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IAEA
International Atomic Energy Agency

INDC
INTERNATIONAL NUCLEAR DATA COMMITTEE

Summary Report of the Technical Meeting on

# International Network of Nuclear Reaction Data Centres

IAEA Headquarters, Vienna, Austria

9 – 12 May 2023

Prepared by

Naohiko Otuka
IAEA Nuclear Data Section, Vienna, Austria

and

David Brown
National Nuclear Data Center, BNL, Brookhaven Upton NY, USA

June 2023

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**Abstract**

This report summarizes the IAEA Technical Meeting on the International Network of Nuclear Reaction Data Centres held at the IAEA Headquarters in Vienna, Austria from 9 to 12 May 2023. The meeting was attended by 24 participants representing 12 cooperative Centres from seven Member States (China, Hungary, Japan, Korea, Russia, Ukraine and USA) and two International Organisations (NEA, IAEA) as well as a participant from Kazakhstan. A summary of the meeting is given in this report along with the conclusions and actions.


Technical Meeting on International Network of Nuclear Reaction Data Centres
IAEA Headquarters, Vienna, Austria, 9 – 12 May 2023

First row (from the left)

Michael Fleming, OECD

Daniela Foligno, OECD

Vidya Devi, IAEA

Second row (from the left)

Jiming Wang, China

David Brown, USA

Sung Chul Yang, Korea

Do Heon Kim, Korea

Roberto Capote, IAEA

Boris Pritychenko, USA

Sandor Takács, Hungary

Osamu Iwamoto, Japan

Naohiko Otsuka, IAEA

Nengchuan Shu, China

Xi Tao, China

Remote participants (left, from the top)

Svetlana Dunaeva, Russia

Marina Mikhailiukova, Russia

Timur Zholdybayev, Kazakhstan

Remote participants (right, from the top)

Sophiya Taova, Svetlana Selyankina, Galina Pikulina, Russia

Svetlana Dunaeva, Russia

Masaaki Kimura, Japan

Olena Gritzay, Ukraine

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## THE INTERNATIONAL NETWORK OF NUCLEAR REACTION DATA CENTRES

National, regional and specialized nuclear reaction data centres, coordinated by the International Atomic Energy Agency, cooperate in the compilation, exchange and dissemination of nuclear reaction data in order to meet the requirements of nuclear data users in all countries. At present, the following data centres participate in the network:

| | |
|---|---|
| NNDC | US National Nuclear Data Center, Brookhaven National Laboratory, Upton, USA |
| NEA DB | OECD NEA Data Bank, Boulogne-Billancourt, France |
| NDS | IAEA Nuclear Data Section, Vienna, Austria |
| CJD | Russian Nuclear Data Centre, Institute of Physics and Power Engineering, Obninsk, Russia |
| CNDC | China Nuclear Data Centre, China Institute of Atomic Energy, Beijing, China |
| ATOMKI | Charged-Particle Nuclear Reaction Data Group, Institute for Nuclear Research (ATOMKI), Debrecen, Hungary |
| NDPCI | Nuclear Data Physics Centre of India, Bhabha Atomic Research Centre, Trombay, Mumbai, India |
| JAEA/NDC | Nuclear Data Center, Japan Atomic Energy Agency, Tokai-mura, Japan |
| JCPRG | Nuclear Reaction Data Centre, Hokkaido University, Sapporo, Japan |
| KNDC | Nuclear Data Center, Korea Atomic Energy Research Institute, Daejeon, Republic of Korea |
| CDFE | Centre for Photonuclear Experiments Data, Moscow State University, Moscow, Russia |
| CNPD | Centre of Nuclear Physics Data, Institute of Nuclear and Radiation Physics, Russian Federal Nuclear Center –All-Russia Research Institute of Experimental Physics, Sarov, Russia |
| UkrNDC | Ukrainian Nuclear Data Centre, Institute for Nuclear Research, Kyiv, Ukraine |

A detailed description of the objectives of the network and the contributions of each Centre to these activities are given in INDC(NDS)-401 (Rev.6), "International Network of Nuclear Reaction Data Centres".

# PREVIOUS NRDC MEETINGS

| | | |
|---|---|---|
| Vienna, 9-12 May 2023 | Centre Heads + Technical | INDC(NDS)-0879 |
| Vienna, 14-17 June 2022 | Technical | INDC(NDS)-0857 |
| Virtual, 4-7 May 2021 | Technical | INDC(NDS)-0829 |
| Vienna, 9-12 April 2019 | Technical | INDC(NDS)-0792 |
| Bahadurgarh, 1-4 May 2018 | Centre Heads + Technical | INDC(NDS)-0762 |
| Vienna, 23-26 May 2017 | Technical | INDC(NDS)-0736 |
| Beijing, 7-10 June 2016 | Centre Heads + Technical | INDC(NDS)-0718 |
| Vienna, 21-23 April 2015 | Technical | INDC(NDS)-0686 |
| Smolenice, 6-9 May 2014 | Centre Heads + Technical | INDC(NDS)-0661 |
| Vienna, 23-25 April 2013 | Technical | INDC(NDS)-0633 |
| Paris, 16-19 April 2012 | Centre Heads + Technical | INDC(NDS)-0618 |
| Vienna, 23-24 May 2011 | Technical | INDC(NDS)-0593 |
| Sapporo, 20-23 April 2010 | Centre Heads + Technical | INDC(NDS)-0573 |
| Vienna, 25-26 May 2009 | Technical | INDC(NDS)-0558 |
| Obninsk+Moscow 22-25 Sept. 2008 | Centre Heads + Technical | INDC(NDS)-0536 |
| Vienna, 8-10 October 2007 | Technical | INDC(NDS)-0519 |
| Vienna, 25-28 September 2006 | Centre Heads + Technical | INDC(NDS)-0503 |
| Vienna, 12-14 October 2005 | Technical | INDC(NDS)-0480 |
| Brookhaven, 4-7 October 2004 | Centre Heads + Technical | INDC(NDS)-464 |
| Vienna, 17-19 June 2003 | Technical | INDC(NDS)-446 |
| Paris, 27-30 May 2002 | Centre Heads + Technical | INDC(NDS)-434 |
| Vienna, 28-30 May 2001 | Technical | INDC(NDS)-427 |
| Obninsk, 15-19 May 2000 | Centre Heads + Technical | INDC(NDS)-418 |
| Vienna, 18-20 May 1999 | Technical | INDC(NDS)-407 |
| Vienna, 11-15 May 1998 | Centre Heads + Technical | INDC(NDS)-383 |
| Vienna, 26-28 May 1997 | Technical | INDC(NDS)-374 |
| Brookhaven, 3-7 June 1996 | Center Heads + Technical | INDC(NDS)-360 |
| Vienna, 2-4 May 1995 | Technical | INDC(NDS)-343 |
| Paris, 25-27 April 1994 | Center Heads + Technical | INDC(NDS)-308 |
| Vienna, 1-3 Sept 1992 | Technical | INDC(NDS)-279 |
| Obninsk, 7-11 Oct 1991 | Center Heads + Technical | INDC(NDS)-0262 |
| Vienna, 13-15 Nov 1990 | Technical | Memo CP-D/210 |
| Vienna, 2-4 Oct 1989 | Centre Heads + Technical | Memo CP-D/200 |
| Vienna, 4-6 Oct 1988 | Technical | Memo CP-D/190 |
| Brookhaven, 27-29 Oct 1987 | Center Heads + Technical | INDC(NDS)-204 |
| Vienna, 7-9 Oct 1986 | Technical | Memo CP-D/159 |
| Saclay, 9-11 Oct 1985 | Center Heads + Technical = 8$^{th}$ NRDC Meeting | INDC(NDS)-178 |
| Vienna, 19-21 Sept 1984 | Technical | Memo CP-D/131 |
| Obninsk+Moscow, 17-21 Oct 1983 | 7$^{th}$ NRDC Meeting | INDC(NDS)-154 |
| Vienna, 3-7 May 1982 | 6$^{th}$ NRDC Meeting | INDC(NDS)-141 |
| Brookhaven, 29.9 - 2.10.1980 | 5$^{th}$ NRDC Meeting | INDC(NDS)-125 |
| Karlsruhe, 8-13 Oct 1979 | 4$^{th}$ NRDC Meeting | INDC(NDS)-110 |
| Paris, 19-23 June 1978 | 3$^{rd}$ NRDC Meeting | INDC(NDS)-99 |
| Kiev, 11-16 April 1977 | 2$^{nd}$ NRDC Meeting = 3$^{rd}$ CPND + 13th 4-C | INDC(NDS)-90 |
| Vienna, 28-30 April 1976 | 2$^{nd}$ CPND Meeting | INDC(NDS)-77 |
| Vienna, 26-27 April 1976 | 12$^{th}$ 4C-Meeting | INDC(NDS)-78 |
| Vienna, 8-12 Sept 1975 | CPND Meeting | INDC(NDS)-69+71 |
| Brookhaven, 10-14 March 1975 | 11$^{th}$ 4C-Meeting | INDC(NDS)-68 |
| Paris, 6-10 May 1974 | 10$^{th}$ 4C Meeting | INDC(NDS)-58 |
| Vienna, 24-26 April 1974 | CPND + PhotoND | INDC(NDS)-59+61 |
| Moscow/Obninsk, 4-8 June 1973 | 9$^{th}$ 4C Meeting | INDC(NDS)-54 |
| Vienna, 16-20 Oct 1972 | 8$^{th}$ 4C Meeting | INDC(NDS)-51 |
| Brookhaven, 25-29 Oct 1971 | 7$^{th}$ 4C Meeting | INDC(NDS)-41 |
| Paris, 5-9 Oct 1970 | 6$^{th}$ 4C Meeting | INDC(NDS)-28 |
| Moscow, 17-21 Nov 1969 | 5$^{th}$ 4C Meeting | INDC(NDS)-16 |

# LIST OF ACRONYMS

| | |
|---|---|
| ATOMKI | Nuclear Research Institute, Debrecen, Hungary |
| BARC | Bhabha Atomic Research Centre, Trombay, Mumbai, India |
| C4 | Computational format for EXFOR data |
| C5 | Extended computational format for EXFOR data using ENDF MF.MT classification |
| CDFE | Centr Dannykh Fotojad. Eksp., Moscow State University, Russia |
| CENDL | Chinese Evaluated Neutron reaction Data Library |
| CHEX | EXFOR check program (originating from NNDC) |
| CIAE | Chinese Institute of Atomic Energy, Beijing, China |
| CINDA | Computer Index of Nuclear Reaction Data |
| CJD | Russian Nuclear Data Centre, IPPE, Obninsk, Russia |
| CNDC | China Nuclear Data Centre, CIAE, Beijing, China |
| CNPD | Centre of Nuclear Physics Data, Russian Federal Nuclear Centre, Sarov, Russia |
| CP... | Numbering code for memos exchanged within the NRDC |
| CPND | Charged-particle nuclear reaction data |
| CRP | Coordinated Research Project (of the IAEA Nuclear Data Section) |
| CSEWG | US Cross Section Evaluation Working Group |
| DOI | Digital Object Identifier, *e.g.* for bibliographic references |
| ENDF-6 | International format for evaluated data exchange, version 6 |
| ENDF/B | US Evaluated Nuclear Data File/B |
| ENSDF | Evaluated Nuclear Structure Data File |
| EXFOR | Format for the international exchange of nuclear reaction data |
| GSYS | Data digitizing system by JCPRG |
| IAEA | International Atomic Energy Agency, Vienna, Austria |
| IBANDL | Ion Beam Analysis Nuclear Data Library, maintained at IAEA |
| INDC | International Nuclear Data Committee |
| IPPE | Institute of Physics and Power Engineering, Obninsk, Russia |
| IRDFF | International Reactor Dosimetry and Fusion File, maintained by the IAEA-NDS |
| JAEA | Japan Atomic Energy Agency |
| JANIS | Java Nuclear Information System of NEA-DB |
| JCPRG | Nuclear Reaction Data Centre, Hokkaido University, Sapporo, Japan |
| JEFF | Joint Evaluated Fission and Fusion File, coordinated by NEA-DB |

| | |
|---|---|
| JENDL | Japanese Evaluated Nuclear Data Library |
| KNDC | Nuclear Data Center, Korea Atomic Energy Research Institute Daejeon, Korea |
| LEXFOR | Part of the EXFOR manual containing physics information for compilers |
| MBDAV | Management Board for the Development, Application and Validation of Nuclear Data and Codes |
| NDS | IAEA Nuclear Data Section, Vienna, Austria |
| NEA-DB | OECD Nuclear Energy Agency Data Bank, Boulogne-Billancourt, France |
| NEANDC | OECD Nuclear Energy Agency Nuclear Data Committee |
| NNDC | National Nuclear Data Center, Brookhaven National Laboratory, USA |
| NRDC | International Network of Nuclear Reaction Data Centres |
| NRDF | Japanese Nuclear Reaction Data File |
| NSDD | International Network of Nuclear Structure and Decay Data Evaluators |
| NSR | Nuclear Science References, a bibliographic system |
| OECD | Organization for Economic Cooperation and Development, Paris, France |
| ORDER | EXFOR program for addition of record identification |
| PhND | Photonuclear data |
| RIKEN | Institute of Physics and Chemistry Research, Wako-Shi, Saitama, Japan |
| TRANS | Name of transmission tapes for data exchange in the EXFOR system |
| UKRNDC | Ukraine Nuclear Data Centre, Kyiv Institute of Nuclear Research, Ukraine |
| WPEC | Working Party on International Nuclear Data Evaluation Co-operation |
| XTRACT | EXFOR indexing program |
| X4PRO | X4Pro Universal, fully relational EXFOR database (professional edition) |
| X4TOC4 | Conversion program from EXFOR to computational format “C4” |
| X5 | JSON format for extended presentation of EXFOR data in original and computational form together with dictionaries and data for automatic renormalization |
| ZCHEX | Current version of CHEX, updated and maintained by NDS |
| 4C... | Numbering code of memos exchanged among the four Neutron Data Centres |

# MEETING SUMMARY

## 1. Introduction

This report summarizes the IAEA Technical Meeting on the International Network of Nuclear Reaction Data Centres held at the IAEA Headquarters in Vienna, Austria from 9 to 12 May 2023. The meeting was attended by 24 participants representing 12 cooperative Centres from seven Member States (China, Hungary, Japan, Korea, Russia, Ukraine and USA) and two International Organisations (NEA, IAEA) as well as a participant from Kazakhstan. (see **Appendix A**). Meetings of this network are held annually, with full meetings involving Centre Heads and technical staff every two years. (The last full meeting was planned to be held in May 2020 at the IAEA Headquarters, but it has been postponed due to COVID-19.)

Main topics of the present meeting were various statistics, manuals and dictionaries, compilation needs, quality control, coding rules as well as software and dissemination (see **Appendix B**). The participants summarized the results of the discussions in 32 conclusions and 95 actions (see **Appendix C**).

## 2. Brief Summary

### 2.1 Opening

**R. Capote**, Deputy Head of the IAEA Nuclear Data Section welcomed the participants. He emphasized importance to receive recommendations from the participants to ensure both accessibility and quality of EXFOR.

**D. Brown** was elected as the chairperson, and the agenda was adopted.

### 2.2 Progress Reports

Progress reports from 12 attending Centres were presented by **R. Capote**, **V. Varlamov, S. Taova**, **M. Mikhailiukova**, **O. Grizay**, **N C. Shu**, **D.H. Kim**, **M. Kimura, S. Takács**, **O. Iwamoto, M. Fleming** and **D. Brown**, who highlighted the staffing, compilation, dissemination and other nuclear data related activities of interest to the network. See progress reports P2023-01 to P2023-10 (**Appendix F**) for further details.

### 2.3 EXFOR General

**V. Devi** presented the statistics of transmissions, journal scanning and preliminary tape checking. She reported that 351 new entries and 1284 revised entries have been newly finalized since the last (2022) NRDC meeting. She also reported NDS takes maximum one week to review a preliminary tape while NEA DB takes two to three months for it.

**V. Devi** reported that the NDS shares responsibility for scanning of 54 journals with CJD, CNDC, CNPD, NNDC and UkrNDC. She mentioned three journals (AE/T, CNPR and JET) were scanned more than three months since no new issues have been published since their last issues.

### 2.4 Manuals and Dictionaries

**N. Otsuka** informed that JAEA managed compilation of neutron-induced reaction data measured at J-PARC or measured by a researcher from JAEA Nuclear Data Center. He proposed their compilation activity to the NRDC Protocol Appendix C as an official responsibility, and it was approved.

**N. Otsuka** reported his attempt to modernize process for production of the EXFOR/CINDA dictionary by replacing the old Fortran code (DAN2X4) with a new Python script. He implemented not only creation of the DANIEL Backup dictionary and TRANS dictionary from the Archive dictionary but also detection of format errors (via the dictionary converted to JSON) and found about 840 errors (though many of them are very minor errors). He plans to release the dictionary produced by this new Python script for testing in parallel with those produced by DAN2X4.

### 2.5 CINDA

**V. Zerkin** reported that (1) regular automatic updates using the EXFOR and NSR databases have been frozen since December 2018 because NSR database is no longer available; and (2) import from EXFOR was performed once (2023-04-26). He also informed that the number of CINDA search on the NDS web server in 2022 increased by 125% compared to 2021.

### 2.6 EXFOR Compilation Needs

**N. Otsuka** reported CNPD, JCPRG and NNDC still have to compile a few articles related with applications (dosimetry, isotope production, ion-beam analysis, accelerator driven neutron source). He also reported there are still fission product yield articles listed in 2019 by NNDC and NDS, and still waiting compilation by CDFE (3 articles), JCPRG (1 article), NEADB (16 articles) and NNDC (57 articles).

### 2.7 EXFOR Quality Control

**N. Otsuka** presented some remarks from his comparison of the isomeric flags (e.g., -G, -M) in EXFOR with NUBASE2020 by using the Dictionary 227 produced with the new procedure from NUBASE2020. He found 306 nuclides with isomeric flags in REACTION SF4 are not seen in NUBASE 2020 and proposed the centres their corrections with priority. He also reported that half-lives in the 309 datasets are coded not under DECAY-DATA but under the heading HL etc. and argued that this must be moved to DECAY-DATA for the quantities other than the data partial for a half-life group (e.g., partial delayed fission neutron multiplicity).

**V. Devi** presented her analysis of EXFOR outliers. She is continuing review of plots made by A. Koning for production cross sections for γ, p, d, t, $^{3}$He and α induced reactions compiled in the EXFOR and TENDL-2021 libraries. As a continuation of her report on γ, d and α induced reactions presented in the last NRDC meeting, she presented some typical errors found in proton-induced reaction data in EXFOR (incorrect reaction product in SF4 such as $^{159}$Ho instead of $^{159}$Dy, wrong copying from the article table such as 48.0 mb instead of 4.8 mb, compilation of same datasets twice, wrong interpretation of uncertainty values such as compilation of "18.0(19) mb" as 18.0±19 mb instead of 18.0±1.9 mb.

### 2.8 EXFOR Coding Rule

**S. Dunaeva** reported heading ERR-HL (uncertainty in half-life) and ERR-IDD (uncertainty in intensity) are sometimes coded even when the partial uncertainties due to the half-life and/or intensity are coded separately under ERR-1 etc. She proposed to allow use of ERR-HL and ERR-IDD only when they are propagated to the total uncertainty (ERR-T) and not coded as fractional (%) partial uncertainties of the quantity, and her proposal was accepted by the participants.

**N. Otsuka** proposed (1) use of a pointer to an independent variable in the multiple reaction formalism, (2) abolishment of the vector common formalism, and (3) use of the multiple reaction formalism to accommodate the cumulative and chain fission product yields together. These proposals were approved.

**V. Devi** introduced presence of gamma production angular differential cross sections separated to two components: gammas following a cascade (1) bypassing quasi-metastable state production ("prompt component") and (2) following production of a quasi-metastable state ("delayed component"), and proposed to compile them with ,PAR/L-,DA,G and -L,PAR,DA,DG, respectively in REACTION SF5-SF7. The proposal was approved.

**V. Devi** also proposed use of non-integers as a flag coded under FLAG and DECAY-FLAG. **V. Zerkin** commented that flagging by a non-integer may not work properly since it could be processed by a computer program not as intended by the compiler (e.g., 11.099999 instead of 11.1). The participants concluded to keep the current restriction (integers only).

**N. Otsuka** reported some production cross section datasets are compiled with REACTION codes violating mass conservation though the reaction is properly taken from the source articles with $^{209}$Bi(p,x)$^{211}$At as a typical example. The participants agreed that EXFOR should not include production cross sections of nuclides which can be produced only by interaction with secondary particles (e.g., $^{209}$Bi(p,α)$^{206}$Pb then $^{209}$Bi(α,2n)$^{211}$At). Considering the high interest of $^{211}$At production, the participants agreed that an exception could be made for the "$^{209}$Bi(p,x)$^{211}$At cross section" already compiled in EXFOR.

**M. Mikhailiukova** argued that the 0th and higher order Legendre coefficients must be compiled together as a single dataset without separation, and the participants agreed with it.

