IAEA
International Atomic Energy Agency

INDC(NDS)-0595
Distr. G, ND

INDC International Nuclear Data Committee

Summary Report of an IAEA Technical Meeting

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

IAEA Headquarters, Vienna, Austria

4 – 8 April 2011

Prepared by

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October 2011

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Produced by the IAEA in Austria

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Abstract

The 19th meeting of the International Network of Nuclear Structure and Decay Data Evaluators was convened at the IAEA Headquarters, Vienna, from 4 to 8 April 2011, by the staff members of IAEA, Nuclear Data Section. This meeting was attended by 35 scientists from 20 Member States, plus IAEA staff, concerned with the compilation, evaluation and dissemination of nuclear structure and decay data. A summary of the meeting, data centre reports, various proposals considered, modified and agreed by the participants, and recommendations/conclusions are presented within this document.

October 2011

GLOSSARY

A	Mass Number
ADNDT	Atomic Data and Nuclear Data Tables
AI	Artificial Intelligence
ALPHAD	ENSDF analysis program
AMDC	Atomic Mass Data Centre
AME	Atomic Mass Evaluations
ANL	Argonne National Laboratory, USA
ANU	Australian National University
ATOMKI	Institute of Nuclear Research of the Hungarian Academy of Sciences
A2, A4	Coefficients of Legendre expansion of γ-γ directional correlation
BIPM	Bureau International des Poids et Mesures, France
BMLW	Reduced magnetic transition probability in Weisskopf units (ENSDF)
BNL	Brookhaven National Laboratory, USA
BR	Branching Ratio
BrIcc	Program to calculate Band-Raman ICC
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)
CIEMAT	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, Spain
CNDC	China Nuclear Data Center, Institute of Atomic Energy (CIAE)
CRP	Coordinated Research Project (IAEA)
CSNSM	Centre de Spectrométrie Nucléaire et de Spectrométrie de Masse, France
DCO	Directional correlation of γ-rays deexiting oriented states
DDEP	Decay Data Evaluation Project
DDG-NA	Deputy Director General of the Department of Nuclear Sciences and Applications (IAEA)
DELTA	ENSDF analysis program
DICEBOX	Monte Carlo statistical model code (developed by F. Becvar and M. Krticka)
DOE	U.S. Department of Energy
DSAM	Döppler-Shift Attenuation Method
EADL	Evaluated Atomic Data Library
EC	European Commission
EFG	Electric field gradient
EGAF	Evaluated Gamma-ray Activation File
EMPIRE	System of codes for nuclear reaction calculations
ENDF	Evaluated Nuclear Data File
ENSDAT	ENSDF analysis program
ENSDD	European Nuclear Structure and Decay Data Network of Evaluators
ENSDF	Evaluated Nuclear Structure Data File
EQM	Electric quadrupole moment
EU	European Union
EURATOM	European Atomic Energy Community
EXFOR	Computer-based system for the compilation and international exchange of experimental nuclear reaction data
Fm	Femtometer
FMTCHK	ENSDF analysis program
FO	Frozen Orbital
FP7 ENSAR	7th Framework Programme, European Nuclear Science and Applications Research (ENSAR)
FP7 ERA-NET	7th Framework Programme, European Research Erea (ERA)

FTE	Full Time Effort/Employment
GABS	ENSDF analysis program
GAMUT	Computer code for gamma-ray energy and intensity analyses of data from ENSDF
GANIL	Grand Accélérateur National d'Ions Lourds, France
GND	General Nuclear Database
GSI	Gesellschaft für Schwerionenforschung mbH, Germany
GTOL	ENSDF analysis program
HF	Hindrance Factor
HFS	Hyperfine structure
HIL	Heavy Ion Laboratory, University of Warsaw, Poland
HSICC	Program to calculate Hager-Seltzer ICC
IAEA	International Atomic Energy Agency
IC	Internal Conversion
ICC	Internal Conversion Coefficients
ICRM	International Committee for Radionuclide Metrology, France
ICTP	International Centre for Theoretical Physics, Italy
IEP-NAS	Institute of Electron Physics of the National Academy of Sciences of Ukraine
IFIN-HH	Horia Hulubai National Institute of Physics and Nuclear Engineering, Romania
IFJ-PAN	Institute of Nuclear Physics PAN, Poland
IIT	Indian Institute of Technology
IMP	Institute of Modern Physics, Chinese Academy of Sciences, China
INDC	International Nuclear Data Committee
INEL	Idaho National Engineering Laboratory (now INEEL)
INEEL	Idaho National Engineering and Environmental Laboratory
INR (Kiev)	Institute for Nuclear Research, Ukraine
INRNE	Institute for Nuclear Research and Nuclear Energy (INRNE), Bulgaria
IP	Isotopes Project at LBNL
IPF	Internal Pair Formation
IUPAC	International Union of Pure and Applied Chemisry
JAEA	Japan Atomic Energy Agency
Jπ/JPI	Spin and Parity
K	Angular momentum protection on the nuclear symmetry axis
KREEP	Geochemical component of some lunar impact rocks
LANL	Los Alamos National Laboratory, USA
LBNL	Lawrence Berkeley National Laboratory, USA
LiveChart	Interactive nuclear structure and decay database (predominantly from ENSDF)
LNHB	Laboratoire National Henri Becquerel, France
LLNL	Lawrence Livermore National Laboratory
LOGFT	ENSDF analysis program
LWM	Limitation of Relative Statistical Weight
M, M$	Transition multipolarity
MDM	Magnetic dipole moment
MPI	Max-Planck-Institut fuer Kernphysik, Germany
MR	Mixing ratio
MSU	Michigan State University
MULT	Multipolarity
MySQL	Relational database engine
NAA	Neutron Activation Analysis
NDP	Nuclear Data Project, Oak Ridge National Laboratory, USA
NDS	Nuclear Data Sheets; journal devoted to ENSDF data
NDS/IAEA	Nuclear Data Section, IAEA
NDWG	Non-Neutron Nuclear Data Working Group (working group of the ICRM)
NEWGTOL	PNPI version of GTOL
NIPNE	National Institute of Physics and Nuclear Engineering, Romania
NIST	National Institute of Standards and Technology, USA

ND	Nuclear Data
NMR	Nuclear 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
NSDFLIB	ENSDF analysis program
NSR	Nuclear Science References – bibliographic file
NUBASE	Experimental nuclear properties database
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
PAN	Institute of Nuclear Physics PAN, Poland
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
RULER	ENSDF analysis program
SHE	Super Heavy Elements
SQL	Structured Query Language
TAEK	Turkish Atomic Energy Authority
TJπ	Proposed theoretical or recommended Jπ
TUNL	Triangle Universities Nuclear Laboratory, USA
USNDP	US Nuclear Data Program
VMI	Variable moment of inertia
WPEC	NEA Working Party on International Evaluation Cooperation
XML	eXtensible Markup Language
XUNDL	Experimental Unevaluated Nuclear Data List
3NDWG	Non-Neutron Nuclear Data Working Group

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

Biennial meetings of the International Network of Nuclear Structure and Decay Data (NSDD) evaluators are held under the auspices of the IAEA, and membership 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 are 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 the World Wide Web, CD-ROM, wall charts of the nuclides, nuclear wallet cards and other such media.

USA 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 Centre 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) coordination of the work of all centres and groups participating in the compilation, evaluation and dissemination of NSDD;

(b) maintenance of and improvements to the standards and rules governing NSDD evaluations;

(c) review of the development and common use of computerized systems and databases maintained specifically for this activity.

Such detailed studies and discussions are undertaken over a five-day period, and this document represents a summary of the Network meeting held in IAEA Headquarters, Vienna, Austria, 4 – 8 April 2011. Thirty-five nuclear data specialists from twenty countries attended this meeting to discuss their work and problems of common interest, specifically with respect to the active membership of the mass chain evaluation team for ENSDF, making this the biggest meeting in the history of the Network.

The first two days were dedicated to a combination of organisational, administrative, 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, horizontal evaluations and technical issues were discussed over the final three days. Problems are still being experienced in maintaining suitable numbers of mass chain evaluators (expressed as FTE – Full Time Effort). The most important issue of the meeting was the uncertain future of the Network due to the ageing of a majority of the existing evaluators. Member States should support the continuing efforts of the Network to train new evaluators by providing the proper working environment in their respective institutions. Thanks to IAEA efforts, six new evaluators are being supported and are actively performing evaluations. The list of participants is given in Annex 1, and the adopted Agenda for the meeting is listed in Annex 2.

Network participants wish to express their solidarity with the representative from Japan and with the people of Japan after the earthquake and tsunami that recently struck Japan.

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
19. Vienna, Austria	04 – 08.04.2011	INDC(NDS)-0595

1. INTRODUCTION

The first meeting of the International Network of Nuclear Structure and Decay Data Evaluators took place in Vienna in 1974. The network has held its meetings mostly every other year since that time.

The data resulting from this international evaluation collaboration are included in the Evaluated Nuclear Structure Data File (ENSDF) and published in scientific journals. They constitute recommended "best values" for a wide range of nuclear structure and decay data parameters. These recommended values are made available to users via various media such as on-line computer services, Web, CD-ROMs, wall-charts of nuclides, handbooks, and nuclear wallet cards. By way of close cooperation within the Network, accurate, freely available data are provided to the user community so as to enhance the quality and reliability of their work. The IAEA Nuclear Data Section"s role within this Network is threefold: first, the compilation, evaluation and dissemination of nuclear structure and decay data; second, the maintenance and improvement of the standards and rules governing nuclear structure and decay data evaluation; and third, monitoring and reviewing the development and use of the computerized systems and databases maintained specifically for such activities.

Daud Mohamad (DDG-NA) welcomed delegates to this, the 19th meeting of the International Network, stressing the importance of the work and their coordinated effort.

2. SUMMARY

The 19th meeting of the International Network of Nuclear Structure and Decay Data (NSDD) Evaluators was held in Vienna, Austria from 4 to 8 April 2011. NSDD meetings are held biennially, usually alternately at the IAEA and a National Centre. Although this 19th meeting had originally been planned to be held at ANU in Canberra, Australia, this could not be realised due to IAEA budgetary constraints. Thus, similar to the previous meeting, attendees assembled at IAEA headquarters in Vienna. Thirty-five participants from twenty countries attended the meeting, representing the majority of data evaluation centres, new evaluation groups and data dissemination centres, making this the largest meeting in the history of the NSDD International Network of Evaluators (Annex 1).

IAEA staff members D. Bin Mohamad (DDG-NA) and D. Abriola (scientific secretary) welcomed all delegates. The Agenda was approved as listed in Annex 2. J.K. Tuli (BNL) and D. Abriola were elected to co-chair the meeting at appropriate times, and D. Abriola and A.L. Nichols were nominated rapporteurs 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 2010-2011. A list of continuous, new and completed actions can be found in Annex 4. Representatives from the individual mass chain evaluation centres presented progress reports on their NSDD studies. These status reports are listed in Annex 5.

The first two days were mostly devoted to administrative and organisational issues, in particular the discussion of actions from previous meetings, the presentation of reports by evaluation centres, as well as reports on the USA and the IAEA Nuclear Data Programs, and the Network Organisational Review, while the last three days focussed on technical matters. Administrative and organizational items are summarized in Section 3, while more technical reports are presented in Section 4. Section 5 contains reviews of the technical discussions; activities related to horizontal evaluations are presented in Section 6. Three specialized technical presentations are summarized in Section 7. Round-table discussions are contained within Section 8, and recommendations and conclusions are given in Section 9.

Regarding the technical work, participants' discussions covered a wide range of topics, in the course of which recommendations to improve the quality of NSDD evaluations were made. A list of actions was prepared, indicating the expert(s) responsible for implementation over the next two years (see Annex 4). The second major concern, namely that of achieving improved financial and technical support within the Network, was also addressed, and NSDD members prepared recommendations to the IAEA as well as the major evaluation centres that addressed these needs. These recommendations include: i) continued organization of joint IAEA/ICTP and IAEA-based workshops designed to train new NSDD evaluators; ii) support by the major NSDD centres of the evaluation work undertaken by new groups through mentoring; iii) maintenance of horizontal evaluations required by users or covered by on-going activities.

The meeting concluded with discussions about a possible venue for the next NSDD meeting, to be held between November 2012 and February 2013. Several centres volunteered to host the meeting, and at the same time acknowledged their willingness to contribute to both the funding for and organizational support of the meeting. Such offers were made by the representatives of Canada (McMaster University), India (IIT, Roorkee), Kuwait (Nuclear Data Centre) and Romania (IFIN-HH).

3. ADMINISTRATIVE AND ORGANIZATIONAL ITEMS

3.1. Report on the US Nuclear Data Program (Herman)

As Head of NSDD, BNL, M. Herman reported on the US Nuclear Data Program (USNDP), with written contributions from R.B. Firestone, T. Kawano, J.H. Kelley, F.G. Kondev, B. Singh, M.S. Smith and A.A. Sonzogni. The composition of the USNDP consists of McMaster University, TUNL and seven national laboratories (ANL, BNL, LANL, LLNL, LBNL, NIST and ORNL).

The following predications were made from a budget perspective:

- FY2011 - 5.7% reduction expected, but not yet confirmed,
- FY2012 - 5.2% increase proposed, and
- FY2013-2017 - 3% increase (assumed cost of living increase).

Economic stimulus funding made for a good FY2010, and some of this revenue will continue to support the program in FY2011. Herman stressed the function of nuclear data as a fundamental link between basic science and applications, and reviewed the relationship and inter-dependencies among the major USNDP databases, namely NSR, XUNDL, ENSDF, RIPL, EXFOR and ENDF.

There were around 2.8 million database retrievals in 2010, showing a continued interest and a stable geographical distribution with 43% of the retrievals from the USA and 25.6% from the EU. The USNDP permanent scientific staff numbers have been in decline from 2007 to 2010 – however, for 2011, the decline has been arrested, and some increase appears possible for the next few years (see Table 1). The main difficulty for the future seems to be the availability of suitably qualified candidates.

	Actuals				Jan		FY13		FY14
								Lab	Lab
	FY07	FY08	FY09	FY10	FY11	FY12	COL	Prop	Prop
Universities	1.7	1.4	1.6	1.6	1.6	1.6	1.6	1.6	1.6
ANL	1.0	1.0	0.8	1.0	1.0	1.0	1.0	1.0	2.0
BNL	7.6	6.7	5.3	5.0	6.2	6.5	6.4	8.4	8.4
LANL	2.2	2.1	1.9	1.6	1.6	1.6	1.7	1.9	1.9
LBNL	2.1	2.1	2.0	2.0	2.0	2.0	2.0	3.0	3.0
LLNL	0.5	0.4	0.2	0.3	0.4	0.4	0.3	0.4	1.4
ORNL	0.3	0.3	0.7	1.1	1.1	1.1	1.1	1.6	1.6
Total	15.3	13.9	12.5	12.6	13.9	14.2	14.1	17.9	19.9
Comp. to 07		**-8.9%**	**-18.0%**	**-17.3%**	**-8.7%**	**-6.9%**	**-7.3**	**17.4%**	**30.5%**

Table 1. Evolution of Full Time Equivalent (FTE) evaluators

A critical issue must be to ensure the continued evolution of young nuclear data scientists worldwide. Herman proposed to make the Nuclear Data (ND) program more attractive by increasing the research component and the adoption of modern technology (to include more theory, high performance computing, AI, etc.). The use of external collaborators is an essential support to the program. BNL has now about 13 external collaborators. Among a number of major objectives, Herman stressed the core activities for FY2011, namely:

- archive of high quality ND for basic nuclear science and technology;
- compilation of bibliography data, nuclear reaction and nuclear structure data to NSR, EXFOR and XUNDL databases;
- dissemination of nuclear physics data through Web-based services.

There are a significant number of retirements expected within the next two to three years that emphasizes the need to attract and retain new personnel to USNDP.

3.2. Report on the IAEA Nuclear Data Program (Abriola)

Abriola reviewed the composition of the IAEA-NDS and its activities related to NSDD including:

- Coordinated Research Projects (CRPs).
- ENSDF evaluations / NSR compilations.
- Financial support for ENSDF evaluator and horizontal evaluation/compilation.
- Coordination of the NSDD Network.
- Workshops.
- Dissemination.

He expressed concern based on the fact that the only CRP related to NSDD ("Updated Decay Data Library for Actinides") has finished, and there is no other proposed CRP to continue such focused NSDD activities at the IAEA. NDS staff continue to be involved in NSR compilations and ENSDF evaluations, in particular Abriola is evaluating mass-chain A=144 in collaboration with A.A. Sonzogni. The IAEA-NDS supports six mass-chain evaluators and two horizontal evaluations (G. Audi (Atomic Masses Evaluation) and N. Stone (Table of Nuclear Moments)); continues to coordinate the NSDD Network; and organizes workshops to disseminate knowledge of NSDD, in particular the Bucharest Workshop on 30 March-3 April, Romania, DDEP Workshop in June 2010, CIEMAT, Madrid, Spain, and the Nuclear Structure and Decay Data: Theory and Evaluation workshop, ICTP, Trieste, 11 - 15 Oct 2010. The latter was organized in collaboration with NNDC and supported 19 participants from 14 countries for training in the methods and procedures adopted to generate ENSDF. Students were divided into five groups in charge of a lecturer and assigned two nuclei to evaluate. This activity was continued after the finalization of the workshop, and concluded with the update of the corresponding ENSDF files. A new ICTP workshop of this series is being planned for 6-17 August 2012. With regards to dissemination, IAEA-NDS staff continue to improve the interactive chart of nuclides (LiveChart), with the development of search and plotting capabilities as well as the introduction of new nuclear moments and nuclear radii. A platform has also been set-up to allow the Web-running of evaluator codes.

3.3. New Evaluation Centres/New Evaluators/Training (Tuli)

There are new evaluators from

Europe:

- Bulgaria: Stefan Lalkovski
- Romania: Alexandru Negret
- Poland: Kazimierz Zuber
- Hungary: Janos Timar
- Ukraine: Dimytri Smychko

  Above are all supported by IAEA-NDS.

- France: GANIL- Manssour Fadil
- Germany – GSI interest?
- Finland – Jyvaskyla - Sakari Juutinen?
- IAEA - Daniel Abriola

India:

- Paresh Joshi – supported by the IAEA

However, Tuli stressed that such participation is fragile, and productivity low. Both the IAEA and NNDC are continually challenged to convince institutions about the importance of the task and the need to provide support. Tuli reported on the Bucharest training workshop for evaluators, held from 30 March to 3 April, 2009 in Romania. Considerable preparative work was undertaken by the seven mentors from the NSDD Network, under the overall coordination of Balraj Singh. Hands-on training was provided during the evaluation of A=84, with the trainees divided into seven groups. Various nuclides were shared amongst these groups. After successful completion, this A=84 evaluation was published under the joint authorship of the 11 trainees and 7 mentors (see November issue of *Nuclear Data Sheets*). Bernd Pfeiffer was thanked for his thorough review. Overall, the workshop was a success and a number of trainees have expressed interest in maintaining future involvement in this work.

Other forms of training are carried out in a mentoring program carried out by B. Singh at McMasters as reported previously. Firestone noted that funds from the USA are available to help NSDD evaluators in their training.

3.4. European Effort (Balabanski)

Balabanski reviewed recent history, starting with an IAEA initiative in 2006 (A.L. Nichols) to organize the funding of European evaluations. The following bodies and institutions were approached:

- EC laboratory directors,
- European Commission (EUROATOM),
- FP7 ENSAR Preparatory Phase,
- NuPECC,
- NuPNET project within FP7.

A Memorandum of Understanding (MoU) for the constitution of the ENSDD (European Nuclear Structure and Decay Data Network of Evaluators) was signed in 2009-2010 by the University of Sofia and INRNE, Bulgaria; IFJ–PAN and HIL, Poland; University of Jyvaskyla, Finland; IFIN–HH, Romania; GANIL and CEA–LNHB, France; CIEMAT, Spain; GSI, Germany; TAEK, Turkey; ATOMKI, Hungary; and the University of Manchester, UK. However, a network of nuclear data evaluators was **not** included in the EC I3 ENSAR project which is funded through the FP7 capacities programme over the period 2010 – 2014. Such a network of nuclear data evaluators does **not** fit within the priorities of the FP7 EUROATM programme. Following the advice of NuPECC, effort was directed towards the FP7 ERA-NET mechanism within the capacities programme (NuPNET project, with funding in the period from 2008 to 2011). Regrettably, no funds were allocated for support to the European Nuclear Structure Data Base (ENSDD).

Balabanski suggested possible future activities to improve and retrieve the situation:

- Keep the community together (organize an ENSDD meeting in 2011).
- Extend MoU beyond 2012.
- Ensure that evaluators are kept involved (by finding support for their activities).
- Apply for the next call for submissions for funding within NuPNET (if in 2012).
- Raise funds within National Funding Agencies.
- Prepare for FP8 (which will be organized in a similar fashion to NuPNET).

3.5. Organisational Review

As co-ordinator of the ENSDF evaluation effort worldwide, J.K. Tuli (NNDC, BNL), provided a detailed overview of the current status of ENSDF, along with numerical information on user access. ENSDF consists of

- 17,096 data sets (c.f. 16,441 in 2009),
- 3,120 nuclides (c.f. 3,045 in 2009),
- 2,384,692 records (c.f. 2,228,606 in 2009), an increase of 7%,
- 4,032 decay data sets (c.f. 3,901 in 2009),
- 9,099 reaction data sets (c.f. 8,746 in 2009).

ENSDF and XUNDL are both distributed electronically twice per year (ENSDF is released as three sub-files: masses 1 to 99, 100 to 199, and 200 to 299). A listing of the status of the mass-chain processing is also issued to the Network every month – on an average, approximately 26 mass chains are undergoing review and processing at any one time. Further statistics were also provided concerning user access to ENSDF data files, articles and citations, as provided by NDS-Elsevier (publisher), both by year, country and specific topic of issue.

Tuli maintains a priority list of 150 nuclides based on the number of experimental measurement papers in NSR that remain unevaluated. Network members should not feel inhibited in applying to evaluate a mass chain of interest to them which does not fall within their particular areas of responsibility – they should contact NNDC (Tuli) to determine the feasibility of undertaking such an evaluation and agreeing on specific activities.

Eleven issues of Nuclear Data Sheets are published every year from January to November, containing mass chain evaluations. An additional issue in December is dedicated to non-ENSDF nuclear data topics.

3.6. Status of ENSDF Evaluations and Estimated Manpower Figures

Tuli summarised the responsibilities of NSDD members, along with manpower commitments of the mass chain evaluators for ENSDF:

North America	No. mass chains	FTE
NNDC, BNL	115	2.45 + 0.5
NDP, ORNL	9	0.35
LBNL	43	0.8
TUNL	19	0.35
ANL	21	0.5
McMaster University	25	1.5
non-North America		
India – IIT	12	0.25
Russia	7	0.25
China – CNDC, Beijing − Jilin University	10	0.4
France – Grenoble/GANIL	11	0.25
Japan − JAEA	10	0.5
Kuwait	7	0.2
Australia − ANU	4	0.1

Specific mass chain responsibilities were also debated and agreed:

Data centre	Mass chain responsibilities
NNDC, BNL	45-50, 57, 58, 60-73 (exc. 62-64), 82, 84-88, 94-97, 99, 118, 119, 136-148, 150, 152-165 (exc. 164), 180-183, 185, 189, 230-240, > 249
NDP, ORNL	241-249
LBNL	21-30, 59, 81, 83, 90-93, 166-171, 184, 186, 187, 191-193, 210-217
TUNL	2-20
ANL	106-112, 176-179, 199-209
McMaster University	1, 31-44, 64, 89, 98, 100, 149, 151, 164, 188, 190, 194
India – IIT	218-229
Russia	130-135, 146
China	51-56, 62, 63, 195-198
France	113-117
Japan	120-129
Kuwait	74-80
Australia	172-175
Hungary	101-105

The Institute of Nuclear Research, Hungary, will be introduced as an ENSDF nuclear data centre, with 0.5 FTE and responsibility for four mass chains (A = 101 to 105).

4. TECHNICAL REPORTS AND ISSUES

In this section preliminary "ACTIONS" are noted, those actions were later discussed and sometimes re-worded or modified. For the final list of actions please see Annex 4: List of continuous, new and completed actions.

