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Summary Report of an IAEA Technical Meeting

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

IAEA Headquarters, Vienna, Austria

8 – 12 April 2019

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July 2019

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Abstract

The 23rd meeting of the International Network of Nuclear Structure and Decay Data Evaluators was convened at the IAEA Headquarters, Vienna, from 8 to 12 April 2019 under the auspices of the IAEA Nuclear Data Section. This meeting was attended by 23 scientists from thirteen Member States and IAEA staff, all of whom are concerned primarily with the measurement, evaluation and dissemination of nuclear structure and decay data. A summary of the meeting, data centre status reports, various proposals assessed and considered for adoption, technical discussions, actions agreed by the participants, and the resulting recommendations/conclusions are presented within this document.

July 2019

GLOSSARY

A	Mass Number
ADNDT	Atomic Data and Nuclear Data Tables
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 internal conversion coefficients
CD-ROM	Compact disk with read-only memory
CE	Conversion Electron
CEA	Commissariat à l'Energie Atomique (French Atomic Energy Commission)
CNDC	China Nuclear Data Centre, Institute of Atomic Energy (CIAE)
CRP	Coordinated Research Project (IAEA)
CSNSM	Centre de Spectrométrie Nucléaire et de Spectrométrie de Masse, France
DDEP	Decay Data Evaluation Project
DDG-NA	Deputy Director General of the Department of Nuclear Sciences and Applications, IAEA
DIR-NAPC	Director of the Division of Physical and Chemical Sciences of the Department of Nuclear Sciences and Applications (IAEA)
DELTA	ENSDF analysis program
DOE	U.S. Department of Energy
EADL	Evaluated Atomic Data Library
EC	European Commission
EC-Beta+	Electron capture-β^+ decay
EFG	Electric field gradient
EGAF	Evaluated Gamma-ray Activation File
EMPIRE	System of codes for nuclear reaction calculations
ENDF	Evaluated Nuclear Data File
ENSDD	European Nuclear Structure and Decay Data Network of Evaluators
ENSDF	Evaluated Nuclear Structure Data File
EU	European Union
EURATOM	European Atomic Energy Community
EXFOR	EXchange FORmat: Computer-based system for the compilation and international exchange of experimental nuclear reaction data, IAEA-NDS
fm	femtometer
FMTCHK	ENSDF analysis program
FO	Frozen Orbital
FP7 ENSAR	7^{th} Framework Programme, European Nuclear Science and Applications Research (ENSAR)
FP7 ERA-NET	7^{th} Framework Programme, European Research Area (ERA)
FTE	Full Time Equivalent
GABS	Gamma ABSolute, 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
HSICC	Program to calculate Hager-Seltzer internal conversion coefficients
IAEA	International Atomic Energy Agency
IC	Internal Conversion
ICC	Internal Conversion Coefficients
ICRM	International Committee for Radionuclide Metrology
ICTP	International Centre for Theoretical Physics, Italy
IFIN-HH	Horia Hulubei Institute of Physics and Nuclear Engineering, Romania
IIT	Indian Institute of Technology
IMP	Institute of Modern Physics, Chinese Academy of Sciences, China
INDC	International Nuclear Data Committee, IAEA-NDS
INIS	International Nuclear Information System, IAEA
IP	Isotopes Project at LBNL, now called Nuclear Data Group of LBNL+UCB
IPF	Internal Pair Formation
JAEA	Japan Atomic Energy Agency
Java-NDS	Nuclear Data Sheets publication code in Java programming language
$J\pi$/JPI	Spin and Parity
K	Angular momentum projection on the nuclear symmetry axis
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, USA
LOGFT	ENSDF analysis program
M	Transition multipolarity
MR	Mixing ratio
MSU	Michigan State University, USA
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 primarily to ENSDF data
NDS-IAEA	Nuclear Data Section, IAEA
NIPNE	National Institute of Physics and Nuclear Engineering, Romania
NIST	National Institute of Standards and Technology, USA
ND	Nuclear Data
NNDC-BNL	National Nuclear Data Center, Brookhaven National Laboratory, USA
NRM	Normalized Residual Method
NSCL	National Superconducting Cyclotron Laboratory, USA
NSDD	Nuclear Structure and Decay Data network
NSR	Nuclear Science References – bibliographic file
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
PABS	Particle ABSolute, ENSDF Analysis program
PANDORA	ENSDF analysis program
PNPI	Petersburg Nuclear Physics Institute of the Russian Academy of Sciences
RADLST	ENSDF analysis code that calculates emitted radiation based on ENSDF
RIKEN	Japanese research organization for basic and applied science

RIPL	Reference Input Parameter Library
RUL	Recommended Upper Limit
RULER	ENSDF analysis program
SHE	Super Heavy Elements
SQL	Structured Query Language
TJ^{π}	Proposed theoretical or recommended J^{π}
TUNL	Triangle Universities Nuclear Laboratory, USA
USNDP	US Nuclear Data Program
UCB	University of California at Berkeley
WPEC	NEA Working Party on International Evaluation Cooperation
XML	eXtensible Markup Language
XUNDL	eXperimental Unevaluated Nuclear Data List

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

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ANNEXES

Foreword

Biennial meetings of the International Network of Nuclear Structure and Decay Data (NSDD) Evaluators are held under the auspices of the IAEA. This network consists of evaluation groups and data service centres in several countries, and has the objective of ensuring the provision of up-to-date nuclear structure and decay data for all known nuclides by means of the evaluation of all relevant experimental measurements. 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 at the time of their evaluation. These data and bibliographic details are also available through the World Wide Web, wall charts of the nuclides, Nuclear Wallet Cards and other such media.

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

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

(a) co-ordination of the work of all data 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.

Detailed studies and discussions are undertaken over a five-day period. This document represents a summary of the network meeting held at IAEA Headquarters, Vienna, Austria, from 8 to 12 April 2019. Nuclear data specialists from thirteen countries along with IAEA staff attended this meeting to discuss their work as well as problems of common interest, particularly with respect to the active membership of the multinational mass chain evaluation team responsible for ENSDF.

The first 1.5 days were dedicated to a combination of organisational, administrative and technical reviews of mass-chain activities and horizontal evaluations, and the progress made across many features of this work from the previous meeting of 22-26 May 2017 to May 2019. Significant segments of the further 2.5 days were committed to specific problems and issues encountered during the previous two years work of individual NSDD evaluators, along with reasonably wide-ranging sessions dedicated to a series of highly-relevant coding and technical developments. All actions were noted throughout the full four days of presentations and discussions, and were further clarified and agreed on the final day of the meeting. The adopted agenda for the meeting is listed in Annex 1, and a list of participants is given in Annex 2.

NSDD Meetings

Place	Date	Report
1. Vienna, Austria	29.04. – 03.05.1974	INDC(NDS)-60
2. Vienna, Austria	03 – 07.05.1976	INDC(NDS)-79
3. Oak Ridge, USA	14 – 18.11.1977	INDC(NDS)-92
4. Vienna, Austria	21 – 25.04.1980	INDC(NDS)-115
5. Zeist, Netherlands	11 – 14.05.1982	INDC(NDS)-133
6. Karlsruhe, Germany	03 – 06.04.1984	INDC(NDS)-157
7. Grenoble, France	02 – 05.06.1986	INDC(NDS)-182
8. Ghent, Belgium	16 – 20.05.1988	INDC(NDS)-206
9. Kuwait, Kuwait	10 – 14.03.1990	INDC(NDS)-250
10. Geel, Belgium	09 – 13.11.1992	INDC(NDS)-296
11. Berkeley, USA	16 – 20.05.1994	INDC(NDS)-307
12. Budapest, Hungary	14 – 18.10.1996	INDC(NDS)-363
13. Vienna, Austria	14 – 17.12.1998	INDC(NDS)-399
14. Vienna, Austria	04 – 07.12.2000	INDC(NDS)-422
15. Vienna, Austria	10 – 14.11.2003	INDC(NDS)-456
16. Hamilton, Canada	06 – 10.06.2005	INDC(NDS)-0476
17. St. Petersburg, Russia	11 – 15.06.2007	INDC(NDS)-0513
18. Vienna, Austria	23 – 27.03.2009	INDC(NDS)-0559
19. Vienna, Austria	04 – 08.04.2011	INDC(NDS)-0595
20. Kuwait City, Kuwait	27 – 31.01.2013	INDC(NDS)-0635
21. Vienna, Austria	20 – 24.04.2015	INDC(NDS)-0687
22. Berkeley, USA	22 – 26.05.2017	INDC(NDS)-0733
23. Vienna, Austria	08 – 12.04.2019	INDC(NDS)-0783

1. INTRODUCTION

The role of the International Network of Nuclear Structure and Decay Data (NSDD) Evaluators 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 evaluations; and third, monitor and review the development and use of the computerized systems and databases maintained specifically for such activities. A primary aim of the network is that accurate and 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 takes on the role of coordinator of the NSDD Network, and at the same time monitors and reviews the development and use of the computerized systems and databases maintained for such activities to ensure the smooth dissemination of nuclear structure and decay data.

Delegates to the 23rd meeting of the International NSDD Evaluators' Network were welcomed by Melissa Denecke, the IAEA Director of the Division of Physical and Chemical Sciences, within the Department of Nuclear Sciences and Applications, and Arjan J. Koning, Head of the Nuclear Data Section, who both stressed the importance of the nuclear structure and decay data measurement and evaluation programs, along with the need to maintain significant coordination efforts worldwide. Paraskevi (Vivian) Dimitriou, Nuclear Data Section, the local organiser of the meeting, also addressed all participants, and provided information regarding the venue and other local arrangements.

Prior to the start of the main technical discussions of the network meeting, deserved praise and thanks were paid to Paraskevi Dimitriou for her enthusiastic work at the IAEA over the previous seven years, as dedicated to advances in nuclear data and more specifically the ENSDF project and related studies. The Agenda was approved as listed in Annex 1. E.A. McCutchan (NNDC, BNL) and P. Dimitriou (IAEA, Nuclear Data Section) were elected to co-chair the meeting at appropriate times, and A.L. Nichols (University of Surrey) was nominated to be rapporteur for the meeting. Twenty-seven nuclear data specialists attended this meeting from thirteen countries, representing the majority of data evaluation/dissemination centres and new evaluation groups (Annex 2).

A list of all ENSDF evaluation centres and groups is given in Annex 3, along with their mass-chain evaluation responsibilities as assigned for 2017-2019. Representatives from the individual mass chain evaluation centres presented progress reports on their NSDD studies, and all of these status reports can be found in Annex 5. Apart from the status reports, other technical reports on horizontal evaluations, databases, and analysis codes are included in the main body of the report. Technical presentations made by participants are available on the IAEA NSDD website, and summaries are provided in Annex 6. Links to all the reports and presentations given during the meeting are listed in Annex 7.

The first 1.5 days were primarily devoted to administrative and organisational issues, in particular the discussion of actions from previous meetings, proposals for specific data centre adjustments, the presentation of status reports by evaluation centres, as well as reports on the USA and the IAEA Nuclear Data Programmes, the network organisational review, workshops, horizontal evaluations and databases. The final 3 days focussed on a wide range of technical matters, and the completion and on-going development of various codes to assist in the evaluation process and to display ENSDF datasets. A list of actions was prepared, indicating those responsible for implementation over the forthcoming two years (see Annex 4). The Continuous, Ongoing and Pending Actions list was separated into two types of list, one containing the continuous, ongoing and pending actions from this and previous meetings, and the other containing a list of more permanent recommended procedures that evaluators should always follow when performing their evaluations.

The meeting concluded with the announcement that plans will be made to hold the next meeting at ANU (Australian National University), Canberra, Australia, in 2021.

2. ADMINISTRATIVE MATTERS AND REPORTING

2.1. Data Centres

A few changes and developments were discussed and noted concerning particular ENSDF Data Evaluation Centres within the network:

Variable Energy Cyclotron Centre (VECC), Kolkata, India (G. Mukherjee): With the move of Ashok Jain from the Indian Institute of Technology at Roorkee, interested parties had provisionally considered the possibility of re-locating the Indian Data Centre to VECC, Kolkata. This proposal was discussed and agreed on the basis of the strong government-based connections of this national laboratory and the possibility of expansion with respect to potential available FTE numbers. Support for this proposal was sought and received from the Director of the VECC during the course of the network meeting, and the suggested re-location was approved.

Drafted/edited statement issued by Gopal Mukherjee (VECC):

With the departure of Prof. Ashok Jain from the IIT, Roorkee, consideration has been given to moving the Indian NSDD centre to another institution. VECC is a national cyclotron accelerator centre operated under the auspices of the Department of Atomic Energy of the Government of India. The centre houses several modern facilities for accelerator-based experimental nuclear physics and other research, and possesses a long history of nuclear structure and reaction studies. Moreover, staff at the VECC in Kolkata have contributed to the international ENSDF evaluation and XUNDL work programmes for a reasonable number of years. Several mass chain evaluations have been performed by the VECC group (S.K. Basu and Gopal Mukherjee), in collaboration with the NNDC and various other institutes and universities within India. VECC has also organized an ENSDF workshop, and taken the lead in completing a mass chain evaluation in collaboration with participants. Furthermore, VECC staff have successfully worked with young evaluators in India (e.g., Sukhjeet Singh Dhindsa) to formulate, propose and initiate a project at the BRNS, DAE, India, for ENSDF evaluation work.

A primary initial aim of the data centre at VECC will be to further unite existing and potential evaluators in India, and continue contributing constructively to the NSDD network. Efforts will be dedicated to keeping up the good work previously carried out at the IIT, Roorkee data centre, assisted by welcome advice and guidance from Prof. Ashok Jain in the years to come.

RIKEN Nishina Centre (H. Sakurai): an agreement has been in place between RIKEN and NSDD since the previous NSDD meeting in 2017, such that a permanent member of staff at RIKEN will undertake XUNDL compilations of all structure and decay data measured at the Nishina Centre. The staff member, Y. Ichikawa, has been trained by the Japanese ENSDF evaluator (H. Iimura), and has also visited Filip Kondev at ANL to work together on XUNDL compilations. They have assembled several XUNDL data sets, although too early to judge whether this work will evolve into an independent and self-sustainable activity. At the moment, there are no plans for RIKEN to get involved in ENSDF evaluation work.

USA membership: contract affiliation of Jagdish Tuli is now identified with Lawrence-Berkeley National Laboratory, Berkeley, USA. Timothy Johnson is no longer with the NNDC.

European membership: EU Horizon 2020 funding has been agreed in principle to support mass chain evaluations for ENSDF within the SANDA project. Participating Data Centres include Bulgaria (0.22 FTE), Hungary (0.4 FTE) and Romania (0.4 FTE). This development was seen as most welcome by the network after much effort expended to obtain such funding by the three centres over approximately 12 to 15 years.

2.2. Organisational Review

2.2.1. NSR *(B. Pritychenko, NNDC-BNL)*

The NSR team for FY2017/18 consists of Boris Pritychenko and Joann Totans (BNL, 1.5 FTE), Balraj Singh (McMaster University) and Emil Betak (Bratislava) as contractors, and Viktor Zerkin (IAEA-NDS) as collaborator. Nuclear Science References (NSR) has evolved over many years to act as a reference database for nuclear structure, reaction and decay data. Primary goals are to provide coverage for all current relevant publications, and to recover and enter previously missing references. Efforts are also regularly made to establish direct communications with authors in *Phys. Rev. C* to assist in the provision of appropriate keywords for their entries in NSR.

NSR statistics for FY2017:
3,714 new reference entries to give a sum total of 229,594 entries;
320 references not detected and registered previously added;
275 entries corrected;
2,021 keyword articles (as of 2 November 2018).

NSR dictionary updates:
279 new nuclides to give a sum total of 7,050 nuclides;
233 new reactions to give a sum total of 8,409 reactions;
105 new radionuclidic decays to give a sum total of 734 decays;
consideration of 19 new journals to give a sum total of 538 journals.

Total number of retrieved references within NSR stood at 10,028,327 in FY2018.

NSR compilation efforts rely significantly upon the contractual efforts of Balraj Singh and Emil Betak. While Balraj Singh has indicated that he will discontinue his work in this area in the near future, equivalent input from LBNL/UCB dedicated to compilations of *Phys. Rev. C* references is now being planned (J. Batchelder and L.A. Bernstein). Both NSR and EXFOR data have been successfully transferred from MySQL to MariaDB software, while all web, database and maintenance software were migrated to new servers and the resulting system fully tested. Work also continues on doi links in NSR, undertaken with the assistance of Viktor Zerkin (IAEA-NDS) – number of such doi links now stands at 145,146 and increasing. Finally, contact has been established with Zaven Hakopov (INIS coordinator, IAEA) via Zerkin, with the aim of providing almost complete PDF coverage for the NSR and EXFOR databases.

2.2.2. XUNDL *(E.A. McCutchan, NNDC-BNL)*

710 datasets from 314 papers were compiled for XUNDL in fiscal year 2017, and 585 datasets from 253 papers were compiled for XUNDL in fiscal year 2018 (see table below). As of 29 October 2018, the full XUNDL database consisted of 8,087 datasets for 2,634 nuclides. The majority of the effort for XUNDL comes from the centers at ANL, BNL, LBNL, McMaster University, MSU, ORNL and TUNL. Approximately 10 papers were compiled as part of the exercises for the Trieste workshop, under the guidance of the workshop lecturers. Additionally, RIKEN has begun to contribute compilations working in conjunction with the ANL data center.

Data centre	FY2017		FY2018		
	Papers	Datasets	Papers	Data sets	PRC pre-pub
McMaster University	137.5	275	86	293	10 papers
TUNL	38	60	32	42	
BNL	31	67	46	73	16 papers
MSU	60	130	54	101	3 papers
ORNL	11.5	15	3	3	
LBNL	18	34	17	22	
ANL	13	115	15	51	
international*	5	14	–	–	
total	314	710	253	585	29 papers

* mainly ICTP, Trieste workshop 2016 split 50/50 with McMaster University.

The most significant development in XUNDL has been the project with *Physical Review C* of the American Physical Society to compile and check papers prior to their publication. A successful pilot project was started in March of 2018, and by the summer of 2018 this initiative had moved to an "opt-in" policy. Upon submission of their manuscript, authors are asked if they would like to send their paper to the USNDP for checking. Currently, approximately 85% of the authors opt-in for pre-publication checking. Major issues were identified with the data in several instances, and led to substantial revisions of particular manuscripts. Authors have provided overwhelmingly positive feedback to this process. The NSDD Evaluators' network can assist in this endeavour by encouraging their experimental colleagues to participate in the pre-publication checking project. Two main avenues are planned to be pursued in the future:

1) Expand pre-publication checking to Elsevier journals – discussions have been initiated with Elsevier to begin this process.
2) XUNDL effort needs to develop a strategy to follow up on manuscripts which went through pre-publication checking, but were not accepted for publication in *Physical Review C*. As publication times can take up to a year, and the programme has only been running for a year, this is a topic which should be addressed within the next 6 months.

The PRC project continues, and will soon move from authors' "opt-in" to an "opt-out" procedure. Newly recruited NNDC staff are and will be trained to assist in the development of the database, while further discussions are needed as how best to solicit unpublished data from authors and consider their incorporation into XUNDL.

2.2.3. ENSDF *(E.A. McCutchan, NNDC-BNL)*

As co-ordinator of the ENSDF evaluation effort, E.A. McCutchan (NNDC-BNL) provided a detailed overview of the current status of ENSDF. As of 15 March 2019, the following are the important summary statistics for ENSDF:

Datasets: 19,090 by 15 March 2019, and 18,765 in 2017,

Nuclides: 3,343 by 15 March 2019, and 3,325 in 2017,

Submitted: 221 nuclides in 2018, and 237 nuclides in 2017.

A listing of the status of mass-chain processing is provided on the NNDC website. Overall productivity continues to decline, with a current average rate of renewal of mass chain evaluations every 9.5 years. Efforts continue to improve the content and quality of ENSDF through exploring new evaluation workflow and to introduce further, more thorough review processes. Various on-going collaborations between the data centres have shown this approach to be more productive than other such studies carried out in singular isolation. Nevertheless, more mass chain evaluations need to be undertaken with greater alacrity.

A priority list of ENSDF mass chain evaluations continues to be maintained based on the XUNDL-based growth of relevant references and previous cut-off date, and colour-coded further in terms of ongoing and work submitted for review. Other procedural impacts were also noted:

- adoption of new masses from AME2016 (published in 2017);
- introduction of submission checklist two years ago to replace the pre-review stage was smoothly implemented with no major subsequent difficulties;
- study of interactive tracking software to monitor evaluated files through the full submission to publication process, as requested by network members (although further work is required to identify a fully appropriate system).

Problems with deriving and adopting decay-scheme normalization factors have proved to be a relatively common occurrence in recent years – examples were shown that illustrated clear conflicts in recommended data assigned to and associated with this important parameter. Evaluators were encouraged to consider carefully the derivation of decay scheme normalization. Simple mistakes were illustrated, such as absolute emission probabilities larger than 100% that can be easily identified through consideration of the decay scheme drawings generated by the JAVA-NDS program.

A serious bottleneck has developed in the ENSDF pipeline of evaluation and peer-review approval prior to publication in the public domain and full adoption in the database: process of undergoing peer review. Various suggestions were discussed, and agreement was reached in principle that for every evaluation submitted, the evaluator (or team of evaluators) should agree to review another available mass chain within the pipeline in a timely manner. However, attendees also acknowledged that a fair number of partially funded evaluators may not currently possess the expertise to undertake such extensive in-depth reviews.

Various summary displays contained at regular intervals within *Nuclear Data Sheets* were considered for either modification/re-adoption, or removal. The Cumulative Index to A-chains is effectively a complete status table of the database contents which is also available on the ENSDF website (as Summary of ENSDF) – overall agreement was reached to dispense with this particular tabulation in *Nuclear Data Sheets*. However, an equivalent proposal to remove the comprehensive listing of the identities and contact details of the approved data centres was rejected – rather, the size of the existing script should be increased somewhat to improve legibility. An alternative solution was finally proposed, i.e., link the *Nuclear Data Sheets* page to the webpage containing the list of NSDD Data Centres, complete with contact details and mass-chain responsibilities. Other topics of discussion included how best to react to user feedback on the presentation and content of the ENSDF data files coupled to the handling of resources, and the agreed provision of citation guidelines. A proposal concerning the implementation of new masses into ENSDF was also considered at this time (previous Q-values become a document record, and new 1Q record is added, with minor changes required to FMTCHK and JAVA-NDS) – accepted without any further modification.

2.2.4. Status of ENSDF evaluations and estimated evaluation effort

The following mass chain responsibility has been adjusted:

China - Jilin relinquished responsibility for A = 63.

The responsibilities of NSDD members, along with evaluation commitments for the mass chain evaluators as they stand for 2019/2020 are summarized in the following table:

Centre		Responsible - no. mass chains	FTE staff
USA			
a	NNDC-BNL	120*	0.4
b	ORNL	9	1.15
c	LBNL	33	1.7
d	TUNL	19	0.6
e	ANL	17	0.5
f	MSU	14	1.0
g	Texas A&M	9	1.0
non-USA			
h	Russia	6	0.2
i	China Beijing	6	1.0
	Jilin	6	0.25
j	India	15	1.0
k	Japan	10	0.2
l	Canada	18	0.39
m	Australia	3	0.1
n	Hungary	5	0.4
o	Romania	6	0.4
p	Bulgaria	5	0.2
TOTAL			

*120 = 302 – number of mass chains taken by all other data centres.

The agreed responsibilities are listed in the following table.

Data Centre	Mass Chains
NNDC-BNL	45-50, 60-73 (ex 62, 64, 67), 82, 84-88, 94-97, 99, 113-116, 136-146 (ex 140, 141), 150, 152-165 (ex 153, 155, 157, 158, 160, 164), 175, 180-183, 189, 230-240, >249
ORNL	241-249
LBNL	21-30, 81, 83, 90-93, 166-171, 184-193 (ex 185, 188-190), 210-214
TUNL	2-20
ANL	109, 110, 176-179, 199-209
MSU	31-44
Texas A&M University	140, 141, 147, 148, 153, 155, 157, 158, 160
Russia – St. Petersburg	130-135
PRC – CNDC, Beijing	51, 62, 195-198
PRC – Jilin University	52-56, 67 [relinquished responsibility for 63]
India - VECC	215-229
Japan - JAEA	120-129
Canada – McMaster Univ.	1, 64, 74-80, 89, 98, 100, 149, 151, 164, 188, 190, 194
Australia - ANU	172-174
Hungary – MTA Atomki	101-105
Romania – IFIN-HH	57-59, 117-119
Bulgaria – Univ. of Sofia	106-108, 111, 112

2.3. IAEA Workshops and Technical Meetings *(P. Dimitriou, IAEA-NDS)*

Highly relevant activities undertaken since the previous NSDD Evaluators' network meeting are described in the following Subsections.

