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ENSDF Evaluations, Policies and Procedures, Codes and Dissemination Tools

Summary Report of the IAEA Consultants' Meeting
4-7 April 2022
(virtual event)

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September 2022

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ABSTRACT

A Consultants' Meeting was convened virtually from 4 to 7 April 2022, under the auspices of the IAEA Nuclear Data Section to review the status of ENSDF, XUNDL, evaluation procedures and policies, as well as ENSDF analysis and checking codes, in preparation for the upcoming biennial Technical Meeting of the international network of Nuclear Structure and Decay Data (NSDD) evaluators. The meeting was attended by fifty scientists from thirteen Member States and IAEA staff. A summary of the meeting, data center status reports, various proposals assessed and considered for adoption, technical discussions, actions agreed by the participants, and the resulting recommendations/conclusions are presented in this document.

September 2022

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ANNEXES

1. INTRODUCTION

The role of the International Network of Nuclear Structure and Decay Data (NSDD) Evaluators is threefold: first, the compilation, evaluation and dissemination of nuclear structure and decay data; second, the maintenance and improvement of the standards and rules governing nuclear structure and decay data evaluations; and third, monitoring and reviewing the development and use of the computerized systems and databases maintained specifically for such activities. A primary aim of the network is to provide accurate and freely available data to the user community to enhance the quality and reliability of their work. The IAEA Nuclear Data Section takes on the role of coordinator of the NSDD Network and, at the same time, ensures the smooth dissemination of nuclear structure and decay data.

The 24th meeting of the NSDD network will be hosted by the Australian National University in Canberra, Australia, in October 2022. The meeting, which was originally planned to take place in 2021, was postponed due to the worldwide travel restrictions in connection with COVID-19. This resulted in an extended period of more than three years between two successive meetings which usually bring together all active members of the network in 2-year intervals to discuss important matters pertaining to the status and work of the network. Therefore, it was considered expedient to hold an interim network meeting in spring 2022, to cover some of the matters that needed to be discussed and to allow the network experts to prepare proposals, policies, and codes for the final round of discussions at the meeting in October 2022. This interim meeting was held 4-7 April 2022 as a virtual event.

Delegates to the interim spring meeting of the International NSDD Evaluators' Network were welcomed by Arjan Koning (Head of the IAEA Nuclear Data Section) who stressed the importance of maintaining cooperation and coordination efforts on nuclear structure and decay data worldwide. Paraskevi (Vivian) Dimitriou (Nuclear Data Section) the scientific secretary of the meeting, addressed all participants setting out the purpose and goals of the meeting.

Prior to the start of the main technical discussions, the agenda was approved as listed in Annex 1. John Kelley, E.A. McCutchan and P. Dimitriou) were elected to co-chair the meeting, and Jun Chen and Alexandru Negret agreed to act as rapporteurs. All in all, forty-seven nuclear data specialists including IAEA staff attended this meeting, representing data evaluation/dissemination centres from twelve countries and new evaluation groups (Annex 2). Links to presentations given during the meeting are available from the meeting website: https://conferences.iaea.org/event/299/contributions/.

A list of all ENSDF evaluation centres and groups is given in Annex 3, along with their mass-chain evaluation responsibilities. The meeting started with a detailed review of all the actions agreed upon at the previous 23rd NSDD meeting. A revised list of actions including new actions is found in Annex 4. The meeting concluded on Thursday afternoon with a session dedicated to the memory of one of the historical members of ENSDF, Murray J. Martin, who passed away in March 2022. A brief summary of the session is presented in an In Memoriam in Annex 5.

2. REVIEW OF ACTIONS FROM THE 23rd NSDD MEETING, VIENNA, 2019

The list of actions adopted at the previous NSDD meeting was reviewed and updated (see Annex 4). A summary of the more extensive discussions is given in the following. The action numbers in brackets correspond to those of the action list of the previous meeting (see: https://www-nds.iaea.org/publications/indc/indc-nds-0783.pdf)

Action #(1): completed
The revised document is available in the shared NSDD folder (OneDrive) for feedback.

Action #(3): new action #3
The Guidelines for Evaluators were revised by Murray Martin in 2015. The last version was published as an ORNL report (ORNL/TM-2022/1835) in January 2022. However, this last version still needs to be checked to see if all the items listed under this action have been implemented. Singh suggested to keep the ORNL-document as is, and to compile any additions needed in a separate document. A new action resulted from this action:
Action on Singh, Chen and Kondev: to review the ORNL/TM-2022/1835 guidelines and produce a separate document with additional guidelines.

Action #(4): withdrawn
Singh withdrew the action to incorporate horizontal evaluations in the ENSDF file (delayed-neutron data ($T_{1/2}$, P_n, B(E2), quadrupole moments) as it is not straightforward and may lead to inconsistencies in the file. Updating these data should be left to the evaluators who should consult the horizontal evaluations when performing their mass chain evaluations. All horizontal evaluations are listed in https://www.nndc.bnl.gov/ensdf/evalcorner/horizontal.html

Action #(5): new policy and action #10
The action on NNDC to run GABS on all ENSDF files is pending the implementation of Adopted Decay datasets. However, GABS has undergone several revisions in the past few years (Tibor Kibedi) and is ready to be used by evaluators to calculate the %Ig and its uncertainties. The remaining issues with the code were discussed and a new action #10 was adopted:
New policy: provide %Ig in decay datasets when applicable. No uncertainty for %Ig should be given if there is no uncertainty in the relative Ig.
Action on NNDC: to check if col 79 is in use in ENSDF.
Action on evaluators and code developers: to include X in col 79 (if it's not in use) and retain it in ENSDF

Action #(6): new action #15
In the previous update of Q-values in the Adopted datasets, the new AME2012 values were added as a second Q record which resulted in FMTCHK, giving error messages. A different approach has been taken this time in which the previous Q records are put into document records. A folder with updated ENSDF files will be made available for evaluators to check and provide feedback to NNDC. Users, however, will not be able to see these updates in the pdf output.
Action on NNDC: provide evaluators with ENSDF files containing prior Q values in the document record.
Action on evaluators: check these ENSDF files with the previous Q values in the document record and provide feedback to NNDC.

Action #(8): completed
Mougeot has submitted a proposal and test examples for including gamma, electron and neutron continuous spectra in ENSDF at previous meetings (Codes 2018, see: https://www-nds.iaea.org/nsdd/ensdfcodes.html; NSDD 2019, see: https://www-nds.iaea.org/nsdd/), so this action is considered completed.

Action #(9): new action #5
The template for presenting Adopted Decay data sets within ENSDF has not been delivered due to insufficient manpower.
Given the importance of Adopted Decay data for applications, there needs to be an organized effort to create a policy that would dictate the content of such Adopted Decay data sets as well as the evaluation methodology.
Action on NNDC: coordinate a working group tasked to prepare proposals for an Adopted Decay dataset.

Action #(11): new action #19
The UncTools package for Monte-Caro error propagation has been completed by Kibedi. A more detailed discussion of the subject of uncertainty propagation is given in Section 6.2.

Action #(13): new action #12
The list of data centers is maintained up to date at the NNDC and IAEA websites. However, putting the link to this webpage in a journal is contingent upon securing a DOI link or permanent URL address. NNDC has obtained a DOI link for ENSDF but not for a webpage. Although IAEA URL addresses should be considered as permanent, IAEA will explore the possibility of getting a DOI link for the data centers webpage.
Action on IAEA: explore obtaining DOI or permanent URL for data centers webpage.

Action #(15): new action #7
Based on the detailed presentation given at a previous USNDP meeting on calculations of Coulomb excitation using GOSIA by Adam Hayes (NNDC), the code can be trusted although the provided uncertainties need to be checked. Users should also be aware of the input parameters and whether they are independent or dependent. It was suggested that experts should put together guidelines for evaluators on how to treat the data obtained from the code.
Action on NNDC: coordinate efforts to prepare guidelines for evaluators on how to treat GOSIA results for Coulomb excitation.

Action #(24): new action #14
Flexibility is needed in applying the RULE on quoted significant figures in the evaluation process. It was agreed that RULE 35 can apply to ENSDF codes for rounding off data where applicable, while the RULE should be relaxed for the evaluators.
Action on code developers and evaluators: apply RULE 35 in codes where applicable but be flexible when it comes to evaluating data.

3. DATA CENTERS

Although status reporting was not among the topics of the meeting, three Data Centers gave updated status reports (Japan, Romania, Bulgaria).

3.1. Japan status report, H. Iimura (JAEA)

Present members of the Japanese group are M. Kanbe (Tokyo City University), J. Katakura (Nagaoka University of Technology), H. Koura (JAEA), S. Ohya (Niigata University), and H. Iimura (JAEA): their affiliations are the former ones except Koura's. Iimura, the leader of the Japanese group, has retired from JAEA in March 2022. The Japanese group is responsible for the evaluation of mass chains from A=120-129. Among these mass chains, A=126 has recently been revised (NDS **180**, 1 (2022), H. Iimura, J. Katakura and S. Ohya). A=120 is being evaluated by Iimura, Kanbe, Katakura and Ohya, and A=124 by Koura.

After his retirement Iimura will not be able to continue the evaluation if financial support cannot be obtained. Kanbe, Katakura and Ohya will leave the evaluation at the same time as Iimura. Koura will continue the evaluation of A=124 although he will not be able to dedicate much time to this work given his other tasks at JAEA. It is not certain that he will continue evaluation work after A=124 is completed.

To procure financial support, Iimura is in discussion with the responsible people at RIKEN and JAEA. In RIKEN, H. Sakurai, the director of RIBF, supports the continuation of ENSDF evaluation in Japan. However, RIKEN cannot hire an evaluator, because emphasis is placed on experimental and scientific research that does not include ENSDF evaluation. In JAEA, the nuclear data laboratory has no intention of supporting the evaluation for ENSDF. On the other hand, the nuclear energy safety division is discussing the possibility of supporting this activity, because ENSDF is related to the decay heat of nuclear fuel.

Iimura will continue his efforts to obtain financial support from the nuclear energy safety division in JAEA. If financial support cannot be obtained, Iimura will discuss with NNDC the transfer of mass chains under their responsibility to other centers when the Japanese group ends its activity.

Discussion

- Both IAEA and US DoE (K. Jankowski) are willing to provide support to maintain the Japan NSDD activities in the future. A separate meeting can be set up to talk about the support to Japanese (and other non-US) groups.
- RIKEN would like to create a position for ENSDF data evaluation since it is an experimental facility that generates a large amount of nuclear structure data. However, a decreasing budget means that there will be no available staff positions in the future. It will be difficult to sustain the ENSDF contribution without long-term support (>5 years). In Japan, there is no agency like the US DoE to support nuclear data activities (H. Sakurai, RIKEN).

