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INDC International Nuclear Data Committee

Summary Report of the 24th Technical Meeting

INTERNATIONAL NETWORK OF NUCLEAR STRUCTURE AND DECAY DATA (NSDD) EVALUATORS

Australian National University, Canberra, Australia
24 – 28 October 2022

J. Chen
Michigan State University
National Superconducting Cyclotron Laboratory
East Lansing, MI, USA

A. Negret
Horia Hulubei National Institute for Physics and Nuclear Engineering
Bucharest-Magurele, Romania

P. Dimitriou
International Atomic Energy Agency
Vienna, Austria

May 2023

IAEA Nuclear Data Section
Vienna International Centre, P.O. Box 100, 1400 Vienna, Austria

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or to:
Nuclear Data Section
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 Vienna
Austria

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ABSTRACT

The 24th meeting of the International Network of Nuclear Structure and Decay Data Evaluators was convened at the Australian National University in Canberra, Australia, from 24 to 28 October 2022 under the auspices of the IAEA Nuclear Data Section. This meeting was attended by 45 scientists (16 in person, 29 remote) from twelve 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.

May 2023

GLOSSARY

A	Mass Number
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
BNL	Brookhaven National Laboratory, USA
BR	Branching Ratio
BrIcc	Program to calculate Band-Raman internal conversion coefficients
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
EADL	Evaluated Atomic Data Library
EGAF	Evaluated Gamma-ray Activation File
ENDF	Evaluated Nuclear Data File
ENSDF	Evaluated Nuclear Structure Data File
EXFOR	EXchange FORmat: Computer-based system for the compilation and international exchange of experimental nuclear reaction data, IAEA-NDS
FMTCHK	ENSDF analysis program to check format in ENSDF dataset
FTE	Full Time Equivalent
GABS	ENSDF analysis program in Fortran to calculate gamma absolute intensity
GLSC	ENSDF analysis program in Java, alternative to GABS and GTOL combined
GTOL	ENSDF analysis program in Fortran to fit to gamma energies and obtain level energies
HF	Hindrance Factor
IAEA	International Atomic Energy Agency
ICC	Internal Conversion Coefficients
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
JAEA	Japan Atomic Energy Agency
Java-NDS	Nuclear Data Sheets publication code in Java programming language
Java-RULER	ENSDF analysis program in Java to replace the RULER program
LBNL	Lawrence Berkeley National Laboratory, USA
LNHB	Laboratoire National Henri Becquerel, France
LOGFT	ENSDF analysis program in Fortran to calculate log ft values
M	Transition multipolarity
MR	Mixing ratio
MSU	Michigan State University, USA
NDS	Nuclear Data Sheets; journal devoted primarily to ENSDF data
NIPNE	National Institute of Physics and Nuclear Engineering, Romania
NNDC-BNL	National Nuclear Data Center, Brookhaven National 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
ORNL	Oak Ridge National Laboratory, USA

PANDORA	ENSDF analysis program in Fortran to check data consistency
PNPI	Petersburg Nuclear Physics Institute of the Russian Academy of Sciences
RADLST	ENSDF analysis code in Fortran to calculate emitted radiations
RIKEN	Japanese research organization for basic and applied science
RIPL	Reference Input Parameter Library
RULER	ENSDF analysis program in Fortran to calculate gamma transition strengths
TUNL	Triangle Universities Nuclear Laboratory, USA
USNDP	US Nuclear Data Program
UCB	University of California at Berkeley
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.

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
24	Canberra, Australia	24 – 28.10.2022	INDC(NDS)-0867

Contents

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, monitoring and reviewing the development and use of the computerized systems and databases maintained specifically for such activities. A primary aim of the network is to provide accurate and freely available data to the user community 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, ensures the smooth dissemination of nuclear structure and decay data.

The 24th meeting of the NSDD network was hosted by the Australian National University in Canberra, Australia, from 24 to 28 October 2022. The meeting, originally planned to take place in 2021, had to be postponed due to the worldwide travel restrictions in connection with COVID-19.

Delegates to the 24th meeting of the International NSDD Evaluators' Network were welcomed by Prof. Tim Senden, Dean of the Research School of Physics, in the new Auditorium. After a brief presentation of the Australian National University by Prof. Senden, Prof. Andrew Stuchbery, Head of the Department of Accelerator Physics and Applications, gave a concise account of the achievements of the Department in the area of nuclear structure and nuclear applications, as well as the role of the Heavy Ion Accelerator Facility in attracting international groups and in training future generations of Australian nuclear scientists, especially in view of the new era of nuclear physics that has dawned in Australia which is driven by nuclear applications and nuclear technologies such as nuclear-powered submarines. Paraskevi (Vivian) Dimitriou (Nuclear Data Section, IAEA) the scientific secretary of the meeting, gave a brief account of the Nuclear Data Section's history ever since its foundation in the early 1960s. The key to the Section's success has been international collaboration and exchange in nuclear data, nuclear information, and nuclear technologies. The main purpose of the NSDD biennial meetings is to enhance international cooperation and coordination on maintenance, development, and dissemination of ENSDF.

Prior to the start of the main technical discussions, the agenda was approved as listed in Annex 1. John Kelley and Paraskevi Dimitriou were elected co-chairs of the meeting, and Jun Chen and Alexandru Negret agreed to act as rapporteurs. All in all, forty-five nuclear data specialists including IAEA staff attended this meeting, representing data evaluation/dissemination centres from twelve countries and new evaluation groups (Annex 2). A list of ENSDF evaluation centres and groups, along with their mass-chain evaluation responsibilities is given in Annex 3, and their declared effort (Annex 4). A revised List of Actions including new actions is found in Annex 5. Representatives from the individual mass chain evaluation centres presented progress reports in their NSDD studies, and all of these status reports can be found in Annex 6. Links to presentations given during the meeting are available in Annex 7. The last annex, Annex 8, is dedicated to an in memoriam for E. Browne, one of the pioneering members of the Network who passed away in May 2022.

2. REVIEW

2.1. Actions Review

The actions from the previous report (INDC(NDS)-0850) were reviewed and their assessments updated accordingly, as given in Annex 3. A summary of some of the discussions is given in the following:

- Action #3: Balraj Singh will re-write an addendum to the guidelines regarding all four issues listed in the action. Evaluators should communicate to him any other issues they identify in the guidelines (See new **Action item #11**).
- Action #5: Adopted decay datasets are meaningful for the decays that are used in the normalization. There are cases where the decay dataset is incomplete, and the Adopted decay dataset cannot be produced.
- Action #9: Experimental uncertainties should be provided by the authors of the publications. However, there are cases where the authors did not determine gamma energies and should not give any uncertainties. In the absence of any feedback from the authors, B. Singh noted that for high-spin datasets, he normally uses Δ=0.3 keV for energies below 1 MeV and Δ=0.5 keV above 1 MeV. Action item should be withdrawn.
- Action #10: How do we fix a situation in which, in a decay dataset, the feeding of a level is larger than the decay of that level? S. Basunia will provide a document explaining this case for inclusion in the guidelines (as recommended in new **Action item #11**).

2.2. ENSDF – XUNDL database update (E.A. McCutchan)

XUNDL database: about 650 datasets were compiled per year by BNL, McMaster, MSU, and TUNL.
ENSDF: 12-14 mass chains were submitted in the past year.
GitLab for ENSDF mass tracking: the new mass-tracking system was presented. The system can, in principle, also be used for submitting mass chains, not only for tracking them in the evaluation pipeline.
Discussion:
Question: Should a continuous integration system be put in place that checks both the Checklist and runs FMTCHK automatically at the moment of submission?
F. Kondev and J. Chen commented that accessing Gitlab was not straightforward as it required passing a cyber security test specific to BNL first. B. Singh added that although he had passed the cyber security test, he still had not been able to access GitLab.
E. McCutchan agreed to help evaluators who failed in trying to access Gitlab, and also to organize a tutorial. The first step was however, to pass the cyber security training at BNL.
P. Dimitriou suggested that time stamps should be visible on the mass-chain overview page. E. McCutchan replied that they were provided in the CSV files that were generated for downloading. She also added that Gitlab would be necessary to all evaluators, especially when the new format and database would become available.

2.3. ICTP Workshop (P. Dimitriou)

The 10th Joint ICTP-IAEA Workshop on NSDD was held on 3-14 October 2022 (https://indico.ictp.it/event/9830/).
It included lectures on theory, experimental techniques, evaluation, codes, databases, and web tools. The practical courses included XUNDL compilation work in the first week and ENSDF evaluation (mass chain A=222) in the second week. B. Singh prepared the material and coordinated the work.
In total, 13 participants from 5 countries attended. Ten participants were funded and three attended at their own cost. The ratio of spendings for students over lecturers is not optimal, since the bulk of the budget is spent on covering lecturers' expenses. Nevertheless, the future success of such

workshops depends on the availability of evaluators to lecture and guide the groups in the practical exercises.

Q&A:

– N. Stone asked how many out of the 13 participants would continue to contribute to NSDD evaluations. This is too soon to say. At least one participant has expressed interest in continuing under a mentorship scheme.
– How was the workshop advertised, and how were the students recruited?
  The workshop was advertised via email announcements to various nuclear data mailing lists, US national labs mailing lists, the NuPECC mailing list and by ICTP. The students were selected on the basis of their background training, research activities and recommendation letters

3. PROPOSALS

3.1. BetaShape code

F. Kondev and B. Singh submitted a proposal to replace the *LOGFT* code (NDS 10, 205-317 (1971)) with the *BetaShape* code developed by X. Mougeot (LHNB) (2015Mo10, 2018Mo04, 2019Mo35) for the calculation of logft values starting from 1 Jan 2023. The code is available on the LHNB website: www.lnhb.fr/rd-activities/spectrum-processing-software/

- The code uses the appropriate form factors so that the forbiddenness 1u, 2u subscripts do not have to be used anymore.
- Shape factors from the latest experiments are included in the output file as comments. If no experimental shape factor is available, then a calculated shape factor is used.
- Some minor issues related to the treatment of non-numeric uncertainties and limits should be addressed before the code is formally adopted and used by evaluators.
- Accordingly, the NNDC online logft calculator should also be replaced with the BetaShape one.
- Differences between Logft and BetaShape values are not always small, but they are caused by the fact that the new code implements a better model.

Adopted policy: starting 1 Jan 2023, the evaluators are allowed to use the code; starting 1 June 2023, new submissions must be done with BetaShape. For resubmissions it remains the evaluator's choice (**Action item #16**).

3.2. GABS code

T. Kibedi's proposal was reformulated as follows: the "N" in column 79 in G-records should be retained and used for normalization. The codes GABS, GLSC and Java-NDS should recognise this flag. FMTCHK should also recognise it and not give an error warning. The proposal was accepted (**Action item #14**).

3.3. Uncertainty propagation

T. Kibedi's proposal to perform uncertainty propagation in ENSDF evaluations using the Monte Carlo method was further discussed. Consensus was reached on the following:

- Propagation based on the Tylor expansion is (1) valid only for linear relations, (2) valid only for small dx/x, (3) disregards correlations.
- The median value (according to standard definition) is the recommended nominal value in MC uncertainty propagation. In cases of asymmetric (skewed PDF) it will not agree with the directly calculated value.

This new policy should be implemented in ENSDF analysis codes where applicable (**Action item #18**).

3.4. Evaluation, tabulation, dissemination of data for applied use

Four proposals addressing different needs were presented by S. Basunia:

- Specific, targeted measurements that are important for applications (for example, ^{67}Cu, ^{61}Cu, ^{56}Fe) should be incorporated immediately in the database instead of waiting for the full mass chain evaluation to be completed. The proposal is to introduce a fast update procedure, whereby a group communicates with the evaluator of the mass chain. If the evaluator cannot perform the update, the group would undertake to do it.

  Q&A:

  Individual nuclei can be evaluated and submitted to ENSDF, the system is already in place. For example, in the case of ^{61}Co decay, an issue was pointed out by R. Capote, the issue was identified in the evaluation, and within 4-5 days it was corrected and sent to R. Capote and the first author of 2021Bl04. The correction in ENSDF was performed in 1-2 weeks.

  However, evaluating individual decay datasets is not practical and diverts effort from mass chain evaluation.

  The whole fast-track updating procedure would benefit from coordination and a priority list. The High Priority Experimental Issues list already exists for issues identified by both experimentalists and evaluators.

- Calculation of total IB+. Total IB+ can be calculated by adding IB+ to all levels. NuDat does it automatically. Example of ^{86}Y (see 2020Gu18, 2022Ud01 where total IB+ comes out similarly but different from the value from the last ENSDF evaluation). The proposal is to include total IB for more visibility.

  Q&A:

  Wallet Cards: there is not much space to add information.

  Total %Ib+ and total EC could be shown, it is calculated anyway by GTOL. It should be in the Adopted data set if it is measured. Whether it can be calculated depends also on the completeness of the level scheme.

- Proposal to change the symbol for minutes from “m” to “min”.

  Q&A:

  General Policies adopt “m” in ENSDF format most likely due to space limitation, however, it should show up as “min” in the output. Change will be implemented with immediate effect.

- The case of “B+” vs. “EC decay” in ENSDF data ID card. If EC DECAY is used in ID card, NuDAT displays EC decay mode or EC+B+ accordingly, however, if "B+ DECAY" is used, it does not consider EC contribution. There are quite a few B+ ID cards currently in ENSDF.

  Q&A:

  According to ENSDF policy, regardless of whether they are both (EC and B+) measured experimentally (as it is often the case) or if one of them was derived from the other one, the name in the ID card should aways be “EC decay”. However, this is confusing and could mislead evaluators and users. Participants agreed that both “EC” and “EC+B+” should be acceptable in DSID. On the contrary, “B+” should not be allowed in the ID card. There are currently about 100 “B+” datasets in ENSDF that need checking. The checking codes need to be adapted to flag the “B+” in the ID card as an error. [Sec. note: the discussion continued after the meeting by email exchange and led to the current formulation of the conclusion and action].

  Action on Jun Chen: modify ConsistencyCheck to flag “B+” in the DSID as error.

  Action on all evaluators**:** use EC+B+ or EC in ID card as applicable**.**

4. ROUND TABLE DISCUSSIONS

4.1. Miscellaneous

4.1.1. X4-NSR PDF database

Access to the X4-NSR PDF database via NSR at NNDC was ceased due to security issues about two years ago. Currently, access is possible only via MyENSDF Webtools or EXFOR on the IAEA web server.

Q&A:

A separate issue was raised by J. Kelley concerning accessing the link to the article when the NSR page is interrogated directly from the Java-NDS PDF output of ENSDF.
Regarding the X4-NSR PDF database, participants agreed that although the IAEA interface enables them to use the database for their work, it is not as user-friendly and convenient as accessing it directly through NSR. V. Zerkin mentioned that the IAEA X4-PDF database and NSR can be connected again on the IAEA web server if NNDC provides the full NSR database. The X4-NSR PDF database is also available as standalone, offline, although with a current size of 180 GB it could be difficult to be transferred through the IAEA security firewall.

4.1.2. Policy implementation and document

F. Kondev suggested that all policies be included in a Word/Latex document that can be modified promptly when policies are updated.