### 2.10 Evaluated Data Libraries

**O. Iwamoto** introduced to the JENDL-5 library released in December 2021. He explained it integrates JENDL special purpose libraries for activation and high energies, and also it is the first JENDL library including the original evaluation of neutron thermal scattering law. **J.-C. Sublet** asked the half-life limit for the target and product nuclides. **Iwamoto** answered that it is one day for the target nuclide and depends evaluator's decision for the product nuclide. **D. Brown** asked if the experimental information from the LANL Chi-Nu experiment was utilized for evaluation of $^{235}$U prompt fission neutron spectrum. **Iwamoto** answered that it was evaluated theoretically without help of the experimental information at the fast neutron region.

### 2.9 Tools for Compilation and Dissemination

**N. Otsuka** presented compilation of experimental isomeric ratios done with his intern Alberto Rodrigo (Universidad Politécnica de Madrid). He introduced extraction of the isomer production cross sections isomeric ratios compiled in EXFOR (12,313 data points for 962 reactions) by using X4Pro. He presented a few typical problems in EXFOR identified during validation of the extracted outputs (duplication, violation of compilation rule, typos by

publishers and authors). He emphasized that users still need good knowledge of EXFOR and physics for proper uses of EXFOR even if a helpful tool (e.g., SQL, JSON) becomes available for better readability of EXFOR.

**N. Otsuka** also introduced development of a new tool helping selection of INSTITUTE codes to accelerate compilation of articles having many affiliations (e.g., publications from n_TOF collaboration). Once the list of affiliations from an article website is copied, the tool proposes candidates of the institute code for each affiliation. He also reported suggestion by the tool was improved by applying the Naïve Bayes classifier.

**S. Okumura** reported development of "Data Explorer", which displays cross sections for various processes and productions as well as fission product yields in EXFOR and evaluated data libraries. Her code systems are open to the public and it was well received by the participants. She made several proposals to EXFOR: (1) addition of the relation between the author and institute, (2) addition of DOI as coded information, (3) reduction of free text, (4) compilation without COMMON section, (5) removal of pointers. **M. Mikhailiukova** asked what purpose of the project and difference with the existing Web Retrieval systems are and suggested to study logic of EXFOR deeper. **S. Dunaeva** commented that presence of the COMMON section is essential to minimize redundancy in EXFOR. **N Otsuka** reminded that the EXFOR format is designed for compilation and exchange of experimental data and should not be confused with a centre-to-user format.

**V. Zerkin** presented progress in databases, retrieval systems, tools and software for access to EXFOR, ENDF, IBANDL and pdf files. His presentation included reports on (1) plotting of covariance in angular differential cross section and fission neutron multiplicity in ENDF-6 format (MF34 and 31), (2) connection to INIS, (3) CSV output from the EXFOR web retrieval system, (4) X4Pro as a universal and fully relational EXFOR database, (5) EE-View (a new viewer for data in EXFOR and ENDF formats) and (6) X5 (EXFOR in JSON).He mentioned that the X4Pro database and X5-json could be treated as NRDC products. The participants supported his idea to distribute X4Pro with X5 if the source code and documentation for X4Pro production are shared within the Network.

**V. Zerkin** reviewed existing distribution of the full EXFOR contents (e.g., standalone database, download of full EXFOR in a computational format, exchange files), and proposed the participants to discuss the NRDC policy for off-line EXFOR distribution considering the purpose, users, contents and formats, frequency, and media/storage. The participants recommended release of the EXFOR Master File, dictionaries, and their documentations as Open Data with Document Object Identifiers (DOI) and an open data license (CC-BY-4.0 or similar). The participants also concluded that the working materials such as preliminary and final trans tapes and backup files should not be included in the Open Data distribution and must be closed to the NRDC participants.

**V. Zerkin** also reviewed the software packages used in the NDS EXFOR system. He categorized his packages to three types (1) standalone tools (e.g., database maintenance tool for conversion of EXFOR/ENDF/CINDA to relational databases), (2) standalone/online tools (e.g., interpreters to generate X4+, C5 etc.), and (3) online tools (e.g., retrieval systems, MyExfor). The participants recommended NDS to share the software source codes and their documentation within the Network.

### 2.10 Other Business

**T. Zholdybayev** informed that the Central Asian group (Kazakhstan and Uzbekistan) compiled seven articles since the last NRCD meeting (EXFOR D8059 which was finally merged into D0924, D8053, D8055-D8057, D8061-D8062) and 13 articles from Kazakhstan are still waiting compilation. He also reported that he found a laboratory logbook recording double differential cross sections of charged particle emission from $^{56}$Fe, $^{60}$Ni, $^{59}$Co and $^{116}$Sn irradiated by deuterons at 25 MeV and from $^{208}$Pb irradiated by alpha particles at 50 MeV, and made these numerical data computer readable for inclusion in an EXFOR entry.

### 2.11 Closing

**N. Otsuka** proposed the dates and places for the next technical NRDC meeting (Vienna, Austria, 14 to 17 May 2024) and for the next full NRDC meeting (Paris, 2nd quarter of 2025), and they were approved.

**M. Fleming** presented possible revisions of the "EXFOR Protocol" to reflect the conclusions on distribution policy of the EXFOR Master File and working materials.

**D. Brown** presented a draft of the Conclusions and Actions for review by the participants.

**M. Fleming** expressed his thanks to Zerkin for his outstanding services to the Network since 1999. **N. Otsuka** thanked for chairmanship taken by Brown.

**R. Capote** called an adjournment of the meeting.

**Appendix A**

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**Appendix B**

# AGENDA

## Tuesday, 9 May 2023

**9:30 – 13:00 (CET)**

| | | | | |
|---|---|---|---|---|
| **1** | **Opening Items** | | | |
| 1.1 | Welcome address | 10 min | | R. Capote |
| 1.2 | Announcement | 5 min | | M. Charisse |
| 1.3 | Election of chairperson, adoption of the agenda, announcements | 5 min | | N. Otsuka |
| **2** | **Progress Reports** | | | |
| 2.1 | NDS | 10 min | P2023-01 | R. Capote |
| 2.2 | CDFE | 10 min | P2023-02 | V. Varlamov |
| 2.3 | CNPD* | 10 min | P2023-03 | S. Taova |
| 2.4 | CJD* | 10 min | P2023-04 | M. Mikhailiukova |
| 2.5 | NDPCI | 10 min | P2023-05 | |
| 2.6 | UkrNDC | 10 min | P2023-06 | O. Gritzay |
| 2.7 | CNDC | 10 min | P2023-07 | N.C. Shu, J.M. Wang |
| 2.8 | KNDC | 10 min | P2023-08 | D.H.Kim |
| 2.9 | JCPRG | 10 min | P2023-09 | M. Kimura |
| 2.10 | ATOMKI | 10 min | P2023-10 | S. Takacs |
| 2.11 | JAEA | 10 min | | O. Iwamoto |
| 2.12 | NEA DB | 10 min | | M. Fleming |
| 2.13 | NNDC | 10 min | | D. Brown, B. Pritychenko |
| | | *150 min* | | |

* The progress reports of CNPD and CJD may be shifted to 10 May since 9 May is a holiday of Russian Federation.

**14:00 – 17:00 (CET)**

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|---|---|---|---|---|
| **3** | **EXFOR Statistics and Coverage** | | | |
| 3.1 | Transmission statistics since the last NRDC meeting | 10 min | WP2023-02 | V. Devi |
| 3.2 | Status of new article compilation (A1) | 10 min | WP2023-03 | N. Otsuka |
| 3.3 | Time interval between submission of preliminary and final tapes | 10 min | WP2023-04 | V. Devi |
| 3.4 | New publications scanned by NDS and other centres | 10 min | WP2023-05 | V. Devi |
| 3.5 | Progress in correction of items on Feedback List (A2) | 10 min | WP2023-06 | N. Otsuka |
| 3.6 | Other actions (A3) | 10 min | WP2023-01 | Chairperson |

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|---|---|---|---|---|
| **4** | **Manual and Dictionary** | | | |
| 4.1 | Review of scanning responsibility (CP-D/1078, A5) | 10 min | WP2023-07 | N. Otsuka |
| 4.2 | Review of compilation responsibility | 20 min | | |
| 4.3 | LEXFOR “Scattering” (4C-3/0421, A15) | 10 min | WP2023-08 | N. Otsuka |
| 4.4 | Dictionary 227 (Nuclides) converted from NUBASE2020 (CP-D/1067, A11) | 20 min | WP2023-09 | N. Otsuka |
| 4.5 | Improvement of Dictionary 3 (Institutes) for efficient compilation (CP-D/1080) | 10 min | WP2023-10 | N. Otsuka |
| | | *130 min* | | |

## Wednesday, 10 May 2022

**9:00 – 13:00 (CET)**

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| **4** | **Manual and Dictionary (cont)** | | | |
| 4.6 | Revision of EXFOR/CINDA Dictionary Manual and format change (CP-D/1081) | 10 min | WP2023-11 | N. Otsuka |
| 4.7 | Deletion of the reference type code K (Abstract of journal) | 10 min | | N. Otsuka |
| 4.8 | Dictionary maintenance | 20 min | | N. Otsuka |
| 4.9 | Other actions (A4, A6-A10, A12-A14) | | WP2023-01 | Chairperson |
| **5** | **CINDA** | | | |
| 5.1 | Status of CINDA database (A16) | 10 min | WP2023-12 | V. Zerkin |
| 5.2 | Other actions (A17) | 5 min | WP2023-01 | Chairperson |
| **6** | **EXFOR Compilation Needs** | | | |
| 6.1 | Compilation of articles with priority (A18, A23-A26) | 10 min | WP2023-13 | N. Otsuka |
| 6.2 | Compilation of articles from completeness checking (A19-A22, A28) | 10 min | WP2023-14 | N. Otsuka |
| 6.3 | Progress in compilation of fission product yields (A27) | 10 min | WP2023-15 | N. Otsuka |
| 6.4 | Individual data requests (A29) | 10 min | WP2023-16 | N. Otsuka |
| 6.5 | Other actions (A30-A33) | 10 min | WP2023-01 | Chairperson |
| **7** | **EXFOR Quality Control** | | | |
| 7.1 | Pending corrections (A34-A51) | 10 min | WP2023-17 | N. Otsuka |
| 7.2 | Duplication | 10 min | WP2023-18 | N. Otsuka |

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|---|---|---|---|---|
| 7.3 | Comparison of REACTION SF4 isomeric flag against NUBASE2020 (CP-D/1052(Rev.)) | 10 min | WP2023-19 | N. Otsuka |
| 7.4 | Illegal repetition of heading (CP-D/1070) | 10 min | WP2023-20 | N. Otsuka |
| 7.5 | Review of production cross-section of a, d, g, h, p, and t induced reactions for validating TENDL-2021 curves | 20 min | WP2023-21 | V. Devi |
| 7.6 | ZCHEX messages from EXFOR Master 2023-04-24 (CP-D/1082, A57-A58) | 20 min | WP2023-22 | N. Otsuka |
| 7.7 | Other actions (A52-A56, A59-A60) | 10 min | WP2023-01 | Chairperson |
| | | *195 min* | | |

**14:00 – 17:00 (CET)**

| | | | | |
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| **8** | **EXFOR Coding Rule** | | | |
| 8.1 | STATUS: Format extension and LEXFOR revision (CP-D/1053, CP-D/1055(Rev.), A63) | 30 min | WP2023-23 | N. Otsuka |
| 8.2 | Usage of ERR-HL and ERR-IDD (CP-D/1038) | 10 min | WP2023-24 | S. Dunaeva |
| 8.3 | Use of pointer for individual variables (CP-D/1056) | 10 min | WP2023-25 | N. Otsuka |
| 8.4 | Gamma production following quasi-metastable state production (CP-D/1057(Rev.), CP-D/1073) | 30 min | WP2023-26 | V. Devi |
| 8.5 | Proposal to use non-integer numbers to define FLAG and DECAY-FLAG (CP-D/1069) | 10 min | WP2023-27 | V. Devi |
| 8.6 | Omission of data type field (SF9) in MONITOR and ASSUMED (CP-D/1071) | 20 min | WP2023-28 | N. Otsuka |
| | | *110 min* | | |

**19:00-**
Social event (“Nestroy Gasthaus & Biergarten”, Weintraubengasse 7, 1020 Wien. U1 Nestroyplatz)

# Thursday, 11 May 2023

**9:00 – 13:00 (CET)**

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| **8** | **EXFOR Coding Rule (cont.)** | | | |
| 8.7 | $^{209}$Bi(p,x)$^{211}$At cross section? - secondary particle induced reaction (CP-D/1072) | 20 min | WP2023-29 | N. Otsuka |
| 8.8 | LEXFOR “Activation” (CP-D/1076) | 10 min | WP2023-30 | N. Otsuka |
| 8.9 | Compilation of the zeroth order Legendre coefficients (4C-4/0233) | 20 min | WP2023-31 | M. Mikhailiukova |
| 8.10 | Other actions (A61-A62) | 10 min | WP2023-01 | Chairperson |
| **9** | **Evaluated Data Libraries** | | | |
| 9.1 | JENDL-5 overview | 30 min | | O. Iwamoto |
| **10** | **Software and Dissemination** | | | |
| 10.1 | Compilation of isomeric ratios | 20 min | | N. Otsuka |
| 10.2 | Utility for INSTITUTE coding (CP-D/1079) | 15 min | WP2023-32 | N. Otsuka |
| 10.3 | Dataexplorer and Exfortables_py by EXFOR Parser | 15 min | | S. Okumura |
| 10.4 | Progress in development of “EXFOR/ENDF/IBANDL" databases, retrieval systems, tools and software (I) | 40 min | | V. Zerkin |
| | | *180 min* | | |

**14:00 – 17:00 (CET)**

| | | | | |
|---|---|---|---|---|
| **10** | **Software and Dissemination (cont.)** | | | |
| 10.5 | Progress in development of “EXFOR/ENDF/IBANDL" databases, retrieval systems, tools and software (II) | 80 min | | V. Zerkin |
| 10.6 | EXFOR offline distribution | 40 min | | V. Zerkin |
| 10.7 | Software of NDS EXFOR system: status, plans for future | 40 min | | V. Zerkin |
| 10.8 | Other actions (A64-A96) | 10 min | WP2023-01 | Chairperson |
| | | *170 min* | | |

# Friday, 12 May 2023

**9:00 – 12:00 (CET)**

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| **11.** | **Other Business** | | | |
| 10.1 | Compilation of experimental nuclear reaction data from Central Asia | 10 min | WP2023-33 | T. Zholdybayev |
| 10.2 | JNST special issue on nuclear data; GRE@T-PIONEeR nuclear data course | 10 min | | N. Otsuka |
| 10.3 | Isomeric ratio | 20 min | | S. Takacs |
| **12.** | **Closing** | | | |
| 11.1 | Dates and places of next meetings | 10 min | | N. Otsuka |
| 11.2 | Review of Conclusions and Actions | 60 min | | Chairperson |
| | | *90 min* | | |

**Appendix C**

# CONCLUSIONS AND ACTIONS

## Conclusions

### General

C1 The next technical NRDC meeting will be held in Vienna, Austria from 14 to 17 May 2024.

C2 The next full NRDC meeting will be held in Paris, France in the second quarter of 2025.

C3 The next EXFOR compilation workshop will be held in Vienna, Austria in the fourth quarter of 2024.

C4 The NRDC supports reviewing and updating the Network Document (INDC(NDS)-0401).

### EXFOR General

C5 The NRDC supports releasing the EXFOR Master Files, Dictionaries and their documentation as Open Data, with Document Object Identifiers (DOI) and an acceptable open data license (CC-BY-4.0 or similar). Each released Master File would then require its own DOI and internet landing page. This distribution should be made retroactively ca. 2015 onward and should not include NRDC working materials such as preliminary and final trans tapes, and backup files.

C6 The NDS open and backup areas require authentication and must be accessible to the NRDC participants only.

C7 The preliminary tape will not be deleted but kept on the NDS open area even after its finalization.

C8 The NRDC supports releasing all EXFOR codes and their documentation as Open Source necessary to support the use of EXFOR data (especially the EXFOR Master Files) by the broader community.

C9 Regarding staff changes in NDS, NRDC recommends sharing EXFOR software source codes and their documentation developed by Zerkin between NRDC centres.

C10 The basic compilation responsibility (Appendix C of NRDC Protocol) of JAEA will be compilation of the neutron data measured at JAEA or measured in Japan in cooperation with JAEA Nuclear Data Center. They will be compiled in area 2 and submitted through NEA DB.

**EXFOR Statistics and Coverage**

C11 The Network finalized 351 new entries since the NRDC 2022 meeting (11 months).

C12 The originating centre should (1) update the N2 field of TRANS (date of transmission) just before submission to the NDS open area, and (2) announce release of a new final tape without delay.

**Manuals and Dictionary**

C13 The revised NRDC Protocol Appendix B (Scanning responsibility) proposed in CP-D/1078 = WP2023-07 was approved.

C14 The revised LEXFOR "Scattering" proposed in 4C-3/0421 = WP2023-08 was approved.

C15 The new format of Dictionary 227 (Nuclides) proposed in CP-D/1067 = WP2023-09 was approved.

C16 Addition and deletion of the institute codes proposed in CP-D/1080 = WP2023-10 was approved.

C17 Revised EXFOR/CINDA Dictionary Manual proposed in CP-D/1081 = WP2023-11 was approved.

C18 The reference type code K (abstract of journal) should not be used since it may introduce inconsistency with the entries which data were compiled from journal abstracts with the reference type code J.

**EXFOR Quality Control**

C19 The keyword ERR-ANALYS must be present with coded information when error fields associated to the dependent variable (e.g., DATA-ERR, ERR-S, ERR-1) are given. Otherwise, presence is optional as proposed in CP-D/1082 = WP2023-22.

**EXFOR Coding Rule**

C20 The revised EXFOR Formats Manual and LEXFOR for the keyword STATUS proposed in CP-D/1053 and CP-D/1055 (Rev.) = WP2023-23 were approved. Use of the reference code field is optional.

C21 The headings ERR-HL and ERR-IDD may be used only when they are propagated to the total uncertainty (ERR-T) and their propagated partial %-uncertainties are not available for coding under ERR-1 etc. as proposed in CP-D/1038 = WP2023-24.

C22 Use of the multiple reaction formalism is not limited to the quantities having the same independent variables. The vector common formalism is no longer necessary, and it will be abolished. The cumulative and chain fission product yields may be compiled together in the same subentry by using the formalism as proposed in CP-D/1056 = WP2023-25. The use of the multiple reaction formalism is limited to the cases listed in LEXFOR "Multiple Reaction Formalism".

C23 The coding rules of REACTION SF4-SF7 for the cascade gammas not following quasi-metastable state production (,PAR/L-,DA,G) and for the cascade gammas following quasi-metastable state production (-L,PAR,DA,DG) proposed in CP-D/1057 (Rev.) = WP2023-26 were approved.

C24 Use of fixed decimal point numbers other than integers under the heading FLAG and DECAY-FLAG proposed in CP-D/1069 = WP2023-27 was not approved.

C25 The data type field (SF9) is always omitted under the keyword MONITOR and ASSUMED as proposed in CP-D/1071 = WP2023-28.

C26 Cross sections for reactions induced by secondary particles are not for compilation as proposed in CP-D/1072 = WP2023-29.

C27 Revision of LEXFOR "Activation" (restriction for use of the method code ACTIV) proposed in CP-D/1076 = WP2023-30 was approved.

C28 Legendre coefficients of 0th order and higher orders must be compiled together as a single dataset as proposed in 4C-4/0233 (Rev.) = WP2023-31.

**Tools for Compilation and Dissemination**

C29 NRDC supports proposal of Zerkin to distribute X4Pro database with X5 as a product of NRDC recommended for users' community. Implementing must include sharing NDS source code and documentation producing X4Pro within NRDC.

C30 NRDC recommends continuing the functioning of Web EXFOR-CINDA-ENDF-IBANDL Retrieval system including MyExfor on NDS and Mirror sites. Standalone version of this system would be also useful.

C31 NRDC recommends continuing maintenance and extension of EXFOR-NSR PDF database at NDS.

C32 NRDC encourages development of other software systems which interact with the EXFOR data.

