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INDC International Nuclear Data Committee

Co-ordination of the International Network of Nuclear Structure and Decay Data Evaluators

Summary Report of an IAEA Technical Meeting

IAEA Headquarters, Vienna, Austria

23 – 27 March 2009

Prepared by

D. Abriola and J.K. Tuli

October 2009

IAEA Nuclear Data Section, Vienna International Centre, 1400 Vienna, Austria

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Abstract

The IAEA Nuclear Data Section convened the 18th meeting of the International Network of Nuclear Structure and Decay Data Evaluators at the IAEA Headquarters, Vienna, 23 to 27 March 2009. This meeting was attended by 22 scientists from 14 Member States, plus IAEA staff, concerned with the compilation, evaluation and dissemination of nuclear structure and decay data. A summary of the meeting, recommendations/conclusions, data centre reports, and various proposals considered, modified and agreed by the participants are contained within this document.

October 2009

Network participants wish to dedicate their work and results to the memory of their close colleagues and co-workers Tom W. Burrows (National Nuclear Data Center, Brookhaven, USA) and Denis De Frenne (National Physics Laboratory, Gent, Belgium). Both will be greatly missed by all in the nuclear data community.

GLOSSARY

AMDC	Atomic Mass Data Center
AME	Atomic Mass Evaluations
ANL	Argonne National Laboratory, USA
ANU	Australian National University, Canberra, Australia
BMLW	Reduced magnetic transition probability in Weisskopf units (ENSDF)
BrIcc	ENSDF analysis program
CATAR	Computer code to calculate ICC by Pauli and Raff
CD-ROM	Compact disk with read-only memory
CE	Conversion Electron
CEA	Commissariat à l'Energie Atomique (French Atomic Energy Commission)
CERN	Conseil Européen pour la Recherche Nucléaire (European Organization for Nuclear Research)
CNDC	China Nuclear Data Center, Institute of Atomic Energy (CIAE) Beijing
CRP	Coordinated Research Project
CSNSM	Centre de Spectrométrie Nucléaire et de Spectrométrie de Masse
DDEP	Decay Data Evaluation Project
DICEBOX	Monte Carlo statistical model code (developed by F. Becvar and M. Krticka)
DOE	U.S. Department of Energy
DSAM	Döppler-Shift Attenuation Method
EGAF	Evaluated Gamma-ray Activation File
EMPIRE	System of codes for nuclear reaction calculations
ENDF	Evaluated Nuclear Data File
ENSDF	Evaluated Nuclear Structure Data File
EU	European Union
EXFOR	Computer-based system for the compilation and international exchange of experimental nuclear reaction data
FO	Frozen Orbital
FTE	Full Time Effort/Employment
GAMUT	Computer code for gamma-ray energy and intensity analyses of data from ENSDF
GANIL	Grand Accélérateur National d'Ions Lourds, France
GSI	Gesellschaft für Schwerionenforschung mbH
GTOL	ENSDF analysis program
IAEA	International Atomic Energy Agency
IC	Internal Conversion
ICC	Internal Conversion Coefficients
ICTP	International Centre for Theoretical Physics, Italy
IIT	Indian Institute of Technology
IMP	Institute of Modern Physics, Chinese Academy of Sciences, China
INDC	International Nuclear Data Committee
INR (Kiev)	Institute for Nuclear Research (Kiev)
IP	Isotopes Project at LBNL
IPF	Internal Pair Formation
JAEA	Japan Atomic Energy Agency
JAERI	Japan Atomic Energy Research Institute, Japan
Jπ	Spin and Parity
LBNL	Lawrence Berkeley National Laboratory, USA

LNHB	Laboratoire National Henri Becquerel
LLNL	Lawrence Livermore National Laboratory
LWM	Limitation of Relative Statistical Weight
MR	Mixing ratio
MSU	Michigan State University
NDP	Nuclear Data Project, Oak Ridge National Laboratory, USA
NDS	Nuclear Data Sheets; journal devoted to ENSDF data
NDS/IAEA	Nuclear Data Section, IAEA
NEWGTOL	PNPI version of GTOL
NIPNE (Bucharest)	National Institute of Physics and Nuclear Engineering (Bucharest)
NMR	Nucleon Magnetic Resonance
NMR/ON	NMR on Oriented Nuclei
NNDC/BNL	National Nuclear Data Center, Brookhaven National Laboratory, USA
NRM	Normalized Residual Method
NSCL	National Superconducting Cyclotron Laboratory, USA
NSDD	Nuclear Structure and Decay Data network
NSR	Nuclear Science References – bibliographic file
NuDAT	Interactive nuclear structure and decay database (predominantly from ENSDF)
NuPECC	Nuclear Physics European Collaboration Committee
NuPNET	Nuclear Physics Network
NWC	Nuclear Wallet Cards
OECD	Organization for Economic Co-operation and Development
ORNL	Oak Ridge National Laboratory, USA
PANDORA	ENSDF analysis program
PNPI	Petersburg Nuclear Physics Institute of the Russian Academy of Sciences
RADWARE	Software package for interactive graphical analysis of gamma-ray coincidence data (developed at ORNL)
RIPL	Reference Input Parameter Library
RT	Rajeval Technique
RUL	Recommended Upper Limit
SHE	Super Heavy Elements
TJπ	Proposed theoretical or recommended Jπ
TUNL	Triangle Universities Nuclear Laboratory, USA
VMI	Variable moment of inertia
WPEC	NEA Working Party on International Evaluation Cooperation
XUNDL	Experimental Unevaluated Nuclear Data List

A-chain evaluation	Mass-chain evaluation: best data for the structure and decay of all nuclides with the same mass number.
Horizontal evaluation	Best values of one or a few selected nuclear parameters for many nuclides irrespective of their mass number.

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FOREWORD

The International Network of Nuclear Structure and Decay Data (NSDD) Evaluators holds biennial meetings under the auspices of the IAEA, and consists of evaluation groups and data service centres in several countries. This network has the objective of providing up-to-date nuclear structure and decay data for all known nuclides by evaluating all existing experimental data. Data resulting from this international evaluation collaboration is included in the Evaluated Nuclear Structure Data File (ENSDF) and published in the journals *Nuclear Physics A* and *Nuclear Data Sheets* (NDS). The results represent the recommended "best values" for the various nuclear structure and decay data parameters. These data and bibliographic details are also available through such media as the World Wide Web, CD-ROM, wall charts of the nuclides, nuclear wallet cards and others.

US efforts are coordinated by the Coordinating Committee of the US Nuclear Data Program. The ENSDF master database is maintained by the US National Nuclear Data Center at the Brookhaven National Laboratory, and these data are also available from other distribution centres including the IAEA Nuclear Data Section.

Biennial meetings of the network are sponsored by the IAEA Nuclear Data Section, and have the following objectives:

(a) To coordinate the work of all centres and groups participating in the compilation, evaluation and dissemination of NSDD;
(b) To maintain and improve the standards and rules governing NSDD evaluations;
(c) To review the development and common use of the computerized systems and databases maintained specifically for this activity.

This work is undertaken over a five-day period, and this document represents a summary of the network meeting held in IAEA Headquarters, Vienna, Austria, 23-27 March 2009. Twenty-two nuclear data specialists from various countries attended this meeting to discuss work and problems of common interest, specifically with respect to the active membership of the mass chain evaluation team for ENSDF. A most encouraging feature of this meeting was the attendance of two new participants from Europe and one from Turkey.

The first two days were dedicated to a combination of technical reviews and discussion papers, addressing particular topics in which progress has been made and problems have been encountered over the previous two years. Specific mass chain activities and administrative issues were debated over the final three days. Problems are being experienced in maintaining suitable numbers of mass chain evaluators (expressed as FTE – Full Time Effort), and these difficulties were extensively discussed during the course of the meeting (particularly with respect to shrinking European involvement). In this connection the efforts of A. Nichols and D. Balabanski to increase European participation were recognized. The list of participants is given in Annex 1, and the adopted agenda for the meeting is listed in Annex 2.

NSDD MEETINGS

Place	**Date**	**Report**
1. Vienna, Austria	29.04. – 03.05.1974	INDC(NDS)-60
2. Vienna, Austria	03 – 07.05.1976	INDC(NDS)-79
3. Oak Ridge, USA	14 – 18.11.1977	INDC(NDS)-92
4. Vienna, Austria	21 – 25.04.1980	INDC(NDS)-115
5. Zeist, Netherlands	11 – 14.05.1982	INDC(NDS)-133
6. Karlsruhe, Germany	03 – 06.04.1984	INDC(NDS)-157
7. Grenoble, France	02 – 05.06.1986	INDC(NDS)-182
8. Ghent, Belgium	16 – 20.05.1988	INDC(NDS)-206
9. Kuwait, Kuwait	10 – 14.03.1990	INDC(NDS)-250
10. Geel, Belgium	09 – 13.11.1992	INDC(NDS)-296
11. Berkeley, USA	16 – 20.05.1994	INDC(NDS)-307
12. Budapest, Hungary	14 – 18.10.1996	INDC(NDS)-363
13. Vienna, Austria	14 – 17.12.1998	INDC(NDS)-399
14. Vienna, Austria	04 – 07.12.2000	INDC(NDS)-422
15. Vienna, Austria	10 – 14.11.2003	INDC(NDS)-456
16. Hamilton, Canada	06 – 10.06.2005	INDC(NDS)-0476
17. St. Petersburg, Russia	11 – 15.06.2007	INDC(NDS)-0513
18. Vienna, Austria	23 – 27.03.2009	INDC(NDS)-0559

1. SUMMARY

The 18th meeting of the International Network of Nuclear Structure and Decay Data (NSDD) Evaluators was held in Vienna, Austria from 23 to 27 March 2009. This biennial meeting was hosted by the IAEA-NDS Vienna, and their staff members made significant contributions towards the preparations of the meeting. Twenty-two participants from fourteen countries attended the meeting, representing the majority of data evaluation centres, new evaluation groups and data dissemination centres (Annex 1).

Drs. N. Ramamoorthy, D. Abriola and A.L. Nichols of the IAEA welcomed all delegates to the meeting. The Agenda was approved as listed in Annex 2. J.K. Tuli and A.L. Nichols were elected to co-chair the meeting at appropriate times, and D. Abriola was elected secretary for the meeting. A list of all ENSDF evaluation centres and groups is given in Annex 3, along with their mass-chain evaluation responsibilities as assigned for 2008-2009, and all specific and continuous actions can be found in Annex 4.

On the first day the actions from previous meetings were discussed, the reports by evaluation centres were presented as well as a report on the US Nuclear Data Program (see Section 2), and the meetings, workshops, trainings and other activities were presented (see Section 3). Discussions over the next two days focused on the organisational review presented by Tuli and specific technical issues either requiring resolution or for information; short summaries of the various presentations are given in Section 4. Work undertaken by the ENSDF evaluation and dissemination centres over the previous two years (see Annex 5) was also considered, along with their planned activities for the forthcoming two years.

Participants discussed a wide range of technical matters, including recommendations to improve the quality of NSDD evaluations. A list of actions was also prepared for implementation during the course of the next two years (see Annex 4). NSDD members prepared recommendations for implementation by the IAEA and the major evaluation centres, which are aimed at improving financial and technical support towards the Network. These recommendations include: the development of stronger links and understanding between key financial organizations and research facilities; planning of IAEA and ICTP workshops designed to train new NSDD evaluators; support by the major NSDD centres of the evaluation work undertaken by new groups through mentoring; and maintenance of the list of horizontal evaluations required by users or covered by on-going activities.

The next Technical Meeting of the International Network of Nuclear Structure and Decay Data Evaluators is planned to be held in April/May 2011, at the Australian National University in Canberra, Australia.

2. REPORTS FROM EVALUATION CENTRES

Representatives from the individual mass chain evaluation centres presented progress reports on their NSDD studies. These status reports are listed in Annex 5.

3. MEETINGS, WORKSHOPS, TRAININGS AND OTHER ACTIVITIES

Tuli presented the status of new evaluation activities throughout the world. The successful establishment of centres in India, Australia, and in the US was reiterated. The various actions taken in training new evaluators were presented.

3.1. Fourth Trieste Workshop

The fourth and most recent in the series of workshops on Nuclear Structure Evaluation was held at ICTP, Trieste, Italy from 28 April to 9 May 2008. This series of workshops has been hosted by ICTP but sponsored by the Nuclear Data Section, IAEA, Vienna, Austria. The aim is to develop a pool of young scientists to do nuclear structure evaluations.

The IAEA Nuclear Data Section, which coordinates technical meetings of the Nuclear Structure and Decay Data Evaluators Network, was requested by the network at the turn of the century to take steps to increase involvement of the scientific community in this work. These workshops are held towards achieving that aim. Although the basic curriculum has remained the same, it is constantly reordered and the procedures and exercises improved based on trainee feedback.

A. Nichols (IAEA) has been the Director of the workshop responsible for most administrative and organizational matters related with the workshop. J. Tuli has acted as the co-Director mostly responsible for the technical and scientific aspects of the workshop. Dr. Alberto Ventura, ENEA, Bologna, Italy, as a co-Director, has acted as liaison with the theory lecturers. C. Tuniz (ICTP) was the local co-Director. In addition to being Directors, both Nichols and Tuli had given supportive lectures. At this workshop, D. Abriola (IAEA) replaced A. Nichols as Director in the middle of the first week.

The only lecturer who has participated in all these workshops (including the pilot workshop) has been Piet Van Isacker of GANIL, France. This year the other theory lecturer was S. Brant from the University of Zagreb, Croatia. Both gave excellent expositions of Nuclear Models and their lectures were very well received.

Lectures on experimental techniques were given by F.G. Kondev, ANL, USA, and by T. Kibédi, ANU, Australia.

D. Abriola (IAEA), C. Baglin (LBNL), E. Browne (LBNL/NNDC), F.G. Kondev (ANL), T. Kibédi (ANU), A. Sonzogni (NNDC) and J. Tuli provided the instruction in various aspects of evaluation techniques and acted as the group leaders for the hands-on exercises.

This year, for the first time, we had access to the candidates' CVs, allowing us to make a good selection of the trainees ensuring that they were qualified for such training. The result was indeed gratifying with a good, interested group of people. Still, the selection process has to be in compliance with ICTP guidelines regarding nationality, age, gender, and personal contacts, etc.

Overall, this was a satisfactory experience. Trainees were good and it was a pleasure working with them. Hopefully some of them will continue in this field.

3.2. European participation

Over the previous twenty years European participation has declined dramatically in the important area of ENSDF evaluations. A. Nichols, D. Balabanski and J. Tuli, with guidance from D. DeFrenne, and F.G. Kondev have undertaken various initiatives towards encouraging the rejuvenation of European participation.

Initiatives included:

1. Letters to various European Laboratories;

2. Contact with the European Union – Brussels;

3. Contact with the European Expert Committee, NuPECC (Nuclear Physics European Collaboration Committee), (Brian Fulton, University of York, Chairman);

4. Joint (Nichols, Kondev, Tuli) NSDD awareness article in the NuPECC journal Nuclear News;

5. J. Tuli gave a talk at a European Town Meeting at Helsinki, Finland;

6. IAEA organized a meeting in Vienna in November 2008.

G. Audi's announcement that the AME+NUBASE activities had been suspended until some institute would ensure their future caused general concern. Representatives from the IAEA voiced this concern and, at the same time, made their interest known to continue these activities as had been done before by Christoph Scheidenberger (GSI Darmstadt), Y. Litvinov (GSI Darmstadt), D. Lunney (CSNSM Orsay), K. Blaum (MPIK Heidelberg), G. Savard (ANL Argonne), K. Sharma (Manitoba University), J. Hardy (Texas A&M) and many more.

IAEA (A. Nichols initiative) organized an information meeting at Vienna, Austria on 10-12 November 2008. The intent was to bring together interested European groups and to encourage Sydney Gales, Director, GANIL, Chairman of newly formed NuPNET (EU) to support this activity. Presentations to the group were made by A.L. Nichols, J. Tuli, F.G. Kondev and B. Singh (see INDC(NDS)-0534, November 2008).

At this meeting a MOU was drafted for the European Community. Dimiter Balabanski/Christoph Scheidenberger were named spokespersons for the group. It was decided to hold a workshop to train evaluators from Europe at Bucharest in April, 2009.

4. TECHNICAL DISCUSSIONS

Extensive technical discussions took place on Tuesday and Wednesday, as chaired by Tuli. The presentations can be accessed at http://www-nds.iaea.org/nsdd/18th_nsdd/presentations/

4.1. Organisational review (Tuli)

4.1.1. Nuclide/Mass Chain priority

Based on experimental papers in NSR, a nuclide/mass chain priority list is prepared by Tuli annually. The last such priority list of 150 nuclides was issued on 17 April 2009. Evaluators should consult this list before starting new evaluation.

4.1.2. Mass Chain assignments

Mass-chain responsibilities of various data centres were reviewed. All data centres, except for LBNL and PNPI, opted to keep their responsibilities unchanged (refer to Annex 3, revised list of A-chain responsibility table).

4.1.3. XUNDL Status Report (Singh)

Singh presented a historical account of XUNDL from its origins in December 1998.
In total, from 1 June 2007 to 20 March 2009 755 were compiled, 724 at McMasters, 30 at ANL and 1 at Manipal.

- Active communication with the authors continued throughout the year. In a few cases such communication prompted authors to publish errata.
- Potential of XUNDL database as a repository of relevant data which for one reason or another cannot be included in a publication.
- Based on comments from researchers and evaluators it would seem that XUNDL compilation activity is useful in both camps.
- Future participation by other data centres would be welcome and might even become necessary at some stage.

4.2. BrIcc-current status, plans and update (Kibédi)

Kibédi reviewed the observation of the first monoenergetic beta spectrum in 1911 that led to the discovery of the conversion electron process (IC for internal conversion) process in 1921. He briefly examined the theory to calculate the ICC (Internal Conversion Coefficients), in particular three models, namely the “no hole”, the “self consistent” and the “frozen orbital” models. Kibédi noted that the “frozen orbital” approximation had been adopted by the NSDD network in 2005. Experimental ICCs with uncertainties better than 5% were analysed in 2007 using three statistical methods to identify discrepant data points, deduce weighted means and uncertainties (LWM, NRM and RT, see Section 4.4). He presented an update of this study that still favours the FO model. The BrIcc code includes all these models. The Z range has been extended to Z = 110 and the atomic binding energies and atomic masses have been updated. Plans for the future include: extend atomic number range beyond Z = 110 (requires binding energies and electron configurations), E0 electronic factors for all atomic numbers ($\Omega(E0)$), shells and energies (Electron conversion using the CATAR code (H.C. Pauli and U. Raff) -IPF and $Z \leq 40$), treatment of mixed M1+E2+E0 transitions, X-ray and Auger electron radiations, mixing ratios from CE data –BrIccMixing (see Section 4.3).

4.3. Mixing Ratio Program (Kibédi)

The aim of this program is to deduce the mixing ratio coefficient of gamma transitions from CE (Conversion Electron) data. Kibédi reviewed the existing programs (CFIT, DELTA and ICCRATIO) and introduced the BrIccMixing with a sample input file. Cases where the absolute ICC or the ratio (R) of ICCs is known are called type A while those where only the unnormalized CE intensities are known are named type N. For N-type or mixed N&A type CE data, the program uses CFIT routines to get best parameters of |MR| and R and calculates theoretical ICCs using BrIcc, but with uncertainties ignored. For A-type only data the program scans the $\chi 2$[ArcTan(MR)] hyper surface, calculates the theoretical $\alpha i,\pi$, $\pm \Delta\alpha i,\pi$ values from BrIcc, finds |MR| where $\chi 2$ is minimal, determines asymmetric uncertainties, ΔMR_{LOWER} and ΔMR_{UPPER} or the limit and creates the graphical output and a calculation report. For the future, correlation effects should be included; this will be explored in collaboration with V. Vanin (São Paulo). Often CE data are given as unnormalized CE intensity: in this case there is another fitting parameter, the normalization factor R. To find optimum parameters and uncertainties on the $\chi 2$(MR,R) hyper surface further development is needed. Most of the MR data in ENSDF are derived from combined CE (ICC, ICC-ratio and CE intensity) and γ–γ (A_2 and A_4) data: the subject requires further development.

4.4. AveTool-Averaging Tools (Kibédi)

The program AveTool combines three different statistical methods to calculate averages of experimental data with uncertainties. These include:

- LWM – Limitation of Relative Statistical Weight
- NRM – Normalised Residual Method
- RT – Rajeval Technique

Kibédi presented the different assumptions and formulae used in the techniques, a sample input file with data from the high precision ICC evaluation and the corresponding report file.

4.5. New band drawings and proposed new format for tables in NDS (Tuli, Singh)

Singh described the new Band drawings for Nuclear Data Sheets. The new drawings are generated using a new program developed at McMaster University. See www-nds.iaea.org/nsdd/18th_nsdd/presentations/ for his presentation.

4.6. Errors in ENSDF (Mitropolsky)

Mitropolsky presented the ENSDF error search as carried out by G. Shulyak (PNPI). This list of errors is reported in http://georg.pnpi.spb.ru. Furthermore, he proposed that NNDC send PNPI the new ENSDF files and they would return a list of errors.

4.7. Revision of GTOL (Mitropolsky)

Mitropolsky presented a proposal for GTOL refinement made by L. Kabina, Yu. Khazov and A. Rodionov from PNPI. He described the algorithm of level scheme optimization and presented an analysis of GTOL results where either the matrix is singular, there are negative diagonal matrix elements, there are unrealistic large diagonal matrix elements or there is a negative level energy. The problem was tracked to i) the presence of an isolated level which is not connected with another by any transitions, ii) a level which is introduced by the only transition to the ground state, iii) an isolated rotational band. The proposed solution includes a block structure of matrix A implemented in the NEWGTOL program.

4.8. Isomer in ^{229}Th (Mitropolsky)

Mitropolsky presented work on the low-lying isomer in ^{229}Th carried out by S. Sakharov (PNPI). He presented the previous energy assigned to this level, but different papers take into account different sets of transitions and levels. A new study investigated the influence of excluding selected levels and transition in the analysis. The proposed value for the isomer energy is 3.8(18) eV with $\chi 2 = 2.19$.

4.9. Rotational bands in double-odd nuclei (Mitropolsky)

Mitropolsky reviewed the work on the systematics of rotational states of doubly odd nuclei on the basis of the variable moment-of-inertia model (VMI) carried out in PNPI. The study includes 197 nucleides with $40 \leq A \leq 254$ and 845 bands (with definite spin-values and not containing less than 3 levels). The parameters of the VMI were adjusted to the data and the systematics presented. Future plans include building an Atlas of rotational bands to doubly odd nuclei continuing the systematics of the rotational bands in doubly even nuclei and studying the full systematics and comparative study of rotational bands in deformed nuclei.

4.10. Status of analysis codes (Tuli)

NNDC continues to maintain and distribute ENSDF analysis codes.

All analysis and utility codes have been converted to FORTRAN 95 (C.L. Dunford), Compaq/Digital Visual FORTRAN for Windows and Lahey/Fujitsu FORTRAN 95 for Linux.

ALPHAD, ComTrans, FMTCHK, ENSDAT, GTOL, NSDFLIB, PANDORA, and RULER have been distributed.