2.3.1. Joint IAEA-ICTP Workshop on Nuclear Structure and Decay Data: Experiment, Theory and Evaluation, 15-26 October 2018, ICTP, Trieste, Italy

Ten lecturers from seven countries were invited to lecture during the two-week workshop, and 17 participants from ten countries were selected to participate. The workshop was very successful - participants worked diligently throughout the two weeks and produced some impressive results:

- during afternoon practical courses, trainees in collaboration with their supervisors/lecturers managed to complete the compilation of ten articles into XUNDL datasets, which were finalized with the help of the supervisors;
- trainees were able to make significant progress in the evaluation of six nuclides belonging to mass chain A = 218, which has subsequently been completed and submitted for review.

Other successful aspects of the workshop are based on the results of a questionnaire to the participants:

All participants acknowledged the high level of the lectures and how beneficial they were to their research work. They also came to appreciate the work of data evaluators, and learned how to be critical of published work. All of the participants acknowledged that they had learned more at this workshop than at any other they had attended before. Their suggestions for improvements, as expressed in the questionnaire, will be taken into due consideration for future workshops.

One PhD student has expressed interest in continuing evaluation work, and discussions are underway between NNDC, IAEA and the student on possible ways to provide both technical support -in the form of mentorship - and financial aid.

Discussions:
Identification of new NSDD evaluators from these workshops has been limited over the previous five years. Therefore, the question that arose was whether this type of two-week course with intense hands-on exercises involving XUNDL compilation and ENSDF evaluation should continue, or whether a more meaningful approach would be to hold a shorter, one-week workshop with less exercises that would be designed for educational outreach rather than training potential ENSDF evaluators. These discussions lead to Actions 20 and 21.

2.3.2. Other Relevant IAEA Technical Meetings

1. Coordinated Research Project (CRP) on Charged-particle Monitor Reactions and Medical Isotope Production (2012-2016/17)

   This programme was defined in terms of five work packages that were mostly concluded in 2017/18 (one publication is still in preparation):
   i) Reference cross sections for charged-particle monitor reactions, *Nucl. Data Sheets* **148** (2018) 338-382.
   ii) Recommended nuclear data for medical radioisotope production: diagnostic gamma emitters, *J. Radioanal. Nucl. Chem.* **319**, Issue 2 (2019) 487–531; https://doi.org/10.1007/s10967-018-6142-4.
   iii) Recommended nuclear data for medical radioisotope production: diagnostic positron emitters, *J. Radioanal. Nucl. Chem.* **319**, Issue 2 (2019) 533–666; https://doi.org/10.1007/s10967-018-6380-5.
   iv) Recommended nuclear data for the production of selected therapeutic radionuclides, *Nucl. Data Sheets* **155** (2019) 56-74.
   v) Selected and recommended atomic and nuclear decay data for medical radionuclides, in preparation (2019).

   An extended database containing data from the above along with all previous relevant medical-based CRPs is available at:

   www-nds.iaea.org/medportal/

Earlier entries have regularly undergone a series of improvements and presentational modifications over the intervening years.

2. Technical Meeting on Nuclear Data for Medical Applications, 10-13 December 2018, IAEA Headquarters, Vienna

   Much has happened involving progress in measurements and evaluations of various atomic and nuclear decay since the previous IAEA-NDS exercise of August 2011 to define at that time present and future data requirements for diagnostic and therapeutic applications in nuclear medicine. These earlier recommendations were only partially addressed during the course of 2012 to 2017 by means of an IAEA coordinated research project (see above), and therefore a further re-assessment was undertaken in December 2018 with respect to the remaining balance of outstanding needs from August 2011, along with consideration of other relevant in-depth reviews that have appeared in the intervening years. Such a re-assessment of the existing data for each radionuclide was undertaken, with the potential to lead on to new measurements prior to any attempted in-depth re-evaluations of the full decay schemes of specific radionuclides.

   An IAEA Technical Meeting was held in Vienna on "Nuclear Data for Medical Applications" at which nineteen consultants and IAEA-NDS staff assessed future medical applications for many radionuclides based upon their existing and potential diagnostic and therapeutic properties. Debate focused upon charged-particle induced reactions and their production cross sections, derivation of optimal yields, and minimisation of radionuclidic impurities, along with decay data requirements. Technical discussions can be found in IAEA report INDC(NDS)-0776, along with listings and recommendations for future work. The resulting excitation functions and decay-data evaluations will be introduced into an already existing IAEA-NDS database (IAEA-NDS medical portal).

3. Consultants' Meeting on Updating Data Needs for Total Absorption Gamma-ray Spectroscopy (TAGS), 19-21 February 2018, IAEA Headquarters, Vienna

   The current state of affairs regarding published and upcoming TAGS measurements were reviewed, along with the results of a co-ordinated effort to assess the decay data of all the important fission product yields contributing to the decay heat of 15 fuel systems for a range of irradiation times as benchmarked by UKAEA staff at Culham, UK. The following topics were discussed:

   - new TAGS measurements and results for beta feedings (available since the last meeting in December 2014);
   - current status of decay data libraries with respect to TAGS data;
   - impact of recent TAGS data on decay heat calculations and antineutrino spectra;
   - assessments of main fission product contributors to decay heat and antineutrino spectra;
   - new priority tables for total absorption and high-resolution gamma-ray spectroscopy measurements;
   - repository of measured decay heat data.

   A publication of the results of the assessment of decay data and impact of TAGS data on both decay heat and antineutrino spectra calculations is in preparation. More information on the presentations and assignments are available on the meeting webpage:

   https://www-nds.iaea.org/index-meeting-crp/TAGS2018/

3. TECHNICAL REPORTS

Status reports from the NSDD Data Centres are given in Annex 5. Annex 6 includes summaries of technical presentations on horizontal evaluations, proposals and developments in ENSDF analysis codes, formats and web tools, and nuclear structure-related measurements. Brief accounts were also given of the status of the ENSDF bibliography database (NSR), and database dissemination applications of Live Chart as well as the web display code JAVA-NDS.

3.1. ENSDF databases

3.1.1. LiveChart of Nuclides *(P. Dimitriou, IAEA-NDS)*

LiveChart is continuously developed and updated by IAEA-NDS staff. Users can retrieve and plot nuclear structure and decay data from the ENSDF database. The beta spectra are calculated using the BetaShape code of X. Mougeot (LNHB) (see further details in Subsection 6.6, and relevant summary within Annex 6).

3.1.2. MyEnsdf Web tools and ENSDF Web editor *(V. Zerkin, IAEA-NDS)*

The primary purpose of MyEnsdf is to run ENSDF codes remotely with users' ENSDF file on the Web server, and so emulate terminal sessions. Currently, the system runs: FMTCHK, chk_ENSDF, chk_PARENT, chk_brackets, PREPRO, XPQCHK, ENSDF_to_XML, ALPHAD, ALPHAD_RADD, BrIcc, BrIccMixing, GABS, GTOL, NEWGTOL, LOGFT, PANDORA, RADLST, RULER, BARON, NDSPUB, and JAVA-NDS.

Web viewers and editor:
ENSDF extension of the EXFOR-CINDA Dictionary system (originated from C. Dunford and V. McLane, NNDC), and developed for use under viewers/editor for interpretation and help/input.

Ensdf+ displays ENSDF file as original "ENSDF cards", and interpretation includes ENSDF symbols, NSR KeyNumber with link to Web NSR and PDF file (if any), simplified plotting of decay schema and gamma transitions with indication of possible mistakes, etc. – also has limited interactive functionality for hiding/showing selected sections.

Ensdf± presents ENSDF file as an interactive tree-graph - modern style for display of ENSDF file structure, with interpretation similar to Ensdf+.

ENSDF Web-Editor is based on Ensdf± view, and extends every node by sets of operations (add, remove, edit, etc.). Operations are mostly implemented on pop-up window, whereby interpretation of ENSDF fields and automatized input system are used.

3.1.3. Medical and Decay Data Portals *(P. Dimitriou, IAEA-NDS)*

As noted previously, two on-line retrieval interfaces are available on the IAEA web server:

Medical Portal: allows on-line retrieval of cross sections for the production of and decay data for a wide range of existing and potential medical radioisotopes based on work undertaken during a series of intermittent IAEA CRPs from 1995 to 2017. Available at http://www-nds.iaea.org/medportal/

Decay Data Portal: created to provide the user with direct and easy access to evaluated decay data available in various databases, such as ENSDF, DDEP and IAEA-CRP decay data libraries. Available at http://www-nds.iaea.org/decayportal/. At present, the user can compare the data in tabulated form. Future planned developments include adding decay data from the evaluated decay-data sub-libraries of ENDF/B, JEFF and JENDL.

Following feedback from the meeting, effort will be made to allow users to upload their own data files and compare them in tabulated form with data in the available databases.

4. ROUND-TABLE DISCUSSIONS

4.1. Consistency in ENSDF

Many participants regarded data consistency as an essential and necessary requirement within the ENSDF datasets. As expressed by Balraj Singh, well-defined efforts should be made to achieve an extremely high degree of consistency throughout the whole ENSDF database.

4.2. Recommended gamma-ray energies for Adopted dataset, and alpha-particle energies for decay dataset

A proposal was made that all gamma-ray and alpha-particle energies should be derived from the evaluated nuclear level energies. However, following extensive discussion, the current policy was upheld that adopts the measured gamma-ray energies in the Adopted dataset and measured alpha-particle energies in the decay dataset.

4.3. Carry over of A2, A4, DCO and conversion coefficient data from individual datasets to Adopted dataset

After a relatively short discussion led by Tuli, participants agreed that DCO values were of no value at all in the Adopted datasets, unless there was proper documentation on experimental geometry and expected values for different multipolarities. Inclusion of experimental conversion coefficients, A2, A4 would be of some merit, and can be included on the basis of the evaluator’s preference.

4.4. GOSIA least-squares analysis in Coulomb excitation

The question was raised as how best to deal with reported data from Coulomb excitation measurements which make use of the GOSIA analysis program. Often, a GOSIA analysis takes literature values as input for well-known half-lives, branching ratios, and mixing ratios. This leaves the situation unclear as to the independence of the results, considering that the analysis can heavily rely on prior data. No firm conclusion could be reached, and therefore an action was placed on John Kelley to discuss the issue with GOSIA analysis experts- see also Action 15.

4.5. Publication of mass chain articles in Nucl. Data Sheets – verbatim copying of material from the previous mass chain evaluation

As strongly argued by Balraj Singh, verbatim copying of material from previous mass chain evaluations without clear and obvious acknowledgements within the new publication was judged as being totally unacceptable. This situation needs to be rectified in all future mass chain articles of Nucl. Data Sheets by means of a carefully worded statement, or series of statements to be provided by NNDC-BNL to a level that should be dependent upon the extent of such adoption(s).

4.6. Handling of systematic uncertainties when averaging measured data

There are no clear guidelines on how to treat systematic uncertainties in measured data when averaging over different measured quantities. Normally, the authors do not mention or quantify the systematic uncertainties, and therefore the evaluator is left with no choice but to ignore them. The discussion on how to treat systematic uncertainties continued in the session on ultra-precise half-lives for ground states and isomers (Subsection 5.1.), which lead to Action 16.

4.7. Mixing derived gamma-ray energies with measured energies from experimental studies

Early in the discussion, McCutchan stressed that this suggestion of assembling mixed energy files would be inconsistent and highly ill-advised. As stated in this clear manner, participants agreed to reject such an approach.

5. PROPOSALS

5.1. Ultra-precise half-lives for ground states and isomers: evaluation issues *(B.Singh, McMaster University, Hamilton, Canada)*

Two points were discussed in this presentation:

1) How to evaluate data for half-lives of ground states and long-lived isomers when total (statistical and systematic) uncertainties cited in the literature are less than 0.01% (termed here as ultra-precise).
2) Justification for assigning minimum total uncertainty of 0.01% on such half-lives as specified in the guidelines by A.L. Nichols and Balraj Singh, Appendix A in Summary Report of an IAEA Technical Meeting of the International Network of NSDD Evaluators, IAEA report INDC(NDS)-0687, August 2015.

Until approximately 1990, the lowest half-life uncertainty was recommended as being ±0.1%, as given by 1990Ho28 evaluation in *Pure Appl. Chem*. **62** (1990) 941, and C.W. Reich, R. Vaninbroukx, IAEA-TEC-DOC-336 (1985) 279. Since then, measurement and analysis techniques have improved, on which basis ±0.01% minimum uncertainty was assigned in 2015. Recent publications 2018Po10 in *Appl. Radiat. Isot*. **40** (2018) 171 for half-life of ^{99m}Tc, and 2015Be07 in *Phys. Lett. B* **743** (2015) 526 for half-life of ^{222}Rn cited uncertainties of ±0.003% and ±0.0044%, respectively, that have prompted this investigation of defining a minimum uncertainty of ±0.01%.

As the most common resources for evaluated isotopic half-lives, current versions of the ENSDF, DDEP and NUBASE databases were searched in their entirety to list cases where evaluated uncertainties were <0.01%. A total of 17 cases were found in ENSDF, 7 in DDEP and 21 in NUBASE, out of which data for 15 nuclides were taken from the ENSDF database. All these half-lives were re-evaluated with the result that assigned uncertainties in the databases were too low to justify their adoption, and that in each of these cases (opinion of Balraj Singh), the uncertainties should have been larger than ±0.01%. He has also looked through journal articles on half-life measurements in the previous approximate four years, and has not found any measurement with less than ±0.01% uncertainty with the exception of the above two articles (2015Be07 and 2018Po10). An unrealistic and erroneous total uncertainty of ±0.0012% has been assigned for the half-life of ^{210}Po in all of the databases, and in the ENSDF database for the last 40 years or so. Balraj re-evaluated the half-life of ^{210}Po based on all the available measurements from 1912 to 1964, and came up with an uncertainty of ±0.036%, together with a recommendation that this half-life needs to be re-measured. Similarly and in the presence of the ultra-precise half-life reported by 2015Be07, he also re-evaluated the half-life of ^{222}Rn which takes into consideration relevant data from 1923 to 2015. The evaluated result had an uncertainty of ±0.021% in contrast to ±0.0044% in 2015Be07.

Even though half-lives of nuclear ground states and long-lived isomers (>1 s) are basic to nuclear physics and applications, our world does not yet seem to have a consistent set of evaluated half-lives with realistic uncertainties throughout the chart of known nuclides. There would appear to be a need to create a database for half-lives of ground states and long-lived isomers based on complete compilations of all the available literature. Careful analyses of the uncertainties would be required under the umbrella of a reputable organization so as to supply recommended values that possess meaningful uncertainties, along with regular exercises to consider newer data in order to update the database whenever required.

Much debate ensued as to what constituted a realistic minimum total uncertainty for half-lives, along with disagreements concerning any rounding-off process and what would be a sensible number of significant figures. Quite clearly, this debate needed to continue in a more focused form with respect to attempting to define the limitations in the many and varied measurement techniques, as well as the complications that can ensue in consideration of the systematic uncertainties. Roberto Capote was also requested to provide the network participants at some future date with an updated comprehensible statement concerning the handling of nuclear data uncertainties within the cross-section community (more particularly, systematic uncertainties and their overall impact).

5.2. **Labelling band configurations -** Action 40 from NSDD network meeting, 2017 *(F.G. Kondev, ANL, USA)*

The original action was identified with the possibility of defining acceptable and all-encompassing band configurations for at least the ground state and isomers when J^{π} are known, These properties can be important when undertaking systematics arguments to resolve J^{π} assignments, and are essential for various applications associated with other nuclear data (e.g., β^{-} and antineutrino spectra).

Kondev (ANL) and Kibedi (ANU) have considered the relative merits of the nomenclature for spherical nuclei (shell-model notation) and deformed nuclei (Nilsson-level notation). The shell-model notation uses only the valence particles (holes) along with spin-parity balances to create the desired labelling. As a reasonably basic single-particle model, the Nilsson approach has been particularly successful when applied to nearly all deformed nuclei, and furthermore produces a simpler layout than the shell model when representing more complicated band structures. A format for presenting the shell-model and Nilsson model configurations was presented and this format was accepted. A discussion ensued on whether evaluators are required to provide configurations for all relevant levels. The consensus was that the configuration should be provided when the authors include such information in their article or when the evaluator has enough expertise to assign configurations to levels.

6. COMPUTER CODES

Participants provided information on their use of the ENSDF suite of programs, and also their own relevant code development work. As noted in some specific short subsections below, more detail can be found in particular relevant entries within Annex 6.

6.1. **ALPHAD and ALPHAD_RadD codes** *(S. Singh, S. Kuma and B. Singh, Akal University, India and McMaster University, Canada)*

Modifications made to the original ALPHAD code have led to the new ALPHAD_RadD code, which allows automatic deduction of radius parameter (r_0) by means of our 2019 updated input file of radius parameter (r_0) for 188 even-even alpha emitters. See also relevant entry in Annex 6.

6.2. **Current status of J-GAMUT code** *(B. Singh, McMaster University, Canada)*

Between June 2017 and March 2019, many modifications and additions were made by Michael Birch, following extensive feedback from E.A. McCutchan, S. Pascu, and C. Nesaraja. The code now does not stall when creating an intermediate file in cases where extremely large level schemes are involved. Some attempts have also been made to make the handling of closely lying energy levels easier. However, it is important for the user to be aware of the limitations of the code. A revised version was circulated to the network on 2 April 2019 for further testing and use. Balraj also demonstrated the workings of the code on 12 April 2019 at the NSDD Evaluators' network meeting, using Pt-190 data file as an example.

Queries and comments should be sent to Balraj Singh at the following email address: balraj@mcmaster.ca

6.3. **GABS code** *(T. Kibédi, ANU, Australia)*

As part of the effort to modernise particular computer codes for application in ENSDF evaluations, the GABS program to calculate decay scheme normalisation factors has been re-written to enhance functionality and improve the user interface of the code. This program was originally written by

Eddie Browne (LBNL) to calculate the Normalisation (NR) and Branching Ratio factors (BR) from the total intensity of the electromagnetic radiations feeding the ground state or within a transition cascade.
E. Browne, *Nucl. Instrum. Methods Phys. Res.* **A249** (1986) 461; erratum, *ibid* **345** (1994) 215.

Significant effort has been expended to improve the uncertainty propagation of the code, and the program manual has been re-written with additional examples to aid the user. A new version of GABS is expected to be released in the near future. See also relevant entry in Annex 6.

6.4. ENSDF codes at NSCL/MSU *(J. Chen, NSCL/MSU, USA (via conference link))*

JAVA-Ruler is under development to replace an old FORTRAN code that lacks maintenance and capability to address the uncertainty propagation of large and asymmetric uncertainties.

Other ongoing work is associated with a ConsistencyCheck code to replace the PANDORA code, and a KeynumberCheck code to search the NSR database in order to find and locate all keynumbers in datasets that have format errors, are irrelevant to the nuclides/mass-chains, or are non-existent. See also relevant entry in Annex 6

6.5. Proposed data format for inclusion of atomic radiations in ENSDF *(T. Kibédi, ANU, Australia)*

Network participants were presented with a suitable data format to include both Auger-electron and X-ray data in ENSDF (see also relevant entry in Annex 6). Full agreement was reached to go ahead with adopting the proposed ENSDF format for these atomic decay data.

A new computer code is also being developed (NS_RadList), which is designed to calculate the full atomic radiation spectra very quickly based on the ENSDF file as input. This approach will allow evaluations of the atomic radiation spectra up to the point when atomic vacancies reach the valence shells, or no other atomic transition is allowed. See also relevant entry in Annex 6.

6.6. BetaShape code *(X. Mougeot, LNHB, CEA-Saclay, France)*

Developments continue with the aim of releasing a new version of the BetaShape program by June 2019 so that tests can be undertaken by data evaluators. A review of the log*ft*-values for a selection of well-defined transitions will also be carried out in collaboration with McMaster University and TU Dresden. This review will be used to validate the code in view of possible adoption by the NSDD Evaluators' network at the Nuclear Data Week in November 2019. See also relevant entry in Annex 6.

6.7. PABS *(S. Basunia, LBNL, Berkeley, USA)*

PABS: computer code to normalize relative branching in absolute scale and calculate realistic uncertainties.
Written in JAVA, PABS is a computer code for the normalization of emission probabilities and calculation of realistic uncertainties. The PABS manual contains instructions on the use of the code, with the algorithm and an example test case (see D.S. Caron, E. Browne, E.B. Norman, LBNL report LBNL-2623E (2009)). A few additional examples were also shown during the course of a presentation to display the capabilities of this code.

6.8. NSR_refs_manager package *(A. Rodionov, PNPI, Russia)*

The program package Nuclear_refs_manager is a software manager of references for publications in nuclear physics which have NSR keynumbers that follow the format of the Nuclear Science References (NSR) bibliographic database. This code is useful for maintaining a collection of publications, i.e. articles, abstracts, private communications, etc., on a PC or laptop, and works on the operational systems Linux (X Window) and MS Windows. For more details see the presentation given at the ENSDF Codes meeting (IAEA report INDC(NDS)-0774).

7. PROBLEMS AND QUERIES

The opportunity was taken at this stage of the network meeting for mass chain evaluators to air difficulties they have experienced in their studies, formulation and generation of ENSDF data files.

7.1. Half-life of ^{67}Fe ground state, and normalization factor for ^{67}Ga EC decay *(D. Yang, Jilin University, People's Republic of China)*

$T_{1/2}$ of ground state ^{67}Fe has been measured by means of two methods: time dependence of β-particle decay (2011Da08 (0.304(81) ms), 2003So21 (0.394(9)) ms), and time dependence of γ-ray decay (2009Pa16 (0.416(29) ms). The most recent measurement of 2011Da08 disagrees with the other two studies, and possesses the larger uncertainty. Also, the fitting procedure of the decay curve in 2003So21 is unclear, and the half-lives of the daughter and granddaughter nuclides may have been defined as fixed parameters. Since $T_{1/2}$ measurements via the detection of β particles are more complex and exhibit somewhat larger uncertainties, the decision was taken to adopt the $T_{1/2}$ measured by means of the γ-ray decay of 67Fe (2009Pa16). Attendees at the NSDD Evaluators' network meeting were in agreement with this particular choice of preferred half-life data.

The absolute intensities of the internal conversion electrons and the total ICCs calculated by means of the BrIcc program can be used to determine the absolute intensities of the γ rays. According to NSDD discussions, even if there are direct measurements of the absolute intensity of the γ ray, the conversion-electron and ICC data are also reliable and should be adopted as well (e.g., see ^{67}Ga EC decay).

Recommendation to evaluators: do not attempt to derive normalisation factors from the available data if such data are seriously doubtful/inadequate. Ensure that your comments define the existing problem, and specify the important measurements still required.

7.2. Possible uncertain levels from gamma-ray coincidence data *(J. Timar, MTA Atomki, Hungary)*

Sec. note: problems presented and proposal discussed – following also prepared as draft Action 19 to address the existing problem:

a) Uncertain energy levels and gamma-ray emissions

Consider the generation of ^{101}Pd from a heavy-ion reaction in which many new levels can be formulated on the basis of coincidence links between the gamma rays, as well as energy and intensity balances. Several of these levels decay only by means of one weak transition, and either do not have populating gammas, or are populated by another weak transition. According to my observations (Timar), these level and gamma placements are uncertain. Furthermore, coincidences between the gamma rays are not published in sufficient detail, except a few example spectra; therefore, both the published levels and placements of the gamma rays in the level scheme are the only "primary data". If the energy and intensity balances are fulfilled, evaluators have to accept these data according to the following principles.

Questions:
1) Should the evaluator adopt these levels as certain or uncertain levels?
2) If they are adopted as uncertain levels, should they also be marked in the reaction data set as uncertain?

Preferred solution would be to mark them in the Adopted levels, Gammas file, as uncertain levels, but in the Reaction data set as certain fully accepted levels.

b) Unrealistically small gamma-ray energy uncertainties

As before, consider the generation of ^{101}Pd from heavy-ion reaction experiments, and spectral studies by means of a gamma-ray detector array. A majority of the observed gamma rays are assigned an energy uncertainty of 0.1 keV (even weak gammas) – such an uncertainty can be unrealistically small for this type of experiment. However, except for three of the gamma-ray emissions, these transitions fit quite well to the level scheme derived via a least-square fit, with GTOL giving $\chi^2/n < 1$ when these uncertainties are adopted. The method of gamma-ray energy determination is not discussed, so we can assume that the authors used a regular method with the usual form of normalization.

Questions:
Should the evaluator
a) keep the original uncertainties (except for two gamma rays) both for the Reaction data set and for averaging in the Adopted data set,
b) keep the original uncertainties for the Reaction data set, but use realistic values for the averaging in the Adopted data set, or
c) use more realistic values for both data sets?

