https://doi.org/10.61092/iaea.b9qq-snv3

INDC(NDS)-0901
Distr. Web LP,G,ND

INDC International Nuclear Data Committee

Summary Report of the 25th Technical Meeting

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

International Atomic Energy Agency, Vienna, Austria
15 – 19 April 2024

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December 2024

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ABSTRACT

The 25th meeting of the International Network of Nuclear Structure and Decay Data Evaluators took place at the International Atomic Energy Agency Headquarters in Vienna, Austria, from 15 to 19 April 2024. Attended by 43 scientists from twelve Member States and IAEA staff, the focus was on the compilation, evaluation, and dissemination of nuclear structure and decay data. To mark the Network's 50th anniversary, a retrospective was organised featuring its history, development and achievements. This report includes a summary of the meeting, status reports from the data centres, various proposals assessed and considered for adoption, technical discussions, agreed actions, and the resulting recommendations and conclusions.

December 2024

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)
DDEP	Decay Data Evaluation Project
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
ICTP	International Centre for Theoretical Physics, Italy
IFIN-HH	Horia Hulubei Institute of Physics and Nuclear Engineering, Romania
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
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
PNPI	Petersburg Nuclear Physics Institute of the Russian Academy of Sciences
RIPL	Reference Input Parameter Library
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
25	Vienna, Austria	15 – 19.04.2024	INDC(NDS)-0901

Contents

ANNEXES

1. INTRODUCTION

The 25th meeting of the International Network of Nuclear Structure and Decay Data (NSDD) Evaluators was held from 15 to 19 April 2025 at the IAEA headquarters in Vienna. This meeting was particularly significant as it marked the 50th anniversary of the network. To celebrate/pay a tribute to this milestone, a special anniversary session was organized featuring talks and presentations by Jagdish Tuli (ENSDF Manager from 1980 to 2016), Alan L. Nichols (head of the Nuclear Data section from 2001 to 2009), Pavel Oblozinksy (Deputy Section Head of the Nuclear Data Section from 1993 to 1999; Head of the National Nuclear data Center from 2002 to 2009), and Paraskevi Dimitriou (Scientific Secretary of the NSDD network since 2013).

The NSDD network has a threefold mission:

1) Compilation, evaluation, and dissemination: the network is responsible for compiling, evaluating, and disseminating nuclear structure and decay data.
2) Standards and rules maintenance: the network maintains and improves the standards and rules governing nuclear structure and decay data evaluations.
3) Monitoring and reviewing: evaluators monitor and review the development and use of computerized systems and databases specifically maintained for these activities.

A primary aim of the network is to provide accurate and freely available data to the user community, thereby enhancing the quality and reliability of their work. The IAEA Nuclear Data Section coordinates the NSDD Network and ensures the broad dissemination of nuclear structure and decay data.

Delegates to the 25th meeting were welcomed by Melissa Denecke, Director of the Division of Physical and Chemical Sciences at the IAEA. She emphasized the importance of nuclear structure and decay data for a wide range of applications and expressed the IAEA's appreciation for the Network's work. In his opening remarks, Roberto Capote, Deputy Head of the Nuclear Data Section, highlighted the crucial role of the Network in supporting all other nuclear data activities within the Section and said he looked with anticipation to the discussions and recommendations that would emerge from the meeting. Paraskevi (Vivian) Dimitriou, the scientific secretary of the NSDD Network, noted that the primary goal of these biennial meetings was to enhance international cooperation and coordination in the maintenance, development, and dissemination of ENSDF. She also pointed out that this 25th meeting was special, marking the 50th anniversary of the Network and thus featuring a retrospective of the Network's achievements over those past 50 years and a memorial session dedicated to Balraj Singh, a prominent and leading member of the Network who had sadly passed away on 9 October 2023. The first annex of this report is thus dedicated to an in memoriam for the late Balraj Singh.Prior to the start of the main technical discussions, the agenda was approved as listed in Annex 2. Elizabeth Ricard (NNDC-BNL) and Paraskevi (Vivian) Dimitriou were elected co-chairs of the meeting, and Jun Chen and Alexandru Negret agreed to act as rapporteurs. All in all, forty-three nuclear data specialists including IAEA staff attended this meeting, representing data evaluation/dissemination centres from twelve countries and new evaluation groups (Annex 3). A list of ENSDF evaluation centres and groups, along with their mass-chain evaluation responsibilities is given in Annex 4, and their declared effort (Annex 5). A revised List of Actions including new actions is found in Annex 6. Representatives from the individual mass chain evaluation centres presented progress reports in their NSDD studies, and all these status reports can be found in Annex 7. Links to the presentations can be found at the meeting website: https://conferences.iaea.org/event/387/.

2. FIFTIETH ANNIVERSAY OF THE NSDD NETWORK

Jagdish Tuli, ENSDF Manager and Editor of the Nuclear Data Sheets, 1980 – 2016

NSDD was the result of a collaborative initiative of Joe Schmidt (IAEA) and Sol Pearlstein (BNL). The main objective was to internationalize nuclear structure data evaluation activities which were, by then, mostly carried out in the United States (ORNL, LBNL, UP) and The Netherlands (Utrecht) and unable to keep up with growing research needs. Since then, a number of staff members of the IAEA Nuclear Data Section have coordinated activities of the NSDD network. Amongst them Alex Lorenze, Hans Lemmel, Doug Muir, Alan Nichols, Daniel Abriola, and Paraskevi Dimitriou (current). The NSDD succeeded, besides the US, in getting many institutions in countries from Asia, Australia, Canada, and Europe involved in this data evaluation effort. The IAEA organized the NSDD network to meet generally every other year to discuss various technical, as well as manpower issues. Regarding the latter, the NSDD network has also conducted workshops, mostly in collaboration with ICTP in Trieste, to popularize these evaluation activities and recruit new evaluators.

Alan Nichols, Head of the IAEA Nuclear Data Section (2001 – 2009)

Apart from the very first five years, almost all of my working career from September 1969 to so-called retirement in April 2009 contained a healthy fraction of effort involving the evaluation and assembly of various decay databases for European and UK nuclear applications. I should add that I have also maintained this modest level of effort beyond 2009.

Let me begin with some relatively early history. As recommended by the International Nuclear Data Committee in October 1973, an IAEA Specialists' Meeting on Nuclear Data Applications was held in Vienna on 29 April – 3 May 1974. The primary aims involved the consideration and development of international efforts to evaluate, assemble and maintain a comprehensive database of nuclear structure and decay data (NSDD) to an agreed format and consistency (see IAEA reports INDC(NDS)-060, September 1974 and INDC(NDS)-061, July 1974). However, my very first association with the IAEA Nuclear Data Section occurred almost exactly two years later on 3-7 May 1976, as one of two UK representatives at what was effectively the second preparative meeting to discuss and agree on the creation of what eventually became the International Network of NSDD Evaluators (see IAEA report INDC(NDS)-79, December 1976), which now embraces the servicing of ENSDF, NSR, NuDat and XUNDL. As with all IAEA meetings at that time, we gathered in the Grand Hotel, on the Ringstrasse, Vienna, Austria, which was the "temporary" headquarters of the IAEA from 1957 to 1979. Mass chains were identified with specific network members, specific effort commitments were agreed, and other attendees were left to undertake debate "at home" prior to making decisions as to whether to join. I recall that the meeting was superbly chaired by Sol Pearlstein (BNL, USA), with the minutes prepared by Alex Lorenz (NDS, IAEA). As for Vienna in 1976, I recall subdued street lighting, dark and empty streets in the evenings, and clanking hotel elevators – just like in "The Third Man" movie, starring Orson Welles, Joseph Cotten, Alida Valli and Trevor Howard, but without any WWII bomb damage.

Since these first two preliminary meetings, biennial meetings of the evolving network have been organised and sponsored by the IAEA Nuclear Data Section in order to:

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

More recently, from the 1990s onwards, the effectiveness of the programme has been dominated by the persistent need for new ENSDF evaluators for a number of disparate reasons. Various initiatives have been made, with little success. Inevitably, financial support is a major issue, with the Nuclear Physics NETwork (NuPNET) still seen as an appropriate vehicle for aligning and generating suitable future European input. Workshops on "Nuclear Structure and Decay Data: Theory and Evaluation" have become a common feature and responsibility of the NSDD evaluators' Network, as sponsored by the Nuclear Data Section, IAEA, Vienna, Austria, and hosted regularly by ICTP, Trieste, Italy, as well as elsewhere. Their aims can be defined as:

a) further development of scientists in their study and understanding of all features of nuclear structure and decay data;
b) identification of potential new candidates to undertake future mass-chain evaluations.

Today we are here to celebrate the 50th Anniversary of the International Network of NSDD Evaluators. And I send my thanks and best wishes to all NSDD evaluators, as they also explore and develop exciting new codes, new formats, and evolving innovative ideas in the years ahead.

Pavel Oblozinsky, Deputy Head of IAEA Nuclear Data Section (1993 – 2000), and Head of the National Nuclear Data Centre, Brookhaven National Laboratory

(Recollections from both sides of the Atlantic)

My first encounter with NSDD goes back to 1983 when I met M. Bhat of the National Nuclear Data Center (NNDC) and learned about the Network and its ENSDF library. This happened in the Smolenice Castle near Bratislava at the memorable IAEA nuclear data meeting which marked the end of the major USA-IAEA crisis caused by Israel bombardment of Iraqi reactor.

In summer 1995, as acting head of the IAEA Nuclear Data Section (NDS), I played a role in the most difficult moment of the NDS history: In-depth peer review of the IAEA nuclear data program by the international panel chaired by Prof. Arima, a famous nuclear structure physicist from Japan. NDS preparations were complex, we owe a lot to former NDS head Ch. Dunford and his friend R. Meyer. NDS managed to impress Prof. Arima with a carefully prepared ENSDF demo session and, contrary to expectations of the IAEA management, the panel produced a highly positive report. It had lasting impact on NDS, including its co-ordination activities. Without Prof. Arima et al. NSDD would not exist today.

Aging ENSDF manpower is the long-term NSDD issue. In 1999, I managed to add the 1st NSDD workshop, aimed to train new structure evaluators, to the IAEA workplan. So far, ten workshops have been held, mostly at ICTP Trieste, Italy.

In 2002, I replaced Charlie Dunford as NNDC head, including his duty to chair the US Nuclear Data Program (USNDP). In this capacity the most stressfull part was reporting to the Department of Energy (DoE), the main USNDP sponsor. Charlie's relation to Dennis Kovar, director of the DoE Office of Nuclear Physics, had been tense. Thanks to advice of R. Meyer, former DoE nuclear data manager, my 2002 report focused on ENSDF and provided a lot of of supporting numbers. This was accepted well by Dennis, he understood the unique value of the ENSDF library and the USNDP budgetary cuts stopped. The financial situtation of the NNDC and thus also NSDD gradually improved.

In 2006, the NSDD softened its position on the Nuclear Data Sheets being an ENSDF-only journal. This allowed CSEWG (chair PO, lead evaluator Chadwick, LANL) to publish a "Big paper" on the ENDF/B-VII.0 library. Since then, the journal regularly publishes important nuclear reaction data papers.

Thank you, NSDD. Good luck and best wishes for the future.

NSDD: the years after 2013, Paraskevi (Vivian) Dimitriou, NSDD Scientific Secretary (2013 – present)

A retrospective overview of the continuous efforts made by the NSDD Network to enhance evaluated nuclear structure and decay data over the past two decades was given. The NSDD network, with the aid of the IAEA, has focused on promoting its work, maintaining technical standards, developing web tools, supporting new evaluations, training new evaluators, offering seed grants to new evaluators, and raising awareness of the importance of the nuclear structure and decay data databases ENSDF, XUNDL, and the auxiliary bibliographic database NSR.

Three new data centres were established in Bulgaria, Hungary, and Romania.

The Network has continued to organise ICTP-IAEA workshops (2012, 2014, 2016, 2018, 2022), and establish mentorship programs to guide new evaluators, providing them with the necessary skills and knowledge to excel in their roles. These mentorship programmes were supported by the IAEA-NDS in the form of seed grants offered to new evaluators thus providing the necessary financial support to encourage new talent to enter the field and continue the legacy of excellence in nuclear data evaluation.

An Advanced Workshop for Active Evaluators was held in 2015 to keep active evaluators updated on the latest advancements and best practices in nuclear data evaluation.

A series of technical meetings have been coordinated to ensure that the analysis and checking codes used in nuclear data evaluation are kept up to date. These meetings have facilitated the sharing of knowledge and the implementation of the latest technological advancements. Web tools (MyENSDF) and databases (X4-NSR PDF) have been developed to facilitate access to literature and evaluation work. These tools have made it easier for evaluators to access the resources they need, thereby enhancing the efficiency and accuracy of their work.

The Network has supported new horizontal evaluations, encouraging comprehensive and cross-disciplinary approaches to nuclear data evaluation. Evaluations of beta-delayed neutron emission data by means of an IAEA Coordinated Research Project, IAEA-sponsored evaluations of nuclear moments, nuclear isomers, etc. have offered high quality data to both ENSDF evaluators and the user community.

Efforts have been made to create awareness about the critical work of NSDD evaluators among various research communities. This has been achieved through targeted outreach, presentations at conferences, and liaising with the Nuclear Physics Expert Collaboration Committee in Europe, the China Nuclear Data Center, and the Japan Atomic Energy Agency. ENSDF is now clearly mentioned in strategic planning documents such as Long-Range Plans in the US and Europe.

Moving ahead, a new format and database structure will inevitably transform ENSDF evaluation and dissemination, making it more amenable to ML/AI applications and paving the way for automation. Whatever the future has in store in technological innovations, nuclear physics expertise and human critical intervention will be indispensable to ensure high quality nuclear data. Training the next generation of nuclear data evaluators is therefore crucial.

3. REVIEW

3.1. Actions Review

Actions from previous meetings were reviewed as follows:

Ongoing Actions

#1- Review of Network Status Report

- **Current Status**: Revision in progress by IAEA.
- **Details**: Vivian noted that changes will occur as the modernization of ENSDF format and codes advances. The report is now more detailed on codes. Libby mentioned that the modernization efforts will be completed in 3-4 years.
- **Next Steps**: Participants will review the report after Vivian re-shares the document link.

#2- Format for Quantification of Auger Electrons and X-rays

- **Current Status**: Update of format checking codes is in progress. Java-NDS already includes the new format.
- **Details**: Java-Formatcheck is not used by all evaluators. The code finds different errors and warnings and is inconsistent with the legacy FMTCHK.
- **Next Steps**: Look into differences between the codes. **Action on Jun Chen**.

#3- Proposal to Publish a Paper

- **Current Status**: Postponed.
- **Details**: Libby suggested postponing as many changes will occur in the next few years.

#4- Adopted Decay Data

- **Current Status**: Ongoing.
- **Details**: A DOE proposal by BNL has been approved and a postdoc has been hired by BNL. Input from the Network is needed regarding the policy. The data will be formatted in the new JSON format.

#5- List of Quantities for 2G Records

- **Current Status**: Ongoing.
- **Details**: Libby mentioned this is part of the ENSDF modernization effort. Members of the Network agreed the discussion should continue with respect to the existing 80-column format as well.

#6 - Coulex Calculation by GOSIA Code

- **Current Status**: Done.
- **Details**: Libby discussed with two specialists. Guidelines could be drafted and shared.

Continuous Actions

Continuous actions remain unchanged.

New Actions Adopted at the Previous Meeting

#11- Update Guidelines for Evaluators

- **Current Status**: In progress.
- **Details**: Caroline will update the guidelines but needs Balraj's working document. Discussion on retrieving information from Balraj's computer involved several participants. Vivian will ask Balraj's daughter to look for any relevant documents.
- **Next Steps**: All evaluators should provide feedback regarding the content of the Addendum to Caroline. **Action on Oak Ridge**.

#12- Meeting on Monte Carlo Propagation of Uncertainties

- **Current Status**: Not organized yet.

- **Details**: Alejandro emphasized the importance of certain quantities like half-lives and branching ratios. Discussion on not adopting uncertainties smaller than the lowest measured uncertainty.
- **Next Steps**: Organize meeting with experts from other fields such as reactions, metrology, and particle physics. **New action on IAEA-NDS**.

#13- Implementation of Policies from Previous Meetings

- **Current Status**: Done.
- **Details**: Presentation by LBL. The decision was to include all the new policies in the Addendum to Guidelines. **Action on Shamsu and all evaluators to provide new policies and guidelines.**

#14- New Policy Implementation on %Ig

- **Current Status**: Done.
- **Details**: Implemented in GABS and GLSC. Updated version of GABS to be made available.

#15- New Policy: Rule 35

- **Current Status**: Done.
- **Details**: Rule 35 becomes Policy 35, should be Recommendation 35 or Guideline 35. Flexible for evaluators. **Action on Caroline to include it and all new guidelines and policies in Guidelines (see action #13).**

#16- Use of BetaShape Starting 2023

- **Current Status**: Done.
- **Details**: Code changes completed. Bugs and issues continuously reported. Relaxation on date of form adoption by evaluators.