For Code Revisions: See the relevant "Read Me" for details. Very little has been done since changes by T. Burrows in October 2007. Latest code status, however, is given online.

Specifically:

1. BrIcc: it is supported and maintained by T. Kibédi.
2. RULER: Modifications made to fix bugs pointed out by several evaluators.
3. GTOL: Modifications suggested by PNPI were implemented.

There are known problems with the following codes:

1. GAMUT (LBNL reponsibility)
2. RADLIST-Update to handle new quantities generated by BrIcc. This will include expanding the atomic data tables to include the O through R atomic electron shells
3. FMTCHK (continuous)

S. Tandel joined NNDC recently, and will be responsible for the maintenance of the codes.

4.11. Treatment of discrepant data: example evaluation of ^{198}Au half-life (Singh)

Singh presented a study carried out at McMaster University on the evaluation of half-life data in ENSDF. ^{198}Au was selected, in particular due to the large dataset of measured values (33) in the last 63 years, plus the appearance during 2007-2008 of 4 independent precise

measurements. All the statistics methods used Avetools (see Section 4.4) except the Boostrap method courtesy of V. Vanin. Singh extensively analysed the different results, recommending ^{198}Au $T_{1/2}$ = 2.6949(6) d.

4.12. Measurement of K conversion coefficient (Nica)

Nica presented new precise internal conversion measurements as tests of internal conversion theory in the case of ^{197m}Pt. The experiments performed at Texas A&M used the KX to γ rays ratio method to obtain a very precise measurement of the detection efficiency and to eliminate possible sources of impurities. The result was a a_K(346.5 γ) = 4.25(7), compared with the theoretical values of 4.190 ("no hole") and 4.275 ("hole", "frozen orbitals").

4.13. EGAF capture gamma-ray effort and collaboration with LLNL (Firestone)

Firestone pointed out that a large set of data was measured at the Budapest Reactor: thermal neutron γ-ray cross sections for all elemental targets (Z = 1-83, 92) except He and Pm. Resulting cross sections had a precision of < 3% for strong transitions. An IAEA Coordinated Research Project (CRP) starting in 2000 evaluated these and other data resulting in the Evaluated Gamma-ray Activation File (EGAF). Following a request of LLNL, the EGAF capture γ-ray data are being input in ENDF format for all isotopes. For low Z isotopes the decay schemes are complete and data can be entered into ENDF directly. For high-A isotopes there are unresolved continuum γ-rays but this missing contribution can be calculated with a statistical model; the DICEBOX Monte Carlo code provides this capability.

Activities (under way and planned) include:

- EGAF data are being updated at LBNL for comparison with DICEBOX calculations;
- Neutron capture datasets for Z = 1-19, 74 have been completed;
- Evaluations of Fe and Gd are in progress;
- LLNL is automating DICEBOX input to select optimal nuclear model parameters and iterate to find the best Jπ values;
- LLNL is developing statistical model methods to extend ENDF capture data to higher neutron energies;
- LBNL plans to expand EGAF to include epithermal neutron data from the Atlas of Gamma-ray Spectra (Moscow, 1978);
- LBNL/LLNL will publish new σ_0 and Jπ values as a by-product of ENDF evaluations.

4.14. Proposed revised policy for inclusion of resonance data in ENSDF (Singh)

Singh presented a proposal for a revised policy towards inclusion of resonance data in ENSDF. See www-nds.iaea.org/nsdd/18th_nsdd/presentations/ for the details of this proposal. After considerable discussion it was decided to allow evaluators more time to provide Singh with feedback on his proposal (see Annex 4 for the actions related to this proposal).

4.15. Information management tools applied to nuclear structure data: developing user-friendly software to improve ENSDF interrogation and dissemination (Verpelli)

Verpelli summarized some earlier work undertaken within IAEA-NDS that led to the current developments, namely the Handbook of Nuclear Data for Safeguards (INDC(NDS)-502 and 0534) and a Table of Nuclides for Kaye and Laby (see http:/www.kayelaby.npl.co.uk/). Data

from several sources were placed in a Relational Database in preparation for both pieces of work. Verpelli presented and demonstrated three new software tools:

- the Live Chart of Nuclides, in which the user could explore the properties of the ground states by passing the pointer over particular nuclei and the different levels and gammas by double clicking,
- the Web Query tool which allows SQL interrogation of the database through a graphic interface,
- pocket ENSDF, a reduced ENSDF (only adopted levels and gammas) in MS-Access format (see Section 4.17).

Future work will include the development of adopted levels and gammas, the inclusion of decay datasets, embedding the results of legacy applications, hosting different data selections, and building a comprehensive relational database.

4.16. Pocket-ENSDF interrogation (Abriola)

Abriola presented the structure of the pocket ENSDF database, the different tables in which the information is being stored and the data fields of those tables. He showed how to build SQL queries to interrogate the pocket ENSDF database, selecting the tables to use, specifying the relationships among the tables and the required conditions. Several examples were presented with the distribution of lifetimes in ENSDF, the systematics of electric quadrupole moments and ratios of level energies of 2^+, 4^+, 6^+ and 8^+ states in even-even nuclei. The output graphs presented a simple way to see trends in the data, and easily spot anomalous data.

5. HORIZONTAL EVALUATIONS

5.1. Atomic Masses Evaluation (AME) (Audi)

Different kinds of horizontal data were reviewed, in particular the AME created by Wapstra in 1959 and, since 1981, in collaboration with Audi. Audi emphasized the different techniques and difficulties in:

- Experimental Data
  Energy relation: reactions - decays → relative measurement
  Inertial mass in EM field → relative measurement
- Data Evaluation
- Treatment of Data
  Least Squares Method
  Flow of Information
  Consistency of Data
- Regularity of the Mass Surface
  From S_{2n} - S_{2p} - Q_α - . . .
  From difference with a smooth function

In conclusion, deriving a mass value from one or several experiments requires expertise as well as mathematical tools. Collaboration with the Institute of Modern Physics (IMP), Chinese Academy of Sciences, has already started in order to ensure the continuity of this task. Full transfer of the AME responsibility to IMP is planned for 2013. It is encouraging to note that a number of institutes have already joined in these efforts, namely CSNSM (Orsay), GSI (Darmstadt), MPI (Heidelberg), ITE (Karlsruhe) and ANL (Argonne).

5.2. New precise mass measurements and ENSDF evaluations (Singh)

Singh presented a compilation of new mass measurements since AME-2003. About 65 primary publications between 2003-2008 were identified and compiled dealing with data not covered in AME-2003. For publications in 2008 (about 200 data points) compiled data are available on www.nuclearmasses.org. In conclusion it is expected that a significant number of such precise mass measurements for nuclei far from the stability line will be published in the near future. Furthermore, a guideline/policy is needed for on-going ENSDF evaluations to make use of these values until an update of AME-2003 becomes available.

5.3. Topical evaluation of Z = 9-14, N = 16-24 nuclides Island of Inversion (Singh)

This is a collaborative effort between researchers and ENSDF evaluators. Singh presented a review of the main experiments:

- Spectroscopic studies include:
  Excited state energies, spins, parities;
  Ground-state spins and parities;
  Precision mass measurements (Penning-trap);
  Cross sections for population of levels, transition probabilities, Log (ft) values, ground state nuclear radius etc.;
  Static magnetic and quadrupole moments of ground states;
- Production and spectroscopy involves:
  Fragmentation of primary beam – separation and acceleration of the secondary beam;
  Further fragmentation or knock-out reactions using secondary target;
  Gamma ray detection by large γ-ray detector arrays, and particles by 4π particle detectors.
- Main experimental facilities:
  NSCL, MSU, USA-GANIL, France;
  ISOLDE/CERN, Switzerland-GSI, Germany;
  RIKEN, Japan-TRIUMF, Canada.

There will be an evaluation, ENSDF style with ~ 3-year update cycle for relevant nuclei and a dissemination page on the NNDC website focusing on the topical evaluation, pointers to relevant evaluated nuclei in ENSDF, a review article (possibly also in NDS) and a bibliography (experiment and theory).

5.4. Systematics of M1 transition rates and RUL (Singh)

Singh analyzed the previous evaluations of P.M. Endt for BM1W (Weisskopf Units), the current Recommended Upper Limits (RUL) and the values present in ENSDF. The values in ENSDF were corrected in the several cases in which errors were found, in particular:

- For particle-unbound levels, total width was used in deducing BM1W.
- Conversion coefficients were significant and were not listed and considered in deduction of BM1W.
- Either incorrect mixing ratio or assumed values were used but not stated.
- Many uncertainties are incorrectly deduced. Minimum % uncertainty should correspond to that in quoted half-life. Sometimes we found uncertainties lower by a factor of 10.

In conclusion new limits were proposed:

Mass Region	Endt RUL	ENSDF RUL	Number of values above RUL	Highest value	Proposed new RUL
6-20	10	10	1	10.9(21)	12
21-44	5	10	0	2.78(10)	4
45-90	3	3	0	1.8(5)	3
91-150	1	3	0*	2.0(7)	3
>150		2	1*	2.1(3)	3

5.5. The physics of nuclear moments and current state of data compilations (Stone)

Stone discussed a variety of new measurement techniques and recent results. An important example is the work on the ground state magnetic moments of Cu isotopes where the methods of on-line nuclear orientation with NMR/ON, fragment polarisation allied to beta-NMR, in-source laser spectroscopy and high resolution collinear laser spectroscopy were used. The objectives were the full study of moments between major shell closures N = 28 - N = 40 for single proton beyond Z = 28, and towards establishing reliable nuclear models for the region of N = 50 [A = 78] (of importance for the r-process). Stone also discussed the moment measurements in fission fragments towards the neutron drip-line. He presented the history of the Table of Magnetic Dipole and Electric Quadrupole Static Nuclear Moments, which is a compilation, and the possible action of updating the 2005 table and producing a new table of recommended values.

6. ENSDF PROPOSALS AND SERVICES

6.1. Proposal to expand PANDORA (Nica)

Nica proposed to expand PANDORA sorting with gammas to final levels list. An example of a possible output was presented for the gammas populating the 1553 keV level in ^{97}Rh.

6.2. Cross-section normalization of gamma rays in capture gamma-ray datasets (Firestone)

Firestone spoke of the need for different γ-ray normalization in thermal-capture data sets. He proposed a new format for the normalization.
See www-nds.iaea.org/nsdd/18th_nsdd/presentations/ for his proposal.

6.3. Recommended Jπ assignments for the RIPL library (Firestone)

ENSDF is the recommended source of nuclear structure information for the Reaction Input Library File (RIPL). RIPL provides input data for modelling codes such as EMPIRE and DICEBOX which are used to perform nuclear reaction calculations. It is important for RIPL to contain the best available Jπ values for all levels, even if there is only theoretical evidence to support them, and such data should come from ENSDF. Firestone proposed that in order to accommodate the needs of RIPL we define a level continuation record TJπ that would give the evaluator's suggested Jπ value. TJπ records should only be given when the Adopted Levels Jπ field is blank or contains multiple possible values and the evaluator can propose a Jπ value on the basis of nuclear model calculations or systematics. The TJπ record is most important for Adopted Levels datasets in nuclei that are produced by neutron capture on stable targets

6.4. Dissemination of ENSDF, publications and services (Tuli)

6.4.1. ENSDF Statistics

Tuli presented the following ENSDF Statistics:
Datasets: 16441
Nuclides: 3045
Records: 2228606
Size: 178.3 MB
Comments Datasets: 455
Adopted Datasets: 3048
Decay Datasets: 3901
Reaction Datasets: 8746

6.4.2. ENSDF Distribution

ENSDF is distributed twice a year (most recent distribution was on 20 October 2008). Evaluation processing status is reported every month (on average, there are 21 mass chains in progress at any one time).

6.5. User-oriented database: NuDat (Sonzogni)

Sonzogni described the enhancements made to his popular NuDat program. See www-nds.iaea.org/nsdd/18th_nsdd/presentations/ for his presentation.

6.6. Nuclear Wallet Cards (Tuli)

The green "Nuclear Wallet Cards" for Radioactive Nuclides was published in March 2004, and was intended for field personnel, e.g., Homeland Security. Coverage was limited to naturally-occurring nuclides plus those radioactive nuclides with half-life >1 h and scope was limited to half-life, decay modes, and list of major gamma rays. There is also a table of γ-rays with their principal source (parent) identified, and some useful appendices. The entire stock – all 5000 copies – has been distributed and currently there are no plans for another edition.

The seventh edition of the blue "Nuclear Wallet Cards" was published in 2005. About 8000 out of a total of ten thousand copies have been distributed. The next (8^{th}) edition is expected in 2010.

The 6^{th} edition is archived by NNDC, following adoption as the half-life standard for the US DOE nuclear-material inventory control.

The Nuclear Wallet Cards file is based on ENSDF, and is regularly updated and available online.

7. NUCLEAR STRUCTURE AND DECAY DATA ACTIVITIES: PAST, PRESENT AND FUTURE

7.1. Nuclear Stucture and Decay Data Network and Alan Nichols (Tuli)

This meeting will be the last Alan Nichols chairs before his mandatory retirement from the IAEA. Thus, this session was devoted to Alan's accomplishments with respect to the NSDD

network. Tuli described the chronology of Alan's participation in the NSDD activity. Alan had attended some of the seminal meetings that created the Network in the mid-1970s. As the Head of IAEA/NDS during the past seven years, Alan recognised that European participation in this Network had fallen to an almost negligible level. He took it on himself to ensure European awareness of this deficiency. His hard work in this area seems to be bearing fruit.

7.2. Evolution of the NSDD evaluation efforts in Europe since 1980 (DeFrenne)

Like Tuli, DeFrenne also described the history of the NSDD. Since DeFrenne himself had served as Chair of the Network before Alan, he provided his perspective to Alan's very successful role as his successor.

7.3. The synthesis of SHE using projectiles beyond ^{48}Ca (Gupta)

Gupta analyzed the different possibilities of synthesis of Super Heavy Elements (SHE) using projectiles beyond ^{48}Ca. The hot fusion method using ^{48}Ca would reach a mass limit with E118, with no targets beyond ^{238}U, ^{237}Np, ^{244}Pu, ^{243}Am, ^{248}Cm, ^{249}Cf. The cold fusion method has achieved a world record for lowest cross-section: E113 with $\sigma(CN) \sim 10^{-15}$ b. There are possibilities for other projectiles. Gupta presented new experimental studies involving quasi-fission and fusion-fission mechanisms, particularly preliminary results with the ^{50}Ti projectile are encouraging. It was suggested that, depending on the pace of experimental activities and the results provided through such studies, future SHE evaluations might benefit from being taken into account in a more quantitative manner. In the future, we can hope for a better understanding of the fusion-fission mechanism for the heaviest elements, the chemistry of the region between $_{108}$Hs & E114, and the performance uncovering key fundamental properties through the availability of mass measurements.

7.4. IAEA activities related to decay data evaluation (Kellett)

Kellett focused on the IAEA Coordinated Research Project (CRP): Updated Decay Data Library for Actinides (2005-2009). The overall objectives of the CRP were:

- Identification of data discrepancies and unfulfilled requirements (in terms of data consistency, quality, …);
- Encouragement of measurements to address these requirements;
- Undertake full decay scheme evaluations using DDEP methodology, which includes documenting all shortcomings/procedures;
- Assembly of a fully updated actinide decay data library.

All completed evaluations are currently available from
http://www.nucleide.org/DDEP_WG/DDEPdata_by_Z.htm
New measurements were undertaken, results published (mainly by Kondev et al. at Argonne National Laboratory, USA), and evaluated.
~ 50% of evaluations are completed and appear on the DDEP website;
~ 25% of evaluations require only minor updates;
~ 25% of evaluations still in the early stages;
Expected completion of evaluations: 3rd quarter 2009; IAEA online database: 4th quarter 2009; final report publication: 1st quarter 2010.

7.5. Both sides of the fence (Kibédi)

Kibédi discussed highlights of his experience of research and data evaluation – as a researcher, he had learnt to become an evaluator by attending the first NSDD Workshop in Vienna, November 2002, where he had encountered new terms, such as Evaluated Nuclear Structure Data File, Mass Chain, Data Set, ENSDF record, ENSDF tools, data compilation, data evaluation, vertical and horizontal evaluation. Improvements appear as new calibration standards for γ-ray spectroscopy, new detector schemes for conversion electron measurements and new theoretical tools to calculate such data. Kibédi presented an evaluation of the calibration data on ^{152}Eu conversion electrons and preliminary results of an experiment to determine for E0 transitions in ^{158}Dy.

7.6. New challenges to European nuclear physics (Balabanski)

Balabanski described future nuclear physics facilities world wide, and related these developments to European effort and the importance of evaluated nuclear data. He mentioned several hot topics related to nuclear structure, including the processes of element creation from iron to uranium and isotope abundances, and the question of what are the magic numbers far away from stability. New experimental facilities included the HIE-ISOLDE linear accelerator, and RIB configurations at MSU, RIKEN, and the European SPIRAL2. Balabanski remarked that Europe produces a considerable amount of nuclear structure data, but effort in data evaluation has steadily diminished in recent years. He ended by thanking Alan Nichols for his continuous efforts to improve European participation.

7.7. Recent decay data measurements of actinide nuclides (Kondev)

Kondev described some problems in the evaluation of the half-life of ^{246}Cm, as noted by Nichols in Applied Radiation and Isotopes 55 (2001), where the need for accuracy better than 1% was specified. He described a recent experiment at Argonne National Laboratory in which a relative half-life method was adopted that achieved the desired goal. Kondev also noted that experimental studies of ^{233}Pa γ-ray emission probabilities had also been inspired by Nichols. He finished his presentation with some cartoons in appreciation of Alan Nichols' efforts to attract new evaluators, whom Alan had called jokingly "elusive butterflies".

7.8. The IAEA roots (Herman)

Herman recounted his time working with Alan at IAEA, in particular his significant cooperation with Alan during the IAEA Coordinated Research Project (CRP) on "Update of X-ray and Gamma-ray decay data standards for detector calibration and other applications".

7.9. Nuclear structure: yesterday, today and tomorrow (Nichols)

Nichols provided his personal opinions and judgements of the past and future of ENSDF activities. He paid special tribute to Alex Lorenz (IAEA-NDS), Charlie Reich, Dick Helmer (both INEL) and Eddie Browne for their inspiration and impact on his own career. Thanks to Alex Lorenz, Alan had participated in an IAEA activity closely connected to ENSDF as early as 1976: the IAEA Advisory Group Meeting on Nuclear Structure and Decay Data for Applications, IAEA, Vienna, 3 – 7 May 1976 (INDC(NDS)-79). Furthermore, Alex had also encouraged his technical involvement in a series of CRPs dedicated to the decay data of actinides and gamma-ray standards. Charlie Reich had taught Alan an immense amount during their combined involvement, amongst other things, within IAEA meetings to define

the Status and Needs for Nuclear Decay Data of Transactinium Isotopes (held at Cadarache, France, 1979 (INDC(NDS)-106)), and as a participant in the IAEA CRP on Transactinium Isotope Nuclear Data (1980-1986), IAEA Technical Reports Series No. 261, 1986. Alan Nichols also acknowledged and paid tribute to Dick Helmer for his guidance and technical contributions to the IAEA CRP on X-ray and Gamma-ray Standards for Detector Calibration that was initiated in 1987 after a consultants' meeting in 1985 (INDC(NDS)-171). An important follow-up CRP to update these standards began in 1998 into which Dick made numerous contributions to the NSDD measurements and subsequent evaluations (IAEA Scientific and Technical Information Report STI/PUB/1287, May 2007). Alan thanked Eddie Browne for his more recent assistance: inspirational statistical analyses, computational short-cuts, mentoring in ENSDF and DDEP, provision of several utility computer codes, and friendly visits to LBNL in order to learn more.
With respect to selected experimental studies, he emphasized the importance of quality data for $T_{1/2}$ and P_γ in detector efficiency calibrations, and the need in X- and gamma-ray spectroscopy to focus on and resolve recognized anomalies and inconsistencies in decay schemes as identified by evaluations. Nichols reviewed several experimental systems, including cluster arrays and total absorption gamma-ray spectroscopy (TAGS). He also emphasized the need for future modeling studies to encompass such exotic phenomena as double beta, proton and cluster decay into the overall theory of nuclear decay.

Nichols stressed that there are many extremely positive demands on nuclear data at the present time, including:

1. half-lives embracing both broad and highly specialized applications, i.e. astrophysics and geochronology,
2. E_α, P_α of actinides,
3. E_γ, P_γ of gamma-ray decay standards $\leftrightarrow$ ENSDF, DDEP,
4. high-energy γ-ray calibrants beyond 10 MeV,
5. $P_\gamma \rightarrow$ β- strength functions: decay schemes of fission products with confidence – decay heat calculations,
6. integration of exotic decay modes, all-encompassing theory for nuclear decay.

Alan Nichols concluded by saying that measurements should be designed to resolve known anomalies and inconsistencies, and address contentious issues. Furthermore, there was a strong need to adopt agreed procedures for all decay data evaluations to ensure their comparability, consistency and credibility.

8. ROUND-TABLE DISCUSSIONS

Three main points were discussed:

1. Databases and program maintenance:
   NNDC announced that it is going to move from Sybase to MySQL.
   S. Tandel is now in charge of program maintenance.
2. NSR
   M. Bhattacharya (NSR manager) would be leaving NNDC, and future inquiries related to NSR should be addressed to his successor, B. Pritychenco.

   The information that some of the NSR compilation was going to be outsourced gave rise to discussion. Kondev expressed doubts about the efficacy of outsourcing and concerns that, in doing so, the quality would not be maintained.

Herman explained that this was not the first instance of outsourcing at NNDC; such a process had been implemented before with the EXFOR database. Nichols, following Kondev's argument, stated that something as significant as outsourcing should be discussed within the NSDD meeting.
Kellett asked who would control and ensure the quality of these multi-centre NSR compilations.
Herman answered that someone at NNDC would check the results, and mentioned that NNDC had trained two potential NSR compilers, one in India and one in Slovakia.
Tuli remarked that responsibility for NSR had been and would remain with NNDC, whereas the exact method of implementation was another issue.
When asked how much of Pritychenco's time would be devoted to NSR compilation, Herman stated an initial effort of 40% that would be subsequently reduced to 20%.
Sonzogni mentioned that he could write a Google search program to pre-scan the database and look for interesting papers to bring to the compiler's attention.
Tuli responded that the initial selection of papers to be sent for the compilers' consideration was made through BNL support staff, but there were plans to change this arrangement.
Nichols advised a trial (along with Sonzogni's program) by continuing to generate inputs into NSR by the usual manner and compare both.
Kondev insisted that NNDC should discuss with the NSDD network before implementing substantial changes.
Tuli argued that people should only approach NSDD if, and only if, the work was not being carried out.
Kondev replied that he would like to see the same quality in NSR compilations as had prevailed when D. Winchell had been in charge.
Sonzogni concluded that the quality issue would soon be resolved.