Preferred solution would be (b) - keep the original uncertainties for the Reaction data set, but use realistic values for averaging in the Adopted data set.

7.3. Evaluation test cases: (1) proton decay, and (2) ambiguous references *(A. Negret, IFIN-HH, Romania)*

a) Proton decay from ^{58}Cu to ^{57}Ni

The previous evaluation of ^{57}Ni contains eleven forms of dataset (and not proton decay). While scanning for new publications, two papers were found in which proton decay from an excited state in ^{58}Cu was discussed: 2002Ru09 and 1998Ru01 (see also Figure from 2002Ru09). Therefore, a new dataset was created for this decay mode. However, another paper referring to proton decay from Gamow Teller states in ^{58}Cu was later encountered (2003Ha43).

Issue

"Proton decay of ^{58}Cu" occurs from the GT states (2003Ha43). The issue discussed in 2003Ha43 is of interest: they used a ^{3}He beam and detected tritons with the Grand Raiden spectrometer at RCNP. They also observed protons and gammas in coincidence with protons, so they can discuss the decay of the Gamow Teller states in ^{58}Cu via proton and gamma decay. But what is the difference between "proton decay" (as discussed in 2003Ha43) and a normal reaction with an additional proton in the exit channel?

Opinion/solution

Negret: despite the discussion of 2003Ha43, my interpretation was that this second case is not "proton decay" but simply a ^{58}Ni(^{3}He,tp-γ)^{57}Ni reaction. So an additional dataset was added that includes no discussion about "proton decay".

b) Including references that contain minimal information

The following note was received from the reviewer of my ^{57}Mn evaluation: "should 2008LuZZ be included?" 2008LuZZ occurs in conference proceedings, and is an overview of the PRISMA-CLARA experiments from Legnaro National Laboratories. And the only reference to ^{57}Mn in 2008LuZZ states that the first excited level is at 83 keV when discussing systematics and general Shell Model calculations. But not clear if the value comes from their experiments, or from somewhere else.

Issue

Should 2008LuZZ be included in the evaluation? To what extent should we include references that have only an extremely small connection to the structure of a certain nucleus, and do not contain any new information.

Opinion/solution

Negret: 2008LuZZ does not possess any new information regarding the structure of ^{57}Mn. Hence, decided not to include this particular reference in the evaluation of ^{57}Mn.

Nevertheless, 2008LuZZ was used in the evaluation of the neighboring ^{57}V nucleus, and there is clear evidence that the level energies of ^{57}V were measured at Legnaro National Laboratories.

7.4. Normalization record and TAS issues in ^{105}Ru *(S. Lalkovski, University of Sofia, Bulgaria)*

Issues with the gamma-ray normalization record and implementation of TAS measurements into the beta-decay dataset were reported and discussed. ^{105}Ru is a neutron-rich nucleus located next to the last stable ruthenium isotope (^{104}Ru), which poses difficulties in production such that few datasets are available. The most recent ENSDF study of the structure and decay data of ^{105}Ru was published in 2005 (2005De52). Since then very little has been added, but many ambiguities remain unresolved.

Over the years, ^{105}Ru has been produced by the (d,p) reaction, β^- decay, thermal neutron capture and heavy ion reactions. A detailed level scheme was established from a (d,p) study (1971Fo01), with a strongly populated ground state. Five years later, a lower energy level was observed in the same reaction and adopted as the ground state (1976Ma49) – thus, the strongly populated lowest energy state was defined as an excited state with the ground state some 20 keV below, and this interpretation was embraced by the spectroscopy community. 1975Su02 is the main beta-decay reference in 2005De52, whereby a 20.55-keV γ transition is reported to feed the ground state. These authors also state that the intensity of this relatively low-energy transition was measured, although no spectrum was presented as proof of existence. Moreover, the value of 20.55 keV appears to come from an earlier article on thermal neutron capture (1974Hr01) in which the energy and intensity of the 20.55-keV transition was deduced; however, this transition resides in the X-ray region, and appears as an unresolved doublet. The article does not contain details of the spectral analysis, which makes evaluation difficult. A later article describes studies performed at the same facility by a different team in which the same gamma ray was observed of significantly different intensity (1978Gu14). Given that no direct feeding was observed from the $½^+$ n-capture state, this allowed both teams to perform intensity balance calculations to deduce the 20.55-keV total internal conversion coefficient. This low-energy transition is highly converted and a precise intensity is of crucial importance for the balance of the level scheme, and hence the determination of the normalization factor for the ^{105}Tc β^- decay scheme.

The other issue related to the gamma-ray intensity normalization is the absolute intensity of the 143-keV transition. As measured by 1981Di01, this value was used in the previous A = 105 evaluation deduced from ^{105}Tc β-decay populated from SF (2005De52). Again no spectra are presented, and no fragment separation was performed which makes the assignment of the 143-keV γ transition to ^{105}Ru difficult (separation was only made on the basis of $T_{½}$). We now know that there are ~20 transitions at that energy in the light fission products mass peak that depopulate states with $E_{level} < 1$ MeV. Unfortunately, level scheme normalization by means of RI(143-keV γ) does not converge with the ΣTI_{tot}(GS) = 100% approach described above.

TAS measurements were published in 2013 that further complicate the picture (2013Jo02). Beta-feeding intensity data were derived from the adoption of available ENSDF-based definitions of the energies of states with particular spin and parity, and the intensity of the GS-GS transition which is highly questionable. A further complication when trying to incorporate such measurements into the present beta-decay dataset is the low-energy resolution of the TAS spectrometer. Correspondence between the experimental levels of ^{105}Ru in ENSDF and the 40-keV TAS bins can be made for the higher energy levels, where level density is low according to ENSDF. However, at low energies, the ^{105}Ru level density in ENSDF is higher which makes unambiguous correlation between the two datasets impossible to achieve. Many levels that are directly fed by the parent in the present evaluation appear not to be so from the TAS measurements. Further discussions with TAS teams and within the NSDD Evaluators' network are needed to resolve the difficulties of merging TAS with β-decay data.

Recommendation to evaluators: if problems arise in bringing TAGS decay data together with existing gamma singles and beta-gamma and gamma-gamma coincidence to formulate a consistent decay scheme, include all data in ENSDF. But maintain the two forms as separate datasets and (in general and if possible) derive the recommended decay scheme from regular gamma-ray spectroscopic studies

7.5. Normalization factor for decay involving transient equilibrium *(C.D. Nesaraja, ORNL, USA)*

A study has been undertaken of the 34.4 h ^{137}Ce isomer which emits a 254-keV γ to the 9.0 h ^{137}Ce gs which then undergoes beta decay to ^{137}La with the emission of a 447-keV γ. 1975He20 provides a ratio of the intensities of both gammas in this transient equilibrium process, although these authors were not clear as to whether the equilibrium correction factor was applied to their ratio.

2007Br03 ENSDF database evaluators used the equilibrium correction factor when deducing the normalization factor from the work of 1975He20. This issue has been discussed at length between Murray Martin and Libby McCutchan, and upon further scrutiny into the 1975He20 work, Martin suggested that the transient equilibrium ratio provided by the authors is ambiguous. This factor must have already been taken into account to reproduce the authors' absolute intensities.

The problem arises that, in a more recent paper (2012To09), the authors have used the absolute values from ENSDF that overcompensate the correction factor. This could be an issue, if indeed the previous evaluation has overcompensated the equilibrium correction factor, because this overcompensation will be used by future researchers (as in the case of 2012To09), and will affect further analyses of such experimental data.

This issue was presented at the 2019 meeting of the NSDD Evaluators' network, and is currently being discussed further by M. Martin, S. Basunia and C.D. Nesaraja.

7.6. GABS: %I_γ calculation when I_γ normalization (NR) is known *(N. Nica, Texas A&M University, USA)*

GABS calculates simultaneously the absolute γ-ray intensities and decay-scheme normalization factor (NR) for converting relative γ-ray intensities to absolute values per 100 decays of the parent nucleus. The program requires a modified *ens* database file as input, with absolute γ feeding of the ground state and associated uncertainty given on the normalization record (columns 42-49 and 50-51, respectively), and each of the γ rays feeding the ground state marked directly with an X or Y in column 79 of the appropriate G records. Output consists of the following: a report file that lists the calculated normalization factor (NR) and the resulting absolute %I_γ determined for each γ ray possessing a relative I_γ value; and the *ens* file with the NR value and ΔNR uncertainty inserted into the normalization record (columns 10-19 and 20-21, respectively), and the %I_γ values contained within the G continuation records.

The NR value can be determined by a different procedure than that based on the γ feeding of the ground state as used currently by GABS. Under such circumstances, GABS should accept such known NR values as an input parameter, and calculate only the %I_γ values. Since this possibility has not been implemented in GABS, the evaluator should use the NR value in the *ens* file if already known, and run the GTOL code in order to obtain the absolute γ feeding of the ground state; and subsequently run GABS with the standard input as described above. However because GABS follows a different procedure to recalculate NR than that used initially, the recalculated NR and ΔNR uncertainty differ from the NR and ΔNR values obtained earlier. Finally, because GABS uses the recalculated NR for the $\%I_\gamma$ values and their uncertainties, these also differ from the more exact data. Although the differences are generally not great, they do differ, as shown in these examples:

^{147}La β^- decay to ^{147}Ce, 117.7γ, $\%I_\gamma$ = **18.3 *25*** (exact), compared with **18 *3*** (GABS),

^{147}Ba β^- decay to ^{147}La, 167.4γ, $\%I_\gamma$ = **15.9 *16*** (exact), compared with **16 *4*** (GABS).

Consequently, GABS should be corrected to produce the more exact values. Based on this analysis, Nica proposed modifying GABS to allow two different calculational modes:

1). calculate NR and $\%I_\gamma$s (actual);

2). allow NR value as input, and calculate $\%I_\gamma$s only if NR has been determined by a different procedure (to be implemented).

Another observation is that GABS does not delete the $\%I_\gamma$ continuation records pre-existing in the input file from the *ens* output file, but rather they are maintained within the output file together with the newly calculated data. If the code is run several times, the accumulation of pre-existing $\%I_\gamma$ continuation records should be deleted manually by the evaluator in an operation that is time consuming. Therefore, we also propose:

3). instruct GABS to delete pre-existing $\%I_\gamma$ values, and replace them with the newly calculated data, in a similar manner to what is done by BrIcc code.

Recommendation: Kibedi (ANU) to consider proposals as outlined above by Nica. **Sec. note**: Action 27 completed in May 2019 - option is now included in GABS.

7.7. PANDORA code and ENSDF CONSISTENCY CHECKING: modifications to give listings of both "γs from level" and "γs to level" - Action 4 from NSDD network meeting, 2017 *(N. Nica, Texas A&M University, USA)*

PANDORA and ENSDF CONSISTENCY CHECKING codes are both very useful in the assignment of J^π values during the course of ENSDF evaluations. The most common approach involves the "bottom up" procedure which starts from the known J^π value of the ground state, and for each successive higher level with known multipolarities for γs depopulating a level, measured L values, and any other information helping in the J^π assignment of the parent level (including all previously assigned J^π values of the lower daughter levels populated by the decay of the parent level). Actual J^π values are then determined by using J^π conservations laws.

The most useful output of both codes in this respect is the *gle* listing, which gives the energy and multipolarity of each γ transition decaying from a certain parent level, together with the energy and J^π value(s) of the lower daughter levels populated by those γ transitions. An example is shown below that lists all γs decaying from the 954.3-keV ($17/2^-$) level:

"γs from level" output (gle)

166.7 2	23.00	8.00	(D+Q)		**954.3 ($17/2^-$)**	787.6 ($19/2^-$)
169.0 3	15.00	8.00	(D+Q)		**954.3 ($17/2^-$)**	786.1 ($15/2^+$)
343.5 3	15.00	8.00	(E2)	0.0308	**954.3 ($17/2^-$)**	611.0 ($13/2^-$)
512.7 2	100.00	8.00	D+Q		**954.3 ($17/2^-$)**	441.6 ($15/2^-$)

The evaluator is recommended to make use of the minimum number of conditions that determine the J^π value(s) to be adopted for each parent level. One can see that (D+Q) 166.7-keV γ to ($19/2^-$) and (E2) 343.5-keV γ to ($13/2^-$) determine ($17/2^-$) for the 954.3-keV level. Measured multipolarities of the 169.0-keV γ and 512.7-keV γ transitions for this J^π assignment are made redundant, and they become available as arguments for the J^π assignments of the 786.1- and 441.6-keV daughter levels. One can also combine this type of pattern with the "up to down" procedure to look for arguments arising from higher energy levels, for which the inverse "γs to level" listings are to be generated by the codes. Both types of listing ("γs from level" and "γs to level") can be used in a combined manner to manage the existing arguments for J^{π} assignments.

Consequently in support of Action 4 from the NSDD network meeting of 2017, our proposal is to instruct *PANDORA* and *ENSDF CONSISTENCY CHECKING* codes to generate the corresponding "γs to level" inverse listings that for our example would be based on the 954.3-keV level:

Proposed "γs to level" output (to be named)

253.5 1	43.00 5.00	(D)		1207.7 ($19/2^+$)	**954.3 ($17/2^-$)**
436.6 1	100.00 11.00	(E2)	0.01508	1390.8 ($21/2^-$)	**954.3 ($17/2^-$)**

Most importantly, the evaluator should also only use the minimum number of arguments when assigning J^{π} values (as recommended by ENSDF policies) in order to make extra "redundant" arguments available for other assignments.

Recommendation: Jun Chen (MSU) to consider proposals as outlined above by Nica.

7.8. Transition Strengths *(S. Basunia, LBNL, Berkeley, USA)*

Observations concerning transition strengths

(a). A table for Recommended Upper Limits (RUL) is given within the General Policy statements of *Nuclear Data Sheets*. RULER output generates warning messages, such as "Discrepancies with RUL on new record: BM1W = 2.6 *4* exceeds RUL(IV) = 2 by 1 to 2 sigma", when the calculated transition strengths exceed the RUL. At what level of discrepancy should the evaluator take serious note of these messages?

Alejandro Sonzogni recommended assessments of the available transition strength values by means of the NuDat "Levels and Gammas Search" tab in order to see the range of transition strength in nearby masses. This discussion brought to light the fact that a footnote on M1 transitions strengths should be applied to account for large M1 values within magnetic rotational bands. Also acknowledged that the RUL table should be revised in the near future.

(b). Adopted Gammas – observed that transition strengths have been quoted from Coulomb Excitation with comments "from measured B(E2)" of a previous evaluation. Are there any good reasons for this approach?

After some discussions among NSDD network members, a recommendation was made preferably to obtain calculated transition strengths from RULER for good accuracy and consistency, rather than quote from the Coulomb Excitation dataset.

7.9. Normalizing decay schemes *(E.A. McCutchan, BNL, USA)*

Exercises on how to normalize complicated decay schemes were circulated to all interested participants; however, they were not discussed at the session due to lack of time.

8. RECOMMENDATIONS AND CONCLUSIONS

The 23rd meeting of the IAEA International Network of Nuclear Structure and Decay Data Evaluators was held at IAEA Headquarters, Vienna, Austria, and attended by 23 participants from thirteen countries along with IAEA staff. Both administrative and technical issues were addressed throughout the course of the meeting. Representatives from the various data centres presented their biennial progress reports, and all active members of the network reported on their work as related to ENSDF. A few additional attendees who are not part of the NSDD evaluators' network presented information related to their research interests of direct relevance to NSDD activities.

A proposal was accepted to recognize the Variable Energy Cyclotron Centre, Kolkata, India, as the new ENSDF Data Evaluation Centre in India (replacing IIT, Roorkee). Further steps to assure the quality and consistency of the databases were also taken, and a detailed set of actions was produced covering the time period up to the next network meeting in 2021. Technical improvements to facilitate the work of evaluators were discussed, with special emphasis placed on improvements to and maintenance of various analysis codes. Related on-going studies associated with specific IAEA-NDS projects were reviewed, along with other highly-relevant code development work.

The roundtable discussion on present and future challenges of the NSDD network highlighted the need for enhanced collaboration among all the network evaluators to meet the increasing demands for up-to-date and reliable ENSDF data. Collaboration should be sought in mass chain evaluations, code developments, and taking on assignments proposed at these meetings.

The main challenges concerning ENSDF policy which were extensively discussed at the meeting include increased consistency within ENSDF evaluations and a more rigorous treatment of experimental uncertainties. A consensus was reached that the latter topic should be addressed in consultation with particle data and reaction data colleagues. Consistency within ENSDF evaluations remains a topic of significant debate that will require further discussions and implementation of more thorough policies.

The biennial IAEA-ICTP workshops held at ICTP, Trieste, Italy, were acknowledged to remain of value as an educational tool rather than publicity in seeking and identifying new ENSDF evaluators. A desired aim of recruitment via such a well-focused workshop had been singularly unsuccessful over recent years, and as a consequence other workshop-related possibilities had been proposed and discussed. These other potential possibilities should be explored over the course of 2020/2022.

IAEA-NDS staff will pursue an invitation to hold the 24th Technical Meeting of the International Network of Nuclear Structure and Decay Data Evaluators at ANU, Canberra, Australia, in the spring of 2021.

23rd Technical Meeting of the

Nuclear Structure and Decay Data Network

8 - 12 April 2019
IAEA, Vienna
M6, Bldg. M

ADOPTED AGENDA

Monday, 8 April

08:00 – 09:00	**Registration (IAEA Registration Desk, Gate 1)**
09:00 – 09:30	**Opening Session** Welcoming address (M. Denecke, DIR/NAPC) Administrative matters Election of Chairman and Rapporteur Adoption of the Agenda
09:30 – 10:30	**Actions Review**
10:30 – 11:00	*Coffee break*
11:00 – 12:30	**Actions Review** cont'd
12:30 – 14:00	*Lunch*
14:00 – 16:00	**Reporting:** 10' unless indicated otherwise 1) USNDP/NNDC (20') 2) IAEA (20') 3) Bay Area (LBNL + UCB) 4) TUNL 5) ANL 6) MSU 7) ORNL 8) TEXAS A&M (15') 9) Canada (15') 10) Romania 11) Hungary 12) Bulgaria 13) India (15') 14) China Jilin 15) China CNDC 16) Japan 17) Australia 18) Russia
16:00 – 16:30	*Coffee break*

16:30 – 18:00 **Reporting** cont'd:

Horizontal, XUNDL, Dissemination

19) XUNDL
20) NUDAT
21) DDEP
22) LIVECHART/MEDICAL PORTAL/DECAY PORTAL

Tuesday, 9 April

09:00 – 10:30 **Data Centres** (P. Dimitriou): 20'
ICTP Workshop (P. Dimitriou): 10'

23) NSR (B. Pritychenko) 10'

Spill over from Reporting session

10:30 – 11:00 *Coffee break*

11:00 – 12:30 **Organizational Review/Policies/Procedures** (E.A. McCutchan): 90'

12:30 – 14:00 *Lunch*

14:00 – 16:00 **Proposals / Items from Evaluators:**

1. Ultra-precise half-lives for ground states and isomers in literature, and evaluation issues (B. Singh) 30'
2. Labelling configurations (F. Kondev) 30'

16:00 – 16:30 *Coffee break*

16:30 – 18:00 **Round-table discussion**

- Consistency in ENSDF: (a) Adopted static moment (b) neutron and/or charged-particle resonances, and associated gamma-ray data in Adopted data sets (c) Eg and Ig values, and levels in Adopted datasets
- Best recommended gamma-ray energies for adopted data sets; and alpha-energies for decay data sets
- Carry over of A2, A4, DCO, Conversion coefficient data from individual data sets to an Adopted data
- How to deal with results from GOSIA least-squares fit analysis in Coul. ex
- Publication of mass-chain articles in NDS: verbatim copy of material from previous mass chains
- Rounding-off and averaging policies
- How to handle systematic uncertainties in measurements in averaging
- Mixing derived gamma-ray energies with measured energies in experimental papers

19:00 ***Dinner in a Restaurant (see separate information)***

ANNEX 1

Wednesday, 10 April

09:00 – 10:30 **Proposals / Items from Evaluators** cont'd**:**

3. Final atomic data format (T. Kibedi) 15'
4. Continuous Data in ENSDF (X. Mougeot, A. Sonzogni) 30'
5. NSEI Database (A. Negret) 15'
6. Logft review project (S. Turkat) 20'

10:30 – 11:00 *Coffee break*

11:00 – 12:30 **Discussion on NSDD network: present and future challenges and how to address them?** (P. Dimitriou)

12:30 – 14:00 *Lunch*

14:00 – 16:00 **Discussions on current challenging topics in ENSDF evaluation** (Coordinator: E.A. McCutchan**)**

- 14:00-14:15 Transition strengths – S. Basunia
- 14:15-14:35 Uncertain Levels/Gammas and Highly precise energies – J. Timar
- 14:35-15:05 TAGS and normalization – S. Lalkovski
- 15:05-15:30 T1/2 and %Ig averaging – D. Yang
- 15:30-16:00 GABS and PANDORA suggestions – N. Nica

16:00 – 16:30 *Coffee break*

16:30 – 18:30 **Discussions on current challenging topics in ENSDF evaluation cont'd**

- 16:30-16:50 Proton decay and ambiguous references – A. Negret
- 16:50-17:10 137Ce EC decay – C. Nesaraja
- 17:10-17:30 DCO ratios and minimum uncertainty – J. Tuli
- 17:30-18:00 Exercises in Decay Data Normalization – E.A. McCutchan
- 18:00-18:30 Ideas for increasing efficiency in evaluation – All

Thursday, 11 April

09:00 – 09:30 Report on IAEA ENSDF Codes Meeting Dec. 2018 (P. Dimitriou)
09:30 – 10:30 GABS/BRICC (T. Kibedi)

10:30 – 11:00 *Coffee Break*

11:00 – 11:30 Alphad_RadD, Alphad (S. Singh)
11:30 – 12:00 J-GAMUT (B. Singh)
12:00 – 12:30 WebRadlst (A. Sonzogni)

12:30 – 14:00 *Lunch*

14:00 – 14:30 Beta-Shape (X. Mougeot)
14:30 – 15:00 ENSDF Editors (V. Zerkin)
15:00 – 15:30 NSR_refs_manager package (A. Rodionov)

15:30 – 16:00 *Coffee break*

16:00 – 16:30 PABS (S. Basunia)

16:30 – 17:00 Consistency Check / NSR Check (Jun Chen - WebEx)
17:00 – 18:00 JAVA-RULER/Python (Jun Chen-WebEx, F. Kondev)

Friday, 12 April

09:00 – 10:00 **Round-table discussion** cont'd
Spill-over from earlier sessions
Proposals for 24th NSDD meeting

10:00 – 12:30 **Approval of Action List / Minutes**

Coffee break in between

12:30 **Closing of the Meeting**

23rd Technical Meeting of Nuclear Structure and Decay Data Evaluators

8 – 12 April 2019
IAEA, Vienna

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ANNEX 3

EVALUATION DATA CENTRES AND MASS CHAIN RESPONSIBILITIES

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A-Chain Evaluation Responsibility

Centre	Mass Chains
a.US/NNDC	45-50,60-73(ex 62,64,67),82, 84-88,94-97,99,113-116,136-146(ex 140,141),150,152-165 (ex 153,155,157,158,160,164),175, 180-183,189,230-240,>249
b.US/NDP	241-249
c.US/LBL	21-30,81,83,90-93,166-171, 184-193 (ex 185,188-190),210-214
d.US/TUNL	2-20
e.US/ANL	109,110,176-179,199-209
f.US/MSU	31-44

Centre	Mass Chains
g. TAMU	140,141,147,148,153,155,157,158,160
h. Russia/StP	130-135
i. PRC-Beijing	51,62,195-198
PRC-Jilin	52-56,67
j. India	215-229
k. Japan	120-129
l. Canada	1,64, 74-80,89,98,100, 149,151,164,188,190,194
m. Australia	172-174
n. Hungary	101-105
o. Romania	57-59,117-119
p. Bulgaria	106-108,111,112