4.1. Reminders

Tuli provided a series of reminders to mass-chain evaluators, based on the difficulties and problems experienced in the handling of evaluated ENSDF data files as submitted to the NNDC for review and processing. Points of note included the following:

- Q-record must be given – Q-values from 2009AuZZ (soon to be updated) should be adopted, and also the values from 2003Au03 be given as comments if different to 2009AuZZ – if Q-value is from elsewhere, give Audi value for comparison;
- always list XREF, even if only one data set with gammas;
- BAND identification should be placed on the first record; other comments, if any, may be placed on the continuation records;
- decay modes and moments of ground states and isomers must be given on the continuation records;
- check nuclear moments against 2005St25/2011STZZ;
- isomer is defined as a nuclear level with $T_{½} > 0.1$ s, or as a nuclide that possesses an IT data set;

- (There were discussions to drop the limit of 0.1 s in definition of an isomer-see action items)
- quote authors‟ measured quantities, check authors‟ quoted older values, check for missed references, note assumptions, document deviations;
- never state "from ENSDF" in a mass-chain evaluation.

Numerous other issues were listed, including problems related to the ordering of comments; J^{π} of targets; ordering of gammas by increasing energy; uncertainty limit of 25; listing of delayed gammas as IT decay; need to note unresolved discrepancies; gross β decay is reliable to better than a factor of three; determination of HF of alpha decay; and many others.

4.2. ENSDF Analysis Codes and Web Access

T. Johnson (NNDC, BNL) is newly responsible for the maintenance and development of the ENSDF analysis codes and Web access to ENSDF and XUNDL. The analysis codes were listed as ALPHAD, BrIcc, DELTA, FMTCHK, ENSDAT, GTOL, LOGFT, NSDFLIB, PANDORA and RULER, accessible through http://www.nndc.bnl.gov/nndcscr/ensdf_pgm/analysis. All program revisions are reported in the relevant "Read me" files associated with the code. A known problem with RULER involves the observation that large uncertainties in the gamma-transition mixing ratios lead to incorrect results in the code. Work is also on-going to resolve particular issues identified with GABS. BrIcc is fully supported by Kibedi (ANU), who has also modified and improved specific features of GTOL.

Web access to ENSDF and XUNDL is in the process of being improved to enhance the visual layout, as well as provide more user-friendly search capabilities for data and references.

4.3. Databases

4.3.1. XUNDL (Singh)

A status report on the XUNDL database was presented by Balraj Singh (McMaster University, Canada), covering the two-year period from 1 April 2009 to 31 March 2011. Attendees were reminded of the purpose and scope of XUNDL to provide prompt and convenient access to the most recent publications of experimental nuclear-structure data via the on-line retrieval systems at BNL. ENSDF-formatted data sets are compiled on each paper, or a set of related papers from the same research group. Atomic mass measurements published since the release of AME2003 have also been compiled separately, and these data are available on the ORNL Web page: http://www.nuclearmasses.org
Participation has grown over the years to include McMaster University, TUNL, ANL, LBNL, University of Jordan, PAN-Krakow, IEP-NAS-Ukraine, and the US Naval Academy.

A commercial program (FINEREADER) is used to create tabulated text files from PDF from journal Web pages, and the TABULAR-TEXT conversion code has been developed at McMaster University to generate ENSDF data sets. All resulting data are run through FMTCHK and GTOL, and BrIcc and LOGFT codes are used to extend the decay data. Level schemes, bands and numerical data in the compiled data set are also run through ISOTOPE-EXPLORER or PANDORA, and all data transcription is checked manually. Requests by the compiler to the authors for additional data and queries to resolve discrepancies and inconsistencies are normally resolved through immediate and direct email communications.
Contents of XUNDL:

- 4,064 compiled data sets since XUNDL was launched in December 1998,
- high-spin structures were mainly covered up to 2003,
- primarily experimental nuclear-structure publications from the major journals since 2004,

- 1,953 nuclides spread over 273 A-chains from ^{1}H to $^{294}118$,
- approximately 400 private communications with the author(s) to resolve difficulties – judged by everyone as an extremely important activity.

Some researchers have begun to use XUNDL as a repository for data not included in their original publication(s). Operational statistics were broken up further in terms of the immediate timeframe from 1 April 2009 to 31 March 2011. The work schedule is almost fully up to-date, apart from about 15 papers that remain to be compiled.

4.3.2. NSR (Herman)

The Nuclear Science References file provides highly relevant links to the literature prior to commencement of a mass chain evaluation. This bibliographic database is maintained through the provision of keywording input from NNDC, USA; IAEA; Institute of Physics, Slovakia; and McMaster University, Canada, all overseen by NNDC staff. M. Herman (NNDC, BNL) listed the highlights of work undertaken during 2010, with the preparation and installation of 3,818 new entries, keywording assembled for 2,331 articles, and the implementation of 101 corrections. The total number of NSR entries as of 30 March 2010 is 200,786 – the complete file is fully available on the Web, and up to-date copies are also regularly distributed to LBNL and the IAEA in Vienna.

Google Scholar has been used recently to identify missing publications and articles of relevance to NSR. Keyword and template initiatives have been proposed in a pilot project with XSB, Inc., and further operational improvements are envisaged through this particular route. In addition, efforts have been made to extend the user community by means of Web integration with EXFOR (cross-section compilations) to attract new data specialists to the benefits of NSR.

Subsequent discussions included the strong belief that a mechanism should be established for the assignment of keynumbers automatically on request.
ACTION: NSR manager.

Also stressed by a number of participants that a request for a keynumber should not be conditional upon the requester providing keywords.
ACTION: NSR manager is responsible for NSR keywords, and should not place this form of demand on any requester, thus the keyword requirement for evaluators should be optional.

A number of NSR references can prove very difficult to acquire (e.g., elderly articles, papers from journals that are now moribund, and laboratory reports). Significant efforts should be made to digitalize such hard-to-get references.

ACTION: NNDC to explore digitisation of obscure and hard-to-acquire references.

4.3.3. NuDat (Sonzogni)

A.A. Sonzogni (NNDC, BNL) presented an update on the continuous development of NuDat, presently defined as NuDat 2.5. The program was successfully migrated to MySQL and new Web servers in August 2009. Cosmetic improvements have included the introduction of a further four colour schemes to give 27 in total, improved data accessibility, removal of jargon, and expansion of the glossary.

Software developments have focussed on the formulation of the coincidence matrix for decay, and significant improvements to the derivation and assembly of atomic radiation following nuclear decay. The Evaluated Atomic Data Library (EADL) assembled in ENDF-6 format from LLNL has been adopted, which lists atomic sub-shells with their corresponding binding energies, and transition energies and probabilities of X-rays and Auger electrons for each sub-shell. Examples of the new data displays in NuDat and the procedures for access were demonstrated. Plans are also being made to upgrade the RADLIST code by means of EADL for $Z \geq 20$.

Sonzogni commented on the feedback from NuDat users − more than 100 emails per year that drive many of the new developments. Interactive charts of the nuclides are the most popular product, followed by the search/browse facilities for decay data.

4.3.4. LiveChart (Abriola)

Work has continued over the previous two years to further develop the capabilities of the IAEA-NDS LiveChart of the Nuclides. Abriola (NDS, IAEA) drew attention to the rapid access point of this user-friendly chart for nuclear structure parameters and individual decay data − see LiveChart of the Nuclides icon on http://www-nds.iaea.org

Verpelli and Vasaros have extended the capabilities of the software throughout 2009 and 2010, respectively. Nuclear charge radii from Angeli and Marinova have been introduced into the database, along with the most recent nuclear moments compiled by Nick Stone. Detailed figures of the level schemes can be easily accessed and displayed by the click of a mouse on "open level scheme", and Abriola demonstrated the complexity that can be reproduced by LiveChart via this route in order to highlight various important features of individual decay schemes. This work will continue, with the re-employment of Verpelli within the Nuclear Data Section from the beginning of May 2011.

5. TECHNICAL DISCUSSIONS

5.1. EGAF File (Firestone)

The capture γ-ray collaboration identified with the Evaluated Gamma-ray Activation File (EGAF) represents the work undertaken by staff of the LBNL Isotopes Project, LLNL Nuclear Data Library, the Budapest reactor facility, and five other organisations. Firestone (LBNL) outlined the development processes in support of EGAF from 1996 up to 2007, leading to the public release of the database in 2006 and the publication of the final IAEA technical report STI/PUB/1263, ISBN 92-0-101306-X. Intercomparisons of the contents of EGAF with the literature and recommended IUPAC data began in 2006 as part on an IAEA exercise to assemble an appropriate database of prompt γ rays for neutron activation analysis (NAA), while LLNL/LBNL also collaborated on the preparation of a capture γ-ray library in ENDF-B format.

The data contents of EGAF were reviewed, in conjunction with neutron-beam experiments undertaken on the Budapest reactor (neutron flux of 1.2 x 10^{8} n cm^{-2}) and planned studies at Munich for ^{2}H, ^{3}He and ^{90}Zr (optimum neutron flux of 2 x 10^{10} n cm^{-2}). Cross section and γ-ray measurements have been completed on all elemental targets from Z = 1 to 83 and 92 (except for He and Pm), and on ^{99}Tc and ^{129}I targets. Total radiative cross sections (σ_0) have been determined from the EGAF σ_γ data for complete level schemes of low-Z nuclides. Complex level schemes have involved the adoption of nuclear structure from the RIPL code (Reference Input Parameter Library), primary γ-ray energies and emission probabilities from measurements on the Budapest reactor, and calculations of the continuum components by means of DICEBOX.

The International Union of Pure and Applied Chemistry (IUPAC) adopted a k_0 database for neutron activation analysis from the measurements of De Corte and Simonits (*At. Data Nucl. Data Tables*, **85** (2003) 47-67), leading to the formation of a k_0 committee to review these data, creation of an IAEA Coordinated Research Project on "Reference Database for NAA", and an IAEA consultants" meeting to be held in April 2011. A number of anomalies and disagreements in the data have arisen during the course of this detailed review process that will need to be addressed and resolved.

A further work programme is envisaged in which the full EGAF evaluation would be published in *Nuclear Data Sheets*, as the most suitable journal for such nuclear data:

- EGAF data set (E_γ, σ_γ, k_0, σ_0, S_n, RIPL levels),
- supportive data sets (E_γ, I_γ),
- activation decay (E_γ, P_γ, σ_γ, k_0),

and the updated EGAF database will be provided to the IAEA. Example data in *Nuclear Data Sheets* layout were provided for consideration. Another possibility would be to adapt the activation decay data for adoption and publication within the Decay Data Evaluation Project (DDEP). LLNL have also started a five-year initiative to develop a General Nuclear Database (GND) that will include ENSDF, ENDF and other data, based on eXtensible Markup Language (XML) to replace ENSDF card images with modern systems.

5.2. Decay Data Evaluation Project (DDEP) and ICRM Decay Data Working Group – Status (Bé)

M.-M. Bé (LNHB, CEA Saclay) reported on the status of the Decay Data Evaluation Project (DDEP) and the Non-Neutron Nuclear Data Working Group (3NDWG) of the International Committee for Radionuclide Metrology (ICRM). Decay-data evaluations for the DDEP require the significant efforts of an international team of approximately fifteen experts based on the following:

- adoption of an agreed methodology for the evaluations,
- specific parameters adopted from recommended values of specialists in a particular field (e.g. Q-values and internal conversion coefficients),
- prepare written documentation that describes all the data used in an evaluation, along with decisions and calculations,
- review of each new evaluation by members of the DDEP group.

The results and recommendations are compiled and edited by LNHB staff at regular intervals in preparation for the publication of Monographie BIPM-5 by the Bureau International des Poids et Mesures (BIPM). Both the ICRM and BIPM have formally approved and recommended the adoption of DDEP evaluated decay data in future nuclear data studies. Various products were described, including hardcopy documents, CDs of Monographie BIPM-5, and rapid availability of the decay data through the LNHB Web site http://www.nucleide.org/DDEP_WG/DDEPdata.htm
Members of the 3NDWG have been primarily involved in the evaluation work of the DDEP and the IAEA Coordinated Research Project of 2005-2009 on "Updated Decay Data Library for Actinides".

The ICRM is in the process of organising a biennial international conference from 19-23 September 2011 at Tsukuba, Japan (ICRM2011). Nineteen papers on decay data have been accepted, covering a wide range of half-life and γ-ray emission probability measurements, as well as a re-assessment of half-life uncertainties involving measurements conducted with the 4πγ ionization chamber of NIST, USA.

LNHB staff are in the process of developing a beta-spectrum program (BetaShape) to undertake analytical calculations of spectral shapes for allowed and first-, second- and third-forbidden unique transitions, based on the Gove-Martin formalism. Experiments are also underway to measure β^- spectral shapes, and validate the theoretical predictions and quantify associated uncertainties. Other relevant nuclear data studies include European Joint Research Projects to determine the half-lives of ^{166m}Ho, ^{151}Sm and ^{129}I, and decay-data measurements at LNHB focussed on applications in nuclear medicine (^{64,67}Cu, ^{82}Sr/Rb, ^{211}At and others).

5.3. New JAVA Code for *Nuclear Data Sheets* (Singh)

Work has continued on the development of a JAVA-based program to list and depict mass chains and individual nuclear structure and decay schemes for adoption in *Nuclear Data Sheets (NDS)*. Coding has been prepared by Roy Zywina (2007/08), Scott Geraedts (2008/10) and Jeremie Choquette (2010 to date) at McMaster University, Canada, under the supervision of Balraj Singh and review of Tuli, Blennau and Baglin.

A band-drawing code was initially written in 2007/08, and incorporated into *NDS* by October 2008. Further work now permits the production of complete tables and drawings – this new JAVA code is ready to produce NDS copy for direct submission prior to review, offering greater flexibility and ease of access when changes need to be made. The program loads ENSDF-formatted data files for either a complete mass chain (or an individual dataset) with a control file that dictates layout and formatting. Output files are generated in LaTeX with drawings in Metapost, and the LaTeX file is converted to PDF format. Example files were shown for A = 40 and 182. A primary aim is to complete the code development and testing by mid-2011, and hand the code over fully to NNDC by July 2011.

ACTION: NSDD Network participants to send all comments concerning example data for A = 40 and 182 and other related thoughts to Balraj Singh by the end of July 2011.

5.4. BrIcc code – E0+M1+E2 Admixtures, and When No Mixing Ratio is Given for M1(E2) or E1(+M2) Transitions (Kibedi, Singh)

Proposals were made by Kibedi (ANU) and Singh (McMaster University) to address problems in the handling of E0 admixtures and ill-defined mixing ratios with respect to the quantification of the internal conversion of γ transitions. Based on angular momentum and parity selection rules, an E0 transition is identified as $J_i = J_f$ and $\Delta\pi = 0$, where J_i and J_f are the spins of the initial and final nuclear levels associated with the γ transition, and Δπ is the change in parity. An admixed E0/E2/M1 transition probability can be expressed as:

$$W(E0) = W_{ic}(E0) + W_{\pi}(E0) + W_{\gamma\gamma}(E0)$$

in which $W_{ic}(E0) = \rho(E0) + \Omega_{ic}(E0)$ for conversion electrons, and
$W_{\pi}(E0) = \rho(E0) + \Omega_{\pi}(E0)$ for electron-positron pairs.

The monopole strength parameter was defined to give a reduced transition probability (B(E0)):

$$B(E0) = \rho^2(E0)e^2R_0^4$$

E2/M1 and E0/E2 mixing ratios are defined as:

$$\delta^2(E2/M1) = \frac{W_\gamma(E2)}{W_\gamma(M1)} \quad \text{and} \quad q_K^2(E0/E2) = \frac{W_K(E0)}{W_K(E2)}$$

Since $\frac{W_L(E0)}{W_K(E0)} = \frac{\Omega_L}{\Omega_K}$ then:

$$\frac{W_L(E0)}{W_L(E2)} = q_K^2\,(E0/E2)\cdot\frac{\Omega_L}{\Omega_K}\cdot\frac{\alpha_K}{\alpha_L}$$

where
E0: electric monopole transition
Ω_{ic}, Ω_{π}: Church & Weneser electronic factors
R0: nuclear radius $R0 = r_0A^{1/3}$, $r_0 = 1.2$ fm
δ: mixing ratio
q_K : mixing ratio for (E0/E2)
ρ(E0): monopole strength parameter
W(E0): transition probability for E0 transition, W(E2) for E2 transition, etc.

Kibedi and Singh proposed that $q_K^2(E0/E2)$ be entered into ENSDF from experimental studies by the evaluators, and Ω_L/Ω_K and α_K/α_L can be calculated by the BrIcc code.
ACTION: Kibedi and Singh to introduce the above procedure into the processing and quantification of E0/E2/M1 γ transitions.

If no mixing ratio (MR) is defined for a known admix γ transition, BrIcc and HSICC assume MR = 1 ± 0. However, compilations of mixing ratios do exist, and should be consulted (1977Kr13, 1986La26). The MR problem within ENSDF can be quantified by identifying the total number of admix γ transitions, and recognising how many have been assigned a mixing ratio and uncertainty (MR ± ΔMR):

	Total	**MR ± ΔMR**
E2/M1	9760	6414
M3/E2	313	240
E4/M3	6	4
M2/E1	1104	862
E3/M2	80	60
M4/E3	9	4
E5/M4	5	3

A comprehensive analysis of all MR(E2/M1) data for J ≤ 6 suggests that MR = 1 is a reasonable value to adopt if there are no other alternative possibilities. Similar analyses of many other ill-defined admix γ transitions support MR ~ 0.1 (see below).

	mean MR	**recommended MR**
E2/M1	0.72(72)	1.0
M3/E2	0.09(9)	0.1
E4/M3	0.13(15)	0.1
M5/E4	?	0.1
M2/E1	0.12(12)	0.1
E3/M2	0.71(61)	1.0
M4/E3	0.012(19)	0.1
E5/M4	0.061(23)	0.1

Tuli urged that internal conversion coefficients be calculated in default by BrIcc with MR(E2/M1) of 1.0, but should be easily overridden by the introduction of known mixing ratios.

5.5. Atomic Radiations (Kibedi, Kondev)

The confident quantification of atomic radiations is important in various spectral analyses of decay data. Both radiative and non-radiative atomic phenomena have been reviewed and specific forms of modelling undertaken, as described by Kibedi (ANU). The consequences of inner-shell vacancies were depicted, including internal conversion, electron capture and their secondary atomic processes (X-ray emissions, Auger electrons and Coster-Kronig transitions), and the creation of a vacancy cascade over relaxation times of the order of 10^{-15} seconds. Derivations of the energies and intensities were also defined for the resulting X-ray and Auger-electron emissions.

Comprehensive sources of internal conversion coefficient data [1, 2] and electron capture probabilities [3] have been adapted for ENSDF processing, while various incomplete databases can be used for X-ray fluorescence yields, Auger and Coster-Kronig transition probabilities [4], semi-empirical Auger energies [5], and radiative and non-radiative yields for K and L shells [6]. X-ray, Auger and Coster-Kronig energies and transition probabilities for single vacancies can also be found in the Evaluated Atomic Data Library (EADL) [7]. Kibedi noted that neutral atom binding energies are an important aspect of the derivation of atomic data, and these need to be confirmed and/or validated as being appropriate for such calculations. Other sources of atomic data were listed – many are based on systematics and contain gaps in the compiled datasets that should be filled, even if only based on theoretical predictions. Various relevant programs were tabulated such as EDISTR [8], RADLST [9], RELAX [10] and EMISSION [11].

Limitations and problems were noted as follows:

- neutral atom binding energies are used for atoms with vacancies (ions),
- a single initial vacancy is considered, while secondary vacancies are ignored,
- atomic radiations only from K and L shells,
- limited information on sub-shell rates,
- Auger spectrum below ~ 1 keV is often omitted.

Complex multi-peak Auger spectra were shown that underline the need to extend the theoretical models beyond the L shell.

The Kolman model has recently been developed to evaluate non-radiative transitions:

- primary vacancies from BrIcc (for conversion electrons) and EC (for electron capture),
- binding energies calculated by the RAINE code for electron configurations of a neutral atom or an ion with single or multiple vacancies,
- Auger and Coster-Kronig transition rates calculated using non-relativistic perturbation theory with screened hydrogenic wave functions (simple general formalism for all shells and transitions),
- propagate vacancies until they reach valence shells (or the shells immediately below),
- partially defrosted orbitals: calculations for all electronic configurations (complete treatment), but adopt single-vacancy transition rates.

ENSDF file is used as input for the nuclear structure data, with atomic data from Schönfeld and Janssen [12]. X-ray and Auger-electron spectra are calculated for the K and L shells.

Future plans include:

- calculate theoretical binding energies by means of the RAINE code,
- incorporate up-to-date atomic data on X-ray emissions,
- include Kalman model to calculate detailed energy spectra of Auger and Coster-Kronig transitions.

A new program is being developed to treat all atomic shells and multiple vacancies in order to evaluate fully the energy spectra of the atomic radiations in detail, with individual ENSDF files used as input.

References:

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5.6. ENSDF Review (Mitropolsky)

Mitropolsky (PNPI) reported on a detailed study by G. Shulyak of the contents of the ENSDF file. The various findings from this extensive exercise can be found on Web site http://georg.pnpi.spb.ru. One proposal would be to include this checking procedure in the pre-publication review of new mass-chain evaluations.
ACTION: Tuli to select and send new mass-chain evaluation files to PNPI for comprehensive data and format checks.

5.7. Issues in ENSDF (Sonzogni)

Sonzogni (NNDC, BNL) provided a brief description of some specific issues he wished to bring to the attention of NSDD Network participants:

- BR of 1 assumed to possess no uncertainty (BR = 1 ± 0) – uncertainties of γ-ray emission probabilities derived from such BR data are really only lower limits, and furthermore their derivation by alternative routes can result in disagreement;
- old decay data sets – consideration should be given to the adoption of new Q-values, along with undertaking LOGFT and BrIcc calculations;
- FMTCHK does not warn the user when $\sum(BR_\beta + BR_{EC}) > or < 100\%$;
- requirement for more detailed atomic radiation data.

He concluded that any future ENSDF format developments needed to address such additional basic issues.

5.8. ND2013 (Sonzogni)

The next International Conference on Nuclear Data for Science and Technology (ND2013) will be held at the Sheraton Hotel and Towers, New York, USA, on 4 to 8 March 2013 (www.bnl.gov/nd2013). Technical topics will encompass:
• nuclear reaction, structure and decay data,
• experimental facilities and detection techniques,
• nuclear data measurements and analysis,
• nuclear theories, models and data evaluation,
• uncertainty quantification and covariances,
• evaluated nuclear data libraries,
• nuclear data processing,
• nuclear data adjustment,
• validation of evaluated data,
• integral experiments,
• cross section and decay standards,
• data dissemination and international collaboration,
• nuclear fission (75th anniversary),
• nuclear data for reactors,
• nuclear decay heat,
• dosimetry and shielding,
• safeguards and security,

- criticality safety,
- homeland security and safety,
- accelerator related applications,
- fusion technology,
- space, cosmic-rays, radiation effects on electronics,
- astrophysics and cosmology,
- medical and environmental applications,
- nuclear physics education.

Details of registration and accommodation costs were given, along with a timetable of the deadlines for preparative actions (abstract submission and hotel reservation deadlines, etc.). Assistance will be warmly welcomed in a wide range of conference activities, including the review of abstracts and articles, and suggestions for topics and speakers.

5.9. J^{π} and MULT Assignments in ENSDF (Singh)

Singh discussed the application of the existing rules for spin-parity assignments:

- Double-standard: one for low-spin states and another for high-spin states - more reliance for the latter on what authors assign, rather than follow the strong rules in *Nuclear Data Sheets*.
- Low-spin levels: rules applied quite well - critical about conversion coefficients, angular correlation, polarization data, etc.
- Usage for high-spin levels in ENSDF seems inconsistent, even though additional rules have been added for such studies in the past few years.
- MULT assignments: separate guidelines have been written, implicit in rules for spin-parity assignments. Perhaps there should be a separate set of guidelines.

Examples:

- E2: from DCO=1.39(51) (DCO alone is parity-insensitive),
- E1: from DCO=0.88(33),
- (E1): from DCO=0.82(60),
- E2: from M$ DCO=1.10 (20),
- E2: from M$ A2=0.20 (5),
- MULT given even when no supporting data exist,
- implied simply from $\Delta(J^{\pi})$, based on some band structure,
- MULT assignments from conversion data: experimental conversion data either quoted or not,
- DCO; A2, A4; POL values not given consistently,
- DCO values given in dataset but no MULT assigned.