3. Dwindling numbers of ENSDF evaluators and NSR compilers:
Farhan remarked that researchers did not want to do evaluation since such work was considered to be time consuming and not research. Furthermore, at the University teachers were paid to teach and not to engage in any other activities.
Tuli pointed out that a different paradigm for evaluators should enable them to devote 50% of their time to evaluation and 50% to research work. He also emphasized the importance of enhancing awareness about the usefulness of this activity.
In response DeFrenne pointed out that European funding for nuclear data activities was almost impossible to come by. Researchers in the 1980s had received a lump sum and could decide how to use these monies, but nowadays everything had become more project- and investment-oriented. He had only been able to continue ENSDF evaluations by including these activities in a broader project.
Firestone said that evaluation work should be carried out by researchers who showed personal interest in this work. He also remarked that there are other databases out there besides ENSDF, and that we should find people in the community, with positions of power that can make a change.
Stone noted that many data evaluations are undertaken for the love of such work, and in the expert's free time. He also pointed out that universities are reluctant to pay, and no more than 20% of a FTE could be expected.
Balabanski reported that nine European countries were about to sign a Memorandum of Understanding to organize European involvement in nuclear structure, particularly with respect to mass chain evaluations.
Nica felt confident that he could start a Nuclear Data Centre at his home university and identify research topics on nuclear data that would be interesting to students.

Kondev pointed out that even if people could be attracted, effort would be wasted if they could not work on the basis of stable, longer-term contracts. Firestone agreed and advised not to lure people into evaluation without having the funds for a permanent position.
Tuli remarked that even at NNDC, which is mostly devoted to nuclear data activities, staff could devote 20-30% of their time to research. He stressed that surely in a university environment, people could dedicate 20-30% of their time to mass chain evaluation.

9. CONCLUSIONS AND RECOMMENDATIONS

All data centres, except for ORNL (USA), NDC, JAEA (Japan) and CNDC, CIAE (China) had representatives in attendance at the meeting.
Data Centres presented satisfactory progress reports covering the period since the previous meeting in June 2007. However, the need for new evaluators for ENSDF persists. Towards that aim, efforts to increase European participation were greatly appreciated. The NSDD workshops at ICTP and the ENSDF-2009 workshop in Bucharest designed to train new evaluators were duly recognized and appreciated.

Certain steps were suggested to assure the quality and completeness of the databases, and a list of actions was prepared.

Technical improvements were discussed to facilitate the work of the evaluators, and tools to disseminate the results were presented and discussed.

NSDD members prepared recommendations for implementation by the IAEA and the major evaluation centres which were formulated to improve financial and technical support towards the Network. These recommendations include development of stronger links and understanding between key financial organizations and research facilities; planning of IAEA and ICTP workshops to train new NSDD evaluators; support by the major NSDD centres of the evaluation work undertaken by new groups through mentoring; and maintenance of the list of horizontal evaluations required by users or covered by on-going activities.

The next Technical Meeting of the International Network of Nuclear Structure and Decay Data Evaluators is planned for April/May 2011, at the Australian National University in Canberra, Australia.

ANNEXES

ANNEX 1

Technical Meeting of the "International Network of Nuclear Structure and Decay Data Evaluators"

IAEA Headquarters, Vienna, Austria
23 to 27 March 2009

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ANNEX 2

18th Meeting of the Nuclear Structure and Decay Data (NSDD) Network

IAEA, Vienna, Austria
23-27 March 2009

Meeting Room C07 IV

AGENDA

Monday, 23 March 2009

08:30-09:00 Registration (IAEA registration desk, Gate 1)

09:00-9:30 **Introduction**

- Welcome remarks
  - DDG-NA or NE, or DIR-NAPC
  - Alan Nichols (SH-NDS)
- Election of Chairman and Rapporteur
- Adoption of Agenda (Chairman)

09:30-10:30 **Actions from Previous Meetings**

List of Actions (carry over from June 2007)

Systematics of M1 transition rates and RUL (Singh-15 mins)
Others

10:30-12:30 **Reports by Evaluation Centres**

NSDD activities and ENSDF evaluators' reports (all centres – 5-10 mins each)

NNDC, USA	Belgian group
IAEA-NDS	TANDAR, Argentina
ORNL, USA	CEN, France
LBNL, USA	JAEA, Japan
TUNL, USA	ANU
ANL, USA	JLU
McMaster, Canada	Kuwait
St. Petersburg, Russia	India

[Coffee Break as needed]

12:30-14:00 *Lunch*

14:00-15:00 Reports by Evaluation Centres (cont'd)

NSDD activities and ENSDF evaluators' reports (all centres – 5-10 mins each)
Institute of Atomic Energy, China
Jilin University, China
IIT, Roorkee, India
Manipal University, India
ANU, Australia
Nuclear Data Project, Kuwait

15:00-15:30 Administrative and Technical Items

Report on the US Nuclear Data Program (Herman)

15:30-17:30 Meetings, Workshops, Trainings and Other Activities

- Report on the IAEA Nuclear Data Programme (Nichols)
  - ICTP-IAEA workshop on NSDD, April/May 2008
  - IAEA Technical Meeting - Reference Data Libraries for Nuclear Applications – ENSDF, 10-11 November 2008 (European angle)
  - IFIN-HH workshop on NSDD, 30 March – 3 April 2009
  - Consideration of future ICTP-IAEA workshops
- New evaluation centres/new evaluators (Tuli)
  - Success of 2008 ICTP workshop
  - European effort
  - Status of new evaluation centres/new evaluators
- Training of new evaluators (Singh)

[Coffee Break as needed]

Tuesday, 24 March 2009

09:00-12:30 Organisational Review (Tuli):

- Activities, priorities and manpower
  - Summary of ENSDF evaluations status and activities in 2008-2009
  - Revision of NSDD membership
  - Estimated manpower of each centre for ENSDF evaluations
  - Future evaluations: priorities
- Re-definition of responsibilities of current groups
- Preliminary mass assignments to new groups
- Data Bases
  - ENSDF Status (Tuli)
  - XUNDL (Singh)
  - NSR Status (Tuli)

[Coffee Break as needed]

12:30-14:00 *Lunch*

14:00-17:30 **Technical Discussions** (20-30 mins each)

1. BrIcc - current status, plans and update (Kibédi)
2. Mixing Ratio Program (Kibédi)
3. AveTool – Averaging Tools (Kibédi)
4. New band drawings and proposed new format for tables in NDS (Tuli, Singh)
5. Errors in ENSDF (Mitropolsky)
6. Revision of GTOL (Mitropolsky)

[Coffee Break as needed]

Wednesday, 25 March 2009

09:00-12:30 **Technical Discussions** (cont'd) (20-30 mins each)

7. Isomer in ^{229}Th (Mitropolsky)
8. Rotational bands in double-odd nuclei (Mitropolsky)
9. ENSDF format and evaluation philosophy/policies (Tuli)
10. Status of Analysis Codes (Tuli)
11. Treatment of discrepant data: example evaluation of ^{198}Au half-life (Singh, 10 mins)
12. Measurement of K conversion coefficient (Nica)

[Coffee Break as needed]

12:30-14:00 *Lunch*

14:00-15:30 **Horizontal Evaluations, including Needs and Plans**

Atomic masses (Audi)

New precise mass measurements and ENSDF evaluations (Singh)

Topical evaluation of Z = 9-14, N = 16-24 nuclides Island of Inversion (Singh)

The physics of nuclear moments and current state of data compilations (Stone)

Others

15:30-17:30 **Technical Discussions** (cont'd) (20-30 mins each)

13. About repeatability in high spin nuclear data (Nica) -Withdrawn
14. EGAF capture gamma-ray effort and collaboration with LLNL (Firestone)
15. Proposed revised policy for inclusion of resonance data in ENSDF (Singh)
16. Information management tools applied to nuclear structure data: developing user-friendly software to improve ENSDF interrogation and dissemination (Verpelli)
17. Pocket-ENSDF interrogation (Abriola)

[Coffee Break as needed]

19:00 **Dinner at a Restaurant in the city centre**

Thursday, 26 March 2009

09:00-12:30 **ENSDF Proposals** (20-30 mins each)

1. Proposal to expand PANDORA (Nica)
2. Cross-section normalization of gamma rays in capture gamma-ray datasets (Firestone)
3. Recommended Jπ assignments for the RIPL library (Firestone)

ENSDF Customer Services

- Dissemination of ENSDF, publications and services
- User-oriented database: NuDat (Sonzogni)
- Nuclear Wallet Cards

[Coffee Break as needed]

12:30-13:30 *Lunch*

13:30-17:00 **Nuclear Structure and Decay Activities Past, Present and Future**

- Nuclear Stucture and Decay Data Network and Alan Nichols (Tuli)
- Evolution of the NSDD evaluation efforts in Europe since 1980 (DeFrenne)
- The synthesis of SHE beyond ^{48}Ca (Gupta)
- IAEA Activities Related to Decay Data Evaluation (Kellett)
- Both Sides of the Fence (Kibédi)
- New Challenges to European Nuclear Physics (Balabanski)
- Recent Decay Data Measurements of Actinide Nuclides (Kondev)
- The IAEA roots (Herman)
- Nuclear Structure: yesterday, today and tomorrow (Nichols)

[Coffee Break as needed]

Friday, 27 March 2009

09:00-12:30 **Conclusions and Recommendations**

Adoption of recommendations and actions

NSDD chairman

Next meeting

[Coffee Break as needed]

12:30 **Adjournment**

ANNEX 3

Evaluation responsibilities: ENSDF data evaluation centres

a National Nuclear Data Center

Brookhaven National Laboratory
Upton, NY 11973, U.S.A.
Contact: J. K. Tuli
e-mail: Tuli@BNL.Gov

b. Nuclear Data Project
Oak Ridge National Laboratory
Oak Ridge, TN 37831, U.S.A.
Contact: M. S. Smith
e-mail: MSmith@ORNL.Gov

c. Isotopes Project
Lawrence Berkeley National Laboratory
Berkeley, CA 94720, U.S.A.
Contact: R.M. Clark
e-mail: RMClark@LBL.Gov

d. Triangle University Nuclear Lab.
Duke University
Durham, NC 27706, U.S.A.
Contact: J. H. Kelley
e-mail: kelley@tunl.duke.edu

e. Argonne National Laboratory
9700 South Cass Ave.
Argonne, IL 60439-4815, U.S.A.
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f. Indian Institute of Technology, Department of Physics, Roorkee Uttaranchal 247667
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Petersburg Nucl. Phys. Inst.
Academy of Sciences of Russia
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188 350, Russia
Contact: I.A. Mitropolsky
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l. Laboratorium voor Kernfysica
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m. Dept. of Physics and Astronomy
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Canada
Contact: J.C. Waddington
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n. Australian National University
Dept. of Nuclear Physics
Canberra ACT 0200, Australia
Contact: T. Kibédi
e-mail: Tibor.Kibedi@anu.edu.

A-Chain Evaluation Responsibility

a.	US/NNDC	45-50,57,58,60-73(ex 62-64),82-90(ex 89) 94-97,99,118,119,136-148,150, 152-165 (ex 164),230-240,>249
b.	US/NDP	241-249
c.	US/LBL	21-30,59,81,83,90-93,166-171,184,186,187, 191-193,210-217
d.	US/TUNL	2-20
e.	US/ANL	176-179,199-209
f.	India	218-229

Center		Mass Chains
g.	Russia/StP	130-135,146
h.	PRC	51-56,62,63,195-198
i.	France	101,104,107-109,111,113-117
j.	Japan	120-129
k.	Kuwait	74-80
l.	Belgium	102,103,105,106,110,112
m.	Canada	1,31-44,64,89,98,100,149, 151,164,188,190,194
n.	Australia	172-175

ANNEX 4

LIST OF CONTINUOUS, NEW AND COMPLETED ACTIONS

CONTINUOUS / ON-GOING / PENDING			
No.	**Responsible**	**Reason**	**Action**
1 (1)	J. Tuli, BNL/NNDC	Quality assurance test	Advise evaluators to run RADLST; comment on agreement of Q-value and sum of decay energies and X-ray intensities measured and calculated. **Continuous**
2 (2)	J. Tuli, BNL/NNDC	Update evaluations priority list.	Send yearly priority list for nuclide and mass chain ENSDF evaluations. Add priority list of the NSDD TM and network document. **Continuous**
3 (3+5)	J. Tuli, BNL/NNDC and all network participants	Keep horizontal evaluations in separate repository, to be used by evaluators.	Task for all: inform Tuli who will maintain a list of horizontal evaluations on NNDC-NDSDD Web site. **Continuous**
4 (4)	BNL/NNDC	ENSDF analysis and checking codes need to remain up to date with respect to formats, physics requirements, and the needs of the community.	Update codes for approved format changes. **Continuous**
5 (6)	All network participants	Highly-relevant information and data from some conferences, meetings and laboratory reports are not always available to NSR compilers in NNDC.	Assist NNDC in obtaining conference proceedings, meeting and laboratory reports for NSR. Copy of unpublished conference reports containing significant NSDD contribution should be sent to NNDC. **Continuous**
6 (7)	IAEA/NDS	Characteristics and parameters of NSDD network have to be regularly updated.	Update NSDD network document and institutions. **Continuous**
7 (8)	BNL/NNDC	Publish versions of ENSDF are required.	Continue journal "publication" of the mass chain evaluations. **Continuous**
8 (10)	All network participants	Misprints and errors found in NSR and ENSDF	Report errors detected in NSR and ENSDF to NNDC. **Continuous**
9 (11)	All ENSDF evaluators	Accelerate the review process.	Each ENSDF evaluator should be willing to do two mass-chain equivalent reviews per FTE-year. Reviewing process for one mass chain should not be longer than 3 months. **Continuous**

N.B. first column: number in brackets indicates the previous action number (see IAEA report INDC(NDS)-0513).

No.	Responsible	Reason	Action
10 (12)	All network participants	Ensure unpublished and current data are prepared tabular form.	XUNDL co-ordinator to ask researchers to provide data in tabular form. **Continuous**
11 (13)	All network participants	Bring NSDD evaluation work to the attention of the nuclear community.	Present network activities at different conferences and meetings. **Continuous**
12 (14)	All network participants	Avoid duplication of work.	Participants should inform the NNDC about any development of software related to NSDD. **Continuous**
13 (16)	Evaluators	Young scientists to evaluate mass chains.	Encourage participation in research/evaluation of nuclear structure data. **Continuous**
14 (17)	All network participants	Improve NSR	Send comments and suggestions on NSR improvements (indexing) to NNDC. **Continuous**
15 (18)	BNL/NNDC	Improve data that quantify Auger electron and continuum beta spectra.	ENSDF codes to provide more detailed presentations of Auger-electron and continuum beta spectra. **Continuous**
16 (19)	All ENSDF evaluators	Check validity of the rules.	Inform NNDC when experimental results appear to contradict the rules; see Section 5.4. **Continuous**
17 (20)	All network participants	Improve quality of evaluations.	Solicit potential non-network evaluation reviewers, and send names to ENSDF manager (NNDC). **Continuous**
18 (21)	NSDD Network	Support new ENSDF evaluators.	Provide local support and mentoring to new ENSDF evaluators of mass chain evaluations. **Continuous**
19 (23)	All network participants	Maintain up to date information on the Network.	Review, modify and correct the contents of INDC(NDS)-421. **Continuous (see also Action 21)**
20 (28)	R. Firestone, LBNL	Data development	Provide Mitropolsky with GAMUT code to implement improvements. Mitropolsky should maintain contact with Tuli and Firestone during this improvement process. **Ongoing**
21 (35)	A. Sonzogni, BNL/NNDC	Modification of ENSDF format to include cluster emission data.	Tandel to study feasibility. **Ongoing**
22 (37)	All network participants	Quality Assurance	Consider differences in nuclear properties between ENSDF and NWC, and adjust if deemed appropriate (after due consideration of evaluation effort for changes to ENSDF) **Continuous**
23 (43)	G. Shulyak, PNPI	To facilitate evaluators' work.	Provide copy of PNPI Editor program to NNDC, BNL. **Pending**

N.B. first column: number in brackets indicates the previous action number (see IAEA report INDC(NDS)-0513).

No.	Responsible	Reason	Action
24 (48)	BNL/NNDC; IAEA-NDS	Outreach	Continue to pursue initiatives to improve the international contributions to the ENSDF mass chain evaluations. **Continuous**
25 (51)	All network participants	Outreach	Formulate and expand contributions to mass chain evaluations within their own countries. **Continuous**

NEW			
No.	**Responsible**	**Reason**	**Action**
26	NNDC	To keep evaluators informed about new rules.	Ensure that all previous guidelines are included within existing evaluators' guidelines. **New**
27	IAEA/NDS	Keep links with horizontal evaluations.	Invite representatives of atomic mass and other horizontal evaluations to next meeting. **New**
28	NSDD evaluators	Quality Assurance	Consider updating evaluation cut-off date when no or little experimentally significant new data are available. **New**
29	Kibédi + Singh + Nichols	Quality Assurance	Draft guidelines for derivation of ground-state and isomer half-lives, and possibly other quantities. **New**
30	Verpelli-Abriola	Improvement of dissemination tools.	Provide plotting capabilities in IAEA-ENSDF tools; provide pre-structured modular SQL-queries capabilities, and band-plotting, including comments retrieval. **New**
31	All	ENSDF improvement	Send to Singh comments/criticisms on his proposal for resonance data by the end of June 2009. **New**
32	J. Tuli, BNL/NNDC	Facilitate evaluators' work.	Analyze Nica's proposal to modify PANDORA. **New**
33	J. Tuli, BNL/NNDC	Improve ENSDF to make useful to RIPL community.	Analyze Firestone proposal to include theoretical Jπ in square brackets in Jπ field or a continuation record. Advise evaluators in cases where more than one Jπ value in brackets – preferred value should be listed first (as requested by RIPL community). **New**
34	All	ENSDF improvement	Send comments before end of June 2009 on Firestone proposal for new field for neutron-capture cross-section normalization factor. **New**

N.B. first column: number in brackets indicates the previous action number (see IAEA report INDC(NDS)-0513).

No.	Responsible	Reason	Action
35	Audi	Provide evaluators with updated AMDC data.	Provide NNDC with latest interim AMDC evaluation of atomic masses by 1 May 2009, and every year thereafter. **New**
36	NSDD evaluators	Provide evaluators with updated AMDC data.	When AMDC list becomes available, evaluators should use these most recent values. **New**

COMPLETED			
No.	**Responsible**	**Reason**	**Action**
(38)	All network participants		Provide Tuli/B. Singh with comments on the proposed improvements in level scheme drawings and tables for Nuclear Data Sheets publication within 2 weeks of receipt of sample pages by e-mail. **Completed**
(39)	All network participants	To keep ENSDF rules up to date	Consider proposals of Singh/Kondev for labelling of bands, configurations and cascades – follow established rules, and provide comments and criticisms. **Completed**
(40)	A. Sonzogni, BNL/NNDC	To facilitate evaluators' work	Provide NSDD network with Java and Linux versions of ENSDF Editor by the end of 2008. **Completed**
(41)	All network participants	Quality Assurance test	Use and comment on ENSDF Editor to Sonzogni. **Completed**
(42)	G. Shulyak, PNPI	Quality Assurance test	Send list of errors found in ENSDF to Tuli by the end of July 2007. **Completed**
(44)	B. Singh, McMaster University	To keep NSDF rules up to date	Continue analysis of BM1W, and provide comprehensive recommendations to modify original Endt rules by the end of 2007. **Completed**
(45)	BNL/NNDC	To facilitate evaluators' work	Rationalise and create appropriate Web links for more convenient access to all available sources of information (including manuals and NSDD workshop material). **Completed**
(46)	All network participants	Quality Assurance test	Provide Pritychenko with feedback/comments on Web sites devoted to B(E2) and ββ-decay. **Completed**

N.B. first column: number in brackets indicates the previous action number (see IAEA report INDC(NDS)-0513).

No.	Responsible	Reason	Action
(47)	F.G. Kondev, ANL; D. Balabanski, University of Sofia	Outreach	Coordinate preparation of an informative article about nuclear data evaluations to be published in appropriate literature/journals (article to be prepared for publication by mid-2008). **Completed**
(49)	D. Balabanski, University of Sofia	Outreach	Explore methods of support for the establishment of ENSDF mass chain evaluations from within Europe. **Completed**
(50)	J. Tuli, BNL/NNDC; A. Nichols, IAEA/NDS	Outreach	Assist in the various national initiatives to improve non-North American contributions to the ENSDF mass chain evaluations – e.g. EU FP7 Town meeting in Helsinki, September 2007. **Completed**
(52)	A. Sonzogni, BNL/NNDC	Improvement of dissemination tools	NuDat: introduce ± symbol to the 'non-standard' layout of ENSDF data with respect to uncertainty (e.g. ± 1.5). **Completed**
(53)	A. Sonzogni, BNL/NNDC	Improvement of dissemination tools	NuDat: acknowledge ENSDF as the data source for NuDat (e.g. at bottom of main Web page). **Completed**
(54)	IAEA/NDS	NSR updates	Bring NSR key-wording responsibilities of NDS in-line with NNDC key-wording timetable. **Completed**
(55)	J. Tuli, BNL/NNDC	Make introductory material easily available.	Approach Elsevier to make introductory material on NSDD available on their Web site and replace old RUL with new. **Completed**
(9)	IAEA/NDS	Co-ordinate network activities in the lengthy period between NSDD meetings	Nominate chairman and deputy chairman for next NSDD meeting at the current NSDD meeting. **Withdrawn**
(22)	J. Tuli, BNL/NNDC	Network should be made aware of needs of NSDD users.	List of horizontal evaluation needs and on-going evaluation activities should be maintained through the NSDD network. **Withdrawn**
(36)	A. Sonzogni, BNL/NNDC		Provide NSDD evaluation centres with a list of radionuclides/details for which either $T_{1/2}$, Jπ and/or decay modes differ between ENSDF and NWC. **Withdrawn**

N.B. first column: number in brackets indicates the previous action number (see IAEA report INDC(NDS)-0513).

ANNEX 5

STATUS REPORTS OF EVALUATION CENTRES

NSDD Meeting, March 23-27, 2009, Vienna, Austria

Report of the National Nuclear Data Center

M. Herman, *et al.*
National Nuclear Data Center
Brookhaven National Laboratory, Upton, NY 11973

March 2009

This report presents the status of nuclear structure, decay data, and related activities of the National Nuclear Data Center (NNDC) for the period June 2007 to February 2009, *i.e.,* since the 2007 NSDD meeting. The name of the NNDC staff member who has the lead responsibility for the part of the activity is given in parentheses.

ENSDF Evaluations Activity (J. Tuli)

NNDC responsibility consists of all mass chains not assigned to any other data center. Currently, it consists of the following 115 mass chains: A = 45-50, 57, 58, 60-73 (ex 62-64), 82-88 (ex 83), 94-99 (ex 98), 118, 119, 136-163 (ex 149, 151), 165, 230-240, >249.

The following mass-chains were evaluated/published since the last meeting (06/2005):

Mass	No. Of Nuclides	Evaluator(s)	Status
45	12	Burrows	Published
49	10	Burrows	Published
72*	6	Sonzogni	Post-Review
96*	7	Sonzogni	Published
97	14	Nica	Post-Review
102	14	De Frenne	Post-Review
137*	15	Browne/Tuli	Published
140	16	Nica	Published
145	16	Browne/Tuli	Published
147	16	Nica	Published
154	15	Reich	Post-Review
155Ta	1	Reich	In ENSDF
159Re	1	Reich	In ENSDF
162	15	Reich	Published

Mass	No. Of Nuclides	Evaluator(s)	Status
225	8	Jain/Raut/Tuli	Final
229	8	Browne/Tuli	Published
230	9	Browne/Tuli	Published
240*	1	Browne	Published
266Rf,270Bh,	2	Burrows	In ENSDF
274Mt,278Rg,			
28213*			

The following mass chains are in progress:

A = 95*, 103, 119, 150, 163, 265-269

(* indicates collaboration with other evaluators)

FTE: 2.95 including the NNDC staff (A. Sonzogni, S. Tandel, and J. Tuli) and four subcontracted evaluators (E. Browne, D. De Frenne, N. Nica and C. Reich).