Q&A:

E. McCutchan noted that this document is already available, however, Nuclear Data Sheets does not allow the Policies document to be included at the beginning of each journal issue. It was proposed to include the policies document in the evaluator's corner and/or in a place on the webpage that is clearly visible to the reader/user, and that it should be updated continuously. E. McCutchan remarked that the wording of the new or revised policies should be decided by the network. As a result, two new actions were placed as follows:

Action on F. Kondev: to formulate a policy regarding the absolute Ig intensities in decay datasets.
Action on T. Kibedi: to formulate an updated policy regarding the electronic factors.
It was agreed to change the title of the current policies from "NDS Policies" to "ENSDF Policies" to correctly reflect that they concern ENSDF evaluation policies while NDS has become broader in scope and publishes research articles in addition to mass-chain evaluations.

4.1.3. Inclusion of theoretical papers in ENSDF

B. Singh stated that the inclusion of theoretical papers in the Adopted data sets is done inconsistently in ENSDF. Sometimes the references are placed at the end of the evaluation or are far too many and unrelated to the structure properties of the nucleus.

Q&A:

E. McCutchan commented that ENSDF users should say if this is an issue or if it is useful to have theoretical papers in ENSDF. Feedback from them is necessary before adopting a policy. Some of the feedback obtained when Java-NDS was launched seemed to indicate that users do not like the long list of references at the end of the file.
Adding theory references requires additional effort, however those are needed only when additional information is provided in the dataset.
J. Kelley suggested that an additional comments dataset could be generated to accommodate the theory references, since for light nuclei, theory and experiment are very tightly interconnected. Generally, evaluators must carefully select which theory papers to include in a file.

E. McCutchan volunteered to send out a questionnaire to selected members of the ENSDF experimental and user community about this issue. The discussion will be resumed after input from the community.

4.2. Evaluation Issues

4.2.1. Level scheme of ^{86}Y

S. Basunia presented the paper of 2022Ud02 on measurements of the excitation functions of proton-induced reactions on ^{86}Sr. The RIPL level scheme file includes many transitions that do not exist in ENSDF (e.g., transition from 3+ to 4-). The excitation function could be reproduced better if a 3+ -> 8+ (isomeric state) transition was added in RIPL. Alternatively, a 3+ -> 7+ transition would be needed.

Q&A:

A. Negret commented that such calculations provide hints that something is missing in the level scheme, however adding a 3+ -> 7+ transition to explain the excitation function is not acceptable.
P. Dimitriou added that nuclear level densities, strength functions, and optical potentials are also essential ingredients of these calculations and must be fine-tuned to reproduce the data.
F. Kondev stated that to identify missing transitions and make spin/parity assignments one needs to design and perform targeted experiments.
B. Singh added that odd-odd nuclei are hard to study and require conversion electron spectroscopy.

4.2.2. Decay modes

J. Kelley suggested that levels populated in (e,e') should be automatically assigned a gamma decay mode (mode=γ) as F. Ajzenberg-Selove did in the past since in light nuclei, $\Gamma\gamma 0$ and BE values often originate from (e,e').
He also discussed the meaning of declarations "%IT=?; %n=?; %a=?" in ENSDF and whether it is clear to the user what the "?" means. Would %n>0; %a>0 be easier to understand?

Q&A:

F. Kondev mentioned that in NUBASE, "%Mode=?" means that the decay mode was observed but the intensity is not known. E. McCutchan commented that in the new format, statements such as "is observed" will be available.
F. Kondev and P. Dimitriou agreed that a clear policy is required so that users understand the meaning of the labels.
Action on J. Kelley: to formulate a policy item "that people may believe".

4.2.3. Minor evaluation issues

N. Nica raised several minor evaluation issues for discussion:

– Case study for typical EC decay cases
  This refers to the situation of a decay dataset when the parent state decays to an isomeric state with known spin, parity, and $T_{1/2}$ values. However, the energy of the decay and the decay of the isomer are unknown, resulting in an unknown energy of the isomer. The situation is exemplified by the ^{147}Tm ε decay in which the 11/2- g.s. decay to the 11/2- isomer 1.6 s 2 long-lived with the g.s-to-g.s Q-value of 10630 *40*. The isomer is placed generically at 0.0+x energy. The issue consists in the fact that the production code calculates E(decay)= $5\cdot10^3$ *5* meaning that a whole 10 MeV interval is assigned for the decay energy. Instead, the generic decay could be more judiciously designated as 10630-x. Or, as the next lower level has E(level)=80.9, the isomer can be placed in the interval 10630-80.9~10550, the decay energy can be given as <10550, which looks physically more relevant than $5\cdot10^3$ *5*.

Q&A:

F. Kondev commented that due to the very scarce information available for this EC decay, the beta energy should not be given, and that as the level scheme is incomplete, the drawing does not serve any meaningful purpose.

E. McCutchan added that the level scheme isn't to scale to begin with.

- Beta-delayed particle ambiguity

  This refers to the usage of %β+p, %β+1p, and %β+2p symbols with some ambiguous connotations, especially when %β+p can designate both the total β-delayed proton emission probability as well as the β-delayed 1-proton emission probability. The same applies to the %β-n, %β-1n, and %β-2n decays.

  Q&A:

  J. Kelley stated that these notations are already defined in the literature, and that redefining them would be confusing.

  B. Singh clarified that, in the first example, %β+p corresponds to a decay to all levels, but it only includes 1p. Similarly, %β+n refers to only one neutron. Adding the Σ would be confusing, as it would be interpreted as the number of neutrons.

- S(n)+x, S(2n)+y ranges

  This refers – as exemplified – to the mathematically incorrect usage of two 2312+x and 8652+y values, where S(n)=2313 and S(2n)=8652 are numerical values of the 1n and 2n neutron separation energies, respectively. The 2312+x and 8652+y values are used to indicate the energy ranges above 2312-keV and 8653-keV respectively, where the β-delayed 1n and 2n states are situated on the decay scheme drawing, when such states of undetermined energies were reported in publications. These ranges are represented above the known levels in the daughter of the β-decay. However, as in the case presented, when there is a 3759.6 bound or resonance level situated in-between 2312 and 8652, the drawing of 2312+x above 3759.6 in the decay scheme by "physical reasons" violates the mathematically correct ordering which should be characteristic of an energy scale.

  Q&A:

  B. Singh commented that the sequence proposed by N. Nica is unrealistic while J. Kelley remarked that as the energy of these levels is unknown, both sequences are right.

  E. McCutchan added that these are not real "levels".

- Extend the capability of Java-RULER.

  This refers to the proposal that JAVA-RULER could be instructed to produce a separate output file with reduced probability values calculated for gamma transitions with incomplete information, which are skipped in the normal output. For example, for a D (dipole) transition, the program could calculate both possible cases, E1 and M1, which could help with the spin-parity assignment. Other situations could be included as well.

  Q&A:

  J. Chen replied that this capability already exists, and that the evaluator can choose to use an independent calculator which does not run on the whole file but case by case. He then demonstrated how this works with an example: right-click on the Java-RULER GUI interface, then select the last option, and copy-paste the gammas in that window. The function is usually used to calculate $T_{1/2}$ from B(E2).

4.2.4. MR value assumption in BRICC

T. Kibedi argued that, as was already shown at the NSDD meeting in 2011, based on the systematics of experimental MR values, the assumption of MR=1(1) in case of no available experimental information is reasonable.

Q&A:

N. Stone pointed out that this assumption includes pure M1, but not pure E2, and is therefore not correct. [Sec. note: further objections were voiced after the meeting, so the decision has been deferred to a following meeting].

4.2.5. Discussion on Limits

Ranges for MC when the value is a limit. Proposes a multiplier of 1000:

Quantities are always:

- Positive: Q-, SP, QA, QP, E, RI, TI, CC, NR, NT, BR, IB, LOGFT
- Positive or Negative: MR

	Limit	Range	Range for MC
UPPER	<0.5	[0 : +0.5]	[0 : +0.5]
	<+0.5	[-infinity : +0.5]	[-499.5:+0.5]
	<-0.5	[-infinity : -0.5]	[-500.5:-0.5]
LOWER	>0.5	[+0.5:+infinity]	[+0.5:+500.5]
	>+0.5	[+0.5:+infinity]	[+0.5:+500.5]
	>-0.5	[-0.5:+infinity]	[-0.5:+499.5]

Using a multiplier of 1000

The proposal submitted by T. Kibedi is to treat limits in MC uncertainty propagation using a rectangle probability distribution function (PDF). The ranges are described in the table shown above.

Q&A:

In the current treatment of uncertainty propagation in the various analysis codes, a value with a limit leads to a derived value with a limit, i.e. a limit generates a limit. In theory, if a limit is introduced in a mathematical formula, the resulting value is not necessarily a limit. However, in many cases in nuclear physics experiments, limits have a significant meaning for experimentalists.

Final proposal that was adopted:

Propagation of limits for lifetimes and energies: use the limit value and propagate it generating limits for the derived quantities.

Propagation of limits for other quantities (MR, RI, TI, BR-decay mode branching ratio): perform Monte Carlo calculations using uniform distributions. (**Action item #28**)

5. ENSDF CODES AND WEBTOOLS

5.1. MyENSDF Webtools and EXFOR-NSR PDF Database (V. Zerkin)

A list of software in MyENSDF updated since April 2022 was given.

Java-NDS is working remotely on MyENSDF. XPQCHK stopped working as a result of a security update.

An update was given on the status of the X4-NSR PDF database:

- covers 79% of NSR, 78% of EXFOR. Total size is 193 GB
- Access is possible directly using NSR keynumbers as shown in link below:

https://www-nds.iaea.org/exfor/servlet/X4sGetX4Pdf?kn=1966Ar15,1971We15,1987KOZF

Q&A:
In the last 3 years the number of PDFs uploaded in the X4-PDF database has decreased, mainly due to the withdrawal of PNPI. The missing PDFs are mainly articles with DOI links. However, it is important to include them in the PDF database because some of the evaluators work from home and might not have access to the journals.
Recommendation: NSDD evaluators should provide their collection of articles to the X4-PDF database focal points for inclusion in the PDF database.

5.2. Analysis and checking codes developed at ANU 2019-2022 (T. Kibedi)

(with B. Tee, J. Dowie and B. Combes)

GABS: The program has been re-written and additional operation modes have been added to calculate the absolute photon intensity, %IG. The uncertainty propagation and the error checking has been improved.

NS_LIB: The development of a new general library to read, verify ENSDF files and carry out common operations (calculation of ICC`s, total intensities, uncertainty propagation, etc) has been continued. Several new codes (BrIcc V3, NS_RadList, UncTools) are being developed using the NS_LIB library.

NS_Radlist: The new atomic radiation library for elements up to Z=100 and all atomic shells has been completed. The testing of the NS_Radlist is progressing well and will be released in early 2023.

UncTools: This script driven code allows to propagate uncertainties using the Monte Carlo method. It also accesses the BrIcc V3 data tables. UncTools was used for the new E0 evaluation (2022Ki03).
Q&A:
Using uniform/rectangle PDFs to propagate limits by means of MC is not necessarily physically correct and could distort the final result. It is a major assumption that is being made on behalf of the user, when we really don't know what the PDF should be. However, as this assumption is used to derive quantities, not to alter the experimental data themselves, an explanation should be sufficient. For example, a relevant section explaining how limits are propagated could be added to the policies.

BrIcc: The current version (2.4) has been used in the last 5 years. Several smaller modifications have been implemented, mainly related to the protocol how total conversion coefficients are put on the G or S_G records. Testing of the new version, v3, which uses the new single data file combining conversion coefficients up to Z=126, pair conversion coefficients up to Z=100, E0 electronic factors for conversion electrons (up to Z=126) and pair conversion (up to Z=100), is underway. The new BrIcc has adopted a Monte Carlo procedure to propagate uncertainties.
Q&A:
F. Kondev asked what happens in cases where experimental CC values exist and should be preserved in the ENSDF file? The answer is that the CC field in the G record is retained for the theoretical CC. After the BrIcc code is run, the evaluator has to manually replace the CC values that were updated by the code.

5.3. Java codes for ENSDF evaluation (J. Chen)

The FRIB/MSU data center will continue to lead the effort in improving and modernizing existing and developing new utility and analysis tools to streamline and facilitate the process of data compilation, evaluation and dissemination, as shown in Fig. 1, and also to ensure efficiency, productivity and quality of data evaluation. All updated or new codes will be made available to the IAEA Nuclear Data Services for inclusion in their code hosting website for downloading. As the work on the new ENSDF format is in progress, the FRIB/MSU data center, in coordination with the ENSDF-format modernization team of NNDC, has been making efforts to develop a new data parser to make existing ENSDF utility and analysis codes developed at FRIB/MSU compatible with the new ENSDF format. This effort in ENSDF code modernization at FRIB/MSU will be continued and synchronized with that of the ENSDF-format modernization. Table 2 lists all ENSDF codes developed at FRIB/MSU (McMaster-MSU Java-NDS code was initiated at McMaster University and continuously developed and completed at MSU).

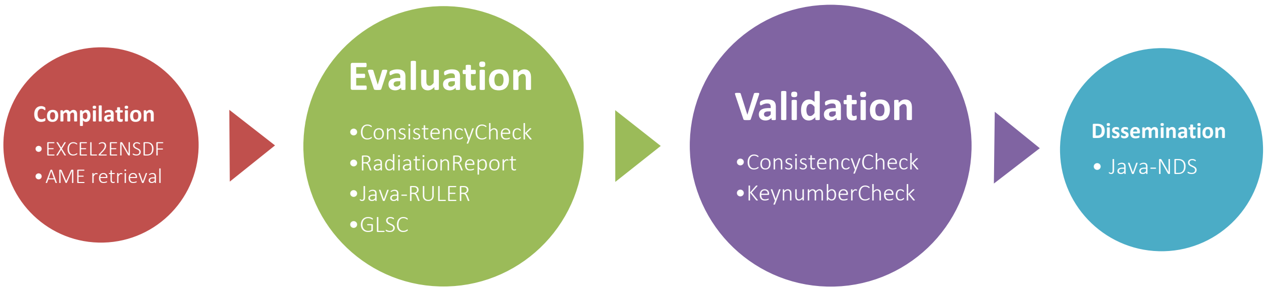

FIG. 1. Flow of the ENSDF evaluation procedure with codes developed at MSU for each step to facilitate evaluation. Size of the circle indicates roughly the relative amount of effort at each step and the codes listed in the circle are those used to facilitate the effort. The goal is to develop a toolkit to streamline and automate the evaluation procedure.

TABLE 2: LIST OF ENSDF JAVA CODES DEVELOPED AT FRIB/MSU. ALL CODES ARE AVAILABLE ON THE IAEA NDS ENSDF CODE WEBSITE.