J^{π} given without parentheses even when not supported by strong arguments (perhaps based only on a cascade of transitions).
Action for all: Evaluators should suggest either additional rules and guidelines or modifications in the existing rules so that some consistency can be achieved.

5.10. +BrIcc – Recent Development in Theoretical Conversion Coefficients (Kibedi)

Kibedi described a recent augmentation of BrIcc that he called +BrIcc. Since the release of version 2.2b in April 2009, several suggestions have been made to improve the BrIcc calculations of ICCs. Hence, a new version has been developed, which adopts double precision and was developed with the latest Intel Fortran compiler for the Windows, Linux and Macintosh operating system. The BrIcc web interface has also been augmented with a

Grapher application to visualize ICC as a function of gamma-ray energy. The new web address of BrIcc: http://bricc.anu.edu.au/

6. HORIZONTAL EVALUATIONS

6.1. Present Status of AME and NUBASE Evaluation (Wang)

The atomic mass tables, which are the main products of the Atomic mass evaluation (AME), are the most reliable source for the values of atomic masses and their uncertainties. Since the completion of AME2003, the latest version of AME published, a large amount of new data emerged from precise mass measurements using Penning traps and storage rings, as well as from nuclear decay and reactions measurements. A new project called "AME-future" is now underway, which is aimed at the production of the new tables (AME2013) to be published in early 2013. Intensive work on this project is continuing in the collaboration between G. Audi, as a coordinator, and contributors from IMP-Lanzhou, GSI-Darmstadt, ANL-Argonne and MPI-Heidelberg.

Following on a significant interest expressed by many colleagues for newly updated mass tables, a bulletin from the atomic mass data center (AMDC) was issued in April 2011. Within this submission, a description of the present mass evaluation status and a distribution of AME2011-preview tables, a preliminary version of AME2013 that contains many changes and improvements, were made. The new mass table can be downloaded at the project webpage: http://amdc.in2p3.fr.

The excitation energies of some isomeric states in some nuclides are determined from gamma decays directly or in cascade to the ground state. ENSDF is a reliable resource of the corresponding values. While in some other cases, the excitation energies of some isomeric states are determined from atomic mass connections to other nuclides, such as the difference of alpha decay energies and so on, then AME is the best resource for the corresponding quantities.

NUBASE is the horizontal evaluation of nuclear and decay properties. Usually the information in NUBASE is adopted from ENSDF evaluation. If there are later experimental results about the related properties, the new information will be included in NUBASE and the appropriate reference is given. It is important to note that ENSDF evaluation should cite the original work rather than NUBASE as a reference.

6.2. Nuclear Moments Compilation (Stone)

A crucial ingredient for ENSDF evaluation is a comprehensive and updated table of Nuclear Moments. Experimental values of the electromagnetic dipole and quadrupole moments of nuclear states are among the best sources of detailed evidence as to the description of the wave functions of those states. As such they provide much needed material to test theories of the structure and excitations of nuclei, being sensitive to both single particle and collective composition of the states. As new results become available it is necessary that an up-to-date tabulation of experiments, with evaluation and recommended best values, be available to the nuclear structure community.

Reviewing the History of Nuclear Moments Compilations, Stone highlighted the very first comprehensive review, that of Gladys Fuller (1976Fu06, J. Phys. Chem. Ref. Data 5, 835 (1976)), followed by that of Pramila Raghavan (1989Ra17, ADNDT 42, 189 (1989) and his own Atomic Data and Nuclear Data Tables (N.J. Stone ADNDT 90 75 (2005)), the standard

source up to now. Under an IAEA-NDS contract, Stone undertook the compilation of a new Table: N.J. Stone INDC(NDS)-0594 (2011) (2011STZZ).
Stone reviewed the basis concepts about Nuclear Moments, namely for the Nuclear Magnetic Dipole and the Electric Quadrupole moments.

Nuclear magnetic dipole moment (MDM)
Nuclear magnetism has contributions from all angular motion with unit the nuclear magneton (n.m.)

Orbital angular momentum:
Single particle - proton charge 1
neutron charge 0
Collective - whole nucleus charge Z/A
valence nucleons - variable

Spin angular momentum:
Single particle - proton $s_{1/2}$ moment + 2.79 n.m.
neutron $s_{1/2}$ moment -1.91 n.m.

The MDM is a sensitive, non-quantised, measure of state wavefunctions.

The basic standards of nuclear magnetism are:
The proton and the deuteron [values from Fundamental Physical Constants see e.g. PR D66 010001 (02)].

Main secondary standards are:

^{23}Na, ^{203,205}Tl, ^{165}Ho, ^{207}Pb, ^{185,187}Re, ^{209}Bi, ^{199}Hg,

From these other standards are derived by ratio to give a complete reference structure throughout the periodic table. Gustavsson and Martensson-Pendrill reviewed the status of knowledge of these secondary standards [PR A58 3611 (1998)] - little change since but the more precise older moments based on earlier values will require adjustment. Stone considered the two methods of measuring MDM namely using external Magnetic fields and Internal magnetic fields (Hyperfine interactions) with their respective corrections like the diamagnetic correction, chemical shift, hyperfine anomaly and Knight shift.

Nuclear electric quadrupole moment (EQM)
Measures the departure from sphericity of the nuclear charge distribution.
If a ellipsoidal shape with major axis a and minor axis b and uniform charge density is considered,

the *Intrinsic* quadrupole moment [for small eccentricity $e = (1 - b^2/a^2))$] is given by

$$Q_0 = 2/5\ ZR_m^2 e(1 + 2e/3) \text{ where the mean radius is } R_m^3 = ab^2$$

and the largest measurable value of this is the *Spectroscopic* quadrupole moment.

$$Qs = Q_0[(2I + 1)/(2I + 2)]$$

For a PROLATE ellipsoid (a > b, football shape) Q_0 is positive.

For an OBLATE ellipsoid (a < b, cushion shape) Q_0 is negative.

The EQM is a sensitive, non-quantised, measure of nuclear shape.

The basic standards have long been accepted as those from muonic atoms.

The reason is that we measure product Q_s x electric field gradient (efg) at the nucleus, while the efg is never directly measured. The muon wavefunction allows a clean calculation of efg mainly for a few light elements: Na, Mg, Al, Cu, As, Nb, Pd and almost all above ~ Sm. Since the late 90"s this has been challenged and supplemented by atomic hfs theorists [Bieron, Pyykko, Sundholm, Kello, Sadlej ……], but the agreement between muonic and atomic results is good only up to a few %. New atomic results also lead to revised Q"s with serious differences from previous „best values" in elements where there were no muonic data. Now the calculated efgs atomic and molecular wavefunctions (light and medium nuclei) and mesonic atom (heavier nuclei) provide a systematic consistent basis for electric quadrupole moment measurements for many elements to precision of a few %.

Many present Table entries still rely on older efg estimates, and/or old B[E2] values.

The time is clearly ripe for a review of all quadrupole moments.

Plan of action:

1. Continue to update new entries at 12 month intervals. Publish update frequency: 3 to 5 years?
2. Address the need for recommended values by:
   a) review of standards, followed by
   b) appropriate reanalysis in the light of revised standards – including Fuller listings
   c) averaging of results to obtain „best values".

6.3. Atlas of Nuclear Isomers and their systematics (Jain)

An outline of the proposed atlas of nuclear isomers was presented. Isomers can be viewed as a separate class of nuclei and offer interesting possibilities to study the behavior of nuclei under varied conditions of life-time, spin, excitation and particle configuration. A systematic of the nuclear properties of isomers like excitation energy, half-life, spin, abundance etc. was presented. Some interesting features in the spin systematic were pointed out.

6.4. Structure and Decay Properties of K-Isomers in Nuclei with A>100: Database and Publication (Kondev, Kibedi)

F.G. Kondev (ANL), T. Kibedi (ANU) and G.D. Dracoulis (ANU) reported on the horizontal evaluation of properties of K-isomers in deformed nuclei with A>100. The data are assembled into ENSDF formatted files, which will be updated continuously.
The physics case for the need of K-Isomers Evaluation was first reported at the 2007 St. Petersburg NSDD meeting. The aims and scope are to evaluate properties of all K-isomers in deformed nuclei – including E_x, K, J^π, $T_{1/2}$, BR, ICC, B(XL), no such systematic study exists up to now.

This evaluation has been encouraged by the research community – e.g. International Workshop on "Atomic Effects in Nuclear Excitation and Decay", 15-19 June 2009, Trento, Italy. The resulting evaluation, in a ENSDF formatted K-isomers file is updated continuously, just like the Table of Superdeformed Bands evaluation (McMaster University & LBNL).

A draft of the review article, (final version to be submited to ADNDT by the end of the year) has been submitted to the editor (D. Schultz) and a positive response has been received.
The data are evaluated in ENSDF format, the evaluators have agreed on general policies (tried to follow the ENSDF policies as much as possible); specialized codes were developed.
The evaluation is essentially completed, can easily be used to update ENSDF; will make specific recommendations to improve ENSDF, like the introduction of the K-quantum number explicitly; the need to include other classes of isomers will depend on the needs of the community.

6.5. Systematics of Nuclear Gamma Transitions (Mitropolsky)

As described previously by Mitropolsky (PNPI), γ transitions extracted from ENSDF are being analysed in both systematic and purely numerical terms at PNPI. These studies have continued, and a subset of ENSDF data has been assembled to undertake such analyses on the basis of A, Z, N, excitation by reaction and decay, $E_L(\Delta E_L)$, J^π, $E_\gamma(\Delta E_\gamma)$, $P_\gamma(\Delta P_\gamma)$, multipolarity, internal conversion coefficients, etc. Various statistical data can clearly be derived such as:

- 237,682 γ transitions in 1,985 nuclides,
- 49,164 γ transitions are contained within ENSDF with no assigned uncertainties,
- ^{38}Ar is listed with as many as 1,984 γ transitions, etc.

Energy distributions can be plotted – for example, E_γ as a function of the number of γ transitions of energy E_γ for decay processes and (n,γ) reactions. The number of γ transition types have been determined in terms of totals, even-even, odd-odd and odd-even nuclei masses (E0, E1, M1, E2, etc.), and these data plotted as a function of E_γ. Finally, Mitropolsky indicated how trends (and lack of trends) can be gleaned from the interrogation of selected datasets extracted from ENSDF. Serendipitous forms of analysis were also considered, such as consideration of the Newcomb-Benford law as applied to individual digits within very large sets of numbers.

6.6. $B(E2; 0_1^+ \rightarrow 2_1^+)$ Evaluation for Even-Even Nuclides of Z = 24 to 30 (Singh)

The main aim of the evaluation by Pritychenko (NNDC, BNL), Horoi (Central Michigan University), Choquette, Karamy and Balraj Singh (McMaster University) was to update an equivalent evaluation published in 2001 (Raman *et al.*, *At. Data Nucl. Data Tables*, **78** (2001) 1). Significant amounts of new data have been produced in the previous 10 years. A pilot project started in November 2009 covering Z ~ N ~ 28 (Cr, Fe, Ni, Zn), and a paper has subsequently been submitted to *At. Data Nucl. Data Tables*.

ACTION: NSDD Network participants to provide comments and feedback to Balraj Singh on the draft paper by September 2011.

Several different classes of B(E2)↑ study were considered, and the evaluation policy was defined as follows:

- deduce model-independent B(E2)↑ values,
- deduce combined B(E2)↑ values: model-independent and somewhat model dependent,
- compile model-dependent values from inelastic scattering data.

Recommended data have been produced for Cr, Fe, Ni and Zn that are model-independent and combined B(E2)↑ values (also have assigned 5% minimum uncertainty to most experiments). Example datasets of compiled and evaluated B(E2) values were shown, along with comparisons with shell-model calculations. Out of a total of 38 nuclei, data were updated or newly introduced for 33 (newer measurements had been made on 15 nuclei since 2000/01, and therefore re-evaluations were undertaken, while first measurements had been carried out on the other 18 nuclei).

Work is now in progress to compile and evaluate the B(E2)↑ values for Z = 4 to 22 (Be to Ti).

7. TECHNICAL PRESENTATIONS

7.1. Internal Conversion Coefficients (ICC) (Nica)

Nica presented a test of internal-conversion theory with a measurement of ^{119m}Sn, in which the KX to γ-ray ratio method was used:

$$\alpha_K \omega_K = \frac{N_K}{N_\gamma} \cdot \frac{\varepsilon_\gamma}{\varepsilon_K}$$

where NK, Nγ are measured from only one K-shell converted transition and ω_K is taken from 1999SCZX (compilation and fit). A very precise detector efficiency of 0.2% was achieved over the energy range from 50 to 1400 keV. 98.8%-enriched ^{118}Sn target was activated at the TAMU Triga reactor, and the resulting γ-ray emission studies focused on the 65.7-keV, M4 γ transition of ^{119m}Sn. The first major difficulty was the very low intensity of 65.7 γ-ray, and the presence of 33.6% impurities in the region of interest (arising from ^{75}Se, ^{182}Ta). Other problems included the poorly-known efficiency below 50 keV, and scattering which affects the SnKX region (2-3% effect). A preliminary result of α_K(expt) = 1601 ± 39 (2.5%) compares with α_K(hole, FO) = 1618, and α_K(no-hole) = 1544.

7.2. How to Draw a Level Scheme? Or About the Nature of Gamma-ray Spectroscopy Data (Nica)

Nica proposed a method for the visualization of regularities in a level scheme which is centered on the assembly of the γ-γ coincidence matrix by either experimental means, or that reconstructed from the known level scheme. The concept for this approach is based on „repeatability": repeated appearance of satellite peaks relative to the coincidence peaks of a reference rotational band at the same location. The repeatability peaks are situated on a regular grid with characteristic distance grid:

$$(\Delta E_{\gamma_1}, \Delta E_{\gamma_2}) =$$

$$= (E^r_{\gamma_1}, E^r_{\gamma_2}) - (E^s_{\gamma_1}, E^s_{\gamma_2}) = (m \cdot d_{grid}, n \cdot d_{grid}), \quad m, n \in Z$$

Peaks appear "statistically" at a number of repeatability positions, including the windows situated on the diagonal of the central valley. Consider the [541]1/2- of ^{163}Tm repeatable satellite peaks on the regular grid with dgrid = 0.8 keV, while for the [411]1/2+ band in ^{163}Tm dgrid = 4.5 keV. If all reference bands are considered, dgrid = 2.7 keV (approximately (4.5+0.8)/2). Nica compared this method with the functional analysis method (FAM), and concluded that "repeatability" constitutes the true nature of nuclear spectroscopy data in allowing full decomposition of the data, and exhibiting general inter-level (inter-band) correlation.

7.3. Mammoths, Meteors, and Supernovae (Firestone)

Firestone presented a detailed description of the theory of mass extinctions in relation to supernovae and meteor impacts, devoting special attention to a set of nuclear techniques relevant to this meeting that help to resolve the puzzle.

Summary of events:

12,900 years ago

- At least 35 mammal genera including mammoths disappeared.
- Paleo-Indians disappeared from the Americas.
- Laurentide ice sheet failed suddenly over Canada.

- Temperatures dropped by 10°C.
- Massive high-temperature forest fires occurred.
- Black algal mat formed over the landscape.
- 500,000 shallow elliptical bays formed over eastern USA.
- Extraterrestrial materials deposited directly over fossils.

35,000 years ago

- Micrometeorites became embedded in mammoth tusks.
- Mammoths, bison, bears, and horses disappeared in Beringia.
- Formation of the Sithylemenkat Lake (Alaska) as a meteor crater.

44,000-37,000-32,000-22,000 years ago

- Supernovae exploded <250 parsecs from Earth.
- Mega-fauna extinctions occurred in Australia 44,000 years ago

Prompt Gamma-ray Activation Analysis (PGAA) and Neutron Activation Analysis (NAA) were applied to over 200 samples, analysing more than 45 elements (PGAA is sensitive to <0.1 mg/cm^3 of any element from H to U; NAA is very sensitive to selected trace elements). Increased Ir concentration, together with other geological evidence and comparison with a lunar meteorite and moon samples from the KREEP region, provided the evidence to conclude that a comet or meteor of unusual Ti-rich, lunar KREEP-like origin impacted near to the Great Lakes (North America) 12,900 years ago, causing the events summarized above.

The events sumarized for 35,000 years ago indicated that Sithylemenkat Lake in Alaska may be the impact crater of a large meteor which shed micro-meteorite shrapnel during descent. Firestone presented diverse evidence pointing to the existence of supernovae in the vicinity of earth during the course of both events. The rates of cosmic-ray impact on the moon and formation of terrestrial radiocarbon sudden increased 44-40,000 years ago, with both phenomena pointing to supernova origins. Thus, renormalizing ^{14}C to a common scale for each supernova, Firestone found the expected signature: a sudden increase in ^{14}C due to γ rays and neutrinos; steady increase in ^{14}C caused by cosmic rays for many centuries; and decay of excess ^{14}C with 5700-year half-life. Supernovae explosions may have stirred up the solar system in turn, causing an increase in meteor impacts.

8. ROUND-TABLE DISCUSSIONS

The following technical issues were discussed.

1. Sonzogni believed that users of ENSDF are confused by various quantities on the normalization N record, especially the lack of uncertainty in BR when defined as 1. He suggested that, when BR is quantified as 1 (± 0), the specified uncertainty of zero should not be adopted. Debate ensued from the point of view of related uncertainties to be found elsewhere within the file (various primary emission probabilities), and this proposal was not adopted.
2. A revised policy for inclusion of p resonances in ENSDF was presented by Balraj Singh, and adopted. While coverage for n resonance was left to the evaluators" judgment, primary transitions from the thermal-n capture state will be included in the Adopted dataset.
3. The evaluation of half-lives in ENSDF was discussed. A reasonably well-defined methodology was proposed for this specific decay parameter by Balraj Singh and Nichols involving statistical procedures known to have been adopted for DDEP studies. Mass chain evaluators should look in some detail at each measurement, all measurement techniques, duration of measurement compared with the known

half-life, identification and inclusion of a range of systematic uncertainties, whether uncertainties are expressed in terms of one sigma or greater precision, etc.

4. Members of the international network of NSDD evaluators agreed to adjust the lower limit of the half-life of a level to be considered an isomer. The current lower limit of 0.1 s was judged to be too high. Therefore, in line with NUBASE, attendees agreed to adopt a lower limit value of 100 ns.
5. Existing data in ENSDF should be double checked for accuracy and consistency. Such efforts are especially important when associated with the adoption of atomic masses and internal conversion coefficients. BrIccE, LOGFT and GTOL should be re-run and checked, and any necessary modifications made even when there are no new nuclear structure data.
6. Adopted Q-values should normally reflect the contents of 2009AuZZ (or later) values. However, when 2009AuZZ/2011AuZZ Q-values differ from those of 2003Au03, suitable comments need to be included in the file. Georges Audi will provide a revised "mid-stream" mass evaluation in April 2011 to replace 2009AuZZ (while the definitive atomic mass evaluation will be published by late 2012 or early 2013).
7. Any citation of older evaluations of nuclear moments should be replaced with the 2005St24 compilation. While 2005St24 is a simple compilation and does not give recommended values, Nick Stone pointed out that he was working on creating a database of evaluated moments.
8. Firestone remarked that USA funds are available to send new evaluators to an established centre to be trained (i.e. LBNL); timing and length of stay would need to be discussed.
9. Nica stated that funding was available for him to mentor one evaluator at Texas A&M for a week of training.
10. Singh made clear that he had been impressed with the participants and overall conduct of the ENSDF-2009 workshop held in Bucharest. Workshops that had focused almost exclusively on serious new evaluators should be held at regular time intervals, and he believed that 2012 would be a suitable year in which to consider such an initiative at Manipal University, India (Gupta agreed).

9. RECOMMENDATIONS AND CONCLUSIONS

Acknowledged representatives from the various data centres presented their biennial progress reports, covering the two years since the previous Network meeting in March 2009. The need for new ENSDF evaluators remains a persistent issue and efforts towards that aim, especially to increase European participation, were greatly appreciated. Dedicated biennial IAEA workshops held at ICTP, Trieste, Italy, for the nuclear community at large along with more specialized meetings, like the ENSDF-2009 workshop in Romania are designed to motivate and train new evaluators.

A proposal was made and accepted to recognize the Institute of Nuclear Research, Hungarian Academy of Sciences, Debrecen, as a new ENSDF Data Evaluation Centre. Steps were suggested to assure the quality and completeness of the databases. With this in mind, a detailed list of actions was produced including the name of the experts in charge of the particular action, covering the time up to the next Network meeting of NSDD evaluators in 2013.

Technical improvements to facilitate the work of evaluators were discussed, and tools to disseminate the results were presented. The need to provide evaluators with updated guidelines was recognized and a committee was appointed to revise and improve the current guidelines.

Members of the International Network of Nuclear Structure and Decay Data Evaluators prepared recommendations with the aim to improve financial and technical support towards the Network, to be implemented by the IAEA and the major evaluation centres. These recommendations emphasized the need to develop stronger links and a clearer understanding between key financial organizations and research facilities, as well as the urgent requirement to recruit new evaluators and support and supervise their evaluation work. A European meeting to investigate and secure funds was proposed for later this year. The 20^{th} Technical Meeting of the International Network of Nuclear Structure and Decay Data Evaluators will be held between November 2012 and March 2013, and (if possible) be hosted by one of the national evaluation centres.