3.2. Romania status report, A. Negret (IFIN-HH)

The two evaluators of the NSDD Data Centre established in IFIN-HH, Bucharest, have committed long term to spend 20% of their time on nuclear structure evaluation activities. This corresponds to a total contribution of 0.4 FTE. Temporarily, their current contribution is reduced to 0.1-0.2 FTE owing to other obligations of both evaluators. Efforts are being made to train more scientists and set incentives for them to engage in evaluation activities.
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 (post review)
58	2010	
59	2018	
117	2009	
118	1992	Under evaluation by S. Pascu, A. Negret, and E. McCutchan
119	2008	

Aside from the two evaluations listed in the above table, the centre is currently involved in the following 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 – final stage, to be submitted
- Evaluation of the decay proprieties of ^{133}I (by A. Negret, submitted for review) and ^{140}La (by S. Pascu, work in progress) as part of an IAEA project dedicated to the re-evaluation of the decay proprieties of nuclei of importance to CTBTO.

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

3.3. Bulgaria status report, S. Lalkovski (Sofia Univ. "St. Kliment Ohridski")

Sofia Data Center responsibilities: A=106, 107, 108, 111, 112.
Dedicated effort: 0.2 FTE.
Ongoing evaluations: ^{117}Sn (90% complete), A=107 (50% complete).
All present evaluations are now funded under the SANDA Project, 2021-2023. Partially secured funding from BgNSF for one more mass chain, end 2023-2024.
Obtained 3-month Fulbright grant (ANL visit), 2022/24.

Previously evaluated mass chains:

- A=105, NDS **161** (2019) 1, S. Lalkovski, J. Timar, Zs. Elekes
- A=112, NDS **124** (2015) 157, S. Lalkovski, F.G. Kondev
- A=207, NDS **112** (2011) 707, F.G. Kondev, S. Lalkovski
- A=200, NDS **108** (2007) 1471, F.G. Kondev, S. Lalkovski

4. HORIZONTAL EVALUATIONS AND DATABASES

4.1. Beta-delayed neutron and nuclear moments databases, P. Dimitriou (IAEA)

Nuclear moments database
The Nuclear Moments database (https://ww-nds.iaea.org/nuclearmoments/) has been updated in the past three years to consider recommended magnetic dipole moments and electric quadrupole moments published by N.J. Stone in INDC(NDS)-0794, INDC(NDS)-0816 and INDC(NDS)-0833 (see Section 4.4). All the tables can be downloaded as CSV files.

Beta-delayed neutrons
The reference database for beta-delayed neutrons has been updated both for microscopic and macroscopic data. The microscopic database has been updated by B. Singh to include all new measurements published in the period August 2020 to January 2022. Ten new papers with revised half-lives and P_n values for 56 beta-delayed neutron emitters were covered: 2021Ha19, 2021Su01, 2021Mi07, 2021Mo10, 2021Ga10, 2021Pi11, 2021Ba34, 2021Wa49, 2021Te02, 202Ju02, 2020Wh02. The macroscopic database was updated according to the report of V. Piksaikin et al. (INDC(NDS)-0849). The experimental uncertainties of the measured integral spectra were estimated. Statistical uncertainties and systematic uncertainties due to the neutron background, recoil particles, thermal peak, efficiency of the neutron spectrometer and neutron flux attenuation effects were considered. Additionally, delayed-neutron spectra were calculated in the 8-group model using the Kalman filtering method.

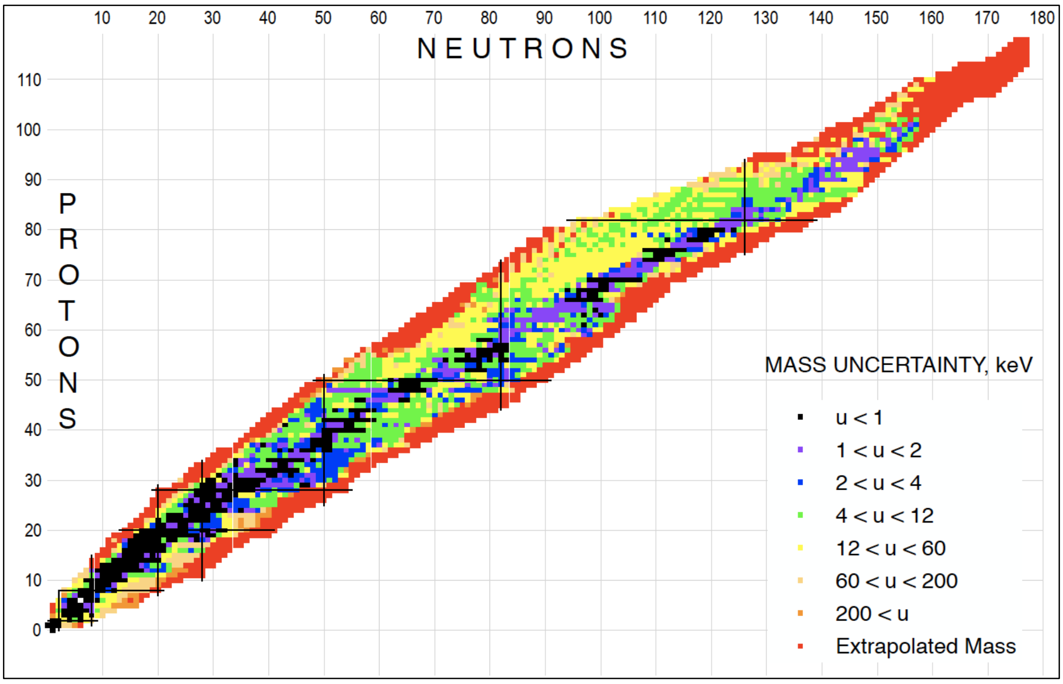
Meeting announcements:
Joint IAEA-ICTP NSDD Workshop: 3 – 14 October 2022.
24th NSDD meeting, Canberra, Australia: 24-28 October 2022.
2nd IAEA Technical Meeting on nuclear data for reactor antineutrinos: 12-16 December 2022.

4.2. DDEP status report, S. Leblond (LHNB)

After several lean years, the DDEP collaboration has recently started a new cycle for the evaluation of decay data. The status of the collaboration will be presented, and recent publications with new recommendations will be detailed. The upcoming work will be discussed, particularly the joint evaluation of Cs-137 performed in collaboration with ENSDF. Within this context, a comparison of various available calculation software will be performed (Lweight, Avelib, AveTool, PMM). Finally, the outlook of the collaboration will be detailed, most notably regarding the training of new evaluators and the evolution of the software tool Saisinuc.

4.3. AME and NUBASE status report, F.G. Kondev (ANL) on behalf of the AME collaboration (G. Audi, W.J. Huang, F.G. Kondev, S. Naimi, and M. Wang)

The mass of the nucleus provides the nuclear binding energy, a fundamental property that is indispensable for the study of nuclear structure, stellar nucleosynthesis and neutron-star composition, as well as atomic and weak-interaction physics. Together with other basic nuclear properties for the ground and isomeric states, such as excitation energies (for excited isomers), quantum numbers, half lives, decay branches and their intensities, these carefully crafted nuclear data are important to both the basic nuclear science program and to many practical applications, and they are a crucial input to the world-wide nuclear data evaluation effort, which is an excellent testimony of their relevance. The new evaluations of atomic masses (AME2020) and basic nuclear physics properties for ground states and isomers (NUBASE2020) were published in March 2021 (https://iopscience.iop.org/issue/1674-1137/45/3) and the recommended data are also available at the collaboration websites at ANL (https://www.anl.gov/phy/atomic-mass-data-resources) and IAEA (https://www-nds.iaea.org/amdc/).



Nuclear chart displaying the mass-excess uncertainties for all (3340) nuclei in their ground state.

4.4. Status of nuclear moments, N.J. Stone (Oxford University)

Since the last presentation concerning this activity three Reports have been published:

- INDC(NDS)-0794 which provides recommended values for the measured magnetic dipole moments of nuclear states of lifetime > 1 ms (https://www-nds.iaea.org/publications/indc/indc-nds-0794/),
- INDC(NDS)-0816 which provides recommended values for the measured magnetic dipole moments of nuclear states of lifetime < 1 ms (https://www-nds.iaea.org/publications/indc/indc-nds-0816/),
- INDC(NDS)-0833 which provides recommended values for the measured electric quadrupole moments of all nuclear states (https://www-nds.iaea.org/publications/indc/indc-nds-0833.pdf).

Improved multi-electron configuration computation has brought recent developments to the calculation of the influence of the medium upon NMR frequencies detected in the presence of an applied magnetic field. This effect, known as diamagnetism or the chemical shift, always reduces the applied field at the nucleus. The last 10 years have seen results which, for the first time, are reliable and attested by several methods, albeit with estimated uncertainties of a few % at best.

The vast majority of precisely known nuclear magnetic dipole moments requires this correction. The consequence is that, although its magnitude reaches only ¬0.5% in medium mass elements and ¬2% in the heaviest, uncertainty in the correction frequently determines the precision of the final, corrected moment, limiting it to parts in 10^4-5, whereas the measurement itself has far higher accuracy.

State-of-the-art corrections have been adopted, where they exist, in the publications cited above. For other elements, still the majority, corrections have been made in line with recent calculations and with reasonable estimated uncertainties.

Very recently significant new calculations for transition metal (d electron) elements have come to our attention (Ref. [1]). They show that, in addition to their diamagnetism, the systems in which the most precise moment results have been obtained for these elements exhibit weak paramagnetic effects. These hitherto neglected effects make positive contribution to the field at the nuclei to a degree which can reverse the sign of the total correction. This important, unexpected development, which may quite possibly be found also in f electron elements (the rare-earths and actinides) will affect many results and requires detailed attention.

Current activity involves bringing the list of published results, which is provided in the on-line database (https://www-nds.iaea.org/nuclearmoments/) of Nuclear Electromagnetic Moments in addition to the recommended values, up to date. This will be completed in the next year.

References

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

5. NSDD AND ENSDF-RELATED MATTERS

5.1. ENSDF and XUNDL update, GitLab mass tracking, E.A. McCutchan (BNL)

An update of ENSDF was given. A new mass chain tracking system has been developed by NNDC on GitLab. The features of this tracking system were presented and a short description along with instructions on how to access the system were provided in a separate file.

The data-checking of submitted articles prior to publication has been established as the default review process for Physical Review C and has been introduced as an optional procedure in European Physical Journal A.

Guidelines for reviewers have been made available for evaluators' feedback. A different approach to updating the Q values in ENSDF has been introduced. Updated Q values will be inserted in the Q record while the previous values will be moved to a document record. The new ENSDF files will be made available to evaluators for comments.