## Actions

### General

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| A1 | Centre Heads | Send to Otsuka revised description of the centre in the Network Document (INDC(NDS)-0401) by end of 2023. |

### EXFOR General

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| A2 | Marian | Follow-up on the effort of the IAEA to mint DOIs. When this becomes available at the IAEA, facilitate the set-up of a procedure to obtain DOIs for the EXFOR Master versions, in line with the IAEA workflows |
| A3 | Marian | Follow up with the IAEA Legal department the NRDC's decision of releasing all the NRDC products under the CC-BY-4.0 license. |
| A4 | Koning | Inform centre heads of final license proposed by the IAEA for distribution of files. |

### EXFOR Statistics and Coverage

| | | |
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| A5 | All | (Standing action) Give the highest priority to compilation of new articles. |
| A6 | All | (Standing action) Correct erroneous entries listed on the EXFOR Feedback List according to the indicated priorities. All urgent corrections must be done by the next meeting. |

### Manuals and Dictionaries

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|---|---|---|
| A7 | Otsuka | (Continuing action) Update Dictionaries every six months. |
| A8 | Zerkin<br>Otsuka | (Continuing action) Propose a numbering scheme for compound codes defined in Dictionary 209. |
| A9 | Otsuka | Revise NRDC Protocol Appendix B according to CP-D/1078 = WP2023-07 and Appendix C according to Conclusion 10 (neutron data by JAEA). |
| A10 | Otsuka | Revise EXFOR Formats Manual for<br>1) CP-D/1053 = WP2023-23 (STATUS)<br>2) CP-D/1056 = WP2023-25 (Multiple reaction formalism)<br>3) CP-D/1069 = WP2023-27 (DECAY-DATA and FLAG)<br>4) CP-D/1071 = WP2023-28 (ASSUMED and MONITOR) |

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| A11 | Otsuka | Revise LEXFOR for<br>1) 4C-3/0421 = WP2023-08 (Scattering)<br>2) 4C-4/0233 = WP2023-31 (Fitting coefficients)<br>3) CP-D/1038 = WP2023-24 (Error)<br>4) CP-D/1055(Rev.) = WP2023-23 (Status)<br>5) CP-D/1072 = WP2023-29 (Production and emission cross sections)<br>6) CP-D/1076 = WP2023-30 (Activation) |
| A12 | Otsuka | Revise EXFOR/CINDA Dictionary Manual according to<br>1) CP-D/1067 = WP2023-09 (Dictionary 227)<br>2) CP-D/1081 = WP2023-11 (full review) |
| A13 | Otsuka | Revise Dictionary 3 according to CP-D/1080 = WP2023-10. |
| A14 | Otsuka | Delete the code K (abstract of journal) in Dictionary 4 (reference type). |
| A15 | Otsuka | Add the codes L- and PAR/L-,DA,G to Dictionary 31 (branches) and 236 (quantities), respectively. |
| A16 | Devi | Summarize the coding suggested in CP-D/1073 = WP2023-26 for LEXFOR “Partial reactions”. |

**CINDA**

| | | |
|---|---|---|
| A17 | Zerkin | (Continuing action) Export EXFOR to CINDA, and distribute it to other Centres. |
| A18 | NNDC | Create meta schema for bibliographic data encompassing CINDA, EXFOR, NSR, Atlas and ENSDF. Report to NRDC for next actions. |

**EXFOR Compilation Needs**

**(**Underlined items are registered in the Article Allocation List.)

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|---|---|---|
| A19 | Foligno<br>Pritychenko | Compile with priority the articles listed in WP2023-16 to respond to the requests from EXFOR users. |
| A20 | Pritychenko | (Continuing action) Compile with priority the neutron source spectra listed in CP-D/0700 (Rev.3). |
| A21 | Pritychenko | (Continuing action) Compile with priority R.G.Lanier+,R,UCAR-10062-89,71,1989 listed in CP-D/0725 Rev. (~WP2012-19). |
| A22 | Pritychenko<br>Nomura<br>Taova | (Continuing action) Compile with priority the light charged-particle induced isotope production cross sections listed in CP-D/0757 = WP2013-12. |

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| A23 | Pritychenko | (Continuing action) Compile with priority T.Mo+,J,NP/A,198,153,1972 listed in CP-D/0832 Rev. |
| A24 | Pritychenko | (Continuing action) Compile with priority W.G. Alberts+,R,NUREG/CP-0029,433,1982 in CP-D/0838 = WP2014-21. |
| A25 | Pritychenko | (Continuing action) Compile the thermal neutron-induced reaction data cited in Mughabghab's "Atlas of Neutron Resonances" and listed in 4C-3/0395 = WP2014-19. |
| A26 | Pritychenko | (Continuing action) Compile F. Bischoff,R,RPI-328-87,146,1966 listed in 4C-3/0404 = WP2016-19. |
| A27 | Pritychenko | (Continuing action) Compile P.L.Reeder+,J,PR/C,15,2108,1977 listed in 4C-3/0410 = WP2018-20. |
| A28 | Pritychenko | (Continuing action) Compile deuteron-induced reaction data compiled by the Frascati group and listed in CP-D/0758. |
| A29 | Foligno<br>Pritychenko<br>Nomura<br>Varlamov | (Continuing action) Compile articles reporting experimental fission product yields and listed in CP-C/464, 465, 466 and CP-D/0979. Inform Devi if an article in the lists is not for EXFOR compilation. Transmit EXFOR entries relevant to these lists separately from other EXFOR entries. |
| A30 | Gritzay | (Continuing action) Compile data measured with filtered neutrons measured at the KINR research reactor with numerical neutron spectra. |
| A31 | Pritychenko | (Continuing action) Monitor availability of P.E. Koehler's time-of-flight spectra on DVDs received from ORELA in 2015 for EXFOR compilation. |
| A32 | Pritychenko<br>Brown | (Continuing action) Perform EXFOR completeness checking for the list of articles (4C-3/0401, articles cited in S. Mughabghab's "Atlas of Neutron Resonances") to identify articles missing in EXFOR, and assign responsibility of compilation of the identified articles to centres by a memo. |

**EXFOR Quality Control**

(Underlined items are registered in the EXFOR Feedback List.)

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|---|---|---|
| A33 | Pritychenko<br>Nomura<br>Taova | Resolve the duplications listed in WP2023-18. |
| A34 | Pritychenko | Revise the datasets of neutron elastic scattering including inelastic scattering contribution as proposed in 4C-3/0420(Rev2). |

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| A35 | Pritychenko | (Continuing action) Replace REACTION SF3=A with EL in C0753.002 (CP-D/0960 = WP2019-31). |
| A36 | Pritychenko | (Continuing action) Revise entries involving several variable atomic and/or mass numbers listed in CP-D/0984 in WP2021-31. |
| A37 | Pritychenko | (Continuing action) Revise DECAY-DATA and DECAY-MON records including EC (electron capture) listed in CP-D/0989 = WP2021-07. |
| A38 | Pritychenko | (Continuing action) Replace EL and INL in REACTION SF3 of 12373.008 with SCT (Memo CP-D/0991 = WP2021-26). |
| A39 | Pritychenko | (Continuing action) Revise entries relevant to 511 keV gamma emission listed in CP-D/1005 = WP2021-33. |
| A40 | Nomura | (Continuing action) Revise entries involving isomers of Nb-102, Tc-102, Rh-108, Sb-128 and Sb-132 according to Appendix of Memo CP-D/1009 (Rev.) = WP2021-28. |
| A41 | Pritychenko<br>Nomura | (Continuing action) Revise REACTION SF3 and SF7 listed in Appendices 1, 2 and 3 of CP-D/1014 = WP2021-10 (Combination of particle codes and their order in REACTION SF7). |
| A42 | Pritychenko | (Continuing action) Replace X with an appropriate code or code combination REACTION SF3 of entries listed in CP-D/1017 = WP2022-24. |
| A43 | Nomura | (Continuing action) Replace the extra heading DATA with an appropriate one as listed in CP-D/1027 = WP2022-28. |
| A44 | Nomura | (Continuing action) Replace ‚INT„BRA with ‚INT„BRS in K2191.007-010 as listed in CP-D/1037 = WP2022-16. |
| A45 | Pritychenko | (Continuing action) Replace TABLE with SCSRS or update the free text unless the numerical data are published in source articles as listed in CP-D/1041 = WP2022-27. |
| A46 | Pritychenko<br>Nomura | (Continuing action) Revise entries relevant to assessment of suspicious E-LVL values as listed in CP-D/1043 = WP2022-26. |
| A47 | Devi<br>Pritychenko<br>Nomura<br>Taova<br>Varlamov | Correct the isomeric flags in REACTION and DECAY-DATA listed in CP-D/1052Rev. = WP2023-19. |

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| A48 | Devi<br>Foligno<br>Pritychenko<br>Nomura<br>Taova<br>Varlamov | Resolve with priority the repetition of data headings listed in CP-D/1070 = WP2023-20. |
| A49 | Foligno<br>Mikhailiukova<br>Pritychenko | Replace NO-DIM with the correct unit for the absolute eta values listed in CP-D/1082(Rev.) = WP2023-22. |
| A50 | Foligno<br>Pritychenko | (Continuing action) Consider addition of numerical data which are not superseded (SPSDD) and suitable for digitization, but still unobtainable (UNOBT) for neutron-induced reaction data published in old literature. |
| A51 | Foligno | (Continuing action) Provide a report on mistakes in bibliographies and spells on each preliminary tape. |
| A52 | Pritychenko | (Continuing action) Revise EXFOR entries compiling data sets from ORELA 40 m flight station listed in the Appendix of 4C-3/407 = WP2017-30 by addition of<br>1) the corrigendum under REFERENCE of the common subentry,<br>2) STATUS=OUTDT to each data subentry with the correction factor in free text. |
| A53 | Soppera | (Continuing action) Provide JANIS Import Log created from the EXFOR Master File to Otsuka on a regular basis. |
| A54 | Otsuka | (Continuing action) Assess the JANIS Import Log provided by Soppera as above and register important errors to the EXFOR Feedback System. |
| A55 | Otsuka | (Continuing action) Review the neutron quasi-elastic scattering cross sections for natural target nuclides and total scattering cross sections similar to the review summarized in Memo 4C-3/0420=WP2022-29. |

**EXFOR Coding Rule**

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| A56 | Takács<br>Otsuka | (Continuing action) Check presence of the cross sections compiled as total (=ground state plus metastable state) independent production cross sections but deviation of the measured values from the actual total cross sections may be non-negligible. |
| A57 | Varlamov<br>Otsuka | (Continuing action) Review the usage of (G,TOT), (G,ABS), (G,SCT) and (G,N) for the cross sections declared as “absorption cross sections” or “total cross sections” by the authors. |

| | | |
|---|---|---|
| A58 | Zerkin | Provide a list of subentries coded with the Vector Common Formalism. |
| A59 | Otsuka<br>Pritychenko | Propose how to keep the $^{209}Bi(p,x)^{211}At$ cross sections in EXFOR listed in CP-D/1072=WP2023-29. |

**Tools for Compilation and Dissemination**

| | | |
|---|---|---|
| A60 | Foligno | (Continuing action) Make available on the NEA Data Bank web site the EANDC and NEANDC reports compiled in EXFOR and not available as INDC reports. |
| A61 | Pikulina | (Continuing action) Continue development and testing of the EXFOR-Editor and InpGraph in cooperation with NDS and other data Centres. |
| A62 | All | (Continuing action) Provide Pikulina feedback on EXFOR-Editor and InpGraph. |
| A63 | Suzuki | (Continuing action) Continue development and testing of GSYS in cooperation with NDS and other centres. |
| A64 | All | (Continuing action) Provide Suzuki feedback on GSYS. |
| A65 | Soppera | (Continuing action) Continue development and testing of the JANIS TRANS Checker in cooperation with NDS and the other centres. |
| A66 | All | (Continuing action) Provide Soppera feedback on JANIS TRANS Checker. |
| A67 | Otsuka | (Continuing action) Provide EXFOR News every month and consider updates to the IAEA NDS website. |
| A68 | Otsuka | (Continuing action) Support update of the Japanese editor (HENDEL) as time permits. |
| A69 | Zerkin | (Continuing action) Update ZCHEX based on comments from compilers. |
| A70 | All | (Continuing action) Provide feedback to NDS on the existing ZCHEX version (on bugs as well as desired additions.). Bugs must be reported with sample entries which are checked and not checked properly by ZCHEX. |
| A71 | Zerkin | (Continuing action) Develop and distribute the program package including a standalone platform independent program to generate X4+ from a standalone EXFOR entry. |

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|---|---|---|
| A72 | All | (Continuing action) Consider using the X4+ format for author approval, and also send feedback to Zerkin. |
| A73 | Zerkin | (Continuing action) Continue development of the EXFOR upload web tool MyExfor. Prepare standalone version of Web EXFOR CINDA-ENDF-IBANDL retrieval system with MyExfor working without Internet (c.f. Conclusion 30) |
| A74 | Zerkin | (Continuing action) Produce: (a) EXFOR Master File with Dictionary-236 and X4Map after every database update, and (b) Dictionaries in MS Access after every Dictionaries update (see also A4). |
| A75 | Zerkin | (Continuing action) Continue development of the additional database encompassing correction factors and relevant comments for suspect/erroneous data (X4-evaluated) presented in WP2010-19; keep NRDC informed about results, impact and usage statistics of the database. |
| A76 | Zerkin | To start public distribution of X4Pro database and package. |
| A77 | Zerkin<br>Pritychenko | (Continuing action) Continue joint development of the EXFOR and NSR databases. |
| A78 | Jin<br>Suzuki<br>Pikulina<br>Zerkin | (Continuing action) Study problems in 2D calibration of original pictures, and process of approval of results of digitizing using plotting facilities. |
| A79 | Foligno<br>Pritychenko | (Continuing action) Finalize and submit EXFOR entries including covariance data provided by Zerkin (WP2017-Z3). |
| A80 | Pritychenko | (Standing action) Provide NSR database to Zerkin with the name aliases to improve the search of EXFOR entries by the author name (WP2014-53). |
| A81 | Pritychenko<br>Zerkin<br>Otsuka | (Continuing action) Investigate assignment of Digital Object Identifiers (DOI) for EXFOR data sets using DataCite and one of EXFOR formats. Start a pilot project and produce several DOI for EXFOR data sets. |
| A82 | Zerkin<br>Pritychenko | (Continuing action) Collaborate with the IAEA INIS Unit for technical matching of the pdf databases maintained by NDS and the Unit. |
| A83 | Zerkin<br>Mikhailiukova | (Continuing action) Arrange a letter to IPPE for opening public access from the NDS web retrieval system to IPPE reports. |

| | | |
|---|---|---|
| A84 | Zerkin | (Continuing action) Prepare a manual describing the EXFOR database related tools available on the NDS web site. |
| A85 | Pritychenko | (Continuing action) To investigate NNDC library for missing private communication relevant to EXFOR compilation. |
| A86 | Zerkin<br>Vrapcenjak | Maintain and extend (as needed) the EXFOR-NSR PDF database. |
| A87 | Vrapcenjak | (Continuing action) Collect articles coded under REFERNECE of newly submitted preliminary tapes but missing in the NDS article collection. |
| A88 | All | (Continuing action) Collaborate with Vrapcenjak for collection of articles coded under REFERENCE of newly submitted preliminary tapes but missing in the NDS article collection. |
| A89 | All | Analyze X5 structure/hierarchy and contents, contact Zerkin with questions and proposals. |
| A90 | Zerkin | Take into account proposals on structure of X4Pro and X4+1(=X5). |
| A91 | Otsuka<br>Zerkin | Prepare distribution EXFOR-Master File and Dictionaries (from 2005 onward). Prepare and distribute among NRDC members a software generating next Master File using previous Master File and TRANS file providing possibility for every NRDC Data Centre to maintain and reproduce Master File locally. |
| A92 | Otsuka | Prepare EXFOR Master landing page(s). Landing page should include data license, corresponding EXFOR Dictionaries and links to documentation. |
| A93 | Zerkin | Prepare software package producing Dictionaries in MS-Access used in EXFOR Editor for Sarov group |
| A94 | Zerkin,<br>Pikulina<br>Taova | Setup software package (A93) in Sarov and start producing Dictionaries in MS-Access used in EXFOR Editor |
| A95 | Marian<br>Otsuka<br>Zerkin | Implement authentication of the NDS open and backup areas and provide access to the NDS participants. |

**Appendix D**

# LIST OF WORKING PAPERS

| Number | Title | Presented by |
|---|---|---|
| WP2023-01 | Conclusions and action of the 2022 NRDC Meeting | |
| WP2023-02 | Transmission statistics since the last NRDC meeting | V.Devi |
| WP2023-03 | Status of new article compilation (A1) | N.Otsuka |
| WP2023-04 | Time interval between submission of preliminary and final tapes | V.Devi |
| WP2023-05 | New publications scanned by NDS and other centres | V.Devi |
| WP2023-06 | Progress in correction of items on Feedback List (A2) | N.Otsuka |
| WP2023-07 | Review of scanning responsibility (CP-D/1078, A5) | N.Otsuka |
| WP2023-08 | LEXFOR "Scattering" (4C-3/0421, A15) | N.Otsuka |
| WP2023-09 | Dictionary 227 (Nuclides) converted from NUBASE2020 (CP-D/1067, A11) | N.Otsuka |
| WP2023-10 | Improvement of institute code expansions (CP-D/1080) | N.Otsuka |
| WP2023-11 | Revision of EXFOR/CINDA Dictionary Manual and format change (CP-D/1081) | N.Otsuka |
| WP2023-12 | Status of CINDA database (A16) | V.Zerkin |
| WP2023-13 | Compilation of articles with priority (A18, A23-A26) | N.Otsuka |
| WP2023-14 | Compilation of articles from completeness checking (A19-A22,A28) | N.Otsuka |
| WP2023-15 | Progress in compilation of fission product yields (A27) | N.Otsuka |
| WP2023-16 | Individual data requests (A29) | N.Otsuka |
| WP2023-17 | Pending corrections (A34-A51) | N.Otsuka |
| WP2023-18 | Duplication | N.Otsuka |
| WP2023-19 | Comparison of REACTION SF4 isomeric flag against NUBASE2020 (CP-D/1052(Rev.)) | N.Otsuka |
| WP2023-20 | Illegal repetition of heading (CP-D/1070) | N.Otsuka |

| | | |
|---|---|---|
| WP2023-21 | Review of production cross-section of a, d, g, h, p, and t induced reactions for validating TENDL-2021 curves | V.Devi |
| WP2023-22 | ZCHEX messages from EXFOR Master 2023-04-24 (CP-D/1082(Rev.), A58) | N.Otsuka |
| WP2023-23 | STATUS: Format extension and LEXFOR revision (CP-D/1053, CP-D/1055(Rev.), A63) | N.Otsuka |
| WP2023-24 | Usage of ERR-HL and ERR-IDD (CP-D/1038) | S.Dunaeva |
| WP2023-25 | Use of pointer for individual variables (CP-D/1056) | N.Otsuka |
| WP2023-26 | Gamma production following quasi-metastable state production (CP-D/1057(Rev.), CP-D/1073) | V.Devi |
| WP2023-27 | Proposal to use non-integer numbers to define FLAG and DECAY-FLAG (CP-D/1069) | V.Devi |
| WP2023-28 | Omission of data type field (SF9) in MONITOR and ASSUMED (CP-D/1071) | N.Otsuka |
| WP2023-29 | 209Bi(p,x)211At cross section? - Secondary particle induced reaction (CP-D/1072) | N.Otsuka |
| WP2023-30 | LEXFOR "Activation" (CP-D/1076) | N.Otsuka |
| WP2023-31 | Compilation of the zeroth order Legendre coefficients | M.Mikhailyukova |
| WP2023-32 | INST-FINDER and its extension with Naive Bayes classifier (CP-D/1079) | N.Otsuka |
| WP2023-33 | Compilation of experimental nuclear reaction data from Central Asia | T.Zholdybayev |

Note: These working papers are available online: http://nds.iaea.org/nrdc/nrdc_2023/.

**Appendix E**

# LIST OF PRESENTATIONS

| TITLE | Presented by |
|---|---|
| Center of Nuclear Physics Data | S. Taova |
| IAEA Nuclear Data Section | R.Capote |
| Ukrainian Nuclear Data Centre:Progress Report 2022/23 | O.Gritzay |
| Center of Nuclear Physics Data | S.Taova |
| 2022/23 status report of China Nuclear Data Center | N.Shu |
| Korea Nuclear Data Center progress report for 2022-2023 | D.H.Kim |
| Progress report on the CDFE 2022/2023 photonuclear data processing activity | V.Varlamov |
| Progress Report for NRDC Meeting 2023 | S.Takacs |
| Progress report of Nuclear Data Center of Japan Atomic Energy Agency for FY 2021 - 2022 | O.Iwamoto |
| NNDC Report to the NRDC | D.Brown |
| EXFOR Activity at CNDC 2022-2023 | J.M.Wang |
| JCPRG progress report | M.Kimura |
| The present status of the EXFOR project: Area #1 | B.Pritychenko |
| Progress report Technical Meeting NRDC2023 10-12 May 2023 held by NDS, IAEA | M.Mikhailiukova |
| EXFOR/CINDA Dictionary Maintenance | N.Otsuka |
| Gamma production following quasi-metastable state production | V.Devi |
| Overview of JENDL-5 | O.Iwamoto |
| Compilation of isomeric ratio for light-particles induced reactions | N.Otsuka |
| Progress in EXFOR/ENDF/IBANDL/PDF databases, retrieval systems, tools and software | V.Zerkin |
| Distribution of whole EXFOR | V.Zerkin |

| | |
|---|---|
| Software of NDS EXFOR system | V.Zerkin |
| Compilation of experimental nuclear reaction data from Central Asia | T.Zholdybayev |
| Isomeric ratio | S.Takacs |
| JNST special issue on ND, GRE@T-PIONEeR ND course | N.Otsuka |

Note: These presentations are available online: http://nds.iaea.org/nrdc/nrdc_2023/.

**Appendix F**

# PROGRESS REPORTS

| Number | Title | Presented by |
|---|---|---|
| P2023-01 | IAEA Nuclear Data Section: Progress Report for period 2022-2023 | R.Capote |
| P2023-02 | Progress report on the CDFE 2022/2023 photonuclear data processing activity | V.Varlamov |
| P2023-03 | Center of Nuclear Physics Data (CNPD), RFNC-VNIIEF | S.Taova |
| P2023-04 | | M.Mikhailiukova |
| P2023-05 | Nuclear Data Physics Centre of India (NDPCI) Progress Report | |
| P2023-06 | Ukrainian Nuclear Data Center: Progress Report for period 2022-2023 Summary of Nuclear Data Activity by Staff of the Ukrainian Nuclear Data Center June 2022 – April 2023 | O.Gritzay |
| P2023-07 | 2022/23 Status Report of China Nuclear Data Center | N.C.Shu |
| P2023-08 | Korea Nuclear Data Center (KNDC) Progress Report for period 2022-2023 | D.H.Kim |
| P2023-09 | Japan Nuclear Reaction Data Centre (JCPRG) Progress Report | M.Kimura |
| P2023-10 | Progress Report NRDC-2023 Technical Meeting | S.Takacs |

Note: These progress reports are available online: http://nds.iaea.org/nrdc/nrdc_2023/.