ANNEX 4

LIST OF ACTIONS AND EXTENDED PROCEDURES

On-going and Incomplete Actions – still to be fully implemented Require biennial consideration				Status 8 April 2019
No.	**Responsible**	**Reason**	**Action**	
1 (3)	IAEA-NDS	Maintain up-to-date information on the network.	Review, modify and correct contents of IAEA report INDC(NDS)-421. **Continuous** **Original update planned by mid/late 2015**	**On-going**: Dimitriou has modified and updated IAEA report INDC(NDS)-421 to issue as IAEA report INDC(NDS)-0700. **Dimitriou to finalise for release by June 2019**
2 (8) + (25) + [new]	ANU NNDC-BNL	Quantification of Auger electrons and X-rays. Data in agreed format within ENSDF	Develop analysis codes to generate detailed/suitable format for Auger-electron and X-ray data. Implement new format – see Subsection 4.2. of IAEA report INDC(NDS)-0733.	ENSDF format for atomic data has been agreed, and now requires implementation – **three linked actions carried forward together. Remains in progress**
3 (17) + (36) + [new]	ORNL (Martin)	Policy implementation: check and modify *Guidelines for Evaluators*.	Implement in *Guidelines for Evaluators*: • unique gamma transitions should be assigned intensities of 100 (see Kuwait network meeting, IAEA report INDC(NDS)-0635, 2013, Action 65); • rewrite text associated with consideration of high-spin J^{π} values as proposed by original authors (guidelines incorrectly written compared with policies); • neutron-rich ground states - policy concerning half-life limits and use of "?" in decay modes; • inclusion of beta-delayed neutron emission branch in β^{-} decay datasets (see IAEA report INDC(NDS)-0733, Subsection 4.1.)	Various agreed additions as well as modifications to *Guidelines for Evaluators.* **Action now transferred to ORNL: ensure *Guidelines for Evaluators* agree with NDS policies** (implementation of changes in guidelines (Murray Martin))

First column: number in brackets is the action number from the previous NSDD network meeting (see IAEA report INDC(NDS)-0733)

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LIST OF ACTIONS AND EXTENDED PROCEDURES

4 (20)	McMaster	Keep ENSDF up-to-date.	Incorporate delayed-neutron $T_{1/2}$, P_n, B(E2) and quadrupole moments into ENSDF files	Moments are fairly straight forward. Mass chain evaluators should consult with horizontal evaluators concerning other parameters. **Requires further thought and discussion**
5 (21)	NNDC-BNL	Policy implementation	Run GABS on ENSDF file	Action is pending implementation of Adopted Decay Datasets, in which absolute photon intensity would be given. GABS has undergone extensive modification (Kibedi) **Action still pending** until GABS has been fully finalised
6 (22)	NNDC-BNL	Maintain/update ENSDF	Adoption of AME2016 data: ENSDF to be updated by placing 2016 Q values on Q record, with previous Q values on document record	Not yet undertaken – still intend to implement **Action continues**
7 (23)	NNDC-BNL and all network participants	Proposed journal publication	Proposed preparation of a comprehensive ENSDF paper – participants to consider proposal, and provide suggestions for additions and changes	Insufficient availability of staff **Action continues**
8 (26) + [new]	NNDC-BNL, also LNHB	Gamma, electron and neutron continuum spectra – policy implementation	Consider form of such spectral data in ENSDF, and submit proposal complete with tested examples – also which and how much data to display	Requires further discussion and development **Adjusted Action continues in conjunction with additional wording (new Action)**
9 (27)	NNDC-BNL	Adopted decay data - policy implementation	Provide template for the presentation of Adopted decay datasets within ENSDF, including development of policies and procedures for creating such datasets.	Still plan to complete **Action continues**
10 (38)	NNDC-BNL	ENSDF processing	High-spin data: evaluators are known to add A2, A4, DCO and POL to 2G records. NNDC-BNL to provide a definitive list of quantities that can be included in the 2G record.	List provided by Zerkin (IAEA-NDS) shows close to 400 entries in 2G records – still need to assess and define suitable policy for 2G records. Collaborative action led by NNDC **Action still stands**
11 (42)	ANU	Data processing	Prepare UNCTools package for dissemination, and send to NNDC-BNL/IAEA-NDS.	**On-going**

First column: number in brackets is the action number from the previous NSDD network meeting (see IAEA report INDC(NDS)-0733)

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LIST OF ACTIONS AND EXTENDED PROCEDURES

NEW ACTIONS, 8-12 April 2019			
No.	**Responsible**	**Reason**	**Action**
12	NNDC-BNL	Guidelines for reviewers of ENSDF evaluations	Develop guidelines for reviewers that encompass main items to consider when reviewing an ENSDF evaluation.
13	NNDC-BNL	List of data centres	Ensure that this particular list is maintained electronically on the ENSDF web page, and explore possibility of putting a link to the webpage in the journal, contingent upon securing DOI (or similar permanent address).
14	IAEA-NDS, NNDC-BNL	ENSDF reference(s)	LiveChart and NuDat to display prominently the individual *Nucl. Data Sheets* references containing the evaluated data.
15	TUNL	Calculation of Coulomb excitation by GOSIA code	Formulate questions and discuss with known experts.
16	IAEA-NDS (Capote)	Data uncertainties, and the problem of systematic uncertainties	Systematic uncertainties cannot be averaged - issues in defining the overall uncertainty of a group of numbers with existing quoted overall uncertainties. IAEA-NDS (*et al.* through NDS (Capote)) to provide guidelines for defining average data and associated uncertainties.
17	NNDC-BNL, MSU	Auger-electron and X-ray decay data	Provide a proposed ordering of atomic and nuclear decay data for a PDF listing.
18	All network participants	Reviewers for ENSDF evaluations	Provide names of potentially willing reviewers of mass chain evaluations (retirees, etc.) to undertake such studies.
19	MTA-Atomki	Uncertainty assignments of gamma-ray energies as related to gamma-ray intensities [**Sec. note:** draft – see Subsection 7.2.]	Provide draft recommendations for assignment of gamma-ray uncertainties (and hence level energies) as a function of gamma-ray intensities when authors do not discuss their uncertainties.
20	IAEA-NDS	IAEA-ICTP NSDD workshops	Continue to organise and implement educationally driven IAEA-ICTP workshops (outreach) with ICTP, Trieste, Italy. These workshops to be one or two weeks duration, depending on aims and content - to discuss further and formulate full programme.

LIST OF ACTIONS AND EXTENDED PROCEDURES

21	IAEA-NDS, NNDC-BNL	IAEA-based and more intense ENSDF evaluation workshops	Organise ENSDF training course at more irregular intervals for positively committed NEW ENSDF evaluators (based at IAEA Headquarters) – such a workshop to be attended by deliberately limited numbers to achieve desired level of training.
22	IAEA-NDS	ENSDF evaluations	Organise an advanced workshop in 2020/2021 for existing NSDD/ENSDF evaluators if NEW ENSDF evaluators training course outlined immediately above cannot be realised over a reasonable timescale.
23	IAEA-NDS	ENSDF codes	Organise technical meeting on Codes and Code Developments at IAEA Headquarters in 2020 for existing code developers.
24	ANU, NNDC-BNL, McMaster University	Data uncertainties – quoted significant figures and handling thereof	Discuss and declare the form of significant figures to adopt in the ENSDF codes for data uncertainties, and also consider in a similar manner an acceptable means of reporting recommended uncertainties.
25	Sukhjeet Singh, McMaster University, NNDC-BNL All evaluators	r_0 table, Alpha_RadD	Assess need for changes (such as asymmetric uncertainties), implement (if necessary), and feed modified data and code to IAEA-NDS for distribution to all evaluators. Check the data, test the code, and feed all comments (including full approval) to original author(s), NNDC-BNL and IAEA-NDS.
26	ENSDF evaluators	J-GAMUT code	Test J-GAMUT, and provide feedback to Balraj Singh.
27	ANU	GABS	Consider modifying GABS to allow two different calculational routes for $\%I_\gamma$ (and *NR*) as specified and proposed in Subsection 7.6. by Nica. [**Sec. note**: Action completed, May 2019]

LIST OF ACTIONS AND EXTENDED PROCEDURES

28	MSU IAEA-NDS ENSDF evaluators	ConsistencyCheck, CheckKeynumber and JAVA-Ruler codes	As a consequence of meeting exchanges, extend ConsistencyCheck code as suggested (e.g., request to define band structure of levels). See also Subsections 6.4. and 7.7. IAEA-NDS to make JAVA-Ruler, CheckKeynumber and extended ConsistencyCheck codes available for testing/use on NDS website. Test JAVA-Ruler, CheckKeynumber and ConsistencyCheck codes, and provide feedback to Jun Chen.
29	LNHB All evaluators	Betashape code and logft calculations	Planned release of Betashape by Mougeot in June 2019. Assess and feedback comments to Mougeot (LNHB) by October 2019.
30	LBNL, IAEA-NDS	Policy implementation	Compile list of policies adopted at previous NSDD meetings (going as far back as 2000).
31	ANU	BrIcc code	Modify code so as to insert total ICC in the gamma-record or SG record, and the asymmetric total ICC uncertainties in the 2G record.

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LIST OF ACTIONS AND EXTENDED PROCEDURES

COMPLETED AND WITHDRAWN ACTIONS, 8 April 2019			
No.	**Responsible**	**Reason**	**Action**
(1)	ENSDF coordinator, NNDC-BNL All network participants	Keeping ENSDF up-to-date.	Maintain a list of horizontal evaluations in separate repository accessible to evaluators. Keep NNDC informed about horizontal evaluations. **Continuous** **DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS PART OF ITEM 20**
(2)	NNDC-BNL	ENSDF analysis and checking codes need to remain up-to-date with respect to formats, physics requirements, and needs of the community.	Update codes for approved changes. **Continuous** **DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS PART OF ITEM 22**
(4)	NNDC-BNL	Facilitate evaluators' work.	Analyse Nica proposal to modify PANDORA. Undertaken by Jun Chen (MSU) **COMPLETED**
(5)	NSR manager	Generation of key numbers.	Keyword requirements for evaluators should be optional; such keywords should be encouraged as they constitute valuable information. **Continuous** **DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS ITEM 30**
(6)	NNDC-BNL All evaluators	Obscure references.	Investigate means to access electronic copies of secondary references that are difficult to track down and acquire. **Continuous** **DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS ITEM 29**
(7)	LBNL	ENSDF into XML.	Work with LLNL on proposed format, liaise with IAEA and report to network. XML schema: work completed - paper prepared by Hurst. See also MyEnsdf. **COMPLETED**

First column: number in brackets is the action number from the previous NSDD network meeting (see IAEA report INDC(NDS)-0733)

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LIST OF ACTIONS AND EXTENDED PROCEDURES

(9)	IAEA-NDS	Maintain links with horizontal evaluations	Invite representatives of atomic mass and other horizontal evaluations to the next meeting. **Continuous** **COMPLETED: DELETED/MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS ITEM 31**
(10)	IAEA-NDS	Training of evaluators	Explore need for additional training workshops. **Continuous** **COMPLETED** (see also New Actions 20, 21 and 22 for proposed future workshops)
(11)	IAEA-NDS/ NNDC-BNL	Information relevant to all ENSDF network members.	Regularly update network website - ensure all relevant talks are made available on website. **Continuous** **COMPLETED: DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS ITEM 27**
(12)	NNDC-BNL	Maintain up-to-date information on network.	Update website with new group responsibilities. **Continuous** **COMPLETED DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS ITEM 26**
(13)	ANL, NNDC-BNL, IAEA-NDS	Maintain and update codes.	Assess status of analysis codes and determine priorities as to which codes should be re-written or corrected. **Continuous** **DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS PART OF ITEM 22**
(14)	McMaster, ANL, NNDC-BNL	Policy clarification.	Revisit Rule 37. **ASSESSED/DELETED**
(15)	LBNL	Incorporation of additional data into ENSDF.	Suggest way of introducing parent-daughter isomeric feeding into ENSDF decay data. **ASSESSED/DELETED**
(16)	Martin	Modify *Guidelines for Evaluators*.	List spins in order of preference. Leads to incorrect interpretations - not favoured by Murray Martin. **DELETED**

First column: number in brackets is the action number from the previous NSDD network meeting (see IAEA report INDC(NDS)-0733)

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LIST OF ACTIONS AND EXTENDED PROCEDURES

(18)	All network participants	Maintain and update codes. Action modified substantially to achieve improved definition	Report bugs in codes and request enhancements to NNDC-BNL and code developers by email. **Continuous** **DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS PART OF ITEM 22**
(19)	IAEA-NDS/ NNDC-BNL	Dissemination of codes.	Coordinate the distribution of ENSDF codes on both web sites. **Completed/Continuous** NNDC/IAEA-NDS to ensure that descriptions of all codes are properly documented within a comprehensive manual. **DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS ITEM 28**
(24)	NNDC-BNL	Provide user community with citation guidelines	Incorporate in NNDC website citation guidelines for referencing ENSDF. See INDC(NDS)-0733, Subsection 2.5.2. for detailed description. **COMPLETED** – see Resources section, as cited in *Guidelines for Evaluators.*
(28)	Experimental Activities Subcommittee	Dissemination of information - experimental activities website	Create website of high-priority nuclear structure and decay data measurements for information and guidance, based on recent mass chain and/or individual nuclide evaluations. See IAEA report INDC(NDS)-0733, Subsection 4.3. for detailed description, and also presentation by Negret (IFIN-HH) at April 2019 meeting. **COMPLETED**
(29)	ENSDF evaluators	Short description of each completed evaluation – dissemination of technical information	Describe problems/inadequacies in their mass chain evaluations, and recommend work to be done. Strongly related to Action (28) above. Little evidence that suitable descriptions are being written by evaluators – feed back to Action (28). Superseded by previous action **WITHDRAWN**

First column: number in brackets is the action number from the previous NSDD network meeting (see IAEA report INDC(NDS)-0733)

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LIST OF ACTIONS AND EXTENDED PROCEDURES

(30)	Policies and Procedures Subcommittee; implemented by NNDC-BNL and MSU	Clarification of the nature of ICCs recommended in ENSDF and listed by JAVA-NDS.	Modify JAVA-NDS such that the conversion coefficient column has a footnote: "Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on gamma-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified." **COMPLETED**
(31)	ENSDF evaluators	Clarification of newly evaluated ENSDF data – policy implementation	If no significant changes in existing evaluation compared with previous evaluation, current evaluator to include such a statement and acknowledge previous evaluator(s). Partially followed by evaluators, but not always. **Continuous** recommendation **DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS PART OF ITEM 16**
(32)	ENSDF evaluators	Direct adoption of XUNDL data sets in ENSDF – policy implementation	If major portions of XUNDL compilation are used in the construction of an ENSDF evaluation, evaluator should acknowledge XUNDL compilers in the abstract of the evaluated mass chain. Partially followed by evaluators, but not always. Same as (31) **Continuous** **DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS PART OF ITEM 17**
(33)	ENSDF evaluators	Policy implementation on half-life limits, and use of "?" in decay mode	For neutron-rich nuclides, follow new policy regarding $T_{1/2}$ and decay mode. See IAEA report INDC(NDS)-0733, Subsection 4.1. for details. Balraj presented his proposals at previous meeting, and also sent them to mass chain evaluators – no response. Adopted as policy. Needs to go into Guidelines for evaluators. **COMPLETED**

First column: number in brackets is the action number from the previous NSDD network meeting (see IAEA report INDC(NDS)-0733)

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LIST OF ACTIONS AND EXTENDED PROCEDURES

(34)	ENSDF evaluators and NNDC	Policy implementation	Adopt tropical year to convert years to days: 1 year = 365.24219 days. NNDC-BNL to parse file and ensure that tropical year definition has been applied in all relevant nuclides. Same as (33), above **COMPLETED**
(35)	ENSDF evaluators and McMaster	Policy implementation	Evaluators to include beta-delayed neutron emission branch in beta-minus decay datasets. See IAEA report INDC(NDS)-0733, Subsection 4.1. for detailed description. McMaster to send a sample dataset to all ENSDF evaluators. Same as (33), above – formal policy wording and example exist – also needs to go into Guidelines for evaluators. **COMPLETED**
(37)	ENSDF evaluators	Policy implementation	If there is no evidence for a given multipolarity in a paper, such data should not be implicitly adopted – of particular concern for high-spin states. Do not simply copy over such data from XUNDL, but rather undertake your own assessment. Large percentage of submissions do not follow this instruction. Evaluate and justify such data, and do not simply copy over data from XUNDL – this is NOT evaluation. *Guidelines for evaluators*. **DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS ITEM 18**
(39)	NNDC-BNL	ENSDF processing	NNDC-BNL to modify FMTCHK so that POL is recognised/accepted by this checking code. **COMPLETED**
(40)	ANL, ANU	Policy implementation	Recommend suitable standard(s) for band configurations - need to agree upon the adoption of a particular nomenclature. **COMPLETED**

First column: number in brackets is the action number from the previous NSDD network meeting (see IAEA report INDC(NDS)-0733)

LIST OF ACTIONS AND EXTENDED PROCEDURES

(41)	NNDC-BNL	ENSDF processing	Level bands: proposed to introduce SEQ(A)$ as a new flag for less clearly defined bands, or individual single bands (already incorporated into FMTCHK and JAVA-NDS). Agreed and adopted **COMPLETED**
(43)	NNDC-BNL	Data processing	ALPHAD code reports HF when no alpha-decay intensity is given. NNDC-BNL to correct the code. **COMPLETED**
(44)	IAEA-NDS	Data handling	IAEA-NDS to consider including JAVA-NDS code in MyEnsdf. **COMPLETED**
(45)	NNDC-BNL	Facilitate evaluators' work	NNDC-BNL to share ENSDF Dropbox link containing private communications and supplemental material with NSDD evaluators. **COMPLETED** Everyone can upload content
(46)	ENSDF evaluators	Procedures	Ensure that mass chain or nuclide evaluations conform to all items on the ENSDF checklist before submitting to NNDC-BNL. **DELETED - MOVED INTO TABLE OF ENSDF-RELATED PROCEDURES AS ITEM 15**

First column: number in brackets is the action number from the previous NSDD network meeting (see IAEA report INDC(NDS)-0733).

ANNEX 4

LIST OF ACTIONS AND EXTENDED PROCEDURES

ENSDF-RELATED PROCEDURES – CONTINUOUS			
Item no.	**Responsible**	**Reason/Topic**	**Extension**
1	All network participants	Relevant data and information from certain conferences, meetings and lab. reports are not always available to NSR compilers	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.
2	NNDC-BNL	Publication of ENSDF	Continue journal publication of the mass chain evaluations in *Nuclear Data Sheets.*
3	All network participants	Misprints and errors found in NSR and ENSDF	Report misprints and errors detected in NSR, XUNDL and ENSDF to NNDC.
4	ENSDF evaluators	Accelerate review process	Each ENSDF evaluator should be willing to review two mass-chain equivalents per FTE-year; reviewing process for one mass chain should take no longer than three months.
5	All network participants	Bring NSDD evaluation work to the attention of the nuclear community	Present network activities at a wide range of appropriate conferences and meetings.
6	All network participants	Avoid duplication of work	Participants should inform the NNDC and IAEA-NDS about any development of software related to NSDD.
7	All network participants	Young scientists to evaluate mass chains	Encourage participation in research/ evaluation of nuclear structure data.
8	All network participants	Improve NSR	Send comments and suggestions on NSR improvements (keywording) to NNDC.
9	All network participants	Identify potential new ENSDF evaluators	All NSDD network participants to come forward at all times with contact details of known suitable candidates who would like to become recognised mass chain evaluators, and possess suitable technical backgrounds – provide such information to IAEA-NDS and NNDC-BNL.
10	All network participants	Support new ENSDF evaluators	Provide local support and mentoring to new ENSDF evaluators.
11	ENSDF evaluators	Check continued validity of the rules	Inform NNDC when experimental results appear to contradict accepted rules.

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LIST OF ACTIONS AND EXTENDED PROCEDURES

12	All network participants	Improve quality of evaluations	Solicit potential non-network evaluation reviewers, and send names to ENSDF coordinator at NNDC. [**Sec. note**: also re-defined as Action 18, while remaining as an approved Procedure]
13	NNDC-BNL, IAEA-NDS	Outreach	Continue to pursue initiatives to improve the international contributions to the ENSDF mass chain evaluations.
14	All network participants	Outreach.	Formulate and expand contributions to mass chain evaluations within their own countries.
15	ENSDF evaluators	Procedures	Ensure that mass chain or nuclide evaluations conform to all items on the ENSDF checklist before submitting to NNDC-BNL. **Large percentage of submissions do NOT follow this instruction.**
16	ENSDF evaluators	Clarification of newly evaluated ENSDF data – policy implementation	If no significant changes in existing evaluation compared with previous ENSDF evaluation, current evaluator to include such a statement and acknowledge previous evaluator(s). **Partially followed by evaluators, but not always.**
17	ENSDF evaluators	Direct adoption of XUNDL data sets in ENSDF – policy implementation	If major portions of XUNDL compilation are used in the construction of an ENSDF evaluation, evaluator should acknowledge XUNDL compilers in the abstract of the evaluated mass chain. **Partially followed by evaluators, but not always.**
18	ENSDF evaluators	Policy implementation	If there is no evidence for a given multipolarity in a paper, such data should not be implicitly adopted – of particular concern for high-spin states. Do not simply copy over such data from XUNDL, but rather undertake your own assessment. **Large percentage of submissions do NOT follow this instruction.**

LIST OF ACTIONS AND EXTENDED PROCEDURES

19	ENSDF evaluators	Adopted dataset	Multiple values – do not carryover, DCOs to Adopted dataset; if evaluator feels DCOs are necessary in Adopted dataset provide details on experimental geometry and expected values for different transition types.
20	All network evaluators	Evaluations in progress	Inform NNDC-ENSDF coordinator about mass chain, individual radionuclide and horizontal evaluations in progress to ensure their inclusion in monthly evaluation processing report. Network participants who publish individual and horizontal evaluations should distribute publication to network.
21	All network participants	Policies	Inform NNDC of discrepancies in the current policies, and propose changes and additions.
22	ANL NNDC-BNL IAEA-NDS All network participants	Maintain and update ENSDF analysis and checking codes	Assess status of analysis and checking codes and determine priorities as to which codes should be re-written or corrected. Report bugs in codes, and request enhancements to NNDC-BNL and code developers by email.
23	NNDC-BNL, IAEA-NDS	ENSDF analysis and checking codes	Notify network of new versions of analysis and checking codes.
24	NNDC-BNL	General policy pages in *Nuclear Data Sheets*	Modify policy pages, as needed.
25	ENSDF evaluators	Keep ENSDF up-to-date	Check NNDC monthly report for nuclides added by others to ENSDF that are your mass-chain responsibility.
26	NNDC-BNL	Maintain up-to-date information on network	Update website with changes in group responsibilities.
27	IAEA-NDS, NNDC-BNL	Information relevant to ENSDF network	Regularly update network website – ensure all relevant presentations/ talks are available on website.
28	IAEA-NDS, NNDC-BNL	Dissemination of codes	Coordinate distribution of ENSDF codes.
29	NNDC-BNL, all network evaluators	Obscure references	Investigate means to access electronic copies of secondary references that are difficult to track down and acquire. Evaluators to relay findings to NNDC-BNL for NSR adoption.

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30	NNDC-BNL	NSR - generation of key numbers and keywords	While keywords are only optional, they constitute valuable information to NSR users – their provision is encouraged.
31	IAEA-NDS	Maintain links with horizontal evaluations	Invite representatives of atomic mass and other horizontal evaluations to NSSD Evaluators' Network meeting.

ANNEX 5

STATUS REPORTS OF NSDD DATA CENTRES

ANNEX 5

STATUS REPORTS OF NSDD DATA CENTRES

Status report of the NSDD center at NNDC-BNL, and USNDP May 2017 – April 2019

A.A. Sonzogni

National Nuclear Data Center, Bldg. 817
Brookhaven National Laboratory, PO Box 5000
Upton, NY 11973, USA

1. Staff

Some significant personnel changes have occurred at the NNDC over the previous two years with the departure of Mike Herman and Tim Johnson in June 2018 and March 2019, respectively. Sadly, Said Mughabghab died in July 2018 following a short illness, and only a few months after the publication of the last edition of his highly admired and respected *Atlas of Nuclear Resonances*.

The NNDC is planning to recruit three post-docs as well as a staff member in the next few months. These new additions will strengthen the ENSDF evaluation activities considerably. Furthermore, we have added two more scientists to our contractor roster: Allan Carlson (ex-NIST) and Olena Gritzvay (ex-Ukrainian Nuclear Data Centre, Institute for Nuclear Research, Kiev, Ukraine).

2. Database advances

A recent highlight of our work has been the XUNDL compilation of articles performed as part of the *Physical Review C* submission/refereeing process. This new development will definitely ensure a higher quality of decay data for inclusion in the ENSDF database.

US ENDF/B-VIII.0 was released in February 2018, and includes an updated decay data sub-library. This particular sub-library has been used in several high-visibility publications on the topic of antineutrino emissions from operational nuclear reactors.

3. Dissemination

NNDC has completely replaced all web and database servers, and are now embarking on modernization of the cluster.