Program Name	Main Functions	Notes
McMaster-MSU Java-NDS	generates PDF outputs from ENSDF file(s) for Nuclear Data Sheets and web-display of ENSDF and XUNDL databases on NNDC retrieval webpages	started at McMaster by Balraj and his students in 2007; re-started by at MSU in 2015 and first released in early 2017
ConsistencyCheck	checks data consistency among ENSDF datasets, group levels and gammas, and average values from different datasets (with user selections), and more	recommended by USNDP and NSDD to replace the legacy PANDORA; useful for preparing Adopted dataset (2018-2019)
Java-RULER	calculates gamma-ray transition strengths in ENSDF file with proper propagations of large/asymmetric uncertainties including the Monte-Carlo approach	solve the long-standing issue of incorrect uncertainty propagation in the legacy FORTRAN code (2018)
Excel2ENSDF	converts an Excel file (formatted data) to an ENSDF file and vice versa; performs simple operations on column data in Excel, such as multiplying a factor or adding a constant	used in XUNDL compilation for converting Excel to ENSDF and also useful for extracting data from ENSDF (2018-2019)
KeynumberCheck	checks NSR keynumbers in ENSDF datasets for format errors, irrelevant or nonexistent papers by searching in an input list of key-numbers or in the NSR database directly	used to catch incorrect, irrelevant or non-existent NSR keynumbers for the final check of an ENSDF evaluation (2018)

Program Name	Main Functions	Notes
GLSC (Gamma to Level Scheme Computation)	performs a least-squares fit to gamma energies to obtain level energies; computes feedings to each level and absolute gamma emission probabilities for decay datasets	more interactive features with more options in GUI for user to control the fitting parameters (2020-2021)
AME-NUBASE viewer	provides easy and customized retrieval of AME (Atomic Mass Evaluation) entries and NUBASE (evaluation of ground-state and isomer properties) entries	used to update Q records in Adopted datasets automatically; simple GUI for easy use (2020-2021)
RadiationReport	calculates energies, intensities, continua and doses of all atomic and nuclear radiations in a radioactive decay; calculate log ft, capture fractions for beta and electron-capture decay	to replace legacy RADLIST and LOGFT Fortran codes; add calculations for high-order (>2) forbidden-unique decays (2022)
AlphaHF	calculates Hindrance Factor (HF) and nuclear radius parameter (R_0) for α decay	to replace the legacy ALPHAD and ALPHAD_RADD Fortran codes (2022)

Q&A:

P. Dimitriou asked whether the codes can be run using scripts and the answer was affirmative.
Comment by J. Chen: the goal is to generate an evaluation toolkit containing everything. So far only one code is missing: FMTCHK.

6. TECHNICAL REPORTS

6.1. ENSDF modernization project (E.A. McCutchan /NNDC/BNL)

The current ENSDF format is an 80-column ASCII dating back to the punch card era. This antique format makes it difficult to make use of modern software developments or machine learning (ML) algorithms and to expand the data types that can be incorporated into ENSDF based on emerging capabilities at new radioactive ion beam facilities. It is, additionally, a barrier to engaging the next generation of data scientists and evaluators. To improve this situation, a tri lab effort between Brookhaven National Laboratory, Argonne National Laboratory and Lawrence Livermore National Laboratory is under way to modernize the ENSDF format and associated tools. The project is fully funded by the Department of Energy, Office of Science, Office of Nuclear Physics, under the Nuclear Data Interagency Work Group FOA funding scheme.

The project starts at the beginning of the data pipeline, by developing new machine learning techniques to more efficiently and accurately extract data from tables in publications. One aspect of performing a XUNDL compilation is usually to extract data from tables in the paper and convert that numerical data into the ENSDF format. This process is hampered by current tabular extraction software, which often misses columns/rows, improperly processes superscripts/subscripts and encounters difficulties with separating mean values with their uncertainties. The tabular extraction portion of this project aims to develop domain specific ML algorithms, first automatically identify tables in a paper, recognize cell content, then extract cell contents and import into a new ENSDF format. This is an effort lead by the Computer Science Initiative at Brookhaven National Laboratory.

The second aspect of the project is to modernize the ENSDF format itself. The National Nuclear Data Center at Brookhaven National Laboratory is currently leading this effort which involves developing a JSON-based schema for ENSDF which will be stored in the object-oriented database, CouchDB. The current construction of the scheme employs a modular structure, to reflect that many similar quantities are repeated throughout the Adopted Levels, Gammas datasets and the supporting reaction and decay datasets. This structure will allow any changes to the schema to be quickly and uniformly propagated throughout the file. Currently, the entire Adopted Levels and Gammas datasets within ENSDF have been converted and pass validation. Additionally, the reactions involving incident neutron particles have been successfully converted. The NNDC is also leading the effort to develop a new python-based editor for the new format which will be available for beta testing within the next year.

Finally, the ENSDF modernization project aims to improve the users' connections with the database, by developing and making public an Application Programming Interface (API) for the new CouchDB database. The API will be coupled to simply python plotting packages, giving the users the opportunity not only to query the database, but also to quickly visualize any data they extract from the database. Development of the API and visualization packages is nearly complete with expected release in early 2023.

6.2. From ENSDF to NuDat: search, filter and visualize nuclear data (D. Mason, E.A. McCutchan, A. Sonzogni /NNDC/BNL)

NuDat has a highly customizable data filter to help users in visualizing specific regions of the chart of nuclides. Users can filter by basic properties such as protons, neutrons, and atomic mass. Additionally, users can filter by any combination of observables available in NuDat, such as half-life, decay modes, Q-values, and separation energies. Once a filter is applied, the chart will highlight the appropriate nuclides that match the filter conditions. A user can choose to highlight all the nuclides that have a half-life between 1 second and 1 minute. This filtered chart of nuclides can be colored by any other observable. The filtering functionality greatly reduces the search space for users to find the exact nuclides that fit their interest or application. One example is reducing over 3400 possible nuclides to approximately 9 that are capable of β^- decay with a number of neutrons between 60 and 80, and a half-life between 1 second and 1 minute. The filtered results can then be viewed on the thermal neutron fission yields for ^{235}U.

NuDat includes a customizable CSV export. Users can specify exactly what datasets to include and either export every nuclide and isomer available in NuDat or only the previously filtered nucleus. Exporting all the data in NuDat would span many columns and thousands of rows. With simple controls, users can choose to export only the observables they are interested in and through the filter only export a subset of nuclides.

A new feature added to NuDat is the export as SVG option. SVGs are scalable vector graphics that use vectors over rasterized pixel image formats such as PNGs. SVGs are resolution independent and can scale to any size without losing quality. SVGs are ideal for publication quality plots and even presentations or large posters. Users can export the entire chart, their current zoomed in view, or specify proton, neutron, and atomic mass ranges. Users can select specific nuclides through the NuDat interface and easily export SVGs with just those nuclides. This is ideal for creating decay chains or showcasing precise regions of the chart. Users can choose the level of detail of text to include in the SVG. Options include no text, the element symbol, the nuclide name, and the full details with dataset values. Another SVG feature is the ability to add stylistic shadows to the chart of nuclides with a flat or gaussian blur effect.

Improvement and updates to NuDat are made based on user requests and suggestions. Feedback is highly encouraged and can be sent to Donnie Mason (dmason@bnl.gov).

6.3. Global Heavy Charged-Particle Decay Database (J. Batchelder, A.M. Hurst, Y.-H. Lee /Univ. California Berkeley)

Nuclei far from stability reveal properties of the structure of the nucleus with an extreme imbalance of the number of neutrons and protons with respect to that of a stable nucleus, allowing a better understanding of fundamental nuclear interactions. In most cases, heavy charged particle decay is the only way to populate the nuclear states necessary to obtain this information.

Nuclei near the proton drip line have large *Q* values for β^+ decay and hence they often β decay to excited states that subsequently decay by the emission of a proton (or alpha particle). This is known as beta-delayed proton (or alpha) emission (β^+p or $\beta^+\alpha$). It is a typical decay mode of very neutron-deficient nuclei. Valuable information for the ground state in the precursor, such as half life, spin, and parity, can be obtained by studying the β^+p-decay properties. The high efficiency and unique experimental signature for detecting protons allow one to study states in the β^+-decay daughter that are not accessible through other means. By measuring the properties of protons emitted to a known state in the daughter, information on the structure of the proton-unbound state can be obtained.

In this work we present an evaluation/compilation of all known beta-delayed and direct heavy charged particle emitters (*p*, α). Branching ratios, half lives, and all relevant *Q* and *S* values (mostly taken or calculated from Ref. [1]) are listed for those nuclei for which these decays are energetically possible. In addition, for those nuclei with known resolved proton and alpha transitions, particle energies, intensities, and the energies of the particle-emitting states are compiled. A list of experimental references for each precursor is also given. The nuclei are organized by their isospin projection (*Tz*) in this evaluation.

An early version of the database has been developed with complete compilations from *T* = -4 to *Tz* = +8, with additional *Tz* groups still to be included up to the heaviest nuclei known (*Tz* = +32). This database will be updated as new papers are published. Information from this database can currently be downloaded as pdf documents, however, we are also developing a JSON-format for future dissemination.

This database is now live and can be accessed at
https://nucleardata.berkeley.edu/research/betap.html
Any corrections, additions, or suggestions to improve this database should be sent directly to batchelder@berkeley.edu. You can also alert us to new papers/thesis, etc. in this way.

References:

[1] M. Wang, W.J. Huang, F.G. Kondev, G. Audi, S. Naimi, Chin. Phys. C **45** (2021) 030003.

6.4. Nuclear Moments Tables (N.J. Stone)

Recently published tables of recommended values of magnetic dipole and electric quadrupole moments were described in the contribution and Report of the last meeting (see: indc-nds-0850.pdf (iaea.org)). This short update gave details of developments in the calculation of the diamagnetic correction to dipole moments. The latest work [1], using newly developed multi-electron configuration computational methods, has revealed that in transition metal elements an applied field will induce, as well as diamagnetic shielding, weak paramagnetism which can seriously reduce, or even change the sign of, the total correction. This hitherto neglected physics will necessitate revision of the recommendations for some 25 elements.

Reference:

[1] Antusek and M Repisky, Phys. Chem. Chem. Phys. **22** (2020) 7065.

6.5. NS_RadList – calculations of atomic radiations from nuclear decay (T. Kibedi, B. Tee, B. Coombes /ANU)

A new numerical database (BrIccEmis_DB), and a computer tool (NS_RadList) have been developed to calculate the full energy spectrum of Auger electrons and X-rays from nuclear decay [1]. The program reads ENSDF files and evaluates the atomic vacancy distribution from electron capture decay (EC) and internal conversion (CE). The EC capture rates are taken either from E. Schönfeld and H. Janssen [2], or from BetaShape [3]. Internal conversion coefficients are from BrIcc [4]. The atomic radiation data table used in NS_Radlist has been constructed from a large set of calculations using BrIccEmis [5]. In these calculations atomic radiation rates are taken from EADL [6] and transition energies are calculated using the RAINE code [7] with semi-empirical corrections [1]. The data file contains the complete atomic radiation spectra for Z=6 to 100 and for initial vacancies on each atomic shell. The "condensed phase" approximation was used, which assumes that the atom is in a molecular environment and any valence vacancy will be filled immediately from the continuum. The spectra are binned in 1 eV bins.

The output files include a detailed report of the calculations with the list of decay energies, intensities of EC, beta, gamma, CE, Auger electron and X-ray radiations, as well as a plot of the emitted atomic radiations. Uncertainties of the atomic radiations are calculated from the uncertainties in the EC and CE processes. Uncertainties in the atomic transition rates in EADL [6] are not very well defined and are excluded from the calculations. The propagation of uncertainties is carried out with UncTools [8] using a Monte Carlo technique.

References:
[1] B.P.E. Tee., et al., EPJ Web of Conf. **232** (2020) 01006.
[2] E. Schönfeld and H. Janssen, Nucl. Instr. and Meth. A**369** (1996) 527.
[3] X. Mougeot, Appl. Rad. and Isot. **154** (2019) 108884.
[4] T. Kibédi, et al., Nucl. Instr. and Meth. A**589** (2008) 202.
[5] B.Q. Lee, et al., Int. J. Radiat. Biol. **92** (2016) 641.
[6] S.T. Perkins, et al., LLNL, UCRL-50400-V-30 1991.
[7] I.M. Band, et al, At. Data and Nucl. Data Tables **81** (2002) 1.
[8] T. Kibédi, B. Coombes and A.E. Stuchbery (in preparation).

7. CONCLUSIONS AND RECOMMENDATIONS

The 24th Technical Meeting of the International Network of Nuclear Structure and Decay Data Evaluators was held in Canberra, from 24 to 28 October 2022. Forty-five experts from twelve countries along with IAEA staff participated in the meeting. Sixteen participants attended in person and the remaining remotely. Representatives from the various data centers presented progress reports, reported on the status of assignments from the previous meeting and on their research interests of direct relevance to NSDD activities.

The list of actions from the interim Spring NSDD meeting was reviewed in detail and several of the items were declared completed. One of the main technical issues that was resolved was the propagation of uncertainties of derived quantities in cases where the measured uncertainties are large, asymmetric or limits. A new policy was adopted and is expected to be implemented in the codes. The important decision to adopt the BetaShape code, developed at LHNB, France, for calculations of beta-decay properties such as *log ft*, average beta energies, as well as beta shape factors and spectra, instead of the legacy LOGFT code, was taken.

The legacy ENSDF analysis codes are being gradually re-written in Java at MSU with enhanced capabilities. The new codes for decay radiation (RadiationReport) to replace RadList and Logft were presented. A new code for format checking (to replace FMTCHK) will be released soon.

The biennial IAEA-ICTP workshops held at ICTP, Trieste, Italy, remain of value as an educational tool as well as a means of seeking and identifying new ENSDF evaluators, provided evaluator members of the network continue supporting the workshop by offering lectures and supervising the practical exercises.

The IAEA is charged with organizing different types of workshops to cover the needs of active evaluators, such as advance training or refresher workshops.

The main challenge facing the network is maintaining and increasing the international contribution to ENSDF, especially in view of the retirement of current evaluators. The network reiterated its recommendation to the IAEA to continue coordinating the effort to enhance international involvement by organising both targeted meetings with stakeholders and outreach activities (webinars).