# IAEA Nuclear Data Section: Progress Report for period 2022-2023

**Summary of Nuclear Data Activity by Staff of the IAEA Nuclear Data Section**

**June 2022 – April 2023**

IAEA Technical Meeting, 9-12 May 2023
Vienna, Austria
Web: https://nds.iaea.org/
E-mail: nds.contact-point@iaea.org

## 1. Staff Changes

The authorized staff level of the Nuclear Data Section (NDS) consists of a total of 16.25 professionals and support staff. The latest staff changes include:

- Ulrike Perstl (Team Assistant) retired in April 2023.

## 2. Compilations

### 2.1 EXFOR transmission

During the reporting period, the following final tapes have been transmitted:

- 3 neutron final TRANS tapes (3208, V040-V041) containing 19 new entries and 60 revised entries;
- 2 CPND final TRANS tapes (B034, D137) containing 38 new entries and 49 revised entries;
- 1 PhND final TRANS tapes (G049) containing 7 new entries and 12 revised entries.

These include contributions from NDS, five other centres (ATOMKI, CNDC, KNDC, NDPCI, UkrNDC) as well as two individual regular compilers (Myagmarjav Odsuren, Timur Zholdybayev).

Myagmarjav Odsuren (National Univ. of Mongolia, Ulaanbaatar) is compiling heavy-ion induced reaction data measured in the area 2 countries (e.*g.*, Germany, Italy) for area D.

Timur Zholdybayev (Institute of Nuclear Physics, Almaty) is compiling charged-particle induced reaction data measured by his group and some other groups in Kazakhstan for area D.

Two regular transmissions of the EXFOR/CINDA dictionaries (TRANS.9126–9127) were done in TRANS, DANIEL (backup) and archive format.

Number of new entries transmitted by final tapes since the NRDC 2022 meeting
(TZ: Timur Zholdybayev, MO: Myagmarjav Odsuren)

| | **NDS** | **ATOMKI** | **CNDC** | **KNDC** | **NDPCI** | **UkrNDC** | **TZ** | **MO** | **Sum** |
|---|---|---|---|---|---|---|---|---|---|
| Neutron | 6 | | 5 | 0 | 8 | 0 | | | **19** |
| CPND | 8 | 9 | * | 5 | 8 | 1 | 3 | 4 | **38** |
| PhND | 3 | | | 0 | 3 | 1 | | | **7** |
| **Sum** | 17 | 9 | 5 | 5 | 19 | 2 | 3 | 4 | **64** |

***** Area S entries are transmitted by CNDC and therefore not included in these statistics.

### 2.2 EXFOR quality control

During the reporting period, **71 preliminary tapes** (PRELIM) uploaded to the NDS open area for checking by NDS and other centres. Both ZCHEX and JANIS TRANS Checker are regularly used. The finalized tapes are also checked against comments from centres before uploading to the NDS open area. NDS also registers comments on EXFOR entries from users and centres to the **EXFOR Feedback List** (https://nds.iaea.org/nrdc/error/) and monitors the correction process by checking each preliminary tape against the feedback list.

Additionally, Alberto Rodrigo (NDS intern) found many problematic isomer production cross sections and isomeric ratios during analysis of experimental isomeric ratios extracted from EXFOR via X4Pro, and summarized the problems in memos (CP-D/1058, 1060, 1061, 1062, 1065, 1066).

### 2.3 EXFOR coverage control

Under the EXFOR compilation control system, **37 journal titles** are regularly scanned by NDS and registered to the EXFOR Compilation Control System (X4CoCoS), and they are listed in the **Article Allocation List** (https:/nds.iaea.org/nrdc/alloc/). This list also includes the scanning records of 19 journal titles received from other centres. The newly published articles are also listed on https://nds.iaea.org/exfor-master/x4compil/. EXFOR statistics for compilers was extended by indicating waiting time for PRELIM files.

### 2.4 CINDA

Regular automatic updates using the EXFOR and NSR databases have been frozen because NSR database is not available since 2019. Import from EXFOR and NSR-2018 was performed once to keep maintenance system alive.

### 2.5 Evaluated data libraries, files and programs

Various new and revised evaluated data libraries, files and programs for data checking, processing and graphical presentation were added, developed and distributed via the NDS Web site (see below).

## 3. Services

### 3.1 Web Services

Further improvements have been implemented in the Web EXFOR-CINDA-ENDF-IBANDL database retrieval systems and Web-Tools for nuclear data compilers and evaluators since the last NRDC meeting:

- ENDF (Evaluated Nuclear Data Files):
  - new and updated evaluated libraries in the ENDF database:
    - TENDL-2021 TALYS-based Evaluated Nuclear Data Library
    - INDEN-Oct2022 evaluations produced by International Nuclear Data Evaluators Network (coordinated by the IAEA)

- software news:
  - plotting covariances for angular distributions of secondary particles MF34
  - plotting covariances of the average number of neutrons per fission MF31
  - API for search and download data of MF4 with uncertainties from MF34

- EXFOR:
  - Web interface connecting EXFOR to International Nuclear Information System INIS (experimental: for ANL, BARC, CEA, FEI, JINR reports only)
  - X5 - comprehensive presentation of EXFOR in JSON including meta-data, dictionary-info, original and computational data, data for renormalization (available on Web and in X4Pro)
  - CSV - comma separated values of EXFOR data in original, basic and computational form for Excel and other Applications (Web)
  - X5 and CSV Web interface: downloading and Html presentations as interactive tree and tables
- EXFOR-ENDF:
  - EE-View - fast experimental-evaluated data viewer (implemented for cross sections and angular distributions with uncertainties): Web interface to EXFOR-ENDF databases
  - Web-API for search and download data in JSON
- EXFOR-NSR PDF database:
  - updates: 70, added 3,237 PDF files
  - database content (PDF files):
    - total: +3, 237 => 226,127
    - EXFOR-PDF: +988 => 27,845 (78% of 35,666)
    - NSR-PDF: +2,249 => 190,886 (~79% of 241,534)
- IBANDL:
  - 3 database updates (total: 4287 Datasets)
  - Web-API to search and download list (CSV) of datasets and data (R33, JSON)

Development of the Web-Tools for EXFOR compilers, ENDF and ENSDF evaluators:

- MyExfor: 3 updates by new versions of ZCHEX and new Dictionaries
- MyEnsdf: added/upgraded codes: JAVA_NDS, FMTCHK, BrIccMixing
- new authorization system, common for Web MyExfor, MyEndf, MyEnsdf, X4NSR-PDF

The Web EXFOR-CINDA-ENDF-IBANDL database retrieval system is also functioning at BARC (India) and “Atomstandart” (Russia). Statistics for usage of the Web retrieval system are presented in figures below.

### 3.2 Packages and databases for Web downloading

- "X4Pro" extends EXFOR Relational database (SQLite) with experimental data points in original and computational form; comes with demo examples on Python and Fortran with (a) retrievals of CS, DA, DAP, DE, DAE, FY from local EXFOR and remote ENDF databases, (b) EXFOR data renormalization to new standards and decay data, (c) user's modifications and various recalculations with Legendre coefficient, (e) plotting covariance data and TKE×Mass distributions coded in EXFOR, (f) populating CouchDB (NoSQL) database using X5.json, etc. Plotting is implemented using Plotly/Matplotlib packages. All codes work on Windows, Linux and MacOS. Two releases.

- (XC4+X4)/C5 of all experimental data from EXFOR for Empire/Talys and other Applications' users: two releases

- IBANDL-Archive with complete library (R33 files) and CSV-index: one release (new)

### 3.3 Document Services

As part of our services, Nuclear Data Services Unit (NDSU) continued supporting the Member States by disseminating IAEA-NDS and INDC reports series as well as data libraries.

The documents produced by the Nuclear Data Section are shared via links to our webpage.

Number of reports published between May 2022 and May 2023.

| Report code | Country of origin | Reports |
|---|---|---|
| IAEA-NDS | Nuclear Data Section | 3 |
| INDC(JPN) | Japan | 1 |
| INDC(NDS) | Nuclear Data Section | 15 |
| INDC(SEC) | NDS Secretariat | 1 |

Various Nuclear Data Packages including pilot projects under development are available for download from our webpage https://nds.iaea.org/cdroms/.

### 3.4 Nuclear Data Newsletters

The Nuclear Data Newsletter is published twice a year (January and July) to inform the scientific community about actual NDS work, meetings held, projects, computer codes developed and new data libraries. During the reporting period, we published two issues of the Newsletter (73 and 74). Next one, No 75 is in preparation and will be published in August 2023. We currently have 89 recipients of hardcopies and 1238 recipients of electronic version.

## 4. Visits and Inter-centre Cooperation

- V.Zerkin (NDS) visited NNDC (BNL, USA) from 1 to 19 May 2022 to deploy and develop ENDF-EXFOR database management system, Web retrieval system, tools and output formats; to extend schema and contents of EXFOR, ENDF and EXFOR-NSR PDF databases.
- N. Otsuka (NDS) visited JCPRG from 23 to 27 January 2023 to improve the web-based EXFOR editor (HENDEL) and EXFOR database update system.

## 5. Nuclear Data Developments

The Nuclear Data Section undertakes long term nuclear data development by implementing Coordinate Research Projects (CRP) and Data Development Projects (DDP). The staff members of NDS who manage NRDC also follow the currently running CRPs and DDPs to observe the actual trends and needs for nuclear reaction data.

### 5.1. Coordinated Research Projects (CRP)

- Recommended Input Parameter Library (RIPL) for fission cross section calculations (2017-2021): *Ongoing.*
- Updating fission yield data for applications (2020-2025): *Ongoing*.

### 5.2 Data Development Project (DDP)

- Intercomparison of PIGE analysis codes to calculate PIGE yields for the analysis of bulk samples: *Ongoing*
- Evaluation of nuclear moments: *Ongoing*
- Verification of data processing codes for generating ACE-formatted files: *Ongoing*
- Stopping power database: *Ongoing*
- Nuclear data libraries for advanced systems: Fusion devices: *Ongoing*
- Nuclear Data for Medical Applications: *Ongoing*
- Maintain the international Neutron Standards file and evaluation techniques: *Ongoing*

## 6. Training Activities (Schools, Workshops)

- Joint ICTP-IAEA Workshop on "Nuclear Structure and Decay Data: Experiment, Theory and Evaluation", 3-14 October 2022, Trieste, Italy.

## 7. Nuclear Data Journal Publications (2022-2023)

**Spectrum averaged cross section measurements of lutetium using standard $^{252}$Cf neutron source**
M. Schulc, R. Capote, et al., *Appl. Radiat. Isot.* **188** (2022) 110378.

**Impact of reactor neutron spectrum on measured spectrum averaged cross sections**
M. Kostal, R. Capote, et al.,*Ann. Nucl. Energy* **179** (2022) 109418.

**EXFOR-based simultaneous evaluation of neutron-induced uranium and plutonium fission cross sections for JENDL-5**
Naohiko Otuka, Osamu Iwamoto, *J. Nucl. Sci. Technol.* **59** (2022) pp. 1004-1036.

**The effect of heavy reflector on neutronic parameters of core**
M. Kostal, R. Capote, et al., *Ann. Nucl. En.* **168** (2022) 108898.

**Production cross sections of samarium-153 and -145 via alpha-particle-induced reactions on natural neodymium**
M. Aikawa, M. Sakaguchi, N. Ukon, Y. Komori, H. Haba, N. Otuka, S, Takács, Appl. Radiat. Isot. **187** (2022) 110345.

**Nuclear data uncertainty in iterative neutron spectrum unfolding**
Katsumi Aoki, Tadahiro Kin, Naohiko Otuka, *J. Nucl. Sci. Technol.* **59** (2022) pp. 907-914.

**EXFOR-NSR PDF database: a system for nuclear knowledge preservation and data curation**
V.V. Zerkin, B. Pritychenko, J. Totans, L. Vrapcenjak, A. Rodionov, G.I. Shulyak *J. Instrum.* **17** (2022) P03012.

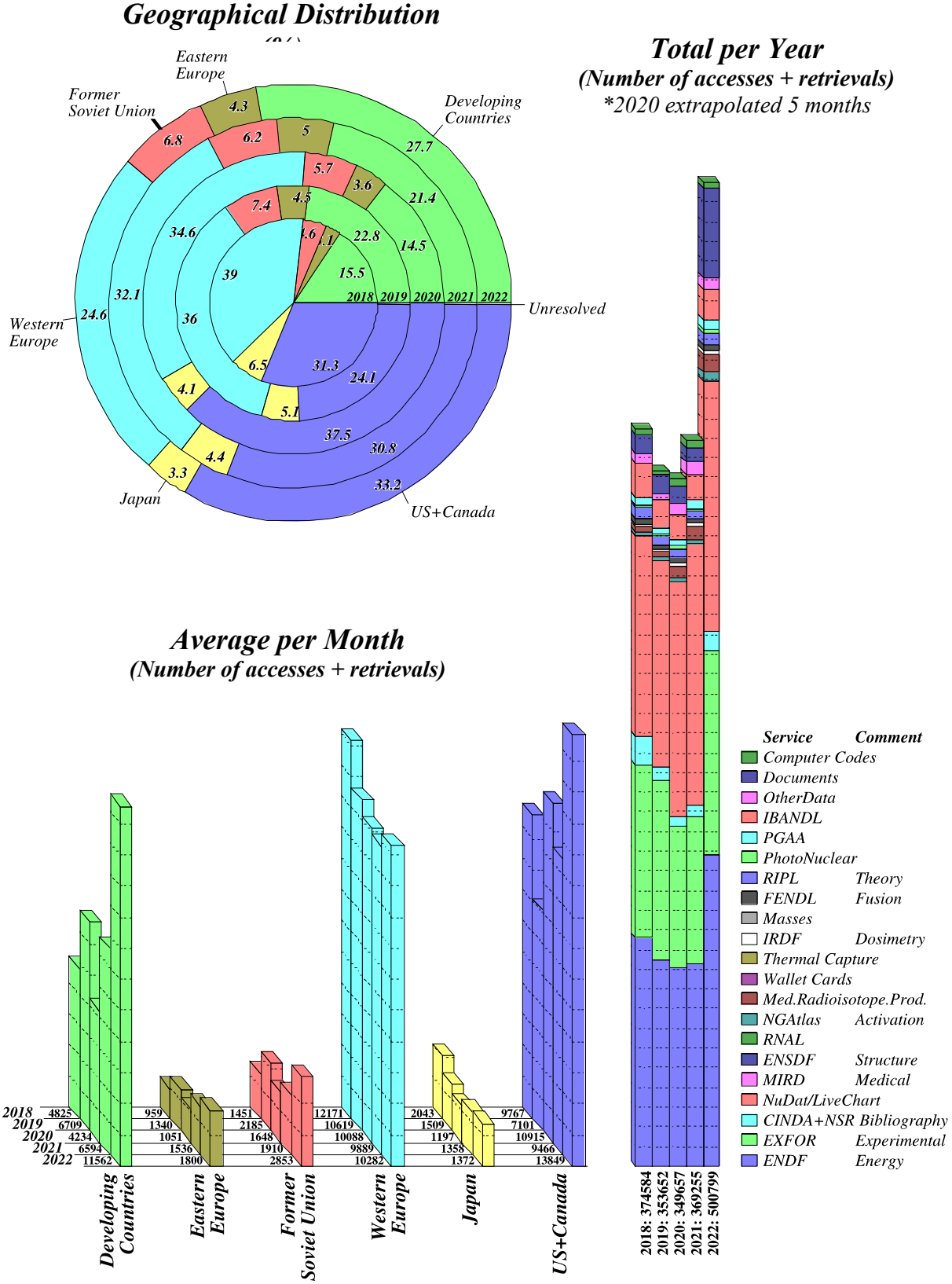
**Iterative Bayesian Monte Carlo for nuclear data evaluation**
E. Alhassan, D. Rochman, A. Vasiliev, M. Hursin, A.J.Koning, H. Ferroukhi, *Nucl. Sci. Tech.* **33**(2022) 50.

**Impact of H in H2O thermal scattering data on criticality calculation: uncertainty and adjustment**
D.A. Rochman, A. Vasiliev, H. Ferroukhi, A. Koning, J.-Ch. Sublet, *EPJ Nucl. Sci. Technol.* **8** (2022) 3.

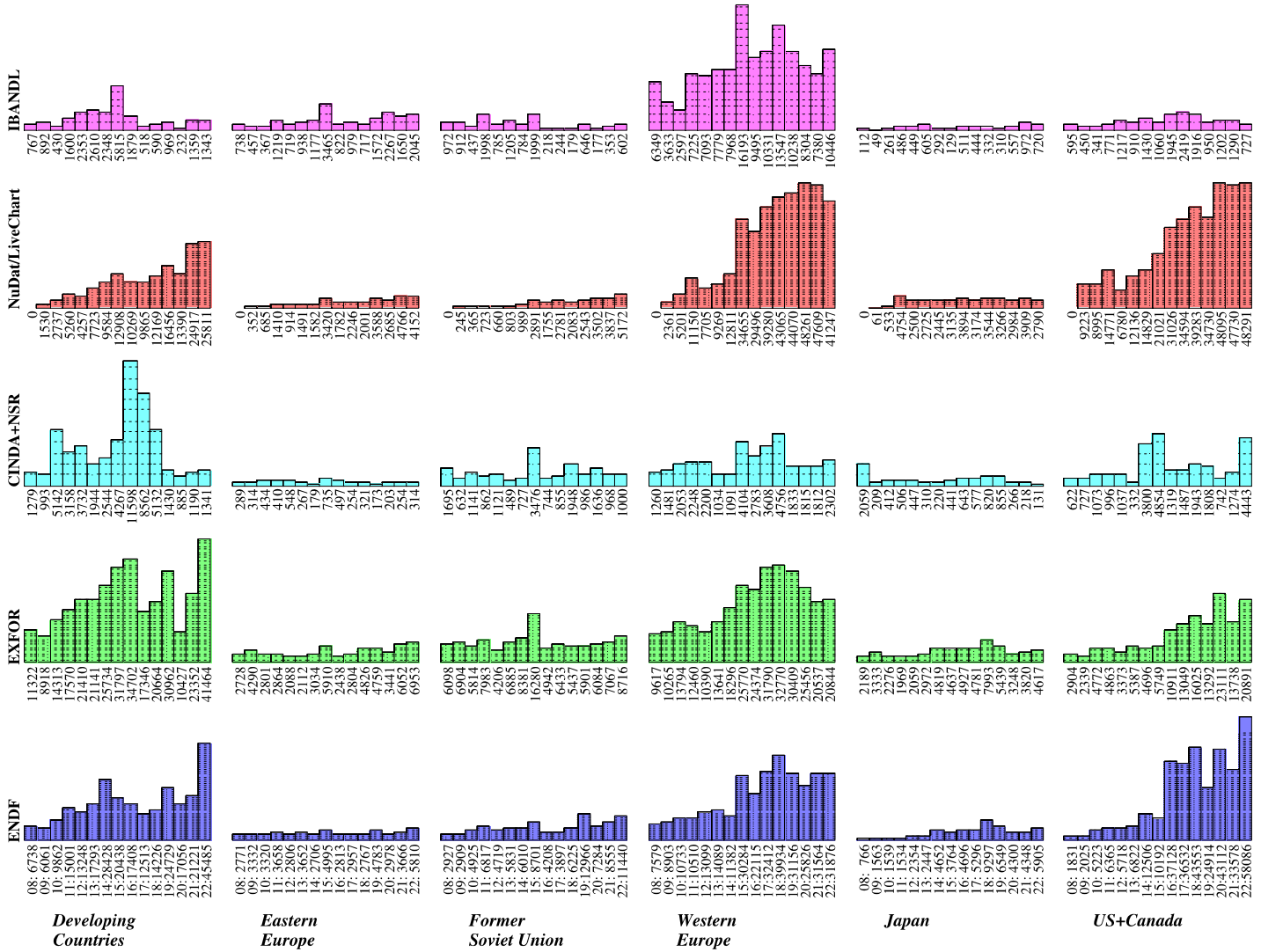
**Advanced breakup-nucleon enhancement of deuteron-induced reaction cross sections**
M. Avrigeanu, D. Rochman, A.J. Koning, U. Fischer, D. Leichtle, C. Costache, V. Avrigeanu, *Eur. J. Phys. **A58** (2022) 3.*

**Radioisotope products and the Medicine of the future: an IAEA perspective**
A. Jalilian, A. Korde, V. Starovoitova, J.Jr. Osso, A. Koning, N. Pessoa Barradas, C. Horak, M. Denecke, *Bull. Sci. Cent. Expert Eval. Med. Prod.* (2022) 539.163:615.31:615.849.