Discussion

- Data-checking:
    - papers not accepted by PRC appear elsewhere, like EPJA, NPA, NIM.
    - there is a commitment to finish data checking within 1 week.
    - Referees' comments will be passed on to evaluators who did the checking.
    - People naturally associated the data checking effort with NNDC, but it should be the nuclear data review group officially, which includes J. Chen and B. Singh.
    - The data checking process is considered confidential, and the compilation will be available to the public (accessible to evaluators) only after the paper being checked has been published, and upon approval by PRC.
- Currency and quality control of XUNDL: there is a one-month timeline for newly published papers.

5.2. A brief comparison of USNDP (& Canada) effort circa 2001 vs 2021, John Kelley (North Carolina State Univ. & TUNL)

In this brief presentation the Nuclear Data Sheets productivity of the US, Canada, and international components of the NSDD was explored for 2000-2001 and 2020-2021. It was realized that the non-Covid-19-year 2019 should have also been included in the comparison.

In 2000-2001, US groups averaged about 15 A-chains/year with about 6.6 FTE committed to the project, Canada averaged about 4 A-chains/year (0.8 FTE) and international input was around 6 A-chains/year (2.75 FTE).

In 2019, US groups published 4 A-chains with about 6.35 FTE committed to the project, Canada published 4 A-chains (0.39 FTE) and international input was around 2 A-chains including an ICTP contribution (3.75 FTE).

In 2020-2021, US groups averaged about 5 A-chains/year with about 7 FTE committed to the project, Canada averaged about 2 A-chains/year (0.4 FTE) and international input was around 1 A-chains/year including an ICTP contribution (3.75 FTE).

On the surface, it is evident that US productivity of A-chain evaluations published in the Nuclear Data

Sheets has fallen from 15/year to 5/year. At the same time, a consistent FTE commitment has been steadily supported. The Canadian productivity may have dropped some in 2020-2021 but appears steady when considering 2019. International contributions have fallen significantly.

A look at the US effort shows a near person-for-person replacement of personnel involved in the project; in the discussion the diversity of focus and shift away from ENSDF evaluations for some sites was mentioned. The general 40% increase of data included in the evaluations (based on increase in gamma transitions) was also mentioned.
Internationally, the loss of data centers at Kurchatov, Bruyeres Le Chatel, Kuwait City and Gent has been offset by new centers at VECC-India, Canberra, Hungary, Romania, and Bulgaria. Throughout the meeting we discussed the need for a solution to maintaining the Japanese effort in the network, and an approaching loss of effort in China. A significant hurdle is finding direct support for the ENSDF evaluation activity and the need to convey the benefits and academic merits of Nuclear Data Evaluation efforts that contribute to the primary databases.

Discussion

- Looking at the mass-chain submission rate, it is 14 mass chains in 2021. The evaluations go in at a level of 15 mass chains/year but are not published at the same level. The bottleneck is the review of mass chains (E.A. McCutchan).
- The USNDP direct funding is not enough, since it is spread out over many different activities including evaluation. This might impact the activity and productivity (F.G. Kondev).
- A detailed survey of ENSDF in 2020 revealed an increase in the number of evaluated gammas by 20% and the number of levels by 40% compared to 2004. It takes more effort to do mass chain evaluations these days than in the past because of the increasing amount of data (A. Sonzogni).

5.3. Proposal to include absolute γ-ray emission probabilities in decay data, F.G. Kondev (ANL)

Proposal submitted by F.G. Kondev, T. Kibedi, J. Chen, T. Kibedi, F.G. Kondev

In many applications of the nuclear structure and decay data, absolute g-ray emission probabilities and their uncertainties are needed. The current policy of applying uncertainty propagation when deriving the absolute g-ray intensities from relative ones may result in an overestimation of the uncertainties for those g rays that are used in the normalization procedure. To avoid this, it has been proposed that the absolute intensity should be explicitly given by the evaluators in any decay data sets where a conversion from relative to absolute g-ray emission probabilities is feasible. This can be achieved by using the computer programs GABS (T. Kibédi, ANU) and GLSC (J. Chen, MSU), which provide the absolute g-ray emission probabilities in a continuation record. It has been proposed that the marker “X” placed in column 79 in the ENSDF decay data set to indicate the g-ray transition used in the normalization procedure, is retained and that the GABS and GLSC codes, as well as FMTCHK code (NNDC, BNL), are modified accordingly.

Discussion

- Δ%Iγ will not be given if ΔIγ is not given. What about the strongest Iγ without uncertainty, e.g., Iγ=100? (S. Basunia).
- For relative Iγ=100 without a given ΔIγ, if there is only one transition then Δ%Iγ can be given (F.G. Kondev).
- For relative Iγ=100, if ΔIγ is given as LT or GT, the limits should be propagated to Δ%Iγ (J. Tuli).
- When using GABS, it is found that Δ%Iγ/%Iγ decreases after normalization compared to its ΔIγ/Iγ, in some cases by a factor of 3 (N. Nica). That is due to correlations among the input Iγ values used to convert relative Iγ to absolute %Iγ. (F.G. Kondev)

5.4. Miscellanea of an ENSDF evaluator (evaluation issues), N. Nica (Texas A&M Univ.)

There are miscellaneous evaluation issues that need attention in evaluators’ everyday activity. Some of them are more important while others not so much. However, policy planning should scan and solve at least the most important ones. Good governance always needs good policies. Some of these issues are:

1. Suggestion for BrIcc

The BrIcc code writes in the *ens* file the standard comment "MR=1.00 FOR E3/M2 AND MR=0.10 FOR THE OTHER MULTIPOLARITIES" every time it is used, which is rarely actual. We propose for BrIcc to detect when this comment is applicable, and to insert it only in such cases.

2. NuDat vs. ENSDF

We propose that the administrators of NuDat (NNDC) or LiveChart (IAEA) inform their "comment blind" users to read evaluator's comments in ENSDF which explain evaluation decisions.

3. 0 vs. 0.0 for ground states

A nuclear ground state is denoted most of the times as "0.0" but also as "0" or "0.". However, we miss a policy to show when to use these symbols and why, or to adopt a definite standard if they make no difference.

4. ENSDF Analysis and Utility Programs – Version

A good practice in the dissemination of ENSDF analysis or checking codes through repositories or online web pages is to provide the exact complete version/date information specific to the code together with the title. For many of the codes, the full version/date appears only in the output file of the code which is produced after one runs the code; therefore, to check if the version in the repository is more recent than or identical to that used by the evaluator, the only way is to download and run the code, which is time consuming. Providing the version/release date of the code with the title would be useful for evaluators and prompt them not to use the outdated versions any longer, but to download and use the up-to-date versions. Another outcome of such good practice would be the elimination of bugs and dissemination of working versions of the codes.

5. Keeping track of Analysis and Utility Programs

Similarly, programmers should make sure that the version/date piece of information is written in the *ens* files each time they are run. It is useful to check whether some versions affected by bugs were used along the years and to rerun the respective repaired codes.

Discussion

- Suggestion for code developers: provide the version and date of the code in a document "d" record in the generated output ENSDF file (E.A. McCutchan).
- Irrelevant comments generated by BrIcc, like assuming MR(E2/M1) = 1.0, will be duly removed from output ENSDF files (T. Kibedi).
- Version of codes will be shown on both the IAEA webpage and repository of ENSDF codes (P. Dimitriou).
- It would be useful if BrIcc and all the analysis and checking codes include the version of the code in the generated generic comment. Will this be implemented in the FMTCHK code? (F.G. Kondev).
- We tailor format and output, but it is surprising that there is no discussion on tailoring output for users (J. Kelley).

5.5. Actions on ENSDF policies adopted at previous NSDD meetings, S. Basunia (LBNL)

Action #30 (NSDD 2019):

The proceedings of the NSDD meetings published by the IAEA (available at: https://www-nds.iaea.org/publications/group_list.php?group=INDC-NDS) contain proposals, discussions, recommendations, and approval/adoption of the ENSDF policies and procedures of the meeting.

We checked nine NSDD meeting reports (2000 - 2017) for a summary of the recommended or approved policies and procedures to make it handy to the ENSDF evaluators. A few of the recommended/adopted policies and procedures from the summary were found in the following:

INDC(NDS)-0456 (2004):

Annex 7. Proposals/Position Papers (p 137)

F.E. Chukreev (CAJAD, Moscow) (p 138)

In the cases, where level energy (A ≤ 61) agrees with the formulae:

E(N,Z)= Eb(N,Z) – Eb(N + 1,Z - 1) + 1.484 (Z - 1/2)/À1/3 - 1.293 MeV for N>Z

E(N,Z)= Eb(N,Z) – Eb(N - 1,Z + 1) - 1.484 (Z + 1/2)/À1/3 + 1.293 MeV for N≤Z

then isobaric spin =isobaric spin (g.s) +1 may be assigned for the level.
In the formulae Eb is binding energy.

INDC(NDS)-0595 (2011):
Members of the international network of NSDD evaluators agreed to adjust the lower limit of the half-life of a level to be considered an isomer. The current lower limit of 0.1 s was judged to be too high. Therefore, in line with NUBASE, attendees agreed to adopt a lower limit value of 100 ns (p 33).

INDC(NDS)-0635 (2013):
Charged-particle and neutron resonance data (B. Singh, p. 25). It was decided that the General Policies would be modified to consider the decisions taken in previous USNDP and NSDD meetings regarding coverage of charged particle and neutron resonance data.

The full summary is available at:
https://conferences.iaea.org/event/299/contributions/21562/attachments/11811/17507/Basunia_NSDD2022.pdf

Discussion

- We must distinguish policies and guidelines for evaluation. A policy must be followed by evaluators while the guideline is a recommendation (F.G. Kondev).
- POL data given in many cases are gamma asymmetry data not POL (G. Mukherjee).
- The policy page in NDS is missing in recent NDS January issue (S. Basunia).
- The lower limit of a $T_{1/2}$ for a level to be considered an isomer has been discussed many times in the past and the lower value of 100 ns has been adopted. However, it has not been written into the policies and is not implemented (S. Basunia, J. Tuli).
- Further checking and complete summary of proposals should be presented for approval in the upcoming NSDD Oct. 2022 meeting.