ENSDF Evaluation Reviews (J. Tuli)

The following evaluations were reviewed:

Browne	178,206
Reich	106,127,147,169,182,198,200
Tuli	55,104,107,108,111,137,214,221,230,234
De Frenne	78, 81, 97

ENSDF Evaluation Processing and Nuclear Data Sheets (J. Tuli)

On an average there were ~22 mass chains in the production pipeline at various stages of production. Evaluations received are checked for their consistency, format and physics content. The manuscripts prepared are returned to evaluators for their approval before they are sent for review. After review, and with corrections and changes made post-review by the evaluator, the final checks are made and the manuscripts prepared for publication.

Every month processing status report is sent to the network.

One issue of **Nuclear Data Sheets** (NDS) was prepared and sent every month to Elsevier.

Twenty mass chains were published in 2007, and seventeen in first eleven issues in 2008. The December issues were special issues of Nuclear Data Sheets with non-ENSDF based content.

The published page count in NDS was 2755+intro pages in calendar year 2007 and 2922+intro pages in 2008.

ENSDF Evaluation Priority and Maintenance (J. Tuli)

A list of nuclides for priority evaluation is prepared and distributed once a year. The last distribution was on April 17, 2008.

NNDC continues to maintain, update, and distribute ENSDF. ENSDF statistics (as of February 18, 2009):

Nuclides	3,045
Datasets	16,525
Records	2,219,000
Size	165 MB
Comments Datasets	456
Adopted Datasets	3,048
Decay Datasets	3,892
Reaction Datasets	8,738
Reference Datasets	291

ENSDF is updated continuously. Two different versions are maintained. One in its original form as sent by the evaluators and the other after it is translated using COMTRANS. The former version is available only via the NNDC web site www.nndc.bnl.gov/nndc/evalcorner.

ENSDF is distributed twice a year. The last distribution was on October 20, 2008. The distribution is in two modes, an update to the file as well as the full ENSDF. The IAEA Nuclear Data Section receives the full file every month.

Nuclear Wallet Cards (J. Tuli)

All copies of Nuclear Wallet Cards for Radioactive Nuclides published in March 2004 have been distributed.

The seventh edition, April 2005, of Nuclear Wallet Cards was produced in July 2005 with 10000 copies printed. About 8000 copies have been distributed. The Nuclear Wallet Cards data file is updated twice a year following ENSDF distribution and is available online.

The next edition of Nuclear Wallet Cards is planned for the year 2010.

Nuclear Science References (M. Bhattacharya)

NSR highlights for the period June-2007 to February-2009:

- 5,780 references added.
- 195,160 total entries.
- 330,000 web queries.
- Significant (50%) reduction in the number of articles published in NPA, EPJ-A, and PLB.
- "Recent References" published quarterly and yearly on the website.

Keyword abstract preparation by the Nuclear Data Section, IAEA Vienna:

- Since late 2005, IAEA Vienna took responsibility for preparing keywords for three European journals, *viz*., Nucl. Phys. A, Eur. Phys. J. A, and Phys. Lett. B.
- Files are prepared at NNDC and sent to Vienna for keywording.
- After few initial glitches, the process is now running smoothly.

Keyword abstract preparation by students at McMaster University:

- A trial phase of preliminary abstract preparation by undergraduate students at McMaster under the supervision of Balraj Singh was undertaken for the past year.
- Files are prepared at NNDC and sent to McMaster for keywording.
- Keyworded files are thoroughly checked for accuracy and completeness at NNDC by the NSR database manager.
- The future of this effort depends on availability of suitable students and someone to train and supervise them in preparing preliminary keyword abstracts in a timely fashion.

Training and Mentoring (J. Tuli)

Jagdish K. Tuli helped organize, and served as co-director, for four IAEA sponsored Nuclear Structure Evaluation and Theory workshops held at ICTP, Trieste, Italy. The first workshop was sponsored by the IAEA, but hosted by the ICTP, and was held during Nov 17-28, 2003. The second and third workshops were jointly sponsored by the IAEA and ICTP, and hosted by the ICTP, and were held during April 4-15, 2005 and Feb 20-March 3, 2006, respectively. The fourth workshop took place at Trieste during April 28-May 9, 2008. Jagdish Tuli and Thomas Burrows, from NNDC, lectured at first three workshops and Jagdish Tuli and Alejandro Sonzogni at the fourth workshop. They also conducted hands-on training for the participants. The materials were prepared, presented and published as the IAEA reports.

Jagdish Tuli also attended and lectured at the DDP workshop at Bucharest during May 12-14, 2008 immediately following the Trieste workshop.

Thomas Burrows mentored and collaborated with Dr. Mohini Gupta of India (a Trieste-03 trainee) in the evaluation of A=260-265. He visited her in India during January 2008. Tom also mentored Dr. Ninel Nica of Texas A&M (a Trieste-05 trainee).

Alejandro Sonzogni mentored and continues to collaborate with Dr. S. Basu of India in evaluations of A=95, 150. Dr. Basu visited NNDC during summers of 2007 and 2008. Alejandro also mentored and continues to collaborate with Dr. Daniel Abriola of IAEA (a Trieste-05 evaluators' workshop trainee) in evaluation of A=72.

Dr. Ashok Jain, R. Raut (Trieste-08 trainee), both of India, and D. Symochko (Trieste-08 trainee), Ukraine, visited Jagdish Tuli at various times and collaborated with evaluations of A=119, 225.

ENSDF Analysis and Checking Codes (S.K. Tandel)

The ENSDF analysis and checking codes continue to be maintained and improved. Recent improvements and their current status are given in a separate report (Appendix A), accompanying these distributions. In addition to NSDFLIB and RULER, FORTRAN 95 versions of ALPHAD, ComTrans, FMTCHK, ENSDAT, GTOL, and PANDORA have been distributed and the FORTRAN 95 versions of the remaining programs are undergoing in-house testing. BrIcc 1.3 ("No hole" approximation), BrIcc 2.0 ("Frozen orbitals" approximation), and BrIcc 2.2 (with extended data tables for Z=5-110, in both BrIccFO and BrIccNH) have been released since the last network meeting; this is a result of collaboration between the Australian National University, National Nuclear Data Center, Petersburg Nuclear Physics Institute, and University of Tennessee. FMTCHK has implemented several new checks based on an error report from PNPI; BrICC outputs can now be recognized. GTOL was converted to double precision to solve platform-dependent problems and additional tables were added to its report. LOGFT had logic added for third and higher order beta transitions. The dimensions for GAMINT were increased in PANDORA, among other modifications. RADLIST was updated to handle BrICC outputs. An initialization problem in RULER was corrected.

NuDat (A. Sonzogni)

Versions 2.4 and 2.5 of NuDat were released since the 2007 meeting. The last version was made available to the public in March 2009. The following are the main upgrades to NuDat:

a) Search for reduced gamma ray transitions in Weisskopf units.
b) Direct access to ENSDF files
c) Charts of nuclides with many more coloring schemes, such as neutron and proton separation energies, alpha Q-values, first 2+ energy; as well as some data from the ENDF/B-VII.0 library.

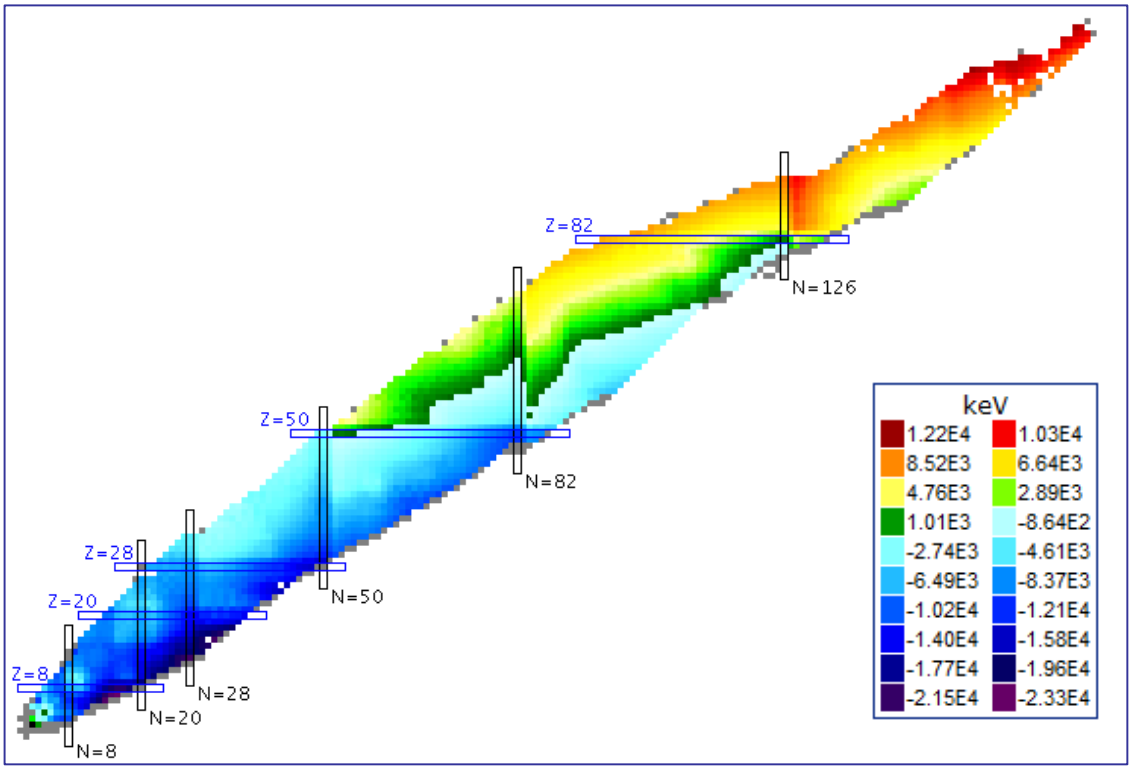
A succinct summary of NuDat contents as of March 2009 is given in the table below:

Number of nuclides	3,175
Number of levels	154,134
Number of levels with known half-life	22,594
Number of gamma rays	230,647
Number of alpha transitions	2,040
Number of gamma-gamma coincidences	2,908,564

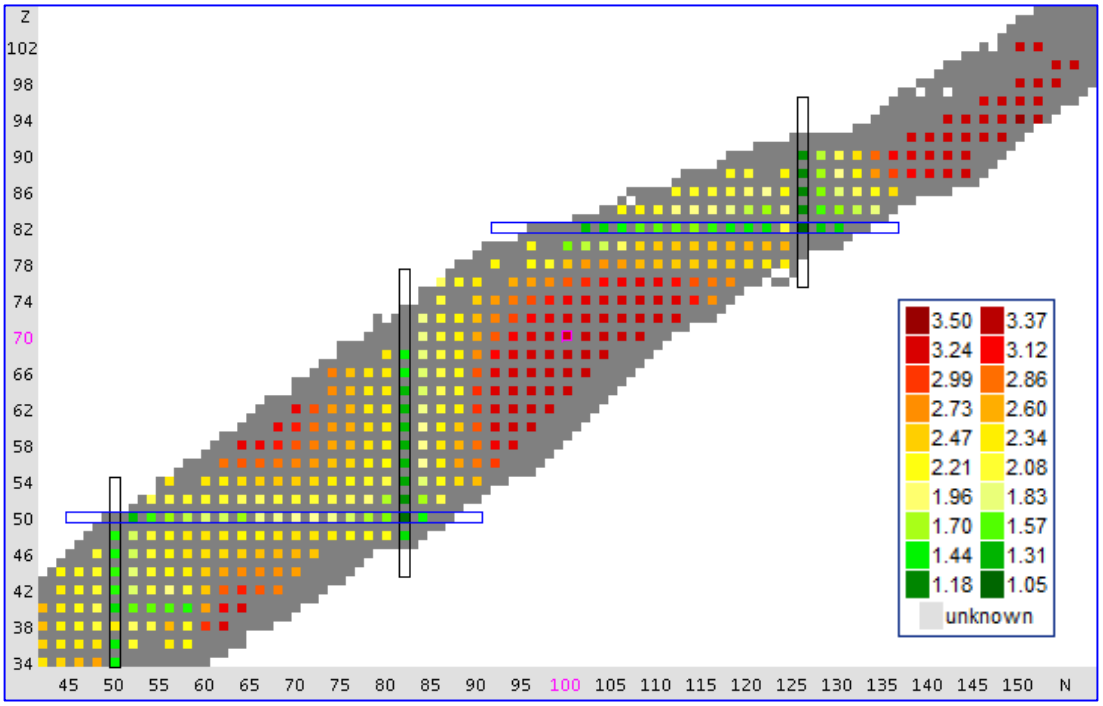
There were 2.066 million retrievals performed from NuDat in the last two years from a very diverse body of users.

As an example of some the chart plots that can be generated with NuDat, we show the alpha Q-value, the ratio of the first 4+ to the first 2+ energy, and the capture cross section for neutrons at thermal energies.

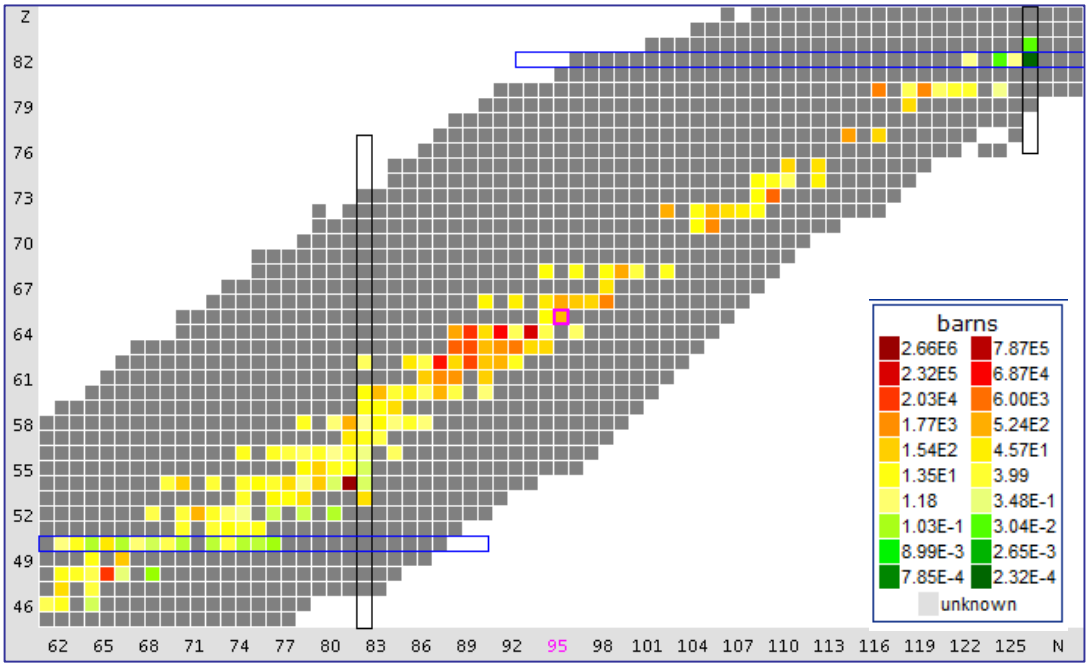
Alpha Q-values from 2003 Audi evaluation:



Ratio of first 4+ to first 2+ energies from ENSDF



Capture cross sections for thermal neutrons from ENDF/B-VII.0



NNDC Computer System (R. Arcilla)

During the reporting period, the NNDC performed the following computing infrastructure upgrades to meet the growing requirements of the nuclear structure and decay data community:

1) Purchased four new Dell servers, i.e. two Web servers and two database servers, to replace the servers which have been powering the NNDC Web-based data services system since April 2004. At the time of writing, the NNDC and BNL's IT department have been installing, configuring and testing the new servers to ensure reliability, high-availability and security for their end-users. Once in production, these servers are expected to offer approximately four times the processing power of the existing ones and will allow NNDC to offer better services.

2) Purchased a new Dell server to replace the aging Linux working server. The new server has been offering a more powerful, a more capable, a more secure and a more modern computing environment for NNDC personnel and its visitors.

3) Upgraded the NNDC local area network (LAN) bandwidth from 100 Megabits/second to 1 Gigabit/second. The higher bandwidth provides a significantly improved network response time for NNDC personnel, its visitors and its remote users.

Horizontal Evaluations & Compilations (B. Pritychenko)

NNDC is continuing to compile and evaluate B(E2) and ββ-decay data. In the last two years 40 and 29 new experimental results were added to the B(E2) and ββ-decay compilations, respectively. NNDC list of adopted ββ-decay values is a primary source of such data on Wikipedia.

Nuclear Data Web Services (B. Pritychenko)

NNDC is continuing to improve its services, accessible at http://www.nndc.bnl.gov, by upgrading its computer infrastructure as described above and improving web retrieval capabilities.

In preparation for an upcoming upgrade of Web and database server hardware and software:

- Web applications were tested with the latest Enterprise version of Red Hat Linux operating system, Apache 2.2.8 and Tomcat 5.5 Web server software. The results indicate high quality and reliability of Java-based applications and possible problems with the Perl legacy codes.

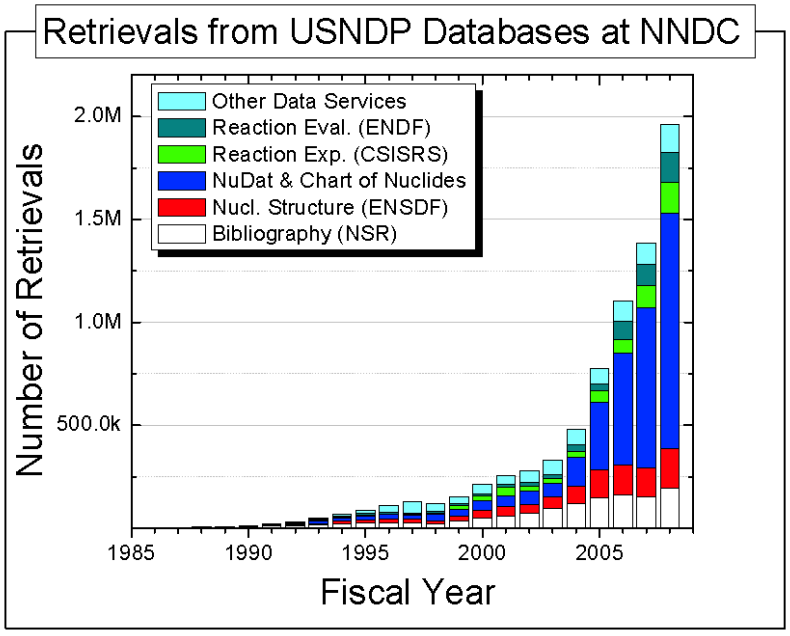
New and/or improved nuclear structure data services introduced in the last two years:

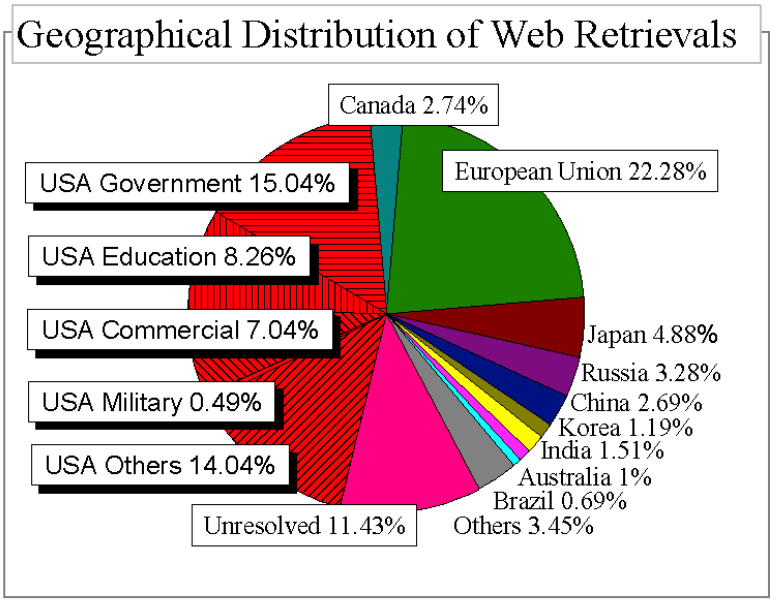
- NuDat 2.4 and 2.5
- NSR 2
- ENSDF Analysis & Utility Programs, http://www.nndc.bnl.gov/nndcscr/ensdf_pgm/
- NSDD Evaluator's Corner, http://www.nndc.bnl.gov/nndc/evalcorner/

The new services and upgrades significantly improved capabilities and user friendliness and increased the value of the NNDC Web services.

Total number of data retrievals at NNDC in fiscal year 2008 increased to 1,961K versus 1,386K in 2007. In the same period, ENSDF data retrievals grew from 142K to 194K, NSR from 153K to 192K and NuDat & Chart of Nuclides data retrievals increased from 776K to 1,145K.