# *IAEA Nuclear Data Services: Web Statistics 2018-2022*



# *IAEA Nuclear Data Services: Web Retrievals by Groups of Countries*



# Progress report on the CDFE 2022/2023 photonuclear data processing activity.

V.V.Varlamov, A.I.Davydov, V.V.Chesnokov, I.A.Mostakov

Progress report for the Technical Meeting of the International Network of Nuclear Reaction Data Centres, 9 to 12 May 2023.

This report shortly describes the main photonuclear data activity results obtained in the Centre for Photonuclear Experiments Data (Centr Dannykh Fotoyadernykh Eksperimentov - CDFE) of the Russia Lomonosov Moscow State University Skobeltsyn Institute of Nuclear Physics for the period of time from the Technical Meeting of the International Network of Nuclear Reaction Data Centres (the IAEA's Headquarters, Vienna, Austria, 14 - 17 June 2022). The compilations of new photonuclear data, corrections of old previously compiled data, together with the results of analysis and evaluation of photonuclear data obtained in various experiments are presented.

## EXFOR Compilation

5 CDFE EXFOR final TRANSes **trans.m118 – trans.m122** and 2 preliminary ***prelim.m123 and prelim.m124*** have been produced and transmitted to the IAEA NDS. All CDFE TRANSes contain **94** ENTRYs – **8** new ones compiled in accordance with the contents of the NRDC Network Memos, the NDS database "Articles for compilation" (https://www-nds.iaea.org/nrdc/alloc/ and 86 old ones corrected in accordance with the new EXFOR format rules and the comments and recommendations of the NRDC experts, first of all Naohiko Otsuka and Daniela Foligno.

The contents of all CDFE TRANSes transmitted to the IAEA NDS during the reported period of time are presented in Table.

**New** and *Old* trans.m* and *prelim.m** contents

| **TRANS** | *Old* | **New** | Total |
|---|---|---|---|
| **m118** | *24* | 0 | 24 |
| **m119** | *27* | 0 | 27 |
| **m120** | *21* | **1** | 22 |
| **m121** | *1* | **4** | 5 |
| **m122** | *2* | **2** | 4 |
| ***prelim.m123*** | *7* | **1** | 8 |
| ***prelim.m124*** | *4* | **0** | 4 |
| **Common** | *86* | **8** | 94 |

## Photonuclear Data Evaluation

The CDFE program of evaluation of reliable partial photoneutron reaction cross sections using the experimental-theoretical method based on objective physical criteria was continued.

In addition to evaluations using experimental neutron yield cross sections obtained in experiments with quasimonoenergetic annihilation photons those were carried out using the relevant data obtained in experiments with bremsstrahlung for $^{51}$V, $^{59}$Co, $^{58,60}$Ni, $^{112,114,119}$Sn,

$^{127}$I, $^{165}$Ho, and $^{181}$Ta. It was found out that in many cases cross sections obtained using corrections of neutron yield cross sections based on statistical model also are not reliable because of some shortcomings of such procedure.

In the same time it was found out that experimental cross sections obtained for $^{159}$Tb and $^{197}$Au using beams of laser Compton scattering photons and the flat efficiency detector are satisfied physical criteria of reliability.

**Main publications**


1. V.V.Varlamov, A.I.Davydov. Experimental and evaluated data on photodisintegration of $^{197}$Au. Physics of Atomic Nuclei, 85, N1 (2022) 1 - 11.
2. V.V.Varlamov, A.I.Davydov, V.N.Orlin. Reliability of photonuclear experiments results for $^{58}$Ni. Physics of Atomic Nuclei, 85, N4 (2022) 316 - 327.
3. V.V.Varlamov, A.I.Davydov, V.N.Orlin. New evaluated data on photonuclear reactions cross sections for $^{60}$Ni. Physics of Atomic Nuclei, 85, N5 (2022) 411 - 424.
4. V.V.Varlamov, A.I.Davydov, V.N.Orlin. The specific features of photoneutron reactions on $^{58}$Ni. Eur. Phys. J. A 58 (2022) 123 (10 pages).
5. V.V.Varlamov, A.I.Davydov. Reliability of $^{159}$Tb partial photoneutron reaction cross sections obtained in various experiments. Physics of Atomic Nuclei, 85, N6 (2023) 361 - 371.
6. V.V.Varlamov, A.I.Davydov, V.N.Orlin. Similarity and distinctions of $^{58,60}$Ni photodisintegration processes. Bull. Rus. Acad. Sci. Phys. (2023), in print.
7. V.V.Varlamov, A.I.Davydov, V.N.Orlin. Partial photoneutron reaction cross sections in experiments with bremsstrahlung. Bull. Rus. Acad. Sci. Phys. (2023), in print.
8. V.V.Varlamov, A.I.Davydov, I.A.Mostakov, V.N.Orlin. Cross sections of partial photoneutron reactions on $^{59}$Co in experiments with bremsstrahlung. Physics of Atomic Nuclei, (2023), in print.
9. V.V.Varlamov, A I.Davydov, V.N Orlin. Status of the results of photonuclear experiments. Moscow University Physics Bulletin. Physics and Astronomy, № 3 (2023), in print.
10. A.I. Davydov1, V.V. Varlamov, V.N. Orlin. Cross sections of partial photoneutron reactions: the problems with reliability and new data. Moscow University Physics Bulletin. Physics and Astronomy, № 3 (2023), in print.


**Short-term (2023/2024) Program**

The main items of CDFE 2023/2024 program, main priorities and most important tasks are traditional and the following:

- continuation of new photonuclear data compilation using EXFOR format, production of new TRANSes (m125, m126, etc.);
- correction of old ENTRYs in accordance with new EXFOR coding rules and the NRDC Network expert's comments and recommendations;
- continuation of analysis and evaluation using objective physical criteria of total and partial photonuclear reaction cross sections obtained in various experiments, carried out using different sources of photons (quasimonoenergetic annihilation photons, laser Compton backscattering photons, bremsstrahlung photons).

# Center of Nuclear Physics Data (CNPD), RFNC-VNIIEF

Technical paper for the NRDC Meeting, IAEA, May 9-12, 2023

S. Taova

Russian Federal Nuclear Center-VNIIEF
Russia, 607188, Sarov, Nizhnii Novgorod region, Mira Ave., 37

Compilation activity

Twelve final files TRANS.F088, TRANS.F089, TRANS.F090, TRANS.F091, TRANS.F092, TRANS.F093, TRANS.F094, TRANS.F099, TRANS.A100, TRANS.A101, TRANS.A102 and TRANS.A103 have been submitted for the EXFOR data library within the last period. Files with letter "A" include revised entries only. Files with letter "F" include both new and revised entries.

Recently particular attention has been paid to the compilation of new articles. Data compilation was carried out in close cooperation with the authors. All new entries in our last TRANS file were approved by authors. In general 25 new entries were prepared for the Exfor.

Software

EXFOR-Editor

Development of EXFOR-Editor - 4.01 has been continued. In the last version there is a possibility of keeping the author's formatting of text information (without deleting of unwanted spaces). For this purpose the "User's Format" option in the "Text Input Regime" group-box is used. Text will be inserted without any transformation. This option is available for all keywords.

One more innovation is the possibility of footnote automatic deleting when entering or editing authors list in a dialog window. It is useful in case you copy information from pdf file.

Update of Dictionaries and checking codes (CHEX and JANIS TRANS Checker) is being carried out on continuing basis.

General

G. Pikulina, S. Selyankina and S. Taova took part in the Workshop on Compilation of Experimental Nuclear Reaction Data (December, 12-16, 2022). G. Pikulina and S. Taova prepared a report "On new features of the Exfor-Editor". The mode of entering data on neutron spectra with a keyword SUPPL-INF (Supplemental Information) and the one of processing the exchanged file TRANS to transfer the compiled experimental data into NDS were demonstrated.

Scanning of journals “Izvestiya Akademii Nauk” and “Yadernaya Fizika” is being performed regularly to reveal articles relevant to be compiled to Exfor library. The reports on scanning results are submitted to the NDS, IAEA.

# Progress Report
# for NRDC2023 Technical Meeting
# (9-12 May 2023)

## 1. EXFOR activity.

EXFOR compilation statistics

| Trans | Status | Date | Entries total | Entries new | Entries revised | Subents total | Subents New | Subents Revised |
|---|---|---|---|---|---|---|---|---|
| 4204 | Final | 2022-06-10 | 46 | 0 | 46 | 271 | 2 | 269(+57nosub) |
| 4205 | Final | 2022-06-10 | 8 | 6 | 2 | 38 | 24 | 14(+12nosub) |
| 4206 | Final | 2022-05-28 | 12 | 0 | 12 | 54 | 6 | 48(+10nosub) |
| 4207 | Final | 2022-10-13 | 26 | 4 | 22 | 181 | 45 | 136(+42nosub) |
| 4208 | Final | 2023-01-18 | 31 | 1 | 30 | 114 | 5 | 109(+20nosub) |
| 4209 | Final | 2023-02-27 | 21 | 2 | 19 | 214 | 9 | 205(17+nosub) |
| 4210 | Final | 2023-02-27 | 10 | 0 | 10 | 40 | 0 | 40 |
| 4211 | Final | 2023-04-19 | 20 | 0 | 20 | 119 | 13 | 106(+38nosub) |
| | **Final** | | **174** | **13** | **161** | **1031** | **104** | **927(+196nosub)** |
| 4212 | Prelim | 2023-03-28 | 21 | 0 | 21 | 130 | 0 | 130 |

## 2. Journal YK - https://vant.ippe.ru/

The journal “Yadernye Konstanty” (YK) is continued to be published in IPPE as the online journal “Yadernye and Reaktornye Konstanty” ("Problems of Atomic Science and Technology. Series: Nuclear and Reactor Constants").

Four regular issues during 2022 year and one issue at 2023 year were published.

## 3. Proposals for EXFOR improvement

-233 2022-06-28 Reply to CP-D/1021 (=WP2022-30); requirement mentioned in Memo CP-D/1050.

-234 2022-10-12 New combination EXL,SIG for EXFOR dictionary 236

-235 2022-12-29 New combinations EXL,DA and EXL,DA,,LEG for EXFOR dictionary 236

-236 2023-03-16 New combinations ,DA,,LEG/4PI and PAR,DA,,LEG/4PI for EXFOR dictionary 236

-237 2023-03-31 New code for dictionary 207 (books) – SNR

**4. NRDC2021 Actions.**

**A1-A2 –** continue as usual

**A52** – finished (UNOBT) in transes 4211 + 4212

**A66** – feedback for InpGraph was sent.

**A68, A70 –** Feedbacks were not sent – no questions for GSYS and JANIS TRANS checker.

**A76, A78** – Feedbacks were not sent – no questions for ZCHEX and X4+ format.

**A86** – has not done – no proposals

**A87** – A message about lab. reports was sent 21 June 2021. I have not received a letter with list of reports (A91, V.Zerkin).

**A96** – several requests were sent to Lidija Vrapcenjak:

N.A.Fedorov+ J,EPJ/A,57,(6),194,2021

L.L.Yu+,J,NP/A,324,160,1979

F.T.Kuchnir+,J,PR,176,1405,1968

G.A.Prokopetz+,J,BAS,40,200,1976

I.V.Barchuk+,J,BAS,41,(1),82,1977

V.Semkova+,R,EUR-20820,2003

R.M.Musaelyan+,J,KSF,,(8),15,1985 (I sent, in Russian)

J,SPL,,(8),16,1985 - Engl.translation of J,KSF,,(8),15,1985

**5. Acknowledgments**

- Il'ya Dashkov and Nikita Fedorov for experimental data and explanations of experiment details,
- Naohiko Otsuka for detailed checking of preliminary transes and productive discussions,
- Daniela Foligno, Manuel Bossant for useful comments of preliminary transes,
- Lidija Vrapcenjak(IAEA) for providing pdf-files of articles.

# Nuclear Data Physics Centre of India (NDPCI)
# Progress Report

IAEA Technical Meeting, 9-12 May 2023
Vienna, Austria

The Nuclear Data Physics Centre of India (NDPCI) keeps compiling data on neutrons, charged particles, and photonuclear induced reaction. This report lists all the EXFOR entries that have been compiled and transmitted to the NDS IAEA since the NRDC-2022 meeting.

**EXFOR Compilation**

The software used for the EXFOR compilation are:

- For compilation: Russian EXFOR editor (http://www-nds.iaea.org/nrdc/nrdc_sft/)
- For digitization: “GSYS" (https://www.jcprg.org/gsys/2.4/)
- For checking purpose: (https://www.jcprg.org/exfor/tool/)

**EXFOR Compilation is done by:**

- Regular compilation activity.
- Organization of workshop for EXFOR compilation every two years by BARC.
- The numerical data collection is done by Dr. Gayatri Mohanto from BARC.
- The EXFOR compilation is done by Dr. Devesh Raj from BARC and DAE project holders.

**Number of new entries compiled since the NRDC 2022 meeting:**

| | | |
|---|---|---|
| Neutron | = | 8 |
| CPND | = | 8 |
| PhND | = | 3 |
| **Total** | **=** | **19** |

# Ukrainian Nuclear Data Center: Progress Report for period 2022-2023
# Summary of Nuclear Data Activity by Staff of the Ukrainian Nuclear Data Center
# June 2022 – April 2023

O. Gritzay, O. Kalchenko
IAEA Technical Meeting, 9-12 May 2023
Vienna, Austria

Web: http://ukrndc.kinr.kiev.ua/
E-mail: ogritzay@ukr.net

Ukrainian Nuclear Data Centre (UkrNDC) is subdivision within the Neutron Physics Laboratory at the Institute for Nuclear Research of the National Academy of Sciences of Ukraine.

## Compilation

We continue collection and compilation of experimental neutron, charged particle and photonuclear data. Number of the new/renew EXFOR's entries sent to the NDS IAEA by UkrNDC is the following:

- for charged particle data – 9 new entries (D5195÷D5203 (91 subentris));
- for photonuclear data – 2 new entries (G4100÷G4101 (7 subentris)) and 1 updated entry (G4099).

We realize review of compilation scope in home journals:

- Nuclear Physics and Atomic Energy;
- Ukrainian Journal of Physics;
- Problems of Atomic Science and Technology, Series Nuclear Physics Investigations;
- East European Journal of Physics.

## Collaboration

We continue our collaboration with the Nuclear Physics Department of Taras Shevchenko National University of Kyiv.

The teaching course "Nuclear Data for Science and Technology and modern computer codes for nuclear data processing" (42 hours) was lectured in 2022-2023 for the fifth-course students of the NPD KNU. This course includes the following items: ENDF/B libraries, EXROR system, ENSDF library, the use of the PREPRO code in work with the ENDF/B libraries, the introduction to NJOY code system, the Network of Nuclear Reaction Data Centers and the use of the on-line services.

We continue our activity within the framework of educational and scientific program of the Institute for Nuclear Research of the National Academy of Sciences of Ukraine on the preparation of a doctor of philosophy in specialty 01.04.16 (physics of the nucleus, elementary particles and high energies).

- The teaching course "Modern codes and nuclear data" (26 hours) was lectured in September-October 2022 for post-graduate students in the 2-nd year of study.

- The teaching course “Experimental methods of nuclear power engineering” (26 hours) was lectured in January-February 2023 for post-graduate students in the 1-st year of study.

**Customer Services**

The UkrNDC site is operating. Ukrainian customers, especially students and those physicists, who wish to prepare the point-wise and multi-group cross sections self-dependently, but do not have a good experience in it, use this site very often. Address of the UkrNDC site: http://ukrndc.kinr.kiev.ua.

**Experimental and Computational Activity**

Calculations for improvement of the interference neutron filter with an average energy of 45 keV were done. About 15 variants of the filter were calculated with the addition of various components and selection of their quantity. We tried to optimize three parameters: filter purity, neutron flux density at the filter output, and minimization of the contribution in the low-energy range. According to the calculations, the filter parameters should be as follows: the average neutron energy is 46.25 keV; half-width of the main line – 3.2 keV; relative purity of the main line – 88.3%; the expected neutron flux density is $1.3\times10^6$ n/(cm$^2\times$s).

Through Russian war, Kyiv research reactor did not operate, so experimental investigation did not fulfilled.

**Acknowledgement**

We are very thankful to Naohiko Otsuka and all colleagues for comments in preparation of the final versions of the UkrNDC entries and also to Lidija Vrapcenjak for sending all requested articles needed for compilations and especially for her help in preparation of D5197 entry.

# 2022/23 Status Report of China Nuclear Data Center

Shu Nengchuan, Wang Jimin, Huang Xiaolong, Xu Ruirui, Liu Lile, Tian Yuan, Sun Xiaodong, Zhangyue, Tao Xi

China Nuclear Data Center (CNDC)
China Committee of Nuclear Data
(CCND) China Institute of Atomic Energy (CIAE)
P.O.Box 275-41, Beijing 102413, P.R.China, E-mail: gezg@ciae.ac.cn

## General Information of China Nuclear Data Center

China Nuclear Data Center (CNDC) was established in 1975 and has been participating in the International Atomic Energy Agency's nuclear data activities as the National Nuclear Data Center of China since 1984. As a window, CNDC has been open to the world since 1978 and has established good cooperative relationships with the International Atomic Energy Agency, OECD/National Energy Agency, as well as major nuclear data centers and institutions around the world.

### 1.1 The current main task of CNDC

1) Management of domestic nuclear data activities.
2) Nuclear data evaluations, libraries and relevant methodology studies.
3) Nuclear data measurements and methodology studies
4) Exchange of nuclear data activities with IAEA, foreign nuclear data centers and agencies.
5) Services for domestic and foreign nuclear data application users.

### 1.2 Mainly Tasks of CNDC in 2022/2023

1) Five-Year-Plan (2021-2025) for nuclear data (CENDL Project).
2) Data evaluation for next CENDL version and sub-library.
3) Methodology studies of nuclear data evaluation (incl. theoretical and experimental for fission process…).
4) Nuclear data measurements and related methodology studies.
5) Compilations for EXFOR.
6) Nuclear data services.

## Nuclear Data Evaluation

### 2.1 Neutron Activation File – CNAF

The first release CENDL-CNAF included 818 nuclei from $^{1}$H to $^{257}$Fm within the neutron energy region of from $10^{-5}$ eV to 20 MeV. The ENDF/B-6 data format was adopted. The general information, comments (MF=1), reactions cross sections (MF=3), nucleus dictionary (MF=8), and split threshold reaction channels (MF=10) are included in the library. Evaluations were obtained using APMN, Unified Hauser-Feshbach and Exciton model (UNF series), Full and Diagonal Reduced R-matrix (FDRR) model calculations or systematic analysis based on available experimental data. When there have many experimental data for a reaction channel, the evaluated experimental data were selected for curve fitting by using a program of orthogonal polynomial fit or spline function fit from threshold to 20 MeV. The fitting results were adopted.

For convenient used in applications, all resonance parameters are already converted into a linearized point-wise format, and reasonably connected at the boundary energy. To calculate the point-wise cross, The ENDF/B Pre-processing codes (PREPRO) were used.

### 2.2 Radioactive Decay Data File: CENDL-3.2/DDL

The CENDL-3.2/DDL included 2350 nuclei between A=66 to A=172 FY region. ENSDF and ENDF format were adopted. Evaluations taken from: (1) CNDC+ Jilin Univ.: ~500 nuclei; (2) DDEP: ~200 nuclei; (3) ENSDF: ~1500 nuclei; (4) JEF3.2: ~150 nuclei (only for stable nuclei). The Q-values of the decay modes are updated to the Atomic Mass Evaluation (AME) released in 2021Wa16. Jπ for g.s. (Jilin Univ.): by systematical comparison, physical analysis and theoretical calculation, spin for ground states is re-assigned for which lacks measurement or questionable. All T1/2 are revised by new measurements (2021, 12). Mean energies for β & γ: from TAGS measurements when available, otherwise from theoretical calculation. For even-even nuclides, from theoretically analysis which employed the self-consistent quasi-particle random phase approximation (QRPA) approach based on covariant density functional theory (CDFT) in Jilin University. Beta-delayed n, p, α emitted are adopted: P1n, P2n from eva. of 2015Bi05, 2020Li32; P1p,P1α from eva. of 2020Ba07 when measurements available, otherwise from systematics or theoretical calculation.

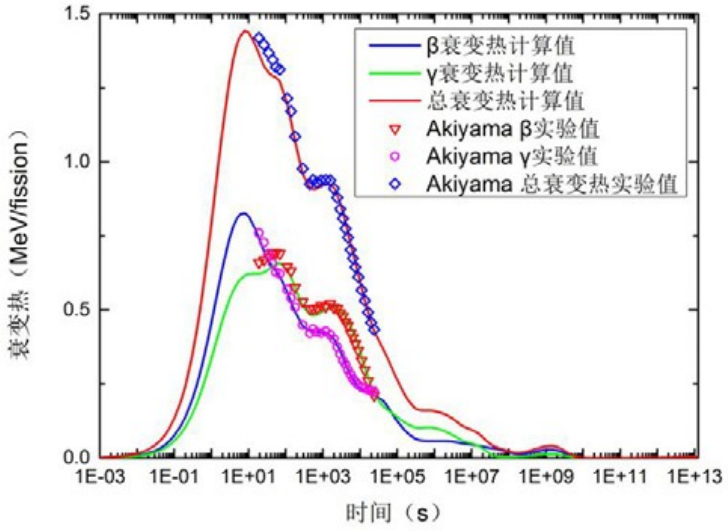



Fig. 1 Decay heat after $^{235}$U fast neutron fission.