ANNEX 5

STATUS REPORTS OF NSDD DATA CENTRES

Status report of the NSDD coordinating centre at IAEA May 2017 – April 2019

Paraskevi Dimitriou

Scientific Secretary
Nuclear Data Section, IAEA, Vienna, Austria

1. Coordination

The 23rd meeting of the NSDD Evaluators' network organized by NDS-IAEA was hosted by LBNL, Berkeley, USA, from 23 to 27 May 2017. This network meeting was attended by 38 scientists from twelve Member States involved in the compilation, evaluation and dissemination of nuclear structure and decay data. A written summary of the meeting was published as IAEA report INDC(NDS)-0733, November 2017.

2. Financial support

Mass-chain evaluations: IAEA-NDS has been supporting S. Pascu (IFIN-HH) since 2016, with a contract to perform mass chain evaluations at the NSDD Data Centre of Romania.

Horizontal evaluations/compilations: NDS-IAEA has continued supporting N.J. Stone to produce a table of evaluated magnetic dipole moments and updated recommended electric quadrupole moments.

Decay Data for Decay Heat and Antineutrino spectra calculations: A.L. Nichols and T. Yoshida received financial support to assess the decay-scheme data of the most important fission products contributing to the decay heat produced from neutron-induced fission on U-235, 238, 233, Pu-239, 241, Th-232, Cf-252, Cm-245.

3. Training

A joint ICTP-IAEA Workshop on Nuclear Structure and Decay Data: Experiment, Theory and Evaluation, was held from 15 to 26 October 2018, at ICTP, Trieste, Italy. Co-director was E.A. McCutchan (BNL). Seventeen participants from 12 countries and ten lecturers attended the workshop. Hands-on exercises consisted of the compilation of XUNDL data sets (10 datasets were submitted to the XUNDL database) and the evaluation of six isotopes of mass chain A = 218. Work on the mass chain evaluation continued after the workshop, and has been submitted for review and publication. The next joint ICTP-IAEA NSDD Workshop will be held in 2021.

4. Codes

A third meeting of the IAEA project on Improvement of Analysis Codes for NSDD Evaluations was held from 3 to 7 December 2018. Progress in the codes under development was reviewed, and new codes such as Java-Ruler, Py-Ruler, ConsistencyCheck, CheckKeynumber, and BetaShape were discussed. Proposals for new formats to accommodate atomic radiation data and continuous spectra in ENSDF were considered in detail. Developments in Alphad_RadD, ensdf editors by V. Zerkin and application of NSR_keynumbers manager by PNPI were also presented. A written summary of the meeting has been published as IAEA report INDC(NDS)-0774, February 2019.

5. Dissemination

LiveChart has been continuously developed and improved to take into consideration the feedback from and needs of the members of the network and the broader user community.

The new Decay Data Portal (available at http://www-nds.iaea.org/Decayportal) provides access to evaluated nuclear structure and decay data available in ENSDF and DDEP and produced by IAEA CRPs. Evaluated decay data from ENDF/B, JEFF and JENDL decay data sub-libraries will also be accessible for comparisons in the future.

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The IAEA ENSDF Codes web page is the sole dissemination site for the ENSDF Analysis and Utility codes. There are now two additional partitions:

- ‘Testing/validation’ for new codes requiring testing and validation,
- ‘PNPI codes’ for codes developed by the PNPI Data Centre.

Members of the NSDD Evaluators’ network are notified by IAEA-NDS by e-mail about new codes and developments.

6. International effort

The NSDD scientific secretary was invited to the Annual Nuclear Data Symposium of the Japan Atomic Energy Agency from 28 to 29 November 2018. Major aims were to promote the work of the NSDD Evaluators’ network, and emphasize the importance of maintaining expertise in nuclear structure and decay data evaluation within Japan. A new evaluator from JAEA has been identified (H. Koura), who has attended the ICTP workshop and started collaborating with the Japan Data Centre.

7. Meetings

A series of Technical, Consultants and Research Coordination Meetings dealing with aspects of nuclear structure and decay data evaluation have been held at the IAEA. For more details, see Subsection 2.3.

8. Technical support

IAEA-NDS staff ensure that all the codes submitted for dissemination from the IAEA web page can be compiled and run on all platforms. Both FMTCHK and the corrected Ruler codes are recent examples.

9. MyEnsdf:

The online web tool MyEnsdf (V. Zerkin (IAEA-NDS)) is kept up-to-date, and has been further developed to include Java-NDS.

10. EXFOR-NSR PDF database

Collaborative efforts with NNDC-BNL to produce a complete collection of PDFs of articles compiled in the EXFOR and NSR databases is ongoing, thanks to generous contributions from the PNPI Data Centre (Rodionov and Shulyak) and the work of J. Totans (NNDC-BNL).

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STATUS REPORTS OF NSDD DATA CENTRES

Status report of the NSDD center at LBNL/UCB May 2017 – April 2019

L.A. Bernstein

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Program Summary

Nuclear Data activities under the Nuclear Data Group of LBNL+UCB (also known as the Isotopes Project at LBNL) cover nuclear structure data evaluation, experiments and evaluation of neutron-capture gamma-ray data for Evaluated Gamma-ray Activation File (EGAF), the evaluation of (n,n′γ) data, reference database for photon strength functions, and nuclear reaction studies at local facilities for applied applications (e.g., deuteron break-up reaction at 88-inch LBNL cyclotron and DD neutron generator at the University of California at Berkeley (UCB), along with other facilities such as the nuclear research reactors at Budapest, Hungary and FRM, Germany, and the cyclotron facility at the University of Oslo through international collaboration). As organised in May 2015, a Nuclear Data Needs and Capabilities for Applications (NDNCA) workshop led to the production of a white paper to agree a comprehensive program and guide such work. The group has also assisted in the co-ordination of meetings and workshops dedicated to nuclear data activities, and will continue to participate in the most relevant IAEA CRPs.

Evaluations/Compilations

Over the reporting period May 2017 to April 2019, mass chains A = 59, 99, 170, 171 and 193 were published in *Nuclear Data Sheets*, while mass chains A = 23, 59 and 186 were submitted for publication (A = 59 published, and the other two in the publication pipeline). Mass chain A = 24, as revised by Firestone in 2006, is also undergoing further revision. Senior ENSDF evaluators on contract to UCB have submitted A = 99 (in conjunction with BNL), A = 82 and A = 229 for publication in *Nuclear Data Sheets*. Furthermore, three mass chains have been reviewed, and 56 datasets from 35 papers have been complied for the XUNDL database. Neutron-capture studies of ^{139}La target related to EGAF have been published in *Phys. Rev. C*, and ^{187}Re(n,γ)^{188}Re analysis is ongoing in collaboration with a student from the Air Force Institute of Technology (Trevor Warren).

A full horizontal compilation of (n,n′γ) data from the Baghdad Atlas is underway. Several datasets have been compiled and evaluated for EXFOR, and are in the process of being added to the database. An earlier plan has also been adopted to expand this compilation into a full horizontal evaluation of (n,n′γ) reactions by incorporating adopted levels and gamma information from ENSDF together with more recent measurements carried out at international experimental facilities. A second horizontal activity has been the evaluation of beta-delayed proton emitters led by Jon Batchelder, which is to be published in *Atomic Data and Nuclear Data Tables*.

Publications/Experimental Studies

Thirty-one journal papers/conference proceedings/meeting reports related to our experimental activities have been published in the reporting period, as authored/co-authored by members of the nuclear data group. The LBNL/UC group has performed several measurements related to a medical isotope production campaign in collaboration with LANL, BNL and international centres - data analyses are in progress.

Other Activities

Following a recommendation by the participants at the 22nd NSDD meeting, a web site has been developed that has been called "*Nuclear Structure Experimental Issues*", formerly known as the "High-Priority Nuclear Structure Request List": http://nucleardata.berkeley.edu/hpnsrl/ by A. Hurst to disseminate inconsistencies related to nuclear structure data for information and possible experimental initiatives and solutions.

The LBNL/UC nuclear data group has played key roles in several meetings:

- Workshop on Applied Nuclear Data Activities (WANDA), 22-24 January 2019, Washington DC, as organized by Bernstein.
- Bernstein was also co-organizer of the 6th International Compound Nuclear Reactions Workshop held at LBNL on 24-28 September 2018, and the Nuclear Data Road-mapping Enhancement Workshop (NDREW), Washington DC, 19-22 January 2018.
- LBNL hosted 22nd NSDD technical meeting, 22-26 May 2017, Berkeley, California.
- Firestone attended meetings of the IAEA Co-ordinated Research Project on "Updating the Photonuclear Data Library and Generating a Reference Database for Photon Strength Functions", 16-20 October 2017 and 17-21 December 2018, IAEA Headquarters, Vienna, Austria.
- Several group members presented papers at Workshops on Nuclear Level Density and Gamma Strength in Oslo, 8-12 May 2017, and in Svalbard, 22-25 May 2018.
- Hurst attended an IAEA consultants' meeting on "Nuclear Data Portal Web Tools" at IAEA Headquarters, Vienna, Austria, 30 July – 1 August 2018 (see IAEA report INDC(NDS)-0763, August 2018).

Two graduate students received their doctoral degrees in August 2018 on the basis of their research work within the nuclear data group: Leo Kirsch (Gamma Strength from Quasi-Continuum Lifetimes using ^{56}Fe(p,p')), and Andrew Voyles (Nuclear Excitation Functions for Production of Novel Medical Radionuclides).
Six more graduate students are now working for their PhDs within the nuclear data group: Amanda Lewis, Eric Matthews, Jonathan Morrell, Morgan Fox, Austin Lo and Christopher Brand.

Future Plans

Continue activities involving the development and maintenance of ENSDF, XUNDL, Photon Strength Functions, EGAF databases and NSR compilations (latter as a new consideration). The group will also lead efforts to compile and evaluate inelastic neutron scattering cross sections, with the goal of developing a new reaction benchmark based on the updated Atlas of Gamma-ray from the Scattering of Reactor Fast Neutrons (http://nucleardata.berkeley.edu). Specific interest will also be devoted to targeted cross-section and decay data measurements in support of medical isotope production, including ^{51,52}Mn, ^{64,67}Cu, ^{68}Ge, ^{72}Se, ^{134}Ce, ^{193m}Pt and ^{225}Ac. These efforts will involve activation measurements by means of charged-particle beams (mainly protons and deuterons) and neutrons from the thick-target deuteron breakup source at the 88-inch cyclotron and the high-flux DD neutron generator located on the UC Berkeley campus. Over the next three years, the LBNL/UC Nuclear Data Group will also participate in two experimental activities supported through the new USA Nuclear Data Interagency Working Group. This initiative includes a collaborative effort to develop a new set of evaluated fission product yields, and improve the ^{238}U(n,n') cross-section evaluation. Both efforts will utilize the intense neutron beams from the 88-inch cyclotron and will be performed in collaboration with nuclear data groups at BNL, LANL and LLNL.

Group members at LBNL and UCB-NE over this reporting period include Lee A. Bernstein (Group Leader), M.S. Basunia, Aaron M. Hurst, Jon Batchelder, Richard B. Firestone, Eddie Browne and Jagdish Tuli, along with Andrew Voyles (post-doctorate), six graduate students mentioned above, and visiting scientists from the University of Oslo (Daniel Murphy, Hannah Lovise, Okstad Ekeberg and Nora Petersen), Charles University in Prague (Milan Krticka), and Bangladesh Atomic Energy Commission (Md. Shuza Uddin).

ANNEX 5

STATUS REPORTS OF NSDD DATA CENTRES

Status report of the NSDD center at TUNL, May 2017 – April 2019

J.H. Kelley[1,2], J. Purcell[1,4], C.G. Sheu[1,3]

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[2] *Department of Physics, North Carolina State University, Raleigh, NC, 27695-8202, USA*
[3] *Department of Physics, Duke University, Durham, North Carolina, 27708-0305, USA*
[4] *Department of Physics and Astronomy, Georgia State University, Atlanta, GA, 30303, USA*

I. ENSDF and XUNDL

TUNL is responsible for data evaluations in the mass range A = 2-20. Since the last IAEA NSDD meeting, we have published a review of A = 12 nuclides. Reviews of A = 2 and A = 13 nuclides are underway, along with evaluations of ^{6}Be and ^{17}O.

Recent Publications from the TUNL Data Evaluation Group

Nuclear Mass A	Publication Status
12	*Nucl. Phys.*, **A 968** (2017) 71 – added to ENSDF in 2018

Future light nuclei will be published exclusively in *Nuclear Data Sheets*. As well as the above published results, we have submitted ^{5,6}H, ^{5}Be, ^{19,20,21}B, ^{8,20}C, ^{10,19,20}N and ^{17}Ne to the ENSDF database since the previous NSDD meeting, and we have added the corresponding files to our website. We also contribute to the compilation effort that covers the A = 2-20 region for XUNDL – this amounts to about five compiled articles per month.

II. World Wide Web Services

TUNL continues to develop new WWW services for the nuclear science and applications communities. PDF and HTML documents have been posted for the TUNL and Fay Ajzenberg-Selove reviews of "Energy Levels of Light Nuclei" and GIF, PDF and EPS/PS files of the energy level diagrams. We also provide focused information on thermal neutron capture data, beta decay data, and measured excitation functions for light-particle reactions relevant to A = 3-20 nuclides. A compiled and evaluated list of lifetime values is maintained for all nuclei in the A = 3-20 region. Following tradition, the web services cover light nuclides whose structure and decay data are published in Nuclear Physics A.

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STATUS REPORTS OF NSDD DATA CENTRES

Progress report of nuclear structure and decay data activities at Argonne National Laboratory, May 2017 – April 2019*

F.G. Kondev

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

1. Program overview

The Argonne Nuclear Data Program is involved in a number of scientific activities carried out within the Co-ordinated Work Plan of the US Nuclear Data Program (USNDP). Emphasis is focused on nuclear structure and decay data, and their applications in nuclear physics research and applied nuclear technologies. Compiled and evaluated data are made available to the US National Nuclear Data Center (NNDC) for inclusion in the Evaluated Nuclear Structure Data File (ENSDF) database, or the results are published directly in peer-reviewed scientific journals. Contributions are also made to various specialized databases that serve specific needs in the fields of nuclear structure, nuclear astrophysics and applied nuclear physics. These efforts include evaluations of atomic masses and complementary nuclear structure data for the Atomic Mass Evaluation (AME) and NUBASE databases, and compilations of recently published nuclear structure data for the Unevaluated Nuclear Data List (XUNDL) database. Measurements are also performed to provide answers to specific questions and so improve the quality of existing databases in specific areas. Experimental activities are carried out at nuclear physics user facilities of the US Department of Energy, and/or at leading nuclear physics laboratories elsewhere via collaborative arrangements.

2. Nuclear Data Evaluation Activities for ENSDF and XUNDL

Nuclear data evaluation activities at Argonne National Laboratory consist mainly of nuclear structure and decay data evaluations for the ENSDF database. The ANL nuclear data center is responsible for the evaluation of nuclei within the A = 109, 110, 176-179 and 199-209 mass chains. The up-to-date status of these evaluations is presented in Tables 1 and 2. During the period of time covered by this report, the A = 188 mass chain was completed and published in *Nuclear Data Sheets* (in collaboration with Prof. S. Juutinen, Jyvaskyla University and Prof. D. Hartley, US Naval Academy), evaluation of the A = 177 mass chain was completed, reviewed and being prepared for publication, while the A = 205 evaluation is currently on-going. Compilations for the XUNDL database and ENSDF evaluations of nuclides for which the first experimental data have become available, along with peer reviews of ENSDF mass chains of other evaluators, were also carried out when requested.

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STATUS REPORTS OF NSDD DATA CENTRES

Table 1. Status of mass chain evaluations assigned to the ANL nuclear data center.

A chain	*NDS* publication	Evaluator(s)	Current status
106	*NDS* **109** (2008) 943	D. De Frenne & A. Negret	106, 107, 108: responsibility re-assigned to University of Sofia in 2017
107	*NDS* **109** (2008) 1383	J. Blachot	
108	updated online 2008	J. Blachot	
109	*NDS* **137** (2016) 1	S. Kumar, J. Chen & F.G. Kondev	completed
110	*NDS* **113** (2012) 1315	G. Gurdal & F.G. Kondev	completed
111	*NDS* **110** (2009) 1239	J. Blachot	111, 112: responsibility re-assigned to University of Sofia in 2017
112	*NDS* **124** (2015) 157	S. Lalkovski & F.G. Kondev	
176	*NDS* **107** (2006) 791	M.S. Basunia	completed/LBNL
177	*NDS* **98** (2003) 801	F.G. Kondev	**completed in 2018**
178	*NDS* **110** (2009) 1473	A. Achterberg *et al.*	completed/Argentina
179	*NDS* **110** (2009) 265	C.M. Baglin	completed/LBNL
199	*NDS* **108** (2007) 79	Balraj 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	**under revision**
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.J. Martin	completed/ORNL
209	*NDS* **126** (2015) 373	J. Chen & F.G. Kondev	completed

Table 2. Evaluated mass chain outside the ANL regions of responsibility.

A chain	NDS publication	Evaluators	Current status
188	*NDS* **150** (2018) 1	S. Juutinen, D. Hartley & F.G. Kondev	completed

2. Other Activities

The Argonne nuclear data program has continued to contribute to on-going evaluations of atomic masses in collaboration with scientists from CSNSM (Orsay, France), IMP (Lanzhou, China) and RIKEN (Japan).

ANL staff have participated in a number of IAEA-led activities over the course of May 2017 to April 2019: CRP on “Nuclear Data for Charged-particle Monitor Reactions and Medical Isotope Production”, technical meetings on “Total Absorption Gamma-ray Spectroscopy for Decay Heat Calculations and Other Applications”, “Nuclear Data for Anti-neutrino Spectra and Applications", “Improvements of analysis codes for Nuclear Structure and Decay Data Evaluations”, and “Nuclear Moments”, as well as lectures at the IAEA-ICTP Trieste workshop on “Nuclear Structure and Decay Data Evaluation: Theory and Experiment”, and consultancies on the development of the LiveChart Web site.

Our program includes nuclear data research activities to complement the main ANL evaluation activities by providing training experience to evaluators on modern experimental techniques and instruments used to produce nuclear data. Such studies have also ensured good contacts with a broad range of nuclear data users and the FRIB and GRETINA research communities. ANL collaborative nuclear structure and decay research activities at the ATLAS and CARIBU facilities are also aimed at improving the quality of existing databases. These efforts included measurements aimed at improving decay data in the actinide region, where the main emphasis has been on the properties of nuclei far from the line of stability and nuclear isomers in heavy nuclei. Furthermore, there is growing involvement at the CARIBU facility in decay studies of neutron-rich nuclei in the fission product region.

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STATUS REPORTS OF NSDD DATA CENTRES

Status report of the NSCL/MSU data center May 2017 – April 2019

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Overview of NSCL/MSU data center

The data center at NSCL/MSU became a member of the NSDD network at the 2015 IAEA NSDD meeting in Vienna, and plays a unique role as part of the FRIB/NSCL facilities. NSCL/MSU is currently responsible for the evaluation of fourteen mass chains (A = 31–44), with further such assignments to be made. NSCL staff also compile data for the XUNDL database, including all data arising from future NSCL and FRIB studies. Furthermore, help has been provided to develop and improve the analysis and utility tools used in data compilations and evaluations. The NSCL/MSU has been independently funded by the US DOE since FY 2017.

Current personnel:
Hiro Iwasaki (supervisor and NSCL/FRIB data committee member)
Jun Chen (PI, 1 FTE)
Previous program manager and PI (November 2014 – July 2017)
Michael Thoennessen (currently APS Editor-in-Chief)

ENSDF evaluations and XUNDL compilations

Along with the primary responsibility of mass chains A = 31-44 for ENSDF data evaluation, the NSCL/MSU data center also takes on additional mass chains selected from the evaluation priority list formulated by the NNDC and co-ordinated within the NSDD network (Table 1).

Table 1. Status of Mass Chain Evaluations at NSCL/MSU.

Mass chain	Year of last evaluation	Evaluator(s) of last evaluation	Current status
31	2013	C. Ouellet and Balraj Singh	up-to-date
32	2011	C. Ouellet and Balraj Singh	up-to-date
33	2011	J. Chen and Balraj Singh	up-to-date
34	2012	N. Nica and Balraj Singh	up-to-date
35	2011	J. Chen, J. Cameron and Balraj Singh	up-to-date
36	2011	N. Nica, J. Cameron and Balraj Singh	up-to-date
37	2012	J. Cameron, J. Chen and Balraj Singh	up-to-date
38	2017	J. Chen	up-to-date
39	2017	J. Chen	up-to-date
40	2015	J. Chen	up-to-date
41	2015	C.D. Nesaraja and E.A. McCutchan	up-to-date
42	2016	J. Chen and Balraj Singh	up-to-date
43	2015	Balraj Singh and J. Chen	up-to-date
44	2011	J. Chen, Balraj Singh and J. Cameron	up-to-date
Additional mass chains			
50	2018	J. Chen and Balraj Singh	post-review
73	2018	Balraj Singh and J. Chen	post-review
98	2018	J. Chen and Balraj Singh	in review
100	2018	Balraj Singh and J. Chen	post-review
123	2019	J. Chen	under evaluation
138	2017	J. Chen	up-to-date
190	2017	Balraj Singh and J. Chen	in review

STATUS REPORTS OF NSDD DATA CENTRES

All mass chains in the A = 31-44 region are up-to-date with respect to the 10-year update cycle. Additional mass chains A = 50, 73, 98, 100 and 190 have been re-evaluated at NSCL/MSU since 2018 in collaboration with Balraj Singh. Two additional mass chains are planned for further such collaboration this year, while a full evaluation of A = 123 is ongoing.

A total of 198 datasets from 102 papers have been compiled for XUNDL since May 2017, including 101 datasets/54 papers in FY2018, and 42 datasets/20 papers in FY2019 so far.

Code development and maintenance

The NSCL/MSU data center continues to take the lead in the code development and maintenance of some new Java programs with graphical user interface (GUI), such as *McMaster-MSU-JAVA-NDS* for the production of *Nuclear Data Sheets* and the web display of the ENSDF and XUNDL databases, *ConsistencyCheck* to monitor data consistency among ENSDF datasets, etc. A list of the codes is given in Table 2 below, and all are available for downloading on the IAEA-NDS web site.

Table 2. Java codes developed and maintained at NSCL/MSU.

Name	Functions	Note	Last update
ConsistencyCheck	check data consistency among ENSDF datasets, group levels and gammas, and average values from different datasets (with user selections), and more	considered as replacement of PANDORA; useful for preparing Adopted dataset	18 March 2019
Excel2ENSDF	convert BETWEEN an Excel file (formatted data) and an ENSDF file; perform simple operations on column data in Excel, such as multiplying a factor or adding a constant (or both) to all values of a record, e.g., adding S(n) to E(n)	extensively used in XUNDL compilation and useful for extracting tabulated data from ENSDF	11 March 2019
Java-RULER	calculate gamma-ray transition strengths in ENSDF file with proper error propagations of large/asymmetric uncertainties	solved a long-standing uncertainty calculating issue in the old FORTRAN code	5 February 2019
KeynumberCheck	check all NSR key-numbers in ENSDF datasets for format errors, irrelevant or non-existent key-numbers (mostly due to mistyping) by searching in an input list of key-numbers, or in the NSR database directly	useful to catch incorrect, irrelevant or non-existent key-numbers for the final check of an ENSDF evaluation	29 January 2019
Java-NDS	generate LaTeX and PDF outputs from ENSDF file(s) for *Nuclear Data Sheets* and web display of ENSDF and XUNDL databases on NNDC retrieval web pages	started at McMaster by Balraj Singh and his students	8 February 2019

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STATUS REPORTS OF NSDD DATA CENTRES

Status report of the NSDD center at Oak Ridge National Laboratory May 2017 – April 2019

C.D. Nesaraja

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Oak Ride, TN 37831, USA

1. Staff

Michael Smith (Group Leader for Experimental Astrophysics and Nuclear Data Program), Caroline Nesaraja (ENSDF evaluator), Murray Martin (ENSDF evaluator and consultant), and Larry Zhang (Computational Astrophysics Programmer).

2. Activities

a) Nuclear Structure Data

ENSDF

This activity consists of mass chain evaluations, and our responsibilities are in the actinide region A = 241-249. Literature cut-off dates for mass chains A = 241-249 are listed below:

Mass Chain and Literature Cut-off Dates from ENSDF Database

241 C.D. Nesaraja, *NDS* **130** (2015) 183, Literature cut-off September 2015
242 Y.A. Akovali, *NDS* **96** (2002) 177, Literature cut-off September 2001
243 C.D. Nesaraja and E.A. McCutchan, *NDS* **121** (2014) 695, Lit. cut-off Sept. 2013
244 C.D. Nesaraja, *NDS* **146** (2017) 387, Literature cut-off August 2017
245 E. Browne and J.K. Tuli, *NDS* **112** (2011) 447, Literature cut-off June 2011
246 E. Browne and J.K. Tuli, *NDS* **112** (2011) 1833, Literature cut-off January 2011
247 C.D. Nesaraja, *NDS* **125** (2015) 395, Literature cut-off March 2014
248 M.J. Martin, *NDS* **122** (2014) 377, Literature cut-off September 2014
249 K. Abusaleem, *NDS* **112** (2011) 2129, Literature cut-off December 2010

Since the last NSDD meeting in 2017, three mass chains have been and are in their various stages of the evaluation process, as shown below.