NNDC web retrievals as a function of time and its geographical distribution are shown in the following plots:





Selected NNDC Publications (6/2007-12/2008)

On the NNDC webpage, http://www.nndc.bnl.gov/articles/jsp/references/formrefs.jsp, a complete list of recent papers and reports by the NNDC staff can be found. A selected list of ENSDF-related papers, published in refereed journals, by the NNDC staff and its subcontracted evaluators is as follows:

Authors	Title	Category	Reference	Year
1	B.Pritychenko, A.A.Sonzogni	Sigma: Web Retrieval Interface for Nuclear Reaction Data	paper	Nuclear Data Sheets **109** 2822	2008
2	D.Rochman, M.W.Herman, S.F.Mughabghab, P.Oblozinsky	New evaluation of the 99Tc neutron-induced cross sections for the ENDF/B-VII.0 library	paper	Nucl.Science and Eng. **158** 68	2008
3	G.Noguere, D.Bernard, C.De Saint Jean, B.Iooss,	Assessment and Propagation of the 237Np	paper	Nucl.Science and Eng. **160** 108	2008

	F.Gunsing, K.Kobayashi, S.F. Mughabghab, P.Siegler	Nuclear Data Uncertainties in Integral Calculations by Monte Carlo Techniques			
4	G.Tagliente, ..., M.T.Pigni, ..., n TOF Collaboration	Experimental study of the 91Zr(n,gamma) reaction up to 26 keV	paper	Phys.Rev.C **78** 045804	2008
5	G.Tagliente, ..., M.T.Pigni, ..., n TOF Collaboration	Neutron capture cross section of 90Zr: Bottleneck in the s-process reaction	paper	Phys.Rev.C **77** 035802	2008
6	H.Hiruta, G.Palmiotti, M.Salvatores, R.Arcilla, Jr., P.Oblozinsky, R.D.McKnight	Few group collapsing of covariance matrix data based on a conservation principle	paper	Nuclear Data Sheets **109** 2801	2008
7	H.Il.Kim, M.Herman, S.F.Mughabghab, P.Oblozinsky, D.Rochman, Y.-O.Lee	Evaluation of Neutron Cross Sections for a Complete Set of Nd Isotopes	paper	Nucl.Science and Eng. **160** 168	2008
8	H.Il.Kim, M.Herman, S.F.Mughabghab, P.Oblozinsky, Y.-O.Lee	Evaluation of neutron cross sections for a complete set of Dy isotopes	paper	Nucl.Instrum.Methods Phys.Res.A **266** 3513	2008
9	H.Wienke, R. Capote, M.Herman, M. Sinl	Deformation-dependent Tamura-Udagawa-Lenske multistep direct model	paper	Phys.Rev.C **78** 064611	2008
10	J.R.Terry, ..., B.Pritychenko	Single-neutron knockout from intermediate energy beams of 30,32Mg: Mapping the transition into the ''island of inversion''	paper	Phys.Rev.C **77** 014316	2008
11	M. Bhattacharya,	ft value of the 0+ to 0+	paper	Phys.Rev.C **77** 065503	2008

	et al.	beta+ decay of 32Ar: A measurement of isospin symmetry breaking in a superallowed decay			
12	M.Herman, M.T.Pigni, P.Oblozinsky, S.F.Mughabghab, C.M.Mattoon, R.Capote, Y.-S.Cho, A.Trkov	Development of covariance capabilities in EMPIRE code	paper	Nuclear Data Sheets **109** 2752	2008
13	M.Salvatores, G.Palmiotti, G.Aliberti, H.Hiruta, R.McKnight, P.Oblozinsky, W.S.Yang	Needs and Issues of Covariance Data Application	paper	Nuclear Data Sheets **109** 2725	2008
14	M.T.Pigni, M.Herman, P.Oblozinsky	Extensive set of cross section covariance estimates in the fast neutron region	paper	Accepted for publication in Nuclear Science and Engineering	2008
15	M.T.Pigni, M.Herman, P.Oblozinsky	Estimated 55Mn and 90Zr cross covariances in the fast neutron energy region	paper	Nuclear Data Sheets **109** 2900	2008
16	R.Arcilla, A.C.Kahler, P.Oblozinsky, M.Herman	Processing Neutron Cross Section Covariances using NJOY-99 and PUFF-IV	paper	Nuclear Data Sheets **109** 2910	2008
17	R.C.Little, T.Kawano, G.D.Hale, M.T.Pigni, M.Herman, P.Oblozinsky, M.L.Williams, M.E.Dunn, G.Arbanas, D.Wiarda, R.D.McKnight, J.N.McKamy, J.R.Felty	Low-fidelity Covariance Project	paper	Nuclear Data Sheets **109** 2828	2008
18	S.F.Mughabghab, P.Oblozinsky	Neutron Cross Section Uncertainties	paper	Nuclear Data Sheets **109** 2863	2008

		in the Thermal and Resonance Regions			
19	T.Kibedi, T.W.Burrows, et al.	Evaluation of theoretical conversion coefficients using BrIcc	paper	Nucl.Instrum.Methods Phys.Res.A **589** 202	2008
20	T.W.Burrows	Nuclear Data Sheets for A = 45	paper	Nuclear Data Sheets **109** 171	2008
21	T.W.Burrows	Nuclear Data Sheets for A = 49	paper	Nuclear Data Sheets **109** 1879	2008
22	A.Algora, ..., A.Sonzogni, et al.	Exploring the reactor heat problem: Study of the beta decay of 104,105Tc using the TAS technique	paper	Eur.Phys.J.Special Topics **150** 383-384	2007
23	A.K.Jain, S.Singh, S.Kumar, J.K.Tuli	Nuclear Data Sheets for A = 221	paper	Nucl.Data Sheets **108** 883	2007
24	E. Birgersson, ..., D. Rochman, et al	Light fission-fragment mass distribution from the reaction 251Cf(nth, f)	paper	Nucl.Phys.A **791** 1	2007
25	E.Brown, J.K.Tuli	Nuclear Data Sheets for A = 137	paper	Nucl.Data Sheets **108** 2173	2007
26	E.Brown, J.K.Tuli	Nuclear Data Sheets for A = 234	paper	Nucl.Data Sheets **108** 681	2007
27	J.A.Zimmerman, ..., B.Pritychenko, et al.	Nuclear reactions with radioactive, isomer beams: Coulomb excitation of 18Fg.s. and its Jpi=5+ isomer 18Fm using a large position-sensitive NaI array	paper	Nucl.Instrum.Methods Phys.Res.A **579** 476	2007
28	M.Herman, R.Capote,	EMPIRE: Nuclear	paper	Nucl.Data Sheets **108** 265	2007

	B.V.Carlson, P.Oblozinsky, M.Sin, A.Trkov, H.Wienke, V.Zerkin	Reaction Model Code System for Data Evaluation			
29	T.W.Burrows	Nuclear Data Sheets for A = 47	paper	Nucl.Data Sheets **108** 923	2007
30	Y.Danon, ..., D.Rochman, et al.	Measurements with the high flux lead slowing-down spectrometer at LANL	paper	Nucl.Instrum.Methods Phys.Res.B **261** 953	2007

Appendix A

Current Status of ENSDF Analysis and Utility Codes

A. With the exception of RadList all ANSI, Open-VMS, Linux, and MS Windows versions are current with those maintained in-house at the NNDC.
B. All analysis and utility codes converted to FORTRAN 95 (C.L. Dunford)
    1. ALPHAD, ComTrans, FMTCHK, ENSDAT, GTOL, NSDFLIB, PANDORA, and RULER distributed
    2. Further in-house testing before distribution of remaining programs
    3. Compaq/Digital Visual FORTRAN for Windows and Lahey/Fujitsu FORTRAN 95 for Linux.
C. Code Revisions (See the relevant "Read Me's" for additional details):

BrICC	1. BrICC 2.2 (Band-Raman Internal Conversion Coefficients using the "frozen orbitals" hole approximation) distributed	
	2. Corrected problems in merging new records into original file	
ComTrans	ENSDF translation dictionary files (ensdf_dic.dat and ra_ensdf_dic.dat) updated to May 4, 2007	
ENSDAT	1.	Program updated to correspond to the May 4, 2007 of the Nuclear Data Sheets publication program
	2.	ENSDF translation dictionary files (ensdf_dic.dat and ra_ensdf_dic.dat) updated to May 4, 2007
FMTCHK	1.	Corrected more problems associated with parsing reactions
	2.	Added check for embedded "+" or "-" in outgoing reactions.
	3.	Allow "XREF=A(123?)" and "XREF=A(?)"
	4.	Corrected problems in GetOut which caused an infinite loop
	5.	Corrected problem in checking Parent Comment records when multiple SF parents on DSID
	6.	Corrected erroneous "NO FINAL LVL" messages when non-numeric gamma energy given
	7.	Corrected erroneous "EL-EG" messages when parent level had "SP" or "SN" in energy field
	8.	Added a check for multiple "FL="'s
	9.	Corrected logic problem which was causing the Level record S field not to be checked when it was relabeled
	10.	Added check for possible typo error if a period is in the last field of a value and a number is in firsf field of the uncertainty
	11.	Attempt to handle cases where level energy should probably be "E+X+Y" which is not currently allowed
	12.	Added various additional checks for extraneous characters, embedded blanks, and junk
	13.	Check for use of period instead of comma
	14.	Added check for missing MS field if $T_{1/2} \leq 1$ ms and not g.s.
	15.	Cleared up problems in getting closest levels if "X+E" were used instead of "E+X"

GTOL	1.	Converted to double precision to address platform-dependent precision problems
	2.	Table comparing input level energies to calculated energies added
	3.	Table comparing input transition energies to calculated energies with χ^2s added.
	4.	Compare normalized χ^2 to critical χ^2 and output warning to terminal and report file if exceeded
	5.	FORTRAN 95 version released
	6.	Changed logic for processing FL=? so that RI and TI would be included in RI(OUT) and TI(OUT)
	7.	Added query to allow user to specify theoretical DCC to be assumed (HSICC, BrICC, or Other). Changed default ICC's from HSICC to BrIcc.
	8.	Added some checks in attempt to determine if level should be held fixed in the least-squares fit
	9.	Added option to place "G" in level energy field. Similar to "F" option but uncertainty will be added in quadrature with that derived from the least-squares adjustment
	10.	Reworked logic so matrix would be recalculated if "FL=" gamma had not been placed within ±10 keV
	11.	Added check on unrealistic large diagonal matrix elements to handle differences between LF95 and DVF
	12.	Added check for level energies such as "SN+X" and ignore de-exciting gammas
	13.	Fixed spurious error message when End of File followed an END record
PANDORA	1.	Modified dimensions of adopted level parameters to be consistent with MAXLEV parameter.
	2.	Added check for existence of source datasets before trying to create file with new XREF's.
	3.	Increased dimensions in GAMINT from 150 to 500 to handle primary capture gammas
RULER	1.	Corrected initialization problem caused in porting from F77 to F95 (null character in F95 instead of " " in F77 if string not initialized). This caused the program to sometimes skip calculations
	2.	Added logic in attempt to correctly calculate values if Γ's or very short $T_{1/2}$'s are given on Level records
	3.	Completely rewrote logic for handling asymmetric uncertainties
	4.	Added comparison of calculated BEλW's and BMλW's or old values, if kept, to RUL and noted discrepancies
	5.	Checked to see if there was an existing BEλW or BMλW and missing multipolarity, δ, *etc.*

	6.	Added four possible warnings to standard output: a. $T_{1/2}$'s in eV or as and insufficient data to derive Γ_γ's b. BEλW or BMλW found but no multipolarity, Δπ unknown, or mixed MULT with no δ c. Problem with asymmetric uncertainties d. Some BEλW's or BMλW's exceed RUL
	7.	Corrected problem for mixed transitions which led to an old transition probability being kept if the other value agreed with the new value
	8.	Cleaned up some problems in the comparison mode which resulted in confusion between IV and IS RUL's
	9.	Cleaned up some formatting problems of new records
	10.	Changed default for theoretical CC's from HSICC to BrIcc
	11.	Automatically create a new file summarizing problems when calculating new values

Analysis Codes								
Code	**Function**	**Version No./Date**	**FORTRAN**					**Documentation**
			ANS[a]	**DVF[b]**	**VMS[c]**	**UNX[d]**		
						Linux	**UNIX**	
ALPHAD	Calculates α R_0's, HF's and theoretical $T_{½}(\alpha)$'s	2.0a 20061106	X	X		X		No (See "Read Me" file)
BrIcc	Calculates internal conversion coefficients, internal electron-positron pair formation coefficients, and E0 electronic form factors	2.2 20080402	-	X[e]		X[ef]	X[eg]	Yes
DELTA	Analyzes angular correlation data	1.01 19930415	X	X	X	X[h]		LUNFD/(NFFR-3048) 1-27

GABS	Calculates absolute ΔI_γ's	9.2 20010207	X	X	X	X[h]	Yes
GTOL	Determines level energies from a least-squares fit to E_γ's & feedings	7.2e 20070601	X	X		X	BNL-NCS-23375/R LUNFD/(NFFR-3049) 1-27
HSICC	Interpolates internal conversion coefficients	11.13f 20011009	X	X	X	X[h]	Nucl. Data **A4**, 1 Nucl. Data Tables **A6**, 235 Nucl. Data Tables **A9**, 119 BNL-NCS-23375/R (1977)
LOGFT	Calculates log *ft*	7.2a 20010220	X	X	X	X[h]	Nucl. Data Tables **A10**, 206 BNL-NCS-23375/R (1977)
NSDFLIB	Support sub-programs for many codes	FORTRAN77 1.5d 19990628	X[i]				Yes
		FORTRAN95 1.6g 20051114	X	X		X	Yes
PANDORA	Physics check of ENSDF data sets. Aids with adopted gammas & XREF	7.0b 20070501	X	X		X	Yes

RadList	Calculates atomic & nuclear radiations. Checks energy balance	5.5 19881005	X	X	X		BNL-NCS-52142
RULER	Calculates reduced transition probabilities	3.2a 20070806	X	X		X	Yes

a ANSI-standard FORTRAN 95, except as noted
b Compaq/Digital Visual Fortran (Win 9x/ME/NT/2000/XP)
c Open VMS Fortran, except as noted
d Lahey/Fujitsu FORTRAN 95, except as noted
e Only executables are available
f INTEL FORTRAN 90
g Digital FORTRAN 90
h Linux GNU f77 Fortran
i ANSI-standard FORTRAN 77

Utility Codes							
Code	**Function**	**Version No./Date**	**FORTRAN**				**Documentation**
			ANS[a]	**DVF[b]**	**VMS[c]**	**UNX[d]**	
ADDGAM	Adds gammas to adopted data set	1.4 20010207	X[e]	X	X	X[f]	No (See "Read Me" file)
COMTRANS	Converts the text comments of an ENSDF dataset to a "rich text format"	7.1 20031124		X [g]		X [g]	No (See "Read Me" file)
ENSDAT	Produces tables and drawings	12.19 20070501		X [g]		X [g]	No (See "Read Me" file)
FMTCHK	ENSDF format checking	10.3a 20071028	X	X		X	No (See "Read Me" PDF or "Read Me" in HTML)
NSDFLIB	Support subprograms for many codes	See above					
TREND	Tabular display of ENSDF data	8.3 20010207	X[e]	X	X	X[f]	No (See "Read Me" file)

a	ANSI-standard FORTRAN 95, except as noted	e	ANSI-standard FORTRAN 77
b	Compaq/Digital Visual Fortran (Win9x/ME/NT/2000/XP)	f	Linux GNU f77 Fortran
c	OpenVMS Fortran	g	Only the executables are available
d	Lahey/Fujitsu FORTRAN 95, except as noted		

IAEA Report
D. Abriola

Nuclear Data Section
Department of Nuclear Sciences and Applications
NSDD Meeting, Vienna, March 2009

IAEA, NSDD activities

- **NSR Compilation**
- **ENSDF Mass chain evaluation**
- **ENSDF-related software**
- **Report on the IAEA NSDD Network and Workshops (Nichols, this afternoon)**
- **ICTP-IAEA workshop on NSDD, April/May 2008**
- **IAEA Technical Meeting - Reference Data Libraries for Nuclear Applications - ENSDF, 10-11 November 2008 (European angle)**
- **IFIN-HH workshop on NSDD, 30 March – 3 April 2009**
- **Consideration of future ICTP-IAEA workshops**

NSR Compilation
Background and IAEA coverage

- **Compilation began in September 2005**
- **Three journals covered by the IAEA (~20-25% of NSR entries):**
  - **Nuclear Physics A (NUPAB)**
  - **European Physical Journal A (ZAANE)**
  - **Physics Letters B (PYLBB)**

IAEA/NNDC collaborative visits
IAEA designated M.A. Kellett as NSR keyword compiler:

- **Initial one week visit to NNDC, July 2005**
- **Second one week visit to NNDC, Dec 2005**
- **D. Winchell, one week visit to IAEA, June 2006**
- **Third one week visit to NNDC, Oct 2006**
- **M. Bhattacharya, one week visit to IAEA, Oct 2007**

IAEA keyword compilation statistics
IAEA has compiled the following papers:

- **2005: 258 [134] (from Sept to Dec)**
- **2006: 479 [348]**
- **2007: 869 [495]**
- **2008: 529 [298]**
- **2009: 118 [57] (to end of Feb)**
- **Total: 2253 [1332] papers in ~3.5 years**

ENSDF Mass chain evaluation

D. Abriola in collaboration with A. Sonzogni (NNDC):

Mass chain A = 96 (14 nuclides) was evaluated in 2007, and published in NDS 109 (2008), 2501-2655

Mass chain A = 72 (12 nuclides) was evaluated in 2008, has been submitted to NNDC and has been in review since January 2009

ENSDF-related software

M. Verpelli has developed:

- **Interactive chart of nuclei**
- **Graphic interface to interrogate ENSDF**
- **Pocket ENSDF relational database**

Interactive chart of nuclei is mainly a dissemination tool, while the graphical interface and Pocket ENSDF are meant as tools for evaluators and specialists.

Isotopes Project

R.B. Firestone (Group Leader), C.M. Baglin, M.S. Basunia,
Guests: E. Browne, O. Helene, H. Choi

Progress Report to the IAEA Advisory Group Meeting on the Nuclear Structure and Decay Data Evaluators' Network
Vienna, Austria
March 23-27, 2009

Mass Chain Responsibility:

A=21-30, 59, 81, 83, 90-93, 166-171, 180-187, 189, 191-193, 210-217

Mass Chain Publications:

A=24 – NDS, **108**, 2319 (2007)
A=25 – submitted
A=28 – ^{28}Ne
A=29 – ^{29}Ne, ^{29}Na in ENSDF
A=30 – ^{30}Ne,^{30}Na,^{30}Mg in ENSDF
A=81 – NDS, **109**, 2257 (2008)
A=93 – submitted
A=137 – NDS, **108**, 2173 (2007)*
A=145 – NDS, **110**, 507 (2009)*
A=166 – NDS, **109**, 1103 (2008)
A=169 – NDS, **109**, 2033 (2008)
A=170 – ^{170}Os, ^{170}Ir in ENSDF
A=179 – NDS, **110**, 265 (2009)
A=184 – submitted
A=187 – submitted
A=214 – NDS, **110**, 681 (2009)
A=229 – NDS, **109**, 2657 (2008)*
A=230 – in ENSDF*
A=240 – NDS, **109**, 2439 (2008)†
* with NNDC, † with McMaster

Neutron Capture Gamma-ray Data:

Evaluated Gamma-ray Activation File (EGAF) – the Isotopes Project evaluates neutron capture γ-ray data in collaboration with the IAEA and the Budapest Reactor Centre. These data are compiled in the EGAF database and are available on the Internet with the IAEA PGAA data viewer (http://www-nds.iaea.org/pgaa/pgaa7/index.html) or from the Isotopes Project website at http://ie.lbl.gov/ng.html.

LBNL/LLNL ENDF Neutron Capture Gamma Library – the Isotopes Project is collaborating with LLNL to put EGAF data into an ENDF format database. This collaboration led to the Brad Sleaford's PhD Thesis *Improved Neutron Capture Data and Evaluation with Statistical Nuclear Structure Models for Transport Libraries* under the direction of R.B. Firestone. ENDF datasets for Z=1-19, 74 have been completed and datasets for Fe and Gd are in progress.

IAEA CRP - *Reference Database for Neutron Activation Analysis* - k_0 data from De Corte/Simonits [ADNDT 85, 47-67 (2003)], σ_0 data from Mughabghab (Atlas of Neutron Resonance), and σ_γ measurements from the Budapest reactor are being evaluated to develop a new k_0/σ_γ database for Neutron Activation Analysis (NAA). See http://www-nds.iaea.org/naa/index.htmlx.

Thermal Neutron Capture Cross Section Measurements:

Neutron Capture γ-ray cross sections σ_γ have been measured using a guided neutron beam at the Budapest Reactor Centre. Total radiative thermal neutron cross sections σ_0 have been deduced directly from these data for light elements and with the aid of statistical calculations for heavy elements.

Reaction	σ_0 (This work)	σ_0(Compiled value)[a]
$^{6}Li(n,\gamma)^{7}Li$	52.6 mb 22	44.8 mb 30
$^{7}Li(n,\gamma)^{8}Li$	46.3 mb 13	45.4 mb 27
$^{10}B(n,\gamma)^{11}B$	390 mb 11	305 mb 16
$^{11}B(n,\gamma)^{12}B$	9.06 mb 2	5.5 mb 33
$^{12}C(n,\gamma)^{13}C$	3.90 mb 6	3.53 mb 7
$^{13}C(n,\gamma)^{14}C$	1.51 mb 3	1.37 mb 4
$^{15}N(n,\gamma)^{16}N$	39 μb 3	24 μb 8
$^{23}Na(n,\gamma)^{24}Na^{g}$	542 mb 3	517 mb 4
$^{23}Na(n,\gamma)^{24}Na^{m}$	478 mb 4	400 mb 30
$^{39}K(n,\gamma)^{40}K$	1.920 b 14	2.1 b 2
$^{40}K(n,\gamma)^{41}K$	90 b 3	30 b 8
$^{41}k(n,\gamma)^{42}K$	1.523 b 22	1.46 b 3
$^{102}Pd(n,\gamma)^{103}Pd$	1.1 b 4	1.6 b 2[b]
$^{104}Pd(n,\gamma)^{105}Pd$	0.75 b 26	0.65 b 30
$^{105}Pd(n,\gamma)^{106}Pd$	21.7 b 5	21.0 b 15
$^{106}Pd(n,\gamma)^{107}Pd$	0.36 b 10	0.30 b 3
$^{108}Pd(n,\gamma)^{109}Pd^{g}$	7.2 b 5	7.6 b 5
$^{108}Pd(n,\gamma)^{109}Pd^{m}$	0.185 b 11	0.185 b 10
$^{110}Pd(n,\gamma)^{111}Pd$	0.34 b 10	0.70 b 17

[a] S. Mughabghab, *Atlas of Neutron Resonances*, Elsevier (2006).
[b] C.L. Duncan and K.S. Krane, Phys. Rev. **C71**, 054322 (2005).

Decay Data Evaluation Project:

The Decay Data Evaluation Project (DDEP) produces high-quality evaluated nuclear and atomic data that includes half-lives, decay modes and branchings, radiation energies and emission probabilities that are needed in applied research and for detector calibrations. Edgardo Browne serves as the DDEP Coordinator and Scientific Editor. Dr. Browne helped organize the Second Workshop for Radioactive Decay Data Evaluators in Bucharest, Romania, May 12-14, 2008 where he delivered five lectures.

Trieste Evaluators Workshop:

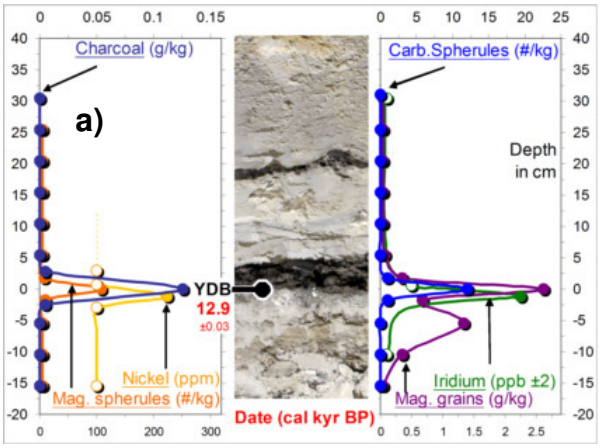
Isotopes Project group members Edgardo Browne and Coral Baglin gave invited lectures at the *IAEA/ICTP "Workshop on Nuclear Structure and Decay Data: Theory and Evaluation",* Trieste, 28 April - 9 May, 2008.