5.6. Open discussion (coordinator: J. Kelley)

- ENSDF archive
  - ENSDF archived zip files will be uploaded to the web monthly. The same will be done for NSR archives.
  - FMTCHK gives an error for two Q records, but that will be resolved with the new ENSDF files which will have the outdated Q records in document records.
- Tracking of evaluation process
  - submissions will go to GitLab and checking codes will be able to run in an automated way to streamline and automate ENSDF mass-chain processing.
  - Guidelines for accessing BNL GitLab were provided in a pdf file.
  - The NSR link in Java-NDS links to the journal page as expected, but in some cases, it links to the NSR query result page.
- Promotion of ENSDF evaluation
  - BNL has plans to promote ENSDF.
  - IAEA is planning ENSDF outreach activities in Japan and China.
  - Part of the effort to attract new evaluators is to convince them that data evaluation benefits their research work. This is true for nuclear structure as much as for nuclear reaction data evaluation. Nuclear structure and decay data have a direct impact on a wide range of applications, such as decay heat and dosimetry calculations, medical imaging, benchmarking neutrino experiments, non-destructive material assay, nuclear astrophysics, etc. The reaction data libraries also rely heavily on the decay data sub-libraries which are almost entirely based on ENSDF. Although there are several published articles on the use of nuclear structure and decay data for specific applications, a more comprehensive review article covering all the possible uses is missing from the international literature.
- ENSDF modernization
  - Timeline of the modernization project and adapting policies to accommodate the new format. How will this be done and will the NSDD be involved?
  - The new format will allow for the ENSDF file to be expanded to include additional forms

of data which will be discussed within the NSDD network.

- No additions have been made to the current ENSDF format (80-column). NNDC is now just transferring the old-ENSDF into the new ENSDF format in JSON.
- NNDC will release the draft format in the next months, and this will become available to evaluators to view in 3 diverse ways.
- In response to the suggestion that the new database should include raw data, documents, images, etc, there was a proposal to generate a different database of which the old ENSDF would be a part in the current 80-column format.
- It was agreed that a new quantity has to be defined in the ENSDF policy and put for discussion before being introduced into the file.
- Chris Morse (NNDC) is taking the lead in the ENSDF modernization, and a new hire will replace Chris as a full-time ENSDF evaluation.

6. ENSDF ANALYSIS AND CHECKING CODES

6.1. Latest developments in BetaShape, X. Mougeot (CEA - Laboratoire National Henri Becquerel)

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 have been elaborated and implemented. The code provides detailed information such as beta and (anti-)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. Distinct options are available, e.g. to include or not the different corrections, to automatically update the Q-value with AME2020 or to create CSV files for automatic coupling with other codes. Since version 2.2 released in June 2021, executables have been made available for various platforms on LNHB website (Ref. [1]): Windows 10, macOS Big Sur (Intel and M1), Scientific Linux 6.7, Ubuntu 20.04 and Centos 8.

Recent developments have been implemented to include realistic atomic effects in the beta decay model. Full numerical, precise calculations of relativistic electron wave functions including atomic screening are very time-consuming, especially at high kinetic energies where the effect is negligible. It is also the case for the atomic exchange effect, which can increase the emission probability up to 20% in beta minus spectra. The complete calculations are even much more time-consuming than for screening. Moreover, the available model was only for allowed decays. Theoretical work has allowed to extend the formalism to forbidden unique transitions. Screening and exchange correction factors have been extensively tabulated to cover more than the known cases, up to Z = 120, 30 MeV and sixth forbidden unique beta transitions. An exponential energy grid has been defined for better accuracy at low energy and the numerical precision of the computed correction factors is better than 0.001%. In addition, the atomic overlap correction in beta decays has been included via a first order modelling. Its influence is in general negligible except close to the end-point energy, which can appear lower by hundreds of eV.

While BetaShape has been extensively validated and tested in various contexts, the NSDD community asked for a validation against ENSDF data in a previous meeting. A collaborative work has been carried out with B. Singh from McMaster University (Canada), S. Turkat and K. Zuber from TU Dresden (Germany) aiming for an update of the 1998 review of log-*ft* values (Ref. [2]). Decay schemes and data with beta transitions or electron captures have been updated manually. BetaShape, with the new developments since version 2.2, has been run over the entire database to update the mean energies and the log-*ft* values. Selection of well-defined transitions which data can be trusted is being finalized and the publication is being drafted.

Forbidden non-unique transitions are approximated as allowed or forbidden unique in the current version of BetaShape. Their treatment requires a much more complicated formalism that includes nuclear structure. A dedicated code has been implemented that is able to calculate any forbidden non-unique transition. Nuclear structure has to be determined beforehand, which has been done with the NushellX@MSU code for several transitions such as ^{36}Cl, ^{99}Tc and ^{176}Lu for which high-precision measurements exist. The influence of different assumptions has been studied in detail: partial or complete lepton current; conserved vector current hypothesis and Coulomb displacement energies to determine relativistic transition matrix elements; and effective axial-vector weak interaction coupling constant g_A to account for incomplete nuclear structure.

[1] http://www.lnhb.fr/rd-activities/spectrum-processing-software/
[2] B. Singh, et al., Review Of Logft Values In beta Decay, Nuclear Data Sheets **84** (1998) 487.

Discussion

- A module of BetaShape was developed for GEANT4 and PENELOPE, it is used by the DDEP evaluations.
- The code runs longer than the classical log-ft code, particularly for EC when the number of atomic shells is large. Tabulation of parameters would help cut down the run time.

6.2. Treatment of uncertainties using Monte Carlo (UncTools) and atomic radiations in ENSDF (NS_RadList), T. Kibédi (ANU)

In most computer tools used for ENSDF evaluations uncertainties are propagated using a method based on Taylor expansions, valid for linear expressions and relatively small uncertainties. As an alternative solution, a Monte Carlo (MC) approach was suggested at the t https://www-nds.iaea.org/publications/indc/indc-nds-0733.pdf. o overcome the limitations. A script driven console application, UncTools has been developed. It is designed primarily for nuclear structure evaluations. The script can contain full ENSDF records, allowing input parameters (energy, intensity, multipolarities, lifetimes, etc) to be parsed directly. Internal conversion coefficients and E0 electronic factors are readily available from the most recent BrIcc tables. Expressions to calculate derived quantitates can be specified in a plain text format. Input parameters are sampled from their probability density functions (PDF) according to the uncertainties (symmetric, asymmetric normal distributions or limits). The values and uncertainties of the output quantities are derived from the PDF obtained from a considerable number, typically 20,000 to 100,000 MC trials. UncTools can handle large problems, involving up to 8,000 parameters and 1000 equations. Results can be obtained as detailed reports, plots or in an XML format. The later one allows UncTools to be called from other codes. Several examples were presented illustrating the benefit of the use of the MC approach. It was suggested that no assumption should be made based on the input parameters. Therefore, the output is solely evaluated from the calculated PDF. The median value is recommended as the best estimate of the output quantity. The lower and upper uncertainties are derived from the 16% and 84% coverage values of the output PDF. In some cases, the shape of output PDF is consistent with a limit. Procedures to deal with these cases are undergoing testing.

NS_RadList has been developed to generate the new atomic radiation (M) records, adopted at the. https://www-nds.iaea.org/publications/indc/indc-nds-0783.pdf. The initial vacancies, responsible for the atomic recombination following electron capture and internal conversion, are calculated from the ENSDF files, using theoretical values from BrIcc (2008Ki07) and Schonfeld (1995ScZY). The mean energies and intensities of the atomic radiation groups, adopted from IUPAC notation, are calculated from a data base containing atomic radiation spectra calculated with BrIccEmis. Detailed energy spectra and spectrum plots are also available. While the atomic transition probabilities in EADL (1991PeZY) do not have firm uncertainties, NS_RadList will evaluate the uncertainties on the X-rays and Auger yields from nuclear decay using UncTools.

Discussion

- Java-Ruler and UncTools treat limits differently. In the case of UncTools, the uniform distribution is used as PDF in the MC calculations.
- In the case of a half-life limit, $T_{1/2} < 5$ ns could mean that $T_{1/2}$ was not measured or that the real $T_{1/2}$ is 5 ps. In such a case, the BE1W obtained from UncTools could be far from reality. Java-RULER calculates the transition strength as a limit that follows directly from the limits of the input.

6.3. Calculation of transition strength, Jun Chen (FRIB/MSU)

Java-RULER has been compared with UncTools by T. Kibedi and tested by F. Kondev for the Monte-Carlo approach for error-propagation and it is concluded that the two codes give consistent results in terms of the range (lower and upper bounds) as well as the probability distribution function (PDF) of the transition strength. However, multiple choices are available for the final value of transition strength and a decision is needed on which one to be adopted: Calculated or Median in the PDF of transition strength where Calculated is directly computed from the values of the input parameters and Median is the value at 50% of the cumulative distribution function (CDF) of transition strength. Calculated and Median of the final PDF are almost identical when uncertainties of input parameters are small and symmetric but could be different otherwise. From the Calculated value point of view, input uncertainties are propagated to the final uncertainty of the transition strength and have no effect on the final value of the transition strength, while from the median value point of view, it is natural to take the value at 50% of the CDF of transition strength. For either choice, the uncertainty is determined as the difference between the choice of the “value” and each bound (lower at 16% and upper at 84%) of the CDF.

Discussion

- Both java-Ruler and UncTools provide calculated, median, and node values. The adoption of the Calculated or Median of the PDF is a matter of policy. For example, the metrology community adopts the median value in cases where the equations are nonlinear, and uncertainties are asymmetric.
- A vote was held on adoption of either the median or calculated value as a policy. The result of the vote was for adoption of the median value. However, adopting the median would require significant changes in many of the ENSDF codes. Also, calculating the initial input values in reverse order starting from the median value will give different results to what was originally measured. Although this is, in principle, a better method to calculate the B(XL), it needs to be discussed with the experimental nuclear physics community.
- Before adopting a new policy on this issue, the network should consult with the other data groups that deal with similar issues.
- There is no common solution for this issue among the different data communities. The full PDF could be given in this case. High-energy physicists use various approaches. In ENDF the number of parameters is of the order of tens of thousands (continuous distributions, etc.) to allow for MC propagation of the uncertainties.
- A new policy could be agreed only for java-RULER and not for all ENSDF quantities as a first step.
- Java-RULER is already available online. UncTools should also be made available for the network to test.
- The conclusion of the discussions was that further study of the issue is needed by a committee that will include both evaluators, researchers, and experts from other data communities.

6.4. New developments for ENSDF evaluation tools, Jun Chen (FRIB/MSU)

The goal of code development at the FRIB/MSU data center is to modernize the legacy ENSDF codes using the Java programing language, and to develop new analysis and utility codes to help facilitate the ENSDF evaluation procedure and improve evaluation efficiency. The table below lists the legacy codes in Fortran and the corresponding modernized codes in Java.

Old Code (Fortran)	New Code (Java)
ENSDAT	McMaster-MSU Java-NDS
RULER	NEW feature Java-RULER (test phase)
GTOL	GLSC (Gamma to Level Scheme Computation)
GABS	
PANDORA	NEW feature ConsistencyCheck
RADLIST	NEW feature RadiationReport (test phase)
LOGFT*	
---	NEW feature AME-NUBASE viewer

In Java-RULER, a new feature has been developed to calculate any of half-life, transition strength or mixing ratios of a single transition if the other two quantities are available from an input containing relevant information in ENSDF format for the transition.

