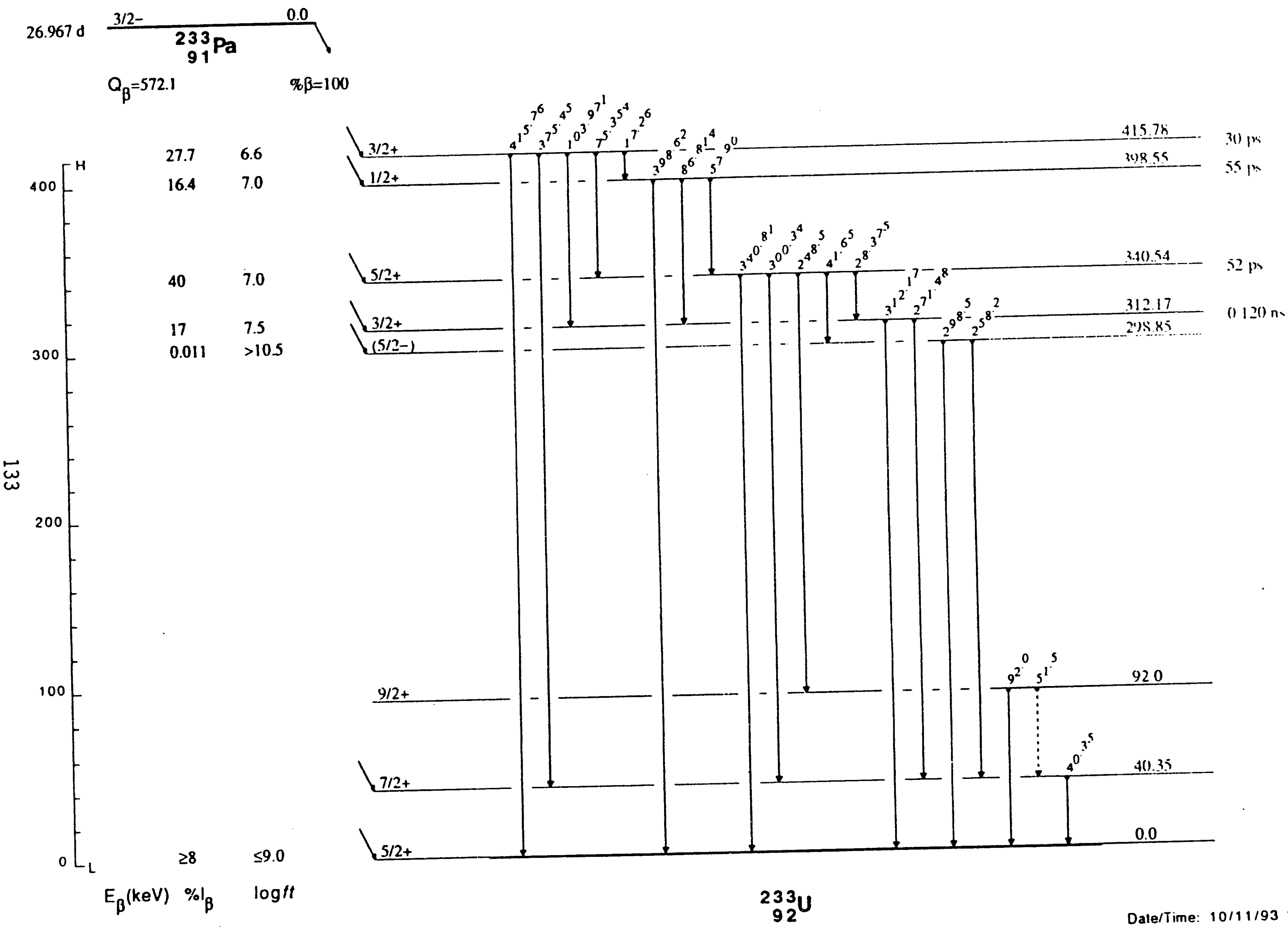
- Beta-test release by January, 1994



$^{193}_{80}Hg$

ADOPTED LEVELS, GAMMAS   SD-1 BAND POSSIBLE CONF=[512]5/2, ALPHA=-1/2 BELOW EG AP 400 AND J1

Date,Time 10/11/93 16 07
Evaluator V S SHIRLEY
Cutoff Date 12/17/90



233PA B- DECAY

Date/Time: 10/11/93 17:34
Evaluator: A. AKOVALI
Cutoff Date: 08/23/90

The *Isotopes CD-ROM*

presented by Jay Z. James, P.E.
Isotopes Project, Lawrence Berkeley Laboratory

at a meeting of the U.S. Nuclear Data Network
October 19, 1993
Asilomar Conference Center, Monterey, California