#17- Samples of Beta Shape Factors

- **Current Status**: Done.
- **Details**: Limited samples were shared with Balraj, Jun, and Tibor. Should be extended to include all samples. **Action on Jun Chen, Tibor Kibedi and Xavier Mougeot to complete checking the format of Beta shape factors.**

#18- Adopt Median Value for MC Propagation

- **Current Status**: Done.

#19- Update General Policies

- **Current Status**: Pending.
- **Details**: No suggestions were sent to Libby.

#20- Modify ConsistencyCheck for "B+" in NSID

- **Current Status**: Done.
- **Details**: Evaluators should use "EC Decay" or "EC+B. A small inconsistency between the Adopted dataset label and the Decay dataset header exists in Java-NDS. Issue resolved in current codes (ConsistencyCheck) but persists in the existing database.

3.2. ENSDF – XUNDL – Nuclear Data Sheets update, E.A. Ricard (NNDC-BNL)

For the XUNDL database, in FY23 623 datasets were compiled from 312 papers. In FY24, 594 datasets were compiled from 302 papers. For the past 2 years, the XUNDL compilation effort is shouldered by the centers from TUNL, MSU, McMaster and BNL. The MSU center has begun involvement of undergraduates in the XUNDL compilation work. Both the BNL and TUNL centers have increased the workforce dedicated to XUNDL compilation. A DOI has been assigned to XUNDL and a new archival webpage has been created which is available at https://www.nndc.bnl.gov/xundlarchivals/. XUNDL is archived on a yearly basis and available through the archival page. The pre-publication checking of manuscripts program continues with the journals Physical Review C and European Physical Journal A.

For the ENSDF database, in FY23 221 nuclides were evaluated including 12 mass chains. In FY24, 207 nuclides were evaluated including 13 mass chains. A DOI has been assigned to ENSDF and a new archival webpage has been created which is available at https://www.nndc.bnl.gov/ensdfarchivals/. ENSDF is archived on a monthly basis available through the archival page. The Gitlab tracking system for mass chain updates was presented. For those evaluators who do not use the Gitlab server, the status of mass chains is downloaded to a .csv each month and emailed to the Network. A major uptick in web downloads has been observed over the past 2 years, mainly with users retrieving data from the NuDat application, which mostly serves ENSDF data. A new training opportunity for nuclear data evaluators was made available through the US Department of Energy in early 2024 which will provide funding not only for the mentee but also for the mentor. Several USNDP centers put in proposals to train new ENSDF evaluators. The ENSDF modernization project and the new Nuclear Wallet Cards modernization effort was briefly summarized, with more extensive presentations planned later in this meeting.

The Nuclear Data Sheets journal is currently ranked 6th out of 81 high energy and nuclear physics journals based on its impact factor. Over the past 5 years the journal has averaged between 2,000 and 3,000 citations per year, while publishing between 10 to 20 articles each year. In 2024, the first issue of the journal was a Special Issue on Nuclear Reactions with a lead article devoted to the Fusion Evaluated Nuclear Data Library (FENDL). The second issue of the year was dedicated to long-time ENSDF evaluator Balraj Singh, with a memorial piece written by P. Dimitriou and two of B. Singh's mass chains completed posthumously by J. Chen, A=76 and A=165.

Discussion:

- G. Mukherjee noted that NuDat 3 performs slowly when the Internet connection is slow. It was announced that an updated version will be available next month to address this issue.
- T. Kibedi suggested sending back the ENSDF/XUNDL file to the author in the PRC checking. It was mentioned that this has been done occasionally.
- F. Kondev proposed that journals should ask authors to provide keywording for NSR. While this could be beneficial, it was noted that it might complicate relationships with authors and should remain a voluntary request. In the long term, it was suggested that authors could communicate directly with NNDC, bypassing PRC.
- There was a discussion on how students from outside the US can remotely access training processes organized in the US.
- P. Dimitriou raised a concern about PRC checking before the review and potential content modifications during the review. It was clarified that any modifications made during the review are communicated and the XUNDL compilation is updated accordingly, although such changes are rare.
- F. Kondev asked if supplemental material is requested from authors. The response was affirmative, noting that authors generally respond positively when approached for supplemental material during the publication process.

4. DISSEMINATION

4.1. NuDat and ENSDF Editor, D. Mason (NNDC-BNL)

NuDat:

The National Nuclear Data Center (NNDC) at Brookhaven National Laboratory (BNL) has overhauled one of its most frequently visited web applications, NuDat. NuDat 3 visualizes the data contained in the Evaluated Nuclear Structure Data File (ENSDF) and features responsive visualizations that significantly improve performance over its predecessor by relying on client-side rendering. An upcoming major update will be released soon including an updated UI and additional datasets. NuDat uses Google Analytics to provide a broad overview of user interactions with the web application. Additionally, NuDat has custom analytics, offering potential physics insights based on the nuclides being searched. The NNDC plans to add new features to NuDat based on user requests and will modernize other web applications. A 3D version of NuDat is also in development.

ENSDF Editor

The ENSDF modernization project has converted the traditional 80-column ASCII format into a hierarchical human-readable data format, JSON. The ENSDF editor is a tool being developed by the NNDC for ENSDF evaluators to create and modify ENSDF datasets in the modern JSON format. A demonstration was shown of the current state of the editor and the feedback received will fuel future developments. The editor will incorporate the suite of ENSDF codes as development matures and aims to provide evaluators with an efficient tool to perform nuclear data evaluations.

Discussion:

- Negret inquired about the proper way to acknowledge NuDat, NNDC, or BNL when using images generated from NuDat. Specifically, he asked if a label appears automatically. The response clarified that a small logo is shown on the pictures to indicate the source.
- P. Dimitriou asked whether it is possible to download the discovery table. It was explained that while tables can be exported, the discovery date might not yet be included in the tables.
- F. Kondev suggested that the source of the data should be acknowledged in the downloaded data. E. Ricard then questioned how this acknowledgment could be included when someone downloads the entire NuDat.
- A. Sonzogni expressed concern about the community's use of data or images without proper citation.

4.2. IAEA-NDS Dissemination: Livechart and related applications, M. Verpelli (IAEA - NDS)

The tools to disseminate Structure and Decay Data are based on a parser feeding a data model that allows querying the database on each field, imposing filtering conditions on any other field.

The following example was given as illustration:

Retrieve the Mixing Ratio for:

* E2/M1 mixed transitions
* from Jπ = 2`+ to 2+ levels
* of even-even nuclides
* having $60 \leq A \leq 150$

The results are format independent and can be dumped, using standard packages, as CSV, XML, SQL, JSON, etc. Visualization tools allow to plot, see the results on a web-based chart of nuclides, and download them.

Over the last years, users' requests to access the data via their own software have increased. To this purpose an Application Program Interface to the data model was developed, which is widely used.

In parallel to the API and Web based applications, dissemination via mobile devices continues with the Isotope Browser (for both Android and iOS).

A further trend is providing simulation tools, which usually wrap the Fortran code into a web application, allowing users to then access Structure and Decay data characterizing the results of the simulation. Examples of this are the Medical Isotope Browser and TALYSworld.

Besides disseminating the data, the IAEA Nuclear Data Section has started to make the software tools available as open source on GitHub.

The mentioned applications can be accessed through links on https://nds.iaea.org/livechart whilst the open source software is available at https://gihub.com/IAEA-NDS.

Discussion:

- J. Tuli asked if the Medical Portal could specify an isotope and provide possible production methods, as well as specify gamma energy and provide source information. It was confirmed that such capabilities exist within the Medical Isotope Browser (MIB) tool.
- R. Capote emphasized that the focus of MIB is primarily on producing isotopes (cross sections) rather than decay data.
- M. Verpelli noted the challenges associated with decay datasets, questioning why energy values differ between decay and adopted datasets. E. Ricard mentioned that an Adopted Decay Dataset will be produced in JSON format to address this issue.
- Nichols suggested that dose calculation should be integrated into the Medical Portal to enhance its utility.

4.3. Status Report on NSR, B. Pritychenko (NNDC-BNL)

Nuclear Science References (NSR) is a major nuclear bibliography database that contains 249,710 bibliographic records. It provides references for the Evaluated Nuclear Structure Data File (ENSDF) evaluations and fundamental nuclear physics research. The NSR workflow went through several major changes in the last year such as the development of Java computer codes to read BiBTex and RIS files from 25 major nuclear physics and engineering journals and the automatic production of NSR entries for keywording. The new system handles large author lists well (the largest one with up to 5,000 entries) and avoids many typographical errors from manual typing. In 2024, we started to work with the INSPIRE collaboration (High energy bibliography). The INSPIRE group helped us to find NSR duplicate entries, and many incorrect doi links and create additional opportunities for future joint projects. At the end of 2023, the NSR librarian Joann Totans retired, and Catherine-Anne Dunn started to work on the NSR and Library support issue. The current year was challenging for NSR, but we regrouped and found new creative ways for the NSR database operations.

Discussion:

- E. Ricard stated that they are trying to mitigate the loss of one person FTE by means of automation.
- P. Dimitriou expressed concern at the reduced financial support for the NSR database.

5. PROCEDURES, POLICIES AND PROPOSALS

5.1. Preparation of source data sets in ENSDF, S. Basunia (LBNL)

A few points related to the source dataset preparation for a mass chain evaluation were raised by S. Basunia. He noted the benefits and importance of the data listing, proposed a procedure to list the NSR articles, which appear with a nuclide search but no useful data, identified and listed missing documents that need to be added as Appendix to the Guidelines by Murray Martin (dated 04/26/2021). He also pointed out that a format document is needed for the decay dataset related to the beta card that accounts for the missing beta branching compared to the total branching (for example 100%). It is mainly applicable if a delayed particle emission branch is present in the decay dataset. It was proposed by Balraj Singh, and the card was first used in the ^{40}P beta decay dataset by Jun Chen, Nuclear Data Sheets for A=40, 140, 1, 2017 (2017Ch09).

Additionally, it was pointed out that recently, for an update, all papers have been checked, not only the ones appearing after the last cut-off date. Effective communication with reviewers and future evaluators is crucial. It is important to clearly indicate which papers were read and what actions were taken. The D card can be used for this purpose. There is a discussion on whether the facility should be mentioned in the description of the reference. Additionally, there is a question about whether all half-lives in the decay datasets should be listed or just the isomeric ones. When authors provide angular distributions and then specify E2, M1, etc., F. Kondev suggests keeping the magnetic/electric character in the dataset but adopting only D, Q, etc.

List of documents that need to be added as Appendix to the Guidelines:

1. γ-ray Intensity Normalization for Radioactive Decays in Nuclear Data Sheets by J. K. Tuli (INDC-NDS-0867 NSDD 2022: Actions # 11 and 13).
2. A Procedure for Normalizing Decay Schemes by E. Browne. It includes the troubleshooting example (INDC-NDS-0867 NSDD 2022: Actions # 11 and 13).
3. Consistency in assigning configurations in ENSDF by F. G. Kondev and T. Kibedi.
4. A new document to be prepared to match the total decay branching with the missing delayed-particle branching by adding a beta card related to the delayed particle in the decay dataset.

There is a proposal to save some documents in the Evaluator's corner for better organization and accessibility.

<u>Discussion:</u>

- F. Kondev suggested that all the issues could be discussed during the evaluator's workshop. He emphasized that all T1/2 values should be included in decay datasets to ensure comprehensive data coverage.
- J. Kelley raised a concern that some reviewers treat their opinions as policies. E. Ricard responded by stating that evaluators should consider reviews as suggestions. If a suggestion is not applied, the evaluator should provide an explanation. F. Kondev added that in their line of work, the evaluator and the reviewer should work collaboratively. E. Ricard also mentioned that if a reviewer agrees to make their name known, this should be disclosed to the evaluator. This should be included in the Reviewer Guidelines.
- E. Ricard pointed out that the current guideline states that if Egs were not reported with uncertainties, then level energies should not be reported with uncertainties either. However, 50% of the evaluators do not follow this guideline, suggesting it should be removed.
- P. Dimitriou noted that while guidelines are not obligatory, they should be implemented in most cases. If an evaluator chooses not to follow a guideline, they should have a valid reason for doing so.
- A. Nichols argued that all quantities without uncertainties should be disregarded to maintain data integrity and reliability.
- J. Tuli mentioned that when averaging is performed, all numbers that are averaged should be provided. However, this is not necessary if Egs are averaged from the datasets. E. Ricard and F. Kondev countered that even in such cases, all averaged numbers should be included in the comments for transparency.

5.2. Proposal for spin-parity propositions using updated logft limits, J. Chen (FRIB/MSU)

The propositions based on logft values/limits are often used for spin-parity assignments in ENSDF evaluation. Particularly, definite logft values or ranges for a complete decay scheme are used as strong arguments. The propositions based on logft values/limits in the current ENSDF policy document are based on the review of logft values in 1973RA10 and are apparently outdated, considering some updates have been made in a review by 1998SI17 and recently by 2023TU02. The work in these two references were led by late Dr. Balraj Singh to include logft values from measurements after the review by 1973RA10. The logft limits in the current propositions should be updated with those from 2023TU02, even though there are no major changes.

Action on E. Ricard (ENSDF Manager): Update the policy immediately.

5.3. Policy for adopting weighted average uncertainty, J. Chen (FRIB/MSU)

In the practice of ENSDF evaluation, when it comes to average multiple values with similar precision, evaluators usually adopt the weighted average of those values using the standard weighted-average formula in statistical theory. But there exist inconsistencies in adopting the uncertainty of the weighted average among evaluators and even for treating different quantities (e.g., the treatment for lifetime is different from other quantities in the current ENSDF guideline). Those inconsistencies come from the following two ways: 1) follow the weighted-average formula to adopt the final uncertainty as the maximum among the internal and external uncertainties; 2) conservatively consider that the uncertainty (no separate systematic and statistical components given) is dominated by the systematic uncertainty which can't be reduced by averaging, and adopt the final uncertainty as the maximum among the internal and external uncertainties, and the smallest input experimental uncertainty.

The uncertainty of a measured value includes a statistical uncertainty arising from randomness from measurement to measurement and a systematic uncertainty which is a consistent difference between the measured value and the true value and arises from systematic effects such as background, detector efficiency and resolution, faulty equipment, calibration or technique, etc.

If values from multiple measurements are in fair agreement within uncertainties, averaging them using the statistical formula can give a smaller uncertainty than any input uncertainty, by treating all input uncertainties as statistical. But in many cases, it is the systematic uncertainty that is dominant in the total uncertainty. The systematic uncertainty such as that from detector calibration cannot be reduced by the statistical averaging analysis, or in other words, systematic uncertainty cannot be reduced in any way by analysing the existing data. Better systematic uncertainty can be achieved by improving experimental instruments and electronics, such as better detector resolution and efficiency calibration, in a new measurement.

Of the two inconsistent ways of adopting the uncertainty of the weighted average (of values in fair agreement), the first one treats all input uncertainties as statistical which results in an underestimated final uncertainty, while the second one treats all input uncertainties as systematic but only uses the statistical formula to find the mean value and it then gives an overestimated final uncertainty by taking an uncertainty not smaller than any input uncertainty. From a conservative point of view, the second way should be followed to adopt the final uncertainty of the weighted average.

Discussion:

- R. Capote highlighted that systematic uncertainty is often hidden or unknown. He suggested adopting scenario 3 as the most conservative approach and proposed forming a small group to develop a policy on this matter. P. Dimitriou agreed to add a meeting to the actions list to address this issue.

- B. Pritychenko noted that in 48% of EXFOR entries, uncertainties are listed without explanation, indicating a need for better documentation and transparency.
- S. Leblond pointed out the complexity of the issue, emphasizing the distinction between type A and type B uncertainties, rather than just systematic and statistical uncertainties.
- E. Ricard discussed the uncertainties in energy (Eg) and intensity (Ig) measurements, noting that very small uncertainties from peak fitting are only statistical. She stressed that systematic uncertainty, which dominates, is mentioned separately, and is related to energy calibration.
- R. Capote also suggested switching to modern terminology, as the current discussion appears outdated to metrology specialists.

5.4. Discernment of lightly bound resonant states, J. Kelley (TUNL)

Lightly bound resonant states refer to states or levels where particles are weakly bound together, often close to the threshold of separation. A state (or level) is a specific energy configuration of a nucleus, while a scattering state occurs when particles interact but do not form a bound state.

Examples: ^{12}Li and ^{13}Li are examples of nuclei that can exhibit lightly bound resonant states due to their unique configurations and weak binding energies.

A newly discovered element with a lifetime greater than (10^{-14}) seconds is noteworthy. Lifetimes longer than (10^{-12}) seconds are considered a possible lower limit for radioactivity, indicating the element's stability and potential for further study.

The isotope ^{9}N, consisting of 2 neutrons and 7 protons, is another example of a nucleus that may exhibit interesting properties due to its composition.