ANNEXES

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

IAEA Headquarters, Vienna, Austria
4 – 8 April 2011

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ANNEX 2

19^{th} Meeting of the Nuclear Structure and Decay Data (NSDD) Network

IAEA, Vienna, Austria
4-8 April 2011
Meeting Room: M5

Adopted AGENDA

Monday, 4 April 2011

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

- Welcome remarks
  D. Bin Mohamad, DDG-NA
  D. Abriola, NDS/NAPC
- Election of Chairman and Rapporteur
- Adoption of Agenda (Chairman)

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

List of Actions (carry over from March 2009)

Others

10:30-11:00 *Coffee Break and Administrative Matters*

11:00-12:30 **Reports by Evaluation Centres**

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

NNDC-USA
IAEA-NDS
ORNL, USA
LBNL, USA
TUNL, USA
CEN, France

12:30-14:00 *Lunch*

14:00-16:00 **Reports by Evaluation Centres (cont'd)**

ANL, USA
McMaster, Canada
St. Petersburg, Russia
JAEA, Japan
Institute of Atomic Energy, China
Jilin University, China
IIT Roorkee, India
[Manipal University, India]
ANU, Australia
Nuclear Data Center, Kuwait
[Debrecen, Hungary]

16:00-16:30 Administrative and Technical Items

Report on the US Nuclear Data Program (Herman)

16:30-17:45 Meetings, Workshops, Trainings and Other Activities

- Report on the IAEA Nuclear Data Programme (Abriola)
  - ICTP-IAEA workshop on NSDD, 11-15 October 2010
- New evaluation centres/new evaluators (Tuli)
  - Status of new evaluation centers/new evaluators
  - European effort (Balabanski)

[Coffee Break as needed]

Tuesday, 5 April 2011

09:00-11:30 Meetings, Workshops, Trainings and Other Activities (cont'd)

- Training of new evaluators (Singh)

Organisational Review (Tuli)

- Activities, priorities and manpower
  - Summary of ENSDF evaluations status and activities in 2009-2010
  - 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
- Network computer programs
- Data Bases
  - ENSDF Status (Tuli)
  - XUNDL (Singh)
  - NSR Status (Herman)
  - NuDat (Sonzogni)
  - LiveChart (Abriola, Vasaros)

[Coffee Break as needed]

11:30-12:30 Technical discussions

1. The EGAF file, Firestone (30 min)
2. Decay Data Evaluation Project (DDEP) and ICRM Decay Data WG, status of activities, M.-M. Bé (15 min)

12:30-14:00 *Lunch*

14:00-17:30 Technical discussions (cont'd)

3. ND 2013, Sonzogni (20 min)
4. Atomic radiations in nuclear decay, Kibedi, Kondev (30 min)
5. Issues in ENSDF, Sonzogni (30 min)

Wednesday, 6 April 2011

09:00-12:30 Round Table: Evaluators' discussion regarding uniformity in ENSDF evaluations

1. Computer codes: new JAVA code for NDS, Singh (15 min)
2. BrIcc code needs some changes for E0+M1+E2 type of admixtures and when no mixing ratio is given for M1(E2) or E1(+M2) transitions, Kibedi, Singh (15 min)
3. ENSDF Error Extraction, Mitropolsky (15 min)
4. Systematics of Nuclear Gamma Transitions, Mitropolsky (15 min)
5. BE2 evaluation for first 2+ states in N ~ Z ~ 28 region, Singh (15 min)
6. Discussion of guidlines for ENSDF evaluations of half-lives of ground states and long-lived isomers, Nichols, Singh (~ 60 min)
7. Moments: is it time to quote only the 2005St24 compilation and not the outdated 1989Ra17?, Singh (5 min)
8. Q values: is it necessary to quote from 2003Au03?, Singh (5 min)

[Coffee Break as needed]

12:30-14:00 *Lunch*

14:00-17:30 Horizontal Evaluations, including Needs and Plans

1. Present status of AME and NUBASE evaluation, Wang (45 min)
2. Nuclear Moments Compilation, Stone (30 min)
3. Atlas of Nuclear Isomers, Jain (20 min)
4. Structure and Decay Properties of K-Isomers in nuclei with A>100: Database and Publication, Kondev, Kibedi (45 min)
5. +BrIcc - recent development in theoretical conversion coefficients, Kibedi (45 min)

19:00 Dinner in a Restaurant in the City
(Restaurant "Weisser Tiger", please see separate information on meeting website)

Thursday, 7 April 2011

09:00-12:30 ENSDF Proposals (Round Table)

1. Revised policy for inclusion of resonance data in ENSDF (Policy presented for approval), Singh (15 min)
2. Assignments of spins and multipolarities in ENSDF, especially when dealing with high-spin data, Singh (~ 60 min)
3. Updated mass chains in ENSDF: evaluators have different approach as to how they deal with earlier data in ENSDF where no new papers have appeared, Singh (15 min)
4. ENSDF evaluation of newer data: Some ways of updating ENSDF for current data on a more efficient basis, Singh (15 min)

[Coffee Break as needed]

12:30-13:30 *Lunch*

13:30-15:00 Technical Discussions (presentations)

1. Internal conversion measurements, Nica (10 min)
2. Data evaluation, Nica (40 min)
3. Mammoths, Meteors, and Supernovae, Firestone (45 min)

15:00-17:30 List of Recommendations and Actions (round table)

[Coffee Break as needed]

Friday, 8 April 2011

09:00-12:30 Conclusions and Recommendations

.. Adoption of recommendations and actions

NSDD chairman

Next meeting *[Coffee Break as needed]*

12:30 Adjournment

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.B. Firestone
e-mail: RBFirestone@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.
Contact: F.G. Kondev
e-mail: kondev@ANL.Gov

f. Indian Institute of Technology,
Department of Physics, Roorkee
Uttaranchal 247667 India
Contact: A.K. Jain
e-mail: ajainfph@iitr.ernet.in

g. Nuclear Data Center
Petersburg Nucl. Phys. Inst.
Academy of Sciences of Russia
Gatchina, Leningrad Region,
188 350, Russia
Contact: I.A. Mitropolsky
e-mail: mitrplsk@pnpi.spb.ru

h. Institute of Atomic Energy
P.O. Box 275 (41), Beijing, PRC
Contact: Ge Zhigang
e-mail: gezg@ciae.ac.cn

Jilin University, Physics Dept.
Changchun 130023, PRC
Contact: Huo Junde
e-mail: jdhuo@mail.jlu.edu.cn

i. Centre de Spectrometrie Nucleaire et de masse
Bat 104-108
F-91405 Orsay Campus, France
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j. Nuclear Data Center
Japan Atomic Energy Agency
2-4 Shirakata-shirane
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m. Australian National University
Dept. of Nuclear Physics
Canberra ACT 0200, Australia
Contact: T. Kibédi
e-mail: Tibor.Kibedi@anu.edu.

n. Institute of Nuclear Research
Hungarian Academy of Sciences
Bem ter 18/c, P.O. Box 5
4001 Debrecen, Hungary
Contact: J. Timar
e-mail: timar@namafia.atomki

A-Chain Evaluation Responsibility

Center	Mass Chains
a. US/NNDC	45-50,57,58,60-73(ex 62-64),82-88 (ex83), 94-97,99,118,119,136-148,150, 152-165 (ex 164), 180-183, 185, 189, 230-240,>249
b. US/NDP	241-249
c. US/LBNL	21-30,59,81,83,90-93,166-171,184,186,187, 191-193,210-217
d. US/TUNL	2-20
e. US/ANL	106-112,176-179,199-209
f. India	218-229
g. Russia/StP	130-135,146
h. PRC	51-56,62,63,195-198
i. France	113-117
j. Japan	120-129
k. Kuwait	74-80
l. Canada	1,31-44,64,89,98,100,149, 151,164,188,190,194
m. Australia	172-175
n. Hungary	101-105

ANNEX 4

LIST OF CONTINUOUS, NEW AND COMPLETED ACTIONS

As of 08/04/2011

CONTINUOUS / ONGOING / PENDING			
No.	**Responsible**	**Reason**	**Action**
1 (3)	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**
2 (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**
3 (5)	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**
4 (19)	NDS	Maintain up to date information on the Network.	Review, modify and correct the contents of INDC(NDS)-421. **Continuous**
5 (7)	BNL/NNDC	Publish versions of ENSDF are required.	Continue journal "publication" of the mass chain evaluations. **Continuous**
6 (8)	All Network participants	Misprints and errors found in NSR and ENSDF.	Report errors detected in NSR, XUNDL and ENSDF to NNDC. **Continuous**
7 (9)	All ENSDF evaluators	Accelerate the review process.	Each ENSDF evaluator should be willing to do two mass-chains equivalent reviews per FTE-year. Reviewing process for one mass chain should not be longer than three months. **Continuous**
8 (11)	All Network participants	Bring NSDD evaluation work to the attention of the nuclear community.	Present Network activities at different conferences and meetings. **Continuous**
9 (12)	All Network participants	Avoid duplication of work.	Participants should inform the NNDC about any development of software related to NSDD. **Continuous**
10 (13)	Evaluators	Young scientists to evaluate mass chains.	Encourage participation in research/evaluation of nuclear structure data. **Continuous**

N.B.: In the first column, numbers in brackets indicate the previous action number (see INDC(NDS)-559).

11 (14)	All Network participants	Improve NSR	Send comments and suggestions on NSR improvements (indexing) to NNDC. **Continuous**
12 (16)	All ENSDF evaluators	Check validity of the rules.	Inform NNDC when experimental results appear to contradict the rules; see Section 5.4. **Continuous**
13 (17)	All Network participants	Improve quality of evaluations.	Solicit potential non-network evaluation reviewers, and send names to ENSDF manager (NNDC). **Continuous**
14 (18)	NSDD Network	Support new ENSDF evaluators.	Provide local support and mentoring to new ENSDF evaluators of mass chain evaluations. **Continuous**
15 (23)	Shulyak, PNPI	To facilitate evaluators‟ work.	Provide copy of PNPI Editor, when finished to the Network to evaluate. **Pending**
16 (24)	BNL/NNDC; IAEA-NDS	Outreach	Continue to pursue initiatives to improve the international contributions to the ENSDF mass chain evaluations. **Continuous**
17 (25)	All Network participants	Outreach	Formulate and expand contributions to mass chain evaluations within their own countries. **Continuous**
18 (27)	IAEA/NDS	Keep links with horizontal evaluations.	Invite representatives of atomic mass and other horizontal evaluations to next meeting. **Continuous**
19 (28)	NSDD evaluators	Quality Assurance *Recommendation*	Consider updating the evaluation cut-off date when no or little experimentally significant new data are available. **Continuous**
20 (32)	Tuli, BNL/NNDC	Facilitate evaluators‟ work.	Analyze Nica‟s proposal to modify PANDORA. **Ongoing**
21 (33)	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). **Ongoing**

N.B.: In the first column, numbers in brackets indicate the previous action number (see INDC(NDS)-559).

NEW 2011			
No.	**Responsible**	**Reason**	**Action**
22	NNDC	Set Priority	Consider New criteria based on XUNDL, NSR to create priority list
23	All evaluators	Evaluations in progress	Inform J. Tuli about mass chain evaluations in progress to be included in monthly processing report
24	NSR manager	Assignment of key numbers	Evaluators should be able to create key numbers remotely. Evaluators will be required to immediately send the relevant reference/article to NNDC.
25	NSR manager	Assignment of key numbers *Recommendation*	The keyword requirement for evaluators should be optional.
26	NNDC	Hard-to-get references	Investigate feasibility of digitizing references that prove hard to acquire.
27	NNDC	XUNDL compilation date	Expand XUNDL index to show compilation date by nuclide.
28	Firestone	ENSDF into XML	Look into possibilities working with LLNL.
29	Kibedi	Calculate conversion coefficients. *Recommendation*	Mixing ratio default to be determined statistically or by evaluator, in either case comments should appear.
30	Kibedi	Mixing ratio for E0, E2, M1.	Suggest changes to format in order to define mixing ratios.
31	Sonzogni, Kibedi	Improve data that quantify Auger electron and continuum beta spectra.	Develop and recommend analysis codes to provide more detailed presentations of Auger electrons and continuum beta spectra.
32	Network	New production code for Nuclear Data Sheets.	Provide comments to B. Singh based on two mass chains (A=40, A=182) placed on the web site.
33	NNDC	Checking code *Recommendation*	Download Mitropolski code and incorporate into FMTCHK.
34	All evaluators	Atomic masses *Recommendation*	Use 2011AuZZ masses and quote 2003Au03 in a comment.
35	Audi	Atomic masses	Provide 2011 evaluation to NNDC by end of April 2011 (2011AuZZ).
36	Evaluators	BE2 compilation	Comments and feedback on the presentation and the paper attached to B. Prytichenko and B.Singh.
37	All	Masses *Recommendation*	To obtain masses for new nuclides, communicate directly with AMDC

38	Evaluators	Moments *Recommendation*	Use N. Stone 2011 evaluation after key number is assigned.
39	All	Half-life evaluations of ground state and isomers.	Provide comments on the draft recommendations by September 2011 to B. Singh.
40	NNDC/IAEA	Remote access	Develop a web interface for ENSDF utility codes to be run remotely.
41	Singh, Baglin, Browne, Kondev, Timor, Sonzogni, Tuli, Abriola	Guidelines	Revise evaluators" guidelines.
42	Network	Policies	Point out to NNDC discrepancies in the current policies, and propose changes and additions.
43	NNDC	Analysis codes	Notify Network of new versions.
44	Evaluators	Isomer definition *Recommendation*	Isomer half-life limit is changed to greater than 100 ns.
45	Evaluators	Charged-particle resonance data *Recommendation*	Adopt new policies and guidelines.
46	Evaluators	Neutron capture gammas *Recommendation*	Include primary gammas in adopted levels.
47	NNDC	General policy pages in NDS.	Modify as required.
48	Firestone	Thermal neutron capture gammas.	Suggest procedure for inclusion of capture gamma intensities in adopted levels.
49	Network	ND2013	Consider attending and present your work.
50	NDS/Abriola	Training of evaluators	Explore if there is need for additional training workshops
51	NDS/Abriola	Improvement of dissemination tools.	Continue to improve tools

COMPLETED			
(1)	Tuli, BNL/NNDC	Quality assurance test	Advise evaluators to run relevant checking codes. RADLST; comment on agreement of Q-value and sum of decay energies and X-ray intensities measured and calculated. **Completed**
(2)	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. **Completed**
(6)	IAEA/NDS	Characteristics and parameters of NSDD Network have to be regularly updated.	Update NSDD Network document and institutions. **Withdrawn**
(10)	All Network participants	Ensure unpublished and current data are prepared in tabular form.	XUNDL co-ordinator to ask researchers to provide data in tabular form. **Withdrawn**
(15)	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. **Withdrawn**
(20)	Firestone, LBNL	Data development	Provide Mitropolsky with GAMUT code to implement improvements. Mitropolsky should maintain contact with Tuli and Firestone during this improvement process. **Withdrawn**
(21)	Sonzogni, BNL/NNDC	Modification of ENSDF format to include cluster emission data.	Tandel to study feasibility. **Withdrawn**
(22)	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) **Withdrawn**
(26)	NNDC	Keep evaluators informed about new rules.	Ensure that all previous guidelines are included within existing evaluators" guidelines. **Withdrawn**
(29)	Kibédi + Singh + Nichols	Quality Assurance	Draft guidelines for derivation of ground-state and isomer half-lives and possibly other quantities. **Completed**
(30)	Verpelli-Abriola	Improvement of dissemination tools.	Provide plotting capabilities in IAEA-ENSDF tools, provide pre-structured modular SQL-queries capabilities, and band-plotting, include comments retrieval. **Completed**

N.B.: In the first column, numbers in brackets indicate the previous action number (see INDC(NDS)-559).

(31)	All	ENSDF improvement	Send to Singh comments/criticisms on his proposal for resonance data by the end of June 2009. **Completed**
(34)	All	ENSDF improvement	Send comments before end of June 2009 on Firestone proposal for new field for neutron-capture cross-section normalization factor. **Withdrawn**
(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. **Completed**
(36)	NSDD evaluators	Use of updated AMDC data.	When AMDC list becomes available, evaluators should use these most recent values. **Completed**

N.B.: In the first column, numbers in brackets indicate the previous action number (see INDC(NDS)-559).

ANNEX 5

STATUS REPORTS OF EVALUATION CENTRES

Report to NSDD FY09-10

Mike Herman
National Nuclear Data Center
Brookhaven National Laboratory

mwherman@bnl.gov

Office of Science
U.S. Department of Energy

Brookhaven Science Associates

BROOKHAVEN NATIONAL LABORATORY

NNDC computer facility

- Upgrade of the Linux cluster mother node
  - from 1 to 2 Xenon processors
  - from 4 to 16 GB RAM
  - increased disk space
- Installation of the new backup server
-

  replaced by a more powerful server in spring 2011

Databases and Services

Database management

- All NNDC databases run on MySQL
- NSR, XUNDL, ENSDF, NuDat maintained and distributed r
- GForge server started in January 2010 (see next slide)

NNDC Web service,

Data retrievals increased by 1%; 2.355 million retrievals in FY10

- Improvements under way in ENSDF and NSR retrieval systems
- Sigma-3.1 released in October 2009
-

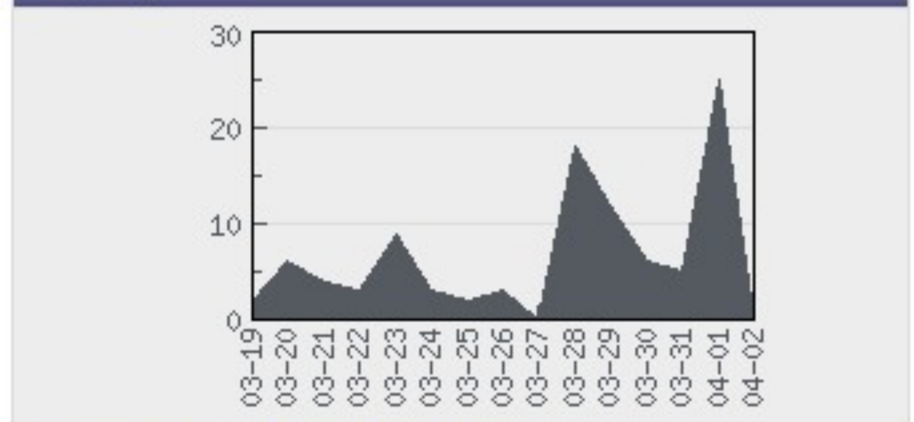
Wallet Cards

NNDC GForge server
https://ndclx4.bnl.gov/gf/

FORGE Advanced Server

- Number of projects: 21
  - structure: 9
  - reactions: 12 (ENDF/B-VII, ENDF-6 Manual, EMPIRE, 3 hosted)
- Number of accounts: 59
  - structure: 12
  - reactions: 47
- Most downloaded:
  - ENDF-6 Manual - 838 times
  - ENDF/B-VII.1 - 639 times

Activity



Recently Registered Projects

(2011-01-07) Generalized Interaction Data Interface
(2011-01-07) Generalized Nuclear Data (GND) format
(2010-01-26) ENDF-6 Manual
(2010-01-19) EMPIRE Nuclear Reaction Code System
(2009-10-30) ENDF/B-VII

Top Downloads

(838) ENDF-6 Manual
(639) ENDF/B-VII
(3) Generalized Nuclear Data (GND) format
(1) Generalized Interaction Data Interface

Recent News

ENDF/B-VII.1beta2 released
Mike Herman
2011-02-22
The beta2 version of the ENDF/B-VII.1 library has been released. It is accessible through the Files tab and as a tag in Subversion tags branch. It is also linked from the button on the ENDF/B-VII front page.
The Subversion repository has been reopened for submissions of new/revised evaluations.

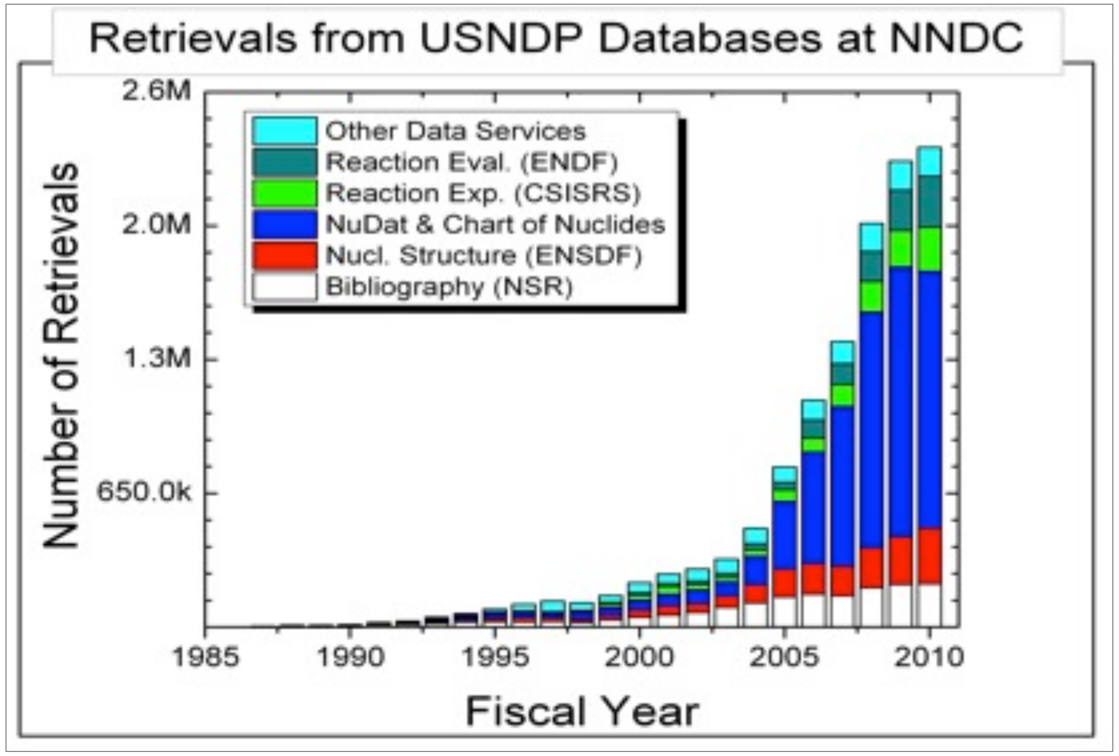
NNDC Personnel Changes

- **New reaction postdoc to join NNDC May/June, reaction data**
- **Gustavo Nobre to join NNDC, postdoc, reaction data**
- **David Brown to join NNDC in August 2011, staff, reaction data**
- **Elizabeth McCutchen to join NNDC in April 2011, staff, structure data**
- Marco Pigni leaving NNDC in April 2011, staff, reaction data
- Pavel Oblozinsky retired March 2011, staff , reaction data
- Caleb Mattoon left NNDC in August 2010, staff, reaction data
- Sujit Tandel left NNDC March 2010 (on leave of absence since June 2009)
- **Tim Johnson joined NNDC in March 2010, staff, structure data**
- Chris Ouellet left NNDC in April 2010, postdoc, structure data
- **Sam Hoblit joined NNDC in April 2010, staff, reaction data**
- Manojeet Bhattacharya left NNDC in July 2009, staff, structure data, NSR
- Chris Ouellet (McMaster) joined the NNDC in March 2009, postdoc, structure data

NNDC Personnel Status FY2010

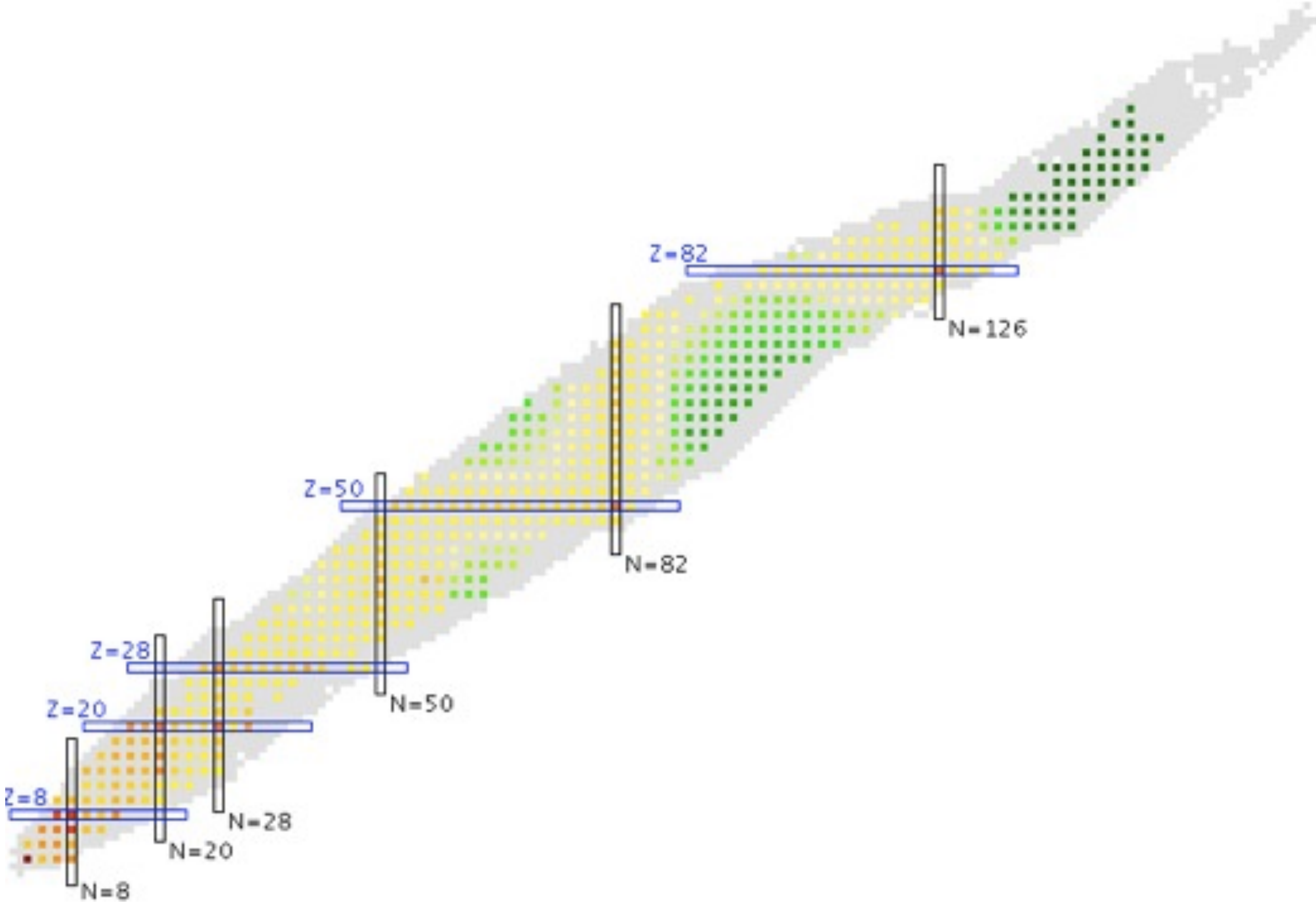
Staff	FTE	Heads	FTE (USNDP)
Permanent	7.35	10	6.00
Temporary	2.33	2	2.33
Professional	3.70	4	3.70
Contractors	2.25	10	2.25
Total	15.63	26	14.28