ANNEX 1

24^{th} Technical Meeting of the
Nuclear Structure and Decay Data Network

24 - 28 October 2022
Physics Department, Australia National University
Canberra, Australia

ADOPTED AGENDA

Monday, 24 October

09:00 – 10:00	**Opening Session**
	Welcoming addresses: Prof. Tim Senden, Director of Research School of Physics (ANU) Prof. Andrew Stuchbery, Head of the Department - Physics Education Centre, Nuclear Physics & Accelerator Applications (ANU) P. Dimitriou (Nuclear Data Section, IAEA)
	Administrative matters: Election of Chairman and Rapporteur Adoption of the Agenda
10:00 – 10:30	*Coffee break*
10:30 – 12:30	**Actions Review**
12:30 – 14:00	*Lunch*
14:00 – 17:30	**Reporting**: 10' each unless otherwise stated
	1) IAEA (20′) 2) AUSTRALIA/ANU 3) US/ANL 4) US/LBNL + UCB 5) US/MSU 6) US/ORNL 7) US/TEXAS A&M 8) US/TUNL 9) BULGARIA/SOFIA UNIV. 10) INDIA/VECC 11) JAPAN/JAEA 12) ROMANIA/IFIN-HH 13) CHINA/CIAE – remote 14) CHINA/JILIN UNIV. – remote 15) HUNGARY/ATOMKI – remote 16) DDEP – remote 17) Manipal Univ. – remote
15:30 – 16:00	*Coffee break*

ANNEX 1

Tuesday, 25 October

09:00 – 10:30 **Reporting cont'd:**

- CANADA/MCMASTER UNIV. (10′) – remote
- ENSDF/NuDat modernization (McCutchan) (20') – remote
- Database for Charged-particle emitters, Batchelder, Yun_Hsuan Lee (20′) – remote
- EGAF Modernization (Hurst) (20′)
- ICTP WORKSHOP 2022 (Dimitriou) (10′)

10:30 – 11:00 *Coffee break*

11:00 – 12:30 **Reporting/Organizational Review/Policies/Procedures**

- USNDP/NNDC report (20′) – remote
- ENSDF/XUNDL status (McCutchan) – remote

Proposals: 10′-20′ for presentation

- BetaShape code (Kondev/Singh)
- Uncertainty propagation (Kibedi)
- GABS (Kibedi)
- Evaluation, tabulation, and dissemination of nuclear data for applied use (Basunia)
- Discussion

12:30 – 14:00 *Lunch*

14:00 – 17:00 **Organizational Review/Policies/Procedures cont'd**

15:30 – 16:00 *Coffee break*

18:00 ***Dinner***

Wednesday, 26 October

09:00 – 12:30 **Roundtable discussion**

Miscellaneous

- NSR X4-PDF database (NNDC) – remote
- General policies document & enforcement (Kondev)
- Theoretical papers references in ENSDF (Singh)
- Discussion

Issues in evaluations

- Evaluation of ^{86}Y (Basunia)
- Decay modes (Kelley)
- Evaluation issues (Nica)
- Discussion

10:30 – 11:00 *Coffee break*

12:30 – 14:00 *Lunch*

14:00 – 15:30 **Roundtable discussion: cont'd**

15:30 – 16:00 *Coffee break*

16:00 – 17:00 **Presentations**

- Atomic radiation data, Kibedi (20′)
- Nuclear Moments Tables, Stone (15′)
- MyEnsdf Webtools, Zerkin (15′) – remote

ANNEX 1

Thursday, 27 October

09:00 – 10:30	**Analysis and checking codes** - Kibedi - Chen
10:30 – 11:00	*Coffee Break*
11:00 – 12:30	**Roundtable discussion cont'd** Cont'd from Wednesday
12:30 –	***Excursion***

Friday, 28 October

09:00 – 10:00	**In Memoriam (Eddie Browne)** Basunia, others
10:00 – 10:30	*Coffee break*
10:30 – 12:00	**Approval of Action List** **Drafting of Minutes** **Next NSDD meeting**
12:00 – 12:30	**Closing of the Meeting**

ANNEX 2

24th Technical Meeting of the Nuclear Structure and Decay Data Network

PARTICIPANTS

Country / Organization		Name	Surname	Affiliation	Email
AUSTRALIA		Tibor	KIBEDI	Australian National University	tibor.kibedi@anu.edu.au
		Andrew	STUCHBERY	Australian National University	andrew.stuchbery@anu.edu.au
		Jackson	DOWIE	Australian National University	jackson.dowie@anu.edu.au
BULGARIA		Stephan	LALKOVSKI	University of Sofia	stl@phys.uni-sofia.bg
CANADA	🎧	Balraj	SINGH	McMaster University	balraj@mcmaster.ca
CHINA	🎧	Xiaolong	HUANG	China Institute of Atomic Energy	huang@ciae.ac.cn
	🎧	Dong	YANG	Jilin University	dyang@jlu.edu.cn
FRANCE	🎧	Sylvain	LEBLOND	CEA Saclay, Laboratoire National Henri Becquerel	sylvain.leblond@cea.fr
HUNGARY	🎧	Zoltan	ELEKES	Institute of Nuclear Research, Hungarian Academy of Sciences	elekes@atomki.hu
	🎧	Janos	TIMAR	Institute of Nuclear Research, Hungarian Academy of Sciences	timar@atomki.hu
INDIA		Gopal	MUKHERJEE	Variable Energy Cyclotron Centre	gopal@vecc.gov.in
	🎧	Anagha	CHAKRABORTY	Visva-Bharati University, Department of Physics	anagha.chakraborty@visva-bharati.ac.in
	🎧	Sukhjeet S.	DHINDSA	Alkal University, Department of Physics	sukhjeet.dhindsa@gmail.com
	🎧	Mohini	GUPTA	Manipal University	mohini.gupta@manipal.edu
	🎧	Ashok K.	JAIN	Amity University	ashkumarjain@yahoo.com
	🎧	Paresh	JOSHI	Homi Bhabha Centre for Science Education, TIFR	pkkjoshi@gmail.com
	🎧	Sushil	KUMAR	Alkal University, Department of Physics	sushil.rathi179@gmail.com
JAPAN	🎧	Hideki	IIMURA	Japan Atomic Energy Agency	iimura.hideki1@gmail.com;
		Hiroyuki	KOURA	Japan Atomic Energy Agency	koura.hiroyuki@jaea.go.jp
	🎧	Hiroyoshi	SAKURAI	Riken Nishina Center	sakurai@ribf.riken.jp
ROMANIA		Alexandru	NEGRET	Horia Hulubei National Inst. for Physics and Nucl. Engineering	negret@nipne.ro
RUSSIA	🎧	Alexander	RODIONOV	Petersburg Nuclear Physics Institute	0z@rambler.ru
UK		Nick	STONE	Oxford University, Department of Physics	nick.stone@physics.oxford.ac.uk

ANNEX 2

Country / Organization	Name	Surname	Affiliation	Email
USA	Filip	KONDEV	Argonne National Laboratory	kondev@anl.gov
	David	BROWN	Brookhaven National Laboratory	dbrown@bnl.gov
	Elisabeth	RICARD-McCUTCHAN	Brookhaven National Laboratory	mccutchan@bnl.gov
	Alejandro	SONZOGNI	Brookhaven National Laboratory	sonzogni@bnl.gov
	Donnie	MASON	Brookhaven National Laboratory	dmason@bnl.gov
	Andrea	MATTERA	Brookhaven National Laboratory	amattera@bnl.gov
	Benjamin	SHU	Brookhaven National Laboratory	bshu@bnl.gov
	Jin	WU	Brookhaven National Laboratory	jwu2@bnl.gov
	Shuya	OTA	Brookhaven National Laboratory	sota@bnl.gov
	Aaron	HURST	Lawrence Berkely National Laboratory	amhurst@berkeley.edu
	Shamsuzzoha	BASUNIA	Lawrence Berkeley National Laboratory	sbasunia@lbl.gov
	Caroline	NESARAJA	Oak Ridge National Laboratory	nesarajacd@ornl.gov
	John	KELLEY	Duke University, Triangle Universities Nuclear Lab.	kelley@tunl.duke.edu
	Jun	CHEN	Michigan State Univ., National Superconducting Cyclotron Lab.	chenj@nscl.msu.edu
	Keith	JANKOWSKI	U.S. Department of Energy Office of Nuclear Physics	Keith.Jankowski@science.doe.gov
	Jon	BATCHELDER	University of California, Dptmt of Nuclear Engineering	batchelder@berkeley.edu
	Yun-Hsuan	LEE	University of California, Dptmt of Nuclear Engineering	abby6677@berkeley.edu
	Ninel	NICA	Texas A&M University	nica@tamu.edu
	Jagdish	TULI	Private	jagdishtuli@gmail.com
Int. Organization	Paraskevi	DIMITRIOU	International Atomic Energy Agency	p.dimitriou@iaea.org
	Viktor	ZERKIN	International Atomic Energy Agency	v.zerkin@iaea.org

ANNEX 3

EVALUATION CENTRES

a. National Nuclear Data Centre
Brookhaven National Laboratory
Upton, NY 11973, U.S.A.
Contact: E.A. McCutchan
e-mail: mccutchan@bnl.gov

b. Nuclear Data Project
Oak Ridge National Laboratory
Oak Ridge, TN 37831, U.S.A.
Contact: M. S. Smith
e-mail: smithms@ornl.gov

c. Nuclear Data Group LBNL+UCB
Lawrence Berkeley National Laboratory
Berkeley, CA 94720, U.S.A.
Contact: L. Bernstein
e-mail: labernstein@lbl.gov

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

e. Argonne National Laboratory
9700 South Cass Ave.
Argonne, IL 60439-4815, U.S.A.
Contact: F.G. Kondev
e-mail: kondev@anl.gov

f. Facility for Rare Isotope Beams,
Michigan State University
East Lansing, MI 48824, U.S.A.
Contact: J. Chen
e-mail: chenj@frib.msu.edu

g. Texas A&M University
College Station TX 77845-3366, USA
Contact: N. Nica
e-mail: nica@comp.tamu.edu

h. Data Centre of the Petersburg Nuclear
Physics Institute,
Gatchina, 188350, Russia.
Contact: I.A. Mitropolsky
e-mail: mitrplsk@pnpi.spb.ru

i. China Institute of Atomic Energy
P.O. Box 275 (41), Beijing, PRC
Contact: Huang Xialong
e-mail: huang@ciae.ac.cn

Jilin University, Physics Dept.
Changchun 130023, PRC
Contact: Dong Yang
e-mail: dyang@jlu.edu.cn

j. Variable Energy Cyclotron Centre,
1/AF Bidhan Nagar
Kolkata 700064, India
Contact: G. Mukherjee
e-mail: gopal@vecc.gov.in

k. Nuclear Data Centre JAEA
Tokai-Mura, Naka-Gun
Ibaraki-Ken 319-1195, Japan
Contact: H. Iimura
e-mail: Iimura.hideki@gmail.com

l. Dept. of Physics and Astronomy
McMaster University
Hamilton, Ontario L8S 4M1
Canada
Contact: B. Singh
e-mail: balraj@mcmaster.ca

m. Australian National University
Dept. of Nuclear Physics
Canberra ACT 0200, Australia
Contact: T. Kibedi
e-mail: Tibor.Kibedi@anu.edu.

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

o. Horia Hulubei National Institute
for R&D in Physics and Nuclear
Engineering (IFIN-HH)
Reactorului 30, 077125
Bucharest-Magurele, Romania
Contact: A. Negret
e-mail: negret@nipne.ro

p. Dept. of Nuclear Engineering
University of Sofia St. Kliment Ohridsky,
Sofia 1164, Bulgaria
Contact: S. Lalkovski
e-mail: stl@phys.uni-sofia.bg

A-CHAIN RESPONSIBILITIES

US/NNDC	45-50,68,70,82,84-88,94-97,99,113-116, 136-146 (ex.140,141),150,152-165 (ex.153, 154, 155,157,158,160, 162,164),175,180-183,189,230-240,>249	Russia/StP	130-135
US/ORNL	69,241-249	India	215-229
US/LBL	21-30,81,83,90-93,166-171, 184-193 (ex 185,188-190),210-214	Japan	120-129
US/TUNL	2-20	Canada	1,64,74-80,89,98,100, 149,151,164,188,190,194
US/ANL	109,110,176-179,199-209	Australia	172-174
US/MSU	31-44, 60-73 (ex. 62,67-70)	Hungary	101-105
TAMU	140,141,147,148,153,155,157,158,160,154,162	PRCBeijing PRC-Jilin	51,62,195-198 52-56,67
Romania	57-59,117-119	Bulgaria	106-108,111,112
Contribution			
Manipal Univ.-India	261, 265		

ANNEX 4

ENSDF Evaluation Effort 24-10-2022

No.	Data Centre	Full-time equivalent (FTE) for ENSDF evaluation
1	ANL/USA	0.4
2	BNL/USA	0.75
3	LBNL/USA	0.9
4	MSU/USA	0.6
5	ORNL/USA	1
6	TAMU/USA	1
7	TUNL/USA	0.6
SUBTOTAL		**5.25**
8	AUSTRALIA	0.1
9	BULGARIA	0.4
10	CANADA	0.39
11	CNDC/CHINA	0.25
12	JILIN/CHINA	0.2
13	HUNGARY	0.4
14	INDIA	0.54
15	JAPAN	0.2
16	ROMANIA	0.15
17	RUSSIA	0.2
TOTAL		**8.08**

ANNEX 5

LIST OF ACTIONS AND EXTENDED PROCEDURES

On-going and Incomplete Actions – still to be fully implemented Require biennial consideration				Status 28 October 2022
No	**Responsible**	**Reason**	**Action**	
1 (1)	IAEA-NDS	Maintain up-to-date information on the network.	Review, modify and correct contents of INDC(NDS)-421. **Continuous** **Original update planned by mid/late 2015**	**On-going**: Dimitriou has modified and updated INDC(NDS)-421 to issue as INDC(NDS)-0700. **Revision in progress**.
2 (2)	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 INDC(NDS)-0733.	ENSDF format for atomic data has been agreed, and now requires implementation. **Done.** **Implementation is in progress**.
3 (4)	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 **Continues**
4 (5)	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.	Coordinate a working group tasked to prepare proposals for an Adopted decay dataset library (content, evaluation methodology) **Continues (in new format)**
5 (6)	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 **Work in progress**
6 (7)	NNDC-BNL	Calculation of Coulomb excitation by GOSIA code	Formulate questions and discuss with known experts.	**Action transferred to NNDC-BNL**: Coordinate effort to prepare guidelines for evaluators on how to treat data obtained using the GOSIA analysis code for Coulomb excitation experiments **Continuous**

First column: number in brackets is the action number from the previous NSDD network meeting (see INDC(NDS)-0850)

ANNEX 5

On-going and Incomplete Actions – still to be fully implemented Require biennial consideration				Status 28 October 2022
No	**Responsible**	**Reason**	**Action**	
7 (11)	ENSDF evaluators	Reviewers Guidelines	Provide feedback to NNDC (E.A. McCutchan) on draft of reviewer guidelines.	**Continuous**
8 (12)	IAEA-NDS	Maintain list of data centers	Explore obtaining DOI or permanent URL for data centers webpage.	To be implemented as soon as IAEA gives permission. **Continuous**
9 (15)	All evaluators	Update Q values to AME2020 in all Adopted datasets	Consult the ENSDF files with the Q values updating approach and provide feedback to NNDC-BNL (E.A. McCutchan).	**Ongoing**
10 (21)	IAEA-NDS	International contribution to NSDD	Explore the possibility of holding a meeting of stakeholders to discuss supporting NSDD evaluations.	**Ongoing** New: In consideration. Feedback from evaluators requested.