### 2.3 CENDL Photonuclear Data file: CENDL-3.2/PD

The photonuclear data (PD) for a total number of 264 materials are all newly evaluated and outputted with the standard ENDF-6 format. All of the photonuclear data are mainly evaluated based on the theoretical calculations with the Chinese photonuclear reaction codes GLUNF for the 6 light nuclei and MEND-G for the 264 medium-heavy nuclei. The incident photon energies for the medium-heavy nuclei are up to 200MeV. In order to extend the incident energy to 200MeV, the n, p, d, t, He-3, α are considered to totally 18th particle emission reactions in the MEND-G code.

To ensure the availability and reliability of the PD file, nuclear data processing code system NJOY2016 and MCNP6 are used to verify and validate the PD library. The testing results show

that the data structure of each nuclide is complete, the data content is reasonable, and can be applied to the simulation of Monte Carlo transport.

**Table 1** Nuclides List of CENDL-3.2/PD

| Type | Nuclides | Count |
|---|---|---|
| **Light element** | Be-9,B-10,11,C-12,N-14,O-16 | 6 |
| **Medium - heavy elements** | Mg-25,26,Al-27,Si-28,29,30,P-31,S-32,33,34,36,Cl-35,37,Ar-36,38,40,K-39,40,41, Ca-40,42,43,44,46,Sc-45,Ti-46,47,48,49,50,V-50,51,Cr-50,52,53,54,Mn-55, Fe-54,56,57,58,Co-59,Ni-58,60,61,62,64,Cu-63,65,Zn-64,66,67,68,70,Ga-69,71, Ge-70,72,73,74,76,As-75,Se-74,76,77,78,80,82,Br-79,81,Kr-78,80,82,83,84,86,Rb-85,87, Sr-84,86,87,88,Y-89,Zr-90,91,92,94,96,Nb-93,Mo-100,92,94,95,96,97,98, Ru-100,101,102,104,96,98,99,Rh-103,Pd-102,104,105,106,108,110,Ag-107,109, Cd-106,108,110,111,112,113,114,116,In-113,115, Sn-112,114,115,116,117,118,119,120,122,124,Sb-121,123, Te-120,122,123,125,126,128,130,I-127,Xe-124,126,128,129,130,131,132,134,136,Cs-133, Ba-130,132,134,135,136,137,138,La-138,139,Ce-136,138,140,142,Pr- | 258 |

**Fundamental theory study for fission data**

### 3.1 Dynamical process of nuclear fission

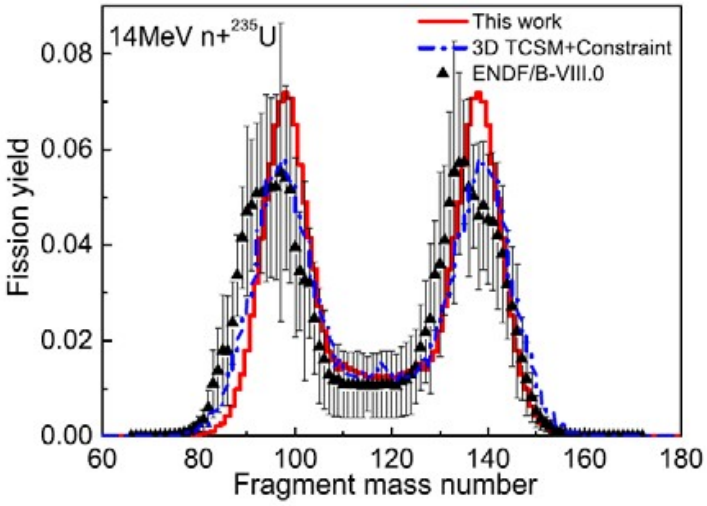



Fig. 2 Calculated fragment mass distribution of 14 MeV n + $^{235}$U fission with the present model (red curve) compared with the result with the 3D Langevin approach plus a constraint on the heavy fragment deformation based on the TCSM (blue dashed-dot curve) and the evaluated data from ENDF/B-VIII.0.

The Langevin approach is extendedly applied to study the dynamical process of nuclear fission within the Fourier shape parameterization, with macroscopic energy – Lublin-Strasbourg Drop model, single-particle levels – Yukawa-folded potential, shell correction – Strutinsky method, pairing correction – BCS method. The results are shown in Figures

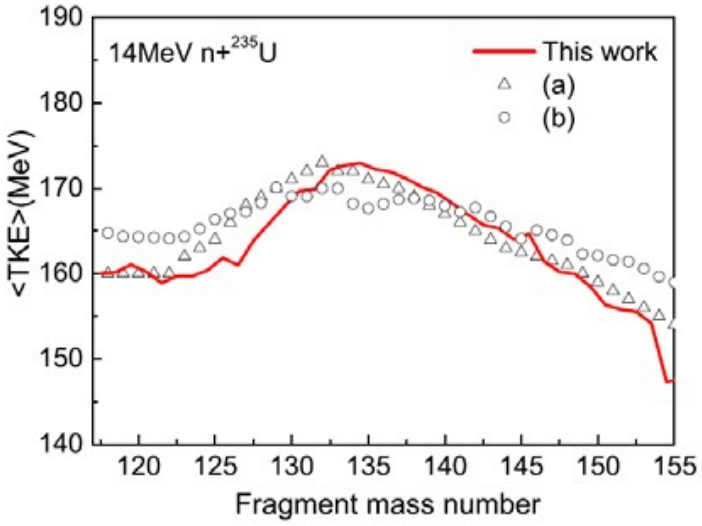



Fig. 3 The calculated TKE as a function of the heavy fragment mass in 14 MeV n + 235U fission compared with the experimental data.

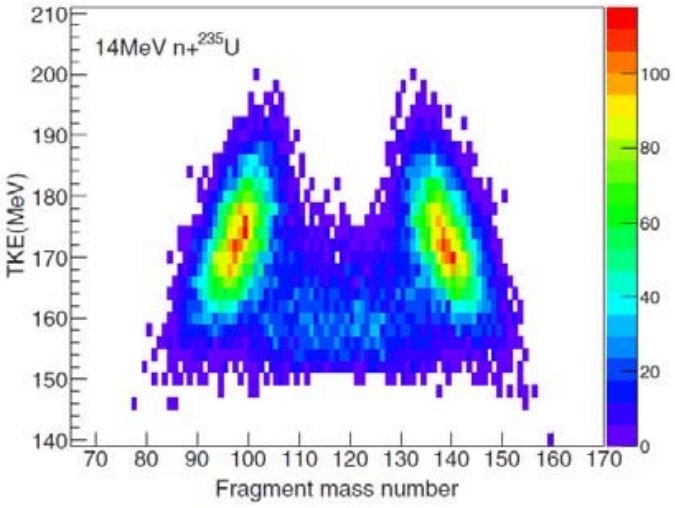



Fig. 4 The calculated mass-energy correlation of the fission fragments in 14 MeV n + $^{235}$U fission.

### 3.2 Fission fragment mass distributions calculation

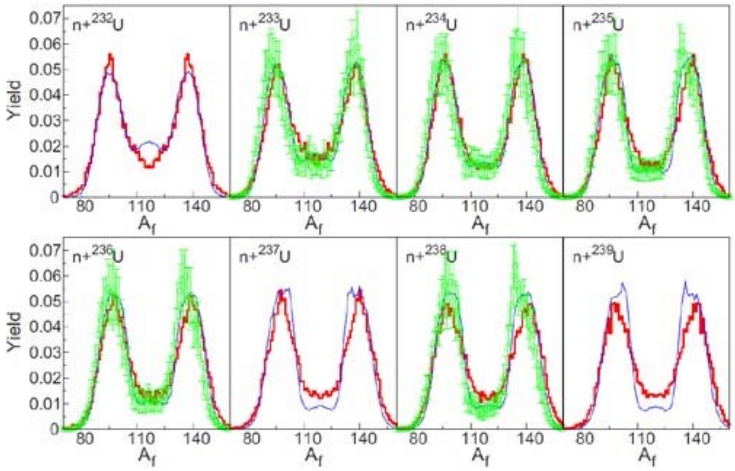



Fig. 5 The calculated fragment mass distribution in 14 MeV n +$^{232-239}$U fission (red curve), compared with the primary fragment mass distribution calculated with the GEF model (blue curve) and the evaluated data from ENDF/B-VIII.0 (green circle).

Using the 3D Langevin approach within the two-center shell model parameterization, the fission fragment mass distributions from 14 MeV neutron induced fission of U, Np and Pu isotopes , as well as the systematic dependence of the averaged TKE on the Coulomb parameter, are well reproduced.

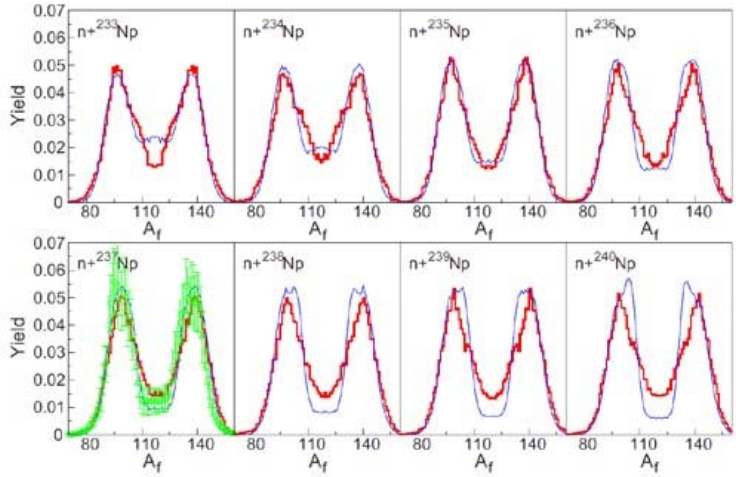



Fig.6 The calculated fragment mass distribution of 14 MeV n + $^{233-240}$Np fission (red curve), compared with the primary fragment mass distribution calculated with the GEF model (blue curve) and the evaluated data from ENDF/B-VIII.0 (green circle).

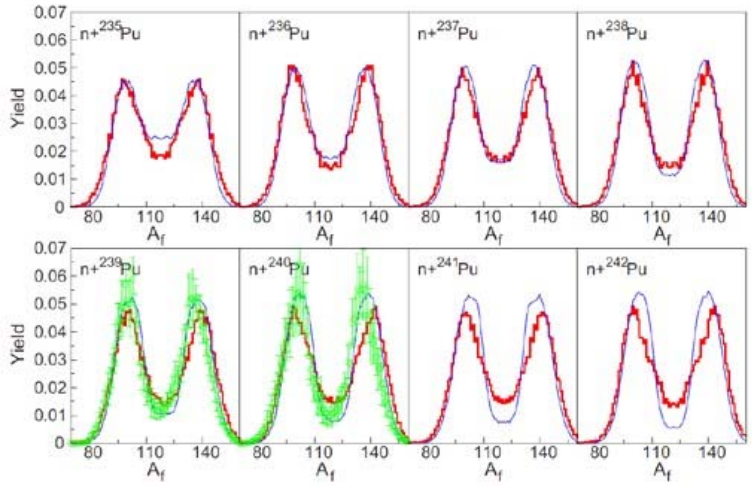



Fig. 6 The calculated fragment mass distribution of 14 MeV n + $^{235\text{-}242}$Pu fission (red curve), compared with the primary fragment mass distribution calculated with the GEF model (blue curve) and the evaluated data from ENDF/B-VIII.0 (green circle).

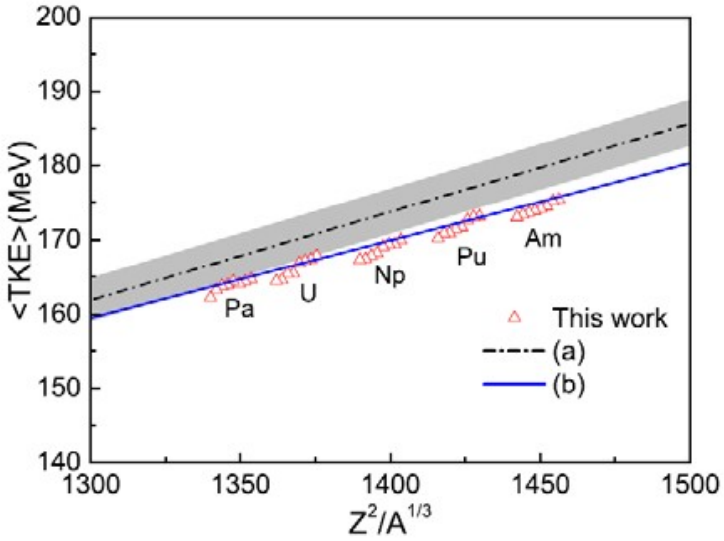



Fig. 7 The calculated systematic dependence of the averaged TKE on the Coulomb parameter Z2/A1/3 of the fissioning systems.

The influence of the neck parameter ε on the fission dynamics at low excitation energy is studied based on the three-dimensional Langevin approach in which the nuclear shape is described with the two-center shell model (TCSM) parameterization, and the elongation, the mass asymmetry and the fragment deformation are set to be the generalized coordinates of the Langevin equation.

Figure 9 shows the calculated fission fragment mass distributions using the Langevin approach with the ε taken to be 0.25, 0.35 and 0.45, respectively, and there is little difference between these results.

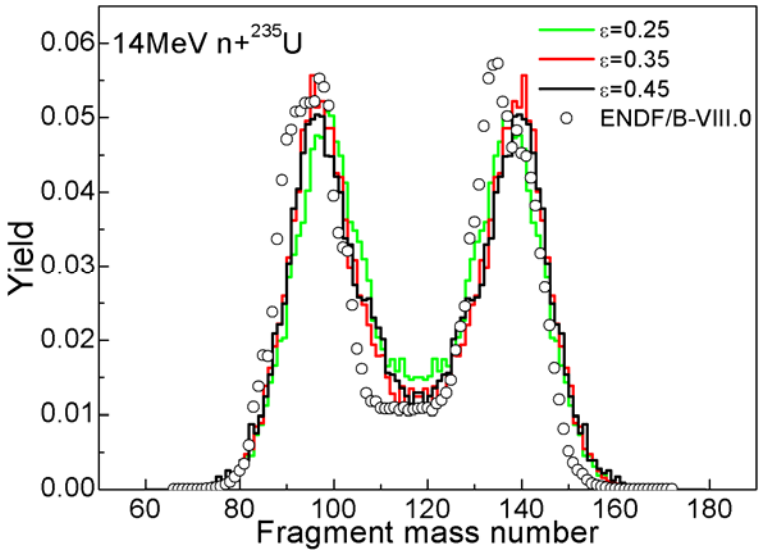



Fig. 8 The fragment mass distributions of 14 MeV n+$^{235}$U fission with the neck parameter ε fixed at 0.25, 0.35 and 0.45, respectively, compared with the evaluated data from ENDF/B-VIII.0.

Figure 10(a) shows the TKE distribution with the ε fixed at 0.25, 0.35 and 0.45, respectively, compared with the experimental data. One can see that the ε has a significant influence on the TKE calculation, which shows that with the increase of ε, the TKE increases and even the peak position of the TKE distribution is shifted toward the right side. The corresponding Coulomb repulsion energy at the scission point and the pre-scission kinetic energy are shown in Figs. 10(b) and 10(c), respectively. It can be seen that the overall behavior of the dependence of the Coulomb repulsion energy on the ε is similar to that of the dependence of the TKE distribution on the ε, and the ε has a very slight influence on the pre-scission kinetic energy, which indicates that the influence of the ε on the TKE mainly results from the Coulomb repulsion energy which is quite sensitive to the scission configuration. The slightly increase of the pre-scission kinetic energy with the ε decreasing may be due to the increase of the elongation of the fissioning nucleus around the scission point and simultaneously the decrease of Coulomb energy leading to a larger collective kinetic energy.

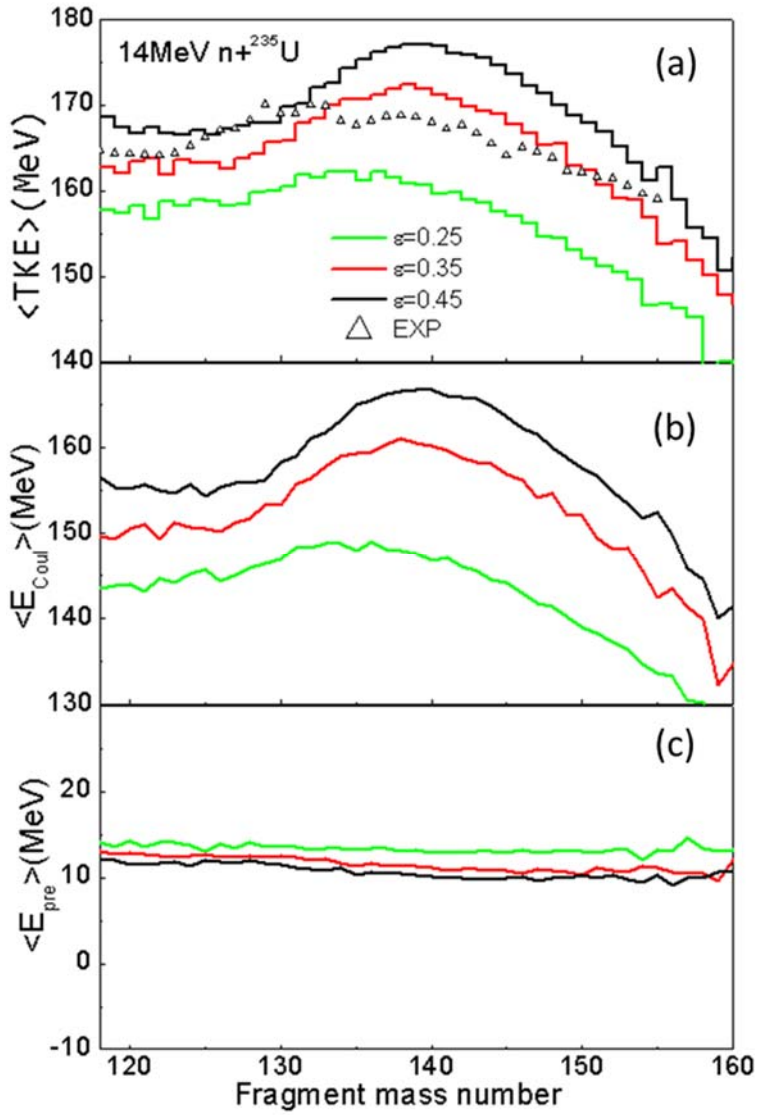



Fig. 9 The TKE distribution of fragments in 14 MeV n+$^{235}$U fission with the neck parameter ε fixed at 0.25, 0.35 and 0.45, respectively, together with the experimental data (a). The corresponding Coulomb repulsion energy at the scission point (b) and the pre-scission kinetic energy as a function of heavy fragment mass number (c) for different values of ε.

**Progress of nuclear reaction theory**

New version of the FUNF nuclear reaction program has been developed with a multiple fission barrier. Based on the earlier version of FUNF2012, we have added the multiple fission barriers model to the FUNF program. Now the FUNF program can calculate the fission cross-section with different kinds of fission barriers. For the case of the n+$^{238}$U reaction, the cross section calculated by the double fission barriers model is much better than the single fission barriers model, especially for the resonance structure in the low energy range, as shown in Fig.10.

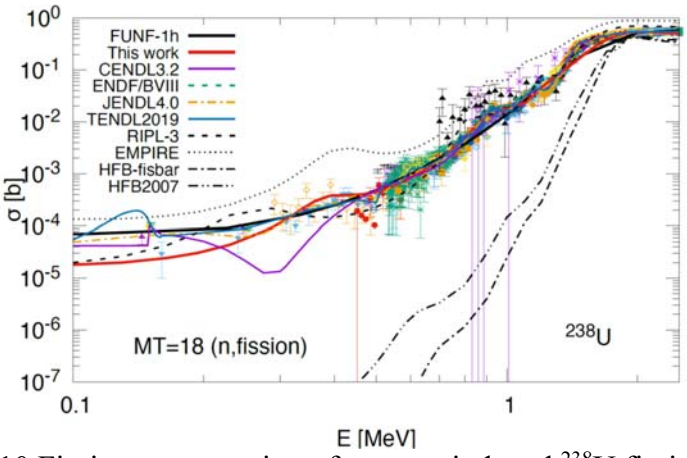



Fig. 10 Fission cross section of neutron induced $^{238}$U fission.

The main excitation function on n+$^{238}$U reactions are evaluated at the energy region 0.1-20MeV, including (n, tot), (n, 2n), (n, f), (n, 3n), (n, γ) cross sections, and average number of fission neutrons NU. Partial evaluations are given in Fig. 11-Fig. 15.