Attachment 22

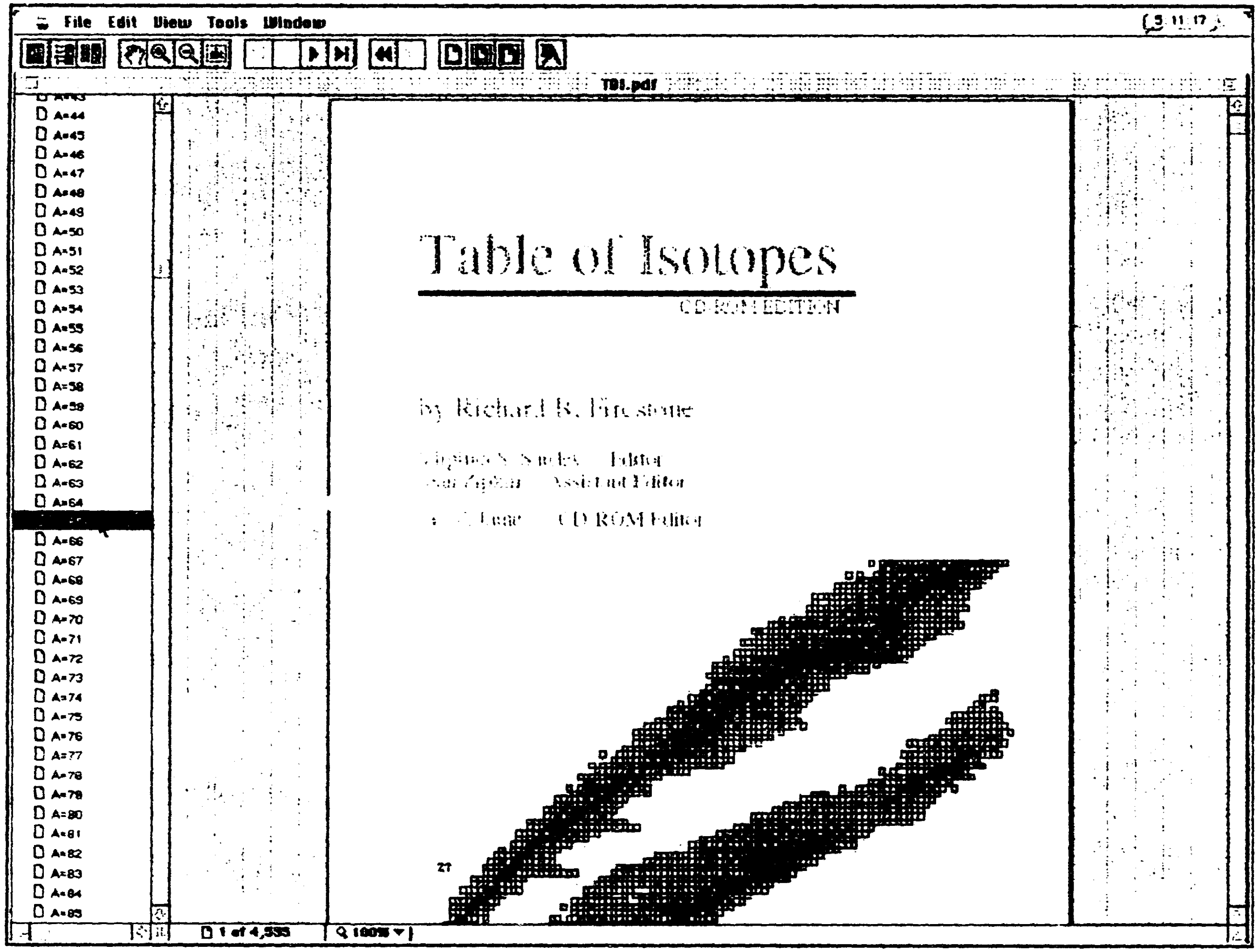
Benefits of Electronic Books

- compactness
- ease of searching
- ease of copying
- ease of updating
- page format retains familiar feel

Demo *Isotopes CD-ROM*

- Acrobat documents
  - draft *Table of Isotopes* (4,500 pages)
  - *Nuclear Structure References* (14,500 pages)
  - *ENSDF Manual*
- Acrobat™ Reader applications
  - Windows & Macintosh
  - beta version will support DOS & UNIX
- raw ENSDF (110 megabytes)
- ENDF/B-VI thrown in for good measure

Acrobat Reader Screen



Please Help

- new technology, unknown potential
- we need comments, suggestions
- sign up for a beta copy
- buy a CD-ROM drive ($149)
- try it out and tell us what you think

Electronic Table of Isotopes (ETOI)