In ConsistencyCheck, a simple average tool is developed to extract data values from an ENSDF comment containing a list of value-uncertainty pairs, calculate the average after adding or removing data points, and then make an ENSDF-format comment for averaging that is ready to be copied and pasted back to an ENSDF file.

In AME-NUBASE viewer, options have been added to retrieve data more conveniently with a customized combination of selections, and to deduce quantities from data in AME and NuBase, like any mass differences from a simple input like 77Co-75Ni.

A new Java code RadiationReport has been developed to replace the legacy RADLIST and LOGFT codes combined. It has improved uncertainty propagation by taking into account correlations and improved precision for calculated energies by using exact masses from AME instead of mass numbers for masses. It also allows asymmetric uncertainty in logft values instead of symmetrized values by the LOGFT code. In addition, functions have been added to calculate logft for high-order (>2) forbidden unique decays which, however, is treated as allowed by LOGFT.

Discussion

– In AME-NUBASE, certain quantities are calculated using covariance matrices (provided in the release). These have not been used to calculate uncertainties in AME-NUBASE viewer. [Note: covariances have been included in the version of the code released after the meeting.]
– In RadiationReport, the conventional way to propagate uncertainties is used, not MC.
– In RadiationReport, atomic data – X rays are calculated form the old atomic data file in logft.
– A tutorial on each of these new codes would be useful. Also, solid default values should be available. Some manuals are already available while the others are in preparation.

6.5. Enhancing user experience to facilitate nuclear physics research through NuDat, D. Mason (BNL)

New archival pages of ENSDF and XUNDL are available online.

In NuDaT interactive decay schemes are being developed for a future update. Analysis of γ-γ coincidences or of the γ cascades could be made using this new representation. An example was given on ^{235}U. Suggestions about the possible implemented features are welcome: For example, what should happen when a gamma is clicked? Coincident gammas could be listed, distributions of these gammas could be built, etc. Diverse options and possibilities were presented.

Discussion

The tool should be standardized and maintained in the long term.

6.6. IAEA dissemination tools, M. Verpelli (IAEA)

The existing web-based applications have been updated with new functions:
Livechart (https://nds.iaea.org/livechart) has now the data, with plotting, of antineutrino and neutrino spectra, total and for each line, as produced by the code Betashape.

The Medical Isotope Browser (https://nds.iaea.org/mib) is now linked to Livechart, to examine the decay properties of the produced nuclides.

A new application to view Nubase 2020 data is now online as standalone page (https://nds.iaea.org/relnsd/nubase/nubase_min.htm) and linked to Livechart.

The application for mobile devices, the Isotope Browser, is continuously updated following users' feedback and, as requested by the INDC, was translated to German.

Regarding the infrastructure to support NSDD network work, the analysis and utility codes were placed on GitHub (https://github.com/IAEA-NSDDNetwork), which allows easier maintenance and version control.

As last item, to answer the increasing number of requests for automated access to data, an API is now available. This is an initial version to collect users' feedback with the aim to move forward with this type of services.

6.7. Status of IAEA webtools, V. Zerkin (IAEA)

ENDF Web interface to radioactive decay data:

Radioactive decay data are presented in ENDF files in the MF8/MF457 section. Currently, the IAEA ENDF database contains decay data of the following libraries available via the ENDF Web system: https://www-nds.iaea.org/endf/

#	Materials	Format	Library	Comment
1)	979	ENDF6	ENDF/B-VI	
2)	3821	ENDF6	ENDF/B-VII.1	
3)	3822	ENDF6	ENDF/B-VIII.0	ENDF/B-VIII, USA, 2018
4)	85	ENDF6	IRDF-2002	
5)	122	ENDF6	*IRDFF-II-aux	IRDFF-II auxiliary files, 2019
4)	2345	ENDF6	JEF-2.2	
4)	3852	ENDF6	JEFF-3.1	
4)	3852	ENDF6	JEFF-3.3	JEFF-3.3, Europe, 2017

#	Materials	Format	Library	Comment
4)	4071	ENDF6	*JENDL-5	JENDL-5, Japan, December-2021
4)	2993	ENDF6	JENDL/DDF-2015	JENDL Decay Data File 2015 (Japan)
4)	3875	ENDF6	UKDD-12	
4)	4035	ENDF6	*UKDD-2020	UK Decay Data Library, 2020
4)	223	LARA	DDEP-2017	data provided by DDEP
4)	3191	LARA	*ENSDF/LiveChart	generated by M. Verpelli from ENSDF- 2021

**Recently added data*

The ENDF Web system provides interactive data search, plot, comparison between data from different libraries, and programmatic access via API with JSON formatted data.

Status of MyENSDF tools and EXFOR-NSR PDF database:

MyEnsdf Webtool:
- JAVA-NDS program v2.1/2021-12-19 installed, McMaster-MSU code, author: Jun Chen.
- Latex2pdf installed, now the result of JAVA-NDS can be converted to PDF online.

EXFOR-NSR PDF database:
- Last year: updates: 85, added PDF files: 1,837.
- Total statistics: 188,903 PDF files, ~79.2% of full NSR (238,544).

Discussion

- Files are received from NNDC monthly. The databases at NNDC and at IAEA should be identical. As yet, PRC articles published after year 2019 are not all in the EXFOR-NSR database.
- The database is an extremely useful resource for evaluators and saves months of work.
- Only conversion from ENDF to JSON format is available, not the reverse.

6.8. A coincidence-decay database for in-field spectroscopy applications, A. Hurst (Univ. of California, Berkeley)

Current fieldable spectroscopy techniques often use single detector systems heavily impacted by interferences from intense background radiation fields. These effects result in low-confidence measurements that can lead to misinterpretation of the collected spectrum. To help improve interpretation of the fission products and short-lived radionuclides produced in a composite sample, a coincidencedatabase is being developed in support of a robust portable γ/X-ray coincidence detector system currently under development at the Pacific Northwest National Laboratory for in-field deployment.

As part of this project, software has been developed to parse all radioactive-decay datasets from the Evaluated Nuclear Structure Data File (ENSDF) archive to enable translation into a more useful JavaScript Object Notation (JSON) format. This format provides a convenient and portable means of data storage that readily supports query-based data manipulation in analysis frameworks. The coincident database described in this work is the first of its kind and contains coincidence γ/γ, γ/X-ray, and γ/<particle> branching ratios (where <particle> = α, β^-, β^+, ϵ) and their corresponding uncertainties, together with auxiliary metadata associated with each decay data set. A few specific examples of the coincidence data sets generated were highlighted (^{137m}Ce, β- decay of ^{60}Ni, β- decay of ^{140}Ba).

Discussion

- The database will be made publicly available.

7. TECHNICAL REPORTS

7.1. Extracting ground-state nuclear deformations from RHIC-BNL and LHC-CERN type of physics experiments, Balraj Singh (McMaster Univ.)

There is a connection between two different fields of nuclear physics: low-energy nuclear physics and relativistic heavy-ion physics experiments at BNL-RHIC and LHC-CERN. Observables in RHI experiments such as elliptic flow fluctuations and centrality from analysis of quark-gluon plasma (QGP) data are strongly affected by the deformation of the colliding ions, where analysis of data is done using the Glauber model, with extensions to the more modern Monte Carlo Glauber model; also, TRENTO, URQMD, and multi-phase transport (AMPT) models. A more direct way of determining ground-state deformation parameters: β_2, β_3 , β_4 and γ in contrast to low-energy nuclear physics methods.

1. G. Giacalone, PRC **99**, 024910 (2019), Elliptic flow fluctuations in central collisions of spherical and deformed nuclei: analysis of quadrupole deformation of ^{197}Au: β_2 = (-)0.11 in ENSDF (taken from 1989Wa11), and -0.125 in 2016Mo08 theoretical calculations.
2. G. Giacalone, Jiangyong Jia, Chunjian Zhang, PRL **127**, 242301 (2021**)**, Impact of Nuclear Deformation on Relativistic Heavy-Ion Collisions: Assessing Consistency in Nuclear Physics across Energy Scales. ^{197}Au+^{197}Au and ^{238}U+^{238}U collisions: RHIC data implies $0.16 \lesssim |\beta| \lesssim 0.20$ for ^{197}Au nuclei, significantly more deformed than reported in the literature.
3. G. Giacalone, Jiangyong Jia, V. Somà, PRC **104**, L041903 (2021), Accessing the shape of atomic nuclei with relativistic collisions of isobars: analysis of data for ^{96}Ru, ^{96}Zr, ^{154}Sm, ^{154}Gd. Octupole deformation indicated for **^{96}Zr** from analysis of data from STAR collaboration at BNL-RHIC, consistent with experimental B(E3) value.
4. Chunjian Zhang, Jiangyong Jia**,** PRL **128**, 022301 (2022), Evidence of Quadrupole and Octupole Deformations in ^{96}Zr + ^{96}Zr and ^{96}Ru+ ^{96}Ru Collisions at Ultrarelativistic Energies: analysis of STAR collaboration data of 2021, authors concluded large quadrupole deformation β_2 of ^{96}Ru and large octupole deformation β_3 of ^{96}Zr and indicated that analysis of isobaric heavy-ion collisions can be used as a precision tool to image shapes of the nuclei."
5. B. Bally, M. Bender, G. Giacalone, V. Somà, PRL **128**, 08321 (2022), Evidence of the Triaxial Structure of ^{129}Xe at the Large Hadron Collider (CERN): Comparison of ^{129}Xe+^{129}Xe and ^{208}Pb+^{208}Pb collisions from experiments at LHC to deduce triaxial.
6. Jiangyong Jia: PRC **105**, 014905 (2022), Shape of atomic nuclei in heavy ion collisions: "In these collisions, two Lorentz-contracted nuclei, by a factor of 100 at RHIC and more than a factor of 1000 at the LHC, forming a hot and dense quark-gluon plasma (QGP) in the overlap region, whose initial shape is correlated with the deformed shape of the nuclei". "…at a timescale much shorter than $\sim 10^{-21}$ s probed by low-energy nuclear structure."
7. Jiangyong Jia, PRC **105**, 014906 (2022), Probing nuclear quadrupole deformation from correlation of elliptic flow and transverse momentum in heavy ion collisions: ^{238}U+^{238}U and ^{197}Au+^{197}Au collisions**,** focused on quadrupole deformation of ^{238}U.
8. Jiangyong Jia, PRC **105**, 044905 (2022), Probing triaxial deformation of atomic nuclei in high-energy heavy-ion collisons: analyzed ^{238}U+^{238}U and ^{96}Zr + ^{96}Zr collisions.

9. Junjie He, Wan-Bing He, Yu-Gang Ma, Song Zhang, PRC **104**, 044902 (2021), Machine-learning-based identification for initial clustering structure in relativistic heavy-ion collisions: $^{12}C+^{197}Au$ and $^{16}O+^{197}Au$ collisions at E(c.m.)=200 GeV: α-clustering structure in light nuclei; three-α triangular for ^{12}C and four-α tetrahedral structure for ^{16}O.