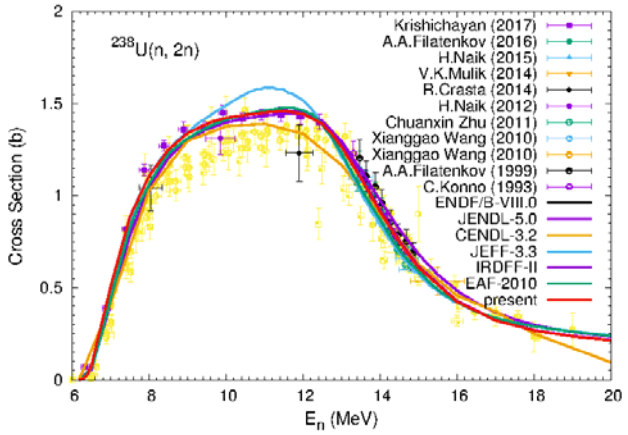



Fig. 11 Evaluated $^{238}$U(n,2n) cross section

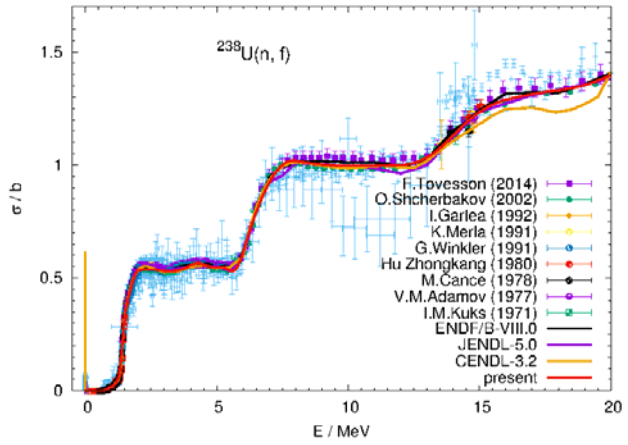



Fig. 12 Evaluated $^{238}$U(n,f) cross section

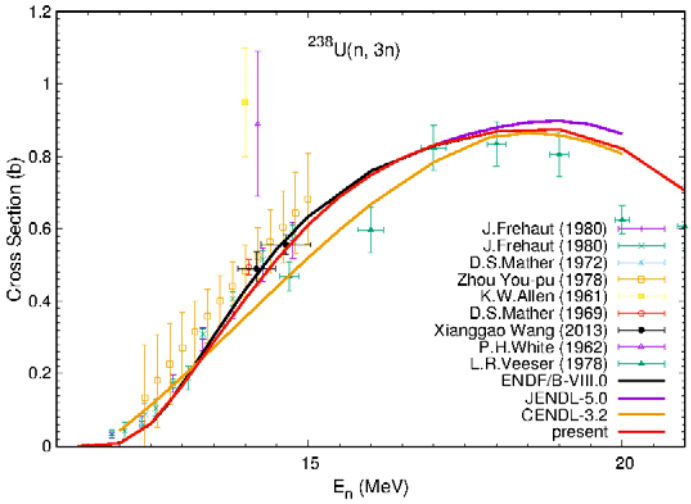



Fig. 13 Evaluated $^{238}$U(n,3n) cross section

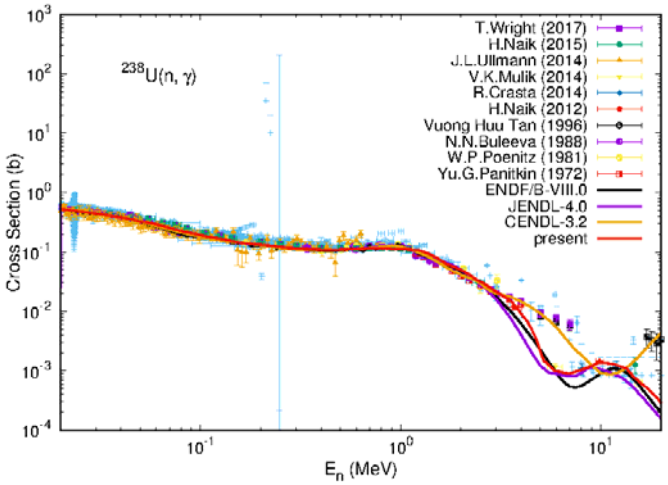



Fig. 14 Evaluated $^{238}$U(n, γ) cross section

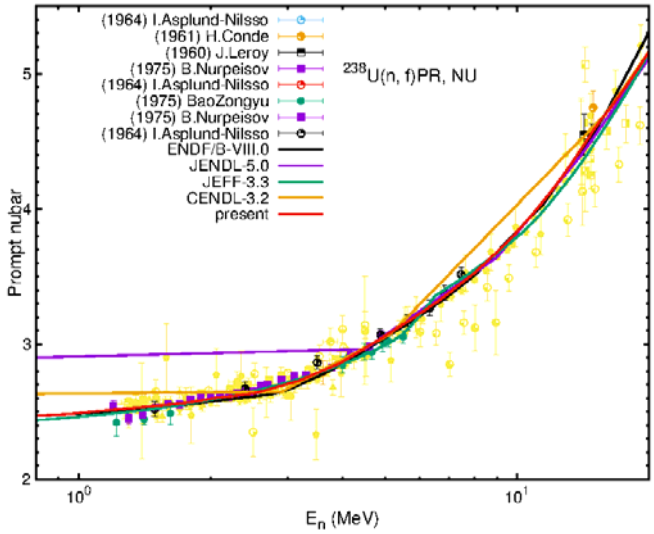



Fig. 15 Evaluated $^{238}$U(n, γ) cross section

The whole set of nuclear data for n+$^{238}$U reactions, are calculated using nuclear theoretic model codes OPTMAN and FUNF at the neutron energy En≤ 20 MeV. Resonance parameters from ENDF/B-VIII.0 are adopted in the final data file. The integral benchmark calculations are also done for the n+$^{238}$U evaluated data. Fig. 16 shows the leakage flus spectra.

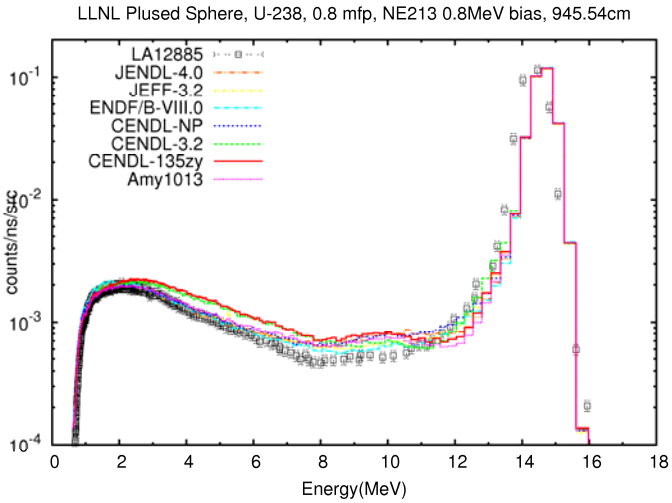



Fig. 16 calculated leakage flus spectra for n+$^{238}$U evaluations

## EXFOR activities and nuclear data services

### 5.1 EXFOR Compilation

More than 475 entries were compiled at CNDC. Since 2010, more than 345 entries were finalized, which included 182 neutron and 163 charged particle entries. Feedback and correction were performed for more than 140 entries.
Since the last NRDC meeting (2022-06-01), 30 new entries have been finalized and 26 entries have been revised, more than 100 articles are under compiling, as shown in Fig. 17.

Currently CNDC is responsible for scanning of 8 journals published in China, namely ASI, CNPR, CNST, CPH/C, CPL, CST, HFH and NTC. The ASI is semimonthly, the HFH is bimonthly, the CNPR is quarterly and others are monthly. Scanning results are submitted to the IAEA/NDS monthly.

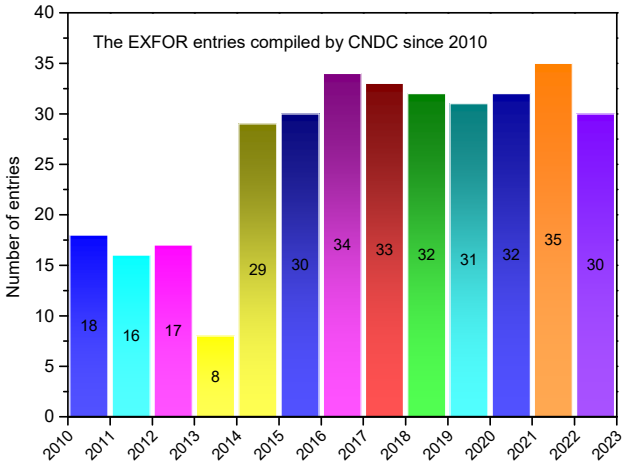



Fig. 17 The number of the finalized EXFOR entries

**Table 2** New entries since the last NRDC meeting (2022-06-01)

| No. | Entry No. | 1st author | Reference | Status |
|---|---|---|---|---|
| 1 | 32809 | Luocheng Yang | J,ARI,164,109242,2020 | Trans.3208 |
| 2 | 32810 | X. X. Li | J,PR/C,106,065804,2022 | Finalized |
| 3 | 32811 | Zhizhou Ren | J,PR/C,102,034604,2020 | Trans.3208 |
| 4 | 32812 | Junhua Luo | J,CPH/C,44,114002,2020 | Trans.3208 |
| 5 | 32814 | Yong Li | J,CPH/C,44,124001,2020 | Finalized |
| 6 | 32855 | Junhua Luo | J,RCA,109,513,2021 | Trans.3208 |
| 7 | 32856 | Xin-Rong Hu | J,CNST,32,101,2021 | Trans.3208 |
| 8 | 32857 | S. Q. Yan | J,AJ,919,84,2021 | Prelim.3209 |
| 9 | 32860 | Luocheng Yang | J,ANE,165,108780,2022 | Prelim.3209 |
| 10 | 32861 | X. X. Li | J,PR/C,104,054302,2021 | Finalized |
| 11 | 32862 | Zengqi Cui | J,EPJ/A,57,310,2021 | Prelim.3209 |
| 12 | 32868 | Zhang Jiang-Lin | J,ASI,71,052901,2022 | Prelim.3209 |
| 13 | 32869 | Wang De-Xin | J,ASI,71,072901,2022 | Prelim.3209 |
| 14 | 32870 | Jie Ren | J,CPH/C,46,044002,2022 | Prelim.3209 |
| 15 | 32873 | Yu.M.Gledenov | J,EPJ/A,58,86,2022 | Prelim.3209 |
| 16 | 32886 | Zhizhou Ren | J,EPJ/A,59,5,2023 | Prelim.3209 |
| 17 | 32887 | Yonghao Chen | J,PL/B,839,137832,2023 | Finalized |
| 18 | 32888 | Chao Liu | J,NIM/A,1041,167319,2022 | Finalized |
| 19 | S0087 | Y.J.Li | J,PR/C,102,025804,2020 | Trans.S031 |
| 20 | S0235 | F.F. Duan | J,PL/B,811,135942,2020 | Trans.S031 |
| 21 | S0249 | Hua Wei | J,CNPR,34,138,2017 | Trans.S031 |
| 22 | S0261 | Wang Tieshan | J,CST,35,496,2001 | Trans.S031 |
| 23 | S0262 | Sun Xufang | J,CST,42,875,2008 | Trans.S031 |
| 24 | S0264 | Su Xiaobin | J,CST,50,395,2016 | Trans.S031 |
| 25 | S0270 | B.Liu | J,ARI,173,109713,2021 | Trans.S031 |
| 26 | S0273 | W. H. Ma | J,PR/C,103,L061302,2021 | Trans.S031 |
| 27 | S0277 | Y. Z. Sun | J,PR/C,104,014310,2021 | Trans.S031 |
| 28 | S0278 | Hao Zhang | J,CPH/C,45,084108,2021 | Trans.S032 |
| 29 | S0279 | Z. Y. Zhang | J,PRL,126,152502,2021 | Trans.S032 |
| 30 | S0295 | B.Gao | J,PRL,129,132701,2022 | Trans.S032 |

### 5.2 Nuclear data services and dissemination

CNDC provides the nuclear data service for institutes, universities or other requirements in China. The Fission Yield (1.0beta) App was developed by Jin Yongli at CNDC. This App can retrieve the fission product yield data of neutron-induced fission and spontaneous fission from various evaluated data libraries. The retrieved data can be shown as plot and saved in JPG and text formats for exchange.

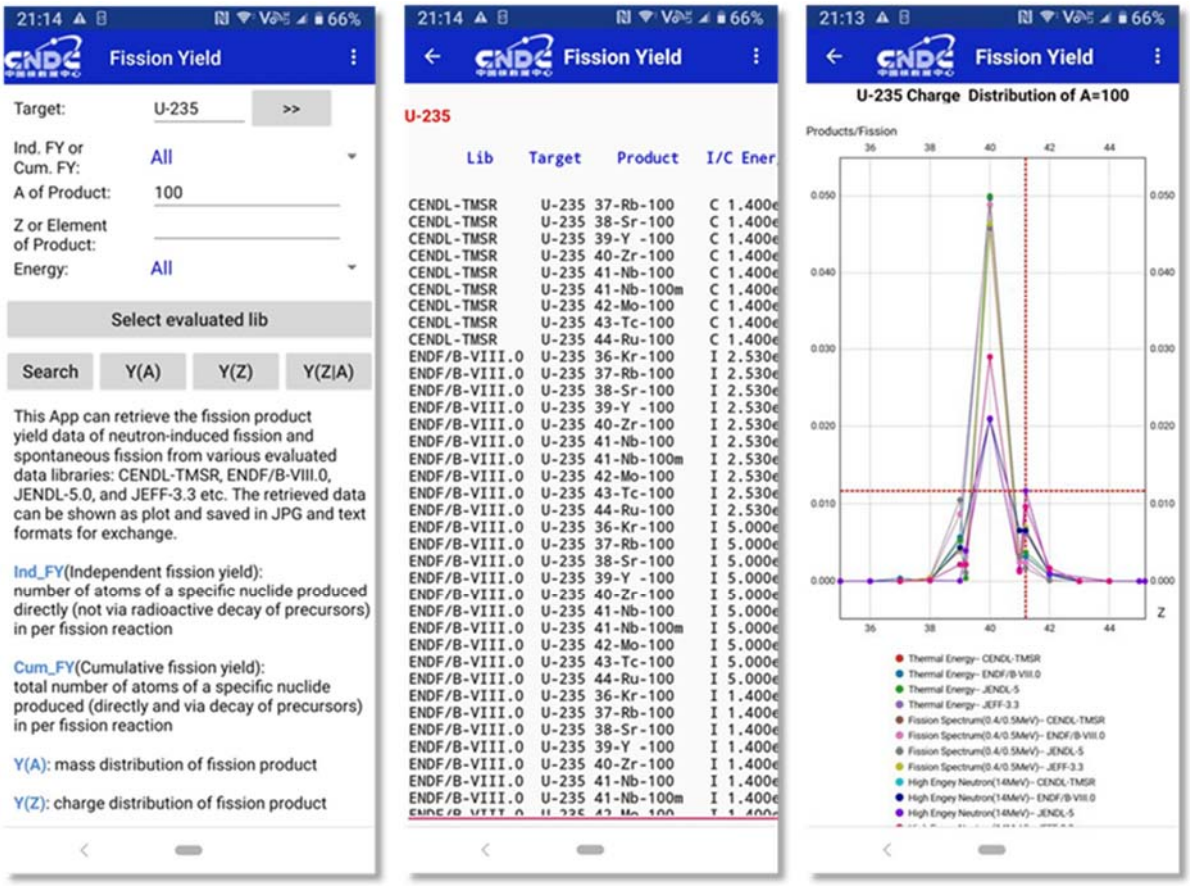



Fig. 18 Interface of the Fission Yield (1.0beta) App

# Korea Nuclear Data Center (KNDC)

Progress Report for period 2022-2023

Technical Meeting on the International Network of Nuclear Reaction Data Centers (NRDC 2023)
9 - 12 May, 2023

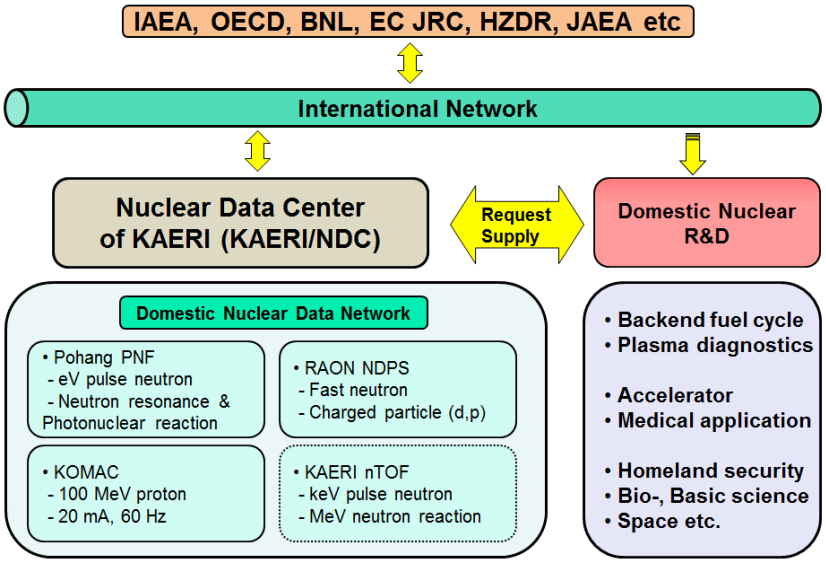
Korea Atomic Energy Research Institute
Daejeon, Korea
*Web: http://atom.kaeri.re.kr/*
*E-mail: kimdh@kaeri.re.kr*

## 1. General

Korea Nuclear Data Center (KNDC, formerly 'Nuclear Data Evaluation Lab.') was established in 1997 to start research on nuclear data in Korea and joined the International Network of Nuclear Reaction Data Centers (NRDC) in 2000. KNDC at Korea Atomic Energy Research Institute (KAERI) performs the following main tasks:

- Evaluation and method development for nuclear reaction data
- Establishment of processing and validation system of nuclear reaction/covariance data
- Measurement of nuclear reaction data and establishment of measurement facility
- Production and validation of atomic/molecular collision data

The mission of our center includes disseminating the outcomes of cooperation with international networks as well as promoting nuclear data research activities and supporting nuclear/radiation R&Ds in Korea. KNDC is also coordinating the measurement activities using domestic accelerators for producing various nuclear reaction data.



KNDC continues to cooperate with the international nuclear data network as follows:

- Participating in IAEA CRP, TM, and CM on nuclear data evaluation, nuclear data processing and validation, atomic/molecular data network, etc.
- Collecting nuclear reaction measurement data in Korea for EXFOR compilation under the guidance of IAEA/NDS
- Participating in the JEFF and WPEC subgroups of OECD/NEA
- Conducting joint research on evaluation, measurement, and validation of nuclear data with foreign research institutes

As of 2023, KNDC consists of 8 regular staffs, 2 post-retirement researchers, a post-doctoral researcher, and 2 Ph.D. students. The latest staff changes include:

- Dr. Jounghwa LEE joined as a regular staff in July 2022.
- Dr. Young-Ouk LEE retired in December 2022 and joined as a post-retirement researcher in January 2023.
- Dr. Haewon SHIN joined as a post-doctoral researcher in January 2023.
- Mr. Changmin SHIN joined as a Ph.D. student in April 2023.

They are working in the following fields:

- Nuclear data evaluation: 2 regular staffs
- Nuclear data measurement: 2 regular staffs and a post-retirement researcher
- Nuclear data processing/validation/application: 2 regular staffs, a post-retirement researcher, and a Ph.D. student
- Atomic/molecular data production: 2 regular staffs, a post-doctoral researcher, and a Ph.D. student

## 2. EXFOR Activity

The compilation of nuclear reaction data obtained in Korea continues to be carried out under the guidance of IAEA/NDS. Since the last meeting in 2022, 8 entries were registered in the EXFOR DB and 10 entries were transmitted after compilation. (See Table 1.)