Nuclear Structure Data



NuDat - ENSDF browser

- NuDat-2.5 maintained regularly, 1.273M retrievals in FY10 - combined with Chart of Nuclides



NSR - bibliography compilation

- 3,818 entries compiled in FY2010 (~41% more than in FY2009)
- contributions from McMaster, NDS-IAEA and E. Betak (under NNDC contract)
- New software for automatic key-wording under development

ENSDF (2010)

8 mass chains completed and submitted (5 NNDC, 3 Collaboration)

Evaluated:

A= 36 (4 nuclides, Nica; *Canada)
A=37 (3 nuclides, Nica; *Canada)
A=65 (13 nuclides Browne,Tuli)
A=95 (10 nuclides, Basu,Sonzogni;*India)
A=99 (14 nuclides, Browne,Tuli)
A=142 (16 nuclides, Johnson,Symochko,Fadil,Tuli)
A=150 (17 nuclides, Basu,Sonzogni)
A=161 (14 nuclides, Reich)
*collaboration
NNDC share of nuclides = 92 (last year = 106)

Published: 6 mass chains
A=65, 66, 72*, 95*, 163*

Reviewed: 8 mass chains
Browne 1(77); Johnson 1(89); Oulette 2(34,65); Reich 2 (50,66), Sonzogni 1(71), Tuli 1(117)

ENSDF (2009)

11 mass chains completed and submitted (4 NNDC, 7 Collaboration)

Evaluated:

A= **31** (2 nuclides Oullete; *Canada)

A=**32** (6 nuclides Oullete; *Canada)

A=**34** (6 nuclides Nica; *Canada)

A=**66** (13 nuclides, Browne, Tuli)

A=**77** (8 nuclides, Nica; *Canada)

A=**84** (6 nuclides, Sonzogni, Tuli; *Bucharest Group)

A=**103** (13 nuclides, De Frenne)

A=**119** (18 nuclides, Symochko, Browne, Tuli)

A=**147** (16 nuclides, Nica)

A=**163** (10 nuclides, Reich; *Canada)

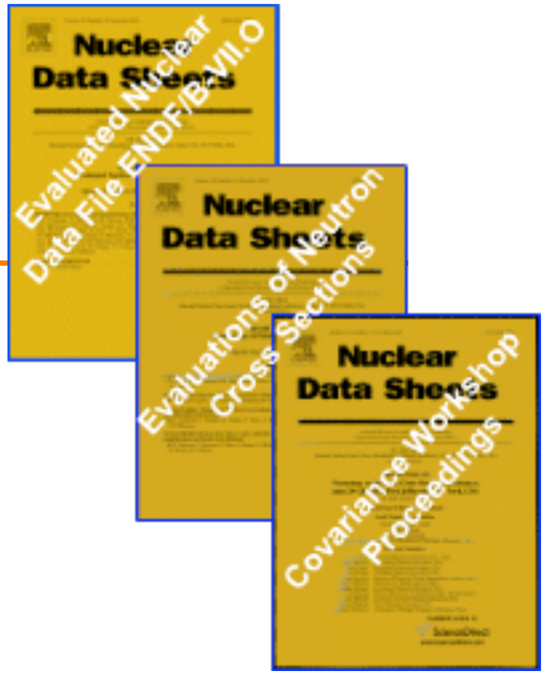
A=**225** (8 nuclides, Jain, Raut, Tuli; *India)

Published: 4 mass chains: A=103, 147, 154, 225*

Reviewed: 11 mass chains: Browne 3 (72, 178, 204); De Frenne 1 (97); Reich 2 (103, 198), Sonzogni 1(93), Tuli 4 (63, 113, 116, 119)

*collaboration

Nuclear Data Sheets



- 10 issues published on ENSDF evaluations in 2010, total number of pages 2800
- 1 issue devoted to reaction data, ~200 pages
  - NJOY paper
  - 2 papers on fission yields
- Impact factor 1.145 (ENDF/B-VII.0 paper out of counting)
- 11 issues published on ENSDF evaluations in 2009, total number of pages 3106
- 1 issue devoted to reaction data, ~200 pages
  - RIPL paper
  - Neutron cross section standards paper
- Impact factor 3.404

IAEA
STATUS REPORT, 2009-2010

D.Abriola
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IAEA Nuclear Data Section,Wagramerstrasse 5
A-1400 Vienna, Austria

Two staff members are engaged in ENSDF-related activities: Mark Kellett undertakes NSR compilations, Daniel Abriola is in charge of ENSDF Mass chain evaluations. Since Marco Verpelli left NDS, Andras Vasaros, a temporary consultant, has been assisting in the further development of LiveChart, the interactive chart of nucleides. He succesfuly implemented several improvements in the software.

NSR Compilation

M.A.Kellett carried out the following NSR compilations:

Year	Papers examined	Papers keyworded
2008	529	298
2009	670	217
2010	596	298

ENSDF mass chain evaluations

D. Abriola in collaboration with A. Sonzogni (NNDC)
Mass chain A = 72 (12 nuclides) was evaluated in 2008-2009, and published in NDS 111 (2010), 1-140.
Mass chain A = 144 (17 nuclides) is being evaluated.

ENSDF-related software

The interactive chart of nuclei has now new capabilities. Level plotting has been incorporated, and ground state properties such as nuclear radii and nuclear electric and magnetic moments have been introduced.

STATUS REPORT OF NUCLEAR DATA ACTIVITIES AT OAK RIDGE NATIONAL LABORATORY

1. Members

The Nuclear Data Group consists of Michael Smith (Group Leader of Nuclear Data & Experimental Astrophysics Program, Chair of the USNDP Astrophysics Taskforce), Caroline Nesaraja (ENSDF evaluator, Astrophysics experimentalist), Eric Lingerfelt (Software Developer), and Murray Martin (ENSDF evaluator and consultant).

2. Activities

i) Nuclear Structure Data

This activity involves evaluating the structure properties of nuclei in mass chains. The international responsibility of the ORNL effort is in the actinide region A=241-249. In 2010, evaluation of data for nuclei with mass number A = 58 in collaboration with McMaster University in Canada was published in Nuclear Data Sheets. Caroline Nesaraja led this effort, and Murray Martin played a key role in mentoring Caroline both in the evaluation and the subsequent review. In 2009 and 2010, both Murray and Caroline worked on the review of A=121, and Murray Martin completed his review on A= 125 in 2010. Presently, work is continuing on the evaluation of A = 152, as well as on the 12 nuclides in mass number A = 69. This latter chain includes 69Br, whose properties are essential for studying the rp-process waiting point nucleus 68Se in X-ray bursts. Recent studies of the mass of 68Se and the decay of 69Br have prompted a reassessment of the 69Br properties relevant for element synthesis and energy generation in these violent explosions on the surfaces of neutron stars. Our evaluation, which is almost complete, will be used for new X-ray burst nucleosynthesis calculations.

ii) Nuclear Astrophysics Data

Our effort in nuclear astrophysics data is closely coupled with our program of measurements of reactions with unstable and stable nuclei at ORNL's Holifield Radioactive Ion Beam Facility. The evaluations and assessments are on reactions that are critical for stellar explosion studies.The highlight of our achievements was the paper published in Nature on the magicity of 132Sn explored through the single particle states of 133Sn. A detailed assessment was made of the low-lying levels in 133Sn that were populated in our HRIBF measurement of 132Sn(d,p)133Sn. The study was performed by the (d,p) reaction in inverse kinematics on 132Sn. The results show consistently high spectroscopic factors for 133Sn levels, compatible with 1 (the maximum value, for pure single particle states) within error bars for all the cases measured. This supports the conclusion that the unstable nucleus 132Sn is the "best example" measured to date of a heavy doubly-magic nucleus. Understanding the nature of the single particle states outside a double shell closure is essential for predicting the properties of thousands of unmeasured exotic nuclei such as those involved in the synthesis of heaviest nuclei via the rapid neutron capture process in supernovae. A number of similar measurements of transfer reactions on neutron-rich unstable nuclei are in progress at ORNL, and our effort in nuclear data will synergistically work with the experimentalists on level assessments needed to fully understand the measurements.

iii) Online Software Systems

Our nuclear astrophysics data effort also includes software work to improve the utilization of nuclear data for studies of astrophysical phenomena. Our major effort focuses on expanding the functionality of the Computational Infrastructure for Nuclear Astrophysics at nucastrodata.org. This is a freely available, online suite of codes that enables Users to, with just a few mouse clicks, quickly make a connection between laboratory nuclear physics results -- and USNDP data bases -- and astrophysical simulations. Users can seamlessly shift between working with nuclear data [e.g., cross sections], processed nuclear data [e.g., reaction rates], and astrophysical simulations. Researchers from over 115 institutions in 29 countries use this software system for their research. New features recently added include a Data Harvester which enables Users to automate the collection of nuclear data from a number of major international databases. This streamlines work that many researchers naturally do as they start a new evaluation, or as they plan a new experiment. Another new feature is a tool that enables Users to quickly carry out studies of the sensitivity of astrophysical predictions on input nuclear physics data. This tool helps guide future experimental, theoretical, and nuclear data work. It also quickly demonstrates the importance of nuclear physics information for a wide variety of astrophysical studies. Another online suite that our effort manages is the Nuclear Mass Toolkit at nuclearmasses.org. This system enables Users to work with experimental, evaluated, and theoretical masses. Anyone can upload their own mass dataset, visualize it, analyze it, and compare to evaluated masses and to 13 different theoretical models. The system is periodically updated with the latest mass measurements as compiled by McMaster Univ., as well as with the latest theoretical mass models. A recent survey of the models was done to choose the "best" mass model using the criteria of RMS deviation from the AME2003 mass evaluation for three different mass regions -- suitable for studies of rp-process burning in X-ray bursts, studies of r-process burning in supernovae, and for research into superheavies.

3) Future Activities

Future mass chains will be evaluated within the range A=241-249 the range assigned to ORNL, as well as others assigned by USNDP / NNDC. Nuclear astrophysical rate evaluations will continue for reactions that are measured at HRIBF with unstable and stable beams. In our software work, we will implement a set of workflow tools for international collaboration in Nuclear Astrophysics in the Computational Infrastructure for Nuclear Astrophysics; we will also explore how these workflow tools may help with ENSDF evaluations at the NNDC. Furthermore, we will also explore the role that our Nuclear Masses Toolkit can play in future mass evaluation efforts.

Isotopes Project

R.B. Firestone (Group Leader), C.M. Baglin, M.S. Basunia, A. Hurst

Guests: E. Browne, L. Bernstein, H. Choi (S. Korea), M. Krtica (Prague), Zs. Revay and L. Szentmilosi (Hungary)

Mass Chain Evaluation

ENSDF
Nuclear Data Sheets
IAEA/NSDD/NNDC

Capture Gamma-ray Cross-Section Evaluation

EGAF, ENDF
RIPL
PGAA, NAA
IAEA, LBNL, LLNL, Budapest

Surrogate Reaction Cross Sections

STARS/LiBeRACE
88” Cycltron
LBNL/LLNL

Basic Research

Astrophysics
Physics
Chemistry
Geology
Paleontology

Mass Chain Evaluation

Mass Chain Responsibility (37):

A=21-30, 59, 81, 83, 90-93, 166-171, 184, 186, 187, 191-193, 210-217

Mass Chain Publications (9+6*):

A=25 – NDS, **110**, 1691 (2009)
A=30 – NDS, **111**, 2331 (2010)
A=65 – NDS, **111**, 2425 (2010)*
A=66 – NDS, **111**, 1093 (2010)*
A=99 – NDS, **112**, 275 (2011)*
A=119 – NDS, **110**, 2945 (2009)
A=145 – NDS, **110**, 507 (2009)*

A=168 – NDS, **111**, 1807 (2010)
A=169 – NDS, **109**, 2033 (2008)
A=179 – NDS, **110**, 265 (2009)
A=184 – NDS, **111**, 275 (2010)
A=187 – NDS, **110**, 999 (2009)
A=214 – NDS, **110**, 681 (2009)
A=220 – NDS, **112**, 1115 (2011)*
A=244 – NDS, **112**, 247 (2011)*

* LBNL/NNDC (E. Browne)

Capture Gamma-Ray Data EGAF

Evaluated Gamma-ray Activation File (EGAF) - LBNL/Budapest/IAEA evaluation of prompt and delayed σ_γ cross sections for all elemental targets.

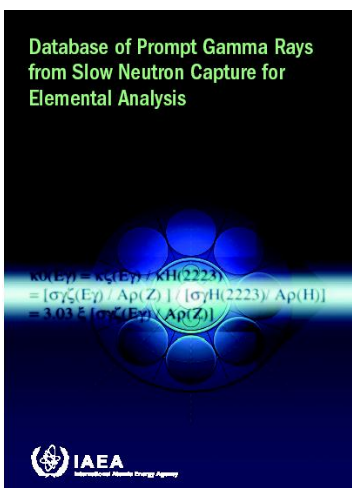
IAEA Data Viewer: http://www-nds.iaea.org/pgaa/pgaa7/index.html

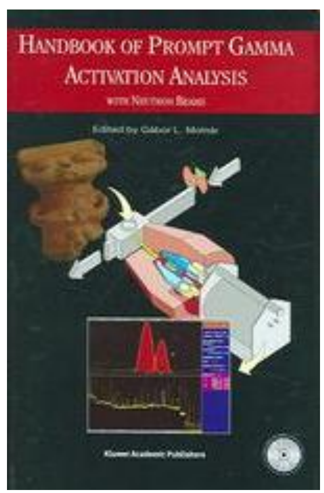
LBNL website: http://ie.lbl.gov/ng.html

Books: *Database of Prompt Gamma Rays from Slow Neutron Capture*

http://www-pub.iaea.org/MTCD/publications/PubDetails.asp?pubId=7030

Handbook of Prompt Gamma Activation Analysis with Neutron Beams, edited by Gabor Molnar, Kluwer Publishers, Dordrecht





REFERENCE DATABASE FOR NEUTRON ACTIVATION ANALYSIS

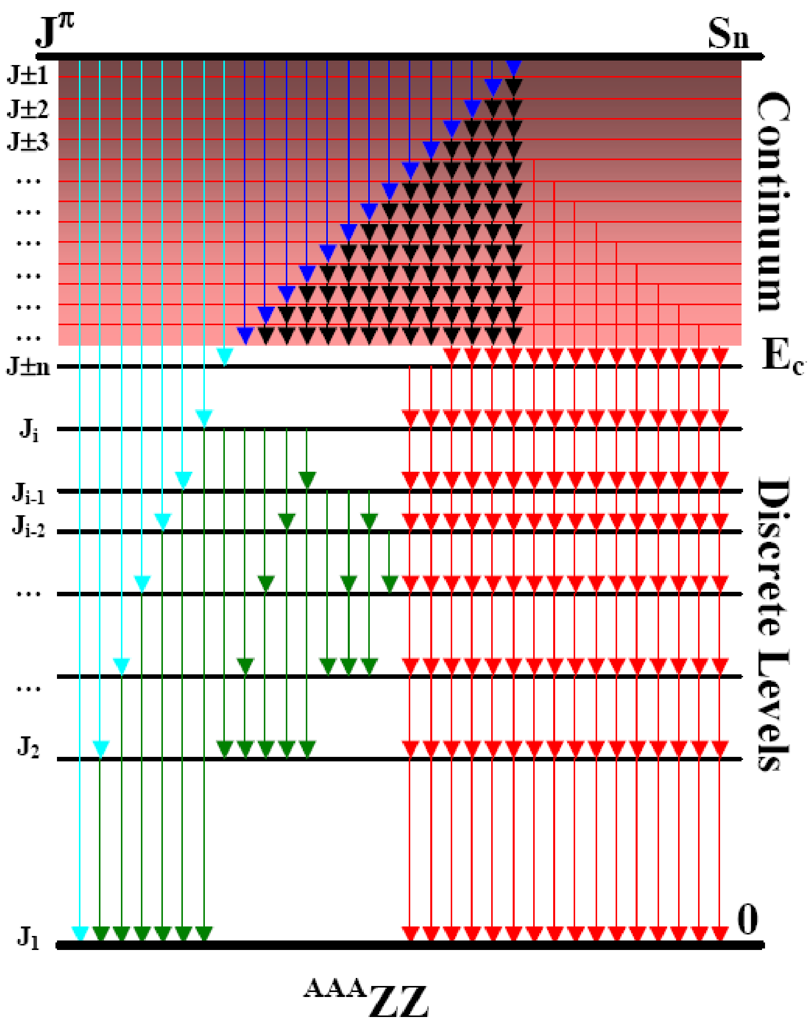
IAEA Co-ordinated Research Project

Project Officer: Mark A. Kellett

Comparison of EGAF (n,γ) and IUPAC k_0 data.

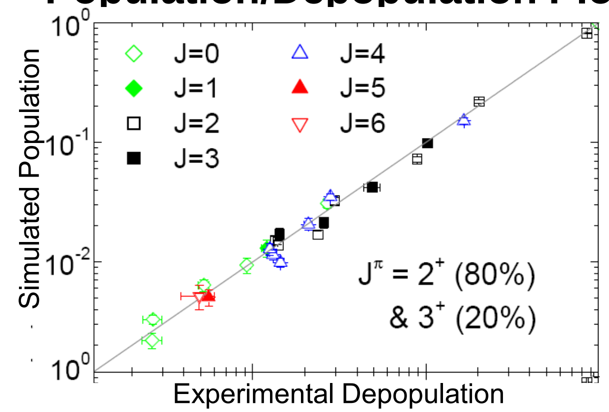
Consultants meeting April 11-13 in Vienna. More discussion later.

LBNL EGAF (n,γ) Evaluation



1. EGAF γ-ray cross sections measured at Budapest Reactor
2. Determine (n,γ) level scheme from EGAF and ENSDF data
3. Calculate statistical feeding to levels below E_{crit} optimizing comparison of D_0, Γ_γ(CS), and intensity balance with experiment.
4. Revise level and γ-ray properties to get best agreement between theory and experiment to get σ_0 and RIPL.

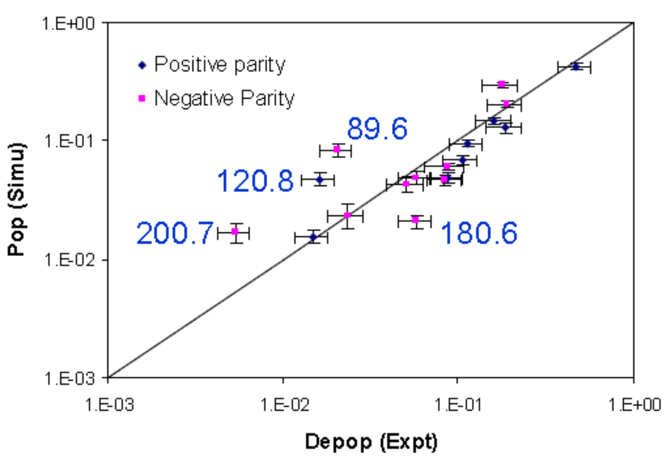
Population/Depopulation Plot



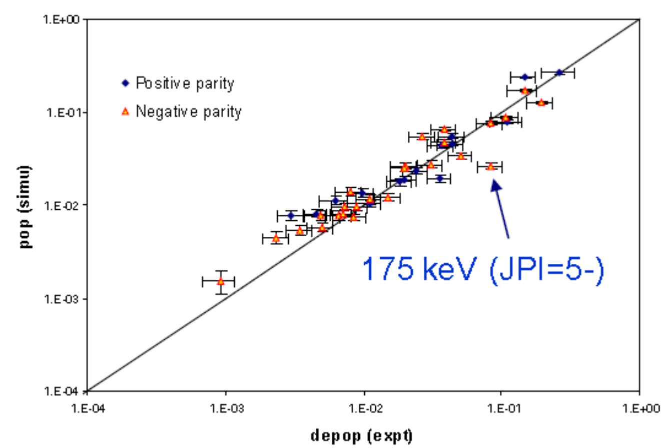
^{151,153}Eu(n,γ) Analysis - Basunia

^{151}Eu(n,γ)^{152}Eu	Simulation	Mughabghab	^{153}Eu(n,γ)^{154}Eu	Simulation	Mughabghab
D_0 (eV)	0.81	0.73(7)	D_0 (eV)	1.0	1.14(8)
Γ_γ(CS) (meV)	93(1)	91(9)	Γ_γ(CS) (meV)	93(3)	99(1)
σ_0(GS, $t_{1/2}$=13 y)	7230(300) b	5900(200) b	σ_0(GS, $t_{1/2}$=8.6 y)	292(12)	312(7)
σ_0($t_{1/2}$=9.3 h)	3410(300) b	3300(200) b			

^{151}Eu(n,g)^{152}Eu



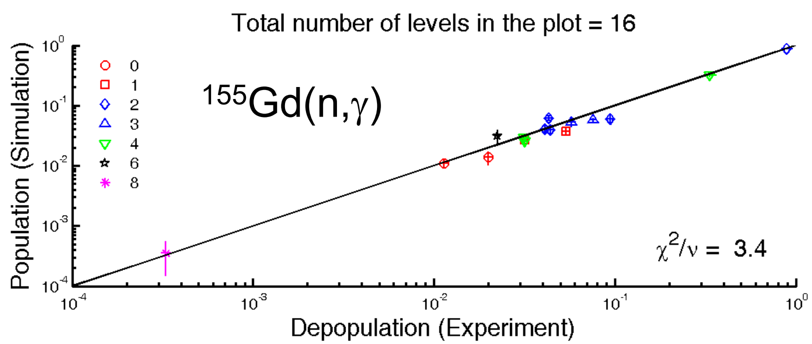
^{153}Eu(n,g)^{154}Eu

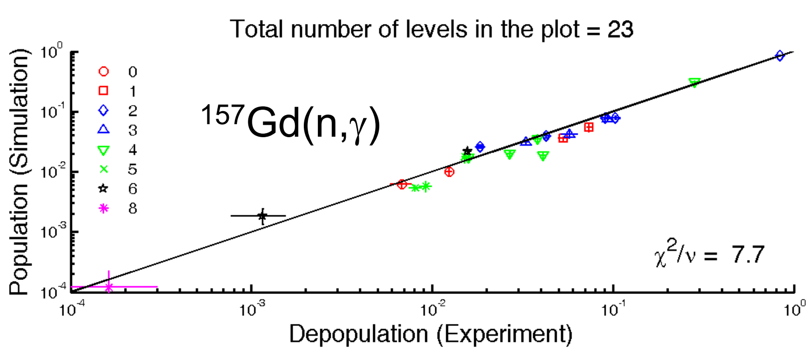


New enriched isotope measurements at Budapest Reactor are being analyzed.