Mass chain	Evaluator	No. of nuclides	Status
137	Nesaraja	16	submitted
242	Martin	9	post review
244	Nesaraja	9	published

Both Murray Martin and Caroline Nesaraja have also reviewed mass chains as requested by the National Nuclear Data Centre since May 2017: A = 76, 197, 217 (Nesaraja), and A = 126 (Martin).

XUNDL

Involves the critical compilation of nuclear structure data from the most recent publications, and their preparation and insertion into the XUNDL database. Frequent communications with the authors of these papers are often required to resolve inconsistencies and to obtain additional details of their measurements and data. ORNL staff efforts began in May 2013 when Balraj Singh visited ORNL to recruit and introduce Caroline Nesaraja to this work, with our first compilations undertaken in FY2014. A request from the new XUNDL co-ordinator was received in April 2016 to either curtail or stop this work entirely. As of FY2019, ORNL staff opted to discontinue these compilations, although still able and willing to compile any paper requested by the NNDC.

b) Nuclear Astrophysics Data

Astrophysics data research is closely coupled with our program of measurements of reactions with unstable and stable nuclei. Recent emphasis has been placed on determining the important uncertainties for the rapid proton-capture process in nova explosions. While such studies will be the focus of measurements at FRIB, many of these critical reactions have yet to be examined. We are currently surveying the literature for information on these proton-capture reactions, and will subsequently perform streamlined assessments of their uncertainties as needed.

c) Other Related Activities

Murray Martin: lectured at the Joint IAEA-ICTP Workshop on Nuclear Structure and Decay Data at the International Centre for Theoretical Physics in Trieste, Italy, from 15 to 26 October 2018. Also trained several workshop students in the evaluation procedures and formats used to produce the Evaluated Nuclear Structure Data File (ENSDF).

3. Future Activities

Future mass chains will be evaluated within the range assigned to ORNL of A = 241-249, as well as others requested by USNDP/NNDC.

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STATUS REPORTS OF NSDD DATA CENTRES

Progress report of the NSDD activities at Texas A&M University May 2017 – April 2019

N. Nica

Cyclotron Institute, Texas A&M University
College Station, TX 77843-3366, USA

1. Overview

Since 2005, staff at the Cyclotron Institute, Texas A&M University (TAMU), have carried out ENSDF mass-chain evaluations under contract to NNDC-BNL on the basis of 0.67 FTE. Precise experimental measurements have also been developed and applied to the determination of internal conversion coefficients (ICCs) as a direct form of assistance in the accurate resolution of a wide range of decay schemes and nuclear data evaluations. TAMU was officially recognised as an NSDD Centre in 2017, with expansion to a full FTE devoted to data evaluation (1 FTE).

2. Mass-chain nuclear structure and decay data evaluations for ENSDF

TAMU staff have agreed responsibility for the timely evaluation of mass chains A = 140, 141, 147, 148, 153, 155, 157, 158 and 160. On average, these nuclei in the rare-earth region of the periodic table have been intensely studied by a variety of techniques, and their large A-chains contain extensive amounts of data for evaluation and adoption in the ENSDF database. Overall, we have previously evaluated nuclear structure and decay data for 18 A-chains and more than 240 nuclei.

All previous TAMU-related mass-chain evaluations:

N. Nica, Nuclear Data Sheets for A = 252, *Nucl. Data Sheets* **106** (2005) 813.

N. Nica, Nuclear Data Sheets for A = 140, *Nucl. Data Sheets* **108** (2007) 1287.

D. Abriola, *et al*., Nuclear Data Sheets for A = 84, *Nucl. Data Sheets* **110** (2009) 2815.

N. Nica, Nuclear Data Sheets for A = 147, *Nucl. Data Sheets* **110** (2009) 749.

N. Nica, Nuclear Data Sheets for A = 97, *Nucl. Data Sheets* **111** (2010) 525.

J. Cameron, J. Chen, Balraj Singh, N. Nica, Nucl. Data Sheets for A = 37, *Nucl. Data Sheets* **113** (2012) 365.

N. Nica, J. Cameron, Balraj Singh, Nuclear Data Sheets for A = 36, *Nucl. Data Sheets* **113** (2012) 1.

N. Nica, Balraj Singh, Nuclear Data Sheets for A = 34, *Nucl. Data Sheets* **113** (2012) 1563.

Balraj Singh, N. Nica, Nuclear Data Sheets for A = 77, *Nucl. Data Sheets* **113** (2012) 1115.

N. Nica, Nuclear Data Sheets for A = 148, *Nucl. Data Sheets* **117** (2014) 1.

N. Nica, Nuclear Data Sheets for A = 141, *Nucl. Data Sheets* **122** (2014) 1.

N. Nica, Nuclear Data Sheets for A = 157, *Nucl. Data Sheets* **132** (2016) 1.

N. Nica, Nuclear Data Sheets for A = 158, *Nucl. Data Sheets* **141** (2017) 1.

N. Nica, Nuclear Data Sheets for A = 140, *Nucl. Data Sheets* **154** (2018) 1.

N. Nica, Nuclear Data Sheets for A = 155, to be published in *Nucl. Data Sheets*.

N. Nica, Nuclear Data Sheets for A = 160, to be published in *Nucl. Data Sheets*.

N. Nica, Nuclear Data Sheets for A = 153, submitted to NNDC for review.

N. Nica, Nuclear Data Sheets for A = 147, evaluation in progress.

Current status of responsible mass chains (A-chain followed by literature cut-off in parentheses):

- ✓140 (November 2018) completed
- ✓158 (February 2017) completed
- ✓157 (December 2015) completed
- ✓148 (October 2013) completed
- ✓141 (June 2012) completed

- ➢155 (January 2004) reviewed and returned to evaluator
- ➢160 (June 2005) in review with NNDC
- ➢153 (December 2005) in review with NNDC
- ➢147 (November 2008) in progress

Since April 2017, we have fully re-evaluated A = 160 and A = 153, published A = 158 and A = 140 and started a new evaluation of A = 147 which remains in progress. Also completed work on a complex peer review of a large A-chain (about one month of continuous re-assessment).

3. Other activities

We have continued to contribute to the mass chain evaluation effort by undertaking experimental ICC measurements aimed at consolidating the theoretical approach of calculating the internal conversion coefficients included within the existing ENSDF database. Following on from our series of spectral measurements, Dirac-Fock calculations with the "frozen orbital" approach for inclusion of the atomic vacancy effect on the converted electron were implemented in the BrIcc code.

We finalized and published the ninth case in our series of methodical ICC studies (*Phys. Rev. C* **98** (2018) 054321: 39.8-keV E3 transition of ^{103}Rh, a complex case that was studied in terms of both β^- and ε decay). Fourteen major publications have now been published on this important topic by the TAMU team. Furthermore, a new set of ICC measurements are currently underway involving the 30.8-keV, M4 transition of ^{93m}Nb. The scope of this series of studies is to test the validity of the "frozen orbital" theory over a large domain of Z and A numbers in the chart of the nuclides.

We have also contributed indirectly to the nuclear data effort by completing high-quality benchmark measurements (half-lives and branching ratios) by β-γ spectroscopy carried out at the Momentum Achromat Recoil Spectrometer (MARS) at the Cyclotron Institute. Several measurements were completed over this two-year time interval (^{30}S half-life published in *Phys. Rev. C* **97** (2018) 035501, and ^{26}Si branching ratios, submitted for publication to *Phys. Rev. C*).

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STATUS REPORTS OF NSDD DATA CENTRES

Status report of the NSDD center at McMaster University May 2017 - April 2019

Balraj Singh

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Hamilton, Ontario L8S 4MI, Canada

ENSDF: evaluations; training, computer codes, network co-ordination.
XUNDL: compilation of current papers, communications with authors.
NSR: writing key-word abstracts of papers in PRC journal.

Horizontal evaluations and compilations:
Beta-delayed neutron (BD-N) emitters: $\%P_n$, $T_{1/2}$ for all potential β-n emitters (IAEA-CRP);
B(E2) for first 2^+ and first 4^+ states in even-even nuclei;
Compilation of nuclear isomers of $T_{1/2} \geq 10$ ns (may include 1 to 10 ns);
Table of r_0 parameters for even-even alpha emitters;
Review of log *ft* values in β decay;
Table of magnetic-dipole rotational (shears) bands.

ENSDF evaluations, May 2017 to April 2019:
Mass chain publications in NDS
A = 254: Balraj Singh, *NDS* **156**, 1-69, February 2019
A = 266, 270, 274, 278, 282, 286, 290, 294, 298, 302: Balraj Singh, *NDS* **156**, 70-147, February 2019
A = 268, 272, 276, 280, 284, 288, 292, 296, 300: Balraj Singh, *NDS* **156**, 148-212, February 2019
A = 164: Balraj Singh and J. Chen, *NDS* **147**, 1-381, January 2018
A = 217: F.G. Kondev, E.A. McCutchan, Balraj Singh, *et al.*, *NDS* **147**, 382-458, January 2018 - IAEA-ICTP 2016 workshop
A = 258: Balraj Singh, *NDS* **144**, 297-322, September-October 2017
A = 189: T.D. Johnson and Balraj Singh, *NDS* **142**, 1-330, May-June 2017

Additional ENSDF updates of 21 nuclides.

Review work: one mass chain for ENSDF/*Nucl. Data Sheets*.
one article on horizontal compilation for *ADNDT* journal.

Mass chains submitted/in pipeline for ENSDF/*Nucl. Data Sheets*
A = 218: Balraj Singh, M.S. Basunia, M.J. Martin, E.A. McCutchan, *et al*.: submitted 28 March 2019, and in review - IAEA-ICTP 2018 workshop; work coordinated by Balraj Singh
A = 190: Balraj Singh and J. Chen: submitted 3 March 2019, and in review
A = 50: J. Chen and Balraj Singh: submitted 30 September 2018; final version submitted 26 March 2019
A = 219: Balraj Singh, G. Mukherjee, S.K. Basu, *et al*.: submitted 2 October 2018; in review
A = 100: Balraj Singh and J. Chen: submitted 19 September 2018; post-review
A = 130: S. Pascu, Balraj Singh, A. Rodionov and G. Shulyak: submitted 18 September 2018; in review
A = 98: J. Chen and Balraj Singh: submitted 18 June 2018; in review
A = 73: Balraj Singh and J. Chen: submitted 1 February 2018; post-review
A = 172: Balraj Singh and T. Kibedi: submitted May 2017; post-review
A = 57: A. Negret, Balraj Singh and R.B. Firestone: submitted April 2017; post-review
A = 76: Balraj Singh and A.R. Farhan: submitted April 2016; post-review - awaiting results of experiment by E.A. McCutchan, *et al*. for ^{76}Br decay to ^{76}Se with Gammasphere array

Mass chains in progress:
A = 149

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A = 194 (with J. Chen, MSU)
A = 64 (with J. Chen, MSU)
A = 132 (with A. Rodionov and G. Shulyak, PNPI)
A = 58 (with C. Nesaraja, ORNL)

Mass chains planned in the next 1-2 years:
A=240, 165, 74, 80, 134 (some in collaboration with other centers)

XUNDL compilation work, May 2017 to April 2019
Compiled: **518** datasets from **182** papers, including **14** papers for which data-check reports were submitted together with compiled datasets for PRC-submitted papers.

Assisted with training in XUNDL compilation work at the 2018 IAEA-ICTP workshop.

Compilation of current papers on Atomic Mass measurements:

1. 2 November 2018: **32** papers with 202 data points compared with data in AME-2016.
2. 15 May 2017: **22** papers with 133 data points compared with data in AME-2016.

Both files are available on *nuclearmasses.org* webpage of Michael Smith at ORNL**,** where since 2008 our compiled Atomic mass data has been made available from a total of about **222** primary publications. Note that these papers are not covered in the XUNDL database.

NSR key-wording of papers, May 2017 to April 2019
1957 articles in issues of *PR-C* from March 2017 to January 2019 were consulted, and keyword abstracts were written for **1392** papers. These keywords were submitted to NNDC for the NSR database, after checking the keyword file by means of the NSRPREP compilation code. Keyword abstracts were also written for **52** papers from the proceedings of the INPC-2007 conference.

Horizontal evaluations and compilations

1. **B(E2) for the first 2^+ and 4^+ states in even-even nuclei (NNDC, BNL+McMaster)**:
   NNDC + McMaster collaboration continues to compile and evaluate B(E2) (and B(E4)) for the first 4^+ states in even-even nuclei, systematic of BE2(4^+ to 2^+)/BE2(2^+ to 0^+) and E(first 4^+)/E(first 2^+), etc. Update of B(E2) values also continues for the first 2^+ states, because this topic is very active in current experimental structure work, and many new papers have appeared since the publication of our B(E2) article 2016Pr01 (*At. Data Nucl. Data Tables* **107** (2016) 1).
2. **Beta-delayed neutron emission probabilities (Pn) and half-lives for Z>28 n-rich nuclei, McMaster University+TRIUMF+NNDC-BNL+CIAE-Beijing+VECC-Kolkata+Valencia +CNEA-Argentina+Warsaw), IAEA-CRP 2012-2017, for Z>28 nuclides (~410 nuclides)**:
   Paper by J. Liang, Balraj Singh, E.A. McCutchan, I Dillmann, M. Birch, A.A. Sonzogni, X. Huang, M. Kang, J.Wang, G. Mukherjee, K. Banerjee, D. Abriola, A. Algora, A.A. Chen, T.D. Johnson and K. Miernik was submitted for publication on 17 May 2018. We received review comments on 25 March 2019. Hopefully, a final version will be submitted in June 2019, incorporating our responses to the reviewers' comments as well as updating the document to include new papers since our earlier submission in 2018.

   Z<28 region (~220 nuclides)
   Since the publication of 2015Bi05 for this region (*Nuclear Data Sheets* **128** (2015) 131-184), relevant tables are in the process of being updated to include data from papers addressing this Z region that appeared after the 2015 publication.
3. **Compilation of nuclear isomers of half-life 10 ns or greater, Amity University, Noida, India+Akal University, India+McMaster University**: presentation by Ashok K. Jain at this meeting.
   Many new papers on nuclear isomers have appeared since the publication of the Atlas of Nuclear Isomers in *Nuclear Data Sheets* **128** (2015) 1.
4. **Update of 1998Ak04 Table of radius (r_0) parameters for alpha-decay hindrance factors, Akal University, India+McMaster University+Amity University, Noida, India**:

presentation by Sukhjeet Singh at this meeting for ALPHAD-RadD code and updated 2019 r_0 table.

Significant new data for new alpha-decaying isotopes, half-lives and branching ratios have become available since 1998Ak04 (*Nuclear Data Sheets* **84** (1998) 1). A paper on updated r_0 parameters by Sukhjeet Singh, S. Kumar, Balraj Singh and A.K. Jain was submitted for publication in July 2018. We received review comments in November 2018, and a revised version, with a thorough checking of various tables and inclusion of newer data, was submitted on 28 February 2019. Apparently, this later submission has not yet been sent for further review to a different reviewer.

5. **Update of 1998Si17 log *ft* review** (*Nuclear Data Sheets* **84** (1998) 487)**, Dresden University (Kai Zuber, Steffen Turkat)+LNHB, CEA Saclay (Xavier Mougeot)+McMaster University (Balraj Singh):** presentation by Steffen Turkat at this meeting (see Annex 6).
   We are planning to use BetaShape code for log *ft* values.
6. **Update of 2000Am02** (*At. Data Nucl. Data Tab*les **74** (2000) 283)**, and 2006-update of NNDC webpage, Table of magnetic-rotational dipole (shears) bands: (Akal University, India+Amity University, Noida, India+McMaster University)**:
   Many new papers have appeared since the previous publication in 2000. See Indian data centre report by Ashok Jain (status report from the Indian data centre, as given below).

Network Coordination:

1. December 2018: participated in an IAEA technical meeting entitled "Improvement of Analysis Codes for Nuclear Structure and Decay Data Evaluations" and dedicated to ENSDF codes - presented Alphad-radD code, J-GAMUT code, and update of r_0 parameters for even-even alpha emitters.
2. October 2018: participated in two-week IAEA-ICTP NSDD workshop at ICTP, Trieste, Italy - lectures and hands-on training in ENSDF formats, XUNDL compilations, and ENSDF evaluation of A = 218.
3. June 2017: participated in the 3rd research coordination meeting of the CRP on "Development of a Reference Database for Beta-delayed Neutron Emission".
4. Sorin Pascu from the Bucharest data centre visited McMaster for two weeks in September 2017, and for another two weeks in July 2018 for consultations concerning ENSDF issues, and to work on mass chain A = 130.

Analysis of experimental data for ^{94}Y decay to ^{94}Zr:
A set of experiments was performed in 2011 at TRIUMF using the 4π HPGe detector array, with Yates as the spokesperson. Balraj Singh participated in the experiment run for a week, and also acted in a consulting role to Anagha Chakraborty and his student during their analysis of the data undertaken at Visva Bharati University, India. Approximately 240 gamma rays have been identified from the singles and γγ-coincidence data, and placed amongst 110 levels of ^{94}Zr with the lowest intensity of 0.001%. This exercise resulted in major improvements to the decay characteristics of ^{94}Y isotope (neutron-rich fission fragment) over the last study by Balraj Singh, *et al*., *J. Phys. G* **2** (1976) 397, where only 54 gamma rays were found with the lowest intensity of ~0.01%, to be placed amongst 22 levels. Current data in the ENSDF database for this decay is identified with a Nuclear Data Sheets 1976 publication. A paper from the 2011 TRIUMF experiment has been published (*Phys. Rev. Lett.* **110** (2013) 022504), while a detailed paper is expected to be submitted for publication in about a year.

Financial Support:
ENSDF, XUNDL and NSR work: 0.70 FTE + travel support for visits to BNL from the US DOE via a contract through NNDC-BNL (note 0.39 FTE is assigned to mass chain evaluations and the rest to XUNDL+NSR work). Travel support in for an IAEA research coordination meeting for beta-delayed neutron decay in 2017, ENSDF codes in 2018, and NSDD in 2019 from the IAEA Nuclear Data Section. Infrastructure facilities: McMaster University, Department of Physics and Astronomy.

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STATUS REPORTS OF NSDD DATA CENTRES

Progress report on NSDD activities at MTA Atomki May 2017 – April 2019

J. Timár and Z. Elekes

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MTA Atomki evaluation centre

The centre at the Institute for Nuclear Research (MTA Atomki) consists of two evaluators: János Timár and Zoltán Elekes, who devote altogether 0.4 FTE as a long-term average to their mass-chain evaluation work. We have been working on mass-chain evaluations since 2009, and our permanent responsibilities are for the A = 101-105. Our evaluation studies are funded by the MTA Atomki.

Over the previous two years, our evaluation efforts for ENSDF have been somewhat less than the planned average, and we aim to address and compensate for this unsatisfactory situation in the next two-year period. Therefore, this lesser effort is reflected in the modest results that we have achieved during the reported period of May 2017 to April 2019.

Status of permanent responsibilities.

Mass	Previous NDS publication	ENSDF update
101	1998	10/2006 – 08/2010
102	2009	08/2009
103	2009	10/2009 – 05/2015
104	2007	09/2007 – 06/2015
105	2005	11/2005 – 06/2015

Mass-chain evaluations and other activities, 2017-2019

• Evaluated mass chain 101 with our Romanian colleagues; our responsibilities are ^{101}Kr, ^{101}Rb, ^{101}Sr, ^{101}Y, ^{101}Zr, ^{101}Ru, ^{101}Rh and ^{101}Pd - submitted for review, and comments received; now working on the implementation of these comments and inclusion of new experimental data.

• Mass chain 105 has been evaluated in collaboration with Stefan Lalkovski (University of Sofia); our responsibilities are ^{105}Rh, ^{105}Ag, ^{105}In, ^{105}Sn, ^{105}Sb and ^{105}Te – submitted and reviewed, and implementation of these comments is currently being addressed.

Other activity

Prepared and submitted a Letter of Intent with two other European data centres (Bucharest, Debrecen and Sofia) to participate in the Horizon 2020 Euratom proposal SANDA in order to obtain funding for ENSDF evaluations in Europe. This Letter of Intent has been approved by the core group proposing the SANDA project, and consequently the ENSDF activity was included in the final proposal. The proposal has also been reviewed by the experts of the European Commission and judged favourably, and has gone forward into the next phase of grant preparation. This is the first time that nuclear structure evaluation for ENSDF has been included in one of the nuclear data projects for funding at a European level

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STATUS REPORTS OF NSDD DATA CENTRES

Status report of the Bucharest NSDD data centre, May 2017 – April 2019

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Introduction

An NSDD Data Centre was established in IFIN-HH, Bucharest, in 2015, with two evaluators dedicating 0.2 FTE each to evaluation (total of 0.4 FTE): Alexandru Negret and Sorin Pascu. This level of activity is supported by IFIN-HH and the IAEA-NDS, with Pascu identified as the main scientific investigator in a Research Contract funded by the IAEA-NDS.

The Bucharest Data Centre responsible for six mass chains:

Mass	Cut-off date for latest ENSDF evaluation	Status
57	24 September 1998	post-review, Negret, Balraj Singh and Firestone
58	10 January 2010	^{58}Co updated by Nesaraja and Balraj Singh (cut-off date 31/10/2015)
59	1 April 2018	evaluation by Basunia
117	1 March 2009	^{117}Mo, ^{117}Tc and ^{117}Ru updated by Balraj Singh (cut-off date 20/7/2015)
118	1 November 1992	^{118}Mo, ^{118}Tc and ^{118}Ru updated by Balraj Singh (cut-off date 31/5/2015) ^{118}Rh, ^{118}Pd and ^{118}Ba updated by Balraj Singh (cut-off 15/12/2006)
119	1 December 2008	^{119}Tc and ^{119}Ru updated by Balraj Singh (cut-off date 20/7/2015)

Evaluation activities

During the period 2017-2019, the following evaluation activities were undertaken:

- Full evaluation of the A = 57 mass chain by Negret, Balraj Singh and Firestone. This mass chain evaluation was submitted for review; comments were received in 2018, and are still being implemented.
- Negret and Balraj Singh completed their evaluation of the ^{86}Sr nuclide (latest evaluation of the A = 86 mass chain had been performed in 2015 by the same authors). The new evaluation of ^{86}Sr is still awaiting inclusion into ENSDF.
- Pascu, Balraj Singh, Rodionov and Shulyak completed a full evaluation of the A = 130 mass chain, which has been submitted for review.
- A full evaluation of the A = 101 mass chain was performed in collaboration with the Hungarian Data Centre established in Debrecen. Negret was in charge of the ^{101}Sn, ^{101}In, ^{101}Cd and ^{101}Ag evaluations, and Pascu evaluated ^{101}Nb, ^{101}Mo and ^{101}Tc, while the other isotopes were evaluated by colleagues at Debrecen. We are in the process of merging all the datasets into one complete evaluation that will later be submitted for review.
- Pascu has started working on the A = 118 mass chain, supported by a Research Contract from the IAEA-NDS. The first four nuclei have been evaluated (^{118}Mo, ^{118}Tc, ^{118}Ru and ^{118}Rh), and this work will continue through 2019 with the next five or six nuclei.

Other activities

Significant effort was directed over the course of 2018 to attract new sources of funding towards ENSDF evaluations undertaken in Europe. Three European data centres (Bucharest, Debrecen and Sofia) submitted a Letter of Intent stating their wish to participate in the Horizon 2020 Euratom proposal entitled SANDA. This Letter of Intent was endorsed by the core group proposing the SANDA project, and consequently the envisaged ENSDF study was included in the proposal. Furthermore, the SANDA proposal was reviewed by experts appointed by the European Commission, and judged favourably by them. At the current moment, further negotiations are taking place. We note that this is the first time nuclear structure evaluations for ENSDF have been included in one of the nuclear data projects funded at the European level which is a most welcome programme evolution.