First column: number in brackets is the action number from the previous NSDD network meeting (see INDC(NDS)-0850)

ANNEX 5

New Actions			
No.	**Responsible**	**Reason/Topic**	**Action**
11	McMaster (B. Singh) All Evaluators	Policy implementation: check and modify *Guidelines for Evaluators*.	Prepare addendum with new items recorded in the recent meetings and not included in the Guidelines for Evaluators published in 2021 (including items of Action #3 of INDC(NDS)-0850). Share new document with evaluators for feedback. Recommendation to evaluators: to share with Balraj comments and suggestions on the existing Guidelines for anything missing
12	IAEA-NDS	Data uncertainties, and the problem of systematic uncertainties	Organise an online meeting (previous to the next NSDD meeting) to address this topic as well as propagation of uncertainties with Monte Carlo techniques (previous Actions #8 and #19).
13	LBNL (S. Basunia)	Implementation of policies adopted at NSDD meetings	Collect documents on decay data evaluation that are not in the Guidelines and add them to the Addendum document of Action #11.
14	ENSDF evaluators Code developers	New policy	Use “N” in column 79 to mark gammas used in intensity normalization when applicable. Implement this policy in GABS and GLSC codes.
15	ENSDF evaluators	New policy	“Rule” 35 (uncertainty rounding limit) is changed to “Policy” 35.
16	ENSDF evaluators	New policy	Starting from January 2023: adopt BetaShape code for β, β^+/EC properties (contingent upon X. Mougeot making the required changes in the code to deal with non-numerical uncertainties). From June 2023: obligatory use of the code (replaces LOGFT).
17	LHNB-Saclay (X. Mougeot)	Implementation of new policy	Send samples of ENSDF files with beta shape factors included in continuation record.
18	ENSDF evaluators ANU (T. Kibedi), MSU (J. Chen)	New policy	Adopt median value (standard definition) for Monte Carlo uncertainty propagation. Implement in ENSDF analysis codes where applicable.
19	NNDC	Policy implementation	Update the General Policies documents with recently adopted policies (wording to be discussed and approved by the community).
20	MSU (J. Chen) ENSDF evaluators	Implementation of policy	Modify ConsistencyCheck to flag “B+” in the DSID card as error. Evaluators should use “EC decay” or “EC+B+” in the dataset ID when applicable.

ANNEX 5

New Actions			
No	**Responsible**	**Reason/Topic**	**Action**
21	ANU (F. Kondev)	New policy	Formulate the updated policy on including %IG in decay datasets.
22	ANU (T. Kibedi)	New policy	Formulate the updated policy regarding the use of the new electronic factors with the new release of BrICC code.
23	NNDC (E.A. McCutchan) ENSDF evaluators	Policy	Consult the user community about the inclusion of theoretical papers in Adopted datasets. [done during meeting] Recommendation: to include (recent) theoretical papers references in the Adopted dataset after other experimental references not fitting in any dataset and before regular general comments.
24	TUNL (J. Kelley)	New policy	Formulate a policy item regarding the meaning of“=?”, “>0”, etc. when there is not sufficient information to assign a value for %mode.
25	ENSDF evaluators	ENSDF codes	Send a request to ANU (T. Kibedi) to test the new NS_RadList code (voluntary).
26	N.J. Stone IAEA/NDS ENSDF evaluators	Nuclear Moments	Mark the nuclei for which the magnetic dipole moments need to be corrected for revised reference values. Include these marked cases in the online moments database. For special cases contact N.J. Stone.
27	NNDC	Training	Organise training/prepare documentation on how to access and use the mass chain tracking system on GitHub.
28	All (ENSDF evaluators, code developers)	Policy on propagation of uncertainties for derived quantities	Propagation of limits for lifetimes and energies: use the limit value and propagate it generating limits for the derived quantities. Propagation of limits for other quantities (MR, RI, TI, BR-decay mode branching ratio): perform Monte Carlo calculations using uniform distributions.
29	NNDC, IAEA/NDS	Access to primary and secondary publications	To make available the X4-NSR PDF database through the NSR interface on the IAEA web server.

ANNEX 5

Completed / withdrawn Actions				Status 28 October 2022
No	**Responsible**	**Reason**	**Action**	
3	McMaster (Balraj Singh)	Policy implementation: check and modify *Guidelines for Evaluators*.	Implement the following in *Guidelines for Evaluators*: • unique gamma transitions should be assigned intensities of 100 (see Kuwait network meeting, INDC(NDS)-0635, 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 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)) **Action now transferred to Balraj Singh (McMaster):** to check if listed items have been included in the revised ORNL Guidelines, and if not, to add them in an Addendum (separate document) **Withdrawn - see new Action (#11).**
8	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.	**Withdrawn - see new Action (#12).**
9	MTA-Atomki	Uncertainty assignments of gamma-ray energies as related to gamma-ray intensities [**Sec. note:** draft – see Subsection 7.2. in INDC(NDS)-0783]	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.	Deferred to next meeting To add in text: For very small uncertainties or no uncertainties evaluators should contact authors to provide them with their results. When authors don't respond: should evaluator assume an uncertainty based on experience and other similar measurements? **Withdrawn**

First column: number is the action number from the previous NSDD network meeting (see INDC(NDS)-0850)

ANNEX 5

Completed / withdrawn Actions				Status 28 October 2022
No	**Responsible**	**Reason**	**Action**	
10	ENSDF evaluators NNDC-BNL ENSDF evaluators, code developers	New Policy Policy implementation	Provide %Iγ in decay datasets when applicable. Δ%Iγ in GABS: it should not be given if there is no uncertainty in relative Iγ. Check if col 79 is in use in ENSDF. Include X in col 79 (if it's not in use) and retain it in ENSDF database.	**DONE** **DONE** **See new Action #14.**
13	IAEA-NDS, NNDC-BNL	ENSDF reference(s)	LiveChart and NuDat to display the NSR keynumber of the Nuclear Data Sheets publication containing the evaluated data.	Requires inclusion in ENSDF datafile – not clear how **Withdrawn**
14	ENSDF evaluators and code developers	New Policy: Data uncertainties – quoted significant digits and handling thereof	RULE 35 to be implemented in the ENSDF codes for rounding off data where applicable.	Flexibility in applying the RULE is maintained for evaluators. **DONE – changed to policy (see new Action #15)**
16	LBNL	Implementation of policies adopted at NSDD meetings	Share the RULE for isospin assignment adopted at NSDD 2003 with NSDD network for further discussion.	**Withdrawn - see new Action #13**.
19	MSU, ANU, Recommended researchers [tbd] IAEA-NDS	Propagation of uncertainties in derived quantities	Study uncertainty propagation using MC method (impact of PDFs, adopted VALUES (mode/median/mean/direct calculation), treatment of limits) for a variety of cases. Formulate proposal(s) for discussion with user community and present feedback at next NSDD meeting. Explore possibility of organising a meeting with experts on propagation of uncertainties in measurements for further insight	**Withdrawn - see new Action #12.**
20	ANU (T. Kibedi)	ENSDF codes – propagation of uncertainties	Make UncTools available to the NSDD network for testing.	**DONE – see new Action #25.**

First column: number is the action number from the previous NSDD network meeting (see INDC(NDS)-0850)

ANNEX 5

ENSDF-RELATED PROCEDURES – CONTINUOUS			
Item no.	**Responsible**	**Reason/Topic**	**Extension**
1	All network participants	Relevant data and information from certain conferences, meetings, and laboratory 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 always come forward 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 contradict accepted rules.
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 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. **Sizeable percentage of submissions do NOT follow this instruction.**

ANNEX 5

ENSDF-RELATED PROCEDURES – CONTINUOUS			
Item no.	**Responsible**	**Reason/Topic**	**Extension**
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 undertake your own assessment. **Sizeable percentage of submissions do NOT follow this instruction.**
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	MSU, 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.

ANNEX 5

ENSDF-RELATED PROCEDURES – CONTINUOUS			
Item no.	**Responsible**	**Reason/Topic**	**Extension**
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.
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.
32	All evaluators	Keep ENSDF up to date.	Evaluators should consult the available horizontal evaluations - an updated list of which is maintained by NNDC - when performing an evaluation.
33	IAEA-NDS	IAEA-ICTP NSDD workshops	Continue to organise and implement educationally driven IAEA-ICTP workshops (outreach) with ICTP, Trieste, Italy. These workshops of one- or two-weeks duration, depending on aims and content, to be discussed further and full programme formulated.
34	IAEA-NDS, NNDC-BNL	IAEA-based and more intense ENSDF evaluation workshops	Organise ENSDF training courses as needed for positively committed NEW or existing ENSDF evaluators (based at IAEA Headquarters) – such workshops to be attended by deliberately limited numbers to achieve desired level of training.
35	IAEA-NDS	ENSDF evaluations	Organise an advanced workshop for existing NSDD/ENSDF evaluators if NEW ENSDF evaluators training course outlined above cannot be realised over a reasonable timescale.
36	IAEA-NDS	ENSDF codes	Organise technical meetings on Codes and Code Developments at IAEA Headquarters for existing code developers.

ANNEX 6

STATUS REPORTS OF NSDD DATA CENTRES

1. IAEA Status Report, Paraskevi Dimitriou

Period covered: 2021-2022

NSDD meetings

Three meetings of the network were held since 2021:
One-day NSDD reporting meeting, 21 May 2021, virtual (https://www-nds.iaea.org/nsdd/)
Spring NSDD meeting, 4-7 April 2022, virtual (https://conferences.iaea.org/event/299/)
24th NSDD TM of the NSDD network, 24-28 October 2022, Canberra (https://conferences.iaea.org/event/323/)

ICTP Workshop

The 10th ICTP-IAEA Workshop on Nuclear Structure and Decay Data was held on 3-14 October 2022. Ten lecturers/supervisors and 13 participants attended the workshop. For more information see Section 2.3. (https://indico.ictp.it/event/9830/).

Financial support

Financial support is provided to our collaborators B. Singh, N.J. Stone, and V. Piksaikin for their contributions to maintaining and updating our horizontal databases.
The seed grant for mass-chain evaluations to Sorin Pascu ended in 2021. Mass chain A=130 was completed, submitted and is currently in post-review status.
A new contract for mass-chain evaluation is in preparation for Anagha Chakraborty.

ENSDF codes dissemination

All the ENSDF analysis and checking codes have their own repository on GitHub. This will facilitate updating and version tracking in the future. Access to the repositories is still possible from the IAEA web interface https://www-nds.iaea.org/ public/ensdf_pgm/.

Decay Data for Monitoring Applications

The evaluation of the decay data of the 30 top priority radionuclides suggested by the CTBTO-IAEA collaboration is underway. An evaluation and review pipeline has been established with a well-defined methodology to produce Adopted decay data sets. The library will be available in ENSDF format as well as other formats required by the user community. The goal is to complete all the evaluations and produced complete data files with beta spectra (BetaShape) and atomic radiation data (BrIccEmiss) by the end of 2023. A technical report describing the work and results will be prepared for publication in 2024. Previous meeting reports are available at: INDC(NDS)-0828 and INDC(NDS)-0859.

Nuclear moments database

The Nuclear Moments database (https://ww-nds.iaea.org/nuclearmoments/) has been updated in the past three years to consider recommended magnetic dipole moments and electric quadrupole moments published by N.J. Stone in INDC(NDS)-0794, INDC(NDS)-0816 and INDC(NDS)-0833. All the tables can be downloaded as CSV files. At present, an effort is underway to update the compilation tables with new data published since 2014 (see Section 6.4).

Beta-delayed neutrons

The reference database for beta-delayed neutrons https://www-nds.iaea.org/beta-delayed-neutron/database.html has been updated both for microscopic and macroscopic data. The microscopic database has been updated by B. Singh to include all new measurements published in the period August 2020 to January 2022. Eleven new papers with revised half-lives and P_n values for 56 beta-delayed neutron emitters were covered: 2021Ha19, 2021Su01, 2021Mi07, 2021Mo10,

2021Ga10, 2021Pi11, 2021Ba34, 2021Wa49, 2021Te02, 202Ju02, 2020Wh02. The macroscopic database was updated according to the report of V. Piksaikin et al. (INDC(NDS)-0849). The experimental uncertainties of the measured integral spectra were estimated. Statistical uncertainties and systematic uncertainties due to the neutron background, recoil particles, thermal peak, efficiency of the neutron spectrometer and neutron flux attenuation effects were considered. Additionally, delayed-neutron spectra were calculated in the 8-group model using the Kalman filtering method.
Plans include updating the microscopic database for nuclei in the region Z<28. The macroscopic database will also be updated with new integral measurements as needed.

2. NNDC/BNL, Dave Brown

David Brown (BNL/NNDC) reported on the status of the NNDC staffing as well as the numerous NNDC activities. Currently the NNDC has 9 staff scientists, 3 post-docs, 4 professional staff and 6 contractors. In the fiscal year 2022, Shuya Ota and Jin Wu joined as scientific staff, both working on ENSDF and related nuclear structure activities, Emanuel Chimanski joined as a post doc working on the NA-22 Gamma Rays Induced by Neutrons project and Sam Kim joined as a post doc working on decay data measurements relevant to the determination of antineutrino spectra. This year also saw the departure of Matteo Vorabbi, who accepted a position as Lecturer at the University of Surrey, and Adam Hayes who left the NNDC to work in industry. The biggest change this fiscal year was that E.A. McCutchan became APS Fellow in 2022. In addition to these changes, the NNDC hosted 28 students, including 3 Nuclear Physics Traineeship students.
The NNDC and its flagship projects including the ENSDF, XUNDL, ENDF, EXFOR and NSR are proceeding well. D. Brown highlighted some of this ongoing work:

- A redesign of the NNDC website with a unified and simplified style, streamlined and automated website build and deployment, and containerized webapps for a more robust and reliable website consistent with modern webserver practices;
- Assignment DOIs for the ENSDF, XUNDL and NSR libraries and development of "landing pages" for these libraries;
- Preparation for the next ENDF release including tagging a Beta version for preliminary validation ahead of 2022 CSEWG and careful reviews of all new evaluations. The next beta release is planned for December 2022;
- ENSDF & XUNDL reported separately;
- Migration from the 80-column ENSDF text format to object-oriented JSON-based database, including a modular, reusable design that can be easily parsed by both humans and computers and is based on industry-standard technology. Adopted and (n,γ) datasets have been migrated and (HI,xnγ), (a,pγ), and other data sets are in preparation.
- Developed the WalletCraft tool to create the next Nuclear Wallet Cards booklet and applications. Under the hood, WalletCraft uses a new JSON-based OODB and experimental measurements (building block of the evaluation) are stored. This new, easy to read and use format also allows us transparent documentation of evaluation history and a faster development of the Wallet cards themselves.

3. ANL STATUS REPORT, Filip Kondev

Period covered: April 2019 – September 2022

I. Program overview
The Argonne Nuclear Data Program is involved in a number of scientific activities carried out within the broad framework of the U.S. Nuclear Data Program (USNDP) Coordinated Work Plan. The main emphasis is on nuclear structure and decay data, and their applications in nuclear physics research, and in applied nuclear technologies. Compiled and evaluated data are made available to the 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. This effort includes evaluations of atomic masses and complementary nuclear structure data for the Atomic Mass Evaluation (AME) and NUBASE databases. Measurements aimed at providing answers to specific questions and at improving the quality of existing databases in specific areas are also performed. The experimental activities are carried out at the U.S. Department of Energy nuclear physics user facilities and/or at leading nuclear physics laboratories elsewhere through collaborative arrangements.

II. Nuclear Data Evaluations Activities for ENSDF and XUNDL

The main emphasis of the nuclear data evaluation activities at Argonne National Laboratory is on nuclear structure and decay data evaluations for the ENSDF database. The ANL nuclear data center has responsibilities for evaluating nuclei within the A=109-110, 176-179 and 199-209 mass chains. The up-to-date status of these evaluations is presented in Table 1 and 2.