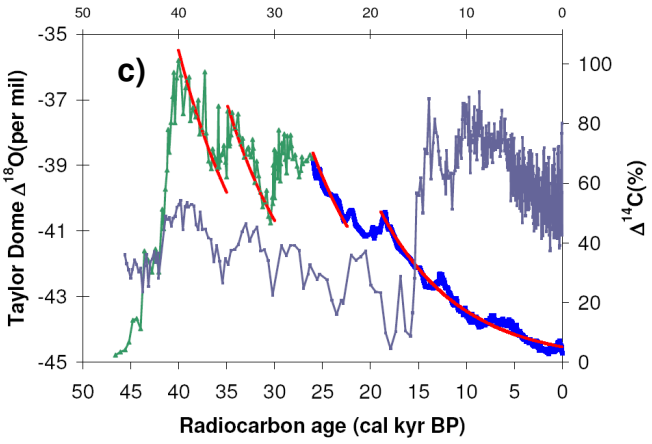
Nuclear Data Dissemination:

The Isotopes Project disseminates nuclear structure, neutron capture and radioactive decay data on its website at http://ie.lbl.gov/toi.html.

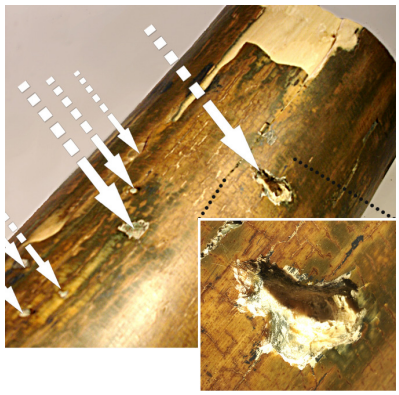
Research:

The Isotopes Project uses γ-ray spectroscopy techniques at the LBNL 88" Cyclotron, LBNL Low Background Facility, and with Budapest Reactor guided neutron beams to study problems of interest to astrophysics, physics, chemistry, geology, anthropology, and archaeology. The following are recent examples of Isotopes Project led research into extraterrestrial impact phenomena that have been widely covered by the media, published in the Proceedings of the National Academy of Science (PNAS), and reported at American Geophysical Union (AGU) meetings.





b)



a) A thin Fe-Ti-Ir rich layer was found stretching from North America to Belgium from the impact of a comet that exploded over Canada 12.9 kyr ago. This caused the extinction of the mammoths and the return of the ice age for 1300 years.
b) Mammoth tusks were found with micrometeorites embedded in them from a meteor impact in Alaska 33 kyr ago.
c) Evidence of near-Earth supernovae 44-, 37-, 32-, and 22-kyr ago are seen in the radiocarbon calibration record. The decay of ^{14}C (red line) produced by these SNe can be followed for the past 18 kyr.

Publications:

1. *Analyses of Oxyanion Materials by Prompt Gamma Activation Analysis*, D.L. Perry, G.A. English, R.B. Firestone, K.-N. Leung, G. Garabedian, G.L. Molnar, and Zs. Revay, J. Radioanal. Nucl. Chem. **276**, 273-277 (2008).
2. *Prompt gamma activation analysis (PGAA) and short-lived neutron activation analysis (NAA) applied to the characterization of legacy materials*, G.A. English, R.B. Firestone, D.L. Perry, J.P. Reijonen, Ka-Ngo Leung, G.F. Garabedian, G.L. Molnár, and Zs. Révay, J. Radioanal. Nucl. Chem. **277**, 25-29 (2008).
3. *Evidence for an extraterrestrial impact 12,900 years ago that contributed to the megafaunal extinctions and the Younger Dryas cooling*, R.B. Firestone et al, Proceedings of the National Academy of Sciences (PNAS) **104**, 16016–16021 (2007). (LBNL-63274).
4. *Thermal neutron capture cross sections of the Palladium isotopes*, M. Krticka, R.B. Firestone, D.P. McNabb, B. Sleaford, U. Agvaanluvsan, T.Belgya, and Z.S. Revay, Phys. Rev. C 77, 054615 (2008).
5. *Lifetime Measurement of the First Excited 2+ State in ^{16}C*, M. Wiedeking, P. Fallon, A.O. Macchiavelli, J. Gibelin, M.S. Basunia, R.M. Clark, M. Cromaz, M.-A. Deleplanque, S. Gros, H.B. Jeppesen, P.T. Lake, I.-Y. Lee, L.G. Moretto, J. Pavan, L. Phair, E. Rodriguez-Vietiez, L.A. Bernstein, D.L. Bleuel, J.T. Burke, S.R. Lesher, B.F. Lyles, and N.D. Scielzo, Physical Review Letters **100**, 152501, 2008.
6. *Cycle of Cosmic Catastrophes,* R.B. Firestone, A. West, and S. Warwick-Smith, Innertraditions (2006).
7. *Fission-product gamma-ray line pairs sensitive to fissile material and neutron energy,* R.E. Marrs, E.B. Norman, J.T. Burke, R.A. Macri, H.A. Shugart, E. Browne and A.R. Smith; Nuclear Instruments and Methods in Physics Research **A592**, 463 (2008).
8. *Measurement of cross sections for alpha-induced reactions on 197Au and thick-target yields for the (,γ) process on 64Zn and 63Cu*, M.S. Basunia, H.A. Shugart, A.R. Smith, E.B. Norman, Phys. Rev. C **75**, 015802 (2007).
9. *Evidence Against Correlations Between Nuclear Decay Rates and Earth-Sun Distance, Eric B. Norman, Edgardo Browne, Howard A. Shugart, Tenzing H. Joshi, and Richard B. Firestone,* Astroparticle Physics 31, 135 (2009).
10. *Improved Neutron Capture Data and Evaluation with Statistical Nuclear Structure Models for Transport Libraries,* Bradley Sleaford, Thesis, University of California, Berkeley Nuclear Engineering Department.
11. *Database of Prompt Gamma Rays from Slow Neutron Capture for Elemental Analysis*, R.B. Firestone, H.D. Choi, R.M. Lindstrom, G.L. Molnar, S.F. Mughabghab, R. Paviotti-Corcuera, Zs. Revay, V. Zerkin, and C.M. Zhou, IAEA STI/PUB/1263, 251 pp (2007).
12. *Parametric analysis of discrepant sets of data,* O. Helene, Nuclear Inst. and Methods in Physics Research A, in press.

Invited talks and lectures:

1. *For the Best Nuclear Data Who Do You Call?,* E. Browne, Colloquium - Spring 2007, Nuclear Engineering Department, University of California, Berkeley, California, 2 April 2007.
2. *Nuclear Data for the Skeptic*, E. Browne, TUNL Seminars – Fall 2007, 20 September 2007.
5. *The Extraterrestrial Impact that Killed the Mammoths and Caused 1,300 years of Global Cooling*, R.B. Firestone, LBNL Institute of Nuclear and Particle Astrophysics, June 6, 2007.
6. *Impacts in the Late Pleistocene,* Richard B. Firestone, KFKI Atomic Energy Research Institute, Budapest Hungary, 3 May, 2007.
7. *Gamma-Ray Emission Probabilities. Program GABS*, E. Browne, Second Workshop for Radioactive Decay Data Evaluators: Training sessions of the Decay Data Evaluation Project (DDEP-2008), Bucharest, Romania, May 12-14, 2008.
8. *Nuclear Data for the Skeptic,* E. Browne, Second Workshop for Radioactive Decay Data Evaluators: Training sessions of the Decay Data Evaluation Project (DDEP-2008), Bucharest, Romania, May 12-14, 2008.
9. *Particle Emission Probabilities*, Edgardo Browne, Second Workshop for Radioactive Decay Data Evaluators: Training sessions of the Decay Data Evaluation Project (DDEP-2008), Bucharest, Romania, May 12-14, 2008.
10. *Discrepant Data. Program LWEIGHT,* Edgardo Browne, Second Workshop for Radioactive Decay Data Evaluators: Training sessions of the Decay Data Evaluation Project (DDEP-2008), Bucharest, Romania, May 12-14, 2008.
11. *Alpha-Decay Hindrance Factors. Program ALPHAD*, Edgardo Browne, Second Workshop for Radioactive Decay Data Evaluators: Training sessions of the Decay Data Evaluation Project (DDEP-2008), Bucharest, Romania, May 12-14, 2008.
12. *How Cosmic Catastrophes Killed the Mammoths,* R.B. Firestone, New Mexico Museum of Natural History & Science, Albuquerque NM, January 11, 2008.
13. *How Cosmic Catastrophes Killed the Mammoths,* R.B. Firestone, Friends of Archaeology, Santa Fe NM, January 12, 2008.
14. *How Cosmic Catastrophes Killed the Mammoths,* R.B. Firestone, Keynote Address to the Central New York Earth Science Student Symposium, Syracuse University, April 4, 2008.
15. *ENSDF Decay*, E. Browne-Moreno, *IAEA/ICTP* Workshop on Nuclear Structure and Decay Data: Theory and Evaluation, Trieste, 28 April - 9 May, 2008.
16. *ENSDF Reactions,* C.M. Baglin, *IAEA/ICTP* Workshop on Nuclear Structure and Decay Data: Theory and Evaluation, Trieste, 28 April - 9 May, 2008.

17. *ENSDF Adopted Levels,* C.M. Baglin, *IAEA/ICTP* Workshop on Nuclear Structure and Decay Data: Theory and Evaluation*,* Trieste, 28 April - 9 May, 2008.
18. *Prehistoric Cosmic Catastrophes and Environmental Change,* R.B. Firestone, Budapest Neutron Centre, November, 2009.
19. *Mammoths, Meteorites, and Supernovae,* R.B. Firestone, Northern California Geological Society, Orinda CA, February 25, 2009.
20. *Mammoths, Meteorites, and Supernovae,* R.B. Firestone, Peninsula Geological Society, Palo Alto CA, March 10, 2009.

Meeting Presentations:

1. *Evidence for a Massive Extraterrestrial Airburst over North America 12.9 ka Ago*, R.B. Firestone, A. West, Zs. Revay, T. Belgya, A. Smith, and S.S. Que Hee, paper PP41A-01, 2007 Joint Assembly, American Geophysical Union, Acapulco, 22-25 May, 2007.
2. *Extraterrestrial Markers Found at Clovis Sites across North America*, A. West, R.B. Firestone, J.P. Kennett, L. Becker, paper PP41A-02, 2007 Joint Assembly, American Geophysical Union, Acapulco, 22-25 May, 2007.
3. *Evidence for an Extraterrestrial Impact Origin of the Carolina Bays on the Atlantic Coast of North America*, G A Howard, A West, R B Firestone, J P Kennett, D Kimbel, W Newell, R Kobres, paper PP42A-05, 2007 Joint Assembly, American Geophysical Union, Acapulco, 22-25 May, 2007.
4. *Evidence for an Extraterrestrial Impact Event 12,900 years ago that Contributed to Megafaunal Extinctions and the Younger Dryas Cooling*, R B Firestone, A West, J P Kennett, L Becker, T E Bunch, Z Revay, P H Schultz, T Belgya, O J Dickenson, J M Erlandson, A C Goodyear, R S Harris, G A Howard, D J Kennett, J B Kloosterman, P Lechler, J Montgomery, R Poreda, T Darrah, S S Que Hee, A R Smith, A Stich, W Topping, J H Wittke, W S Wolbach, paper PP43A-01, 2007 Joint Assembly, American Geophysical Union, Acapulco, 22-25 May, 2007.
5. *Is There Evidence for Impact-Triggered Fires at the End Pleistocene?*, W S Wolbach, A Stich, J B Kloosterman, *L Becker, J Kennett, R Firestone, A West, paper PP43A-03, 2007 Joint Assembly, American Geophysical Union, Acapulco, 22-25 May, 2007.
6. *Formation of the Carolina Bays: ET Impact vs. Wind-and-Water*, R Kobres, G A Howard, A West, R B Firestone, J P Kennett, D Kimbel, W Newell, paper PP43A-10, 2007 Joint Assembly, American Geophysical Union, Acapulco, 22-25 May, 2007.
7. *Neutrons, Nuclear Structure, and the Death of the Mammoths*, R.B. Firestone, Z. Révay, T. Belgya, A. West, Paper NUCL136, 234th ACS National Meeting, Boston MA, August 2007.
8. *Study of the (3He,t) Charge Transfer Reaction as a Surrogate for Neutron Energy Between 10 to 20 MeV,* M. S. Basunia, CNR* 2007 Compound-

Nuclear Reactions and Related Topics, Yosemite Ca, 22-26 October, 2007.

9. *New Methods for the Determination of Total Radiative Thermal Neutron Cross Sections (s0),* R.B. Firestone*,* CNR* 2007 Compound-Nuclear Reactions and Related Topics, Yosemite Ca, 22-26 October, 2007.
10. *The history of recent cosmic impact and its potential role in Holocene rapid climate change,* W.B Masse, D.H. Abbott, M. Baillie, G. Barrientos, K. Ernstson, R.B. Firestone, V.K. Gusiakov, S.K. Haslett, M. A. Rappenglück, International Conference 100 Years since Tunguska Phenomenon: Past, Present and Future, June 26-28 , 2008, Moscow.
11. *Micrometeorite Impacts in Beringian Mammoth Tusks and a Bison Skull,* J.T. Hagstrum, R.B. Firestone, A. West, Z. Stefanka, Z. Revay, Rappenglück, International Conference 100 Years since Tunguska Phenomenon: Past, Present and Future, June 26-28 , 2008, Moscow.
12. *Micrometeorite Impacts in Beringian Mammoth Tusks and a Bison Skull,* R.B. Firestone, A. West, Zs. Stefanka, Zs. Revay, and J.T. Hagstrom, AGU Fall Meeting, 10-14 December 2007, San Francisco, CA
    Paper U23A-0865.
13. *Elemental Analysis of the Sediment, Magnetic Grains and Microspherules from the Younger Dryas Impact Layer*, R.B. Firestone, A. West, Zs. Revay, J.T. Hagstrom, A. Smith, and S.S. Que Hee, AGU Fall Meeting, 15-19 December 2008, San Francisco, CA
    Paper PP13C-1472.

Nuclear Data Sheets:

1. *A=24*, R.B. Firestone, Nuclear Data Sheets **108**, 2319 (2007).
2. *A=81*, C.M. Baglin, Nuclear Data Sheets **109**, 2257 (2008).
3. *A=137*, E. Browne and J.K. Tuli, Nuclear Data Sheets **108**, 2173 (2007).
4. *A=145*, E. Browne and J.K. Tuli, Nuclear Data Sheets **110**, 507 (2009).
5. *A=166*, C.M. Baglin, Nuclear Data Sheets **109**, 1103 (2008).
6. *A=169*, C.M. Baglin, Nuclear Data Sheets **109**, 2033 (2008).
7. *A=179*, C.M. Baglin, Nuclear Data Sheets **110**, 265 (2009).
8. *A=214*, S.-C. Wu, Nuclear Data Sheets **110**, 681 (2009).
9. *A-229*, E. Browne and J.K. Tuli, Nuclear Data Sheets **109**, 2657 (2008).
10. *A=240*, B. Singh and E. Browne, Nuclear Data Sheets **109**, 2439 (2008).

TUNL Contributions in the US Nuclear Data Program and NSDD

Nuclear Data Evaluation Program

J.H. Kelley, Elaine Kwan,

Jim Purcell, and Grace Sheu

Nuclear Structure Evaluation
TUNL Nuclear Data Evaluation Project
Kelley, Tilley, Weller

- We are responsible for nuclear structure evaluation in the A=2-20 mass region
  - Energy Levels of Light Nuclei reviews published in Nuclear Physics A
  - ENSDF files for A=2-20
- Web interface for A=3-20 Information

TUNL Nuclear Data Evaluation Project

Evaluation Activities

- Energy Levels of Light Nuclei
  - Follow style of Fay Ajzenberg-Selove
  - Broad scope of reactions is included – discussion format.
  - Adopted levels/gammas, Energy Level Diagrams
- ENSDF
  - More rigorous information required
  - Better documentation of original sources
  - reaction data sets/decay data sets
  - Adopted levels/gammas, decay widths, etc.

TUNL Nuclear Data Evaluation Project

Recent Evaluation Activities

- Manuscript for A=3 essentially complete
- Evaluation of A=11 essentially finished
  - Manuscript for “Energy Levels of Light Nuclei”
  - ENSDF File
- Other work in progress:
  - A=12 Evaluation for “Energy Levels” all papers reviewed except for ^{12}C
  - A=13 Evaluation for “Energy Levels” all except ^{13}N,C

TUNL Nuclear Data Evaluation Project

Recent Compilation Activities

- Compilation of Thermal Neutron Capture references and data
- Compilation of β-decay references and data
- Compilation of ground state decay information
- Committed to XUNDL (A=3-20)

TUNL Nuclear Data Evaluation Project

Energy Levels of Light Nuclei, A = 3 - 20

Nuclear Data Evaluation Project

TUNL Nuclear Data Evaluation

Information on mass chains and nuclides available on this website:

3	4
5	6
7	8
9	10
11	12
13	14
15	16
17	18
19	20

Group Info
Publications
HTML
General Tables
Level Diagrams
Tables of E_i's
ENSDF
Thermal N Capt.
G.S. Decays
NuDat at BNL
Palm Pilot
Useful Links
Citation Examples

Home
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Email

Search:

- TUNL Nuclear Data Group: Who we are and what we do.

Our publications on Energy Levels of Light Nuclei, A = 5 - 20:

- Publications: TUNL evaluations of A = 3 - 20, and modified versions of Fay Ajzenberg-Selove's publications of A = 5 - 20, are available here in PDF format. The most recent HTML documents of A = 3 - 20, and EL diagrams of A = 4 - 20 are also available here. Some reprints and preprints may be requested by mail.

- HTML for Nuclides: HTML documents are available for individual nuclides found within the TUNL or FAS evaluations.

Resources relating to our publications:

- General Tables: General Tables in HTML for A = 5 - 10 nuclei.

- Energy Level Diagrams are available for A = 4 - 20 nuclides.

- Tables of Energy Levels: a brief listing of tables of energy levels from the most recent publication for each nuclide A = 4 - 20.

- SiteMap and Complete List of Available TUNL Documents: Trying to find a specific TUNL evaluation or preliminary report, HTML document, General Table, Update List or Energy Level Diagram? Click here for a complete list of what's available on our website.

Applications and databases relating to the A = 3 - 20 nuclides:

- ENSDF: Information for A = 2 - 20 nuclides available through the National Nuclear Data Center (NNDC) site.

- Thermal Neutron Capture Data: Summary of level and branching intensity data measured in Thermal Neutron Capture.

- Ground-State Decay Data: Summary of half-life, branching intensity, and mass excess data measured in ground state beta- and charged-particle-decay.

- NuDat at BNL: Allows to search and plot nuclear structure and nuclear decay data interactively.

- Palm Pilot Physics Page: Links to Palm applications and databases that are of interest to the Nuclear Physics community.

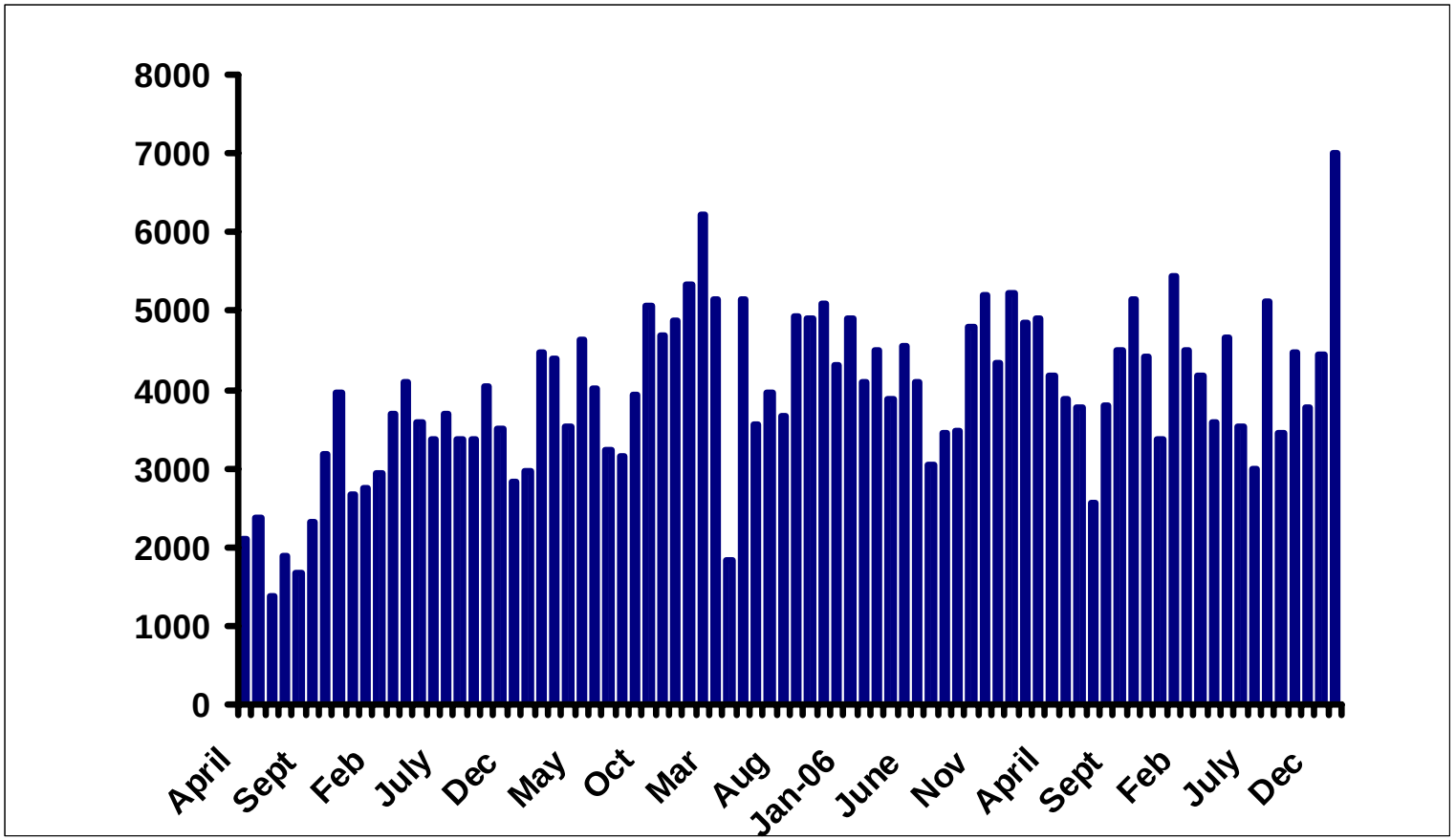
Helpful links:

- Links Important links to the National Nuclear Data Center, online nuclear physics journals, and other useful sites.

- Citation examples A brief listing of examples of how to format your bibliography, references or citations from the information you obtain from our website.

TUNL Nuclear Data Evaluation Project

WWW (April 02 –present)



Using Analog - finding issues with excluding new search engine "robots"

TUNL Nuclear Data Evaluation Project

Progress Report on Nuclear Structure and Decay Data Activities at Argonne National Laboratory*

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Argonne National Laboratory
Argonne, Illinois 60439

Prepared for the 18th meeting of the *Nuclear Structure and Decay Data* Network
Vienna, Austria, March 23-28, 2009

Period covered: July 2007 – March 2009

I. Program overview

The Argonne Nuclear Data Program (ANL NDP) includes a variety of scientific activities carried out within the broader framework of the Coordinated Work Plan of the U.S. Nuclear Data Program that is sponsored by the Office of Nuclear Physics, Office of Science, U.S. Department of Energy. Among these are the compilation and evaluation of nuclear structure and decay data, and the development of nuclear data measurements, analysis, modeling, and evaluation methodologies for use in basic science and technology applications. Contributions are also made to various specialized databases serving specific needs in the fields of nuclear structure, nuclear astrophysics, and applied nuclear physics.