Conclusion: we need to pay attention to articles in relativistic heavy-ion physics.

7.2. Medical radioisotopes production studies: ^{67}Cu case, N. Nica (Texas A&M)

Medical radionuclides are central in nuclear medicine in the fields of diagnostic imaging and radioimmunotherapy (RIT). At the Cyclotron Institute a study was initiated to test if the production of medical radioisotopes is possible through inverse-kinematics reactions. Our first study, which is reported here, is about the production of ^{67}Cu.

Copper is a trace element that takes part in important biochemical processes and can be linked to proteins, antibodies, and other important molecules. ^{67}Cu (T1/2 = 61.8 h) can be used in theragnostic pairs together with other short-lived copper isotopes such as ^{61}Cu (T1/2 = 3.3 h) and ^{64}Cu (T1/2 = 12.7 h). From the radioactive point of view this is a $\beta-$ decay emitter with a maximum energy of Emax = 577 keV and with γ transitions of 185 keV (48.7%), 93 keV (16%) and 91 keV (7%). ^{67}Cu offers the possibility of single-photon emission computed tomography (SPECT) using the imaging of the radiotracer distribution with the existing technology for the 140 keV γ rays of 99mTc. It also allows the possibility of the treatment of smaller size tumors (up to 4 mm). The main reason it is not in wider preclinical and clinical use is its limited availability.

Our approach through inverse-kinematics nuclear reactions can be innovative because for inverse kinematics the reaction products are strongly focused along the beam direction and can easily be collected for immediate use. The use of a low energy beam can be tuned to maximize the ^{67}Cu but reduce the impurities. Thus, one can collect almost pure ^{67}Cu in an Al catcher of 124 micron thick placed after the reaction gas cell, which can be measured or used with minimum radiochemical processing.

A beam of ^{70}Zn ions accelerated at 15 MeV/nucleon by the K500 superconducting cyclotron entered the cryogenic gas cell target filled with H2 gas at 2.7 atm and 87 K through a 4 microns Havar window. The 7 MeV degraded beam and exiting products of the ^{70}Zn+p reaction passed through an identical Havar window, being collected by an Al catcher. A block of natZn of 20 mm thick was also used as an extra production environment by the secondary neutron produced in the reaction gas cell target.

After 36.5 h of cooling, the Al catcher was placed at 17.2(10) mm in front of a gamma-ray HPGe detector whose efficiency calibration was simulated with GEANT4 and ENGnrc codes. Multiple spectra were acquired for 67.3 h, which were afterwards carefully analyzed for quantitative production of ^{67}Cu and impurities. An activity of 1.8(5) kBq/pnA*h was obtained for ^{67}Cu, with decreasing activities for the main impurities, which are ^{69m}Zn, ^{90}Nb, ^{87m}Y, ^{89}Zr, ^{22}Na, ^{86}Y, and ^{87}Y. The activities of the impurities can be further reduced for the first three of them that are shorter-lived or are much smaller than the activity of ^{67}Cu for the longer-lived ones. This proves the feasibility of inverse kinematics reaction for ^{67}Cu.

7.3. Recent nuclear structure and decay data efforts, Dong Yang (Jilin Univ.)

In the last year, three activities have been funded by national funds in China.

1. Decay data evaluation for CENDL-DDL database of CNDC

The decay data of twenty-two nuclides were re-evaluated for the Chinese Decay Data Library (CENDL-DDL). Several differences are observed in comparison with the ENSDF data. These differences are attributed to i) new measurements, ii) adoption of only the latest measurement from the same laboratory, iii) not always adopting the most recent measurement, iv) in cases where the strong g-rays feeding the ground state have a large ICC and lead to large uncertainty in the normalization factor, the measured absolute intensity is adopted, v) other considerations related to physics and measurement method.

2. Systematics study for the ground states' spin of odd-Z nucleus

To provide more information on the spin assignment in cases where measurements are missing and to help obtain a better understanding of the nuclear structure properties, a study of the systematics of ground-state spin values of odd-Z nuclei in the range Z=25 - 67 was performed. The study focused on the spin assignment of about thirty nuclides and the results are being prepared for publication.

3. Statistical analysis of half-life measurements

A proper account of the experimental uncertainties associated with a half-life measurement will allow for a reasonable estimate of the weight of that measured value in the averaging procedure and avoid any underestimation of the final uncertainty. A systematic review is being performed of half-life measurements with a view of analyzing the data using different analysis methods and checking whether there are statistical affects in the measurement results.

8. CONCLUSIONS AND RECOMMENDATIONS

The interim Spring meeting of the IAEA International Network of Nuclear Structure and Decay Data Evaluators was held virtually. Forty-seven experts from twelve countries along with IAEA staff participated in the meeting. Both administrative and technical issues were addressed throughout the course of the meeting after a long pause of 3 years due to COVID-19 related restrictions. Representatives from the various data centers presented progress reports, status of assignments from the previous meeting and information related to their research interests of direct relevance to NSDD activities.

The list of actions from the 23rd NSDD meeting was reviewed in detail and several of the items were declared completed. The remaining and new actions will be discussed further at the 24th NSDD meeting in October 2022. One of the main technical issues that remains to be resolved is the propagation of uncertainties of derived quantities in cases where the measured uncertainties are large, asymmetric or limits. This issue which involves policy, implementation and codes adjustment will require special attention at the next meeting. Another challenge facing the network is the maintenance and enhancement of international contribution, especially in view of the retirement of current evaluators. In this respect, the Japan Data Center was at the core of the discussions at this meeting.

A new tracking system for monitoring the status of mass-chain evaluations has been developed on GitLab by BNL. The legacy ENSDF analysis codes are gradually being re-written in Java at MSU with enhanced capabilities. Different ways of retrieving ENSDF data using APIs and ENDF interfaces and enhanced plotting features are continuously developed and updated at IAEA and BNL.

The biennial IAEA-ICTP workshops held at ICTP, Trieste, Italy, remain of value as an educational tool as well as a means of seeking and identifying new ENSDF evaluators. The IAEA is charged with organizing different types of workshops to cover the needs of active evaluators, such as advance training or refresher workshops.

NSDD Spring Meeting: Consultancy Meeting on ENSDF Evaluations, Policies and Procedures, Codes and Dissemination Tools

Adopted Agenda

Monday, 4 April 2022

List of Actions, Reports

13:00	Welcome address	KONING, Arjan DIMITRIOU, Paraskevi
13:10	Review of List of Actions	DIMITRIOU, Paraskevi
14:00	IAEA update: databases, meetings, funding	DIMITRIOU, Paraskevi
14:10	Progress and prospects (JPN)	IIMURA, Hideki
14:25	Status report (ROM)	NEGRET, Alexandru
14:35	Status report (BUL)	LALKOVSKI, Stefan
14:45	Status report (RUS)	MITROPOLSKY, Ivan
14:55	*Break*	
15:00	Recent progress of the DDEP collaboration	LEBLOND, Sylvain
15:20	Status of AME/NUBASE	KONDEV, Filip
15:40	Status of nuclear moments tables	STONE, Nick

Tuesday, 5 April 2022

ENSDF and NSDD matters: mass chain/horizontal evaluations, policies, coordination etc

13:00	Update on ENSDF, XUNDL, GitLab tracking system	RICARD-MCCUTCHAN, Elizabeth
13:30	A brief comparison of 2001 and 2021: US effort as listed in USNDP work plans; net productivity in NSDD	KELLEY, John
13:50	Absolute intensities in decay data sets	KONDEV, Filip
14:10	Miscellanea of an ENSDF evaluator (evaluation issues)	NICA, Ninel
14:30	*Break*	
14:40	Action #30, 2019 NSDD: Compilation of ENSDF policies adopted at previous NSDD meetings	BASUNIA, Shamsuzzoha
15:00	Open discussion	KELLEY, John

ANNEX 1

Wednesday, 6 April 2022

Codes, evaluation and dissemination tools

13:00	Latest developments in BetaShape (precise atomic screening and exchange; logft review with Balraj, Zuber and Turkat).	MOUGEOT, Xavier
13:20	Monte Carlo propagation of uncertainties - UncTools	KIBEDI, Tibor
13:50	RULER codes: inter-comparison exercise	CHEN, Jun KIBEDI, Tibor
14:10	New developments for ENSDF evaluation tools	CHEN, Jun
14:40	*Break*	
14:45	Enhancing User Experience to Facilitate Nuclear Physics Research through NuDat	MASON, Donnie
15:00	IAEA DisseminationTools	VERPELLI, Marco
15:20	ENDF Web interface to radioactive decay data. Status of EXFOR-NSR PDF database.	ZERKIN, Viktor
15:40	A coincidence-decay database for in-field spectroscopy applications	HURST, Aaron

Thursday, 7 April 2022

Technical reports

13:00	Recent NSDD research at Jilin University	YANG, Dong
13:20	Extracting ground-state nuclear deformations from RHIC-BNL and LHC-CERN type of physics experiments	SINGH, Balraj
13:40	Medical Radioisotopes Production Studies: ^{67}Cu Case (experimental)	NICA, Ninel
14:00	Drafting of Summary Report	
15:00	In Memoriam: Murray Martin	TULI, Jagdish, DIMITRIOU Pararskevi
16:00	Closing of the meeting	

ANNEX 2

IAEA Consultancy Meeting
ENSDF Evaluations, Policies and Procedures, Codes and Dissemination Tools
4-7 April 2022 (virtual event)

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ANNEX 3

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US/ORNL	69,241-249	India	215-229
US/LBL	21-30,81,83,90-93,166-171, 184-193 (ex 185,188-190),210-214	Japan	120-129
US/TUNL	2-20	Canada	1,64,74-80,89,98,100, 149,151,164,188,190,194
.US/ANL	109,110,176-179,199-209	Australia	172-174
US/MSU	31-44, 60-73 (ex. 62,67-70)	Hungary	101-105
TAMU	140,141,147,148,153,155,157,158,160	PRCBeijing PRC-Jilin	51,62,195-198 52-56,67
.Romania	57-59,117-119	Bulgaria	106-108,111,112