Discussion:

- P. Dimitriou and J. Kelley suggest defining a scattering length and establishing a policy, proposing a limit of -4 femtometers (fm).
- F. Kondev questions whether there is a consensus among specialists on this matter, highlighting the need for agreement in the scientific community.

5.5. Policy for listing decay modes deduced only from observation in resonant reactions, J. Kelley (TUNL)

In ENSDF one should add for a level above particle separation energy: %N=100 or AP 100, if a resonance is observed to be populated in (X,γ) reactions.

Decay modes should be listed for each level for light nuclei.

A policy is needed for a resonance level that is observed but has no decay mode listed.

Discussion:

- A. Sonzogni remarked that this does not apply to heavy masses as particle decay is extremely unlikely due to angular momentum (a neutron can't carry away that much of angular momentum for high-spin level in heavy nuclei).
- J. Tuli mentioned that using %n>0; %a>0 makes more sense than %n<100;%a<100.
- J. Kelley agreed that there should be a guideline not a policy.

5.6. Proposal to propagate uncertainties in ENSDF using Monte Carlo techniques, T Kibedi (Australian National Univ.)

A core part of the evaluation work is to derive quantities form measured ones. For example, to deduce reduced transition strengths one needs to use level lifetimes, gamma-ray intensities, multipole mixing ratios, conversion coefficients, which are not always well-defined, i.e. known with large relative uncertainties or as limits. The approach to propagate uncertainties and limits used in ENSDF is based on the Taylor series method. This gives reasonable results when the relative uncertainties are small (less than a few percent) and the relation between input and output quantities is linear. The treatment of complex cases involving non-linear relations or limits is extremely challenging. To overcome these limitations a Monte Carlo (MC) approach was suggested at the 22nd Technical Meeting of the NSDD Network (INDC(NDS)-0733, Annex 6, p 77).

In the MC approach, the experimental quantities and their uncertainties are represented with Probability Density Functions (PDF). The output quantity will be derived by statistical methods from its PDF, obtained by sampling the PDF`s of the input quantities and evaluating the relation between input and output for a sufficiently large time.

In ENSDF three types of quantities are used, which could be: (a) symmetric uncertainties (?); (b) asymmetric uncertainties; (c) limits. Key element of the approach is to adopt suitable PDFs [1]. For the first case a normal distribution is the most appropriate model. For asymmetric uncertainties different approaches have been suggested. In NUBASE [2] the uncertainties are symmetrized. A more accurate solution, based on the General Extreme Value (GEV) distribution was suggested [3], which in comparison to other types of asymmetric distributions, is applicable for much larger asymmetric cases. Currently there is no clear consensus in the literature on the choice of a suitable PDF to represent limits. It was suggested to retain the limits on half-lives and energies. It was also suggested, that using rectangle distribution could introduce a strong bias. This bias could be removed using the so called Generalized Normal Distribution (GND), first suggested by Subbotin in 1923 [4]. Furthermore, estimating the output quantity as the statistical mean value may not be correct as the output PDF could be heavily tailed. The median value of the distribution, obtained from the ordered output values is a more realistic estimate [5]. The uncertainties of the output quantity can be obtained from the coverage interval of the PDF. Using MC method also removes the correlation of the input parameters through the equation being evaluated.

With the availability of powerful CPUs the Monte Carlo technique to propagate uncertainties is widely used, for example in the metrology, high energy physics, nuclear astrophysics communities. Some of the recent ENSDF codes (UncTools, NS_RadList, java-Ruler) already use the Monte Carlo approach.

UncTools, developed at the ANU, is designed to parse an ASCII script with input parameters, equations and complete ENSDF records. It also accesses the full BrIcc data table. UncTools can handle a large number of input parameters and equations. The output can be a calculation report, a plot or an XML file. The latter allows UncTools to be called from or used by other codes. This is used in NS_RadList to evaluate emission rates of complex decay schemes. A typical plot of the probability density function of the total conversion coefficient of the 52.5(1) keV M1+E2, MR=0.9(5) transition in ^{75}Ge is shown in Fig. 1. The recommended value is α_{tot}=3.9(+17-23) compared to the present value from BrIcc of α_{tot}=3.9(24).

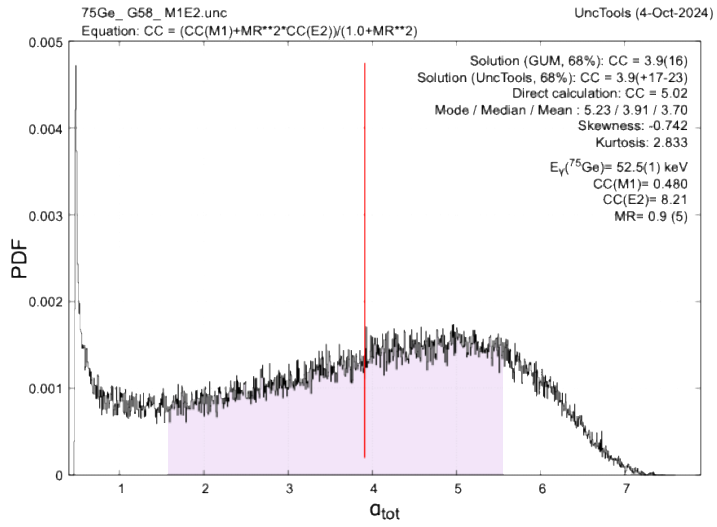


FIG. 1. Probability density function of the total conversion coefficient of the 52.5 keV transition in ^{75}Ge.

Further studies and consultation with the NSDD Network are planned to adopt uniform approaches across the ENSDF tools to use Monte Carlo techniques to propagate uncertainties consistently.

<u>References</u>

[1] Evaluation of measurement data - Supplement 1 to the "Guide to the expression of uncertainty in measurement" Propagation of distributions using a Monte Carlo method, Report JCGM 101:2008, JCGM (Joint Committee for Guides in Metrology) 2008.

[2] G. Audi, F.G. Kondev, et al, Chin. Phys. C **41** (2017) 030001.

[3] A. Possolo, C. Merkatas, O. Bodnar, Metrologia **56** (2019) 045009.

[4] M.T. Subbotin, Matematicheskii Sbornik, **31** (29123) 296

[5] M. Cox, A. O'Hagen, Accred. Qual. Assur. **27** (2022) 19

<u>Discussion:</u>

- R. Capote emphasized that MC methods should be adopted for uncertainties and that the PDF must be specified whenever a normal distribution is not employed. Decay data are important for activation measurements, so uncertainty quantification is required.
- F. Kondev stated that the user community should be involved in the discussions regarding uncertainty propagation and MC methods.
- E. Ricard mentioned that authors appreciate the recalculations of B(E2) with MC uncertainty in the data checking procedure.
- A. Sonzogni commented that uncertainties are treated disparately when it comes to decay data. John Hardy's beta-decay measurements are very precise, almost half a sigma (standard deviation) while we don't know how to calculate fission yield uncertainties.
- P. Dimitriou noted that while MC was agreed upon at the previous NSDD meeting, it was also stated that for lifetimes and energies, the limits should generate limits.
- P. Dimitriou recommended conducting an inter-comparison exercise testing different PDFs on a range of examples from ENSDF before such a meeting is held, to ensure the topic is explored in depth and useful recommendations are made as a result of the discussions.

6. ANALYSIS AND CHECKING CODES AND FORMATS

6.1. ANU analysis codes, T. Kibedi (Australian National Univ.)

The ANU is responsible for the development of BrIcc, BrIccMixing, GABS, AveTools, NS_RadList and UncTools.

The current stable version of BrIcc was released on 17-Jun-2020. In 2023 the internal conversion coefficient table has been recalculated using the Frozen-orbital approximation. The data table was extended down to 0.3 keV above the electron binding energies for each atomic shell in Z=4-126. The new BrIccFO v3.1 data table also includes pair conversion coefficients for Z=1-100 using data tables from [1, 2] and the new E0 electronic factor tabulations [3]. The data table is currently available through UncTools. A New version of the BrIcc evaluation tool is also being developed.

To treat uncertainties using Monte Carlo (MC) propagation techniques, the new code UncTools has been developed and extensively tested. The selection of appropriate probability density functions, PDF for cases of asymmetric uncertainties or limits is not trivial. The NSDD meeting has endorsed the development of the MC methods and recommended further investigations and consultations with experts from other fields to develop detailed policies for the ENSDF. It was recommended, that the IAEA should organize a small technical meeting dedicated to various aspects of the MC techniques.

NS_RadList has been further developed to treat uncertainties in the nuclear decay parameters (intensities, mixing and branching ratios, etc.). The current version also reads EC capture rates from the new BetaShape code. The code also evaluates the mean decay energies of a, b, g, CE, X-ray, and Auger electrons, which is used to test decay schemes for completeness. NS_RadList has been extensively tested using ENSDF data sets prepared for the Decay Data Library for Monitoring Applications. A full report is being prepared on the development and the use of NS_RadList.

References

[1] P. Schlüter, G. Soff, At. Data Nucl. Data Tables **24** (1979) 509.
[2] C. Hoffman, G. Soff, At. Data Nucl. Data Tables **63** (1996) 189.
[3] J.T.H. Dowie, et al., At. Data Nucl. Data Tables **131** (2020) 101283.

Discussion:

- N. Nica enquired about the connection between NS_Radlist and Java-NDS. It was clarified that Java-NDS had been modified to incorporate the display of atomic radiation.
- P. Dimitriou asked about the availability of BriccEmis. T. Kibedi responded that the new versions of BrIcc will be included in UncTools with the core issue being the uncertainty propagation.
- E. Ricard asked about the neutrino spectra, and it was explained that this data is obtained from BetaShape.

6.2. Workflow of ENSDF evaluation with ENSDF Java codes, J. Chen (FRIB/MSU)

ENSDF code development and modernization at FRIB/MSU data center engages in modernizing the legacy ENSDF Fortran codes using the Java programming language and in developing new analysis and utility codes, with the goal to streamline and automate the evaluation process, ensure evaluation quality, and improve evaluation efficiency in the workflow of ENS evaluation.

An ENSDF mass-chain evaluation is started by first setting up the evaluation folders for nuclides in the mass-chain, each containing individual datasets from the previous evaluation. This can be easily done with the help of the “Setup evaluation folder” function of the McMaster-MSU Java-NDS program.

For compiling tabulated data from references into ENSDF, the Excel2ENSDF program can work efficiently with any open-source common Optical Character Recognition (OCR) software, to convert an Excel data table pre-formatted from the original Excel table that was extracted and created by the OCR into an ENSDF dataset. Its reversed conversion function (ENSDF2Excel) is also a very handy tool for converting an ENSDF to an Excel table with which an evaluator can view/edit the data in Excel and then convert the edited data back to ENSDF.

In the evaluation stage, several tools can be used to analyze the data and facilitate the evaluation process. The GLSC program combines all functions of the legacy GTOL and GABS and simplifies the usage for getting the report and output. A newly added feature makes it very easy to generate with a few clicks a final output file that combines results from the GTOL (fitted level energies) and GABS (%Iγ) functions, and calculated beta feedings for decay datasets. Other useful features are: 1) calculate Eγ from level-energy differences (by GLSC); 2) extract values from comments and average them (average tool in ConsistencyCheck); 3) wrap a free-format text to ENSDF-format comments (wrap tool in ConsistencyCheck); 4) a tool to calculate a single transition strength (by the B(XL) calculator in Java-RULER); 5) a tool to calculate a single logft value (a logft calculator in RadiationReport); 6) a tool to calculate a single HF of an alpha decay branch (a HF calculator in AlphaHF); 7) a tool to extract conversion coefficients in continuation records and in comments and make an input file as input for BriccMixing; 8) a tool to make batch operations on all values of the same record, like adding an constant to E(level).

The ConsistencyCheck program groups together the same type of records from different datasets so that all data of the same records can be seen in one screen by the evaluator to evaluate, without the hassle to switch datasets for those records back and forth. Based on the automatical grouping, it also generates a preliminary Adopted dataset by making the pre-selections of the best values among all datasets or average, as well as needed comments for such selections. This dataset can serve as a starting point for the evaluator to make the final Adopted dataset.

At the end of an evaluation, all datasets will go through the checking procedure, with ConsistencyCheck for checking inconsistencies and possible physics errors, KeynumberCheck for checking wrong or irrelevant NSR keynumbers, and FormatCheck for checking ENSDF-format errors. Once they are all done, the final ENSDF files of each individual datasets and the Adopted dataset of each nuclide can be automatically merged into a single file with all nuclides and datasets in order, by using the merging function of the ConsistencyCheck program. At last, the McMaster-MSU Java-NDS file can be run on the single ENSDF file of the mass-chain evaluation to generate a pdf output that can be submitted along with the ENSDF file.

Discussion:

- F. Kondev asked if help could be generated when using the file in the command line. The response indicated that while the codes can be run in the command line, it is preferred to keep the process simple and user-friendly, using clicks instead.
- It was mentioned that it is possible to exclude certain known keynumbers from those flagged by errors.
- T. Kibedi enquired about the recommended averaging method. The response clarified that the default methods are weighted/unweighted averages, and the code displays the averaging results without recommending any specific method.

6.3. Status of BetaShape code, X. Mougeot (LNE-LNHB)

The BetaShape code has been developed to provide more accurate nuclear decay data. Improved theoretical models of beta decays and electron captures for allowed and forbidden unique transitions were elaborated and implemented. The code provides detailed information such as beta and neutrino spectra with their mean energies; capture probabilities and capture-to-positron probability ratios for each subshell; log-ft values; or experimental shape factors. BetaShape takes as input standard ENSDF files that are eventually updated. Various options are available, e.g. different physical corrections, automatic update the Q-value with AME2020 or creation of CSV files for automatic coupling with other codes. Since version 2.2 released in June 2021, executables were made available for various platforms on LNHB website: Windows 10, macOS Big Sur (Intel and M1), Scientific Linux 6.7, Ubuntu 20.04 and Centos 8.

At the 24th meeting of the NSDD Network in Canberra (24-28 October 2022), the forthcoming version of BetaShape (version 2.3) was adopted to replace the legacy code LogFT. Specific requests were formulated to match ENSDF policies and improve the reliability of the results. Regarding technical improvements, one can mention the possibility to modify the rounding limit of printed numbers via a simple option; the provision of f-values and average energy of emitted neutrinos; handling of branching ratios through the BR and NB parameters; or the modification of forbiddenness assignment when Jπ are ambiguous. The physical model of beta decay was also improved including the atomic screening, exchange and overlap corrections thanks to extensive tabulation of full numerical calculations. In addition, the uncertainty treatment was extended to non-numeric uncertainties (AP, SY, GT, etc.) and to asymmetric uncertainties via the min-max method. A manual describing all the options and the generated output files was also created. All the material of this 2.3 version was made available on the IAEA-NSDD GitHub Repository in September 2023. This BetaShape version was used in a new review of the log-ft values, a collaborative work performed with B. Singh (McMaster University), S. Turkat and K. Zuber (TU Dresden) [Atomic Data and Nuclear Data Tables 152, 101584 (2023)].

During the 2023 USNDP meeting (13-17 November 2023), feedback was given leading to fixing a few bugs when generating the CSV files, and adding a comment line in the updated ENSDF that gives the code version used. This 2.3.1 version was released in December 2023. Since then, other feedback pointed to a problem that was identified to be due to using ENSDF files created in Windows on Unix based systems (different end-of-line characters are used by these systems). In addition, running BetaShape was not possible on some mass chains. These two issues were treated by fixing some bugs, managing unexpected situations, and re-writing the input ENSDF file at the very beginning, when the code is called. This version was tested over the whole ENSDF database (archive version as of January 2024) and no problem was detected. During the present 25th meeting of the NSDD Network, there was also a request to introduce environment variables to call BetaShape from anywhere in the system, and to find a solution to accelerate the calculation of the electron capture transitions. These requests will be addressed prior to the next release of the BetaShape code.

<u>Discussion:</u>

- F. Kondev noted that in some cases, the effective Q-value is negative. When a level is very close to the Q-value, the calculated logft becomes very small. It was explained that if the transition energy is negative, the calculation is not performed, indicating an error in the masses or the level scheme.
- Sonzogni pointed out that the end-point energy in EC+B+ records is not updated by logft, leading to inconsistencies with the Q-values. It was suggested that this redundant information should be removed.

7. HORIZONTAL EVALUATIONS

7.1. Nuclear Moments, N.J. Stone

The first part of the talk presented a statistical breakdown of magnetic dipole and electric quadrupole moment measurements over the last 30 years. The most apparent change was the dramatic reduction of new results on short-lived (< 1 ms) states reflecting the closure of many smaller facilities with the loss of long-standing groups.

The talk continued with discussion of the studies of long sequences of isotopes and isomers produced at on-line laser facilities. These offer sets of internally consistent results which are derived from measured ratios to well established, usually stable isotope, moment values. The reference values are thus of major importance.

New results on Sb isotopes were taken as an example [1]. For the magnetic dipole moments, the largest uncertainty derives from a poorly known correction for diamagnetism in the system in which the relevant reference isotope NMR measurements were made. A modern calculation of this correction is needed. All electric quadrupole moments of the Sb nuclei were recently reassessed with a 51% increase following an improved calculation of the electric field gradient acting in the system studied [2].