$^{155,157}Gd(n,\gamma)$ analysis- Choi

Non 1/v g-factor corrections are in progress with separated isotopes





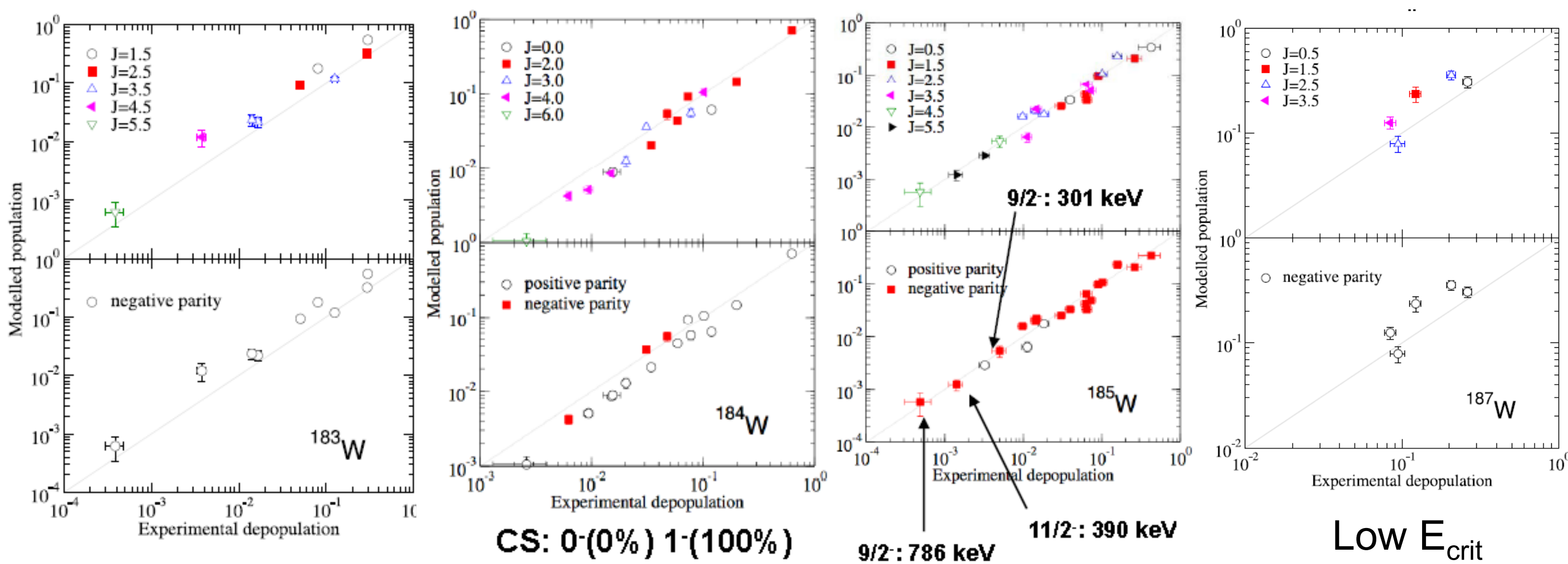
$^{155}Gd(n,\gamma)^{156}Gd$	
Reference	σ_0
Tattersall (1960)	49,800(600)
Pattenden (1958)	66,000(2,000)
Groshev (1962)	61,000(5,000)
Mughabghab	60,900(500)
This work	66,200(4,100)
$^{157}Gd(n,\gamma)^{158}Gd$	
Pattenden (1958)	264,000(4,500)
Tattersall (1960)	213,000(2,000)
Groshev (1962)	240,000(12,000)
Sun (2003)	232,000(14,000)
Leinweber (2006)	226,000
Mughabghab	254,000(815)
This work	216,000(5,000)

^{182,183,184,186}W(n,γ) analysis- Hurst

Significant problems remain with the spins, parities, and completeness of the ^{187}W level scheme. Separated isotope measurements have been performed in Budapest and are being analyzed.

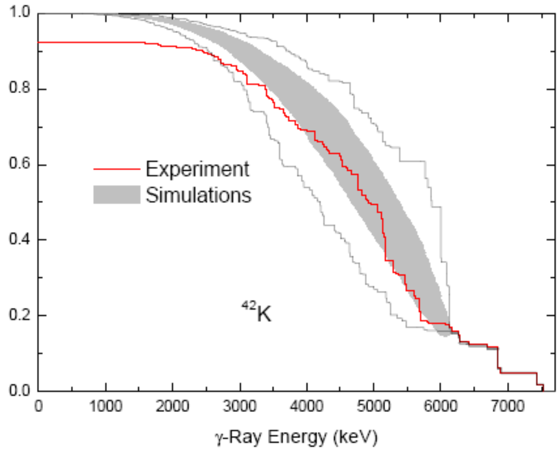
*Revised for new decay scheme normalization from NDS.

Isotope	σ_0 (barns) Mughabghab	σ_0 (barns) Simulation
^{182}W	19.9(3)	18.4(8)
^{183}W	10.4(2)	8.0(2)
^{184}W	1.7(1)	1.4(2)
^{186}W	34.9(5)*	34.1(5)



^{41}K

Complete ^{39,40,41}K(n,γ) data of von Egidy *et al*[1] and Krusche *et al*[2,3] were renormalized to EGAF σ_γ data with small DICEBOX correction.



Cumulative distribution of ^{42}K primary γ-rays. Gray region contains 68% of all simulations with various models.

[1] T. von Egidy et al, J. Phys. G. Nucl. Phys. **10**, 221 (1984). [^{39}K(n,γ)]
[2] B. Krusche et al, Nucl. Phys. A **417** (1984). [^{40}K(n,γ)]
[3] B.Krusche et al, Nucl. Phys. A **439** (1985). [^{41}K(n,γ)]

	Author (Year)	σ0±Δσ (b)
^{39}K	Pomerance (1952)	1.87±0.15
	Gillette (1966)	1.4
	Hansen (1949)	2.9±0.7
	Von Arb (1984)	2.206±0.025
	Atlas (Mughabghab)	**2.1±0.2**
	This work	**2.24±0.03**
^{40}K	Asghar (1978)	30
	Beckstrand (1971)	30±8
	Pomerance (1952)	66±20
	Gillette (1966)	70
	Atlas (Mughabghab)	**30±8**
	This work	**94±7**
^{41}K	Seren (1947)	1.0±0.2
	Pomerance (1952)	1.19±0.10
	Koehler (1967)	1.2±0.1
	Gryntakis (1976)	1.28±0.06
	De Corte (2003)	1.42±0.02
	Gleason (1975)	1.43±0.03
	Heft (1978)	1.43±0.03
	Lyon (1960)	1.45
	Ryves (1970)	1.46±0.03
	Kappe (1966)	1.49±0.03
	Kaminishi (1982)	1.57±0.17
	Atlas (Mughabghab)	**1.46±0.03**
	This work	**1.54±0.03**

IAEA Reaction Input Parameter Library (RIPL)

RIPL nuclear structure data for ^{106}Pd based on ENSDF

```
106Pd
  number of levels:                                  133
  number of gamma-rays:                              212
  number of levels in a complete level scheme:       30
  number of levels with assigned spin and parity:    8
  neutron separation energy:                         9.561510 [MeV]
  proton separation energy:                          9.345901 [MeV]

---------------------------------------------------------------------------------------------
 NL    EL[MeV]     S/P  F     T1/2[s]  Ng s unc                  s-info   nd m        p       mode
                                            Nf      Eg[MeV]      Pg            Pe            Icc
---------------------------------------------------------------------------------------------
  1    0.000000    0.0  1   -1.00E+00  0 u                        0+   0
  2    0.511851    2.0  1    1.21E-11  1 u                        2+   0
                                             1        0.512   9.946E-01   1.000E+00   5.455E-03
  3    1.128010    2.0  1    3.12E-12  2 u                        2+   0
                                             2        0.616   6.461E-01   6.482E-01   3.252E-03
                                             1        1.128   3.515E-01   3.518E-01   7.525E-04
  4    1.133770    0.0  1    6.80E-12  2 u                        0+   0
                                             2        0.622   9.968E-01   1.000E+00   3.171E-03
                                             1        1.134   0.000E+00   0.000E+00   0.000E+00
  5    1.229250    4.0  1    1.34E-12  1 u                        4+   0
                                             2        0.717   9.978E-01   1.000E+00   2.183E-03
--- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- --- ---
 33    2.591200   -1.0  0                1                    (2,3)+   0
                                            11        0.659   1.000E+00   1.000E+00   0.000E+00
 34    2.624400    0.0  1                3 u                     0+   0
                                             7        1.062   3.608E-01   3.611E-01   8.584E-04
                                             3        1.496   2.505E-01   2.506E-01   4.201E-04
                                             2        2.113   3.883E-01   3.883E-01   0.000E+00
 35    2.626870   -1.0  0                3                    (2,3)+   0
                                             7        1.065   7.453E-02   7.453E-02   0.000E+00
                                             3        1.499   6.211E-01   6.211E-01   0.000E+00
                                             2        2.115   3.043E-01   3.043E-01   0.000E+00
```

J^{π} are taken directly from ENSDF but unique assignments needed.

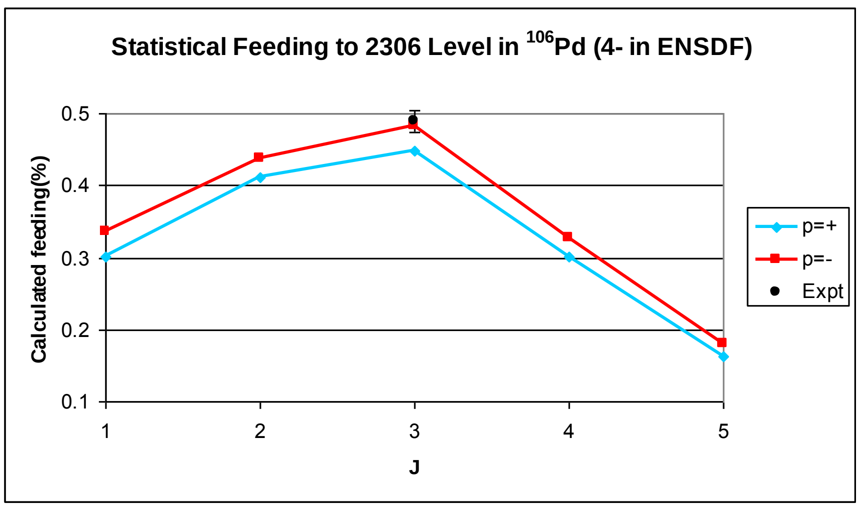
J^{π} uncertain

E_{crit} is the highest level energy with complete J^{π} and γ-ray information.

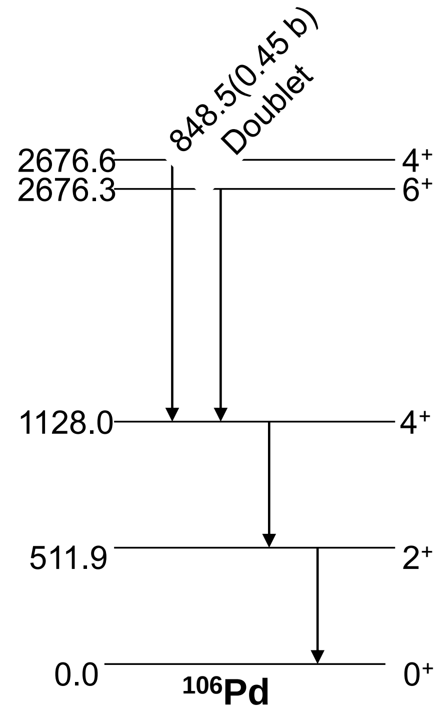
LBNL RIPL Evaluation

Improved Adopted Level, Gamma data for (n.γ)

- J^{π} and γ-ray evaluation using statistical model calculations.
- Improved level scheme from EGAF (n,γ) data.
- Use of theory and systematics for J^{π} assignments.
- Inclusion of new RIPL data in EGAF and NDS publication.



Statistical model calculations can help determine the most likely J^{π} assignment.

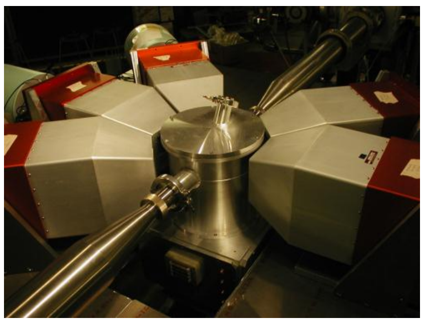


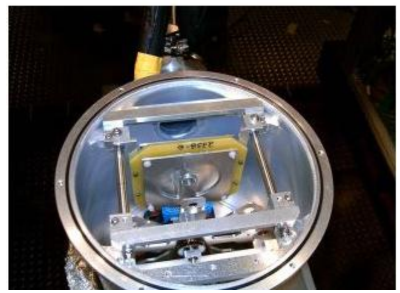
Eg (keV)	Transition	σ_{γ} (b)
848.6	$4^+ \to 4^+$	0.345±0.022
848.3	$6^+ \to 4^+$	0.103±0.022

Doublet cross section ($\sigma_{848.5\gamma}$=0.448 b) populating the 4^+ and 6^+ can be divided based on DICEBOX calculation.

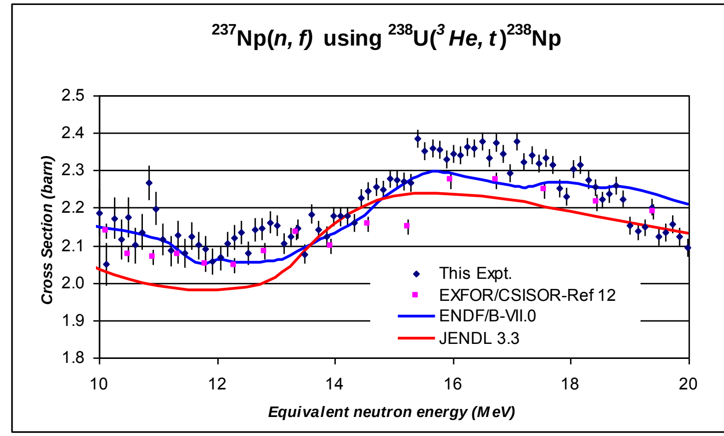
Surrogate Reaction Measurements

Target Chamber+6 "Clover" Ge





Interior w/S2 Si detectors



S. Basunia, et al, NIM B267, 1899 (2009).

LBNL LiBeRACE/STARS experiments – Particle/g-ray coincidence measurement. Isotopes Project is the lead LBNL LiBeRACE/STARS experimental group

- ^{238}U(^{3}He,t) surrogate reaction, see above right.
- ^{167}Er(d,p) – search for collective nuclear structure contribution to statistical decay (2011)
- ^{106,108,110}Pd(p,p') – ^{107}Pd s-process waiting point nucleus surrogate reaction cross section study (2011)
- ^{73}Ge(d,p) – surrogate cross section measurement, preliminary NIF experiment (2011).

Decay Data Evaluation Project

Edgardo Browne served as DDEP Coordinator and Scientific Editor until he was succeeded by **Filip Kondev** (Argonne National Laboratory) following the 9-11 June, 2010 DDEP Meeting in Madrid.

The LBNL Isotopes Project has begun discussions of evaluating (n,γ) activation data for the DDEP effort.

Table of Radionuclides

Contributors 2004: *Bé M.-M., Chisté V., Dulieu C., Browne E., Chechev V., Kuzmenko N., Helmer R., Nichols A., Schönfeld E., Dersch R.*

Contributors 2006: *Bé M.-M., Chisté V., Dulieu C., Browne E., Baglin C., Chechev V., Kuzmenko N., Helmer R., Kondev F., MacMahon D., Lee K.B.*

Contributors 2008: *Bé M.-M., Chisté V., Dulieu C., Browne E., Chechev V., Kuzmenko N., Kondev F., Luca A., Galán M., Pearce A., Huang X.*

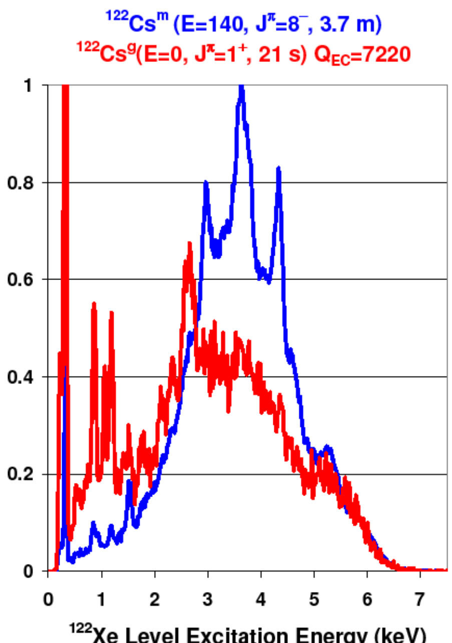
Contributors 2010: *Bé M.-M., Chisté V., Dulieu C., Mougeot X., Browne E., Chechev V., Kuzmenko N., Kondev F., Luca A., Galán M., Nichols A.L., Arinc A., Huang X.*

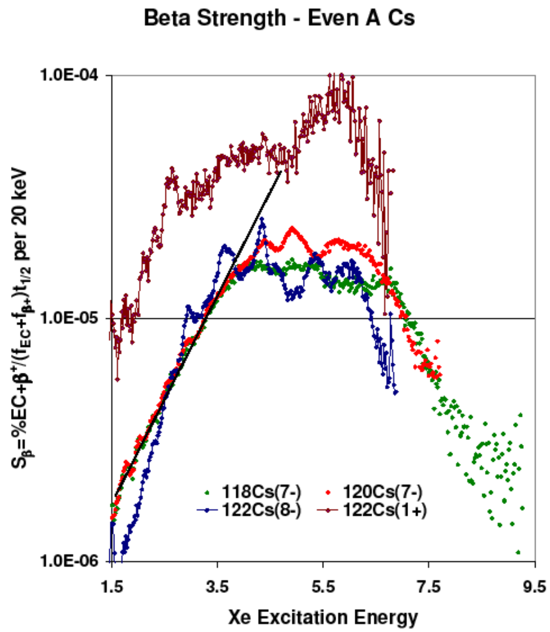
Activation Isotopes Proposed Evaluation List

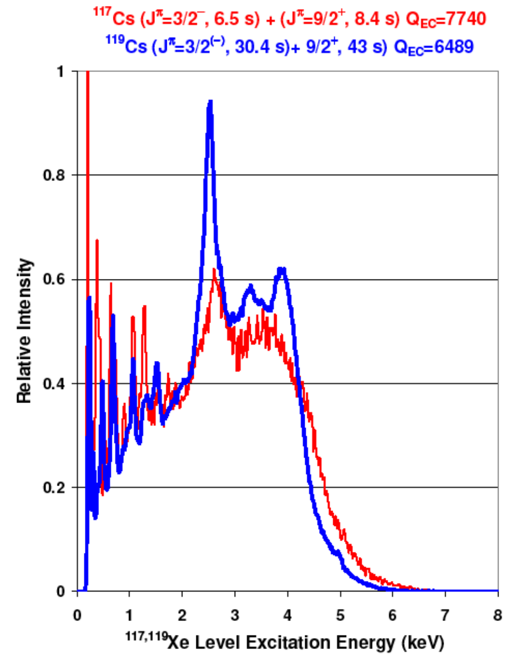
3H	46Sc(m+g)	77Se	100Tc	125Sn(m+g)	137Ce(m+g)	167Er	193Os
8Li	47Sc	79Se(m+g)	101Tc	122Sb(m+g)	139Ce(m+g)	169Er	192Ir(m+g)
10Be	51Ti	81Se(m+g)	97Ru	124Sb(m+g)	141Ce	171Er	194Ir(m+g)
12B	52V	83Se(m+g)	103Ru(m+g)	125Sb	143Ce	170Tm	191Pt
14C	51Cr	80Br(m+g)	105Ru	121Te(m+g)	142Pr(m+g)	169Yb(m+g)	193Pt(m+g)
16N	55Cr	82Br(m+g)	104Rh(m+g)	123Te	147Nd	171Yb	195Pt
19O	56Mn	79Kr(m+g)	105Rh	125Te	149Nd	175Yb(m+g)	197Pt(m+g)
20F	55Fe	81Kr(m+g)	103Pd	127Te(m+g)	151Nd	177Yb(m+g)	199Pt(m+g)
23Ne	59Fe	83Kr	107Pd(m+g)	129Te(m+g)	149Pm	176Lu	198Au(m+g)
24Na(m+g)	60Co(m+g)	85Kr(m+g)	109Pd(m+g)	131Te(m+g)	151Pm	177Lu(m+g)	199Au
27Mg	59Ni	87Kr	111Pd(m+g)	128I	145Sm	175Hf	197Hg
28Al	63Ni	86Rb(m+g)	108Ag(m+g)	131I	151Sm	178Hf(m+g)	197Hg
31Si	65Ni	88Rb	110Ag(m+g)	125Xe(m+g)	153Sm(m+g)	179Hf	199Hg
32P	64Cu	85Sr(m+g)	107Cd	127Xe(m+g)	155Sm	180Hf	203Hg
35S	66Cu	87Sr	109Cd	129Xe	152Eu(m+g)	181Hf	205Hg(m+g)
37S	65Zn	89Sr	111Cd	131Xe	154Eu(m+g)	182Ta(m+g)	204Tl
36Cl	69Zn(m+g)	90Y(m+g)	113Cd	133Xe(m+g)	153Gd	182Ta	206Tl(m+g)
38Cl(m+g)	71Zn	93Zr	115Cd(m+g)	135Xe(m+g)	155Gd	181W	205Pb(m+g)
37Ar	70Ga	95Zr	117Cd(m+g)	137Xe	159Gd	183W	207Pb
39Ar	72Ga(m+g)	97Zr	114In(m+g)	134Cs(m+g)	161Gd	185W(m+g)	209Pb
41Ar	71Ge	94Nb(m+g)	115In	131Ba(m+g)	160Tb	187W	210Bi(m+g)
40K	73Ge	95Nb(m+g)	116In(m+g)	133Ba(m+g)	157Dy(m+g)	186Re(m+g)	233Th
42K	75Ge(m+g)	97Nb	113Sn(m+g)	135Ba	159Dy	188Re(m+g)	233Pa
41Ca	77Ge	93Mo(m+g)	117Sn	136Ba	165Dy(m+g)	185Os	236U
45Ca	77As	99Mo	119Sn	137Ba	166Ho(m+g)	189Os	239U
47Ca	76As	101Mo	121Sn(m+g)	139Ba	163Er	190Os	239Np
49Ca	75Se	99Tc(m+g)	123Sn(m+g)	140La	165Er	191Os(m+g)	

DDEP evaluated as of 5 May 2010 in red

Total Absorption Spectrometer (TAS) Research







Isotope	AME (Audi)		TAS
	E	Q_{EC}	
^{118}Cs(2)	0	9670(16)	9570(100)
^{118}Cs(7$^-$)	100(60)		
^{120}Cs(2$^-$)	0	8284(15)	8340(100)
^{120}Cs(7$^-$)	100(60)		
^{122}Cs(1$^+$)	0	7220(30)	7020(100)
^{122}Cs(8$^-$)	140(30)		7190(100)
^{124}Cs(1$^+$)	0	5929(9)	5890(100)

Isotope	AME (Audi)		TAS
	E	Q_{EC}	
^{117}Cs(9/2$^+$)	0	7740(60)	7470(100)
^{117}Cs(3/2$^-$)	150(80)		
^{119}Cs(9/2$^+$)	0	6489(17)	6480(100)
^{119}Cs(3/2$^+$)	50(30)		
^{121}Cs(9/2$^+$)	0	5372(18)	5300(100)
^{121}Cs(3/2$^+$)	68.5(3)		
^{123}Cs(1/2$^+$)	0	4205(15)	4210(100)

Fun Nuclear Applications

1. **Younger Dryas Impact Event (12,900 yr BP)**
   a. *Cycle of Cosmic Catastrophes*, R.B. Firestone, A. West, Inner Traditions (2007)
   b. R.B. Firestone et al, *Evidence for an extraterrestrial impact 12,900 years ago that contributed to the megafaunal extinctions and the Younger Dryas cooling,* PNAS 104, 16016 (2007).
   c. R.B. Firestone, *The Case for the Younger Dryas Extraterrestrial Impact Event: Mammoth, Megafauna and Clovis Extinction,* Journal of Cosmology 2, 286-288 (2009).
   d. R.B. Firestone, et al, *Analysis of the Younger Dryas Impact Layer,* J. Siberian Federal University. Engineering and Technologies 1, 30-62 (2010).
2. **Meteorite Impacts in Mammoth Tusks (35,000 yr BP)**
   a. R.B. Firestone, *Evidence of four prehistoric supernovae <250 pc from Earth during the past 50,000 years,* American Geophysical Union Fall Meeting, 14-18 December 2009, San Francisco, CA, paper PP31D-1386.
   b. *Micrometeorite Impacts in Beringian Mammoth Tusks and a Bison Skull,* J.T. Hagstrum, R.B. Firestone2, A. West, Z. Stefanka, Z. Revay, J. Siberian Federal University. Engineering and Tecjnologies 1, 123-132 (2010).
3. **Discovery of Near-Earth Prehistoric Supernovae 44-, 37-, 32-, and 22-kyr ago**

SPECIAL LECTURE "Mammoths, Meteors, and Supernovae" on Thursday

Isotopes Project Future Plans

1. **Evaluation**
    a. Continued mass chain evaluation for ENSDF
    b. RIPL data for EGAF
    c. Thermal (n,γ) data for EGAF
    d. Activation data for DDEP, EGAF
    e. XUNDL compilation with UC Berkeley students
2. **Research**
    a. Thermal (n,γ) measurements at the Budapest and Munich Reactors
    b. STARS/LiBeRACE experiments
        i. Surrogate reaction studies
        ii. Statistical model studies
    c. Applied research
        i. PGAA/NAA analytical chemistry
        ii. Extraterrestrial impact
        iii. Prehistorical supernovae
3. **Dissemination** – update of the on-line Table of Radioactive Isotopes and other selected services.