ANNEX 4

LIST OF ACTIONS AND EXTENDED PROCEDURES

On-going and Incomplete Actions – still to be fully implemented Require biennial consideration				Status 7 April 2022
No	**Responsible**	**Reason**	**Action**	
1 (1)	IAEA-NDS	Maintain up-to-date information on the network.	Review, modify and correct contents of IAEA report INDC(NDS)-421. **Continuous** **Original update planned by mid/late 2015**	**On-going**: Dimitriou has modified and updated IAEA report INDC(NDS)-421 to issue as IAEA report INDC(NDS)-0700. **Revision in progress**.
2 (2)	ANU NNDC-BNL	Quantification of Auger electrons and X-rays. Data in agreed format within ENSDF	Develop analysis codes to generate detailed/suitable format for Auger-electron and X-ray data. Implement new format – see Subsection 4.2. of IAEA report INDC(NDS)-0733.	ENSDF format for atomic data has been agreed, and now requires implementation – **three linked actions carried forward together.** **Done.** **Implementation is work in progress**.
3 (3)	McMaster (Balraj Singh)	Policy implementation: check and modify *Guidelines for Evaluators*.	Implement in *Guidelines for Evaluators*: • unique gamma transitions should be assigned intensities of 100 (see Kuwait network meeting, IAEA report INDC(NDS)-0635, 2013, Action 65). • rewrite text associated with consideration of high-spin J^{π} values as proposed by original authors (guidelines incorrectly written compared with policies). • neutron-rich ground states - policy concerning half-life limits and use of "?" in decay modes; • inclusion of beta-delayed neutron emission branch in β^{-} decay datasets (see IAEA report INDC(NDS)-0733, Subsection 4.1.)	Various agreed additions as well as modifications to *Guidelines for Evaluators.* **Action now transferred to ORNL: ensure *Guidelines for Evaluators* agree with NDS policies** (implementation of changes in guidelines (Murray Martin)) **Action now transferred to Balraj Singh (McMaster):** to check if listed items have been included in the revised ORNL Guidelines, and if not, to add them in an Addendum (separate document)
4 (7)	NNDC-BNL and all network participants	Proposed journal publication	Proposed preparation of a comprehensive ENSDF paper – participants to consider proposal, and provide suggestions for additions and changes	Insufficient availability of staff **Continues**
5 (9)	NNDC-BNL	Adopted decay data - policy implementation	Provide template for the presentation of Adopted Decay datasets within ENSDF, including development of policies and procedures for creating such datasets.	Still plan to complete **Action modified**: Coordinate a working group tasked to prepare proposals for an adopted decay dataset library (content, evaluation methodology)

ANNEX 4

On-going and Incomplete Actions – still to be fully implemented Require biennial consideration				Status 7 April 2022
No	**Responsible**	**Reason**	**Action**	
6 (10)	NNDC-BNL	ENSDF processing	High-spin data: evaluators are known to add A2, A4, DCO and POL to 2G records. NNDC-BNL to provide a definitive list of quantities that can be included in the 2G record.	List provided by Zerkin (IAEA-NDS) shows close to 400 entries in 2G records – still need to assess and define suitable policy for 2G records. Collaborative action led by NNDC **Action still stands** **Work in progress**
7 (15)	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
8 (16)	IAEA-NDS (Capote)	Data uncertainties, and the problem of systematic uncertainties	Systematic uncertainties cannot be averaged - issues in defining the overall uncertainty of a group of numbers with existing quoted overall uncertainties. IAEA-NDS (*et al.* through NDS (Capote)) to provide guidelines for defining average data and associated uncertainties.	**Deferred to next meeting**
9 (19)	MTA-Atomki	Uncertainty assignments of gamma-ray energies as related to gamma-ray intensities [**Sec. note:** draft – see Subsection 7.2. in INDC(NDS)-0783]	Provide draft recommendations for assignment of gamma-ray uncertainties (and hence level energies) as a function of gamma-ray intensities when authors do not discuss their uncertainties.	**Deferred to next meeting**

First column: number in brackets is the action number from the previous NSDD network meeting (see IAEA report INDC(NDS)-0783)

ANNEX 4

NEW ACTIONS – 7 April 2022			
Item no.	**Responsible**	**Reason/Topic**	**Action**
10	ENSDF evaluators NNDC-BNL ENSDF evaluators, code developers	New Policy Policy implementation	Provide %Iγ in decay datasets when applicable. Δ%Iγ in GABS: it should not be given if there is no uncertainty in relative Iγ. Check if col 79 is in use in ENSDF. Include X in col 79 (if it's not in use) and retain it in ENSDF database.
11	ENSDF evaluators	Reviewers Guidelines	Provide feedback to NNDC (E.A. McCutchan) on draft of reviewer guidelines.
12	IAEA-NDS	Maintain list of data centers	Explore obtaining DOI or permanent URL for data centers webpage.
13	IAEA-NDS, NNDC-BNL	ENSDF reference(s)	LiveChart and NuDat to display the NSR keynumber of the Nuclear Data Sheets publication containing the evaluated data.
14	ENSDF evaluators and code developers	New Policy: Data uncertainties – quoted significant figures and handling thereof	RULE 35 to be implemented in the ENSDF codes for rounding off data where applicable. Flexibility in applying the RULE is maintained for evaluators.
15	ENSDF evaluators	Update Q values to AME2020 in all Adopted datasets	Consult the ENSDF files with the Q values updating approach and provide feedback to NNDC-BNL (E.A. McCutchan).
16	LBNL	Implementation of policies adopted at NSDD meetings	Share the RULE for isospin assignment adopted at NSDD 2000 with NSDD network for further discussion.
17	IAEA-NDS Code developers	Version tracking of codes	Provide versions of codes on ENSDF Codes webpage and GitHub repository. Generate a document record in the output ENSDF file containing the version of the code.
18	NNDC-BNL	Policy implementation	Include in General Policies: the lower limit of the half-life required for an isomer is 100 ns (as of NSDD 2011).
19	MSU, ANU, Recommended researchers [tbd] IAEA-NDS	Propagation of uncertainties in derived quantities	Study uncertainty propagation using MC method (impact of PDFs, adopted VALUES (mode/median/mean/direct calculation), treatment of limits) for a variety of cases. Formulate proposal(s) for discussion with user community and present feedback at next NSDD meeting. Explore possibility of organising a meeting with experts on propagation of uncertainties in measurements for further insight
20	ANU	ENSDF codes – propagation of uncertainties	Make UncTools available to the NSDD network for testing.
21	IAEA-NDS	International contribution to NSDD	Explore the possibility of holding a meeting of stakeholders to discuss supporting NSDD evaluations.

ANNEX 4

COMPLETED AND WITHDRAWN ACTIONS – 7 April 2022			
Item no.	**Responsible**	**Reason/Topic**	Action
(4)	McMaster	Keep ENSDF up to date.	Incorporate delayed-neutron $T_{1/2}$, P_n, B(E2) and quadrupole moments into ENSDF files **Conclusion: Implementation is impractical – evaluators should consult the horizontal evaluations. Move to ENSDF evaluation procedures (#32).**
(5)	NNDC-BNL	Policy implementation	Run GABS on ENSDF file. Former action is pending implementation of Adopted Decay Datasets, in which absolute photon intensity would be given. GABS has undergone extensive modification (Kibedi) **Action still pending** until GABS has been fully 36inalized **GABS has been fully updated. See new policy and new action item #1.**
(6)	NNDC-BNL	Maintain/update ENSDF	Adoption of AME2016 data: ENSDF to be updated by placing 2016 Q values on Q record, with previous Q values on document record Not yet undertaken – still intend to implement **Different approach adopted for including AME2020 Q values. New files available for feedback.** **See new action item # 16.**
(8)	NNDC-BNL, also, LNHB	Gamma, electron, and neutron continuum spectra – policy implementation	Consider form of such spectral data in ENSDF, and submit proposal complete with tested examples – also which and how much data to display **Done.** **Proposal and test examples submitted by X. Mougeot (LHNB) at ENSDF Codes (2018) and NSDD (2019) meetings.**
(11)	ANU	Data processing	Prepare UNCTools package for dissemination and send to NNDC-BNL/IAEA-NDS. **Done (see new action item # 21).**
(12)	NNDC-BNL	Guidelines for reviewers of ENSDF evaluations	Develop guidelines for reviewers that encompass main items to consider when reviewing an ENSDF evaluation. **Done- work document available for feedback – see new action item # 12).**
(13)	NNDC-BNL	List of data centres	Ensure that this list is maintained electronically on the ENSDF web page and explore possibility of putting a link to the webpage in the journal, contingent upon securing DOI (or similar permanent address). **First part is completed.** **See new action item # 12 on IAEA-NDS.**

ANNEX 4

COMPLETED AND WITHDRAWN ACTIONS – 7 April 2022			
Item no.	**Responsible**	**Reason/Topic**	Action
(14)	IAEA-NDS, NNDC-BNL	ENSDF reference(s)	LiveChart and NuDat to display prominently the individual *Nucl. Data Sheets* references containing the evaluated data. **Done.** **See new action item #13 about adding NSR keynumber.**
(17)	NNDC-BNL, MSU	Auger-electron and X-ray decay data	Provide a proposed ordering of atomic and nuclear decay data for a PDF listing. **Done**
(18)	All network participants	Reviewers for ENSDF evaluations	Provide names of potentially willing reviewers of mass chain evaluations (retirees, etc.) to undertake such studies. **Withdraw: already exists in ENSDF PROCEDURES (item # 12).**
(20)	IAEA-NDS	IAEA-ICTP NSDD workshops	Continue to organise and implement educationally driven IAEA-ICTP workshops (outreach) with ICTP, Trieste, Italy. These workshops to be one- or two-weeks duration, depending on aims and content - to discuss further and formulate full programme. **Continuous – moved to ENSDF PROCEDURES Item # 33.**
(21)	IAEA-NDS, NNDC-BNL	IAEA-based and more intense ENSDF evaluation workshops	Organise ENSDF training course at more irregular intervals for positively committed NEW or existing ENSDF evaluators (based at IAEA Headquarters) – such a workshop to be attended by deliberately limited numbers to achieve desired level of training. **Continuous – moved to ENSDF PROCEDURES Item # 34.**
(22)	IAEA-NDS	ENSDF evaluations	Organise an advanced workshop in 2020/2021 for existing NSDD/ENSDF evaluators if NEW ENSDF evaluators training course outlined immediately above cannot be realized over a reasonable timescale. **Not possible in 2020-21 due to COVID – moved to ENSDF PROCEDURES Item # 35.**
(23)	IAEA-NDS	ENSDF codes	Organise technical meetings on Codes and Code Developments at IAEA Headquarters in 2020 for existing code developers. **Not possible in 2020 due to COVID-19. Continuous – moved to ENSDF PROCEDURES Item # 36.**
(24)	ANU, NNDC-BNL, McMaster University	Data uncertainties – quoted significant figures and handling thereof	Discuss and declare the form of significant figures to adopt in the ENSDF codes for data uncertainties and consider in an analogous manner an acceptable means of reporting recommended uncertainties. **Done (see New Action # 14).**
(25)	Sukhjeet Singh, McMaster University, NNDC-BNL	r_0 table, Alpha_RadD	Assess need for changes (such as asymmetric uncertainties), implement (if necessary), and feed modified data and code to IAEA-NDS for distribution to all evaluators. Check the data, test the code, and feed all comments