II. Program activities

II.1 Nuclear Structure and Decay Data Evaluations for ENSDF

The main emphasis of the nuclear data activities at Argonne National Laboratory is on nuclear structure and decay data evaluations for the ENSDF database. ANL NDP has responsibilities for evaluating nuclei within the A=176-179 and 199-209 mass chains. The up-to-date evaluation status is presented in Table 1. During the period of time covered by this report, evaluations of the A=202 and 206 mass chains were completed, reviewed and published in *Nuclear Data Sheets*. The A=204 mass chain evaluation was also completed and submitted to NNDC for review. Evaluations of A=177 and 209 (in collaboration with Dr. G. Mukherjee, Kolkata, India) mass chains are continuing. We have started evaluation of the A=174 mass chain in collaboration with Dr. T. Venkova, INRNE, Bulgaria and Dr. T. Kibedi, ANU, Australia.

* This work is supported by the Office of Nuclear Physics, U.S. Department of Energy, under Contract No. DE-AC02-06CH11357.

Table 1. Evaluation status of mass chains assigned to the ANL NDP group

Mass Chain	NDS publication	Evaluator	Current Status
176	NDS **107** (2006) 791	M.S. Basunia	completed/LBNL
177	NDS **98** (2003) 801	F.G. Kondev	completed/under revision
178	NDS **72** (1994) 221	E. Browne	completed/Argentina
179	NDS **110** (2009) 265	C.M. Baglin	completed/LBNL
199	NDS **108** (2007) 79	B. Singh	completed/McMaster
200	NDS **108** (2007)1471	F.G. Kondev & S. Lalkovski	completed
201	NDS **108** (2007) 365	F.G. Kondev	completed
202	NDS **109** (2008) 699	S. Zhu & F.G. Kondev	completed
203	NDS **105** (2005) 1	F.G. Kondev	completed
204	NDS **72** (1994) 409	C.J. Chiara & F.G. Kondev	completed
205	NDS **101** (2004) 521	F.G. Kondev	completed
206	NDS **109** (2008)1527	F.G. Kondev	completed
207	NDS **70** (1993) 315		to be evaluated/FY2009*
208	NDS **108** (2007)1583	M. Martin	completed/ORNL
209	NDS **63** (1991) 723		being evaluated/FY2009**

* In collaboration with Dr. S. Lalkovski, University of Sofia, Bulgaria
** In collaboration with Dr. G. Mukherjee, India

It is envisioned to begin evaluation of the A=207 mass chain in July 2009, in collaboration with Dr. S. Lalkovski, University of Sofia, Bulgaria, as indicated in Table 1. The ultimate goal is to complete evaluations of all mass chains within the ANL region of responsibility in the next 1-2 years. Argonne NDP is also involved in reviewing evaluations completed by other members of the NSDD network. Following on a request from the Editor of *Nuclear Data Sheets*, a review of the A=208 mass chain was completed, while that for the A=133 mass chain is ongoing. Since March 2008, ANL staff has been contributing to the XUNDL compilation activities.

II.2 Specialized decay data evaluations the IAEA-CRP on "Updated Decay Data Library for Actinides"

ANL NDP staff has been participating in the activities of the IAEA-CRP on "Updated Decay Data Library for Actinides". Evaluations on ^{243,245,246}Cm, ^{206}Hg, ^{206,207,209}Tl, and ^{209,211}Pb were assigned to our program. Following recommendations made at the first IAEA-CRP meeting, measurements of half-lives, and γ–ray and α–particle emission probabilities for selected nuclides of interest (^{233}Pa, ^{240}Pu, $^{243\text{-}246}$Cm, and ^{249,250}Cf) were initiated at Argonne National Laboratory. Work on ^{240}Pu, ^{244,246}Cm, and ^{250}Cf was

completed and the results were published in two journal articles. Analysis of the ^{233}Pa and ^{243}Cm data is continuing.

II.3 Other Activities

ANL NDP staff attended the latest IAEA/ICTP organized workshops on "Nuclear Structure and Decay Data: Theory and Evaluation" that took place in Trieste, Italy in May 2008. Two lectures entitled "Experimental Nuclear Structure Methods and Techniques" and "Contemporary Nuclear Structure Physics at the Extreme" were presented. ANL NDP staff also participated in the activities of the DDEP training workshop in Bucharest, Romania (May 2008), where three lectures were presented.

In collaboration with scientists from the Australian National University, ANL NDP staff is involved in a horizontal evaluation (topical review) of properties of K-isomers in deformed nuclei. Data are compiled in ENSDF format, evaluated, and processed using codes developed by the collaboration. The evaluation activities are continuing.

Our program is also involved in complementary experimental nuclear structure and decay data activities in collaboration with scientists from several U.S. national laboratories and universities, and leading nuclear physics institutes overseas. The main emphasis is on studies of properties of K-isomers in a wide range of nuclei, properties of nuclei far from the line of stability, and spectroscopy of heavy nuclei. Some of the results from this effort have already been published and the relevant data were submitted to the appropriate data centers for inclusion into the ENSDF and XUNDL databases.

III. Personnel & Effort

ANL NDP is a member of the U.S. Nuclear Data Program that is sponsored by the Office of Nuclear Physics, Office of Science, U.S. DOE. One ANL full-time staff (1.0 FTE) and a part-time post-doc (~0.4 FTE) have been contributing to the program activities during the time period covered by this report.

IV. Publications & Presentations (2007-2009)

- **33** articles in peer-reviewed scientific journals
- **10** articles in refereed conference proceedings & books
- **54** contributed abstracts in conference proceedings & meetings
- **3** technical reports & preprints
- **21** presentations at scientific conferences & professional meetings
- **3** invited seminars & colloquia

Nuclear Data Project at McMaster University

Status Report: June 1, 2007 to March 20, 2009

Balraj Singh

NSDD-2009, Vienna, Austria: March 23-27, 2009

ENSDF Work

- **Permanent Responsibility**:

A= 1 (2005), **31**(1998,s)
32(1998,w), **33**(1998)**,**
34(1998,w***), **35**(1998), 36(1998,w)
37 (1998,w), **38** (2008),
39 (2006), **40** (2004),
41 (2001), **42** (2000),
43 (2001), **44** (1999),
64 (2007), **89** (1998,s),
98 (2003), **100** (2008),
149 (2004), **151** (2009),
164 (2001), **188** (2002),
190 (2003), **194** (2006)

* In collaboration with Ninel Nica

- w: work in progress
- s: revision submitted
- The number in parentheses gives the year of last revision in ENSDF database
- During 2007-09, work was also done on many other (priority) A-chains and nuclides, which are outside McMaster's A-chain responsibility

Mass-chain Evaluations Published/submitted (June 1, 2007 to March 23, 2009)

- **A=85**, B. Singh, NDS (submitted Sept 2008, pre-review)
- **A=89**, B. Singh, NDS (submitted Sept 2008, pre-review)
- **A=31**, C. Ouellet and B. Singh, NDS (submitted August 2008, review)
- **A=78**, A.R. Farhan and B. Singh, NDS (submitted Feb 2008, final)
- **A=58**, C. Nesaraja, S. Geraedts and B. Singh, NDS (submitted Sept 2007, post-review)
- **A=182**, B. Singh and J. Roediger, NDS (submitted Sept 2007, post-review)
- **A=151,** B. Singh, NDS **110**, 1-264 (2009)
- **A=240,** B. Singh and E. Browne, NDS **109**, 2439-2499 (2008)
- **A=135,** B. Singh, A.A. Rodionov and Yu. Khazov, NDS **109**, 517-698 (2008)
- **A=100,** B. Singh, NDS **109**, 297-516 (2008)
- **A=38,** J.A. Cameron and B. Singh, NDS **109**, 1-170 (2008)

Updates and Reviews for ENSDF (June 1, 2007 to March 23, 2009)

Nuclide Updates (by B. Singh):

- **64 nuclides, many were either new nuclides in ENSDF or for which excited-state data became available for the first time; including SD band updates for four nuclides. Some nuclides were also in the region of "island of inversion".**

- As of March 20, 2009, the ENSDF database is mostly current on the coverage of all the publications of SD structures in nuclei, except data from 6 papers published in the last one year or so.

Review of A Chains for ENSDF and nuclides for DDEP (by B. Singh):

- **A=24 (by J.A. Cameron), 102, 124, 187 for ENSDF.**
  2 nuclides reviewed for DDEP

Interaction with a user of ENSDF

PHYSICAL REVIEW C **77**, 064301 (2008)

Determination of the $2_1^+ \rightarrow 0_1^+$ transition strengths in ^{58}Ni and ^{60}Ni

J. N. Orce,[1,*] B. Crider,[1] S. Mukhopadhyay,[1] E. Peters,[2] E. Elhami,[1] M. Scheck,[1] B. Singh,[3] M. T. McEllistrem,[1] and S. W. Yates[2]

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(Received 24 March 2008; published 2 June 2008)

Gamma-ray angular distribution measurements following the ^{nat}Ni$(n, n'\gamma)$ reaction were carried out at 1.6 and 1.8 MeV neutron energies. Through the Doppler-shift attenuation method, the lifetime of the 2_1^+ state in ^{58}Ni is determined as $\tau = 1.00^{+0.15}_{-0.10}$ ps, which yields a $B(E2; 2_1^+ \rightarrow 0_1^+)$ value of $9.4^{+1.0}_{-1.2}$ W.u. From previous measurements and this work, average values of $\tau = 0.94(3)$ ps and $B(E2; 2_1^+ \rightarrow 0_1^+) = 10.0(4)$ W.u. are recommended as standards for normalization. In addition, a longer lifetime of $\tau = 1.30^{+0.30}_{-0.20}$ ps has been determined for the 2_1^+ state in ^{60}Ni, which yields an $E2$ strength of $10.7^{+1.7}_{-2.5}$ W.u. Our results support an enhancement of proton-core excitations and related quadrupole and pairing strengths in the light Ni isotopes, in agreement with mean-field and shell-model calculations.

DOI: 10.1103/PhysRevC.77.064301 PACS number(s): 21.10.Tg, 21.10.Re, 25.40.Fq, 27.40.+z

Lifetime of first 2^+ state in ^{58}Ni

Measurement and evaluation

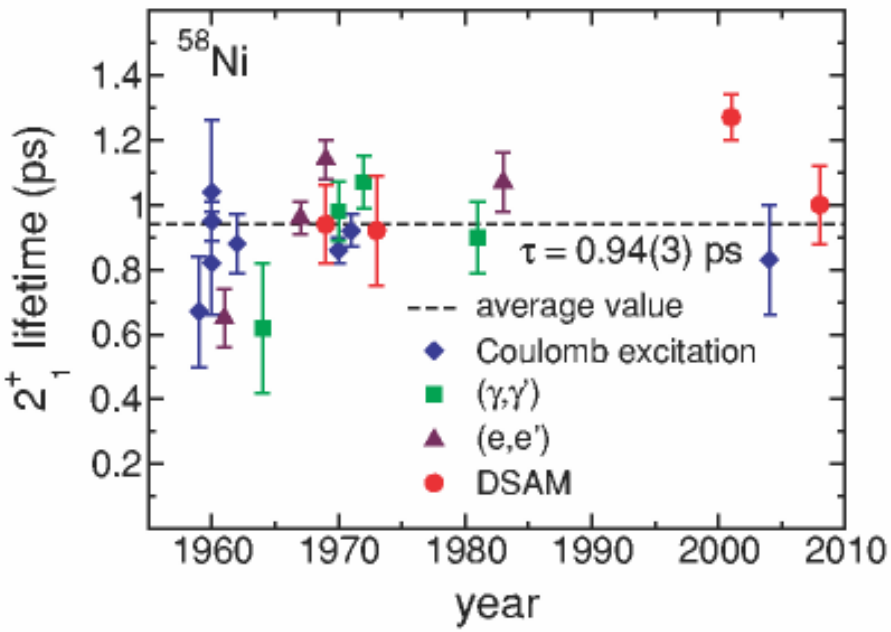

FIG. 5. (Color online) Average value obtained for the lifetime of the 2_1^+ state in ^{58}Ni. The average comprises twenty measurements, including this work, and gives a final standard value of $\tau = 0.94(3)$ ps.

XUNDL work

Compilation of Data from Recent Literature (June 1, 2007 to March 20, 2009)

- Since June 1, 2007, **724** compiled (but checked for internal consistency) new datasets and **88** updated (for new papers from the same groups, errata or replies from authors to our enquiries) datasets from about 350 recent (from June 2007 onwards) publications have been prepared at McMaster and included in XUNDL database. (Includes 14 dataset drafts prepared by Khalifeh Abu-saleem at Jordan)

- **30** compiled datasets (from PL-B and JP-G articles in 2008-09) received from Filip Kondev (ANL) and **1** from Mohini Gupta (Manipal) were checked, edited and sent to NNDC.

- Up-to-date on the coverage of data from experimental structure papers, ~15 papers published in the last month or so are being compiled.

- Continued correspondence with the original authors. Some errata published based on this communication and sometimes the errors were corrected in the transitional period between the paper available online and in final published form.

- In 2008, we also started compiling papers on **new mass measurements**.
  2008 compilations are available on www.nuclearmasses.org. Others from 2003-2007 have been compiled but remain to be checked.
  Details of this work can be found in the XUNDL status report and elsewhere.

Key-wording for NSR

- **Oct 2007**: Based on XUNDL compilation experience with undergraduate students, **first trial to involve undergraduate students** at McMaster to write keywords for papers included in NSR. Training, supervision and checking of the key-worded file (prior to sending it to NNDC) by B. Singh.

- Scott Geraedts: PR-C journal: from Oct 2007 to Dec 2008, part of Jan 2009. Processed **1200** articles, written key-words for **775** papers. (Subcontract with NNDC)

- Maxim Mitchell: Miscellaneous journals: from Dec 2007 to Aug 2008. processed **254** articles, written key-words for **196** papers. (Subcontract with NNDC)

- Allison MacDonald: PR-C journal; Jan 2009 - .

  Still under training and learning. Processed **122** articles, written key-words for **92** articles, now working on the March 2009 issue of PRC.

- We feel that with good training, supervision and checking, bright undergraduate students can carry out this activity successfully, as Scott has shown over the past 16 months or so. We intend to continue this activity in cooperation with NNDC.

- Total 1630 primary articles processed; written keywords for 1115 (Oct 2007 onwards)

  (Int. J Mass Spectrometry **251** (April 2006) & Hyperfine Interactions **129** (Dec 2000): 50 articles; found missing in NSR; supplied keywords)

NDS: Band drawings and other items

- At 2007 NSDD there was a presentation about band drawings in NDS. It was implemented in 2008 with the help of Scott Geraedts at McMaster, including work on the re-pagination of NDS publications.

  (Separate presentation at this meeting)

Work in Progress
(as of March 23, 2009)

A=31, 58, 78, 85, 89, 182: At pre-review, review or post-review stage, will be updated and completed for final publication in NDS. (A=58 and 78 are in collaboration with ORNL and Kuwait, respectively)

A=32: Collaboration with Chris Ouellet (BNL). Expected completion Fall 2009.

A=34: Collaboration with Ninel Nica (Texas A&m). Expected completion Fall 2009.

A=50: Collaboration with Zoltan Elekes and Janos Timar (ATOMKI). Expected completion Fall 2009.

A=71: Collaboration with Khalifeh Abu-saleem (Jordan). Expected completion Fall 2009.

A=76: In collaboration with Ameenah Farhan (Kuwai)t. Expected completion in 2009.

Compilation of recent data for XUNDL: Continued work on compilation of current experimental nuclear structure publications. Also compilation of new mass measurements.

NSR key-wording for NSR: Continued work on key-wording of PR-C papers.

New nuclides and nuclides for which excited state data become available: Continued work on evaluation of such nuclides for ENSDF.

Collaborative Work as a Part of Training/Mentoring of ENSDF Evaluators

- **Collaboration with Dr. Zoltan Elekes and Janos Timar (ATOMKI, Hungary):**

  Subsequent to the November 2008 meeting in Vienna to encourage participation by EU countries in ENSDF effort, Dr. Zoltan Elekes and Janos Timar expressed interest on collaborative work on A=50 mass chain. Dr. Elekes visited McMaster Jan 4-14, 2009 and Dr. Timar is scheduled to visit us in July 2009. We expect to complete A=50 by Fall 2009. This mass chain was last updated in ENSDF in April 1995.

- **Collaboration with Dr. Khalifeh Abu-saleem (University of Jordan):**

  We came in contact with Dr. Abu-saleem (Ph.D. work at ANL with R. Janssens) in August 2008 through Filip Kondev. He had already attended the Trieste ENSDF workshop in April 2008. After some initial training with formats and procedures through compilation of XUNDL datasets, we started on evaluation of A=71 mass chain (last updated in ENSDF in Feb 1993).

  Dr. Abu-saleem visited McMaster Jan 25-Feb 6, 2009 for training and work on A=71. He is scheduled to visit again in August 2009.

Collaborative Work as a Part of Training/Mentoring of ENSDF Evaluators (cont)

- **Post-doctoral fellowship for 75% ENSDF work and 25% nuclear astrophysics work was established at McMaster in September 2007:** Christian Ouellet worked on this position from Sept 2007 to Feb 2008 and received training in ENSDF procedures and formats while evaluating A=31 nuclides. This mass chain was submitted in August 2008 and is currently under review. Chris has now joined NNDC. We plan hiring another post-doctoral fellow, ~80% for ENSDF work, in June 2009. The person will be trained through evaluation of A=33 mass chain.

Collaborations with Dr. Ameenah Farhan (Kuwait), Dr. C. Nesaraja (ORNL), Dr. N. Nica (Texas A&M) and Dr. A.K. Jain (IIT, Roorkee) on various mass chains and other topics continue through visits and e-mail communications. Dr. Farhan (Kuwait University) visited McMaster for about 10 days in November 2008 to work on A=78 and 76. Dr. Nica is scheduled to visit McMaster in June 2009.

Other Related Activities

International coordination:

- November 10-11, 2008: B. Singh participated in a technical meeting organized by the IAEA Nuclear Data section to seek and encourage EU countries to take part in ENSDF evaluations.

- ENSDF workshop in Bucharest Mar 29-Apr 3, 2009; participation in training and coordinating exercise work on evaluation of A=84 mass chain.

Personnel and Funding

- Alan Chen: Assoc. Professor, Head of the Project
- Jim Waddington: Emeritus Professor: Co-PI of the project
- John Cameron: Emeritus Professor (volunteer work for ENSDF work since 1998 for A=31-44 mass region)
- Balraj Singh: Research Scientist, Nuclear Data Evaluator
- Christian Ouellet: Post-doctoral fellow: Sept 2007-February 2009.

- Undergraduate Students (part-time):
- Scott Geraedts: since March 2007
- Allison MacDonald: since November 2008

- Two FTE support for evaluation + partial support for undergraduate students (from DOE, USA + NSERC, Canada)

DATA CENTER AT PETERSBURG NUCLEAR PHYSICS INSTITUTE STATUS REPORT, 2007-2009

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General

The Data Center is a part of the Nuclear Spectroscopy Laboratory in the Neutron Research Department of the Petersburg Nuclear Physics Institute. It consists of five physicists, one mathematician and one programmer.

Data base of the NSR

The Data Center continues to referee Russian publications on nuclear physics in the format NSR. Among them there are abstracts of the reports presented on the Annual Conference on Nuclear Spectroscopy and Structure of Atomic Nuclei, preprints of Joint Institute for Nuclear Research (Dubna) and Petersburg Nuclear Physics Institute (Gatchina).

Evaluation for the ENSDF

The PNPI area of responsibility is A = 130 – 135:

Mass number	Last publication	Comment
130	*NDS*, **93** (2001)	by B.Singh
131	*NDS*, **107** (2006)	
132	*NDS*, **104** (2005)	
133	*NDS*, **75** (1995)	in post review (will be published 2009)
134	*NDS*, **103** (2004)	by A.Sonzogni
135	*NDS*, **109** (2008)	

A new for us mass chain **A =146** (*NDS*, **82** (1997)) is in preparation (will be finished this year).

Two mass chains were reviewed by our Data Centre in this period. We can be drawn for this activity more intensively.

ENSDF error extraction and code refinement

For the search for errors in the ENSDF a code set was created by G.Shulyak. It is located on the Web-site of the Data Center. There is a full list of the ENSDF errors (http://georg.pnpi.spb.ru/). We propose to include the error checking in the procedure of the new ENSDF review.

G.Shulyak has completed the ENSDF editor program. It is located on the Web-site of the Data Center.

The code GTOL was corrected. L.Kabina proposed a new version of the code for large level schemes.

Systematics or horizontal evaluations

Special or problem oriented databases are needed for application of the nuclear data from the ENSDF in physics and technologies. In the Data Center three databases were created on the base of the ENSDF: ANGTOL, ROTAN and NAADF.

The database ANGTOL enables to compare and analyze the ENSDFs.

The database ROTAN is oriented for analysis of nuclear rotational states.

The database NAADF can be used in neutron activation analysis. It contains actual data on properties of stable and radioactive elements, decays and nuclear reaction, characteristic gamma-radiation.

Publication

In the period there are 27 publication: 3 books, 14 articles and 10 preprints and abstracts

Status Report Belgian Group

I retired since October 1, 2006 from all my Research and Teaching activities at the University of Ghent. I hope to continue, as long as I have the capacities to do so, the mass chain evaluation work for the NSDD Network

Since the last meeting in 2007 I finished the evaluation of A=102 and recently A=103 and plan the evaluation of A=110 and A=105 for the next two years.

I acknowledge very much the logistical support of the Ghent University and the financial support of NNDC for the passed two years.

18th Meeting of the Nuclear Structure and Decay Data Network IAEA Headquarters, Vienna, Austria 23-27 March 2009

1.- Report of ENSDF nuclear data evaluation

Evaluation group: E. Achterberg, O.A. Capurro, G.V. Martí.
TANDAR Lab, Department of Physics, National Atomic Energy Commission, Buenos Aires, Argentina.

During the period covered by this status report our work involved the evaluation of nuclear structure data for nuclides in the **A=178** mass chain, and the publication of the evaluation of the data for the **A=191** mass chain nuclides.

Summary of the nuclides of the A=178 mass chain evaluationx

a) The **^{178}Re, ^{178}Os, ^{178}Ir, ^{178}Pt, ^{178}Au, ^{178}Hg, ^{178}Tl** and **^{178}Pb** isotopes had already been evaluated during 2005, and were completed by early February 2006, under contract ARG/12480/R2 (2005).

b) The **^{178}Yb, ^{178}Lu, ^{178}Hf, ^{178}Ta** and **^{178}W** nuclides were processed during 2007/2008, with the support of IAEA contract ARG/14244 (2007). A partial report for some of these nuclides was already presented at the **17th Meeting of the Nuclear Structure and Decay Data Network,** held at the Petersburg Nuclear Physics Institute, St. Petersburg, Russia, June 11-15, 2007. In July 2008, the complete **A=178** ENSDF file was uploaded to the NNDC server. In December 2008, the reviewed version of this file arrived at our lab. In February 2009, the revised file was uploaded to the NNDC, and is currently in the post-review process.