References

[1] S. Lechner, et al., Physics Letters B **847** (2023) 138278.
[2] P. Pyykko, Molecular Physics **116** (2018) 1328.

7.2. Adopted Decay Data Library, E.A. Ricard (NNDC-BNL)

The Evaluated Nuclear Structure Data File (ENSDF) forms the cornerstone of low energy nuclear physics as the world's only comprehensive resource for recommended nuclear structure and decay data. By far, the most viewed and downloaded portion of ENSDF is the radioactive decay data. This is because radioactive decay is relevant not only for our basic understanding of nuclear properties and stellar nucleosynthesis but is highly used in numerous applications of nuclear science in society. Medical imaging and therapy require an accurate knowledge of the energies and intensities of all emitted radiation. The field of nuclear forensics uses gamma/beta/alpha spectroscopy to characterize and identify isotopes in a non-destructive manner. In terms of nuclear energy, the determination of the decay heat and the antineutrino spectra from a reactor requires a full understanding of the radiation emitted from the over 800 fission fragments. Despite the significance of decay data, it can take decades for it to be fully evaluated and disseminated back into the nuclear science community. This new project aims to accelerate the decay-data evaluation process, ensuring timely incorporation into both the ENSDF and ENDF libraries. Leveraging ongoing efforts to modernize the ENSDF format and evaluation pipeline, we will expand the types of decay data currently stored in ENSDF and begin populating a standalone Adopted Decay Data Library. We note that the need for accelerated decay data evaluations was recently highlighted in both DOE NSAC reports on Nuclear Data.

The first step in this project will be the identification of new measurements requiring incorporation into ENSDF. This will be accomplished through a cross comparison of data currently in ENSDF with new measurements found in XUNDL which occurred following the latest ENSDF evaluation. This process will likely generate a substantial list of potential decay data for evaluation. To prioritize this list, we will consult subject-matter experts representing the major fields which utilize decay data.

We will expand the data evaluation process to include a number of important quantities currently absent in ENSDF. These include x-ray energies and intensities, Auger electron energies and intensities, continuous spectra, average light particle and electromagnetic energies, and any additional quantities suggested by the expert panel. These additions are enabled by the on-going effort to convert the ENSDF database into a modern format. For the first time, we will store all individual measurements in an object-oriented database. Making this data easily accessible to software will significantly reduce the evaluation time, as our collaboration has recently demonstrated with a new object-oriented version of the Nuclear Wallet Cards.

Decay data evaluations will be performed by a postdoc, hired as part of this project, who will be mentored and trained by the ENSDF evaluators at the NNDC. The ENSDF evaluations will be converted into the GNDS format for inclusion into ENDF. We plan for these new decay data evaluations to mature into a standalone, Adopted Decay Data Library, which can serve the needs of the applications and basic science communities.

Discussion:

- R. Capote noted the overlap of this adopted decay data library with DDEP. E. Ricard replied that the new library will be driven by users' needs and they plan to visit NIST to discuss their needs.
- J. Tuli mentioned that producing a recommended adopted decay data set and decay chain are two different types of evaluations as the latter involves time-dependent gammas produced when mother and progenies are in equilibrium. This was confirmed by X. Mougeot who added that in DDEP they perform these evaluations separately to avoid double counting.
- A. Sonzogni remarked that the new adopted decay data library would eliminate the need for normalization factors in ENSDF. Also, important information is missing in ENSDF, such as the 511-keV gamma ray and delayed neutrons.
- E. Ricard clarified that all evaluators at NNDC-BNL will contribute to the project to ensure 12 nuclides per month are evaluated and the library is delivered on time.

7.3. Thermal capture and gamma emission, R. Capote Noy (NDS - IAEA)

The goal of the project is to address issues in gamma data of evaluated cross-section files, specifically transitioning measured data from EGAF/PGAA to ENSDF.

The IAEA has engaged a consultant to process new PGAA measurements from both Budapest and Munich research reactors. An updated PGAA ATLAS will be created.

A new EAGF-II file will be generated from the updated PGAA ATLAS.

A code will be developed to identify primary, secondary, isotope, and ground-state transitions using the adopted ENSDF scheme.

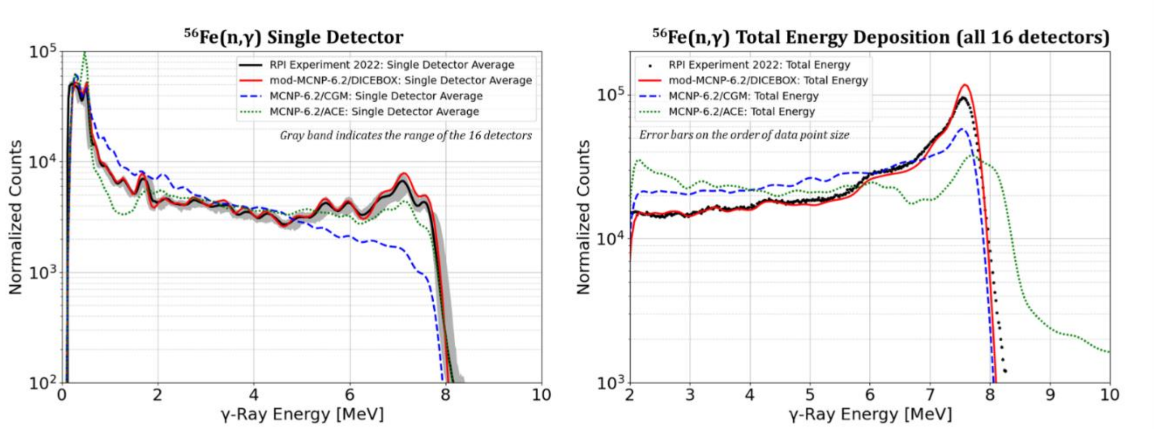
Finally, we will compile a comprehensive and vetted list of thermal capture cross sections.

Discussion:

- F. Kondev recommended to have all the PGAA measurements published so that they can be incorporated into ENSDF.
- J. Tuli pointed out that the Budapest data is elemental data while ENSDF contains isotopic data.

7.4. Validating thermal neutron capture γ-ray data using the RPI Gaerttner LINAC Center, K. Cook (RPI)

Experimental and simulation methods used to validate thermal neutron capture γ-ray spectra were presented. Measurements are completed using the time-of-flight (TOF) method with the RPI LINAC and Capture γ-Ray Multiplicity Detector to measure gammas emitted via thermal neutron capture. Simulation methods include modeling γ-ray cascades using DICEBOX and transporting the cascades through the detector system using a modified version of MCNP-6.2. Results were shown for both single detector spectra and total energy deposition spectra for multiple isotopes including ^{56}Fe, ^{59}Co and ^{55}Mn.



7.5. Berkeley databases, A. Hurst (Univ. of California Berkeley)

The presentation provided an overview of several database projects developed and maintained at UC Berkeley serving various nuclear physics applications. These database projects generally fall within the scope of either nuclear reactions: pyEGAF [1]; APGAA [2]; the Baghdad Atlas [3], or nuclear structure and decay: BEApR [4]; paceENSDF [5], however, given the often inherent synergy between the different categories there is a natural overlap between the areas of application. The presentation is not an exhaustive account of these projects (nor meant to be) but is rather intended to give a flavour of their respective applications by highlighting a few specific use cases and examples, as well as to advertise the accessibility of the projects to the wider community and potential users. A brief description of each project is given below:

pyEGAF: A Python package enabling access, manipulation, analysis, and visualization of thermal neutron-capture gamma-ray data from the Evaluated Gamma-ray Activation File (EGAF). The package is bundled with the complete library of all 245 EGAF datasets in the original ENSDF and translated RIPL and JSON formats.

APGAA: Analytical attenuation in Prompt Gamma Activation Analysis (PGAA); a program implemented in C++ to calculate the attenuation integrated over the sample thickness for elemental and compound sample materials utilized in PGAA measurements. The package comes complete with the XMuDat database of mass-attenuation coefficients for 100 elements.

The Baghdad Atlas: A downloadable software platform to build and interact with an SQLite relational database of inelastic neutron-scattering gamma-ray data. All 105 datasets, corresponding to 76 natural and 29 enriched samples, and associated utility software are shipped together as part of the package.

BEApR: The BErkeley Alpha and proton Radioactivity database is a global heavy charged-particle database arranged by algebraic isospin projection, as well as by charge and mass, for proton-rich nuclides that undergo direct proton or alpha decay, in addition to beta-plus charged-particle emission.

paceENSDF: Python Archive of Coincident Emissions from ENSDF; a Python package enabling access, manipulation, analysis, and visualization of radioactive decay data from the ENSDF archive, and corresponding derived coincidence gamma-gamma and gamma-X-ray emissions. The project comes bundled with 3254 decay datasets in the original ENSDF format in addition to translated JSON and RIPL formats. A total of 2394 JSON-formatted gamma-gamma and gamma-X-ray coincidence datasets are also included in the project. The coincidence datasets were derived from the corresponding ENSDF datasets containing gamma-ray records.

References

[1] A.M. Hurst, R.B. Firestone, E.V. Chimanski, Nucl. Instrum. Meth. A **1057** (2023) 168715, https://pypi.org/project/pyEGAF/.

[2] A.M. Hurst, N.C. Summers, L. Szentmiklosi, et al., Nucl. Instrum. Meth. B **362** (2015) 38, https://github.com/AaronMHurst/attenuation_integration.

[3] A.M. Hurst, L.A. Bernstein, T. Kawano, et al., Nucl. Instrum. Meth. A **995** (2021) 165095, https://github.com/AaronMHurst/baghdad_atlas.

[4] https://nucleardata.berkeley.edu/research/betap.html

[5] A.M. Hurst, B.D. Pierson, B.C. Archambault, et al., EPJ Web of Conf. **284** (2023) 18002, https://pypi.org/project/paceENSDF/

Discussion:

- For ^{28}Si(n,g)^{29}Si, sum of primary cross section is 0.185(2) b, with an uncertainty of about 1%. Question: how is the uncertainty so small when the measured Ig has an uncertainty >2%?

8. TECHNICAL REPORTS

8.1. K forbiddenness in beta decay, F.G. Kondev (ANL)

Unlike in electromagnetic decays, experimental information about beta-decaying K isomers is sparse, and, consequently, the role of the K quantum number on the beta-decay transition strength (often expressed in log ft units) is still not well quantified.

We have surveyed the nuclear physics databases ENSDF and NUBASE2020 for K-forbidden beta decays in deformed odd-odd nuclei with Qbeta<1.5 MeV and we unambiguously identified only a limited number of first-forbidden transitions that have different ΔK. The deduced K-hindrances as a function of ΔK are shown in Fig. 1. For each order of ΔK, the beta-decay transition strength is suppressed by 101.9 (≈80). While there is a striking correlation of increasing beta-decay hindrance with increasing ΔK, like that observed for gamma decays, there is not a correspondingly simple specification of the degree of K forbiddenness. Nevertheless, the implication for nuclei away from the line of stability, where the decay Qbeta values are large (Qbeta >4 MeV), is clear: it would be unlikely to observe beta-decay transitions with large ΔK, unless a specific K-mixing scenario is invoked. For example, even for ΔK=2 forbidden decays, one may expect log ft ~9-10 and therefore the decays would be expected to proceed via non-K-forbidden transitions, by minimizing ΔK=0,∓1.

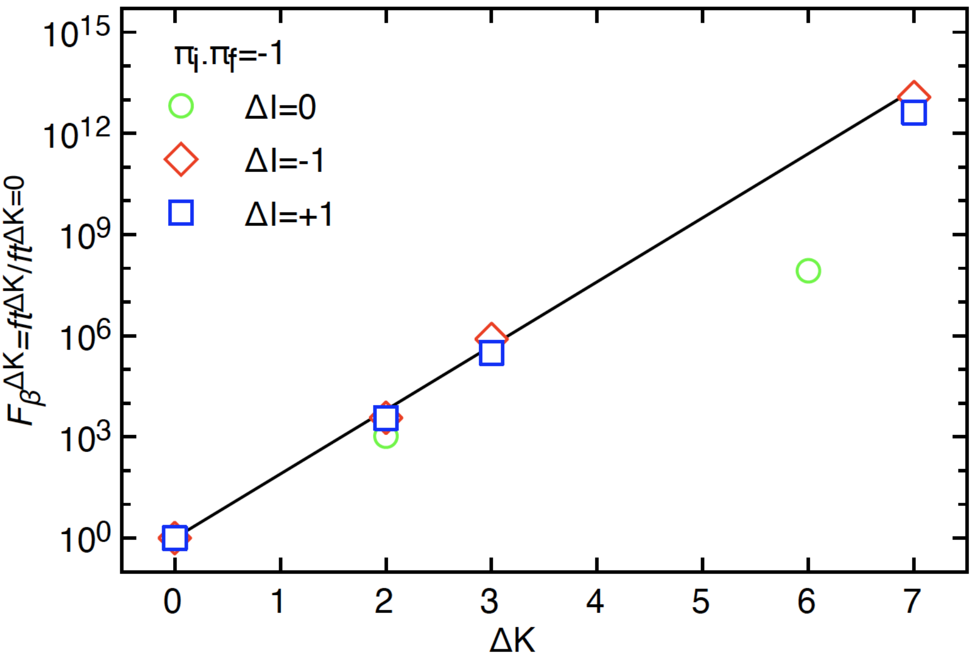


FIG. 1. Hindrance factors as a function of ΔK for first-forbidden transitions observed in beta-decays of deformed nuclei. The solid line is drawn to guide the eye and corresponds to $F_b^{\Delta K}=10^{(1.9*\Delta K)}$.

Discussion:

- E. Ricard stated that as a compiler for XUNDL she does not question the authors' data.
- F. Kondev stressed that incomplete decay schemes should not be normalized to get absolute intensities %IB and %IG nor should logft values be calculated in such cases.
- A. Sonzogni noted that systematics of logft values for high Q-values are missing.

8.2. Data-based research project: How to build a level scheme?, N. Nica (Texas A&M University)

Level and decay schemes are graphical means for the presentation of nuclear structure data used by the scientific community as well as by the ENSDF nuclear structure data evaluation community. Moreover, for the latter level schemes are also of technical interest for getting optimum and unified types of levels schemes. Beyond all this, a question has arisen: can the concept of a level scheme still be of interest for basic physics research?

Level schemes are 2D graphs of which only the vertical direction – the energy scale – is well defined, but with an arbitrary scale on the horizontal direction, where the bands can be interspersed freely as long as the pattern of their interconnecting transition is preserved.

We start from the observation that the ensemble of experimental bands gamma-ray energies as function of spin I can be described on average as a beam of parallel lines, 2c(2I+k-1), where 2c is the beam constant slope and the k integer-number are the bands offsets. We can determine these parameters by a least-squares fit applied simultaneously to all the bands of a nucleus. We can also deduce the effective second order moment of inertia, $"I"^2_{eff} = \hbar^2/2c$, which describes the average rotational motion of the real rotational bands.

To represent the 2c(2I+k-1) bands, one can first build a 3D Double Helix discrete structure, on which the rotational bands can be drawn as decay paths. Double Helix is the new prototype for high-spin level schemes.

The experimental gamma-ray energy can be decomposed as $E\gamma=2c(2I+k-1+k'+fn)$, where $(k'+fn)$ is the deviation of the experimental $E\gamma$ value from the $(2I+k-1)$ average value, with k' an integer number and fn a fractional quantity. This can be rewritten as $E\gamma= 2cband(2I+k+k'-1)$, with $2cband=2c[1+fn/(2I+k+k'-1)]$, where 2cband is a real number and $(2I+k+k'-1)$ an integer number, respectively. One can also get the bands second order moments of inertia, $"I"^2_{band} = \hbar^2/2cband$. With this decomposition we get a complete description of the experimental bands of a nucleus.

The 2cband(2I+k+k'-1) decomposition allows a unitary 3D representation of the rotational bands as decay paths on the Double Helix. The apparent rotations of the bands contain information on macroscopic and microscopic nuclear motion.

Double Helix is the geometrical place of the discrete angular momentum states available for the rotational motion of the nucleus, which defines a Semiclassical Meta-Trajectory. On average, one can assume that Nuclear Matter's Motion itself follows the Semiclassical Meta-Trajectory of the Double Helix, with the actual levels selected by the rotational bands' paths.

Through Repeatability, Nuclear Matter's Double Helix Motion can be seen as a Semi-classical Vortex Motion.

8.3. The update of an evaluation when no new experimental information is available, A. Negret (IFIN-HH)

This technical presentation addressed a particular case: the update of an existing ENSDF evaluation of a nucleus when no new experimental information dedicated to that isotope became available. In such case the new ENSDF evaluation implies mainly the update of the Q-values according to the latest mass evaluation and possibly of other quantities based on horizontal or theoretical evaluations (e.g. the conversion coefficients, logft values, etc.). Further, the ENSDF update may highlight changes of the evaluation policies or even the subjective style of the new evaluator.