Collaborators are welcome to work with the LBNL Isotopes Project

TUNL Contributions in the US Nuclear Data Program and NSDD

Nuclear Data Evaluation Program

J.H. Kelley,

Jim Purcell, and Grace Sheu

Nuclear Structure Evaluation
TUNL Nuclear Data Evaluation Project

- 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

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

- Energy Levels of Light Nuclei: A=3
  - http://dx.doi.org/10.1016/j.nuclphysa.2010.08.012
  - NPA 848 (2010) 1-74
- Evaluation of A=11 (early 2011)
  - Manuscript for “Energy Levels of Light Nuclei”
  - ENSDF File
- Other work in progress:
  - A=12 Evaluation for “Energy Levels”
  - A=13 Evaluation for “Energy Levels” (Jim Purcell)

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)

- Contemplating compilation of charged particle reaction cross section vs Energy (p,X), (a,X)

TUNL Nuclear Data Evaluation Project

Triangle Universities Nuclear Laboratory TUNL UNC NCSU

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 EL's
ENSDF
Thermal N Capt.
G.S. Decays
NuDat at BNL
Palm Pilot
Useful Links
Citation Examples

Home
SiteMap
Directory
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.

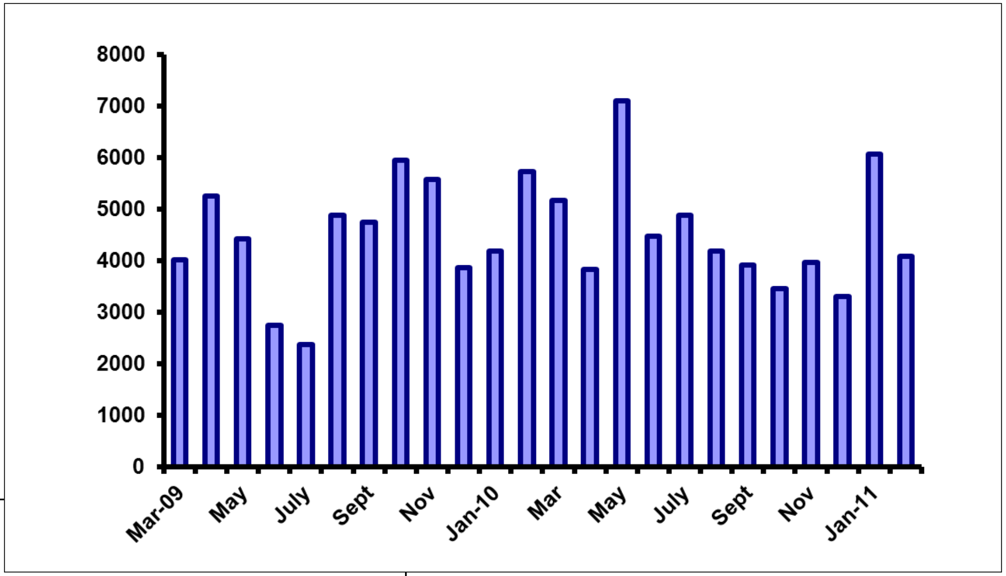
Helpful links:

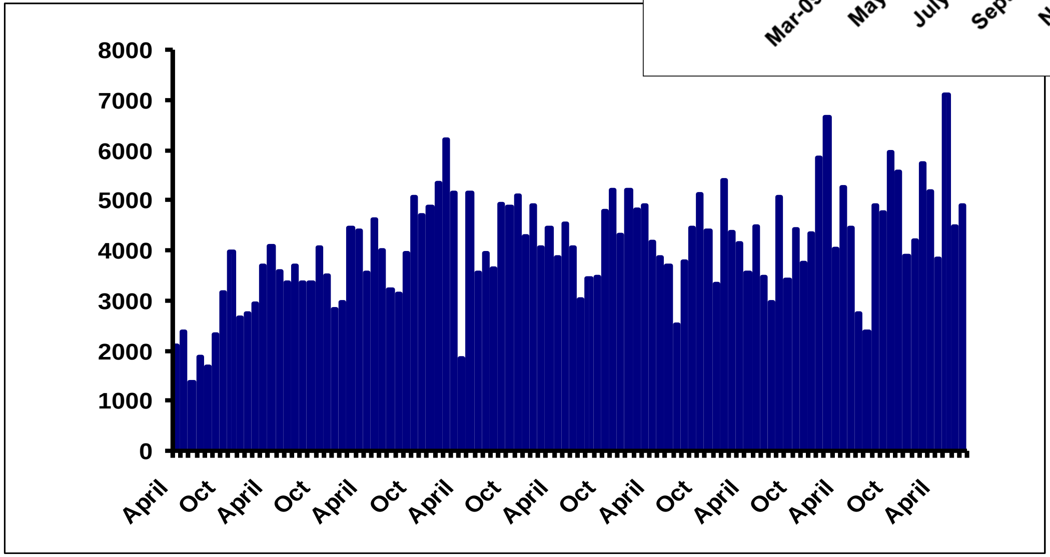
• Links Important links to the National Nuclear Data Center, online nuclear physics journals, and other useful sites.

• 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 (Mar 09–present)





TUNL Nuclear Data Evaluation Project

CEN, France

Vienna 2011

Jean BLACHOT

From the beginning (1978) to 2009, the work was done with the funding of the CEA.

Now I am only a consultant for The CSNSM ORSAY

the laboratory in charge of AME and NUBASE without funding.

All the work is done at home.

30 years of publication

2010BL02	NDS 111, 717 (2010)	**2010BL05**	NDS 111, 1471 (2010)
2009BL02	NDS 110, 1239 (2009)	**2008BL12**	NDS 109, 1383 008)
2007BL18	NDS 108, 2035 (2007)	**2006BL02**	NDS 107, 355 2006)
2005BL05	NDS 104, 791 (2005)	**2005BL06**	NDS 104, 967 (2005)
2003BL10	NDS 100, 179 (2003)	**2002BL10**	NDS 95, 679 (2002)
2002BL20	NDS 97, 593 (2002)	**2001BL04**	NDS 92, 455 (2001)
2000BL05	NDS 89, 213 (2000)	**2000BL21**	NDS 91, 135 (2000)
1999BL07	NDS 86, 505 (1999)	**1999BL28**	NDS 86, 151 (1999)
1998BL03	NDS 83, 1 (1998)	**1998BL04**	NDS 83, 647 (1998)
1998BL09	NDS 84, 277 (1998)	**1997BL09**	NDS 81, 599 1997)
1997BL10	NDS 81, 753 (1997)	**1996BL04**	NDS 77, 299 (1996)
1995BL09	NDS 75, 739 (1995)	**1994BL07**	NDS 73, 81 (1994)
1993BL03	NDS 68, 311 (1993)	**1992BL08**	NDS 66, 451 1992)
1992BL11	NDS 67, 1 (1992)	**1991BL01**	NDS 62, 709 (1991)
1991BL02	NDS 62, 803 (1991)	**1991BL03**	NDS 63, 305 (1991)
1991BL09	NDS 64, 1 (1991)	**1991BL13**	NDS 64, 913 (1991)
1990BL01	NDS 59, 333 (1990)	**1990BL03**	NDS 59, 729 (1990)
1990BL05	NDS 60, 139 (1990)	**1990BL12**	NDS 60, 889 (1990)
1987BL01	NDS 50, 63 (1987)	**1987BL23**	NDS 52, 565 (1987)
1985BL14	NDS 45, 701 (1985)	**1984BL11**	NDS 41, 111 (1984)
1984BL13	NDS 41, 325 (1984)	**1982BL18**	NDS 35, 375 (1982)
1981BL08	NDS 32, 287 (1981)		

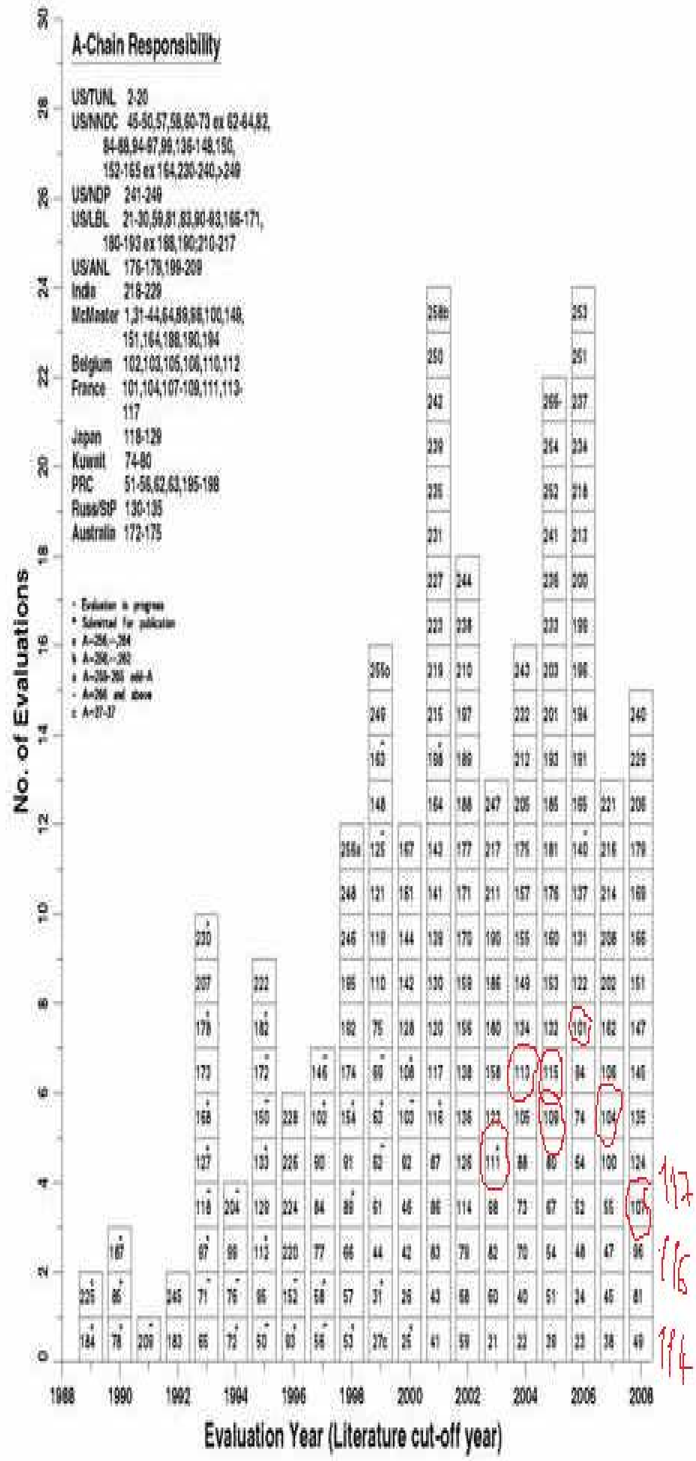
	NDS	Dat--ENSDF	Comments*
101	NDS 83, 1 (1998) ENSDF (2006)	200610	Kr (10) Sn (07)
104	NDS 108,2035(2007)	200709	
107	NDS 109, 1383 (2008)	200702	Sr (10)
108	NDS 91, 135 (2000) ENSDF (2008)	200810	Y (10)
109	NDS 107, 355 (2006)	200602	Xe (06)
111	NDS 110, 1239 (2009)	200905	Zr (10)
113	NDS 111 , 1471(2010)	201006	
114	NDS 97, 593 (2002)	200301	Send BNL March 2011
115	NDS 104,967 (2005)	200505	Nb(10),Mo(10),Rh(07)
116	NDS 111, 717 (2010)	201004	Mo (10)
117	NDS 95, 679 (2002) ENSDF (2011)	201101	

* New Z or comments

ENSDF Status (A>20)

Average Age=7.0

20-Feb-2009



FUTURE OUTLOOK??

CAN CONTINUE at HOME

I HAVE

PC

SOFTWARE

GOOD CONNEXION INTERNET

BUT

No FUNDING !!!

OLD

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

Filip G. Kondev

Nuclear Engineering Division
Argonne National Laboratory
Argonne, Illinois 60439

Prepared for the 19th meeting of the *Nuclear Structure and Decay Data* Network
Vienna, Austria, April 4-8, 2011

Period covered: March 2009 – March 2011

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=204** and **207** mass chains were completed, reviewed and published in *Nuclear Data Sheets*. Evaluation of **A=133** was also completed in collaboration with the St. Petersburg group and submitted for publication in *Nuclear Data Sheets*. Evaluation of ^{84}**Rb**, assigned temporarily to the Argonne program at the IAEA-organized workshop in Bucharest, was completed and published in *Nuclear Data Sheets*. Evaluations of **A=177** and **209** (in collaboration with Dr. G. Mukherjee, Kolkata, India) mass chains are continuing. We have initiated evaluation of the **A=174**

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

mass chain in collaboration with Dr. H. Xiaolong, CNDC, China and Dr. T. Kibedi, ANU, Australia, and **A=188** in collaboration with Prof. S. Juutinen (Jyvaskyla University, Finland). ANL staff is currently evaluating **A=110** and **112** (in collaboration with Dr. S. Lalkovski, University of Sofia) mass chains from a new region that was recently assigned to the Argonne nuclear data program. It fits well with the expected future growth of data from the CARIBU facility at ATLAS and will allow better interactions with data users at ANL.

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 **110** (2009) 1473	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 **111** (2010) 141	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 **112** (2011) 707	F.G. Kondev & S. Lalkovski	completed
208	NDS **108** (2007) 1583	M. Martin	completed/**ORNL**
209	NDS **63** (1991) 723	M. Martin	**being evaluated/****

** In collaboration with Dr. G. Mukherjee, India

II.2 Contributions to XUNDL database

Since 2009 ANL NDP staff is contributing to the XUNDL database. **39** (FY09) and **38** (FY10) compilations, covering the journals Physics *Letters B*, *Journal of Physics G*, *Nuclear Physics A* and *Nuclear Instruments and Methods,* were completed and submitted to NNDC. The evaluators interacted with the leading authors on several occasions in order to collect additional data and to resolve data ambiguities.

II.3 Other Activities

The ANL staff participated in the activities of the international DDEP collaboration. The Argonne program continued to contribute to the ongoing evaluation of atomic masses (AME) and to the development of the complementary nuclear structure database, NuBase, in collaboration with scientists from CSNSM (Orsay), GSI (Darmstadt) and IMP (Lanzhou).

In collaboration with Dr. T. Kibedi and Prof. G.D. Dracoulis 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 Nuclear Data related research activities. This effort complemented the main ANL evaluation activities by providing training experience to the evaluator on modern experimental techniques and instruments that are used in nuclear data production. It also allowed maintaining contacts with a broad range of nuclear data users and with the FRIB and GRETINA research communities, in particular. Decay data measurements aimed at improving decay data in the actinide region continued in collaboration with scientists from the Physics Division. Analysis of decay data for ^{233}Pa, which are relevant to measurements of the $^{232}Th(n,\gamma)$ and $^{237}Np(n,\gamma)$ cross sections, was completed and a manuscript was submitted to *Nuclear Instruments and Methods A*. As a part of the Argonne nuclear data contribution to the gsfma112, gsfma149 and gsfma184 collaborations, analysis of the ^{174}Lu data was completed and the results were published in *Physical Review C*. Contributions were made to collaborative nuclear structure and decay research activities at the ATLAS facility aimed at providing answers to specific questions and at improving the quality of existing USNDP databases in specific areas. The main emphasis was on properties of nuclei far from the line of stability and nuclear isomers in heavy Pu, Cm, No and Rf nuclei. Detailed calculations on properties of single- and multi-quasiparticle states using a Woods-Saxon potential and several pairing models were carried out. Comparisons with other theoretical models were also performed. Work on nuclear structure properties of ^{77}Ge, which are of relevance to the phenomenon of neutrinoless double beta decay of the neighboring ^{76}Ge isotope, was completed in collaboration with scientists from the Physics Division. The results were published in *Physical Review C* and the data (including additional unpublished details) were provided to the XUNDL coordinator and included in the XUNDL database. Work on thermal equilibrium of ^{176}Lu via K-mixing has been completed in collaboration with scientists from the University of North Carolina at Chapel Hill. The results were published in the journal *Physical Review C*. Studies were initiated on in-beam and decay properties of the proton-rich nuclide ^{180}Tl, which are related to the understanding of the large electron-capture delayed fission branch observed in this nuclide, and on decay properties of the long-lived ($T_{1/2}$=160.4 d) isomer in ^{177}Lu. Analysis of data relevant to the structure of states above the long-lived isomer in ^{186}Re, which are of relevance to the $^{187}Re/^{187}Os$ cosmo-chronometer, is continuing. The last two activities were carried out under the auspices of the USNDP Nuclear Astrophysics Data Task Force.

The Argonne nuclear data program staff is a Co-PI of two research projects in collaboration with scientists from the Physics Division and INL, which are funded through the Application of Nuclear Science and Technology initiative by DOE/ONP. One of the projects is aimed at implementing the Accelerator Mass Spectrometry (AMS) technique for measurements and evaluations of actinide cross-sections that are relevant to advanced fuel cycles (AFC). The second project will utilize the CARIBU facility and various instruments at Argonne, such as the Total Absorption Gamma-ray Spectrometer and the X-ray array, to study decay properties of neutron-rich fission products, which are of relevance to AFC research and astrophysics applications. Contributions were made to both projects during the time period covered by this report.

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 full-time post-doc (1.0 FTE – funded through ARRA project) have been contributing to the program activities during the time period covered by this report.

IV. Publications & Presentations (2009-2011)

- **42** articles in peer-reviewed scientific journals
- **5** articles in refereed conference proceedings & books
- **47** contributed abstracts in conference proceedings & meetings
- **18** presentations at scientific conferences & professional meetings
- **5** invited seminars & colloquia

Nuclear Data Project at McMaster University

Status Report: April 1, 2009 to March 30, 2011

Balraj Singh

NSDD-2011, Vienna, Austria: April 4-8, 2011

ENSDF Work

- **Permanent Responsibility**:

A= 1 (2005), **31**(1998,s), **32**(1998,s),
33(1998,s), **34**(1998,s*),
35(1998,s), **36**(1998,s*)
37 (1998,s*), **38** (2008),
39 (2006), **40** (2004),
41 (2001), **42** (2000),
43 (2001,w), **44** (1999,w),
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 2009-11, work was also done on many other (priority) A-chains and nuclides, which are outside McMaster's A-chain responsibility

Mass-chain Evaluations submitted (April 1, 2009 to March 31, 2011)

- **A=129**, J. Timar, Z. Elekes and **B. Singh**, NDS (submitted Sept 2010, post-review)
- **A=61**, K. Zuber and **B. Singh**, NDS (submitted Sept 2010, pre-review)
- **A=37**, **J. Cameron, J. Chen, B. Singh** and N. Nica, NDS (submitted Sept 2010, review)
- **A=36**, N. Nica, **J. Cameron and B. Singh**, NDS (submitted Sept 2010, review)
- **A=35**, J. Chen, J. Cameron and B. Singh, NDS (submitted August 2010, review)
- **A=33**, J. Chen and B. Singh, NDS (submitted March 2010, final)
- **A=32,** C. Ouellet and B. Singh, NDS (submitted Sep 09, pre-rev)
- **A=34,** N. Nica and **B. Singh**, NDS (submitted Sept 09, post-rev)
- **A=77, B. Singh** and N. Nica, NDS (submitted Sept 09, post-rev)

Mass-chain Evaluations published (April 1, 2009 to March 31, 2011)

- **A=50:** Z. Elekes, J. Timar and **B. Singh,** NDS 112, 1-131 (2011)
- **A=71**: K. Abusaleem and **B. Singh,** NDS 112, 133-273 (2011)
- **A=182:** B. Singh and J.C. Roediger: NDS 111, 2081-2330 (2010)
- **A=163**: C.W. Reich and **B. Singh**: NDS 111, 1211-1469 (2010)
- **A=58:** C. Nesaraja, **S. Geraedts and B. Singh**, NDS **111**, 897-1092 (2010)
- **A=151**: B. Singh, NDS **110**, 1-264 (2009)
- **A=78**: A. Farhan and **B. Singh**, NDS **110**, 1917-2080 (2009)

- **A=84**: D. Abriola, M. Bostan, S. Erturk, M. Fadil, M. Galan, S. Juutinen, T. Kibédi, F. Kondev, A. Luca, A. Negret, N. Nica, B. Pfeiffer, **B. Singh**, A. Sonzogni, J. Timar, J. Tuli, T. Venkova and K. Zuber NDS **110**, 2815-2944 (2009) (Bucharest workshop)

Other publications

- *The Nuclear Science References (NSR) database and Web Retrieval System*. B. Pritychenko, E. Betak, M.A. Kellett, **B. Singh** and J. Totans, Nuclear Instruments and Methods in Physical Research A (accepted for publication in March 2011)

- *Evaluation of half-life of ^{198}Au*. J. Chen, S. D. Geraedts, C. Ouellet and B. Singh, Applied Radiation and Isotopes (accepted for publication in March 2011)

- *An Update of B(E2) Evaluation for $0_1^+ \rightarrow 2_1^+$ Transitions in Even-Even Nuclei near N~Z~28.* B. Pritychenkoa, **J. Choquette**, M. Horoic, **B. Karamy, B. Singh**, Atomic Data and Nuclear Data Tables (submitted March 2, 2011)

- *Status of vibrational structure in ^{62}Ni.* A. Chakraborty, J. N. Orce, S. F. Ashley, B. A. Brown, B. P. Crider, E. Elhami, M. T. McEllistrem, S. Mukhopadhyay, E. E. Peters**, B. Singh,** and S. W. Yates. Physical Review C 83, 034316 (2011)

Updates and Reviews for ENSDF (April 1, 2009 to March 31, 2011)

Nuclide Updates (by B. Singh):

- **~110 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 some of the nuclides.**

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

- **3** full-length mass chains, **6** nuclide updates **for ENSDF.**

  3 nuclides reviewed for DDEP

Other ENSDF-related activities

- *An Update of B(E2) Evaluation for 0_1+ → 2_1+ Transitions in Even-Even Nuclei near N~Z~28.* Paper submitted to ADNDT.

  (Separate presentation)

- **Compilation of directly measured nuclear spins:** summers 2009 and 2010; Allison MacDonald, Babak Karamy, B. Singh. Plan to submit a paper to NDS.

Some Interaction with users of ENSDF

PHYSICAL REVIEW C **83**, 034316 (2011)

Status of vibrational structure in ^{62}Ni

A. Chakraborty,[1,*] J. N. Orce,[1,†] S. F. Ashley,[1,‡] B. A. Brown,[2,3] B. P. Crider,[1] E. Elhami,[1,§] M. T. McEllistrem,[1] S. Mukhopadhyay,[1,∥] E. E. Peters,[4] B. Singh,[5] and S. W. Yates[1,4]

[1]*Department of Physics and Astronomy, University of Kentucky, Lexington, Kentucky 40506-0055, USA*
[2]*National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, Michigan 48824, USA*
[3]*Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan 48824, USA*
[4]*Department of Chemistry, University of Kentucky, Lexington, Kentucky 40506-0055, USA*
[5]*Department of Physics and Astronomy, McMaster University, Hamilton, Ontario, Canada L8S 4M1*

(Received 15 December 2010; published 16 March 2011)

Measurements consisting of γ-ray excitation functions and angular distributions were performed using the $(n,n'\gamma)$ reaction on ^{62}Ni. The excitation function data allowed us to check the consistency of the placement of transitions in the level scheme. From γ-ray angular distributions, the lifetimes of levels up to ~3.8 MeV in excitation energy were extracted with the Doppler-shift attenuation method. The experimentally deduced values of reduced transition probabilities were compared with the predictions of the quadrupole vibrator model and with large-scale shell model calculations in the fp shell configuration space. Two-phonon states were found to exist with some notable deviation from the predictions of the quadrupole vibrator model, but no evidence for the existence of three-phonon states could be established. $Z = 28$ proton core excitations played a major role in understanding the observed structure.