TABLE 1. STATUS OF MASS CHAIN EVALUATIONS ASSIGNED TO THE ANL NUCLEAR DATA CENTER

A Chain	NDS publication	Evaluator	Current Status
109	NDS **137** (2016) 1	S. Kumar, J. Chen & F.G. Kondev	completed
110	NDS **113** (2012) 1315	G. Gurdal & F.G. Kondev	completed
176	NDS **107** (2006) 791	M.S. Basunia	
177	NDS **159** (2019) 1	F.G. Kondev	completed
178	NDS **110** (2009) 1473	E. Achterberg *et al.*	
179	NDS **110** (2009) 265	C.M. Baglin	
199	NDS **108** (2007) 79	B. Singh	
200	NDS **108** (2007) 1471	F.G. Kondev & S. Lalkovski	**completed in FY22**
201	NDS **108** (2007) 365	F.G. Kondev	**completed in FY21**
202	NDS **109** (2008) 699	S. Zhu & F.G. Kondev	completed
203	NDS **177** (2021) 509	F.G. Kondev	**completed in FY20**
204	NDS **111** (2010) 141	C.J. Chiara & F.G. Kondev	completed
205	NDS **166** (2020) 1	F.G. Kondev	**completed in FY19**
206	NDS **109** (2008) 1527	F.G. Kondev	completed
207	NDS **112** (2011) 707	F.G. Kondev & S. Lalkovski	completed
208	NDS **108** (2007) 1583	M. Martin	
209	NDS **126** (2015) 373	J. Chen & F.G. Kondev	completed

TABLE 2. EVALUATED MASS CHAINS OUTSIDE THE ANL REGION OF RESPONSIBILITIES

A Chain	NDS publication	Evaluator	Current Status
188	NDS **150** (2018) 1	S. Juutinen, D. Hartley & F.G. Kondev	completed
112	NDS **124** (2015) 157	S. Lalkovski & F.G. Kondev	completed

III. Other Activities

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

The ANL staff participated in a number of IAEA-led activities, including the 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 lecturer at the ICTP-IAEA organized Trieste workshop on "Nuclear Structure and Decay Data Evaluation: Theory and Experiment", and consultancies on the development of the LiveChart Web application.

Our program is also involved in complementary Nuclear Data related research activities. This effort complemented the main ANL evaluation activities by providing training experience to the evaluator on modern experimental techniques and instruments that are used in nuclear data production. Such activities also allow to maintain contacts with a broad range of nuclear data users and with the FRIB and GRETINA research communities, in particular. Contributions were made to collaborative nuclear structure and decay research activities at the ATLAS and CARIBU facilities at ANL aimed at improving the quality of existing databases. This effort also included measurements aimed at improving decay data in the actinide region, where the main emphasis was on properties of nuclei far from the line of stability and on nuclear isomers in heavy nuclei. There is a growing involvement of our program in dedicated decay studies of neutron-rich nuclei in the fission product region at the CARIBU facility.

4. LBNL/UCB Status Report, Shamsuzzoha Basunia

Program Summary:
Nuclear structure data evaluation, evaluation of other data, like direct and beta delayed proton and alpha emitter, (n,n′γ) – Bagdad Atlas, γ-X coincidences, etc. including development of the Natural Language Processing tools, EGAF modernization, and targeted nuclear reaction at 88-Inch Cyclotron at LBNL and elsewhere are some of the common goals of the Nuclear Data Group. The members are also involved in the organization/coordination of workshops/meetings related to applied nuclear data activities and serving in the NSAC committee.

Evaluation/Compilation/Tool:
In this reporting period mass chains A=186, A=213 were published and A=30, A=191 and A=213 were submitted (of which A=213 was also published in this period and two others were in the publication pipeline). Two mass chains were reviewed.
Compilation/evaluation of other data, like (n,n′γ) from the Baghdad Atlas, beta-delayed proton emitters were continued for web dissemination. The γ-X-ray coincident database was developed for the fieldable-spectroscopy techniques, as part of the DTRA-funded portable γ-X-ray coincidence detector system (Si-drift and CeBr detectors) developed at PNNL for detection of fission-product debris.
NucScholar development was ongoing for AI/ML methods to accelerate the nuclear science literature search. The prototype search engine is available at https://nucscholar.lbl.gov/

Publications:
A total of fourteen journal papers have been published by the nuclear data group members as author/co-author during this reporting period.

Other Activities:
The LBNL/UC nuclear data group played a key role in committee/meetings. This included:

- Nuclear Science Advisory Committee:
- NSAC - Nuclear Data Subcommittee, Chair: L.A. Bernstein
- NSSC Nuclear Data Summer School, UC Davis, Aug 1 – 12, 2022

Contributions:

- The Tri-laboratory Effort in Nuclear Data (TREND) for Isotope Production, DOE Isotope Program Strategy Meeting, Virtual, April 24, 2022. (L.A. Bernstein)
- The ICTP-IAEA Workshop on Nuclear Structure and Decay Data: Theory, Experiment and Evaluation, October 3 -14, 2022, ICTP, Trieste. (M.S. Basunia)
- Compound-nucleus reactions: (n,γ) and (n,n'γ), NSSC Nuclear Data, Summer School, UC Davis, August 2022 (A.M. Hurst)

Personnel:
In this reporting period, group members at LBNL and UCB-NE include Lee A. Bernstein (Group Leader), Shamsuzzoha Basunia, Bethany Goldblam, Aaron M. Hurst, Jon C. Batchelder, Andrew Voyles, Josh Brown along with contractors Jag K. Tuli (ENSDF) until Sept 30,2021 and Walid Younes.

5. MSU/FRIB Status Report, Jun Chen

Period covered: May 2021 – October 2022

1. Overview of FRIB/MSU data center

The MSU Nuclear Data Center at FRIB was established under USNDP in April 2015 and has been funded by an independent grant directly from DOE-SC since 2016. Its current main responsibility is the evaluation of mass chains A=31-44 and A=60-73 (excluding 62, 67-70 done at other centers) in ENSDF (Evaluated Nuclear Structure Data File), assigned within the International Network of Nuclear Structure and Decay Data (NSDD) evaluators. In addition, the MSU data center plays a major role in and have made significant contributions to data compilation for XUNDL (eXperimental Unevaluated Nuclear Data List) including prior-publication data review and compilation of manuscripts submitted to collaborative journals such as Physical Review C. The MSU data center has been also taking the leading role in development and maintenance of new utility and analysis codes for XUNDL compilation and ENSDF evaluation, and modernization of all the legacy codes used in ENSDF evaluation.
Current personnel (since July 2017, 1 FTE): Jun Chen (PI, 1 FTE)

2. ENSDF evaluations and XUNDL compilations

In FY22, the MSU data center has completed and submitted full evaluations of A=32, 44 and 165 mass chains, with the latter two in collaboration with Dr. B. Singh from the data center at McMaster University, Canada. In addition, detailed reviews of full evaluations of two mass chains were done as requested, with the effort approximately equivalent to one-fourth to one-third of that for a full mass-chain evaluation for each review. Evaluations of A=33, 80 and 151 in collaboration with Dr. B. Singh and review of at least one mass-chain evaluation are planned for FY23. Status of all mass chain evaluations at FRIB/MSU is listed in Table 1, including those from collaboration but not in FRIB/MSU responsibility.
For XUNDL compilations, a total of 913 datasets from 457 papers for 667 nuclides have been compiled at the MSU data center since 2014, including 95 datasets/40 papers in FY22 among which 36 datasets/20 papers are done for the PRC data checking. The MSU data center will continue the effort for data checking and will also continue to recruit top MSU undergraduates for XUNDL compilation to strengthen the involvements of MSU students in the nuclear data program.

ANNEX 6

TABLE 1: STATUS OF MASS CHAINS ASSIGNED TO OR EVALUATED AT MSU
A 10-year cycle applies for update in general. Mass chains with status highlighted in red are scheduled to be updated with the priority given to the oldest ones.

Mass Chain	Year of last evaluation	Evaluator of last evaluation	Current status
31	2022	J. Chen and B. Singh	0-year old
32	2022	J. Chen	In-review
33	2011	J. Chen and B. Singh	Under-evaluation
34	2012	N. Nica and B. Singh	10-year old
35	2011	J. Chen, J. Cameron and B. Singh	11-year old
36	2011	N. Nica, J. Cameron and B. Singh	11-year old
37	2012	J. Cameron, J. Chen and B. Singh	10-year old
38	2017	J. Chen	5-year old
39	2017	J. Chen	5-year old
40	2015	J. Chen	7-year old
41	2015	C. D. Nesaraja and E.A. McCutchan	7-year old
42	2016	J. Chen and B. Singh	6-year old
43	2015	B. Singh and J. Chen	7-year old
44	2022	J. Chen and B. Singh	In-review
60	2013	E. Browne and J. K. Tuli	9-year old
61	2015	K. Zuber and B. Singh	7-year old
63	2008	J. Huo, D. Yang, et al.	14-year old
64	2021	B. Singh and J. Chen	1-year old
65	2010	E. Browne and J. K. Tuli	12-year old
66	2021	C. D. Nesaraja	Post-review
71	2021	B. Singh and J. Chen	Post-review
72	2010	D. Abriola and A. A. Sonzogni	12-year old
73	2019	B. Singh and J. Chen	3-year old
Additional mass chains from ENSDF priority list			
48	2021	J. Chen	1-year old
50	2019	J. Chen and B. Singh	2-year old
98	2020	J. Chen and B. Singh	2-year old
100	2021	B. Singh and J. Chen	1-year old
123	2021	J. Chen	1-year old
138	2017	J. Chen	5-year old
149	2022	B. Singh and J. Chen	0-year old
164	2017	B. Singh and J. Chen	5-year old
165	2022	B. Singh and J. Chen	In-review
167	2021	B. Singh and J. Chen	Post-review
190	2020	B. Singh and J. Chen	2-year old
194	2021	J. Chen and B. Singh	1-year old

3. The FRIENDS data project at FRIB

The FRIENDS (FRIB Integral Experimental Nuclear Data Services) project was started by the FRIB/MSU data center in 2021 with the aim to provide seamless support for data needs to FRIB users throughout the stages of proposal preparation to publications of results, as an integral part of the FRIB experimental support. Main services of FRIENDS are categorized into 4 stages of an experimental work as illustrated in Fig. 1: proposal preparation, data taking, data analysis, and publication preparation, but are not limited to each individual stage

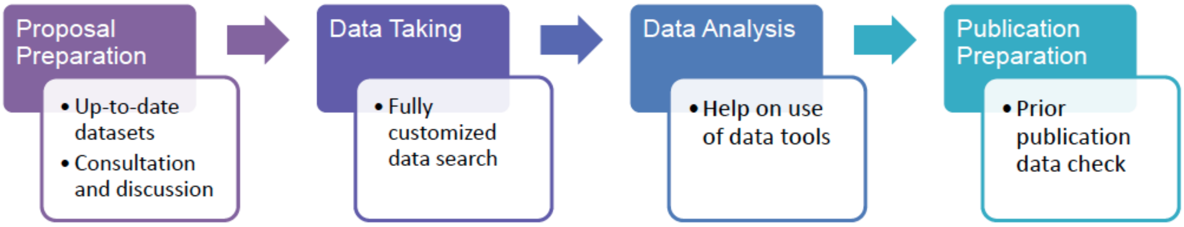

FIG. 1. Data services of FRIENDS provided to users at each stage of an experimental work at FRIB.

6. ORNL Status Report, Caroline Nesaraja

1. Members

The Nuclear Data Group consists of Michael Smith (nuclear astrophysics data, 0.2 FTE), Caroline Nesaraja (ENSDF evaluator, 1.0 FTE) and Larry Zhang (nuclear astrophysics data, 1.0 FTE).

2. Activities

a) Nuclear Structure Data

ENSDF

This activity consists of mass chain evaluations, and our responsibility is in the actinide region A=241-249 as well as A=69. The current literature cut-off dates of these mass chains are listed below:

Mass Chains and Literature cut-off dates from ENSDF database

241 C.D. Nesaraja. NDS 130, 183 (2015) (Lit cut-off Sept. 2015)
242 Y. A. Akovali. NDS 96, 177 (2002) (Lit cut-off Sept. 2001)
243 C.D. Nesaraja & E.A. McCutchan. NDS 121, 695 (2014) (Lit cut-off Sept. 2013)
244 C.D. Nesaraja. NDS 146, 387 (2017) (Lit cut-off August 2017)
245 E. Browne & J.K. Tuli. NDS 112,447 (2011) (Lit cut-off June 2010)
246 E. Browne & J.K. Tuli. NDS 112,1833 (2011) (Lit cut off Jan. 2011)
247 C.D. Nesaraja. NDS 125, 395 (2015) (Lit cut-off March 2014)
248 M.J. Martin. NDS 122, 377 (2014) (Lit cut-off Sept. 2014)
249 K. Abusaleem. NDS 112, 2129 (2011) (Lit cut-off Dec. 2010)
69 C.D. Nesaraja. NDS 115, 1 (2014) (Lit cut-off Jul. 2013)

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

Mass Chain	Evaluator	#Nuclides	Status
137	Nesaraja	16	Editorial Review
246	Nesaraja	9	Submitted
242	Martin/Nesaraja	9	Editorial Review

b) Nuclear Astrophysics Data

The nuclear astrophysics data research is closely coupled with our program of measurements of reactions with beams of unstable and stable nuclei. Our current emphasis is on determining the uncertainty of reactions important for explosive nucleosynthesis occurring in nova explosions. Recently, the uncertainties of a set of thermonuclear reaction rates relevant for nova explosions have been adopted from a published collection (STARLIB) to work with a set of thermal profiles for nova outbursts. A temperature-averaging procedure was developed to determine representative uncertainties for these reactions over the temperature histories of 23 zones for a nova outburst on a 1.35 solar mass white dwarf star. The rate uncertainties are currently being tested in an uncertainty quantification (UQ) analysis of nova nucleosynthesis. The UQ study utilizes a Monte Carlo shell around the nucleosynthesis code XNET, and rate uncertainties are propagated through the system to determine uncertainties in abundances synthesized in the explosion. Modifications of the input rate uncertainties are also in progress to better represent the overall uncertainties of the thermonuclear burning. A scheme to incorporate these uncertainties into a standardized reaction rate library REACLIB is also being developed. Additionally, the nuclear data needs for nuclear astrophysics were detailed in a report submitted to the Nuclear Data Subcommittee of the US Nuclear Science Advisory Committee, along with a prioritization of efforts and a plan to meet these data needs for the next decade.

3. Future Activities

Future mass chains will be evaluated within the range A=241-249 & A=69, the range assigned to ORNL, as well as others assigned by USNDP/ NNDC.

7. Texas A&M Status Report, Ninel Nica

The goal of our evaluation center is to promote and accomplish mass-chain nuclear structure data evaluation at the Texas A&M University – Cyclotron Institute as regular activity and foresee future developments, as well as to address gaps in data through targeted experiments. We have been part of the ENSDF evaluation effort since 2005, working under contract with the National Nuclear Data Center in Brookhaven National Institute, and continuing as an evaluation center which, as such, has been funded by the Cyclotron Institute Grant since 2018. We contribute to the evaluation effort with 1 FTE/FY.