The presentation concentrated on the case of ^{101}Cd. Although no new experimental information on ^{101}Cd became available after the cut-off date of the latest evaluation (i.e. year 2006), the new evaluation involved important changes: the available material was reorganized differently excluding one dataset that did not provide significant structure information and reorganizing a dataset dedicated to heavy-ion induced reactions.

Furthermore, the presentation addressed an open issue regarding the spin assignments of the excited levels of ^{101}Cd based mainly on the angular distributions determined in a study of the ^{50}Cr(^{58}Ni,2pnag): Although the angular distributions are not sensitive to the electric or magnetic nature of the detected g transitions, the authors of the original paper [1] used them to assign M1 or E2 character to many transitions and consequently to develop an extended level scheme based also on systematics, the observed band sequence and a comparison with Shell Model calculations.

The presenter argued that, although the arguments used to establish the level scheme may indeed not be very solid, disregarding them is not constructive. Therefore, the preference of the new evaluator is to re-check the systematics presently available and to keep the previous spin assignments as tentative rather than to downgrade the existing level scheme.

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

References

[1] M. Palacz, et al., Nucl. Phys. A **608** (1996) 227.

8.4. What was wrong with the ^{54}Mn level scheme?, G. Mukherjee (VECC)

Recently, we have published a work on the structure of ^{54}Mn (Z = 25, N = 29) nucleus by using the gamma ray spectroscopy method utilizing the INGA (Indian National Gamma Array) setup with 11 clover HPGe detectors [1]. The ^{55}Mn(^{4}He,αn)^{54}Mn reaction with 34 MeV alpha beam, delivered from the K-130 cyclotron at VECC, Kolkata, was used for this. A new level scheme has been proposed from this measurement with the addition of several new transitions and levels. In addition, several discrepancies have been noted from the previous measurement on the same nucleus using the ^{51}V(^{20}Ne,Xγ) reaction with 145 MeV 20Ne beam by G. Kiran Kumar et al. [2], the data of which were evaluated and put in the ENSDF data base by Yang Dong and Huo Junde [3]. These have been discussed in this presentation.

A new band-like structure was proposed in Ref. [2], based on a 7+ state at 1669-keV excitation energy. This newly proposed band, extended up to a tentative spin of 15ħ, consisted of 5 transitions of energy 847, 349, 925, 981 and 226 keV, which decays to the 1073-keV 6+ state by a 596-keV transition. However, the presence of this band itself is in doubt. The 226-, 349- and 925-keV γ rays have not been observed in our α-induced experiment in the same sum-gated spectrum, which was also the case in Ref. [2] (see Ref. [1]). The relative height of 925-keV peak, shown in this spectrum in Ref. [2], is about 3 times more than that of 706-keV (a known low-lying intense γ line in ^{54}Mn), which is in contradiction to their placements in the level scheme shown in Ref. [2]. The 981 keV γ-ray was placed in a different location in Ref. [4] and we have found this placement correct and have restored it (details are given in Ref. [1]). It may also be noted that the 847- and 596-keV gamma rays originate from the (n,n'γ) reaction on Iron and Ge (in the HPGe detector). The only other spectrum shown in Ref. [2] in support of their newly placed gamma rays is one gated by 847-keV. Hence, their placements are always in doubt, and it is quite possible that the 596 and 847 keV γ rays do not belong to ^{54}Mn with as large intensities as proposed in Ref. [2]. Therefore, the new band-like structure, suggested in Ref. [2] does not exist and has been removed in the proposed level scheme presented in Ref. [1].

The spin and parities of two important levels, assigned in Ref. [2], have been modified in our α-induced work, the 1138-keV level (modified to 6- from 6+) and the 1926-keV level (modified to 7+ from 7-). These modifications of the low-lying states are important to understand the structural aspect of ^{54}Mn as described in Ref. [1]. It may be noted that Table 1 in Ref. [2] had certain discrepancies. The authors of Ref. [2] used pure dipole gates for DCO ratio measurement and they assigned a dipole transition even though the DCO value they determined was much less than unity (for two gamma rays of same multipolarity, the DCO ratio should be 1). For example, they assigned (and Ref. [3] adopted) dipole nature for transitions with DCO ratio as low as 0.61 (for 769 keV transition from 1137 keV state) or 0.41 (in case of 852 keV transition from 1926 keV state), when gated by a dipole transition. Therefore, it is not only the positive or negative parity, but the whole measurements leading to the spin-parity assignment of Ref. [2] which are doubtful. One of the possible reasons for this could be that the excited states in ^{54}Mn were produced in a more complicated reaction of ^{51}V(^{20}Ne,X) at a very high beam energy in that work which produces more than 50 nuclei (as per PACE-4 prediction). So, a clean measurement was not possible. It is also quite possible that different yrast and non-yrast states of the nucleus of interest were produced in different reaction mechanisms in that case. The angular momentum orientation of the residue is not well known in such cases where different types of reactions are involved. In comparison, the measurement with the α beam was quite clean and a more reliable spin-parity assignment was made by determining the DCO ratio as well as the linear polarization P and comparing these measured values with the calculated ones (see Ref. [1] for details).

In conclusion, it appears that certain aspects of the gamma-ray spectroscopic data analysis in Ref. [2] may lack thoroughness. For the benefit of users, it is recommended that the current evaluation of ^{54}Mn in ENSDF be revised considering the findings presented in Ref. [1].

References
[1] S. Basu, G. Mukherjee, et al., Eur. Phys. J. A. **59** (2023) 229.
[2] G. Kiran Kumar, S. Mukherjee, et al., J. Phys. G: Nucl. Part. Phys. **35** (2008) 095104.
[3] Yang Dong, Huo Junde, Nucl. Data Sheets **121** (2014) 1.
[4] D.C. Radford, A.R. Poletti, J. Phys. G: Nucl. Phys. **5/3** (1979) 409.

9. CONCLUSIONS AND RECOMMENDATIONS

The 25th Technical Meeting of the International Network of Nuclear Structure and Decay Data Evaluators was held at the IAEA Headquarters in Vienna, from 15 to 19 April 2024. Forty-three experts from twelve countries along with IAEA staff participated in the meeting both in person and remotely. Representatives from the various data centers presented progress reports and discussed new emerging issues and research interests of direct relevance to NSDD activities.

The list of actions from the previous NSDD meeting was reviewed in detail and several of the items were declared completed. One of the main technical issues that was addressed was the overall treatment of uncertainties, be it error propagation or treatment of statistical and systematic uncertainties. Discussions explored adopting new policies aligned with advanced statistical methods and best practices adopted in other related fields such as metrology and nuclear reaction data evaluation. The consensus was that such a complex issue requires further technical exchanges with experts and discussion. Uncertainty quantification will be addressed in depth and breadth at a dedicated meeting that will be organised by the IAEA.

The obligatory adoption of the BetaShape code for calculations of beta-decay properties, instead of the legacy LOGFT code, was relaxed to provide extra time for extensive testing of the code in ENSDF evaluations. The legacy ENSDF analysis codes have all been re-written in Java at MSU with enhanced capabilities. The new code for format checking (Java Formatcheck) has been released and is being validated against the legacy FMTCHK code.

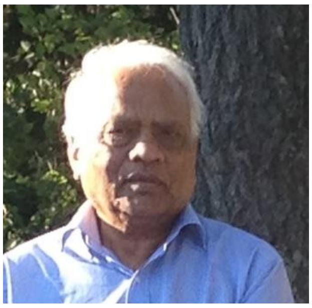
The progress in modernization of ENSDF using the new JSON format was presented and a new ENSDF editor was demonstrated live for the evaluators to provide prompt feedback.

New policies for discernment of decay modes in light nuclei and JPI assignment to consider the new logft systematics were recommended.

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 plan for the next year is to hold either a beginners Joint ICTP-IAEA Workshop in Trieste or an advanced workshop at the IAEA.

The main challenge facing the Network is maintaining and increasing evaluators' effort in mass-chain evaluations, especially in view of the retirement and loss of senior 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). In the USA, on the other hand, a recent funding effort lead by USNDP will support the training of two new evaluators who could then be fully integrated long-term into the ENSDF evaluation workforce.

In Memoriam: Balraj Singh, 1938 – 2023



Our colleague, friend, and one of the longest serving members of the Network, Balraj Singh, died on Monday 9 October 2023. A special session was held at the 25th NSDD meeting in his memory. Tributes were made by Jagdish Tuli, Alan Nichols, Jun Chen, and many other members of the Network. The tributes by the three of his longest and closest colleagues and friends are summarized in the following:

Jagdish Tuli, USA:

Most of us first met Balraj at the NSDD meeting in Karlsruhe, Germany in 1984. He was representing the Kuwait data center. Later he moved to McMaster University in Canada, and ever since, was a constant presence at the NSDD, representing Canada. Balraj was a brilliant physicist and perhaps the best-ever ENSDF evaluator. He contributed to all aspects of evaluation work. He was also the most prolific evaluator. He was the creator of XUNDL. He produced many highly cited horizontal evaluations and reviews. Balraj took very active interest in development of computer programs. He corresponded with numerous researchers and provided very valuable feedback to their publications. Balraj trained many young evaluators. He was an all-rounder who knew many languages and, with excellent social skills created many ever-lasting friendships. He was a religious, moral and principled man. He was a great colleague and a dear friend and will always be remembered and missed!

Alan Nichols, UK:

I will greatly miss Balraj, and not just as a reviewer of some of my work. He was always both kind and thoughtful, maintained high integrity, and could best described as "one of the good guys" - he is a huge loss. All of his own compilation and evaluation work was of high-quality and comprehensive in analysis and content. His productivity was immense from the point of view of both the ENSDF and XUNDL databases, along with his publication of various co-authored compilations of atomic and nuclear parameters.

Balraj was a strong character: a teacher, a mentor, and co-worker to many, many people. You name them, Balraj could train them: undergraduates, post-graduates, post-doctorates, nuclear physicists, lecturers, readers, professors, and even retirees. An ENSDF mass-chain evaluator extraordinaire, with over 150 complete mass chains evaluated and published in his name, plus a few more yet to appear under the guidance of Jun Chen. His many systematic reviews of nuclear parameters included logft, B(E2), E2 transition probabilities, β– delayed-neutron emissions probabilities and half-lives, nuclear spins of ground states and long-lived isomers, nuclear radius parameters (r0) in even-even α decay, super-deformed nuclear bands and fission isomers, magnetic dipole rotational bands, and the Atlas of Nuclear Isomers, plus assistance in the development and improvement of some of our much used data analysis codes.

Balraj played a significant role as a teacher at the joint ICTP-IAEA workshop on "Nuclear Structure and Decay Data: Experiment, Theory and Evaluation" that was developed and held regularly at Miramare, Trieste, Italy, and also elsewhere around the world. He will be sorely missed, particularly in Canada and the USA – a true "giant of our times[1]" within the field of nuclear data. A loss to the evaluation and understanding of nuclear structure and decay data, and therefore to the nuclear data and wider nuclear physics communities.

Our condolences and sympathy are extended to all of Balraj's family and friends.

[1] "…. standing on the shoulders of giants" (words attributed to Isaac Newton, 1675)

Jun Chen, USA:

Balraj was more than a data evaluator.
To me, Balraj was a mentor, a teacher and, of course, a friend despite the age difference.

I've known Balraj since 2009 when I obtained my PhD in nuclear physics at McMaster University and started working with him as a postdoc for the nuclear data program. He trained me as a nuclear data evaluator and helped me with his precious experience accumulated over the decades. Some of the lessons he taught me I could never have learned from anyone or anywhere else.

After I moved to US, we continued collaborating and kept close contact via email and phone communication. We met every year in winter, at the US Nuclear Data Program annual meeting at Brookhaven National Lab. He shared with me his ideas about modernizing the existing ENSDF codes and developing new codes and encouraged me to implement those ideas. He also made significant contributions to the development of those codes by helping to test them and providing feedback and suggestions.

I was very happy to ride with him from LaGuardia airport to Brookhaven and between the Hampton Inn and the lab every day during the meeting. We went out for dinner together and explored different restaurants near the hotel. I remember fondly, that finding a good restaurant was always a challenge either because the food was not good, or because they didn't have a vegetarian option, as Balraj was vegetarian. But in the end, Balraj always managed to create his own vegetarian dish.

There are too many memories with him, and he will be missed throughout my lifetime. His great legacy in the nuclear data program will endure, influencing ENSDF evaluators for generations to come.

ANNEX 2

IAEA Technical Meeting of the
Nuclear Structure and Decay Data Network (NSDD)

15 – 19 April 2024
IAEA, Vienna
Room: C-CR2 (Hybrid)

ADOPTED AGENDA

Monday, 15 April

09:30 – 10:30	**Opening Session – 50th anniversary of the NSDD Network**
	Welcoming addresses: Melissa Denecke, NAPC-Director Roberto Capote Noy, NDS, Deputy Section Head
	Retrospective: 50 years of NSDD Jagdish Tuli (15′) Alan L. Nichols (15′) P (Vivian) Dimitriou (10′) Pavel Oblozinsky (10′)
10:30 – 11:00	*Coffee break – area in front of CR-2*
11:00 – 12:30	Administrative matters Election of Chairman and Rapporteur Adoption of the Agenda
	Actions Review
12:30 – 14:00	***Lunch***
14:00 – 17:00	**Reporting**: 10′ each unless otherwise stated (total 160′)

1) IAEA (20′)
2) US/BNL (20′)
3) US/ANL
4) US/LBNL + UCB
5) US/MSU
6) US/ORNL
7) US/TEXAS A&M
8) US/TUNL
9) AUSTRALIA/ANU
10) BULGARIA/SOFIA UNIV.
11) HUNGARY/ATOMKI
12) INDIA/VECC
13) JAPAN/JAEA
14) ROMANIA/IFIN-HH

Coffee break as needed

Tuesday, 16 April

09:00 – 10:30 **Status reporting cont'd:** 10' each unless otherwise stated

15) CHINA/CIAE
16) CHINA/JILIN UNIV
17) RUSSIAN FEDERATION/PNPI
18) DDEP, Leblond (15')
19) AME/NUBASE, Kondev (15')
20) Nuclear Data Activities at Sofia University, Lalkovski

10:10 – 10:40 *Coffee break*

10:40 – 12:30 **Organizational Review/Policies/Procedures/Evaluation Issues**

- ENSDF/XUNDL/Nuclear Data Sheets status/news, Ricard (40')
- Compilation/Evaluation of a source dataset for ENSDF, Basunia (30')
- Updated proposition for JPI assignment, Chen (30')

12:30 – 14:00 ***Lunch***

14:00 – 15:20 **Policies/Procedures/Evaluation Issues cont'd -** 15' unless otherwise stated

- Policy for adopting weighted average uncertainty, Chen (30')
- Discernment of lightly bound resonant states, Kelley
- Policy for listing decay modes only from observation in resonance reactions, Kelley
- Updating and correcting General Policies in Nuclear Data Sheets, Kibedi

15:20 – 15:50 *Coffee break*

15:50 – 17:00 **Dissemination:** 15' each unless otherwise stated

- NuDAT (FRIB Discovery), Mason
- LiveChart, Medical Isotopes, Isotope Browser, Verpelli
- Wallet Cards and Handbook of Radioactive Nuclei and Web applications, Ricard, Shu
- NSR, Pritychenko
- APRENDE nuclear data project, Lalkovski (10')

Wednesday, 17 April

09:00 – 10:30 **Analysis and checking codes -** 30' each

Developments/reported issues

- BrIcc, NS_RadList, GABS, Kibedi
- ENSDF Java codes, Chen
- BetaShape, Mougeot

10:30 – 11:00 *Coffee Break*

11:00 – 12:30 Uncertainty propagation

Presentation: Kibedi
Discussion

12:30 – 14:00 ***Lunch***

14:00 – 15:30 **Data (library) development projects -** 15' each

- Nuclear Moments, Stone
- Decay Data for Monitoring Applications, Kondev
- Adopted Decay Data Library, Ricard
- Thermal Capture and Gamma Emission, Capote
- Experimental validation of neuron capture cascades, Cook
- Berkeley Nuclear Database Projects, Hurst

15:30 – 16:00 *Coffee Break*

16:00 – 17:30 **In Memoriam – Balraj Singh**

19:00 Social Dinner

Thursday, 18 April

09:00 – 10:30	**Technical presentations**
	- K-forbiddeness in beta decay, Kondev (30’) - How to build a level scheme, Nica (40’) - The update of an evaluation when no new experimental information is available, Negret (20’) - What is wrong with the ^{54}Mn level scheme? Mukherjee (15’)
10:45 – 11:15	*Coffee Break*
11:15 – 12:30	**Roundtable discussion**
	Workshops-Training schools, Dimitriou NSDD outlook, Dimitriou
12:30 – 14:00	***Lunch***
14:00 – 17:00	**ENSDF modernization**
	Project status, Ricard ENSDF JSON Format, Morse ENSDF Editor, Mason Demo, Q&A
	Coffee break as needed

Friday, 19 April

09:00 – 12:00	**Roundtable Discussion and Approval of Action List**
	Coffee break as needed
12:00 – 12:30	**Closing of the Meeting**

ANNEX 3

25th Technical Meeting of the Nuclear Structure and Decay Data Network

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ANNEX 3

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ANNEX 4

NSDD Data Centres

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c. Nuclear Data Group LBNL+UCB
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Mass-chain responsibility

US/NNDC	1,45-50,64,68,70,82,84-89,94-100,113-116, 136-146 (ex.140,141),149-152,159,161,163-165,175,180-183,189,190,194,230-240,>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	Australia	172-174
US/ANL	109,110,176-179,188,199-209	Hungary	101-105
US/MSU	31-44, 60-80 (ex. 62,67-70)	PRCBeijing PRC-Jilin	51,62,195-198 52-56,67
TAMU	140,141,147,148,153-158,160,162	Bulgaria	106-108,111,112
Romania	57-59,117-119		
Contribution			
Manipal Univ.-India	261, 265		

ANNEX 5

ENSDF Evaluation Effort 19-04-2024

No.	Data Centre	Full-time equivalent (FTE) for ENSDF evaluation
1	ANL/USA	0.5
2	BNL/USA	2.75
3	LBNL/USA	0.9
4	MSU/USA	0.65
5	ORNL/USA	1
6	TAMU/USA	1
7	TUNL/USA	1.35
SUBTOTAL		**8.15**
8	AUSTRALIA	0.3
9	BULGARIA	0.7
11	CNDC/CHINA	0.50
12	JILIN/CHINA	0.50
13	HUNGARY	0.15
14	INDIA	0.54
15	JAPAN	0.2
16	ROMANIA	0.3
17	RUSSIA	0.2
TOTAL		**11.54**

ANNEX 6

LIST OF ACTIONS AND EXTENDED PROCEDURES

On-going and Incomplete Actions – still to be fully implemented Require biennial consideration				Status 15 April 2024
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**: Draft is available on NSDD-shared folder for review and feedback.
2 (2)	ANU NNDC-BNL MSU	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. Implement new format in checking code.	ENSDF format for atomic data has been agreed, and now requires implementation**.** **Done** **In Progress – pending the adaptation of the format checking codes** **In Progress**.
3 (3)	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 **Postpone** to next meeting.
4 (4)	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) **Ongoing** DoE funded project (post-doc) to deliver Adopted decay data library (only in new format).
5 (5)	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** using new format. Remains to be done for ENSDF 80-column format.