Zr-94 structure experiment at TRIUMF

- Phonon-Coupled Excitations and Mixed-Symmetry States in Zr-94.
- (Through the study of Y-94 decay to Zr-94 at TRIUMF-ISAC facility: using radioactive ion beam and 8π gamma-detector array)
- Experiment proposal by **Steve Yates** et al.; accepted in July 2010
- Participants:
- U. of Kentucky: S.W. Yates, F. M. Prados, A. Chakraborty, E. Peters, B. Crider
- TRIUMF: A. Garnsworthy, J.N. Orce
- U. of Guelph: L. Bianco, B. Hadinia, C.E. Svensson, P.E. Garrett, J. Michetti-Wilson, A. Diaz Varela, S. Chagnon-Lessard, A. Laffoley, R. Dunlop, E. Rand, J. Wong, K.G. Leach, P. Finlay, B. Jimeddorj
- Simon Fraser U.: D. Cross, K. Starosta, C. Andreoiu
- **McMaster U.: B. Singh**
- Georgia Tech.: W.D. Kulp, J.L. Wood

Last publication on Y-94 to Zr-94 decay:

- B. Singh, H.W. Taylor, and P.J. Tivin, J. Phys. G: Nucl. Phys. 2, 397 (1976)

XUNDL work

Compilation of Data from Recent Literature
(April 1, 2009 to March 31, 2011)

- Since April 1, 2009, **786** compiled datasets and **80** updated (for new papers from the same groups, errata or replies from authors to enquiries) datasets from about 300 recent (from April 2009 onwards) publications have been prepared at McMaster and included in XUNDL database.

- Additional **101** datasets with other centers: **44** with K. Abusaleem from **Jordan**; **49** with K. Zuber from **Krakow**; **6** with D. Hartley from **US Naval Academy** and ANL; **2** with D. Symochko from Ukraine.

- **125** datasets from **TUNL**; **66** from **ANL**; **10** from **LBNL** were checked and edited

- Up-to-date on the coverage of data from experimental structure papers, ~10 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.

- Compilation of papers on **new mass measurements since AME-2003.**

  Oct 2009 –Oct 2010: 24 primary papers (~ 140 data points); Mar 2009 –Oct 2009:
  19 primary papers (~85 data points) on an ORNL webpage: www.nuclearmasses.org

Key-wording of PRC for NSR

- **Involve undergraduate students** at McMaster to write draft of NSR keywords for papers in PRC. Training, supervision and checking of the key-worded file (prior to sending it to NNDC) by B. Singh.

  Allison MacDonald: Jan 2009 – Sept 2010

  Babak Karamy: March 2009 -

  Jeremie Choquette: March 2010 -

- Our experience over the past 4 years is that with good training, supervision and checking, bright undergraduate students can carry out this activity successfully.

Total 2077 PRC articles; prepared keywords for ~1400

NDS JAVA software code: Further to band drawings

- 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, as presented at NSDD-2009
- Since then work has continued on further developments of JAVA code for generating NDS: Scott Geraedts and Jeremie Choquette

  (Separate presentation at this meeting)

Work in Progress
(as of March 31, 2011)

A=31, 32, 34, 35, 36, 37, 61, 85, 89, 129 : At different stages in pipeline, will be completed during 2011 and 2012 for final publication in NDS.

- **A=44 (previous 1999)**
- **A=57: with Dr. K. Zuber (Krakow). (previous: 1999)**
- **A=62: with Dr. A. Nichols (Surrey). (previous: 1999)**
- **A=75: with Dr. A. Negret (Bucharest). (previous: 1999)**
- **A=76: with Dr. A. Farhan (Kuwait U).(previous: 1994)**
- **A=139: with Dr. P. Joshi (TIFR, Mumbai) (previous: 2001)**

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 ATOMKI, Hungary group:**

  Dr. Timar visited us in July 2009 and September 2010, each time for about 2 weeks. A=50 was completed in Fall 2009 and published in January 2011. A=129 was submitted in September 2010; at post-review stage.

- **Collaboration with University of Jordan, Jordan:**

  Dr. Abu-saleem visited McMaster in August 2009 and in January 2010 for about 2 weeks each time. A=71 was completed in 2010 and it was published in January 2011.

- **Collaboration with Institute of Nuclear Physics, Krakow:**

  Dr. Zuber visited McMaster in August 2010 for about 2 weeks. A=61 was completed and submitted in Sept 2010, at pre-review stage. Work started on A=57.

- **Collaboration with TIFR, Mumbai, India:**

  Dr. Joshi visited McMaster in June 2010 for about 2 weeks. A=139 is in progress.

- **Collaboration with University of Surrey, UK:**

  Dr. Nichols visited McMaster in October 2009 for one week and in November 2010 for 2 weeks. A=62 is in progress. (Alan Nichols is training the trainers!).

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:** Dr. Jun Chen joined as post-doctoral fellow at McMaster in June 2009, ~80% for ENSDF

  Collaborations with Dr. Ameenah Farhan (Kuwait), Dr. N. Nica (Texas A&M) on various mass chains and other topics continue through visits and e-mail communications. Dr. Nica visited McMaster in June 2009 for 2 weeks.

  Collaboration with Dr. Alexandru Negret, Bucharest, Romania. Work on A=75 is continuing. He is scheduled to visit McMaster in July 2011

Other Related Activities

International coordination:

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

- IAEA-NSDD workshop at ICTP, Trieste Oct 11-15, 2010. Coordinated evaluation of 10 nuclides at the workshop and continued work during Oct 2010 to January 2011.

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
- Jun Chen: Post-doctoral fellow: June 2009 -

- Undergraduate Students (part-time):
- Scott Geraedts: summer 2010
- Allison MacDonald: Nov 2008 to Aug 2010
- Babak Karamy: March 2009 to April 2011
- Jeremie Choquette: March 2011 -

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

PETERSBURG NUCLEAR PHYSICS INSTITUTE DATA CENTER STATUS REPORT, 2009-2011

I.A.Mitropolsky
PNPI, Gatchina, Leningrad region, 188300, Russia
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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.

Main directions of the Data Center activity

- Nuclear data evaluation (vertical evaluation)
- Analysis of large sets of nuclear data (search and correction of errors)
- Improvement of evaluation tools (new algorithms and codes)
- Systematics of nuclear data (horizontal evaluation)
- Search for new regularities in nuclear data

Nuclear Data Evaluation in the ENSDF format

The PNPI field of responsibility is the mass chains with A = 130 – 135:

Mass number	Last publication	Comment
130	*NDS*, **93** (2001)	in preparation since 2010
131	*NDS*, **107** (2006)	
132	*NDS*, **104** (2005)	
133	*NDS*, **112** (2011)	
134	*NDS*, **103** (2004)	
135	*NDS*, **109** (2008)	
146	*NDS*, **82** (1997)	will be finished 2011

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 each new ENSDF review.

The codes for the error search are also located on our Web-site and may be used by any evaluator.

There are some corrections to the basic evaluation codes RADLIST and LOGFT.

Improvement of evaluation tools

We could not renovate the code GAMUT in the part of optimization of level schemes.

S. Lisin finished the ENSDF editor. It is designed for the editing and checking of text files with the regular structure (the ENSDF format). The editor is written in the C++ and operates in the MS WINDOWS environment. It is located on our Web-site and may be tested by any evaluator.

Horizontal evaluations or systematics of nuclear data

Nuclear gamma transitions from the ENSDF are systematized. They are separated on excitation types and multipolarities. The energy distributions of the gamma transitions are parameterized with Rayleigh (Wigner-Dyson) like distribution.

Results of the analysis testify to the chaotic nature of nuclear excitations and applicability of nuclear models with the weak chaos.

Search for new regularities in nuclear data

Analysis of distribution of the first significant digits in the large sets of measurement results (experimental data). Distributions of the first significant digits in nuclear life-times and transition energies correspond to Newcomb-Benford law.

Publications

For the period there were 31 publications: 4 books, 18 articles and 9 preprints and abstracts.

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

Hideki Iimura
Nuclear Data Center
Japan Atomic Energy Agency

1. Members

Present members of Japanese group are: A. Hashizume, H. Iimura, M. Kanbe, J. Katakura, K. Kitao, S. Ohya, and Y. Tendow. This March 31, Katakura has retired JAEA, but he has a part-time position in JAEA and can continue evaluation as a member of our group. Our group has a meeting once a year to exchange information on each member's progress in evaluation.

2. Mass chain evaluation

The mass chain evaluation on which Japanese group has responsibility is A=120-129. Regarding A=118, evaluation of this mass chain is continued by Kitao and Kanbe. However, it has already been accepted by the network that the responsibility of A=118 will be transferred to another group after Japanese group finishes the present revision.

Status of Mass Chain Evaluation

Mass	Last NDS publication		Status
	Year	Evaluators	
118	1995	Kitao	Evaluating (Kitao, Kanbe)
120	2002	Kitao, Tendow, Hashizume	
121	2010	Ohya	
122	2007	Tamura	
123	2004	Ohya	
124	2008	Katakura, Wu	
125	2011	Katakura	
126	2002	Katakura, Kitao	
127	1996	Kitao, Oshima	Post review with evaluator (Hashizume) since June 2010
128	2001	Kanbe, Kitao	

As to A=129, we agreed to the proposal by NNDC that the evaluation of this mass chain was temporally made by Canadian group. This is limited only for the present revision, and we will undertake the responsibility of A=129 in the next revision. In other mass chains, A=121 (Ohya) and 125 (Katakura) was published in last and this year. We are going to start evaluation of A=120 (Hashizume), 126 (Iimura, Katakura), and 128 (Ohya, Kitao), for which the publication year of NDS is relatively old.

2. Chart of the nuclides

New version of chart of the nuclides from Japanese Nuclear Data Committee and Nuclear Data Center, JAEA was published last year. The web page of the chart (http://wwwndc.jaea.go.jp/CN10/index.html) was also revised. Although publication of this chart was periodically made every 4 years until 2004, it took 6 years this time. Compilation members are changed from Horiguchi, Tachibana, Koura, and Katakura in 2004 version to Tachibana, Koura, and Katakura in 2010 version. We will continue the revision of this chart.

Status Report on Nuclear Structure and Decay Data Activities in China

Huang Xiaolong[1], Huo Junde[2]
1.China Nuclear Data Center, China Institute of Atomic Energy,
P.O.Box 275(41), Beijing 102413, China
2. Department of Physics, Jilin University, Changchun 130012, China
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1. Mass Chain Evaluation

The NSDD group in China Nuclear Data Center (CNDC) has permanent responsibility for evaluating and updating NSDD for A=51,195-198; temporary for A= 67 and 174. In recent 2 years, the mass chain A=174, 195 and 198 have been revised using available experimental decay and reaction data. A=198 was published in NDS in 2009. Now A=174 and 195 are being updated.

The NSDD group in Jilin University (JLU) has permanent responsibility for evaluating and updating NSDD for mass chain: A=52, 53, 54, 55, 56, 62, and 63. In recent 2 years, the mass chain A=53, 56, 62 and 63 have been revised using available experimental decay and reaction data, and published in NDS.

The status is as follows:

Table 1 Status of Mass Chain Evaluation in CNDC

Mass chain A	Status	Evaluators
51	NDS,107,2131(2006)	Huang Xiaolong
52	NDS, 106, 773 (2007)	Huo Junde
53	NDS, 110, 2689 (2009)	Huo Junde
54	NDS, 107, 1393 (2006)	Huo Junde
55	NDS, 109, 787 (2008)	Huo Junde
56	NDS, 86, 315 (1999)	Huo Junde, Post Review
62	NDS, 91, 317 (2000)	Being evaluated by Dr. B. Singh et.al,
63	NDS, 92, 147 (2001)	Huo Junde, ENSDF(2009.6)
195	Being updated	Huang Xiaolong ENSDF(2007)
196	NDS,108,1093(2007)	Huang Xiaolong
197	NDS,104,283(2005)	Huang Xiaolong, Zhou Chunmei
198	NDS,110,2533(2009)	Huang Xiaolong
67	NDS,106,159(2005)	Huo Junde,Huang Xiaolong,J.K.Tuli
174	Being updated	F.G.Kondev, T.Kibedi, Huang Xiaolong

2. Decay Data Measurement and Evaluation

In recent 2 years, the decay data for ^{56}Co, ^{66}Ga, ^{213}Bi, ^{213}Po,^{217}At, ^{217}Rn, ^{221}Fr, ^{223}Fr, ^{225}Ac, ^{225}Ra, ^{231}Th, ^{234,234m}Pa, ^{235}U nuclides have been updated and recommended using available experimental data. The recommended data and evaluated comments were published in DDEP website.

Also China group has re-evaluated the main relative γ-ray intensities for ^{56}Co and ^{66}Ga based on China measurements for high energy calibration of Ge detectors. The results are listed in Table 2 and Table 3.

Table 2 Main measured and evaluated relative γ-ray intensities for ^{56}Co

E_{γ}	Measurements				Evaluations	
(keV)	**Raman(2000)**	**Molnar(2002)**	Yu Weixiang **(2006)**	**Dryak(2008)**	**IAEA(Rec.)**	Present(Rec.)
846.8	100.0	100.0(2)	100.0(5)	100	100	100.0
1037.8	14.11(22)	14.07(5)	14.15(8)	14.10(6)	14.04(5)	14.09(3)
1175.1	2.25(4)	2.252(10)	2.26(2)	2.258(7)	2.250(9)	2.253(6)
1238.3	66.6(10)	66.20(17)	66.26(26)	66.68(20)	66.45(16)	66.27(18)
1360.2	4.23(7)	4.22(15)	4.26(3)	4.32(4)	4.283(13)	4.273(3)
1771.4	15.42(25)	15.24(8)	15.36(9)	15.39(8)	15.46(4)	15.45(3)
2015.2	3.03(5)	2.976(15)	3.02(2)	3.018(24)	3.019(14)	3.019(8)
2034.8	7.835(120)	7.69(3)	7.79(5)	7.814(40)	7.746(13)	7.758(17)
2598.5	17.1(3)	16.82(8)	16.62(12)	17.03(15)	16.97(4)	16.76(12)
3202.0	3.16(6)	3.196(18)	3.16(3)	3.243(30)	3.205(13)	3.134(13)
3253.4	7.815(160)	7.85(4)	7.62(6)	7.99(2)	7.87(3)	7.66(3)
3273.0	1.84(4)	1.854(13)	1.82(2)	1.899(8)	1.856(9)	1.815(4)
3451.2	0.93(3)	0.94(1)	0.919(10)	0.951(10)	0.943(6)	0.926(8)

Table 3 Main measured and evaluated relative γ-ray intensities for ^{66}Ga

E_{γ}	Measurements				Evaluations	
(keV)	**Raman(2000)**	**Molnar(2002)**	**Baglin(2002)**	Yu Weixiang **(2006)**	**IAEA(Rec.)**	Present(Rec.)
833.6	16.02(24)	15.92(6)	15.94(14)	15.85(17)	15.93(6)	15.92(5)
1039.4	100.0(16)	100.0(3)	100.0(9)	100.0(5)	100.0(3)	100.0
1333.2	3.17(5)	3.171(13)	3.20(3)	3.15(2)	3.175(13)	3.17(1)
1918.8	5.33(8)	5.360(23)	5.44(6)	5.36(4)	5.368(23)	5.37(2)
2189.9	14.54(21)	14.39(6)	14.50(13)	14.12(12)	14.42(6)	14.37(5)
2422.9	5.12(8)	5.072(24)	5.15(6)	5.17(4)	5.085(24)	5.10(2)
2752.3	61.2(8)	61.34(26)	61.5(6)	60.80(40)	61.35(26)	60.71(6)
3229.2	4.06(8)	4.087(22)	4.07(4)	4.00(6)	4.082(22)	3.99(1)
3381.4	3.96(8)	3.950(23)	3.99(4)	3.83(4)	3.960(23)	3.86(2)
4086.5	3.38(8)	3.455(20)	3.42(4)	3.36(5)	3.445(20)	3.37(1)
4806.6	4.93(11)	5.04(3)	5.00(7)	4.99(8)	5.03(3)	4.99(3)

3. Other Related Activities- Chart of the Nuclides

The Chart of the Nuclides was developed taking into account the data obtained in 1998-2006. Unlike widespread nuclide charts the present Chart of Nuclides contains evaluated values of the main characteristics such as mass excess, nuclide percent abundance, thermal neutron capture cross sections for stable and natural long-lived nuclides; half-life, decay energy and spin, parity of ground/isomeric state for radioactive nuclides. These values are supplied with the standard deviations and taken from the evaluated data of China Nuclear Data Center, Nuclide Guide-3, International Chart of Nuclides-2003, Nuclear Wallet Cards, evaluated thermal neutron capture cross sections and evaluated atomic data. The presented data are applicable in medicine, agriculture, environmental protection etc.

4. Other Activity

Dr. Huang Xiaolong (CNDC) has collected all the articles relevant to ENSDF from Chinese journal of "High-Energy Physics and Nuclear Physics" (in chinese) (from 1984 to 2009) and sent to Dr. B. Singh in 2010.

Status Report on Nuclear Structure and Decay Data Activities in Jilin University

Huo Junde
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Email: huojd@jlu.edu.cn

1. Mass Chain Evaluation

The NSDD group in Jilin University (JLU) has permanent responsibility for evaluating and updating NSDD for mass chain: A=52, 53, 54, 55, 56, 62, and 63. In recent 2 years, the mass chain A=53, 56 and 63 have been updated using available experimental decay and reaction data since last evaluation. A=62 is being evaluated by Dr. B.Singh et al.

The status is as follows:

Table 1 Status of Mass Chain Evaluation in JLU

Mass chain A	Status	Evaluators
52	NDS, 106, 773 (2007)	Huo Junde
53	NDS, 110, 2689 (2009)	Huo Junde
54	NDS, 107, 1393 (2006)	Huo Junde
55	NDS, 109, 787 (2008)	Huo Junde
56	NDS, 86, 315 (1999)	Huo Junde, Post Review
62	NDS, 91, 317 (2000)	Being evaluated by Dr. B.Singh et al.,
63	NDS, 92, 147 (2001)	Huo Junde, ENSDF(2009.6)

4. Other Activity

JLU group has collected the articles relevant to ENSDF from Chinese journal of “High-Energy Physics and Nuclear Physics” (in chinese) (from 1977 to 1983).

Indian Institute of Technology Roorkee (India)
Report for 2009-2010

1. The nuclear data group at Roorkee consists of the following collaboration:
    1. Prof. A.K. Jain, Roorkee
    2. Dr. Sukhjeet Singh, MM Univ, Mullana, Ambala
    3. Dr. Paresh Joshi, HBCSER, TIFR, Mumbai

2. Dr. Sainath, Hyderabad has expressed a keen desire to participate in the ENSDF evaluation work. We have invited him to the Roorkee center in May 2011 to work out the modalities. He is a trained experimental nuclear physicist.

3. We (SS, AKJ, JT) have completed A=222 mass chain evaluation. It has just been submitted to the editor.

4. Dr. Paresh Joshi, Tata Institute, Mumbai was inducted in the evaluation work in 2008 after attending the training workshop at ICTP in 2008. He also spent few weeks at McMaster and BNL later on. He is now working on A=139 mass chain as suggested by J. Tuli, NNDC. The work is at an advanced stage and will be submitted within 2 months.

5. A horizontal evaluation of Nuclear Isomers has been started with the aim of defining some new research problems. A presentation based on these studies will be made at this meeting.

6. Department of Atomic Energy (Govt. of India) has formally announced the setting up of Nuclear Data Physics Centre of India (NDPCI). Dr. S. Ganesan, who is the Program Officer of this centre, has indicated that all the nuclear data related activities such as ENSDF, EXFOR etc. will be brought under one umbrella and funding will be provided to support activities in these areas. An initial seed funding of about 10 million Indian Rupees has been made for the purpose.

7. The project funding for the evaluation work at Roorkee has been approved by NDPCI and we expect to receive the funds soon. This will help us in supporting the visits of ENSDF evaluators at Roorkee and also hire a trained person.

Nuclear Data Evaluations at Manipal University

Status Report: March 31, 2009 to March 31, 2011

M. Gupta
Manipal University, Manipal, Karnataka, India

In collaboration with
T. W. Burrows
National Nuclear Data Center, Brookhaven National Laboratory, Upton, NY, USA

19th IAEA-NSDD meeting Vienna, Austria, 4-8 April 2011

A=260-265

The evaluation methodology developed in 2005Gu33 (A=266-294) has been 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 about ≈44 nuclides. Approximately 50% of these nuclides have been experimentally studied using chemical techniques.

Additionally, the ENSDF database was updated for ^{293}117 (4 nuclides) and ^{294}117 (7 nuclides). Future updates will include ^{268}Hs, ^{271}Hs and ^{267}Sg and nuclides with A>266 for which decay products are produced in the mass region of current interest.

Future Plans:

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.

THE AUSTRALIAN NATIONAL UNIVERSITY

Activity report
Australia National University
(2009-2011)

T. Kibèdi

THE AUSTRALIAN NATIONAL UNIVERSITY

Outline

Mass Chains

- A172 with C. Baglin, 172Au and 172Er updated
- A173 with F.G. Kondev (ANL) and S. Eerturk (Nidge Univ. Turkey)
- A174 with F.G. Kondev (ANL) and H. Xiaolong (CIAE, China)
- A84 with ENSDF training workshop (2009 Bucharest)

Horizontal evaluations

- Compilation of high precision ICC`s with T.W. Burrows (NNDC), M.B. Trzhaskowskaya (Gatchina) (draft)
- Tables of Prolate Deformed Nuclear K-Isomers with F.G. Kondev (ANL) G.D. Dracoulis (ANU) (draft)

BrIcc

- current version (2.2b) released in June-2010
- **2010Tr02** paper on resonances at low energies
- ICC for superheavy elements ND2010 presentation and accepted in ADNDT
- Version 2.3 compiled with Intel Fortran on Windows, Linux and Machintosh (pre-release)
- BrIcc Grapher released Apr-2010
- BrIcc Emission (development)
- New web versions: http://bricc.anu.edu.au/index.php

IAEA Meeting on the Coordination of the International Network of Nuclear Structure and Decay Data Evaluators
IAEA, Vienna, Austria
4 – 8 April 2011

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

This report covers the evaluation activities of the Kuwaiti Group for the period (March 2009 – April 2011).

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

- Mass Chain A = 78:
  Published September 2009 (carried out in collaboration with Balraj Singh, McMaster University).

- Mass Chain A = 76:
  Ameenah Farhan (Kuwait University) and Balraj Singh (McMaster University) are currently working on A = 76 (expected completion in fall 2011).

Personnel:

- Ameenah Farhan is still working as a part-time researcher for the center (L.T. 20%)

- The Kuwait Group will continue its fruitful collaboration with Dr. Balraj Singh (McMaster University) in order to fulfill its commitments.

Financial Support:
The research activities of the Kuwait Nuclear Data Center are funded by Kuwait University.

Nuclear Structure and Decay Data Evaluation at Atomki Debrecen, Hungary

Status Report

Zoltán Elekes and János Timár

19th Meeting of the Nuclear Structure and Decay Data (NSDD) Network, IAEA, Vienna, Austria, 4-8 April 2011

About the group

- Working on mass-chain evaluation since the 2008 Vienna meeting
- Two evaluators with alltogether 0.5 FTE
- Temporary mass chains (courtesy of NNDC and the Japanese center)
- Help from Balraj Singh, Tibor Kibédi, Daniel Abriola
- Financial support: Atomki, IAEA, McMaster Univ.

Mass-chain evaluations

- **A=84:** D. Abriola, M. Bostan, S. Erturk, M. Fadil, M. Galan, S. Juutinen, T. Kibédi, F. Kondev, A. Luca, A. Negret, N. Nica, B. Pfeiffer, B. Singh, A. Sonzogni, J. Timar, J. Tuli, T. Venkova and K. Zuber NDS 110, 2815-2944 (2009) (Bucharest workshop). ^{84}Zr with Tibor Kibédi.

- **A=50:** Z. Elekes, J. Timar and B. Singh, NDS 112, 1-131 (2011)

- **A=129:** J. Timar, Z. Elekes and B. Singh, NDS (submitted Sept 2010, post-review)

- **A=128:** Started the evaluation. Plan to submit at the end of 2011.

Future plans

We plan to continue mass-chain evaluation. About one mass / year.

Short-term plan:

- 2011: A=128 (approved by NNDC, courtesy of JAEA, Japan)
- 2012: A=46 (approved by NNDC, courtesy of NNDC, USA)
- 2013: A=98 (may be in collaboration with McMaster, Canada)

Long-term plan:

- Atomki wold like to become an Evaluation Center
- We would like to get permanently assigned mass chains in the A=50, 100 and/or 130 regions.

Thank you

- McMaster, Canada for the hospitality. 3 x 2 weeks collaboration trip for evaluation of A=50 and A=129
- IAEA for financial support through Research Contract No. 15902/R0

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