Our direct contribution to the effort consists of more than 300 nuclei and 21 mass chains evaluated, already published (18) or in the process of publication (3) in the Nuclear Data Sheets, as well as posted in the ENSDF database. While our activity covered a large range of the atomic chart between mass numbers A=34 to A=252, our actual responsibility spans the Rare Earth region with the 140, 141, 147, 148, 153, 155, 157, 158, 160, 154, 162 mass chains. As sustained by our proposal and adopted by vote at this meeting, the last two mass chains were recently officially adopted as our responsibility.
As a profile characteristic of our center, all these mass chains are consistently the largest sizes and most complex of the atomic mass chart (17 nuclides, over 20,000 database lines on average, and 400-500 pages of abridged published manuscripts), reason for which the whole process of evaluation, review and publication converges to completion very slowly. Thus, while the evaluation work regularly takes not more than a year, the review process typically takes at least twice as long, followed by the update work of the newly published data and post review, which results in a total of 3-4 years for the whole cycle. Although the tendency is to somehow shorten this time span, the whole publication effort continues to be long and complex, not only for the evaluator but also for the sustained review effort, which is quite difficult and time consuming.

Since 2019 we published the following mass chains: A=155 (Nucl. Data Sheets 160, 1 (2019)), A=155 (Nucl. Data Sheets 170, 1 (2020), A=160 (Nucl. Data Sheets 176, 1 (2021)), and A=147 (Nucl. Data Sheets 181, 1 (2022)). We also successfully evaluated the A=141 (2020), A=162 (2021) and A=154 (2022) mass chains, of which A=141 is ready for publication, while A=162 has been-reviewed once, and A=154 is under the first review. All these mass chains were published by us (NN), except for A=147, to which Balraj Singh contributed with the ^{147}Pm nucleus. In this period, we also timely reviewed four mass chains. For the next fiscal year 2023 we plan to fully evaluate the A=148 mass chain.

Overall, the status of the Texas A&M University Center mass chains is in good shape with all the mass chains in our responsibility being updated well within the ten years cycle.

8. TUNL Status Report, John Kelley

1. ENSDF & XUNDL

TUNL is responsible for data evaluations in the mass range A = 3-20. Since the last NSDD/IAEA meeting we submitted a review of A=13 nuclides to the Nuclear Data Sheets. Reviews of A=5 and A=14 nuclides are underway along with evaluations of ^{18,19}Ne.

We contribute to the compilation effort that covers the A=2-20 region for XUNDL; this amounts to about 4-5 compiled articles/month.

2. World Wide Web Services

TUNL continues to develop new WWW services for the nuclear science and applications communities. We have posted PDF and HTML documents for the TUNL and Fay Ajzenberg-Selove "Energy Levels of Light Nuclei" reviews 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 the A=3-20 nuclides. We also maintain a compiled and evaluated list of lifetime values for all nuclei in the A=3-20 region.

Supported by the U.S. Department of Energy Director of Energy Research, Office of High Energy and Nuclear Physics, Contract Nos. DEFG02-97-ER41042 (North Carolina State University); DEFG02-97-ER41033 (Duke University).

9. Australian National University Status Report, Tibor Kibedi

Period covered: 2019-2022

Mass chain evaluations. The ANU has primary responsibilities for A=172-175. During the last two years, the A=172 evaluation has been completed in collaboration with B. Singh (McMaster). The final submission, including the reviewer's comments is expected in the first half of 2023. Part of the evaluation of A=174 by E. Browne and J.K. Tuli has been completed.

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 has been evaluated. All experimental information on transition rates, mixing ratios and level life-time (or absolute transition rates) were considered to extract ρ^2(E0) strength parameters. Conversion coefficients are taken from BrIcc (2008Ki07) and the new Ω(E0) electronic factor tabulations (2020Do01). The full report (2022Ki03) was published in Prog. Part. Nucl. Phys. 123 (2022) 103930.

Critical nuclear decay data for monitoring applications

The ANU is responsible to evaluate ^{137}Cs β^- (completed in Aug 2022), ^{136}Cs β^- and ^{131}I β^-, as well as to carry out the calculations of atomic radiations for all nuclei considered in this program using NS_Radlist.

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

More than 120 experimental ratios of E0 sub-shell conversion electron and/or conversion to pair conversion intensities have been compiled to benchmark the new Ω(E0) tabulations. It was concluded that on average theory overestimates experiment by about 5%. We propose to adopt a 5% uncertainty for the new Ω(E0) tabulations. The full report (2020Do01) was published in At. Data and Nucl. Data Tables 131 (2020) 101283

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

High resolution low energy electron measurements have been carried out to study the conversion electron to Auger electron emission energies and rates from the electron capture decay of ^{125}I. The new measurements allowed to examine fine details of the energy spectrum, including the effect of electron shake-off as well as the so called ``atomic structure effect" related to adjustment of the atomic field following electron capture. Our data indicate, that the transition rates obtained from EADL could underestimate the Auger yield, by about 15-20%. (see M. Alotiby et al., J. El. Spect. and Rel. Phenom. 232 (2019) 73)

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

Two new theoretical tabulations of E0 electronic factors have been developed. One for conversion electrons using 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). The second 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 BrIcc. The full report (2020Do01) was published in At. Data and Nucl. Data Tables 131 (2020) 101283. The tables will be available in the new version of BrIcc.

10. Bulgaria St. Kliments University Status Report, Stephan Lalkovski

Nuclear data evaluations were carried out for ^{117}Sn and the A=107 mass chain nuclei. All available nuclear structure and decay data for each of the nuclei considered were retrieved from literature sources, compiled in ENSDF format and evaluated. ^{117}Sn was submitted to NNDC/BNL for inclusion in ENSDF. After receiving the editor's comments, the evaluation of ^{117}Sn is in post-review status. The revised evaluation will be submitted in summer 2023. Most of the work on mass chain A=107 is done. The evaluation is funded by the EURATOM SANDA project and should be completed by August 2023, well within the project completion date. In addition, I have performed one mass-chain review for ENSDF (A=252) and have completed the evaluation of one nucleus (^{144}Pr) for the IAEA project "Decay Data for Monitoring Applications". I am also reviewing the evaluations of two other nuclei for this IAEA project.

I plan to evaluate the neutron rich nuclei in mass chain A=-117 in collaboration with the Romania Data Center so that we can jointly publish mas chain A=117. Regarding the other mass-chain responsibilities of the Sofia Data Center, after submitting the final version of A=107, I plan to start evaluating A=111.

11. McMaster University Status Report, Balraj Singh

Period covered: June 2021 to October 2022

ENSDF: Publications:

A=149: B. Singh, J. Chen, NDS (in press).
A=231: B. Singh, J. Tuli, E. Browne (in press).
A=31: J. Chen, B. Singh, NDS 184, 29-405 (Sept-Oct 2022).
A=147: N. Nica, B. Singh, NDS 181, 1-474 (March-April 2022).
A=64: B. Singh, J. Chen, NDS 178, 41-537 (Dec 2021).
A=194: J. Chen, B. Singh, NDS 177, 1-508 (Nov 2021).
A=219: B. Singh, G. Mukherjee, S.K. Basu, Sr. Bhattacharya, Su. Bhattacharya, A. Chakrabarti, A.K. De, R. Gowrishankar, A.K. Jain, S. Kumar, S. Singh, NDS 175, 150-268 (July-Aug 2021).

ENSDF evaluations submitted:

A=31: J. Chen, B. Singh: submitted Sept 2021: published.
A=231: B. Singh, J.K. Tuli, E. Browne: submitted July 2021: in press.
A=71: B. Singh, J. Chen: submitted Sept 2021: post-review stage.

A=167: B. Singh, J. Chen: submitted Sept 2021: in review.
A=77: B. Singh: submitted Jan 2022: post-review stage
A=224: B. Singh, S. Singh: submitted: March 2022: in ENSDF.
A=44: J. Chen, B. Singh: submitted Sept 2022: in review.
55 individual nuclide evaluations: in ENSDF.

XUNDL compilations:
92 new and 75 updated datasets from 90 papers, including 35 papers for PRC-Data checking; for the latter, reports were also prepared, and some PRC papers went through two rounds.
Mass measurement papers from November 2020 to October 2022: ~32 papers: being compiled: to be sent Nov 2022 to make the data file available on Michael Smith's (ORNL) webpage: www.nuclearmasses.org.

NSR keywording:
Total number of articles from PRC and other literature consulted: 992.
Keyword abstracts prepared: 762.
Training of new compiler for keywording PRC articles.

Topical: Published.
Systematic trends of 0^+_2, 1^-_1, 3^-_1 and 2^+_1 excited states in even-even nuclei: B. Pritychenko, B. Singh, M. Verpelli, Nucl. Phys. A 1027 (2022) 122511.
Atlas of nuclear isomers – Second Edition: S. Garg, B. Maheshwari, B. Singh, Y. Sun, A. Goel, A.K. Jain, ADNDT 150 (2023) 101546.

Topical: On-going and planned:
Log ft review: S. Turkat, X. Mougeot, B. Singh, K. Zuber: Expected submission of paper Dec 2022.
Beta-delayed neutron emitters: update of IAEA-NDS BDN reference database: Expected completion: June 2023.
r0 radius parameters for even-even α decays: update: S. Singh, S. Kumar, B. Singh, J. Chen: Expected completion: Feb 2023.
B(E2) for first 2+ and 4+ states in e-e nuclei: B. Pritychenko, B. Singh: ongoing.
Gamma-transition strengths for M1, E2, E1, M2, etc.: J. Chen, B. Singh: ongoing.
High-spin multi-qp dipole bands with dominant M1 transitions: S. Singh. S. Kumar, B. Singh, A.K. Jain: ongoing.
Nuclear Isomers: 0.1-10 ns: S. Garg, B. Maheshwari, B. Singh, Y. Sun, A.K. Jain: planned.
Proton radioactivity: B. Singh, A.A. Sonzogni, J. Chen, (and possible Prof. P. Arumugam, IIT, Roorkee, India): planned.

12. CNDC Status Report, Xiaolong Huang

CIAEA Data Centre comprises three contributors:
Huang Xiaolong: Major NSDD contributor
Liu Lilie: Temproary NSDD contributor, major FTE
Wang Xianghan: graduate student.

Status of the mass chains in CIAE region of responsibility:

Mass chain A	Status	Evaluators
51	NDS, 144, 1 (2017)	Wang Jimin, Huang Xiaolong
62	NDS, 113, 973 (2012)	Balraj, Huang Xiaolong, being evaluated
195	NDS, 121, 395 (2014)	Huang Xiaolong, Kang Mengxiao
196	NDS, 108, 1093 (2007)	Huang Xiaolong, under review
197	NDS, 104, 283 (2005)	Huang Xiaolong, Wang Jimin, Kang Mengxiao, under review
198	NDS, 133, 221 (2016)	Huang Xiaolong, Kang Mengxiao

ANNEX 6

Contribution to DDEP: None in the past year. Review of ^{87}Rb evaluation.

Radioactive Decay Data File: CENDL-DDL

- The first release CENDL-DDL included 2351 nuclei between A=66 to A=172 FY region. ENSDF and ENDF format were adopted. Evaluations taken from:
  - CNDC+ Jilin Univ.: ~500 nuclei;
  - DDEP: ~200 nuclei; (3) ENSDF: ~1500 nuclei;
  - JEF3.2: ~150 nuclei (only for stable nuclei).
- The Q-values of the decay modes are updated to the Atomic Mass Evaluation (AME) released in 2021Wa16.
- All $T_{1/2}$ are revised by new measurements (2022,6).
- Mean energies for β & γ: from TAGS measurements when available, otherwise from theoretical calculation. For even-even nuclides, from theoretically analysis which employed QRPA approach in Jilin University.
- Beta-delayed n, p, α emitted are adopted: P_{1n}, P_{2n} from evaluation of 2015Bi05, 2020Li32; P_{1p}, $P_{1\alpha}$ from evaluation of 2020Ba07 when measurements available. Otherwise from systematics or theoretical calculation.

Decay App

A decay data App has been developed to retrieve decay data and build the decay chain for the specified mass number A from various evaluated decay data libraries such as CENDL-DDL, JENDL-5.0, ENDF/B-VIII.0, JEFF-3.3, etc. The retrieved data are provided in PDF formats for exchange. The App is available at: http://www.nuclear.csdb.cn/.

13. Jilin University Status Report, Dong Yang

1. Members

   At present, members of Jilin university (JLU) group include: Yang Dong, Li Jian and a postgraduate Chen Duo. Huo Junde retired.
2. Mass Chain Evaluation

   Jilin university is responsible for the mass chains: A=52, 53, 54, 55, 56, and 67. The 55 and 67 mass chains are being evaluated.

Mass	Last publication
52	Yang Dong, Huo Junde, NDS, 128, 185-314 (2015)
53	Huo Junde, NDS, 110, 2689-2814 (2009)
54	Yang Dong, Huo Junde, NDS, 121, 1-142 (2014)
55	Huo Junde, NDS, 109, 787-942 (2008)
56	Huo Junde, Huo Su, Yang Dong, NDS, 112, 1513-1645 (2011)
67	Huo Junde, Huang Xiaolong, J.K. Tuli, NDS, 106, 159-250 (2005)

3. Other research activities of the group:
   a) Decay data evaluation for CENDL-DDL database of CNDC: 22 nuclides' decay data has been reevaluated;
   b) Systematics study for the ground states' spin of odd-Z nucleus;
   c) Statistical analysis of half-lives measurement results.

14. ATOMKI Status Report, Z. Elekes, Janos Timar

Period covered: May 2021-October 2022

The center 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 mass-chain evaluation work. We have been working on mass-chain evaluations since 2009. Our permanent responsibilities are the A=101-105 mass chains. Our evaluation work is funded by Atomki and Horizon 2020 Euratom project SANDA.

Mass-chain evaluations
The full evaluation of the A=101 mass chain has been completed and submitted for review. We have started to evaluate the A=103 mass chain, and completed 10 out of 15 isotopes.

Future Plans
We would like to complete the evaluation of the A=103 mass chain in 2022 and the A=46 mass chain in 2023. We intend to start the evaluation of the A=102 mass chain in 2023.

15. India Centre Status Report, Gopal Mukherjee

Period covered: 2021-2022

Introduction:
The India NSDD network centre has been involved and contributed to the following different aspects of the nuclear structure and decay data evaluation network.

- Mass A Chain Evaluations
- Horizontal Evaluations
- Code development and
- Training

India NSDD Centre is assigned the mass chains A = 215 - 229 for evaluation. Apart from that, the centre is involved in the horizontal evaluation of nuclear isomers, magnetic and anti-magnetic rotational band, E3 transitions etc., the development and maintenance of ALPHAD_RadD code and contributes to the training program.

Present Status of the Mass Chain evaluation:
The present status of the mass chains assigned to the India centre are given in the following table.