6 (6)	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. **Done** based on limited feedback-to draft Guidelines for network.
7 (7)	ENSDF evaluators	Reviewers Guidelines	Provide feedback to NNDC (E.A. Ricard) on draft of Reviewers Guidelines.	**Ongoing**
8 (9)	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. Ricard).	**Ongoing**
9 (10)	IAEA-NDS	International contribution to NSDD	Explore the possibility of holding a meeting of stakeholders to discuss supporting NSDD evaluations.	**Ongoing** In consideration. Feedback from evaluators requested.
10 (11)	McMaster (B. Singh) All Evaluators ORNL (C. Nesaraja) IAEA-NDS	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.	**Action transferred to ORNL** (Caroline Nesaraja). Recommendation to evaluators: to share with ORNL comments and updates/additions on the existing Guidelines to be included in the Addendum. Draft document – use Balraj Singh's latest draft. Obtain draft from Kavita Singh.
11 (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, #28).	In-person meeting to be organised in 2025 at IAEA. The meeting will gather experts from other communities dealing with both decay, reactions, and integral data.

12 (15)	ENSDF evaluators ORNL	New policy	"Rule" 35 (uncertainty rounding limit) is changed to "Policy" 35.	Not a policy but a guideline for codes – flexible for evaluators. To be added in Guidelines Addendum.
13 (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).	Required changes to the code **were done.** Relaxed the implementation of obligatory use of code until remaining issues resolved. Evaluators should send feedback to X. Mougeot (CEA-Saclay)
14 (17)	LHNB-Saclay (X. Mougeot) X. Mougeot, J. Chen, T. Kibedi	Implementation of new policy	Send samples of ENSDF files with beta shape factors included in continuation record. All 131 beta shapes should be checked.	**Done** (in collaboration with Balraj Singh **In progress**
15 (19)	NNDC-BNL	Policy implementation	Update the General Policies documents with recently adopted policies (wording to be discussed and approved by the community).	**Pending** input from evaluators.
16 (21)	ANL (F. Kondev)	New policy	Formulate the updated policy on including %IG in decay datasets.	**Ongoing**
17 (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.	**Ongoing** To be implemented in BrICC code using ENSDF 80-column format.
18 (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.	**Ongoing**
19 (25)	ENSDF evaluators	ENSDF codes	Send a request to ANU (T. Kibedi) to test the new NS_RadList code (voluntary).	**Ongoing**
20 (28)	All (ENSDF evaluators, code developers) ANU, MSU	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.	For dedicated meeting see Action #12 Further work on treating limits with appropriate PDF – form working group – complete exercises. **Ongoing**

First column: number in brackets is the action number from the previous NSDD Network meeting (see INDC(NDS)-0867))

New Actions			
No	**Responsible**	**Reason**	**Action**
21	NNDC-BNL	Reviewer Guidelines	Include statement that reviewer anonymity is not mandatory but at the discretion of the reviewer.
22	ORNL (C. Nesaraja)	Guidelines	Remove statement saying that when E_γ values are not reported with uncertainties then evaluators should report level energies without uncertainties.
23	NNDC-BNL	Update policy	Update the policy regarding the rules used in assigning Jpi values based on logft values – Draft of updated policies is available on NSDD-shared for review.
24	ANL (F. Kondev)	New policy	Provide updated policies for treatment of deformed nuclei.
25	TUNL (J. Kelley)	New policy	Formulate policy on what defines a level and what a scattering state.
26	IAEA-NDS	Dissemination	Extend IAEA Medical Isotopes Browser to include dose calculations.
27	All evaluators	Guidelines When the E field of the B+ or B- decay dataset is filled manually, the value does not get updated by logft and becomes inconsistent with the Q-values.	Remove this redundant information from the E field as it will be automatically completed by Java-NDS. Place the experimental value (if it exists) in the comments.
28	NNDC-BNL	Updated bibliographic resources	Ensure NSR keynumbers assigned for relevant references.
29	NNDC-BNL	Updated bibliographic resources	Ensure NSR article keywording done promptly.
30	NNDC-BNL	ENSDF formats	Finalize new ENSDF JSON format and distribute schema.
31	NNDC-BNL	ENSDF editor	Complete the development of a new editor for ENSDF JSON format.
32	TUNL (J. Kelley)	ENSDF	Formulate a guideline for listing decay modes of resonance levels in light nuclei.
33	NNDC-BNL, ANU, MSU, LHNB-Saclay, IAEA-NDS	Codes and new JSON format	Form a working group to discuss ENSDF codes with new JSON format.
34	NNDC-BNL	Update bibliographic resources	Provide scanned pdfs to IAEA to be included the IAEA XFOR pdf database.
35	MSU (J. Chen)	Update Guidelines	Formulate a guideline for adding pseudo levels to account for beta-delayed particle intensities in decay datasets.
36	MSU (J. Chen)	ENSDF codes	Compare legacy FMTCHK and Java Formatcheck to identify source of differences in errors and warnings.

Completed / withdrawn Actions				Status 15 April 2024
No	**Responsible**	**Reason**	**Action**	
8	IAEA-NDS	Maintain list of data centres	Explore obtaining DOI or permanent URL for data centres webpage.	**Done** DOI is not appropriate for this webpage since it will be continuously updated. The preferred solution is to assign a permanent URL which has been agreed.
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.	**Done**
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.	**Continuous – moved to ENSDF Procedures** **Done** – pending distribution of GABS.
20	MSU (J. Chen) ENSDF evaluators MSU	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. Fix the small issue in the dataset header and the Adopted dataset header.	**Done** **Continuous – moved to ENSDF procedures** **Done**
23	NNDC (E.A. McCutchan) ENSDF evaluators	New 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.	**Done**
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.	Redundant – values revised in online tables – report will be revised accordingly. **Withdrawn**
27	NNDC	Training	Organise training/prepare documentation on how to access and use the mass chain tracking system on GitHub.	Documentation distributed – evaluators should contact NNDC for additional guidance. **Done**

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	Improve NSR	Send comments and suggestions on NSR improvements (keywording) to NNDC.
8	All network participants	Identify potential new ENSDF evaluators	All NSDD network participants to encourage participation in research/ evaluation of nuclear structure data and to 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.
9	All network participants	Support new ENSDF evaluators	Provide local support and mentoring to new ENSDF evaluators.
10	ENSDF evaluators	Check continued validity of the rules	Inform NNDC when experimental results contradict accepted rules.
11	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]
12	NNDC-BNL, IAEA-NDS	Outreach	Continue to pursue initiatives to improve the international contributions to the ENSDF mass chain evaluations.
13	All network participants	Outreach.	Formulate and expand contributions to mass chain evaluations within their own countries.
14	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.**

ENSDF-RELATED PROCEDURES – CONTINUOUS			
Item no.	**Responsible**	**Reason/Topic**	**Extension**
15	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.**
16	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.**
17	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.**
18	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.
19	ENSDF 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.
20	All network participants	Policies	Inform NNDC of discrepancies in the current policies and propose changes and additions.
21	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.
22	NNDC-BNL, IAEA-NDS	ENSDF analysis and checking codes	Notify network of new versions of analysis and checking codes.
23	NNDC-BNL	General policy pages in *Nuclear Data Sheets*	Modify policy pages, as needed.
24	ENSDF evaluators	Keep ENSDF up to date	Check NNDC monthly report for nuclides added by others to ENSDF that are your mass-chain responsibility.
25	NNDC-BNL	Maintain up-to-date information on network	Update website with changes in group responsibilities.

ENSDF-RELATED PROCEDURES – CONTINUOUS			
Item no.	**Responsible**	**Reason/Topic**	**Extension**
26	IAEA-NDS, NNDC-BNL	Information relevant to ENSDF network	Regularly update network website – ensure all relevant presentations/talks are available on website.
27	IAEA-NDS, NNDC-BNL	Dissemination of codes	Coordinate distribution of ENSDF codes.
28	NNDC-BNL, ENSDF 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.
29	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.
30	IAEA-NDS	Maintain links with horizontal evaluations	Invite representatives of atomic mass and other horizontal evaluations to NSSD Evaluators' Network meeting.
31	ENSDF 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.
32	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.
33	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.
34	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.
35	IAEA-NDS	ENSDF codes	Organise technical meetings on Codes and Code Developments at IAEA Headquarters for existing code developers.
36	**ENSDF evaluators**	**New policy**	**Use "N" in column 79 to mark gammas used in intensity normalization when applicable.**
37	**ENSDF evaluators**	**Implementation of policy**	**Evaluators should use "EC decay" or "EC+B+" in the dataset ID when applicable.**
38	**NNDC-BNL, IAEA-NDS**	**Access to primary and secondary publications**	**Make available the X4-NSR PDF database through the EXFOR and MyENSDF interface on the IAEA web server. Keep the database updated.**

ANNEX 7

STATUS REPORTS OF NSDD DATA CENTRES

1. IAEA Status Report, P. Dimitriou (IAEA - NDS)

Period covered: 2022-2024

Meetings with nuclear structure and decay data component:

Nuclear Data for Reactor Antineutrino Applications, 16 - 20 January 2023
https://conferences.iaea.org/event/337/

Consultants' Meeting on Comprehensive European plan to acquire and curate nuclear data, 25 - 27 April 2023, https://conferences.iaea.org/event/347/

Technical Meeting on Nuclear Data for Medical Applications, 29 – 31 August 2023
https://www-nds.iaea.org/index-meeting-crp/TM-MedApps-Aug2023/

67th IAEA General Conference Side Event: Providing nuclear data for tomorrow's nuclear solutions, 25 September 2023, https://www-nds.iaea.org/index-meeting-crp/GC67-SideEvent/

Consultant's Meeting on Evaluation of Photon Strength Function Data, 7 – 9 October 2023
https://conferences.iaea.org/event/365/

Technical Meeting on Decay Data for Monitoring Applications, 23 – 25 October 2023
https://www-nds.iaea.org/publications/indc/indc-nds-0890.pdf

Technical Meeting on Thermal Capture and Gamma Emission, 23 – 25 October 2023
https://www-nds.iaea.org/index-meeting-crp/CM%20Thermal%20GAMMA%202023/

7th International Workshop on Compound Nuclear Reactions and Related Topics, 8 – 12 July 2024
https://conferences.iaea.org/event/368/

Presentation at:

NuPECC Meeting, Vienna, 1 December 2022
Applied Antineutrino Physics Workshop, 18 – 21 September 2023, York, UK
Low-energy Community Meeting, 8 August 2024, TUNL, US

Financial support:

Financial support was provided to N.J. Stone to update the compilation of measured magnetic dipole and electric quadrupole moments.

Two contracts have been awarded for mass chain evaluations in India: Anagha Chakraborty (^{30}P and A=225) and Sushil Kumar (A=215 and 220).

ENSDF enhancement effort:

Recent activities undertaken to enhance the ENSDF efforts, particularly focusing on initiatives outside the United States, were presented. These activities include presentations, contributions to strategic Long Range Plan documents, event organization, and international collaboration.

A presentation was delivered at the Nuclear Physics European Collaboration Committee (NuPECC) in 2023. This presentation focused on the current state and future directions of the ENSDF evaluation efforts, highlighting the importance of international collaboration and the integration of global data.

A section on nuclear data evaluation and nuclear databases was authored for the European NuPECC Long Range Plan, which was published in June 2024. This section provided a comprehensive overview of the current nuclear data landscape and outlined strategic recommendations for future developments, maintenance of databases and attraction of a new generation of evaluators.

A side event on the role and need for nuclear data for future technologies was co-organized at the IAEA General Conference in 2023 with the purpose of creating awareness of the importance of nuclear data and the need to maintain and enhance the nuclear data resources worldwide.

Efforts were made to liaise with colleagues in Japan and China to explore ways to enhance their contributions to the ENSDF.

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 project will be completed by the end of 2024 with the creation of a complete library of recommended decay data, and atomic radiation data (BrIccEmiss). A technical report describing the work and results will be prepared for publication in 2025.

Nuclear moments database:

The Nuclear Moments database (https://ww-nds.iaea.org/nuclearmoments/) has been updated to consider new published data published since 2014 (see 7.1 and Nick Stone's presentation). Furthermore, the recommended magnetic moments table will also be updated to include up-to-date corrections on diamagnetism. A technical report is in preparation.

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 data. Articles published since 2015 for Z<28 and since 2020 for Z>57 were compiled and evaluated by Balraj Singh. A total of 242 nuclei in the Z = 2 – 28 regions, and 118 in the Z > 57 region were revised or included in the database for the first time. In addition, data consistency checks were made using the following databases: ENSDF and XUNDL at NNDC; NuBase2020 (2021Ko07), and TUNL database at Duke University for half-lives and Pn of nuclei with A=2-20. The updates will be uploaded to the online database and a techncial document will be prepared for publication.

Coordinated Research Projects:

A new CRP on Updating and Improving Nuclear Level Densities for Applications is starting in 2024 with a duration of 4 years. Details about the goals and deliverables are given in INDC(NDS)-0889.

Workshops:

A proposal to organize a Joint ICTP-IAEA Workshop on Nuclear Structure and Decay Data 2025, in Trieste, Italy, has been accepted. The dates of the workshop are 6 – 17 October 2025.

Personnel:

Two NDS staff members retired in autumn of 2023: J-C. Sublet and V. Zerkin.
In June 2024, Alejandra Martinez joined the Nuclear Data Section as an IT expert and software engineer.

2. NNDC-BNL Status Report, David Brown (NNDC - BNL)

David Brown reported on updates and general progress at the National Nuclear Data Center (NNDC) since the previous Central Heads NSDD meeting. He began by presenting the NNDC's Mission and Vision (equivalent to a Terms of Reference document). He then moved on to summarize workforce changes at the NNDC. These changes include the hiring of a post-doc (Dr. Sanjanee Waniganeththi), the promotion of Dr. Emanuel Chimanski to staff, the retirement of JoAnn Totans, the NNDC librarian, and the departures of post-docs Dr. Amber Lauer-Coles (now staff at Savannah River National

Laboratory) and Dr. Sam Kim (now a post-doc at Los Alamos National Laboratory). With these changes, the NNDC is comprised of 9 staff scientists, 1 post-doc, 4 professional staff and 7 contractors.