- **Complete Nuclear Data Presentation**
  - **Level-scheme drawings**
    - **Decay schemes**
    - **Nuclear bands**
  - **Table of all properties**
  - ***ENSDF* applications**
- **Multiplatform**
  - **Macintosh**
  - **Windows**
  - **Unix**
- **Easy to use**
  - **Graphical user interface**
  - **Multiple windows**
  - **Rapid, random access to data**
- **Editable**
  - **User/evaluator *ENSDF* editor**
  - **Modernized *ENSDF* file structures**
  - **Easy output for user applications**
- **Beta-test release by January, 1994**

ETOI on the Macintosh computer.
Version 0.5
Date: October 17, 1993
Please direct suggestions and comments to

Frank Chu
Isotopes Project, 50A-6102
Lawrence Berkeley Laboratory, Berkeley, CA 94720
Tel: (510) 486-7648
Fax: (510) 486-5757
email: fchu@nsdssr.lbl.gov or SYFChu@lbl.gov

<u>Overview of *Electronic* Table of Isotopes (ETOI):</u>

- At the start of the **ETOI** program, a title page is displayed, and it may be cleared by clicking on the *OK* box, or by entering a carriage return.

- Selecting *ENSDF* Format data
  If a default set of *ENSDF* is available:
    A window to display the default *ENSDF* data is automatically opened, and the user is prompted to select a nucleus.
  To select a different *ENSDF* format file:
    User is prompted to select an *ENSDF* mass-chain file through the *Macintosh Standard Get File* dialog, followed by the selection of a nucleus in the file.

- After a nucleus is chosen, the first data set of that nucleus (typically Adopted Level, Gammas) is displayed in the window. The user can select other dataset from the **DataSets** menu or through the DS button **DS↑↓**.

- After the data set is chosen, a complete level drawing is displayed in the window. One can use the **Structures** menu or BS button **BS↑↓** to limit the level drawing display to a certain structure based on *Band* and/or *E* comments in *ENSDF* . The selection by *Band* and *E* is under the **Option** menu.

- **ETOI** allows user to open multiple windows so that level drawings can be displayed side by side for comparison. To open a new window the user can select **OpenDefault** (for default *ENSDF* set) or **Open** (for other *ENSDF* files) under **File** menu.

- By clicking on different windows, users can switch windows. They can also select the windows by using **Windows** menu.

- By default, the energy scaling is adjusted to maximize the window display. Users can change scaling up or down by a factor of **1.5** by clicking on scale bottons on the left side of the window Scal ⇧⇩. Users can also choose some fixed scalings from the **Scale** menu.

- Under the **Option** menu, a range of selections are available for displaying gamma transitions as follows:
  - ShowGammaComplete
  - ShowGammaInParts---with this selection gammas are shown only one layer at a time to avoid overlapping. To display a higher or lower layer, one use keyboard ⇑ or ⇓ , or click on arrows mark by γ ⇧⇩.
  - ShowGammaCascade---clicking on the energy field of a level, the program displays all the gammas from that level cascading to the ground state.
  - ShowGammaSelect---users can select levels by clicking at the energy field to show the gammas deexcitating that level.
  - NoGamma

- When the mouse cursor is inside an active **ETOI** window, it can be one of the following three shapes:

  - ↖ indicates that the cursor located an active area where some selection can be made.

-  indicates that the display can be moved. The amount of movement is given by the displacement of the mouse while it is held down.

-  indicates that the cursor is located at a position where if the mouse is pressed certain information would be displayed. The information may include author (AUT HOR), legend(LEGE ND), or a complete list of band titles (title box).

- Under the **Option** menu users can set parameters to customize the display of drawings.

- A user can print out the window display by selecting **Print** under the **File** menu. One can chose either landscape or portrait print. The portait mode prints a smaller scale covering a much wider range of level energies. If the printing is sent to a color printer, please select color in **PrinterSeup.**

- To quit the program, from the keyboard enter **⌘Q**, or select **Quit** under **File** menu.

<u>How to create a Default *ENSDF* Set</u>:

- When **ETOI** runs an *ENSDF* data base, it creates an auxiliary file called 'key' in the same folder as the *ENSDF* files. To designate a default *ENSDF* file set the user can create an alias of the 'key' file, rename it '*keyCD*", and move it to the folder where the **ETOI** application resides.

- When ENSDF files reside on read only media the 'keyCD' file will be automatically created in the application folder. One should restart the **ETOI** program so that the program can find the default *ENSDF* folder.

US Nuclear Data Network

Electronic Access to Nuclear Data

Hands-on Exhibit

Surf and Sand Bldg.

October 20-22, 1993

DATE FILMED

9/21/94

END