Mass Chain	Year of last Evaluation (Cutoff date)	Reference/ Journal	Earlier Evaluator(s)	No. of XUNDL data sets / Present status (October, 2022)
215	2013 (Oct. 22, 2013)	NDS 114, 2023 (2013)	B. Singh, GM *et al.* *(VECC workshop)*	**28 (being evaluated by Sushil Kumar, SSD, AKJ, GM, BS)**
216	2007 (March 1, 2007)	NDS 108, 1057 (2007)	S.-C. Wu	**21 (25) (being evaluated)**
217	2018 (Dec. 01, 2017)	NDS 147, 382 (2018)	F. Kondev *et al. (Trieste Workshop: 7 authors from India)*	15 (17)
218	2018 (Oct. 30, 2019)	NDS 160, 405 (2019)	B. Singh et al., (Trieste Workshop: 4 authors from India)	4 (21)

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Mass Chain	Year of last Evaluation (Cutoff date)	Reference/ Journal	Earlier Evaluator(s)	No. of XUNDL data sets / Present status (October, 2022)
219	2021 (May 19, 2021)	NDS 175, 150 (2021)	B. Singh, GM et al.	***Published***
220	2011 (Oct. 2010)	NDS 112, 1115 (2011)	E. Browne and J. Tuli	14 (15)
221	2007 (Jan. 15, 2007)	NDS 108, 883 (2007)	P.K. Joshi, R. Chakrabarti	17 ***(being reevaluated)***
222	2011 (Mar. 31, 2011)	NDS 112, 2851 (2011)	S.S. Dhindsa, A.K. Jain, J. Tuli	15 ***Being evaluated by B. Singh (+ ICTP 2022 Workshop Trainees)***
223	2001 (May 2001)	NDS 93, 763 (2001)	E. Brown	***8 (being evaluated: P. Joshi, R. Chakrabarti)***
224	2015 (Oct. 15, 2015)	NDS 130, 127 (2015)	S. Singh & B. Singh	08
225	2009 (Dec. 2008)	NDS 110, 1409 (2009)	A.K. Jain, R. Raut, J. Tuli	07 (will be taken up by A. Chakraborty)
226	1996 (Feb. 1996)	NDS 77, 433 (1996)	Y.A. Akowali	***New Evaluation being completed by SSD and BS***
227	2016 (15 Jan., 2016)	NDS 132, 257 (2016)	F. Kondev et al. (8 authors from India)	08 (11)
228	2014 (Dec. 31, 2012)	NDS 116, 163 (2014)	K. Abusaleem	09 (11)
229	2008 (June 2008)	NDS 109, 2657 (2008)	E. Browne and J. Tuli	21 Being evaluated by J. Tuli and B. Singh

In addition to the Assigned (A = 215 – 219) mass chains, the following other mass chains have been / are being evaluated:

A = 90
S.K. Basu and E.A. McCutchan
Nucl. Data Sheets 165 (2020) 1- 32

A = 23
M.S. Basunia and A. Chakraborty
Nucl. Data Sheets 171 (2021) 1–252

A = 23
M.S. Basunia and A. Chakraborty
Nucl. Data Sheets 171 (2021) 1–252

A = 30
M.S. Basunia and A. Chakraborty
Under Review

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Present Status of other evaluation activities:
Based on the available data and on the initial work, the scope of the horizontal evaluation project of "Magnetic and Anti-Magnetic Rotational Bands" has been decided to be expanded as “Multi-qp structures in high-spin physics dominated by dipole (M1) transitions of dipole bands in Nuclear landscape”. The NSR, ENSDF and XUNDL databases were consulted and compiled the experimental data of definite/tentative 235 MR bands observed in 120 nuclei. Based on the consultation, a set of criteria has been adopted to label a dipole band as definite MR band. It is now a bigger project and will therefore take little longer to complete. Its completion is to be expected by 2023-24.

Another horizontal evaluation under way is on the "Reduced B(E3) transition rates for E3 decay in nuclear chart”. This project is on-going with a Ph.D student involved in this work. Two publications have already resulted from this work.

In regard to the AlphaD-RadD code, revised r0 parameters of even-even alpha emitters are being compiled. All the alpha decay data sets are being updated as per discussion with B. Singh and will be sent to J. Chen.

Regarding the contribution to the training program, 8 Ph.D students from India attended the last Trieste Workshop on nuclear structure and decay data: Experiment, Theory and Evaluation. They took part in the XUNDL compilation and evaluation activities. Gopal Mukherjee also contributed as XUNDL guide and as a lecturer.

16. Manipal University Status Report, Mohini Gupta

Mass chain responsibility: A=260-265

Status of Data sets for A=265 and A=261:
Submitted, 27 January 2018
Reviewers comments received, 25 May 2021
Re-submitted, 28 March 2022

Current status:
Re-compiling with Java NDS
AME update

17. JAEA Status Report, Hideki Iimura

After April 2022, three long-standing members; S. Ohya, J. Katakura, and M. Kanbe, stopped evaluation work and left the Japanese group. The present members of the Japanese group are H. Iimura and H. Koura (JAEA). H. Iimura, who is responsible for the Japanese group, has retired from JAEA in March, 2022.

The Japanese group is responsible for the mass chains from A=120-129. However, because the Japanese group has become smaller, its mass chains responsibility will have to be reduced. However, H. Iimura and H. Koura are now evaluating A=120 and 124, respectively. H. Iimura’s next evaluation candidate is A=122.

After his retirement H. Iimura established a private company which has a contract with the nuclear safety research center of JAEA that allows him to continue the evaluation work for ENSDF. However, the terms of the contract don’t allow for enough time to be devoted to ENSDF. Therefore, it is critical to find an additional source of financial support.

As another activity apart from mass chain evaluation, about one thousand sheets of the JAEA chart of nuclides were printed and distributed to high schools in 2021 by using crowdfunding for education. A new edition of the JAEA chart of nuclides is being prepared by H. Koura with planned publication in spring 2023.

18. IFIN-HH Status Report, Alexandru Negret

The two evaluators of the NSDD Data Centre established in IFIN-HH, Bucharest, have committed, on a long-term basis, to spend 20% of their time (0.4 FTE in total) on nuclear structure evaluation activities. Due to other obligations, both evaluators have reduced their current contribution temporarily to 0.1-0.2 FTE. Efforts are being made to make evaluation activities more attractive and to offer training to more scientists.

The table below presents the status of the mass chains falling under the responsibility of the Bucharest Data Centre:

Mass number	Cut-off date of the latest ENSDF evaluation	Observations
57	1998	Under evaluation by A. Negret, B. Singh and R. Firestone (postreview)
58	2010	Under evaluation by C. Nesaraja and B. Singh
59	2018	
117	2009	
118	1992	Under evaluation by S. Pascu, A. Negret, and E.A. McCutchan
119	2008	

Other evaluation activities:

- Evaluation of A=130 by S. Pascu, B. Singh, A. Rodionov, G. Shulyak – post review,
- Evaluation of A=101 by J. Timar, Z. Elekes, A. Negret, S. Pascu – with the reviewer,
- Evaluation of several isotopes with A=86 by A. Negret and B. Singh – work in progress,
- Evaluation of the decay proprieties of ^{133}I (by A. Negret, post-review) and ^{140}La (by S. Pascu, submitted for review) as part of an IAEA project dedicated to the re-evaluation of the decay proprieties of nuclei of importance for CTBTO.

The evaluation activity in IFIN-HH received funding from the Euratom research and training programme 2014-2018 under grant agreement No 847552 (SANDA).

19. Status of the Decay Data Evaluation Project (DDEP), Xavier Mougeot, Sylvain Leblond

The members of the *Laboratoire National Henri Becquerel* (*LNHB*) – the French national metrology laboratory for ionising radiation – are strongly involved in the Decay Data Evaluation Project (DDEP). Since 2020, the coordination of the project has been performed by X. Mougeot since M.A. Kellett had to step down owing to a change in his professional situation, although he remains in the role of special advisor. C. Dulieu continues to develop and maintain the software tools of the collaboration. Finally, S. Leblond joined the LNHB in October 2020 to reinforce the data evaluation effort of DDEP.
After several lean years, the LNHB group has recently started a new cycle in the evaluation of decay data. Since 2021, six new evaluations have been published: ^{52}Mn, ^{52m}Mn, ^{124}I, ^{131}Cs, ^{87}Rb, ^{6}He. The group has also been working to finalize the review of several unpublished evaluations, among them ^{137}Cs, ^{103}Pd/^{103m}Rh, ^{68}Ga and ^{236}Th (which are expected to be published within the next year). Besides, the LNHB has tried to strengthen the collaboration with the NSSD network by initiating a joint evaluation on ^{137}Cs.

All these evaluations are performed in the scope of the DDEP and are published on the LNHB website, in the dedicated section: http://www.lnhb.fr/nuclear-data/nuclear-data-table/. The webpages have been steadily improved over the years, most notably the Laraweb tool: http://www.lnhb.fr/nuclear-data/module-lara/. Initially developed to help users to perform queries in the database (for emissions identification or radionuclide decay properties), the tool provides now the possibility to calculate the evolution of the activity and emission intensities of all nuclides of a given decay chain. Also, an online display of BetaShape calculation has recently been made available for users. These developments have created a notable impact in the community as the number of accesses to the DDEP webpages has been multiplied by seven during the last five years.

The BetaShape code, developed by X. Mougeot, has also been improved to include precise calculations of forbidden unique transitions in beta decays and electron captures. Distributed freely as an executable from the LNHB website, the code is available for Linux, MacOS and Windows operating systems. A more precise treatment of the forbidden non-unique transitions has also been developed but requires the use of an external nuclear structure code and therefore is not yet available to the community.

The shortage of manpower, mentioned in the previous status report, is still very relevant for the DDEP and the LNHB has taken a series of actions to attract newcomers to the field. First, developments have been performed to simplify the use of SAISINUC, the main DDEP software evaluation tool. A new user guide has been written to guide newcomers in the use of the software. A dedicated DDEP evaluator webpage, gathering all the codes, guidelines and tools for evaluators has been created. In addition, a training workshop was organized in March 2022 at LNHB with six potential new evaluators. Finally, both S. Leblond and X. Mougeot attended, as participant and lecturer respectively, the IAEA-ICTP workshop on Nuclear Structure and Decay Data in October 2022. With the very first DDEP evaluation performed by B. Zimmerman published in July 2021, the efforts taken by the LNHB group have started to pay off.

In conclusion, the recent progress of the DDEP at LNHB has been presented. While the group is strongly lacking manpower and international support, most notably from the metrology community, a new cycle of evaluator training and tool developments has started to refresh the collaboration.

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PRESENTATION LINKS

#	Author	Title	Link
1	P. Dimitriou	IAEA status report	IAEA status report
2	T. Kibedi	ANU status report	ANU status report
3	F. Kondev	ANL status report	ANL status report
4	S. Basunia	LBNL+UCB status report	LBNL+UCB status report
5	J. Chen	FRIB/MSU status report	FRIB/MSU status report
6	C. Nesaraja	ORNL status report	ORNL status report
7	N. Nica	TAMU status report	TAMU status report
8	J. Kelley	TUNL status report	TUNL status report
9	S. Lalkovski	Sofia Univ. status report	Sofia Univ. status report
10	G. Mukherjee	India centre status report	India centre status report
11	H. Koura	JAEA status report	JAEA status report
12	A. Negret	IFIN-HH status report	IFIN-HH status report
13	X. Huang	CIAE status report	CIAE status report
14	D. Yang	Jilin Univ. status report	Jilin Univ. status report
15	Z. Elekes	ATOMKI status report	ATOMKI status report
16	S. Leblond	DDEP status report	DDEP status report
17	M. Gupta	Manipal status report	Manipal status report
18	B. Singh	McMaster Univ. status report	McMaster status report
19	D. Brown	USNDP/NNDC status report	USNDP/NNDC status report
20	E. Ricard-McCutchan	XUNDL/ENSDF Database Update	XUNDL/ENSDF Status
21	B. Singh / F. Kondev	Adoption of the Betashape code	Betashape code
22	T. Kibedi	Uncertainty propagation	Uncertainty propagation
23	T. Kibedi	GABS code	GABS code
24	S. Basunia	Evaluation, tabulation, and dissemination of nuclear data for applied use	Evaluation, tabulation, dissemination of ND
25	D. Mason	ENSDF/NuDat modernization	ENSDF/NuDat modernization

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26	J. Batchelder	Database for charged-particle emitters	Database for charged-particle emitters
27	A. Hurst	EGAF modernization	EGAF modernization
28	P. Dimitriou	ICTP Workshop 2022	ICTP WS 2022
29	T. Kibedi	Atomic radiation data	Atomic radiation data
30	N. Stone	Nuclear moments table	Nuclear moments table
31	V. Zerkin	MyEnsdf Webtools	MyEnsdf Webtools

Edgardo (Eddie) Browne-Moreno
(1939-2022)

In Memoriam

Edgardo (Eddie) Browne- Moreno was born in 1939 in Paraguay. He received both his BS (1963) and PhD degree (1970) in physics from the Instituto Balseiro, University of Cuyo, Argentina. For his PhD thesis, he worked with Frank Asaro at the Lawrence Berkeley National Laboratory (LBNL).

Eddie joined the Isotopes Project at LBNL in the mid-1970s. He was one of the main authors of the Table of Isotopes, 7th Edition, 1978, as well as first author of the Table of Radioactive Isotopes, 1986. He was one of the founding members of the Decay Data Evaluation Project, based in BNM-CEA/LNHB, Saclay, France. Eddie was a visiting professor at the School of Nuclear Engineering, Bariloche, Argentina, for the academic year 1980. Although Eddie retired in 2002, he continued working until 2019 on a part-time basis under contracts with LBNL, BNL (Brookhaven National Laboratory), and UCB (University of California at Berkeley). He authored 98 scientific publications which have received over 3000 citations to this date.

Besides evaluation of a notable number of mass chains, about 54, for the Evaluated Nuclear Structure Data file (ENSDF), Eddie was also involved in experimental measurements with his LBNL colleagues. The study of the nuclear structure of ^{231}Th from the alpha decay of ^{235}Np (1973Br12) was one of the most enjoyable and rewarding studies undertaken, he would always recall. Similarly, he considered many of his later works, like the study of the nuclear penetration effects in ^{233}U (1989Br24), half-life measurements of ^{44}Ti (1998No06), and the search for the decay of the 3.5-eV level in ^{229}Th (2001Br20) as fulfilling accomplishments. He often addressed issues of decay data that he would identify during his evaluation work. He used his measurements and decay data issues to teach a new generation of nuclear structure data evaluators. He was an inspiring teacher with excellent communication skills. He mentored numerous new ENSDF evaluators and introduced many in Latin America to the nuclear structure work.

Eddie was a kind and friendly person, soft spoken, and had a great sense of humour. He had a love for languages and a curiosity of how they related to each other, and he also loved to play the piano. Eddie is survived by his wife Magdalena and their three sons Guillermo, Ernesto and Gerardo.

Eddie will be greatly missed.

Nuclear Data Section	E-mail: nds.contact-point@iaea.org
International Atomic Energy Agency	Fax: (43-1) 26007
Vienna International Centre, P.O. Box 100	Telephone: (43-1) 2600 21725
A-1400 Vienna, Austria	Web: http://www-nds.iaea.org