This was followed by a description of the status of the various nuclear data libraries that NNDC either contributes to or maintains. He noted that i) progress on both NSR and EXFOR compilation has been steady and, in 2023, content from FRIB's Discovery of Nuclides Project was integrated; ii) compilation and evaluation for XUNDL and ENSDF has also been steady; iii) a new three-year project "Adopted Decay Data" had started. Updates from this project will be provided in future Centre Heads meetings. Finally, he presented an update on the next ENDF/B library release. At the time of its presentation, ENDF/B-VIII.1-beta3 had been recently released and was described as the "best performing" ENDF library yet. However, it was still under revision and members of CSEWG were working hard to resolve an issue at high reactor burn-up and to draft the "big paper" describing the release.

During the COVID-19 pandemic, several of the shelves in the NNDC library collapsed. Because of this, the NNDC ramped up its library downsizing project. The Brookhaven National Laboratory library cataloged over 2000 books and proceedings at no cost to USNDP. These publications were cross referenced against on-line content by Cat Dunn and, if the reference was found on-line, it was added to NSR. Of the articles that could not be found online, as many as possible were scanned for NSR and sent to DOE's Office of Scientific and Technical Information (OSTI.gov).

The NNDC runs one of the busiest websites at Brookhaven National Laboratory, with approximately 11 million retrievals in FY23, a substantial rise from FY22, and this rise is in partly due to NNDC's website modernization efforts. Indeed, all web applications show a consistent increase, most notably with ENSDF, NSR, and NuDat3 retrievals. The essential drivers behind the web dissemination improvements are the dedicated team comprised of Ramon Arcilla (the NNDC System Administrator), Ben Shu (the NNDC Webmaster and software developer), and Donnie Mason (web and software developer). It is also worth pointing out that the NNDC web servers were upgraded following a 5-year lifecycle plan. The total number of servers was decreased from 5 to 3, but the number of available cores increased from 10 to 28, the RAM increased from 192 GB to 384 GB and the disk storage increased from 4.2 TB to 14 TB.

The NNDC continues a sizable student and visitor program. In FY23 there were 24 interns, comparable to the 28 interns in FY22, for a total of 108 interns since 2014. 53% of the NNDC interns are from groups underrepresented in physics. The NNDC was able to support 8 interns to attend the American Physical Society Division of Nuclear Physics meeting in 2024. Also, one of the NNDC students, Adam Oppenheimer was the winner of the Department of Energy Ignite Off competition describing his project modeling NEOS and RENO antineutrino spectra.

The NNDC's commitment to diversity and inclusion went beyond hosting student interns and included several outreach activities including:

- Women in Science and Engineering (WISE) program, hosting 80+ STEM students from Stony Brook on 2 full day Saturday programs with hands-on labs and presentations about nuclear data and applications.
- RENEW program, hosting 50+ URM students for a 2-week program led by BNL's Physics Department and included 1 day at NNDC with activities adapted from the WISE program.

Finally, D. Brown reported on two nuclear data initiatives which may be of interest to the NSDD:

- Ion stopping power measurements: The stopping power of ions in matter is critical information for many activities, e.g. nuclear science, radiotherapeutics, and radiation shielding. However, data on stopping powers are sparse or non-existent for many materials. The NNDC is developing a program to measure stopping powers of ions in various materials to address this need.
- Precise fission yield measurements at NSLS-II: With Laboratory Directed Research and Developing funding, Andrea Mattera and Mehmet Topsakal are taking advantage of the bright X-ray beams and advanced detectors at NSLS-II to precisely measure charge yields of long-lived fission products from neutron-induced fission of ^{235,238}U and ^{239,241}Pu using synchrotron-based X-ray Fluorescence (s-XRF). As a proof of concept, they are attempting to measure the neutron capture rate from a reactor irradiation of a Rh foil. The capture causes the transmutation of Rh into Pd, a change we calculate is detectable with s-XRF.

3. Progress Report on Nuclear Structure and Decay Data Activities at Argonne National Laboratory[2], Filip G. Kondev (ANL)

Period covered: October 2022 – April 2024

Program overview

The Argonne Nuclear Data Program is involved in several 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 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 libraries. 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.

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 Tables 1 and 2.

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

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 **192** (2023) 1	F.G. Kondev	**completed in FY22**
201	NDS **187** (2023) 355	F.G. Kondev	**completed in FY21**
202	NDS (in press)	F.G. Kondev	**completed in FY23**
203	NDS **177** (2021) 509	F.G. Kondev	completed
204	NDS **111** (2010) 141	C.J. Chiara & F.G. Kondev	completed
205	NDS **166** (2020) 1	F.G. Kondev	completed
206	NDS (under review)	F.G. Kondev	updating
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
229	NDS (under review)	J. Tuli, E. Browne, B. Singh, F.G. Kondev	updating

Other Activities

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

The ANL staff participated in several IAEA-led activities, including development of the "Decay Data Library for Monitoring Applications", "Total Absorption Gamma-ray Spectroscopy for Decay Heat Calculations and Other Applications", "Nuclear Data for Anti-neutrino Spectra and Applications", "Nuclear Data for Medical Applications", and provided a lecturer at the ICTP-IAEA organized Trieste workshop on "Nuclear Structure and Decay Data Evaluation: Theory and Experiment".

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 (LBNL)

Period covered: November 2022 – April 2024

Program Summary

Nuclear structure data evaluation for the ENSDF database and the evaluation of beta delayed and direct heavy charged particle emitters, (n,n′γ) – Bagdad Atlas, and γ-X coincidences (and decay) have been continued. A web-based library of scintillator properties and their response to recoil nuclei (Berkeley Lab Scintillator Library) has been developed. Targeted nuclear reaction (n,n′γ) and decay studies at 88-Inch Cyclotron, LBNL and elsewhere in collaboration with scientists from other institutions are ongoing. Organized workshop related to applied nuclear data and chaired Nuclear Data Subcommittee of the NSAC (Nuclear Science Advisory Committee).

Evaluation*/Compilation/Tools*

In this reporting period mass chains A=24, 191 were published and A=25, 81 were evaluated and submitted for publication. One nuclide of the mass chain A=25 was evaluated by Anagha Chakraborty from India. Currently, mass chains A=25, 30, and 81 are in the pipeline for publication in the Nuclear Data Sheets, of these A=30 was submitted earlier. Two mass chains were also reviewed.

Compilation/evaluation of beta-delayed and direct heavy charged particle emitters for the Berkeley Evaluated Alpha & proton Radioactivity (BEApR) database is ongoing and the data will be available online.

Open source Python libraries paceENSDF (Python Archive of Coincident Emissions from ENSDF) and pyEGAF (Python Evaluated Gamma-ray Activation File) have been developed and maintained on PyPI and GitHub, https://pypi.org/project/paceENSDF/ and https://pypi.org/project/pyEGAF/, respectively. These python modules enable interaction, analysis, and visualization of the ENSDF-decay data for coincidence γ-γ, γ-X-ray data or EGAF (n,γ) data.

A nuclear data library for scintillator detector materials has been created (https://scintillator.lbl.gov/) to aid the development of fundamental theories or empirical relations between basic material properties and scintillation performance.

Publications

Fifteen journal papers were published by the nuclear data group members as author/co-author during this reporting period.

Other Activities

Committee/meeting:

- Nuclear Science Advisory Committee: Nuclear Data Subcommittee Chair: L.A. Bernstein;
- Fusion Nuclear Data Roundtable at White House for Nuclear Data for Fusion Energy Systems, May 4, 2023.

Conference/Workshop contributions:

- L.A. Bernstein, Nuclear Data for Fusion Workshop, Nuclear Data for Fusion. Office of Science and Technology Policy. Washington DC, May 4, 2023;

- J. C. Batchelder, International Conference on Proton-Emitting Nuclei (PROCON2023), Warsaw, Poland, June 25 - 30, 2023;
- L.A. Bernstein, 11th International Conference on Isotopes, Investigating High-Energy Proton-Induced Reactions: Implications for Level Densities and the Pre-equilibrium Exciton Model. Saskatoon, SK Canada, July 24, 2023;
- A.M. Hurst, invited participation at the IAEA "Consultants Meeting on Thermal Capture and Gamma Emission", October 23-25, 2023.

Personnel

In this reporting period, group members at LBNL and UCB-NE include Lee Bernstein (Group Leader), Shamsuzzoha Basunia, Bethany Goldblum, Aaron Hurst, Jon Batchelder, Andrew Voyles, Josh Brown, and Mathis Wiedeking who is a new member and joined the group in January 2024. Two postdoctoral researchers and eight graduate students from UCB were also associated with the group.

5. Status report of FRIB/MSU Data Center, Jun Chen (FRIB/MSU)

Period covered: November 2022 – April 2024

Overview of FRIB/MSU data center

The MSU Nuclear Data Center at FRIB was established under USNDP in April 2015 and was funded by an independent grant directly from DOE-SC since 2017. Its current main responsibility is the evaluation of mass chains A=31–44 and A=60-80 (excluding 62, 67-70 at other centers; 30 mass chains in total) in ENSDF, 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 has 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) include Jun Chen (PI, 1 FTE). Two proposals have been submitted to DOE: one for hiring an additional permanent ENSDF evaluator, and the other for hiring a nuclear data trainee with a special focus on nuclear astrophysics data.

ENSDF evaluations and XUNDL compilations

In the reporting period, the MSU data center completed and submitted full evaluations of A=63, 33 and 76 mass chains, with the latter two in collaboration with late Balraj Singh from the data center at McMaster University, Canada. In addition, detailed reviews of full evaluations of two mass chains (A=13 and A=81) 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=65, 80 and 151 (A=80 and A=151 will still have Balraj's name) and review of at least one mass-chain evaluation are planned for FY24.

For XUNDL compilations, a total of 976 datasets from 503 papers for 696 nuclides have been compiled at the MSU data center since 2014, including 60 datasets/43 papers in the reporting period among which 27 datasets/19 papers are done for the PRC data checking. Since 2018, 1-2 top MSU undergraduate students were recruited and trained for XUNDL compilation and, so far, 6 students have contributed 65 datasets from 44 papers. 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.

Code development and maintenance

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, and also to ensure efficiency and productivity in and quality of data evaluation. All updated or new codes will be made available to the IAEA Nuclear Data Services for inclusion on their code hosting website for downloading. As work on the new ENSDF format is in progress, the FRIB/MSU data center is developing a new data parser to make existing ENSDF utility and analysis codes developed at FRIB/MSU compatible with the new ENSDF format, in coordination with the ENSDF-format modernization team of NNDC. This effort in ENSDF code modernization at FRIB/MSU will be continued and synchronized with that of the ENSDF-format modernization.

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 to FRIB users' data needs 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: proposal preparation, data taking, data analysis, and publication preparation, but are not limited to each individual stage.

Other data activities at FRIB

The data evaluator also gets involved in collaborative research activities at FRIB on improving nuclear data. Efforts have also been made for evaluation of decay data of selected isotopes for the IAEA/CTBTO decay data project, as well as for the Nuclide Discovery Data project in collaboration with Michael Thoennessen.

6. Status Report of Nuclear Data Activities at Oak Ridge National Laboratory, Caroline Nesaraja (ORNL)

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, 0.2 FTE).

Activities

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. Currently the 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	M.J. Martin & C.D. Nesaraja. NDS 186, 263 (2002) (Lit cut-off Dec. 2021)
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	C.D. Nesaraja. NDS 189, 1 (2023) (Lit. cut-off Feb. 2023)
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 stage of evaluation process as shown below.

Mass Chain	Evaluator	# Nuclides	Status
69	Nesaraja	16	Review
246	Nesaraja	9	Editorial Review
249	Nesaraja	9	To be published

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 status of nuclear data for nuclear astrophysics was thoroughly reviewed in the article "Nuclear Data Resources and Initiatives for Nuclear Astrophysics", Michael S. Smith, Frontiers in Astronomy & Space Sciences 10:1243615 (2023); doi: 10.3389/fspas.2023.1243615. Topics covered in the article include the importance of nuclear data for nuclear astrophysics, a comprehensive list of resources in 7 categories, challenges and data gaps, and future strategies for meeting the most critical data needs. Additionally, another review article was published, "Nuclear Data for Space Exploration", Michael S Smith, Ramona L Vogt, Kenneth A LaBel, Frontiers in Astronomy & Space Sciences 10:1228901 (2023); doi: 10.3389/fspas.2023.1228901. This review focused on nuclear data needed to understand the harmful effects of the secondary radiations emitted when galactic cosmic rays interact with spacecraft materials. The status of work in this field was surveyed, data gaps identified, and collaborative research projects are suggested to fill those gaps.

Other Activities related to Nuclear Data

In 2022, C.D. Nesaraja was elected a member of the Nuclear Science Advisory-Nuclear Data Subcommittee. Together with all the members and Michael Smith, two reports were published: First Report of the Nuclear Data Subcommittee of the Nuclear Science Advisory Committee (doi.org/10.2172/1890079) and Second Report of the Nuclear Data Subcommittee of the Nuclear Science Advisory Committee (doi.org/10.2172/1959550)

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 University Evaluation Center Status Report, Ninel Nica (Texas A&M University

The goal of our evaluation center is to promote and accomplish mass-chain nuclear structure data evaluation at Texas A&M University - Cyclotron Institute as a 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. Since 2018 we have been working as an evaluation center funded by the Cyclotron Institute Grant. We contribute to the evaluation effort with 1 FTE/FY.

Our direct contribution to the effort consists in 310 nuclei and 22 mass chains evaluated, already published (19) in the Nuclear Data Sheets, which are also posted in the ENSDF database. Another 3 mass chains are in the process of publication. 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, 154, 155, 156, 157, 158, 160, 162 mass chains. As sustained by our proposal and adopted by vote at this meeting, the A=156 mass chain was officially adopted as part of our responsibility, which now totals 12 large mass chains.

In our center we evaluate the mass chains that consist of very large size and complexity of the nuclear chart (17 nuclides, over 20,000 database lines, 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 gets at least twice as long, followed by the update work of the newly published data and by the post review, which totals 3-4 years for the whole cycle. Although the tendency is to shorten this cycle somehow, 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 the last 2022 NSDD meeting in Australia we fully evaluated, then completed the post review and editorial work, and finally published the A=141 mass chains (Nucl.Data Sheets 187, 1 (2023)). We also successfully submitted the newly evaluated A=148 mass chain for review (in September 2023) and did all the post review and editorial review work for A=162 (to be published in Nucl.Data Sheets 195, 1 (2024)). We timely completed the review work of the A=63 mass chain. For the next 2024 fiscal year we started to fully evaluate the A=156 mass chain.

Overall, the Texas A&M University Center is in good compliance with its responsibilities: all the mass chains in our responsibility are under ten years since previous evaluations.

8. Status Report of the NSDD Data Center at TUNL, John.H. Kelley (TUNL/NCSU)

The TUNL team comprises J.H. Kelley (TUNL/NCSU), J. Purcel (TUNL/Georgia State University) and Kiana Setoodehnia (TUNL/Duke University).

ENSDF & XUNDL

TUNL is responsible for data evaluations in the mass range A = 3-20. Since the last NSDD/IAEA meeting we are progressing on reviews of A=14 (Kelley) and A=5 (Purcell) along with evaluations of ^{18,19}Ne (Setoodehnia). Comments on A=13 (submitted in 2022) are being addressed. Single nuclide updates on 4n,^{7}H, ^{9}N ^{16}Be were submitted to the DB manager.

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

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. ENSDF related activities report – ANU, Tibor Kibédi (Australian National University)

Period covered: 2022 - 2024

ENSDF evaluations

The ANU responsibilities include A=172-174 mass chains. Most of the work was focussing on the A=172 mass chain. It was carried out in collaboration with Balraj Singh. The evaluation was completed in 2017 and the revision has been carried out in 2018. The implementation of the revision has been almost completed, but with the unexpected passing of Balraj Singh it was halted. In early 2024 all files have been moved to the ANU. As several new papers have been published, it was decided to carry out a revision of the mass chain, which is being carried out at the ANU. It is expected that A=172 mass chain will be completed in the second half of 2024.

Additionally, work has been carried out to evaluate the A=173 and 174 mass chains, the completion of which is planned for the next 2 years.

ENSDF Codes

The ANU is responsible for the development of BrIcc, BrIccMixing, GABS, AveTools, NS_RadList and UncTools.

The current stable version of BrIcc was released on 17-Jun-2020. In 2023 the internal conversion coefficient table has been recalculated using the Frozen-orbital approximation. The data table was extended down to 0.3 keV above the electron binding energies for each atomic shell in Z=4-126. The new BrIccFO v3.1 data table also includes pair conversion coefficients for Z=1-100 using data tables from [1, 2] and the new E0 electronic factor tabulations [3]. The data table is currently available through UncTools. A new version of the BrIcc evaluation tool is also being developed.

To treat uncertainties using Monte Carlo (MC) propagation techniques the new code, UncTools, has been developed and extensively tested. The selection of appropriate probability density functions (PDF) for cases of asymmetric uncertainties or limits is not trivial. The NSDD meeting has endorsed the development of the MC methods and recommended further investigations and consultations with experts from other fields to develop detailed policies for the ENSDF. It was recommended, that the IAEA should organize a small technical meeting dedicated to various aspects of MC techniques.