Table 1. Compilation statistics of KNDC

| No. | TRANS | ENTRY | SUBJECT | STATUS |
|---|---|---|---|---|
| 1 | D136 | D7031 | Proton | EXFOR |
| 2 | D136 | D7032 | Proton | EXFOR |
| 3 | D136 | D7033 | Proton | EXFOR |
| 4 | D137 | D7034 | Proton | EXFOR |
| 5 | D137 | D7035 | Proton | EXFOR |
| 6 | D137 | D7036 | Proton | EXFOR |
| 7 | D137 | D7037 | Proton | EXFOR |
| 8 | D137 | D7038 | Proton | EXFOR |
| 9 | | D7039 | Proton | Compiled |
| 10 | | D7040 | Proton | Compiled |
| 11 | | D7041 | Proton | Compiled |
| 12 | | D7042 | Proton | Compiled |
| 13 | | D7043 | Proton | Compiled |
| 14 | | 30851 | Neutron | Compiled |
| 15 | | 30852 | Neutron | Compiled |
| 16 | | 30853 | Neutron | Compiled |
| 17 | | 30854 | Neutron | Compiled |
| 18 | | 30855 | Neutron | Compiled |

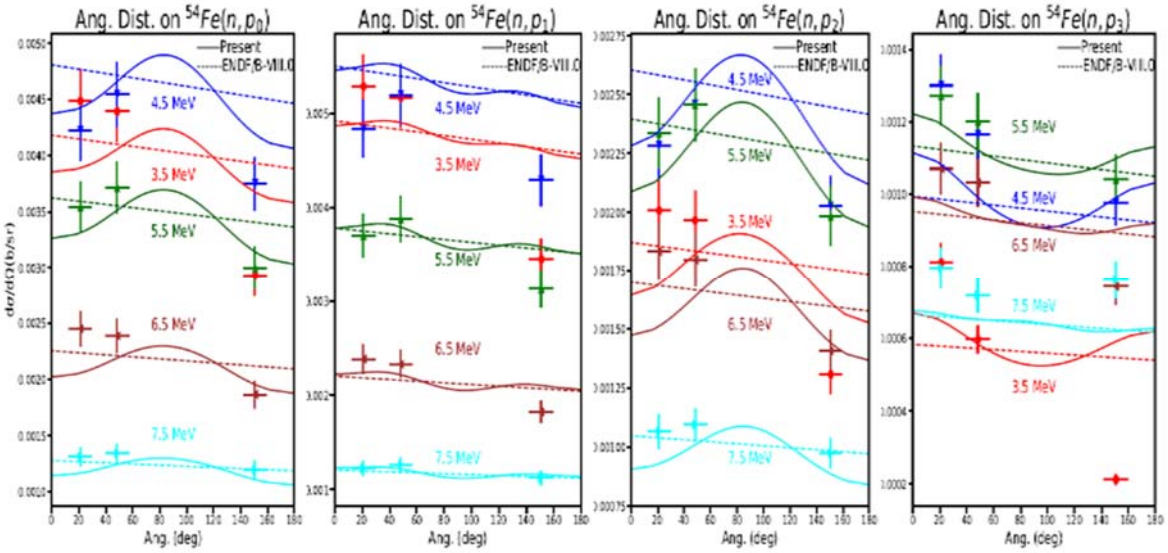
The draft was checked through a tool of JCPRG. (http://www.jcprg.org/exfor/tool/)

## 3. Nuclear Data Activities

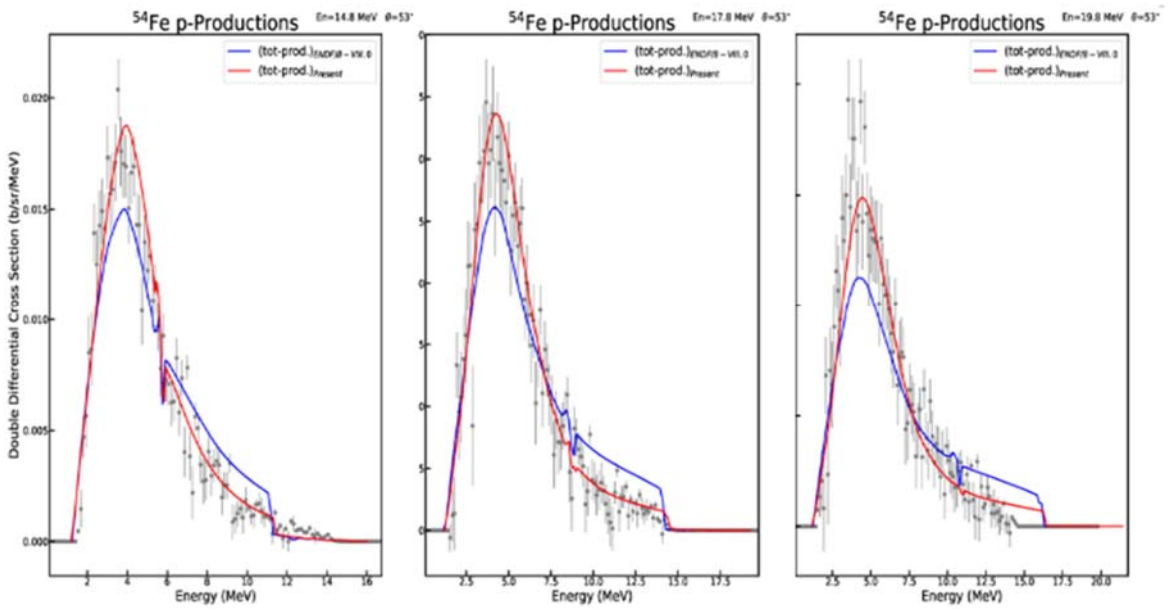
### 3.1 Evaluation

A research on improving angular distributions and energy spectra of neutron-induced charged particle was completed in 2022 through the International Nuclear Energy Research Initiative (I-NERI) project with Los Alamos National Laboratory (LANL). We evaluated angular distributions and energy spectra of discrete and continuum levels for Fe, Ni, Zn based on the experimental (n,p) and (n,α) reaction cross sections. Additionally, we predicted angular distributions and energy spectra of (n,p) and (n,α) reactions for unmeasured nuclides, such as Cr, Mn, Co, Cu, and so on. Eventually, it was decided that the new evaluations on angular

distributions and energy spectra of neutron-induced charged particle reactions would be incorporated into the next ENDF/B release. In conclusion, we have submitted the evaluated files for a total of 58 nuclides to the repository of the ENDF/B-VIII.1-β1 version.



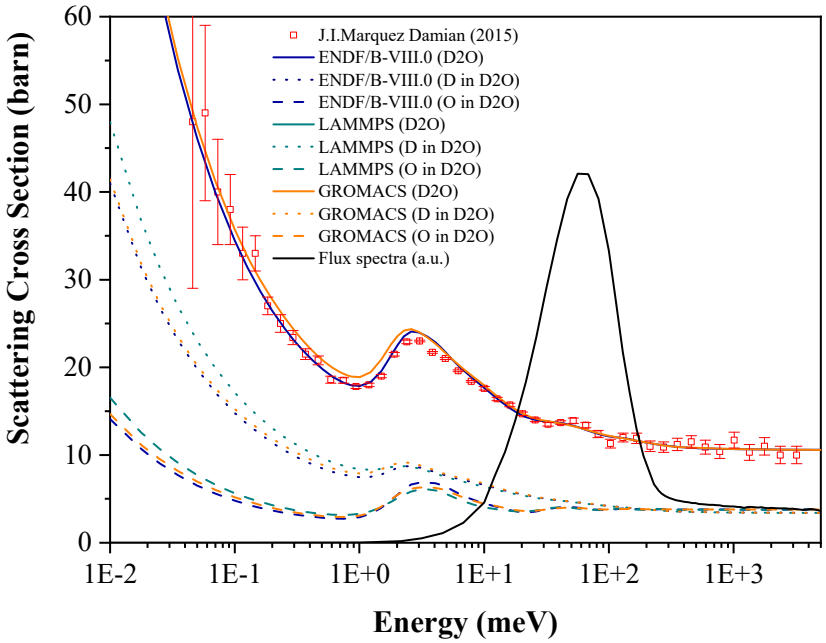

Angular Distribution of $^{54}$Fe(n,p)



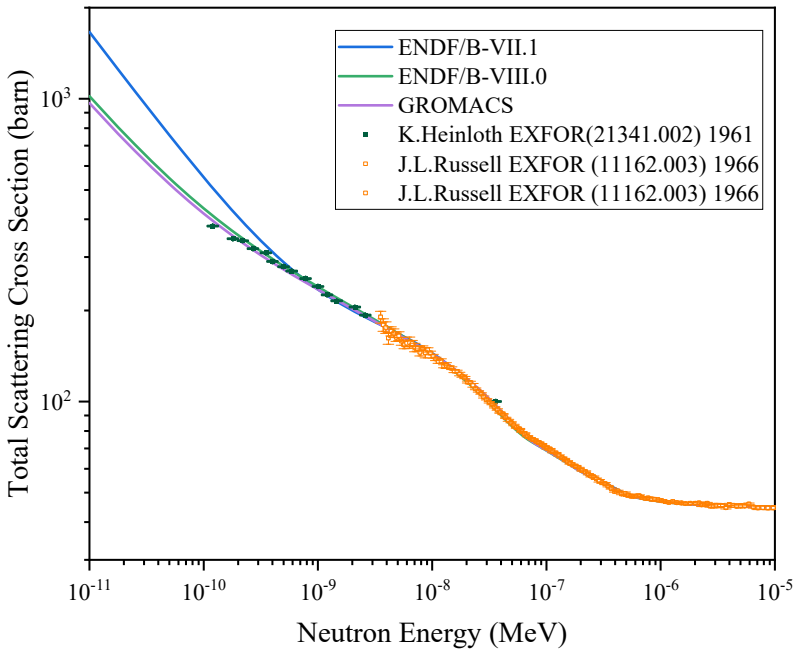

Energy Spectrum of $^{54}$Fe(n,p)

A research on producing thermal neutron scattering data based on molecular dynamics code simulation has been conducted since 2022. Preliminary TSL data of $D_2O$ and $H_2O$ were produced using the frequency spectrum and/or Sköld correction factor obtained by GROMACS

and LAMMPS code simulations with TIP4P/2005f or SPC/E water models. It was confirmed that the TSL data showed comparable performances to those of ENDF/B-VIII.0 through validation calculation using criticality benchmark problems taken from ICSBEP.



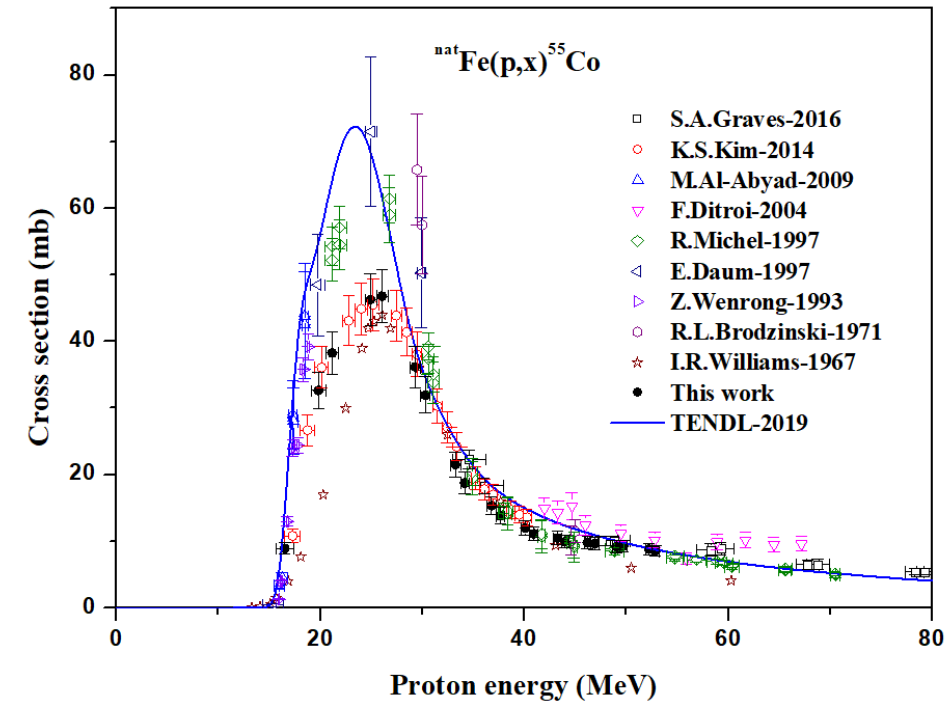

Scattering Cross Sections for $D_2O$

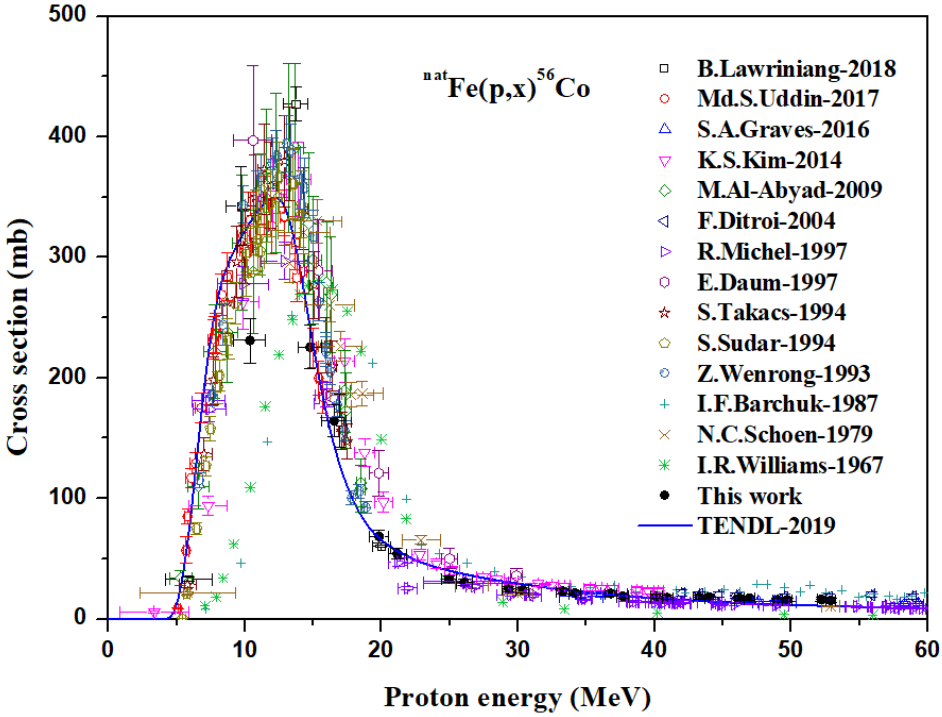



Scattering Cross Sections for $H_2O$

### 3.2 Measurement

The production cross sections for the proton induced reactions of $^{nat}$Fe were measured using a stacked-foil activation technique with a proton energy of 57 MeV at the proton LINAC of the Korea multi-purpose accelerator complex (KOMAC). The measured values were compared with the experimental data of the literature and the data from the TENDL-2019 library.



### 3.3 Cooperation

We continue to cooperate with the following experimental groups for nuclear data production in Korea:

- Kyungpook National University (KNU)
- Sungkyunkwan University (SKKU)
- Institute for Basic Science (IBS)

Since the last meeting, some events have been held in cooperation with KNDC.

- "The 11th Korea-Japan Joint Summer School on Accelerator and Beam Science, Nuclear Data, Radiation Engineering and Reactor Physics" was held in Gyeongju, Korea from August 1 to 4, 2022. This event was organized by KOMAC of KAERI and supported by KNDC. The purpose of this event is to introduce the latest research activities on accelerators, reactor physics, nuclear data, etc. in Korea and Japan to graduate students and to inspire their research motivation.


- The "Workshop on Low Energy RI Research" was held in Daejeon, Korea from July 20 to 21, 2022. This workshop was organized by RAON of Institute for Basic Science (IBS). The EXFOR database and nuclear data measurement in Korea was introduced in this

workshop.

- The “Reactor Physics Asia 2023 (RPHA23)” conference is being organized to resume in Gyeongju, Korea from October 24 to 26, 2023. This conference is hosted by the Reactor Physics and Computational Science Division of the Korean Nuclear Society, cosponsored by the counterpart divisions of the Chinese Nuclear Society and the Atomic Energy Society of Japan.

### 3.4 Web Service

KNDC provides the following three main web services. These websites are constantly being updated.

- Nuclear Data Chart (http://atom.kaeri.re.kr/nuchart/): nuclide information, nuclear reaction data, cross section data plot and comparison
- Application Library (http://atom.kaeri.re.kr/NDVG/): processed nuclear data library for Monte Carlo (ACE) and deterministic (MATXS) neutron transport codes, processed covariance data (COVFIL), fission product yield and decay data for SCALE
- Atomic Data (http://pearl.kaeri.re.kr/pearl/): atomic database including photoionization cross section, electron impact ionization (EII) rate coefficient, and dielectronic recombination (DR) rate coefficient

### 3.5 Support for Nuclear/Radiation R&Ds

KNDC supports domestic and foreign nuclear/radiation R&Ds by providing nuclear data related information, how to process nuclear data, working libraries for application, etc. The main support details for 2022 were as follows:

- Technical advice on the utilization of $D_2O$ thermal neutron scattering data of ENDF/B-VIII.0 for Hanaro research reactor (KAERI)
- ACE-format TSL library (with 18 temperatures) of O-in-$D_2O$ for Hanaro research reactor (KAERI)
- Energy spectrum analysis data of existing nuclear data libraries (LANL)

# Japan Nuclear Reaction Data Centre (JCPRG)

# Progress Report

*Nuclear Reaction Data Centre (JCPRG),*
*Faculty of Science, Hokkaido University*
http://www.jcprg.org

IAEA's Technical Meeting on the
"International Network of Nuclear Reaction Data Centres"
May 9-12, 2023

## 0. General

The Japan Nuclear Reaction Data Centre (JCPRG) is a research center for nuclear data activities in Hokkaido University Sapporo. The main objectives of JCPRG are as follows:

a) Compilation of nuclear reaction data for two databases, NRDF and EXFOR
b) Evaluation of nuclear reaction data
c) Development of software and systems for compilation and evaluation
d) Education of the graduate school students

## 1. Compilation

### 1.1 NRDF

NRDF database is the original nuclear reaction database of JCPRG. Our initial EXFOR entries were provided by converting the NRDF format to the EXFOR format. Nowadays, both NRDF and EXFOR formats are generated simultaneously using the database creation editor HENDEL. From June 2022 to April 2023, we have compiled 61 new papers of charged particle and photonuclear reaction data.

### 1.2 EXFOR

Since the last NRDC meeting, we have transmitted 63 new and 15 revised entries as 6 trans and prelim files (E133-E137, J011 and K021) to the NDS open area. Our transmissions are summarized in Tables 1.

**Table 1. EXFOR E-entries transmitted from JCPRG to NDS IAEA in 2022.**

| TRANS | TRANS Status | ENTRY Tot. | ENTRY New | ENTRY Rev. |
|---|---|---|---|---|
| E133 | Final (2022/06/14) | 2 | 0 | 2 |
| E134 | Final (2022/06/14) | 11 | 11 | 0 |
| E135 | Final (2022/08/19) | 30 | 29 | 1 |
| E136 | Final (2023/3/8) | 13 | 13 | 0 |
| E137 | Prelim (2023/4/8) | 12 | 2 | 10 |
| J011 | Final (2022/08/19) | 2 | 2 | 0 |
| K021 | Final (2022/08/19) | 8 | 6 | 2 |

## 2. System Development

### 2.1 Data Retrieval System

We have 3 data retrieval systems mentioned below.

- NRDF (http://www.jcprg.org/nrdf/)
- NRDF/A (http://www.jcprg.org/nrdfa/)
- EXFOR/ENDF (http://www.jcprg.org/exfor/)

The relational database management system MySQL has been adopted for the databases to search and retrieve NRDF, EXFOR and ENDF data. For EXFOR, new trans files are copied from the NDS open area, and the MySQL database is updated periodically.

### 2.2 Coding Software

We have a coding editor and digitizing software applicable for the coding purpose.

- Coding editor "HENDEL" (https://www.jcprg.org/manuals/hendel/)
- Digitization software "GSYS" (https://www.jcprg.org/gsys/2.4/)

# Progress Report
## NRDC-2023 Technical Meeting
(9-12 May, 2023, Vienna)


## Institute for Nuclear Research, ATOMKI
(S. Takács)


**Nuclear Data Activities at ATOMKI in 2022-2023**

The usual experimental work was resumed back after COVID period. New experiments were performed at atomki cyclotron and tandetron laboratories, as well as at facilities of collaborating international laboratories. Data evaluations of the experiments are ongoing.

### 1. Organization and Staff

The organizational structure of the institute had changed again, from laboratories to research groups.

The following groups may publish experimental nuclear data for compilation in EXFOR.

Nuclear technology group: Number of active staff member: 5 persons.
Nuclear astrophysics group: Number of active staff member: 7 persons.
Experimental nuclear physics group: Number of active staff member: 5 persons.

### 2. EXFOR compilation

During the covered period 6 new entries were created and 14 old entries were revised and transmitted to IAEA NDS.
The compiled new entries include all the newly published articles and other articles assigned for compilation to ATOMKI.

### 3. Nuclear data related activities in ATOMKI:

- Compilation of all newly measured and published experimental data in EXFOR. (continuous)
- Compilation of nuclear decay data
- Evaluation of cross sections for medical isotope production and charged particle beam monitoring. (technical contracts)
- Imaging Technologies for Process Investigations and Components Testing: Radioactive tracing of industrial processes by using Thin Layer Activation (TLA) and Positron Emission Tomography. (CRPs)

### 4. Publications in 2022 – 2023

About 35+ papers were published during the last period. Papers published on research work made in international collaborations with variety of compilation responsibility.

**Appendix G**

# REVISIONS OF EXFOR PROTOCOL

(revisions from IAEA-NDS-0215 Rev.2018/06)

| Data compilation responsibility | |
|---|---|
| **Current description** | **Revision** |
| Removal of "NDS shall keep an archival copy of the latest version of each of the EXFOR entries and shall be ready to provide the data to any Centre should it be required." | (Delete.) |

Procedure for transmitting new exchange files

| **Current description** | **Revision** |
|---|---|
| Request NDS to delete the preliminary version from the NDS open area | Request NDS to move delete the preliminary version to subdirectory TRANS.ARCHIVE from the NDS open area. |
| (New) | NDS will maintain preliminary and final versions of exchange files, dictionaries, and the source codes of the official programs to create updated EXFOR Master File. The NDS open area is for distribution of these materials to the Network and should not be accessible for the public. |

EXFOR Master File (new section)

| **Current description** | **Revision** |
|---|---|
| (New) | The EXFOR Master File is the continuously updated file generated from the common Master File of *DD*, *MM*, *YYYY* and all exchange files finalized since that date. The Network has responsibility for ensuring reproducibility of the EXFOR Master File including the maintenance of an official program that creates the EXFOR Master File. NDS shall make available on a publicly accessible and referenced website the EXFOR Master File. |

(The actual date will replace *DD*,*MM*,*YYYY* when the network start distribution of the EXFOR Master File.)

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