ANNEX 4

COMPLETED AND WITHDRAWN ACTIONS – 7 April 2022			
Item no.	**Responsible**	**Reason/Topic**	Action
	ENSDF evaluators		(including full approval) to original author(s), NNDC-BNL and IAEA-NDS. **Asymmetric unc. not implemented yet.** **Jun Chen to implement treatment of asymmetric uncertainties in new Java code.**
(26)	ENSDF evaluators	J-GAMUT code	Test J-GAMUT and provide feedback to Balraj Singh. **No feedback provided - future maintenance of code uncertain.** **Withdrawn**
(27)	ANU	GABS	Consider modifying GABS to allow two different calculational routes for $\%I_\gamma$ (and *NR*) as specified and proposed in Subsection 7.6. by Nica. [**Sec. note**: Action completed, May 2019] **Done**
(28)	MSU IAEA-NDS ENSDF evaluators	ConsistencyCheck, CheckKeynumber and JAVA-Ruler codes	Extend ConsistencyCheck code as suggested at previous meetings (e.g., request to define band structure of levels). See also Subsections 6.4. and 7.7. IAEA-NDS to make JAVA-Ruler, CheckKeynumber and extended ConsistencyCheck codes available for testing/use on NDS website. Test JAVA-Ruler, CheckKeynumber and ConsistencyCheck codes, and provide feedback to Jun Chen. **Done**
(29)	LNHB ENSDF evaluators	Betashape code and logft calculations	Planned release of Betashape by Mougeot in June 2019. Assess and feedback comments to Mougeot (LNHB) by October 2019. **Done.** **Versions released in 2019, 2021 and latest version in preparation.**
(30)	LBNL, IAEA-NDS	Policy implementation	Compile list of policies adopted at previous NSDD meetings (going as far back as 2000). **Done**
(31)	ANU	BrIcc code	Modify code to insert total ICC in the gamma-record or SG record, and the asymmetric total ICC uncertainties in the 2G record. **Done**

First column: number in brackets is the action number from the previous NSDD network meeting (see IAEA report INDC(NDS)-0783)

ANNEX 4

ENSDF-RELATED PROCEDURES – CONTINUOUS			
Item no.	**Responsible**	**Reason/Topic**	**Extension**
1	All network participants	Relevant data and information from certain conferences, meetings, and lab. reports are not always available to NSR compilers	Assist NNDC in obtaining conference proceedings, meeting, and laboratory reports for NSR. Copy of unpublished conference reports containing significant NSDD contribution should be sent to NNDC.
2	NNDC-BNL	Publication of ENSDF	Continue journal publication of the mass chain evaluations in *Nuclear Data Sheets.*
3	All network participants	Misprints and errors found in NSR and ENSDF	Report misprints and errors detected in NSR, XUNDL and ENSDF to NNDC.
4	ENSDF evaluators	Accelerate review process	Each ENSDF evaluator should be willing to review two mass-chain equivalents per FTE-year; reviewing process for one mass chain should take no longer than three months.
5	All network participants	Bring NSDD evaluation work to the attention of the nuclear community	Present network activities at a wide range of appropriate conferences and meetings.
6	All network participants	Avoid duplication of work	Participants should inform the NNDC and IAEA-NDS about any development of software related to NSDD.
7	All network participants	Young scientists to evaluate mass chains	Encourage participation in research/ evaluation of nuclear structure data.
8	All network participants	Improve NSR	Send comments and suggestions on NSR improvements (keywording) to NNDC.
9	All network participants	Identify potential new ENSDF evaluators	All NSDD network participants to always come forward with contact details of known suitable candidates who would like to become recognised mass chain evaluators and possess suitable technical backgrounds – provide such information to IAEA-NDS and NNDC-BNL.
10	All network participants	Support new ENSDF evaluators	Provide local support and mentoring to new ENSDF evaluators.
11	ENSDF evaluators	Check continued validity of the rules	Inform NNDC when experimental results contradict accepted rules.
12	All network participants	Improve quality of evaluations	Solicit potential non-network evaluation reviewers and send names to ENSDF coordinator at NNDC. [**Sec. note**: also re-defined as Action 18, while remaining as an approved Procedure]
13	NNDC-BNL, IAEA-NDS	Outreach	Continue to pursue initiatives to improve the international contributions to the ENSDF mass chain evaluations.
14	All network participants	Outreach.	Formulate and expand contributions to mass chain evaluations within their own countries.
15	ENSDF evaluators	Procedures	Ensure that mass chain or nuclide evaluations conform to all items on the ENSDF checklist before submitting to NNDC-BNL. **Sizeable percentage of submissions do NOT follow this instruction.**
16	ENSDF evaluators	Clarification of newly evaluated ENSDF data – policy implementation	If no significant changes in existing evaluation compared with previous ENSDF evaluation, current evaluator to include such a statement and acknowledge previous evaluator(s). **Partially followed by evaluators, but not always.**

ANNEX 4

ENSDF-RELATED PROCEDURES – CONTINUOUS			
Item no.	**Responsible**	**Reason/Topic**	**Extension**
17	ENSDF evaluators	Direct adoption of XUNDL data sets in ENSDF – policy implementation	If major portions of XUNDL compilation are used in the construction of an ENSDF evaluation, evaluator should acknowledge XUNDL compilers in the abstract of the evaluated mass chain. **Partially followed by evaluators, but not always.**
18	ENSDF evaluators	Policy implementation	If there is no evidence for a given multipolarity in a paper, such data should not be implicitly adopted – of particular concern for high-spin states. Do not simply copy over such data from XUNDL but undertake your own assessment. **Sizeable percentage of submissions do NOT follow this instruction.**
19	ENSDF evaluators	Adopted dataset	Multiple values – do not carryover, DCOs to Adopted dataset; if evaluator feels DCOs are necessary in Adopted dataset provide details on experimental geometry and expected values for different transition types.
20	All network evaluators	Evaluations in progress	Inform NNDC-ENSDF coordinator about mass chain, individual radionuclide, and horizontal evaluations in progress to ensure their inclusion in monthly evaluation processing report. Network participants who publish individual and horizontal evaluations should distribute publication to network.
21	All network participants	Policies	Inform NNDC of discrepancies in the current policies and propose changes and additions.
22	MSU, ANL, NNDC-BNL IAEA-NDS All network participants	Maintain and update ENSDF analysis and checking codes	Assess status of analysis and checking codes and determine priorities as to which codes should be re-written or corrected. Report bugs in codes, and request enhancements to NNDC-BNL and code developers by email.
23	NNDC-BNL, IAEA-NDS	ENSDF analysis and checking codes	Notify network of new versions of analysis and checking codes.
24	NNDC-BNL	General policy pages in *Nuclear Data Sheets*	Modify policy pages, as needed.
25	ENSDF evaluators	Keep ENSDF up to date	Check NNDC monthly report for nuclides added by others to ENSDF that are your mass-chain responsibility.
26	NNDC-BNL	Maintain up-to-date information on network	Update website with changes in group responsibilities.
27	IAEA-NDS, NNDC-BNL	Information relevant to ENSDF network	Regularly update network website – ensure all relevant presentations/ talks are available on website.
28	IAEA-NDS, NNDC-BNL	Dissemination of codes	Coordinate distribution of ENSDF codes.
29	NNDC-BNL, all network evaluators	Obscure references	Investigate means to access electronic copies of secondary references that are difficult to track down and acquire. Evaluators to relay findings to NNDC-BNL for NSR adoption.

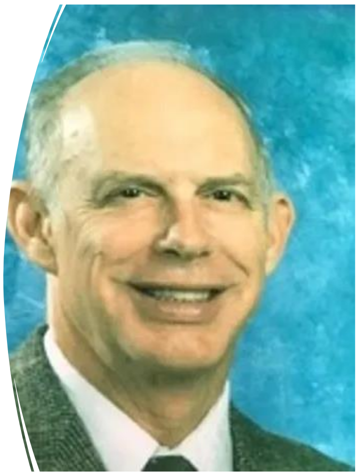
ANNEX 4

ENSDF-RELATED PROCEDURES – CONTINUOUS			
Item no.	**Responsible**	**Reason/Topic**	**Extension**
30	NNDC-BNL	NSR - generation of key numbers and keywords	While keywords are only optional, they constitute valuable information to NSR users – their provision is encouraged.
31	IAEA-NDS	Maintain links with horizontal evaluations	Invite representatives of atomic mass and other horizontal evaluations to NSSD Evaluators' Network meeting.
32	All evaluators	Keep ENSDF up to date.	Evaluators should consult the available horizontal evaluations -an updated list of which is maintained by NNDC-when performing an evaluation.
33	IAEA-NDS	IAEA-ICTP NSDD workshops	Continue to organise and implement educationally driven IAEA-ICTP workshops (outreach) with ICTP, Trieste, Italy. These workshops to be one- or two-weeks duration, depending on aims and content - to discuss further and formulate full programme.
34	IAEA-NDS, NNDC-BNL	IAEA-based and more intense ENSDF evaluation workshops	Organise ENSDF training courses at more irregular intervals for positively committed NEW or existing ENSDF evaluators (based at IAEA Headquarters) – such a workshop to be attended by deliberately limited numbers to achieve desired level of training.
35	IAEA-NDS	ENSDF evaluations	Organise an advanced workshop for existing NSDD/ENSDF evaluators if NEW ENSDF evaluators training course outlined above cannot be realised over a reasonable timescale.
36	IAEA-NDS	ENSDF codes	Organise technical meetings on Codes and Code Developments at IAEA Headquarters for existing code developers.

ANNEX 5

In memoriam

Murray J. Martin



Our dear colleague and friend, unwavering supporter of and dedicated contributor to the NSDD network, Murray John Martin, passed away on 15 March 2022.

Murray Martin was born on June 22, 1935, in Regina Saskatchewan, Canada. After obtaining an M.A. in experimental physics from the University of Saskatchewan, he moved to McMaster University in Hamilton, Ontario to pursue his Ph.D. degree in theoretical physics.

Following his graduation, Murray accepted a job with the Nuclear Data Project led by Katherina Way in Washington, D.C. In 1964 the Data project was moved to the Physics Division at Oak Ridge National Laboratory (ORNL) where Murray spent his professional career until his retirement in 1997. He eventually became head of the group and Editor-in-Chief of the journal Nuclear Data Sheets. After retirement, he continued to work part-time as a consultant to the Data Project.

Murray's achievements are numerous. As an evaluator he contributed some of the most important evaluations and as a teacher he trained and mentored many evaluators of the NSDD network. His Guidelines for Evaluators and seminal work on the logft tables for beta decay are still widely used to date.

Above all, Murray was a kind, thoughtful, and respectful person, who offered his wisdom generously and cared for his colleagues and students deeply.

As we all witnessed in the special In memoriam session we held during this meeting, Murray's legacy will live on.

He will be sorely missed by all of us in the NSDD network.

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