NS_RadList has been further developed to treat uncertainties in the nuclear decay parameters (intensities, mixing and branching ratios, etc.). The current version also reads EC capture rates from the new BetaShape code. The code also evaluates the mean decay energies of a, b, g, CE, X-ray and Auger electrons, which is used to test decay schemes for completeness. NS_RadList has been extensively tested using ENSDF data sets prepared for the Decay Data Library for Monitoring Applications. A full report is being prepared on the development and the use of NS_RadList.

References

[1] P. Schlüter, G. Soff, At. Data Nucl. Data Tables **24** (1979) 509.

[2] C. Hofman, G. Soff, At. Data Nucl. Data Tables **63** (1996) 189.

[3] J.T.H. Dowie, T. Kibedi, et al., At. Data Nucl. Data Tables **131** (2020) 101283.

10. Sofia Data Centre Status Report, Stefan Lalkovski (Sofia University)

Period covered: 2022 -20224

Nuclear data evaluation activities carried out in the Sofia Data Centre (SDC) consist (mainly) of nuclear structure and decay data mass chain evaluations for ENSDF. In the reporting period the A=107 mass chain evaluation was completed and prepared for submission to ENSDF. We have also performed evaluations on nuclei from the A=117 mass chain, in collaboration with ATOMKI and IFIN-HH. Within this joint effort, SDC is responsible for the evaluation of the neutron-rich nuclei to ^{117}Sn, of which ^{117}Ru,

^{117}Rh, ^{117}Pd and ^{117}Sn are already evaluated and ready for inclusion in the new A=117 mass chain evaluation. The plan for the next two years is to complete A=117 and A=111.

SDC was also involved in the CTBTO Project. ^{144}Pr beta-decay data was compiled and evaluated and sent to the reviewer. The review report was received, and the author's answer sent back to the reviewer. SDC is also involved in the evaluation and the review process of 4 more nuclei. This work is still in progress.

In the past two years, the effort dedicated to ENSDF mass chain evaluations was approximately 0.2 FTE (Stefan Lalkovski) and only partially funded by SANDA (5 person-months (PM) for the entire project duration of 4 years). In the next reporting period, that is 2024-2026, we shall work on the new EU funded project – APRENDE, where 24 PM will be dedicated by a new evaluator (O.Yordanov). He is now hired on APRENDE cost at 0.5 FTE, which will help to consolidate the effort in SDC. As part of the training, the new evaluator will be initially involved in the A=117 mass chain evaluation and data compilations for XUNDL (agreed with NNDC) and then on the two A=106 and 111 mass chain evaluations, constituting the M41 APRENDE deliverable due in the project's 4th year.

11. Status Report of NSDD in CNDC, Huang Xiaolong（China Nuclear Data Center, CIAE）

Members of NSDD in CNDC group

Regular employee: Huang Xiaolong， Liu Yangyang and Liu Lilie;
Graduate student: Tian Ronghe.
FTE is 0.5 for the last two years.

Mass Chain Evaluation

CNDC is responsible for the mass chains: A=51, 62, 195, 196, 197 and 198. The present status is as below:

TABLE 1. MASS CHAIN EVALUATION IN CNDC

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

DDEP

Update the evalaution of ^{229}Th; Reviewed the evaluation of ^{55}Fe, 87Rb.

Other research activities of the group

Radioactive Decay Data File: CENDL-DDL

- The first release CENDL-DDL included 2358 nuclei between A=66 to A=172 FY region. Evaluations are mainly taken from CNDC, ENSDF and DDEP library, etc.
- The Q-values of the decay modes are updated to the Atomic Mass Evaluation (AME) released in 2021Wa16;
- All T1/2 are revised by new measurements (2022,12).

Decay App

An Android Phone App is released for the decay data of various evaluated data libraries, see Fig. 1 in detail.

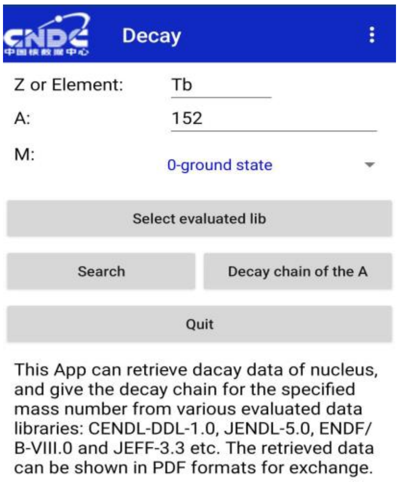

FIG. 1. Decay app by CNDC

12. Status Report of Jilin University, Yang Dong (Jilin University)

Members

At present, Members of Jilin university (JLU) data centre include Yang Dong and a student Chen Duo who will graduate in two months.

FTE for last two years is 0.5.

Mass Chain Evaluation

Jilin University is responsible for the mass chains: A=52, 53, 54, 55, 56, and 67. The status is as below:

Mass	**Last publication**	**Status**
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)	all references collected
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)	To be submitted in one month

Published articles of nuclear data research of the group

- Xiaolong Huang*,Dong Yang*, Zhigang Ge, et al, The nuclear decay database in fission product mass region, Chinese Physics C (2024)， DOI:10.1088/1674-1137/ad3b9d;
- Huanyi Ye, Jian Li*, Dong Yang*, Low-lying state investigations of odd-A Mn isotopes around N=28, Commun. Theor. Phys. 75(2023) 025302;
- Xuan Pang, Bao-Hua Sun,...Dong Yang, et al, Progress of photonuclear cross sections for medical radioisotope production at the SLEGS energy domain, Nuclear Science and Techniques (2023)34:187;
- Prediction of ground state spin of odd A nuclei based on decision tree method, Huifeng Wen, Tianshuai Shang....Dong Yang*, Acta Phys.Sin.Vol.72, No.15(2023), 152101.

13. Progress Report of the Institute for Nuclear Research (ATOMKI), Zoltan Elekes (ATOMKI)

Period covered: October 2022 – April 2024

ATOMKI Data Center

Members: János Timár, Zoltán Elekes
FTE: 0.15 – 0.15 (0.30)
Permanent mass chain responsibilities: 101, 102, 103, 104, 105.

Ongoing evaluations

- A=101 mass chain evaluation has been submitted to Nuclear Data Sheets and reviewer's report received
- A=103 mass chain evaluation has been submitted to Nuclear Data Sheets
- Review of a mass chain has been completed.

Plans

- Resubmit A=101 mass chain evaluation with corrections
- Resubmit A=103 mass chain evaluation if we receive the reviewer's report
- Start evaluating A=104 mass chain.

Support

- A=101 and 103 mass chain evaluations have been supported by the SANDA Horizon 2020 project
- New APRENDE EU project has been granted to support our future activities
- Mass chain evaluations are included in the future activities of ATOMKI.

14. Status **Report on Nuclear Structure and Decay Data activities at the India NSDD Centre, Gopal Mukherjee (VECC)**

Period covered: 2022 – 2024

Evaluators

Gopal Mukherjee: VECC, Kolkata
Ashok Kumar Jain: Amity Inst. Nucl. Sc. & Tech., Amity University, Noida
Sukhjeet Singh Dhindsa: Akal University, Talwandi Sabo, Punjab
Sushil Kr. Rathi: Akal University, Talwandi Sabo, Punjab
Paresh K. Joshi: HBCSE, Tata Inst. Fundamental Research, Mumbai
Anagha Chakraborty: Visva Bharati University, Santiniketan, West Bengal

Introduction

In addition to generating nuclear structure data through gamma ray spectroscopy experiments, the India NSDD network centre is involved and contributed in the following different aspects of the nuclear structure and decay data evaluation network:

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

Assigned mass chains: A = 215 - 229.

Apart from the assigned mass chains, India evaluators also involved in the evaluation of other mass chains in collaboration.

In horizontal evaluations, review of magnetic-and antimagnetic-rotational structures in nuclei has been done. In addition, nuclear radius parameters have been updated.

Present Status of the Mass Chain evaluation:

A = 222: This mass chain was taken up for evaluation at the IAEA-ICTP Workshop during October 03-14, 2022. This mass chain, led by Prof. B. Singh and S. Basunia, has been completed with the help of trainee evaluators from different countries, 8 of them are from India. The evaluation has been included in the ENSDF data base and published (Nuclear Data Sheets 192 (2023) 315–421 (December 2023)).

A = 226: This mass chain is being evaluated by Sushil Kumar, Sukhjeet Singh, B. Singh, A.K. Jain. The evaluation is completed, and final checking is in progress.

Other mass chains:

A = 24, 25 and 30: In all the three mass chains, Dr. Anagha Chakraborty collaborated with S. Basunia. The work has been completed for all the three mass chains. A = 24 mass chain is published (Nucl. Data Sheets 186 (2022) 3). A = 25 and 30 are under review.

Horizontal Evaluation

- Review of magnetic-and antimagnetic-rotational structures in nuclei:
  Sushil Kumar, Sukhjeet Singh, Balraj Singh, A.K. Jain.
  Status: Completed and uploaded in arxiv. https://arxiv.org/abs/2303.00499.
- Nuclear radius parameters (r0) for even-even nuclei from alpha decay:
  Sushil Kumar, Sukhjeet Singh, B. Singh, A.K. Jain.
- This is an update of the previous work [2020Si16]. In this work, the spin-independent part of Preston's equations is used to deduce the radius parameters of even-even alpha emitters.
  Status: Ongoing, working on this project with Dr. Jun Chen.

Publications (during this period)

1. **2023GA02**: At.Data Nucl.Data Tables 150, 101546 (2023): S. Garg, B. Maheshwari, B. Singh, Y. Sun, A. Goel, A.K. Jain: *Atlas of nuclear isomers-Second edition.*
2. **2023NI05**: Eur.Phys.J. A 59, 78 (2023): A.L. Nichols, P. Dimitriou, A. Algora, M. Fallot, L. Giot, F.G. Kondev, T. Yoshida, M. Karny, G. Mukherjee, B.C. Rasco, K. P. Rykaczewski, A.A. Sonzogni, J.L. Tain: *Improving fission-product decay data for reactor applications: part I-decay heat.*
3. **2023SI22:** Nucl. Data Sheets 192, 315 (2023): B. Singh, M.S. Basunia, J. Chen, P. Dimitriou, B.M.S. Amro, S. Basu, S. Das, A. Karmakar, M.J. Lazaric, S.R. Leblond, S.S. Nayak, C. Ngwetsheni, A. Rathi, P.S. Rawat, B. Rohila, V. Vallet: *Nuclear Structure and Decay Data for A=222 Isobars.*
4. **2022BA40**: Nucl.Data Sheets 186, 3 (2022): M.S.Basunia, A.Chakraborty, *Nuclear Data Sheets for A=24.*
5. **arXiv: 2303-00499**: Sushil Kumar, Sukhjeet Singh, Balraj Singh, A.K. Jain: *Review of magnetic-and antimagnetic-rotational structures in nuclei.*

15. Japan Centre Status Report, Hideki Iimura (JAEA)

Present members of the Japan centre are H. Iimura and H. Koura (JAEA), who devote altogether 0.2 FTE to the mass chain evaluation work. The Japan centre is responsible for the mass chains from A=120-129. 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 from JAEA, H. Iimura made a contract with the nuclear safety research center of JAEA to continue the evaluation work for ENSDF. However, the amount of the contract is too small for enough time to be devoted to the evaluation work. Also it is uncertain whether the contract can be made after 2025. Therefore, it is absolutely necessary to find financial supports.

As another activity apart from mass chain evaluation, the 12th edition of JAEA chart of the nuclides was published by H. Koura et al. in March 2023. In this chart, the total number of the experimentally identified nuclides is 3328, increasing by 29 nuclides compared to the last edition in 2019. The theoretical half-lives are presented for the half-life-unmeasured nuclides.

16. Status report of the Bucharest Data Centre, A. Negret (IFIN-HH)

The two evaluators (A. Negret and S. Pascu) of the NSDD Data Centre established in IFIN-HH, Bucharest have committed, on the long term, to spend 20% of their time (0.4 FTE in total) for nuclear structure evaluation activities. As a temporary situation, the contribution was reduced to 0.1-0.2 FTE during the years 2021-2023.

Efforts are being made to attract and to train more scientists into the evaluation activities. A postdoc started his training in ENSDF evaluation techniques in December 2023.

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. McCutchan
119	2008	

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 – post review since 2023;
- Evaluation of A=86 by A. Negret and B. Singh – post review since 2024;
- Evaluation of the decay proprieties of 133I (by A. Negret, completed) and 140La (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;
- Review of one mass chain (A=202) by A. Negret (second half of 2023) and of the decay of ^{143}Ce evaluated by B. Singh as part of the above-mentioned IAEA project.

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

17. Status Report of the Data Center at Petersburg Nuclear Physics Institute, I.A. Mitropolsky (PNPI)

Reporting period: 2022 – 2024

General

The Data Center is a part of the Nuclear Spectroscopy Laboratory in the Neutron Research Department of the Petersburg Nuclear Physics Institute. Our main activity consists in providing information support in the field of fundamental research and nuclear technologies on reactors and accelerators, and in the evaluation of nuclear data for nuclear spectroscopy.

Evaluation in the ENSDF format

The PNPI area of responsibility in the evaluation process includes nuclides with A = 130 – 135:

Mass number	Last publication	Comment
130	NDS, 93 (2001)	completed; post review corrections
131	NDS, 107 (2006)	
132	NDS, 104 (2005)	in process
133	NDS, 112 (2011)	
134	NDS, 103 (2004)	
135	NDS, 109 (2008)	

Object-oriented databases on the ENSDF basis

The database of nuclear moments is a compilation of data taken from the latest version of the ENSDF file, and N.J. Stone's tables in 2019STZV (INDC(NDS)-0794 (2019)). Information contained in the database could be useful for the statistical analysis of data, horizontal evaluations, the global nuclear data systematics and the search for new regularities.

The database may be downloaded from the cloud storage: https://disk.yandex.ru/d/hKieGTkM-Xk6ag.

18. Decay Data Evaluation Project Status Report, Sylvain Leblond (LNHB-CEA)

The Decay Evaluation Data Project (DDEP) has been established in 1995 as an initiative of metrology laboratories with the help of ENSDF evaluators. This international effort aims at providing up-to-date recommended decay data to communities of nonexperts in these data such as metrology, nuclear medicine or nuclear industry. In particular, the DDEP focus is on providing information on practical quantities like the energies and the absolute intensities of the various emissions (of nuclear and atomic origins) resulting from a decay.

The coordination of the project is performed by Xavier Mougeot from the Laboratoire National Henri Becquerel (LNHB). A local team of four staff members contributes to the effort of evaluation and reviewing while also being responsible for the edition and publication of the DDEP recommendations. However, workforce remains locally very limited as these members can only dedicate a small fraction of their time to the DDEP. Beyond the LNHB team, the main workforce of the collaboration consists of several international experts from various countries in America, Asia, Europe etc. Unfortunately, the contribution of these evaluators is made on a volunteer basis, so none of them can fully dedicate to DDEP.

The recommendations for each nuclide are published in the BIPM monography series and mainly disseminated through the LNHB website. The evaluations are available in various file format to accommodate the community needs and different simulation codes. In addition, a Comments report is provided for each evaluation to track down the work and choices performed by the DDEP evaluator. The LARAWEB online tool has been continuously developed over the last decade to provide users an easy way to access, display and query the database. Recently, a tool has been developed to calculate the absolute intensities of the different radiations emitted by all the nuclides of a specific decay chain. In addition, the online tool BetaShape on the Web has been set-up on the website to provide a simple way to display the recommended spectra calculated from the BetaShape code (developed at the LNHB).

The DDEP has a long history of collaborations with various partners to provide reliable and up-to-date decay data on specific subjects. In particular, the DDEP has been strongly involved in the 2007, 2013 and 2019 Coordinated Research Projects of the IAEA. This collaboration has led to the production of more than 100 decay evaluations over a decade. The DDEP was also strongly involved in the production of the decay database of the Joint Evaluated Fission and Fusion File (JEFF) European library (version 3.3). Following this contribution, the DDEP has been assigned the responsibility for the update of the decay database for the upcoming JEFF library major update. The DDEP is also involved in the evaluation of decay data within European metrology research projects such as MetroMMC or Prima-LTD. Finally, the LNHB has recently started a new internal collaboration with the Nuclear Energy Division of CEA to perform decay data evaluations (in the scope of DDEP) for reactor applications.

Due to the local reorganization of the LNHB in 2016, the DDEP had some lean years between 2017 and 2020 during which no new evaluation was published by the collaboration. From 2020, the recruitment of a part time evaluator at the LNHB has helped to slowly recover from this situation. Consequently, 13 evaluations have been published between 2021 and 2024, while three additional publications are expected by the end of June 2024.

Over the last decade, the DDEP has lost several important and experienced evaluators leading to an insufficient workforce. In order to attract new evaluators, the LNHB has organized a training workshop at CEA from 7-9 March 2022 and will organize an additional one from 21-25 October 2024. In addition to these events, a new permanent staff member will be hired at LNHB and will partly dedicate his time to DDEP.

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