Following discussions during the NSDD meeting at Berkeley in 2017, Alexandru Negret has been involved in the development of a Nuclear Structure Experimental Issues (NSEI) database linked to ENSDF. The purpose of such a database is to gather nuclear structure experimental requests from various users of ENSDF that may identify cases where experimental data are questionable and/or missing. Furthermore, the nuclear structure community of experimentalists are able to react to the NSEI requests either by solving the issue by means of available results or by planning new experimental investigations. A web page has been hosted by the servers of UCB:

https://nucleardata.berkeley.edu/hpnsrl/

The next step of this project will be to make the database available to the NSDD network, to be followed later on by other appropriate scientific communities.

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STATUS REPORTS OF NSDD DATA CENTRES

Status report on activities at the NSDD centre, University of Sofia, May 2017 – April 2019

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1. Introduction

During the 22nd Nuclear Structure and Decay Data Evaluators' network meeting, held from 22 to 26 May 2017 at the Lawrence Berkeley National Laboratory, CA, USA, a new nuclear data centre was approved at the University of Sofia "St. Kl. Ohridski". As agreed, Stefan Lalkovski has been partially assigned to the Centre constituting a total of 0.2 FTE to the project. One additional purpose of the centre is to perform horizontal mass-chain evaluations for considered inclusion in ENSDF. The centre is responsible for five mass chains: A = 106, 107, 108, 111 and 112.

2. Status of responsible mass chains

Mass chain*	Last evaluation	Evaluator(s)
106	May 2007	Full evaluation: D. De Frenne & A. Negret 36 refs. since last evaluation cut-off date
	June, July 2015	Add ons: Balraj Singh (Sr, Y, Zr, Nb) 9 new refs. since 2015
107	March 2008	Full evaluation: J. Blachot 28 refs. since last evaluation cut-off date
	June 2015	Add ons: Balraj Singh (Sr, Y, Zr) 8 new refs. since 2015
108	July 2008	Full evaluation: J. Blachot 27 refs. since last evaluation cut-off date
	June, July 2015	Add ons: Balraj Singh (Y, Zr) 6 new refs. since 2015
111	February 2008	Full evaluation: J. Blachot 23 refs. since last evaluation cut-off date
	June, July 2015	Add ons: Balraj Singh (Zr, Nb, Mo) 11 new refs. since 2015
112	August 2014	Full evaluation: S. Lalkovski & F.G. Kondev 10 refs. since last evaluation cut-off date

***** Do not appear in the high-priority list, 1 May 2018.

3. Evaluation activities

Main focus has been on the A = 105 in collaboration with Debrecen Data Centre (János Timár, Zoltán Elekes) – on the high-priority request list, with a cut-off date for the previous evaluation of 1 September 2004.
Status:
• mass chain evaluated, and submitted on 31 October 2018;
• check list and review comments received on 21 November 2018;.
• ready for re-submission by 8 April 2019.

4. Plans for the next two years

The nuclear data centre joined the SANDA initiative (Supplying Accurate Nuclear Data for energy and non-energy Applications) on the basis of a Horizon 2020 project proposal which was approved this year and is expected to start in September 2019. Our proposal for evaluation work was identified with WP4: Nuclear data evaluations and uncertainties; Task 4.2. Fission yields, and nuclear structure and decay data evaluations; Sub-task 4.2.2. Evaluation of nuclear structure and decay data - dedicated total effort (Stefan Lalkovski) of 5.3 person-months for mass-chain evaluations only. Hence, funding for two years at this level of 0.22 FTE is now considered to be secured from the end of 2019 to the end of 2021. Nuclear Data evaluations of one mass chain (A = 107) will be performed in this period. Depending on the progress achieved, a second mass chain evaluation will also begin in the same period (most likely to be mass chain A = 106).

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STATUS REPORTS OF NSDD DATA CENTRES

Status report from the NSDD centre, India, May 2017 – April 2019

A.K. Jain[1], Sukhjeet Singh[2], P. Joshi[3] and G. Mukherjee[4]

[1] *AINST, Amity University Uttar Pradesh, Noida, India*
[2] *Akal University, Talwandi Sabo, Punjab, India*
[3] *HBCSE, TIFR, Mumbai, India*
[4] *Variable Energy Cyclotron Centre, Kolkata, India*

Mass chain evaluations - status (A = 215-229)

India has the responsibility for mass chains A = 215-229. The current status of each of these mass chains is presented in the table below.

Mass chain	Year of evaluation	Journal reference	Earlier journal reference and update evaluator(s)	New data sets, and present status, 14 March 2019
215	2013	*NDS* **114** (2013) 2023	J.K. Tuli, *et al.*	13
216	2007	*NDS* **108** (2007) 1057 + updated ENSDF files	S.-C. Wu + Balraj Singh and M. Birch	9
217	2018	*NDS* **147** (2018) 382	Balraj Singh, *et al*.	nil
218	2006	*NDS* **107** (2006) 1027 + updated ENSDF files	A.K. Jain and Balraj Singh + Balraj Singh and Birch	new evaluation submitted to NNDC
219	2001	*NDS* **93** (2001) 763 + updated ENSDF files	E. Browne; + Balraj Singh (and M.Birch)	new evaluation submitted to NNDC
220	2011	*NDS* **112** (2011) 1115	E. Browne and J.K. Tuli	5
221	2007	*NDS* **108** (2007) 883 + updated ENSDF files	A.K. Jain, Sukhjeet Singh, Suresh Kumar and J.K. Tuli + Balraj Singh and M. Birch	new evaluation submitted to NNDC, December 2018
222	2011	*NDS* **112** (2011) 2851	Sukhjeet Singh, A.K. Jain and J.K. Tuli	4
223	2001	*NDS* **93** (2001) 763 + updated ENSDF files	E. Browne + Balraj Singh and M. Birch	evaluation underway - BRNS workshop, HBCSE, 2016
224	2015	*NDS* **130** (2015) 127	Sukhjeet Singh and Balraj Singh	2
225	2009	*NDS* **110** (2009) 1409 + updated ENSDF files	A.K. Jain, R. Raut and J.K. Tuli + Balraj Singh and M. Birch	2
226	1996	*NDS* **77** (1996) 433; + updated ENSDF files	Y.A. Akovali; + Balraj Singh, *et al*.	evaluation underway
227	2016	*NDS* **132** (2016) 257	F.G. Kondev, *et al*.	2
228	2014	*NDS* **116** (2014) 163	Khalifeh Abusaleem	1
229	2008	*NDS* **109** (2008) 2657 + updated ENSDF files	E. Browne and J.K. Tuli + Balraj Singh and M. Birch	10

Progress in mass chain evaluations

Mass chains evaluated

Nuclear data sheets of A = 221, submitted to NNDC, 2018
Nuclear data sheets of A = 219, submitted to NNDC, 2018
Nuclear data sheets of A = 217, *NDS* **147** (2018) 382

A = 217 mass chain was evaluated as part of an IAEA-ICTP workshop, 2016: Sushil Kumar (Punjab, India) participated in this workshop, and contributed to the evaluation of ^{217}Ra.

Nuclear data sheets of A = 218, submitted to NNDC, 2019, by Balraj Singh

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A = 218 mass chain was evaluated as part of an IAEA-ICTP workshop, 2018: Indu Bala (New Delhi), Ritwika Chakraborti (Mumbai), Debasmita Kanjilal (Kolkata) and Soumen Nandi (Kolkata) participated in this evaluation work.

Mass chains undergoing evaluation

A = 223, 226

Horizontal Evaluations

1. Nuclear radius parameters (r_0) for even-even alpha emitters
Sukhjeet Singh, Sushil Kumar, Balraj Singh and A.K. Jain, submitted to *Nuclear Data Sheets*, February 2019.

   Decay data for 186 even-even alpha emitters have been analysed to extract nuclear radius parameters (r_0) based on the Preston spin-independent formalism for alpha-decay probabilities. A suite of databases available at the website of National Nuclear Data Center (NNDC), Brookhaven National Laboratory, USA, was consulted to ensure the completeness and reliability of available experimental data pertaining to the alpha decay of all even-even nuclides. After a comprehensive literature review, 26 new even-even alpha emitters have been added to the previous evaluation published by Y.A. Akovali (1998Ak04).

2. Tables of MR and AMR bands
Sukhjeet Singh, Sushil Kumar, Deepika Choudhuri, Balray Singh and A.K. Jain - in progress.

   We present a recent in-depth assessment of all experimentally observed MR bands pertaining to the mass region 58<A<206. There was a total of 120 MR bands in 56 nuclei in an earlier study by Amita *et al*. (2000), while another subsequent compilation consisting of a total of 178 bands observed in 76 nuclides was published on-line (2006). We have updated the earlier compilation to include 41 MR bands as observed in 31 new nuclides. Additionally, 19 MR bands already available in the earlier compilation have been extended to higher spins. Therefore, as a consequence of these further studies, we have added 358 M1 and 196 E2 transitions to the previous compilation. A maximum number of 55 MR bands have been identified in the Pb isotopes. Among all 219 MR bands, a total of 160 are of regular nature, whereas 53 exhibit irregular behaviour, 14 possess signature splitting, and 77 show a back-bending phenomenon.

   We have also extracted AMR bands with their probable configuration assignments. Up until the present time, 16 AMR bands have been observed in 12 different nuclides, of which the lightest and heaviest nuclides are ^{100}Pd and ^{144}Dy, respectively. A maximum number of five AMR bands are observed in the Cd and In isotopes.

3. Atlas of Nuclear Isomers
A.K. Jain, Bhoomika Maheshwari, Swati, Alpana Goel and Balraj Singh

   Our earlier publication in *Nuclear Data Sheets* 128 (2015) 1–130 contains a listing of 2469 isomers with half-lives greater than 10 ns, and continues to be an active area of research with many measurements being reported. Since 2015, we have come across 70 new cases of nuclear isomers, while three other cases reported earlier have been discarded (see tables below). An updated Atlas is being prepared in which all of these isomers have been compiled along with their data, with the following noteworthy observations:

   - seniority isomers decaying by E1 decay mode are predicted, and have been seen for the first time;
   - B(E2) anomaly in the decay of the first 2+ levels of Sn isotopes has been resolved for the first time;
   - generalised seniority scheme shown to be more broadly valid;
   - generalised seniority Schmidt model for magnetic moments has been proposed.

A half-life limit of 10 ns was used, in contrast to ENSDF in which this limit has been 100 ns. Although we feel that 10 ns is a very useful limit, even lower half-lives had to be defined in order to show the existence of odd-multipole decaying seniority isomers.

New isomers – 70 cases			
^{26}P	^{120}I	^{160}Nd	^{179}Tl
^{52}Co	^{123}Sn	^{160}Sm	^{184}Tl: two cases
^{72}Co	^{127}Cd	^{161}Pm	^{189}Re:two cases
^{76}Co: two cases	^{128}Cd	^{161}Sm	^{191}Re: two cases
^{79}Zn	^{130}In	^{162}Sm	^{195}Bi: two cases
^{92}Rh	^{133}Xe	^{163}Eu	^{203}At: two cases
^{94}Rb	^{135}Ba	^{163}Gd	^{208}Pb: three cases
^{96}Y	^{140}Sb	^{164}Gd	^{209}Tl: two cases
^{96}Cd	^{150}Pr	^{165}Tb	^{212}Ra
^{97}Cd	^{152}Pr	^{166}Tb	^{213}Ra: two cases
^{98}Y: two cases	^{156}Lu	^{167}Tb	^{220}Pa: two cases
^{98}Ag	^{158}Nd	^{168}Tb	^{254}Rf: two cases
^{98}Cd	^{158}Pm	^{172}Dy	^{258}Rf: two cases
^{119}Sn	^{159}Pm	^{172}Ta: two cases	

Three discarded isomers			
30	43	^{73}Zn	isomer with 5.8 s half-life removed on the basis of 2017Ve05 studies
57	73	^{130}La	110.4-keV isomer with half-life of 17(5) ns (1996Xu01) was not verified by 2014Io01 studies – latter group saw only a prompt transition, with an upper limit for the half-life set at <10 ns; therefore, isomer removed from compilation
63	75	^{136}Pm	27.3+X keV: this isomer was a misprint

Isomers with revised half-lives – 62 cases			
^{16}N	^{94}Ru	^{132}Te: two cases	^{184}Pt
^{26}Al	^{94}Pd: two cases	^{132}Xe	^{187}Re
^{31}Mg	^{96}Pd	^{134}Te	^{191}Re
^{34}Al	^{96}Cd	^{134}Nd	^{193}Bi: three cases
^{58}Co	^{98}Y: two cases	^{135}Ba	^{194}Po
^{65}Fe	^{99}Tc	^{136}Xe	^{195}Bi
^{66}Co	^{107}Cd	^{136}Ba	^{199}Pt
^{70}Br	^{119}Sn	^{137}Ba	^{200}Pb
^{72}Co	^{121}Sn	^{152}Tm	^{203}At
^{76}Ni	^{124}Sn	^{153}Ho	^{208}Pb
^{90}Nb	^{125}Sn	^{159}Sm	^{210}Pb
^{90}Mo	^{127}Xe	^{173}Ta: two cases	^{229}Th
^{92}Ru	^{130}In	^{179}Tl	^{235}U
^{93}Ru	^{131}La	^{180}Ta	^{251}Fm

Publications from the isomer studies:

1. Atlas of Nuclear Isomers, A.K. Jain, B. Maheshwari, S. Garg, M. Patial and Balraj Singh, *Nuclear Data Sheets* **128** (2015) 1.

2. 6^+ isomers in neutron-rich Sn isotopes, B. Maheshwari, A.K. Jain and P.C. Srivastava, *Phys. Rev. C* **91** (2015) 024321.

3. Odd-tensor electric transitions in high-spin Sn isomers and generalized seniority, B. Maheshwari and A.K. Jain, *Phys. Lett. B* **753** (2016) 122.

4. Asymmetric Behaviour of the B(E2; $0^+ \rightarrow 2^+$) values in $^{104-130}$Sn and generalized seniority, B. Maheshwari, A.K. Jain and Balraj Singh, *Nucl. Phys. A* **952** (2016) 62.

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5. Goodness of generalized seniority in semi-magic nuclei, A.K. Jain and B. Maheshwari, *Nucl. Phys. Rev.* **34** (2017) 73-81.

6. Generalized seniority states and isomers in tin isotopes, A.K. Jain and B. Maheshwari, *Physica Scripta* **92** (2017) 074004.

7. $\Delta\nu = 2$ seniority changing transitions in yrast 3^- states and B(E3) systematics of Sn isotopes, B. Maheshwari, S. Garg and A.K. Jain, *Pramana – J. Phys, Rapid Communications*, **89** (2017) 75.

8. Generalized seniority Schmidt model and the g-factors in semi-magic nuclei, B. Maheshwari and A.K. Jain, under review.

Updates

Balraj Singh has suggested that we lower the half-life limit of the isomers further to 1 ns. This would entail the inclusion of 900 more cases from within the ENSDF database. We would welcome the opinions of network members as to whether this suggestion would be to their overall benefit and use.

Present Atlas of Isomers has been accessed and read 800 times, and cited in 16 publications/papers.

STATUS REPORTS OF NSDD DATA CENTRES

Status report of the NSDD centre at Jilin University May 2017 – April 2019

Yang Dong

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Staff

Huo Junde, Yang Dong, and Hou Kairan (postgraduate student). Although Prof. Huo Junde has retired, he will continue his evaluation work.

Mass Chain Evaluations

Jilin University group is responsible for mass chains: A = 52, 53, 54, 55, 56 and 67. Mass chain A = 67 has been evaluated and submitted for review, while mass chain A = 55 is in the process of being evaluated and all references collected by Hou Kairan. The status of each mass chain is given below.

Mass chain	Previous publication	Status
52	*NDS* **128** (2015) 185	
53	*NDS* **110** (2009) 2689	
54	*NDS* **121** (2014) 1	
55	*NDS* **109** (2008) 787	evaluation underway
56	*NDS* **112** (2011) 1513	
67	*NDS* **106** (2005) 159	evaluation completed and submitted for review

Other research activities

Studies of high-spin states of nuclei formed by means of heavy-ion fusion-evaporation reactions and in-beam spectroscopy on the HI-13 tandem accelerator at the China Institute of Atomic Energy:

- Candidate chiral doublet bands in ^{138}Pm, K.Y. Ma, J.B. Lu, …. D. Yang, *et al*., *Phys. Rev. C* **97** (2018) 014305;
- A development of lifetime measurement based on the differential decay curve method, Jian Zhong, Xiao-Guang Wu, Ying-Jun Ma, ….. K.Y. Ma, Dong Yang, *et al*., *Nucl. Sci. Technol.* **29** (2018) 108;
- Structure of a positive-parity band in ^{130}Pr, K.Y. Ma, J.B. Lu, …… D. Yang, *et al*., *Eur. Phys. J.* A **53** (2017) 10.

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STATUS REPORTS OF NSDD DATA CENTRES

Status Report of the NSDD centre at CNDC May 2017 – April 2019

X. Huang, J. Wang, Y. Liu

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Staff

Huang Xiaolong and Wang Jimin. Ms Liu Yangyang is a graduate student.

1. Mass Chain Evaluations

The NSDD group at the China Nuclear Data Centre (CNDC) has permanent responsibility for evaluating and updating NSDD for A = 51, 62, and 195-198. Over the previous two years, mass chains A = 196 and 197 have been in the process of revision on the basis of the available experimental decay and reaction data: A = 197 is undergoing a second review, while A = 196 is still being evaluated.

A = 62 was assigned to CNDC from Jilin University (JLU group, China) in 2011, and was evaluated by Balraj Singh *et al*. in 2012. The status of each mass chain is as follows:

Status of Mass Chain Evaluations at CNDC.

Mass chain A	Current status	Evaluators
51	*NDS* **144** (2017) 1	Wang Jimin, Huang Xiaolong
62	*NDS* **113** (2012) 973	Balraj Singh *et al.*
195	*NDS* **121** (2014) 395	Huang Xiaolong, Kang Mengxiao
196	*NDS* **108** (2007) 1093	Huang Xiaolong, evaluation underway
197	*NDS* **104** (2005) 283	Huang Xiaolong, Wang Jimin, Kang Mengxiao, undergoing second review
198	*NDS* **133** (2016) 221	Huang Xiaolong, Kang Mengxiao

2. Decay Data Evaluations

(1) DDEP decay data evaluations

The CNDC group has been a member of the DDEP decay data evaluation project since 2007. Over the previous two years, we have updated the main decay data for ^{108m,110m}Ag, as contributions to this project.

(2) CENDL decay data sub-library of fission products

An evaluated CENDL decay data sub-library of fission products is being developed to meet the requirements of burn-up and decay-heat calculations, and analyses of the antineutrino anomaly. These decay data files are based on the contents of several other national evaluated data libraries, and the estimate is that approximately 1415 nuclides will be included in the CENDL sub-library to undertake decay-heat calculations, reactor antineutrino spectral analyses, and decay chain studies to aid in fission yield evaluations.

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STATUS REPORTS OF NSDD DATA CENTRES

Status report of the Japanese group for nuclear structure and decay data evaluations, May 2017 – April 2019

H. Iimura

Research Group for Nuclear Data
Japan Atomic Energy Agency

Members

M. Kanbe (former affiliation: Tokyo City University), J. Katakura (former affiliation: Nagaoka University of Technology), H. Koura (JAEA), S. Ohya (former affiliation: Niigata University), and H. Iimura (JAEA) who also serves as group leader. Y. Ichikawa (RIKEN) joined our group in 2018. The group holds a meeting once a year to exchange information on the progress of each member with their evaluations, and is also a sub-group of the JENDL committee.

1. Mass chain evaluations

Japanese NSDD group is responsible for the mass chain evaluations of A = 120-129. The Turkish group revised A = 128 and 129 in 2014/2015, while A = 123 is undergoing evaluation by another centre. Both Iimura and Ohya are in the process of correcting mass chain A = 126 after the return of the file by NNDC from a full review. Hashizume continued evaluating mass chain A = 120 until mid-2018, but is now unable to continue this work because of ill health – Kanbe and Katakura have taken over this set of evaluations which remains ongoing. Koura attended the joint IAEA-ICTP workshop on NSDD at ICTP, Trieste, Italy, in 2018, and has started the mass chain evaluation for A = 124.

Status of Mass Chain Evaluations for A = 120-129.

Mass	Previous *NDS* publication		Status
	Year	Evaluator(s)	
120	2002	Kitao, Tendow, Hashizume	Evaluation underway (Katakura, Kanbe)
121	2010	Ohya	
122	2007	Tamura	
123	2004	Ohya	Evaluation underway (by another centre)
124	2008	Katakura, Wu	Evaluation underway (Koura)
125	2011	Katakura	
126	2002	Katakurs, Kitao	Corrections underway (Iimura, Ohya)
127	2011	Hashizime	
128	2015	Timar, Elekes, Singh	
129	2014	Timar, Elekes, Singh	

2. XUNDL

Ichikawa has continued the compilation of nuclear structure and decay data determined at RIKEN RIBF for the XUNDL files. Several completed files were sent to the NNDC in 2018.

3. JAEA Chart of the Nuclides

The 11th edition of the JAEA Chart of the Nuclides was published at the end of March 2019 by Koura *et al*. Experimental data published up to the end of June 2018 were used in the preparation of this particular edition. The total number of identified nuclides contained in this edition has increased to approximately 3300 when compared with 3150 as defined in the previous 2014 edition. Printed copies of the new chart can be obtained from the IAEA-NDS upon request and without charge.

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STATUS REPORTS OF NSDD DATA CENTRES

Progress report on nuclear structure and decay data activities, Australian National University (ANU), May 2017 – April 2019

T. Kibédi

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Mass chain evaluations

The ANU has primary responsibilities for A = 172-175. Over the previous two years, the A = 172 evaluation has been completed in collaboration with Balraj Singh (McMaster University). Final submission is expected in the first half of 2019, after taking into account and incorporating the reviewer's comments. Part of the evaluation of A = 174 with E. Browne and J.K. Tuli has been completed, and is undergoing pre-review – full evaluation is planned for completion later in 2019.

Horizontal evaluation of E0 and mixed M1+E2+E0 transitions *(with A. Garnsworthy, TRIUMF, and J.L. Wood, Georgia Tech)*

The spectroscopic information on the decay properties of pure E0 and mixed E0+E2+M1 transitions are in the process of being evaluated, with the aim of compiling all experimental information on transition rates, mixing ratios and level life-time or absolute transition rates in order to extract ρ^2(E0) strength parameters. Attention is being paid to determining the E2/M1mixing ratios of the E0+E2+M1 transitions. Conversion coefficients and E0 electronic factors are being taken from BrIcc (2008Ki07) and the new Ω(E0) tabulations. A primary focus of this study is to explore the spin dependence of the monopole matrix elements which is crucial to extend our understanding of the structure of 0^+ states in atomic nuclei.

Ratios of sub-shell conversion electron and pair conversion intensities of pure E0 transitions *(with J. Dowie, ANU)*

More than 120 experimental ratios of E0 sub-shell conversion electron and/or pair-formation intensities has been compiled to benchmark the new Ω(E0) tabulations. This exercise has shown that theory overestimates experiment on average by about 5%. Under these circumstances, we propose to adopt a 5% uncertainty for the new Ω(E0) tabulations.

Precision electron measurements to benchmark theoretical atomic transition energies and rates *(with M. Vos, B. Tee and M. Alotiby, ANU)*

High resolution low-energy electron measurements have undertaken to study the conversion electron to Auger electron emission energies and rates from the electron capture decay of ^{125}I. These new measurements allowed us to examine fine details of the energy spectrum, including the effect of electron shake-off as well as "the atomic structure effect" related to adjustment of the atomic field immediately after electron capture. Our data indicate that the transition rates obtained from EADL can potentially underestimate the Auger yield by about 15-20% (see M. Alotiby, *et al*., *J. Electron Spectrosc. Relat. Phenom.* **232** (2019) 73).

New theoretical Ω(E0) electronic factor tabulations for E0 transitions *(with J. Dowie and T. Eriksen, ANU)*

Two new theoretical tabulations of E0 electronic factors have been developed:

1. conversion electrons obtained by means of a modified version of the CATAR program developed by Pauli and Raff with a relativistic-Hartree-Fock-Slater approach (*Comp. Phys. Comm.* **9** (1975) 392);

2. conversion-electron tabulation based on the model developed by Wilkinson (*Nucl. Phys.* **A133** (1969) 1).

Both tabulations have the same coverage in terms of Z, atomic shells and multipolarities as that of BrIcc. A full publication for *At. Data Nucl. Data Tables* is being prepared, and the tables will be available in the new version of BrIcc.