Summary of the reevaluation for mass A=191.

The final, post-review, revision for the evaluation of the data for the A=191 nuclides were performed by us in early 2007. The resulting version has been published in **Nuclear Data Sheets** 108, 2319-2518 (2007).

France Group Status Report

Jean Blachot

jblachot@orange.fr

We have since the beginning of the network (1977) the responsibility for 11 Mass chains. All the work these last years was done as a consultant for the laboratory of Bruyères le Chatel CEA France. The collaboration stopped last December 2008

Next ?

We start a new collaboration with the Orsay Laboratory (G. Audi) and we hope to prepare a new version of Nubase and to continue to update the 11 Mass chains.

These last two years, we have extensively used the EVP program. These tools are for me a great help , we only regret that the information about them are not so easily available than the other analysis or utility programs!!!

The use of data from the ^XUNDL database has greatly helped me to optimize the evaluation time.

1. Status of publications :

	NDS	Dat--ENSDF	Comments*
101	NDS 83, 1 (1998)	**200610**	**ENSDF Sn (07)**
104	NDS 108,2035(2007)	**200709**	
107	NDS 109, 1383 (2008)	**200702**	
108	NDS 91, 135 (2000)	**200810**	**ENSDF**
109	NDS 107, 355 (2006)	**200602**	**Xe in Ensdf**
111	NDS 100, 179 (2003)	**200310**	**Post review dec 2008**
113	NDS 104 , 791(2005)	**200505**	
114	NDS 97, 593 (2002)	**200301**	
115	NDS 104,967 (2005)	**200505**	**Tc,Rh(07)**
116	NDS 92, 455 (2001)	**200104**	**Pre review 2/2/09**
117	NDS 95, 679 (2002)	**200205**	

*** Ensdf status or comments**

2. Status of XUNDL.

Many files of XUNDL have been used for our evaluation in ENSDF.
The following files are available to update ENSDF but not evaluated for ENSDF.
The XUNDL files already in ENSDF are not listed below.

101

101SN EC DECAY:1.9 S:XUNDL-2

104

107

108

108RU 252CF SF DECAY:XUNDL-3 2009Lu01

109

111

114

114**PD**	114RH B- DECAY:	2003LH01
	114RH B- DECAY:	2003LH01
114**AG**	208PB(16O,XG):	2003PO11
114**CD**	114CD(N,N'G):	2003BA57
114**IN**	113IN(N,G):	2002SAZO
	113IN(D,P):	2002SAZO
	115IN(D,T):	2002SAZO

115

115Pd 252CF SF DECAY:XUNDL-5

116

117

117**Ag**	252CF SFDECAY;	2002Hw06
117**PD**	248CM SF DECAY:	2004UR04
117**IN**	238U(12C,XG):	2002LU15

Status Report of Japanese Activities for Nuclear Structure and Decay Data Evaluation

J. Katakura
Nuclear Data Center
Nuclear Science and Engineering Directorate
Japan Atomic Energy Agency

1 Members

The present official members of Japanese group for the evaluation of Nuclear Structure and Decay Data are following: H. Iimura, J. Katakura, M. Kanbe and S. Ohya. Unofficial voluntary evaluators are K. Kitao, Y. Tendow and A. Hashizume. We are trying to find new members who has interest in ENSDF evaluation, but have not succeeded to have a new member.

2 Mass-chain evaluation

The mass chain evaluation on which Japanese group has the responsibility is for A=120-129. The last publication of the mass chain and the status are listed in Table 1.

Table 1: Status of Mass Chain Evaluation

Mass	Last NDS publications	Evaluators	Status
120	NDS 96, 241 (2002)	Kitao	
121	NDS 90, 107 (2000)	Tamura	Evaluating (Ohya)
122	NDS 108, 455 (2007)	Tamura	
123	NDS 102, 547 (2004)	Ohya	
124	NDS 109, 1655 (2008)	Katakura, Wu	
125	NDS 86, 955 (1999)	Katakura	Evaluating (Katakura)
126	NDS 97, 765 (2002)	Katakura, Kitao	
127	NDS 77, 1 (1996)	Kitao, Oshima	Post review of new evaluation (Hashizume)
128	NDS 94, 227 (2001)	Kitao, Kanbe	
129	NDS 77, 631 (1996)	Tendow	Evaluating (Tendow)

The NDS publication after the previous meeting is A=124. The evaluation of A=127 is now under post review. Other evaluations are being continued and the evaluations of A=121, 125 and 129 are being expected to be submitted this year.

Status Report of the Nuclear Structure and Decay Data evaluation activities at the Australian National University (2007-2009)

T. Kibédi
Dep. Of Nuclear Physics, Research School of Physics and Engineering, The Australian National University

Evaluation of high precision experimental conversion coefficients (with †T.W. Burrows, NNDC)

This evaluation project was initiated during the development of BrIcc with the intention to select the most appropriate atomic model used in the RAINE code [1,2]. Experimental ICC values considered had to meet with the following requirements:

a) Relative accuracy of ICC must be <= 5%. If more than one measurement is known, the limit was set to 15%.
b) If more than one value is known, take the weighted average using a combination of three statistical methods, the Limitation of Relative Statistical Weight, the Normalized Residual and the Rajeval Technique.
c) Gamma ray energies with uncertainty, multipolarities and mixing ratios with uncertainties have been taken from the relevant adopted data set of ENSDF.
d) Only E2, M3, E3, M4, E4, M5, E5 are considered
e) The experimental ICC data published in journals or in conference proceedings had to be sighted

In many cases the published ICC values have been corrected using the most up to date values for X-ray fluorescence yields, gamma-ray intensities and conversion coefficients. In the last two years the main effort was to complete the collection of primary publications, and to verify the data set containing 680 primary measured ICC data. 228 ICC values have been adopted and the corresponding theoretical ICC values have been calculated using a special version of the RAINE code. A publication for the Atomic Data and Nuclear Data Tables is being prepared.

[1] M. Band, M. A. Listengarten and M. B. Trzhaskovskaya, Computer Program Complex RAINE VI. Description of Codes, Leningrad Nuclear Physics Institute Report LNPI-1479 (1989)
[2] M. Band, M. B. Trzhaskovskaya, C.W. Nestor, Jr., P.O. Tikkanen, S. Raman, Atomic Data and Nuclear Data Tables, 81 (2002) 1

Tables of Prolate Deformed Nuclear K-Isomers (with F.K. Kondev, ANL and G.D. Dracoulis, ANU)

Adopted spectroscopic information on K-forbidden transitions depopulating high-K isomeric states in nuclei ranging from A=170 to 254 has been deduced by critical evaluation of the available experimental data. Values of f_ν, the reduced hindrance factor per degree of K-forbiddenness, have been determined. The work was continued to collect primary experimental information from published works, conference proceedings and other sources. The evaluated information is stored in ENSDF format and BrIcc and a modified version of the RULER code is used for the analysis. The ANU responsible for the Z=74-82 isotopes.

BrIcc conversion coefficient data base (with †T.W. Burrows, NNDC)

The current version of BrIcc allows to obtain electron and pair conversion coefficients and E0 electronic factors from a range of tables, shown below:

Table 1: Data tables used in BrIcc.

Data Table	Reference	Z	Shells/IPF	L	TranEner [keV][a]
Internal Conversion Coefficient (ICC)					
BrIccFO	2008Ki07 - based on the model using the *'Frozen Orbitals'* approximation of 2002Ba85	5–110	All shells	1–5	ε_{ic}+1–6000
BrIccNH	2008Ki07 - based on the model using the *'No Hole'* approximation of 2002Ba85	5–110	All shells	1–5	ε_{ic}+1–6000
Pair Conversion Coefficient (PCC)					
ScPcc	1979Sc31	0–100[b]	IPF	1–3	1100–8000
HoPcc	1996Ho21	50–100	IPF	1–3	1100–8000
Electronic factor Ω(E0)[c]					
HsOmg	1969Ha61	30–42	K[d],L1[e],L2[f]	0	ε_{ic}+6–1500
BeOmg	1970Be87	40–102	K	0	51f–2555
		40–102	L1,L2	0	51–2555
PaOmg	1986PaZM	8–40	K[e]	0	511–12775
		8–40	IPF	0	1431–12775

a) ε_{ic} is the binding energy for the ic-shell
b) Used for Z < 50
c) Electronic factors are only calculated for even Z values at present
d) Not used
e) Used for Z < 40
f) For Z=40–58: 51.1 keV; for Z=60–82: 102.2 keV; for Z=84–96: 153.3 keV and for Z=98–102: 204.4 keV

Three corrections on the BrIccFO and BrIcc NH tables have been made during the last two years. It was noted that the atomic mass numbers used in the original code were not up to date. For nearly 40 atomic chemical elements the atomic masses have been changed and new tables have been calculated. Atomic masses have been adopted from the 2007 evaluation of IUPAC Commission on Atomic Weights and Isotopic Abundances. Two smaller corrections were also made to correct the lowest energy point is a few atomic numbers in the BrIccFO and BrIccNH tables and in PaOmg table for Z-34.

Some additional data tables have been compiled from older tabulations. These tables are provided for expert users and are listed in Table 2.

Table 2: Legacy electron conversion coefficient tables

Data Table	Reference	Z	Shells	L	TranEner [keV][a]
Internal Conversion Coefficient (ICC) [i]					
HsIcc	Based on the Hager and Seltzer 1968Ha53 and Dragoun et al. 1971Dr11 tables	30–103	K, L, M and N+ shells[g]	1–4	ε_{ic}+1–1500[h]
Internal Conversion Coefficient (ICC)					
RpIcc	Based on the Rösel et al. 1978Ro21 and 1978Ro22 tables	30–104	All shells	1–4	ε_{ic}+2–3000[j]

g) For K-, L-, and M-shells: Z=30–103; for N+ shell Z=37–100

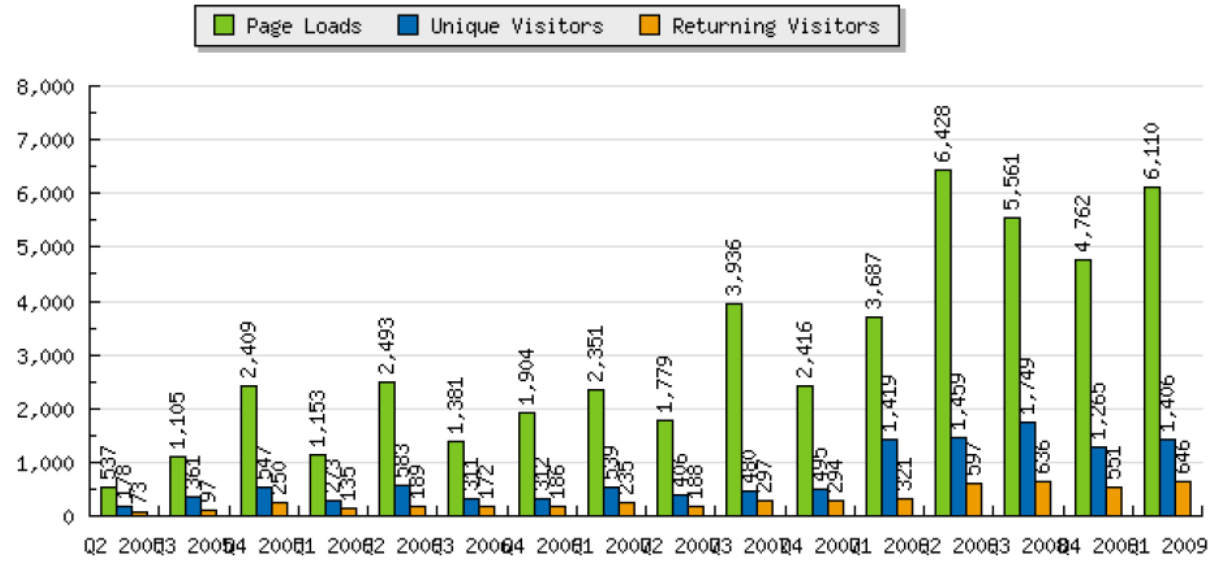
h) For K-shell: εic+1 – 1500(1650) keV; for L-shell: εic+1 – 1000(1550) keV; for M-shell: ε_{ic}+1 – 150(510) keV; for N+ shell: 50 – 500 keV

i) K-, L- and M-shell ICC values for L=3 and 4 multipolarities have not been scaled as recommended by 1990Ne01. ICC values should be multiplied by 0.975 (10) for L=3 and 0.975 (5) for L=4 to agree with values from HsIcc.

j) For K-shell: ε_{ic}+2 – 3000(5000) keV; for L-shell: ε_{ic}+2 – 1500 keV; for M-, N-, O-, P- and Q-shells: ε_{ic}+2 – 500(1500) keV

The current version of the program is 2.2b and was released on 19-Jan-2009. The BrIcc code is supported on Windows and Linux operating systems. Several request has been received to release a Machintosh version, however the lack of resources makes it impossible to achieve.

Web Interface since 2005:



A comprehensive publication on BrIcc have been published in the Nuclear Instruments and Methods in Physics Research A 589 (2008) 202-229.

BrIccMixing (with †T.W. Burrows, NNDC)

A new computer code has been developed to determine Mixing Ratio (MR) and Normalization Factor (R) from conversion electron data. It uses two procedures to determine the best parameter values and uncertainties: (a) Chi-squared fit, based on the CFIT [1] program; and (b) searching the χ^2(ICC$_{Theor}$(MR), ICC$_{Exp}$) hypersurface. Theoretical conversion coefficients are determined using BrIcc [2,3] routines and numerical tables calculated with the *"Frozen Orbital"* (BrIccFO) approximation. Procedure (b) presented here is similar to the method used by the DELTA program [3], however our solution takes into account the uncertainty of the theoretical ICC values attributed to the energy uncertainty and the accuracy of the calculations.

The current version is developed for 32 bits Windows and it is using a graphical interface to show the χ^2(ICC$_{Theor}$(MR), ICC$_{Exp}$) hypersurface. A Linux version is being tested. The program can be obtained from:
ANU: http://wwwrsphysse.anu.edu.au/~txk103/briccmixing/win32/BrIccV22MixingSetup.exe
NNDC: http://www.nndc.bnl.gov/nndcscr/ensdf_pgm/analysis/BrIcc/BrIccV22Mixing.zip

[1] M. Ryšavý and O. Dragoun, Computer Phys. Comm. 19 (1980) 93
[2] T. Kibédi, T.W. Burrows, M.B. Trzhaskovskaya, P.M. Davidson, C.W. Nestor, Jr., Nucl. Inst. and Meth. in Phys. Res. A v589 (2008) 202;
[3] I.M. Band, M.B. Trzhaskovskaya, C.W. Nestor, Jr., P.O. Tikkanen and S. Raman, At. Data and Nucl. Data Tables 81, 1 (2002)
[4] L.P. Ekstrom, *"DELTA - a computer program to analyze gamma-gamma correlations from unaligned states"*, Nuclear Physics LUNFD6/(NFFR-3048) 1-27 (Lund University. 1983).

AveTools (with †T.W. Burrows, NNDC)

The program AveTools combines three different statistical methods to calculate averages of experimental data with uncertainties. These include:

a) LWM - Limitation of Relative Statistical Weight
b) NRM - Normalised Residual Method
c) RT - Rajeval Technique

A detailed description of the methods used can be found in M.U. Rajput and T.D. MacMahon, Nucl. Instr. and Meth. in Phys. Res. **A312** (1992) 289.
The program is based on LWEIGHT v1.3, EV4 and RajNew codes developed by D. MacMahon (Imperial Collage Reactor Centre, London, UK) and E. Browne (LBL, Berkeley, USA)

Several modifications have been made to handle exceptions in program execution and to detect errors in the data input. This program was originally developed for the ICC evaluations, but it is designed to be used in any evaluation work. The program can be obtained from:
ANU: **http://wwwrsphysse.anu.edu.au/~txk103/avetools/linux/avetools.exe** (Linux 32 bits)
http://wwwrsphysse.anu.edu.au/~txk103/avetools/linux64/avetools.exe (Linux 64 bits)
http://wwwrsphysse.anu.edu.au/~txk103/avetools/win32/AveTools.exe (Windows 32 bits)
NNDC: http://www.nndc.bnl.gov/nndcscr/ensdf_pgm/utility/AveTools.zip

Other activities

- ENSDF workshop, Trieste 2008
- DDEP workshop, Bucharest 2008

Status Report

To IAEA 18th Technical Meeting on International Network of Nuclear Structure and Decay Data Evaluators

Jilin University Group

Junde HUO
Department of Physics
Jilin University
Changchun 130023
China

1. Status of mass chain evaluation

Jilin university (JLU) group is responsible for nuclear structure and decay data evaluation of mass chain: A=52, 53, 54, 55, 56, 62, and 63.

Status of publication in Nuclear Data Sheets (NDS)

A	Publication	Status
52	NDS, 106, 773 (2007)	
53	NDS, 87, 507 (1999)	In review, since Nov. 2007
54	NDS, 107, 1393 (2006)	

A	Publication	Status
	（cont'd）	
55	NDS, 109, 787 (2008)	
56	NDS, 86, 315 (1999)	Evaluating
62	NDS, 91, 317 (2000)	Evaluating by Drs. B. Singh and J. N. Orce (Kentucky U)
63	NDS, 92, 147 (2001)	In review, since Feb. 2009

2. Other activity

ENSDF evaluation review: A=45.

IAEA Meeting on the Coordination of the International Network of Nuclear Structure and Decay Data Evaluators
IAEA, Vienna, Austria
23-27 March 2009

Status Report
Kuwait Nuclear Data Center
Physics Department – Kuwait University
Ameenah Farhan

This report covers the evaluation activities of the Kuwait Group for the period (June 2007 – March 2009).

Mass Chain Evaluation:

Kuwait Nuclear Data Center has permanent responsibility for evaluating and updating NSDD for A =74 – 80.

Mass Chain A = 78:

A=78 was evaluated in collaboration with Dr. Balraj Singh (McMaster University). This work was submitted February 2008 and it is now in a post-review stage with NNDC

Mass Chain A = 76:

Ameenah Farhan and Balraj Singh are currently working on A = 76. This mass chain is expected to be completed by the end of 2009.

Personnel:

- Ameenah Farhan is still working as a part-time researcher for the center.
- The Kuwait Group will pursue its fruitful collaboration with Dr. Balraj Singh (McMaster University) in order to fulfill its commitment towards the International Network.

Financial Support:

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Indian Institute of Technology Roorkee (India)
Report for 2008-2009

1. The nuclear data group at Roorkee now consists of the following members:
    1. Prof. A.K. Jain, Roorkee
    2. Dr. Suresh Kumar, Delhi University
    3. Dr. Sukhjeet Singh, MM Univ, Mullana, Ambala

2. We have completed A=225 mass chain evaluation in collaboration with Dr. J. Tuli. A.K. Jain spent two weeks at NNDC, BNL for this work in Summer 2008.

3. Dr. Paresh Joshi, Tata Institute, Mumbai attended the ICTP Workshop in 2008. He has now expressed desire to work in collaboration with the Roorkee center. He has spent a week at Roorkee for further training and discussion and is now working on A=139 mass chain as suggested by J. Tuli, NNDC.

4. A.K. Jain attended the meeting of Indian Nuclear Data Committee constituted by Director, B.A.R.C., Mumbai held on 12 March 2008. He made a presentation of the ENSDF activities at Roorkee center. It was suggested that a long term plan is needed to fund such an activity.

5. Dr. S. Ganesan, who is chairing this committee, has expressed the hope that it should be possible to support all such activities under one umbrella and provide funding. It is expected that an announcement may be made in near future.

6. Roorkee center has seen the joining of two new faculty in nuclear theory. The number of Ph.D. students in nuclear physics has also gone up to 4. Two of them are working in both experiment and theory. These students will also be trained in the ENSDF activity in near future. It is also expected a faculty in experimental nuclear physics will also be appointed in near future which will further boost our activities.

Nuclear Data Evaluations at Manipal University

Status Report: May 31, 2007 to March 31, 2009

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Manipal University, Manipal, Karnataka, India

In collaboration with
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18th IAEA-NSDD meeting Vienna, Austria, 23-27 March 2009

A=260-265

The evaluation methodology used in 2005Gu33 (A=266-294) is currently being applied to the mass region A=260-265. While the evaluation technique is based on 1992Ba77, additional evaluation tools include using the approximations of 1984Sc13 for estimates of half-lives and an updated parameter set for the Viola-Seaborg phenomenology (1966Vi04).

The nuclides which form the subject matter of the present evaluation were covered in 1999Ar21, 1999Ak02, and 2001Ak11 and 2000Fi12 (^{265}Rf). New data are available and an update is due. Also, some of the α-decay mass chains from heavier nuclei (A≥266) end in this region and it was felt that the same evaluation methodology adopted for (distant) ancestors could be usefully extended to descendents within a given α-decay chain for consistency and uniformity of treatment. In instances where no new data are available, a re-evaluation of existing data within this internally consistent framework also yields useful information.

The current evaluation spans about 9 elements comprising ≈41 nuclides. Approximately 50% of these nuclides have been experimentally studied using chemical techniques which are important and are taken into account. About 20 new entries have been added to NSR primarily from the journals Radiochimica Acta, Angewandte Chemie and NIM A to date.

The ENSDF database was updated for ^{265}Sg and ^{261}Rf. These two nuclides accounted for about 15 of the ~20 additions to NSR.

Evaluations are in progress.

Future Plans:

Updates for A=266-294 may become necessary over the next two years depending on the pace of experimental data becoming available.

It is intended that data evaluations for the mass region A≥260 will be continued.

References:

1966Vi04: J. Inorg.Nucl.Chem. 28, 741 (1966); V.E.Viola, Jr., G.T.Seaborg; Nuclear Systematics of the Heavy Elements - II. Lifetimes for Alpha, Beta and Spontaneous Fission Decay.

1984Sc13: Z.Phys. A316, 19 (1984); K.-H.Schmidt, C.-C.Sahm, K.Pielenz, H.-G.Clerc; Some Remarks on the Error Analysis in the Case of Poor Statistics.

1992Ba77: Prog.Part.Nucl.Phys. 29, 453 (1992); R.C. Barber, N. N. Greenwood, .Z.Hrynkiewicz, Y.P.Jeannin, M.Lefort, M.Sakai, I.Ulehla, A.H.Wapstra, D.H.Wilkinson; Discovery of the Transfermium Elements.

1999Ar21: Nucl.Data Sheets 88, 155 (1999), A .Artna-Cohen; Nuclear Data Sheets for A = 249-265 (odd).

1999Ak02: Nucl.Data Sheets 87, 249 (1999), Y.A .Akovali, Nuclear Data Sheets for A = 248, 252, 256, 260, 264.

2000Fi12: Nucl.Data Sheets 90, 391 (2000), R. B. Firestone, J. Gilat, Nuclear Data Sheets for A = 267-293.

2001Ak11: Nucl.Data Sheets 94, 131 (2001), Y.A. Akovali, Nuclear Data Sheets for A = 250, 254, 258, 262, 266.

2005Gu33: Nucl.Data Sheets 106, 251 (2005); Erratum Nucl.Data Sheets 107, 789, (2006); M.Gupta, T.W.Burrows; Nuclear Data Sheets for A = 266-294.

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