ENSDF code developments *(with B. Tee, J. Dowie and B. Combes, ANU)*

1. **GABS:** the program has been re-written and additional operation modes have been added to calculate the absolute photon intensity, %IG; uncertainty propagation and error checking have also been improved.
2. **NS_LIB:** development of a new general library to read, verify ENSDF files and carry out common operations (calculation of ICCs, total intensities, uncertainty propagation, etc.) has been continued – several new codes (BrIcc V3, NS_RadList, UncTools) under development share many of the 200 subroutines;
3. **NS_Radlist:** this new atomic radiation library for elements up to Z = 100 that covers all atomic shells has been completed – testing of NS_Radlist has begun, and the first release of the code is planned for 2019;
4. **BrIcc:** current version 2.4 has been used over the previous five years:
    - several smaller modifications has been implemented, mainly related to the protocol of how total conversion coefficients are placed in the G or S_G records;
    - testing of the new version, which uses the new single data file combining conversion coefficients up to Z = 126, pair formation coefficients up to Z = 100, E0 electronic factors for conversion electrons up to Z = 126, and pair formation up to Z = 100 is underway;
    - Monte-Carlo procedure has been adopted in the new BrIcc to propagate uncertainties.

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STATUS REPORTS OF NSDD DATA CENTRES

Status report – Petersburg Nuclear Physics Institute May 2017 – April 2019

I.A.Mitropolsky and A. Rodionov

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The Data Centre is part of the Nuclear Spectroscopy Laboratory in the Neutron Research Department of the Petersburg Nuclear Physics Institute (PNPI), and covers the work of three physicists and one mathematician (Ludmila Kabina, Ivan Mitropolsky, Alexander Rodionov, Georgy Shulyak).

Our main activity is connected with information support of fundamental research nuclear reactor technologies, and the evaluation of nuclear data for nuclear spectroscopy.

1. ENSDF evaluations

PNPI area of responsibility for ENSDF evaluations is identified with mass chains A = 130 to 135.

Mass number	Last publication	Comments
130	*NDS* **93** (2001) 33	evaluation completed, 2018 review underway
131	*NDS* **107** (2006) 2715	
132	*NDS* **104** (2005) 497	evaluation underway – Balraj Singh
133	*NDS* **112** (2011) 855	
134	*NDS* **103** (2004) 1	
135	*NDS* **109** (2008) 517	
Additional mass chain		
146	*NDS* **136** (2016) 163-452	evaluation completed and published

2. Object-oriented databases

The ANGTOL database is designed to solve the following problems:

- analyses of the quality of nuclear level schemes – to check the placement of transitions in the level scheme;
- statistical analysis of ENSDF data and construction of various distributions of nuclear characteristics;
- global nuclear data systematics, and the search for new regularities.

Both the ROTAN database and BARON code are designed for the analysis of rotational bands in nuclei, the model description of energies of rotational levels, and the systematics of parameters describing nuclear rotation. Polynomial parametrization of Bohr-Mottelson or the model of variable moment of inertia is used to describe the rotational energies, and such an analysis can be a useful evaluation process for the unambiguous selection of levels in the rotational band.

The ISOTIME database contains information relating to the lifetimes of nuclear states, which provides the means of identifying both types of decay and their production channels. Such an approach has proved to be very useful in the systematization of nuclear isomers, whereby full spectroscopic information can be presented for each isomer.

MASCA allows us to work with atomic masses to calculate nuclear binding energies, particle separation energies, decay energies, and energy parameters of nuclear reactions. All such resulting nuclear data can be presented in both tabular and graphical forms.

NUCLEAR_REFS_MANAGER is a useful package of programs for maintaining the collection of publications - articles, preprints, abstracts, private communications, etc., which possess keywords in NSR database format.

ANNEX 6

TECHNICAL PRESENTATIONS: CODES (1), OTHER (2)

ANNEX 6

TECHNICAL PRESENTATIONS: CODES (1), OTHER (2)

ALPHAD and ALPHAD_RadD *codes*

Sukhjeet Singh[1], Sushil Kumar[1] and Balraj Singh[2]

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[2]Department of Physics and Astronomy, McMaster University, Hamilton, ON, Canada

Modifications made to the original ALPHAD code has led to the new ALPHAD_RadD code, which allows automatic deduction of radius parameter (r_0) by means of our 2019 updated input file of radius parameter (r_0) for 188 even-even alpha emitters. Discussions during the course of the NSDD-2019 meeting focussed initially on input statements concerning the radius parameter in the output and report files. Bugs/issues found in the original version of ALPHAD during the process of evaluation of the r_0 parameters were also resolved, some at NNDC and others by the authors:

1. Alpha records when alpha intensity absent in an input dataset in ENSDF format: report file erroneously gave 100% alpha branch, followed by an unrealistic low hindrance factor.
2. Problem with unplaced alpha records in an ENSDF formatted input data file: a serious issue which led to an incorrect calculation of the radius parameter (r_0), and hence hindrance factors.
3. Symbols for super-heavy elements Z = 112-118: ALPHAD was updated to read the official symbols for the super-heavy elements (SHE) in an ENSDF-formatted file.
4. Asymmetric uncertainties in the half-life of a parent nuclide: currently both codes use only the upper uncertainty as a symmetric uncertainty, ignoring the lower uncertainty. We plan to resolve this issue in the future.

Revised ALPHAD and ALPHAD_RadD packages were sent to the IAEA-NDS on 11 March 2019.

Details of the evaluation of the radius parameters for 188 even-even alpha emitters were also discussed, together with our submission of a paper on the update of the 1998 Table of radius parameters (r_0) in July 2018, and a revised version in February 2019 for publication in *Nuclear Data Sheets*.

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TECHNICAL PRESENTATIONS: CODES (1), OTHER (2)

GABS code – new version to evaluate normalisation factors and absolute photon intensities

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As part of the effort to modernise particular computer codes for application in ENSDF evaluations, the GABS program used to calculate decay scheme normalisation factors has been re-written to enhance functionality and improve the user interface of the code. The program was originally written by Eddie Browne (LBNL) to calculate the Normalisation (NR) and Branching Ratio factors (BR) from the total intensity of the electromagnetic radiations feeding the ground state or within a transition cascade.
E. Browne, *Nucl. Instrum. Methods Phys. Res.* **A249** (1986) 461; erratum, *ibid* **345** (1994) 215.

Knowledge of the absolute photon intensities (%IG) can play a pivotal role in many applications of nuclear decay data. These intensities can be calculated from the relative photon intensities (RI), NR and BR factors as %IG = RI*NR*BR. However, when a particular transition is used in the normalisation process, the uncertainty of %IG for this transition can be overestimated. This limitation can be overcome by calculating %IG during the normalisation procedure. Sometimes NR and BR can be independently determined from the transitions that feed the ground state, whereby GABS could be used to calculate %IG from RI, NR and BR.

Over the previous two years, the GABS code has been completely re-written in order to simplify the logic and add extensive error checking along with new functionalities. The present version can be used in three different modes:

(a) -F mode to calculate NR and BR for single and multiple data sets, and %IG when NR is not known,
(b) -C mode to calculate %IG from RI, NR and BR when NR and BR are known,
(c) -M mode to search transitions that feed the ground state directly.

This new version of the code allows the use of transitions without any uncertainty assigned to the relative photon intensity. The assumption is made that the other transitions feeding the ground state carry all of the uncertainty of the photon intensities – constitutes a major difference when compared with previous versions.

When direct α, β or EC feeding from the parent state to the ground state does exist, this decay branch can now be specified on a N-continuation record, which simplifies the preparation of the input file and the program logic. Significant effort has also been expended to improve the uncertainty propagation of the code, and the program manual has been re-written with additional examples to aid the user. Rounding of the output numerical values has been modified, in line with the practice of many widely used statistical programs. The new version of GABS is expected to be released in the near future.

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TECHNICAL PRESENTATIONS: CODES (1), OTHER (2)

New and updated ENSDF codes at NSCL/MSU

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A primary goal of code development at the NSCL/MSU data center is to modernize the legacy ENSDF codes by means of the Java programing language, and to develop new analysis and utility codes to help facilitate the ENSDF evaluation procedure and improve evaluation efficiency.

Java-RULER will replace the old FORTRAN code that lacks maintenance and capability in dealing with the uncertainty propagation of large and asymmetric uncertainties. This new code not only keeps all functions that the old one possesses, but also solves the uncertainty-propagation issue by including two additional approaches – Minimum and Maximum approach, and Monte-Carlo approach – as well as the existing Taylor expansion approach that can only deal with relatively small (<10%) and symmetric uncertainties. The Monte-Carlo approach has the potential to become the standard.

Other relevant codes developed at NSCL/MSU:

1) ConsistencyCheck code aims to replace the PANDORA code in FORTRAN; this code has more functions than PANDORA for checking data consistency among datasets, as well as many additional features that help speed up the preparation of Adopted datasets.
2) KeynumberCheck code helps to find and locate all keynumbers in datasets that have format errors (missing/redundant characters, wrong format, etc.), are irrelevant to the nuclides/mass-chains, or are non-existent (mostly due to mistyping), by searching the online NSR database. Also can provide a list of possible missing references.

TECHNICAL PRESENTATIONS: CODES (1), OTHER (2)

Proposed data format for inclusion of atomic radiations in ENSDF

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Auger electrons and X-rays are emitted following the creation of atomic vacancies in electron capture (EC) and internal conversion (IC) processes, and are required for many radioisotopic applications. The energy released in these processes is also important for the calculation of the total energy from radioactive decay. Participants at the 22nd NSDD Evaluators' network meeting accepted a proposal to develop computer tools and a suitable data format to include both Auger-electron and X-ray data in ENSDF:

https://www-nds.iaea.org/publications/indc/indc-nds-0733.pdf

A new physical model, BrIccEmis has been developed to describe the full atomic radiation spectrum from nuclear decay [1]. This model uses ENSDF as input for all required nuclear decay data, BrIcc for internal conversion coefficients [2], EC rates from the Schönfeld model [3], and atomic transition rates from the Evaluated Atomic Data Library (EADL) [4]. A Monte-Carlo approach has been adopted in BrIccEmis to ensure a correct treatment of the propagation of the atomic vacancies. Transition energies are evaluated from a direct calculation of the atomic configuration by means of the RAINE code [5]. The calculations outlined above are rather computer intensive, and therefore a new database of pre-compiled atomic radiation spectra has been assembled to overcome this limitation [6].

A new computer code is also being developed (NS_RadList), which is designed to calculate the full atomic radiation spectra very quickly based on the ENSDF file as input. This approach will allow evaluations of the atomic radiation spectra up to the point when atomic vacancies reach the valence shells, or no other atomic transition is allowed. As multiple vacancies are created during the vacancy cascade, continuously shifting transition energies will result in a very large number of discrete energies. The data format adopted for the ENSDF is based on the IUPAC classification [7], whereby a number of radiation classes have been defined for X-rays (KL2, KL3, KM, etc.) and for Auger electrons (KLL, KLX, LLM, etc.) by means of the shell indicators involved in the transitions. While NS_Radlist evaluates the complete radiation spectrum for each of the classes, only the mean energy and transition probability will be included in ENSDF. A new record type has been adopted, with a letter "M" in column 8, and "A" for Auger electrons and "X" for X-rays in column 7. Each record should contain the energy and transition probability for a single transition (see sample below). These atomic radiation records should appear after the parent and the normalisation records.

Typical atomic radiation records for ^{103}Pd EC decay are given below, as follows:

```
103RH  AM E(Tot)= 0.416$ I(tot)= 9.78E+02$
103RH2AM E(Ktot)= 17.758$ I(Ktot)= 1.77E+00$
103RH2AM E(KLL)= 16.857$ I(KLL)= 1.24E+00$
103RH2AM E(KLX)= 19.627$ I(KLX)= 4.88E-01$
…
103RH  XM E(tot)= 11.995$ I(tot)= 1.44E+01$
103RH2XM E(Ktot)= 20.661$ I(Ktot)= 7.47E+00$
103RH2XM E(KL2)= 20.134$ I(KL2)= 2.16E+00$
```

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TECHNICAL PRESENTATIONS: CODES (1), OTHER (2)

[1] B.Q. Lee, *et al*., *Int. J. Radiat. Biol*. **92** (2016) 641,
http://dx.doi.org/10.3109/09553002.2016.1153810
[2] T. Kibédi, *et al*., *Nucl. Instrum. Methods Phys. Res.* **589** (2007) 202,
https://doi.org/10.1016/j.nima.2008.02.051
[3] E. Schönfeld, *Appl. Radiat. Isot*. **49** (1998) 1353.
[4] S.T. Perkins, *et al*., Lawrence Livermore National Laboratory report UCRL-50400-V-30 (1991).
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[6] B.Q. Lee, *et al*., in preparation.
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ANNEX 6

TECHNICAL PRESENTATIONS: CODES (1), OTHER (2)

BetaShape code

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The first version of BetaShape as a new code for improved calculations of beta spectra was released during 2016. Major features of this code are improved theoretical modelling of the beta-decay process, a database of experimental shape factors, the provision of mean energies and log*ft*-values, as well as beta and neutrino spectra, the ability to interface with ENSDF files, and the propagation of the uncertainties from the input data. This code is also used by the DDEP (Decay Data Evaluation Project) international collaboration for decay data evaluations.

Developments since then have been implemented in a new version of the code. Radiative corrections have been modified from previous modelling developed in the 1970s to an accurate and modern model developed in the context of the high-precision study of super-allowed beta decays. Furthermore, the treatment of uncertainty propagation has been modified when there is a lack of uncertainty information in the input file since the previous treatment led to unrealistic values. The database of experimental shape factors has been updated for the ^{36}Cl and ^{138}La β^- transitions, and the ground-state-to-ground-state β^+ transition occurring in ^{14}O decay has been added. Following a request from various users who experienced difficulties in using the code, a specific file format for continuous data compatible with the ENSDF format has been proposed to provide recommended β spectra directly. A continuation record has also been suggested to provide the parameters of an experimental shape factor within individual ENSDF files.

Recently, the calculation of electron capture transitions has also been included in the BetaShape code. Improved modelling of electron captures for allowed and forbidden unique transitions has been developed, which is based on the Behrens-Bühring formalism. Relativistic wave functions of the atomic electrons are calculated by means of an iterative procedure with a convergence to precise atomic orbital energies, as taken from modelling in terms of the Relativistic Local Density Approximation which includes electron correlations. Such energies have been interpolated from Z = 92 to 120, and parameters have been tabulated to speed up drastically the calculation of the wave functions. These wave functions are used to determine every overlap needed for additional corrections. The two common approaches from Bahcall and Vatai to correct for the atomic overlap and exchange effects have been extended to every subshell in a unified formulation, with the electron occupation taken precisely into account. Shake-up and shake-off effects (which create secondary vacancies) and the influence of the hole arising from the capture process have been considered. Radiative corrections based on Coulomb-free theory have been included. Uncertainties are estimated. The BetaShape code provides relative capture probabilities and their ratios, and includes capture-to-positron ratios for each subshell. Splitting of the branch between electron capture and β^+ decays and the log*ft*-value are also given. A comparison with different precise measurements available in the literature has highlighted good agreement and consistent results in the validation of this modelling. These developments are part of the European EMPIR project MetroMMC.

Other ongoing work within the European EMPIR project MetroBeta is related to the inclusion of the nuclear structure component in the calculation of low-energy weak interaction decays. A preliminary code has been validated by means of simple nucleon wave functions determined from a simple shell model that considers both non-relativistic and relativistic harmonic oscillator solutions. Theoretical shape factors and partial half-lives of about twenty allowed and forbidden beta transitions have been calculated and compared with measurements. This work has to be considered as a first step, with only single particle nuclear matrix elements being calculated in spherical symmetry. However, this approach lays the foundations of future work for a correct treatment of deformed nuclei and forbidden non-unique transitions by means of nuclear wave functions from precise nuclear structure models.

The new version of the BetaShape code is still under development. A released version is expected by June 2019 to be tested by evaluators. A review of the log*ft*-values for a selection of well-defined transitions will be carried out in collaboration with McMaster University and TU Dresden. This review will be used to validate the code in view of possible adoption by the NSDD Evaluators' network at the Nuclear Data Week in November 2019.

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TECHNICAL PRESENTATIONS: CODES (1), OTHER (2)

Database of Nuclear Structure Experimental Issues (NSEI)

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Action 28, IAEA report INDC(NDS)-0733, November 2017

As defined at the 22nd meeting of the NSDD Evaluators' network that took place in LBNL, Berkeley, USA in 2017, Action 28 reads "Create website of high-priority nuclear structure and decay-data measurements for information and guidance".

This note summarizes the response to this action with respect to the creation and evolution of the Nuclear Structure Experimental Issues (NSEI) Database with the following aims and purposes:

- gather experimental issues raised by evaluators or users of ENSDF;
- display them to the community of experimentalists;
- address the issues through new experiments, or extended analysis of available experimental data.

The website was designed through collaborative effort between co-authors at the IFIN-HH, Romania and University of California Berkeley, USA, and is hosted by servers at Berkeley. Accessed can be gained via: https://nucleardata.berkeley.edu/hpnsrl/
This website allows users to add new experimental issues, and also to upload comments to existing issues. Both these actions are subject to the approval of the moderators of the website (i.e., authors of this short information note), who will then reach out to researchers who might potentially be able to address a particular issue (or issues).

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TECHNICAL PRESENTATIONS: CODES (1), OTHER (2)

Review of log*ft* values

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Balraj Singh, J.L. Rodriguez, S.S.M. Wong and J.K. Tuli published a review in 1998 on log*ft* values (*Nucl. Data Sheets* **84** (1998) 487-563; https://doi.org/10.1006/ndsh.1998.0015). The authors used the ENSDF database of August 1997, and extracted β-transitions fulfilling certain cut-off criteria. As a result ~3900 reliable transitions and their corresponding log*ft* value were analysed.

Nuclear transition data have improved since 1998, not least because of the establishment of mass determinations by means of Penning traps whereby Q-values can be determined much more precisely. Furthermore, most half-lives and decay schemes have undergone revisions, and Mougeot is in the process of finalising his BetaShape code which is able to calculate log*ft* values and update the latest Q-values simultaneously (X. Mougeot, *Phys. Rev.* **C91** (2015) 055504; http://link.aps.org/doi/10.1103/PhysRevC.91.055504). Taking these various developments into account, a recalculation of log*ft* values would be of benefit through adoption of contemporary data and analysis procedures in order to update the work undertaken in 1998.

There are a total of ~25200 β-transitions available in the ENSDF database of January 2019. Approximately 7100 of these transitions fulfil necessary criteria, such as e.g., availability of strongly assigned J^{π} values for parent and daughter nuclei. Beside objective cut-off criteria, there are also exclusion criteria which are more difficult to handle. Due to the fact that γ-feeding into the nuclear level of interest can hinder the correct determination of the log*ft* values for the corresponding β-transition (Pandemonium effect), certain transitions in complex decay schemes have to be excluded.

This presentation is based on collaboration between Xavier Mougeot (Laboratoire National Henri Becquerel, France), Balraj Singh (McMaster University, Canada), and Kai Zuber and Steffen Turkat (both Technische Universität Dresden, Germany).

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TECHNICAL PRESENTATIONS: CODES (1), OTHER (2)

Test of internal conversion theory: Precise α_K and α_T internal conversion coefficient measurements of 39.752(6)-keV *E3* transition in ^{103m}Rh

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The ninth in a series of precise internal conversion coefficient (ICC) measurements has been completed which focused on the 39.752(2)-keV, *E3* transition in ^{103m}Rh. These measurements started more than fifteen years ago at the Cyclotron Institute in support of ICC theoretical calculations. By measuring ICC values at 1-2% relative precision, one can assess and guide Dirac-Fock calculations with respect to which of the various theoretical approaches fit the experimental values better: those that ignore or those that include the atomic vacancy. All previous results, as well as the value reported here, have shown that calculations in which the atomic vacancy is included are in better agreement with experiment. As a result of our measurements, the ENSDF community has chosen to adopt the “frozen-orbital” approach whereby calculations by means of the BrICC code include the atomic vacancy.

The 39.752(2)-keV γ transition in ^{103m}Rh was studied via both ^{103}Ru β^- decay and ^{103}Pd ε decay. We used the Kx to γ rays ratio method for α_K measurements, and deduced α_T from the γ-ray intensity balance at the 39.8-keV level. Both α_K and α_T results were determined from ^{103}Ru β^- decay studies, and the ^{103}Pd ε decay measurements were used as a consistency check. Two sources of ^{nat}Ru and one source of ^{nat}Pd were prepared by thermal neutron activation at the Triga reactor of the Nuclear Science Center of Texas A&M University, and then monitored be means of an HPGe detector for several months. We determined the detector efficiency very precisely by measurements and Monte-Carlo simulations: 0.2% for the energy interval 50-1400 keV, 0.4% for the energy interval 1400-3500 keV, and ~1% for the energy interval 10-50 keV. All impurity radiations and other contaminants were thoroughly reduced.

Our experimental results are α_K = 141.1(23) and α_T = 1428(13). Dirac-Fock calculations that include the effect of the atomic vacancy yield α_K = 135.3(1) and α_T = 1404(1), while those that exclude the vacancy yield α_K = 127.5(0) and α = 1388(2). These results are in disagreement with both types of calculations, albeit less so for the calculations that include the vacancy. However if a small 0.04% *M4* admixture is included as found by the measurement that assigned the *E3* multipolarity for this transition in the first place, the calculations that include the vacancy give α_K = 139.3(1) and α_T = 1426(1), and those that exclude the vacancy give α_K = 131.2(1) and α_T = 1410(2). Thus, good agreement is re-established with theory in which the vacancy is included, while the disagreement persists if the theory vacancy is ignored.

N. Nica, J.C. Hardy, V.E. Iacob, V. Horvat, H.I. Park, T.A. Werke, K.J. Glennon, C.M. Folden, V.I. Sabla, J.B. Bryant, X.K. James and M.B. Trzhaskovskaya, *Phys. Rev. C* **98** (2018) 054321, and references therein.

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TECHNICAL PRESENTATIONS: CODES (1), OTHER (2)

Status of the Decay Data Evaluation Project (DDEP)

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The Fundamental Data Unit of the *Laboratoire National Henri Becquerel* (*LNHB*) – French national standards laboratory – performs a number of full decay scheme evaluations as part of the Decay Data Evaluation Project (DDEP). Particular attention is paid to the atomic data, with both conversion- and Auger-electron data included, as well as the emitted X-rays.

Evaluated data from the LNHB are part of the DDEP, whose current working membership was listed along with the means of access to these data. Recommended DDEP datasets are currently available within seven hardcopy volumes of the Monographie-5 series published by the *Bureau International de Poids et Mesures* (*BIPM*), which can also be downloaded free of charge from:
https://www.bipm.org/en/publications/scientific-output/monographie-ri-5.html
along with volume 8 which was assembled and issued in 2016.

The recommended data and detailed evaluator comments are also available from the new LNHB website, with a specific section dedicated to DDEP:
http://www.lnhb.fr/nuclear-data/nuclear-data-table/
Recently, PenNuc files have also been added. These specific files can be used as an input to the PENELOPE Monte-Carlo simulation code with PenNuc add-on. This add-on manages the decay scheme and the atomic relaxation of the chosen radionuclide with uncertainty propagation automatically, allowing easy evaluation of dose or energy spectrum deposited in a detection system. A similar module is being developed at LNHB for the Geant4 Monte-Carlo simulation code. Alternatively, a tool for alpha and gamma spectrometry has been developed at the LNHB to provide a user interface that allows searches of the DDEP database to be made, which is available at:
http://www.lnhb.fr/donnees-nucleaires/module-lara/
Some criteria can be set on intensities and energies, and consequently the decay scheme is redrawn on-the-fly.

LNHB staff are also developing a code to calculate precisely beta and electron capture decays, in conjunction with an experimental programme to validate the code. Further details were given in the separate presentation made during the "computer codes" session of the meeting.

Details of the DDEP have been given, along with where evaluated data can be downloaded. There is a shortage of decay data evaluators, and hopefully other metrology institutes will help to fill this void. Nevertheless, manpower issues are expected to remain a major concern for the future.

23rd Meeting of the *International Network of Nuclear Structure and Decay Data Evaluators*

8 – 12 April 2019
IAEA Headquarters, Vienna International Centre, 1400 Vienna, Austria

Links to Presentations

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5	Kelley	TUNL	PDF slides
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7	Iimura	Japan	PDF slides
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11	Nica	Texas A&M	PDF slides
12	Basunia	LBNL/UCB	PDF slides
13	Nesaraja	ORNL	PDF slides
14	Rodionov	Russian Fed.	PDF
15	Singh	Canada	PDF
16	Kibedi	ANU	slides
17	Dimitriou	IAEA	slides
18	Sonzogni	NNDC/BNL	PDF slides

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2	E. McCutchan	ENSDF Status Report	slides
3	B. Pritychenko	NSR Status Report	slides
4	X. Mougeot	DDEP Status Report	slides
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3	T. Kibedi	Final Atomic Data Format	PDF
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19	B. Singh	J-GAMUT	PDF
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