

IAEA Nuclear Data Section: Progress Report for period 2023-2024

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

May 2023 – April 2024

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Vienna, Austria

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1. Staff Changes

The authorized staff level of the Nuclear Data Section (NDS) consists of a total of 16 professionals and support staff. The latest staff changes include:

- Monfero Charisse (Team Assistant) relocated to the Section office in October 2023.
- Elias Szende (Team Assistant) joined in October 2023.
- Viktor Zerkov (Software Engineer) retired in October 2023.
- Jean-Christophe Sublet (NDSU – Unit Head) retired in November 2023.

2. Compilations

2.1 EXFOR transmission

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

- 5 neutron final TRANS tapes (3209-3212, V042) containing 58 new entries and 87 revised entries;
- 6 CPND final TRANS tapes (B035, D138-D142) containing 110 new entries and 148 revised entries;
- 3 PhND final TRANS tapes (G050-G052) containing 11 new entries and 0 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.9128–9129) were done in TRANS, DANIEL (backup) and archive format.

Number of new entries transmitted by final tapes since the NRDC 2023 meeting
(TZ: Timur Zholdybayev+Feruzjon Ergashev, MO: Myagmarjav Odsuren)

	NDS	ATOMKI	CNDC	KNDC	NDPCI	UkrNDC	TZ	MO	Sum
Neutron	6		31	5	16	0			58
CPND	24	9	*	5	35	10	10	17	110
PhND	6			0	2	3			11
Sum	36	9	31	10	53	13	10	17	179

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

2.2 EXFOR quality control

During the reporting period, **68 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, Lidija Vrapcenjak is checking the code strings for the primary reference systematically to improve connection between the EXFOR database and pdf database (c.f. CP-D/1098).

2.3 EXFOR coverage control

Under the EXFOR compilation control system, **18 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/>). Additional 19 journal titles were scanned until by December 2023 but stopped due to separation of Vidya Devi. This list also includes the scanning records of 19 journal titles (including 2 titles scanned by both CNPD and NDS) 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 resumed after freezing period.

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-2023 TALYS-based Evaluated Nuclear Data Library
 - INDEN- Aug2023 evaluations produced by International Nuclear Data Evaluators Network (coordinated by the IAEA)
 - Updated JENDL-5 Japanese evaluated nuclear data library (2021)
- EXFOR:
 - establishing procedures for regular maintenance and distribution on GitHub:
 - EXFOR-Archive - all Entries from official TRANS files starting from 2005
 - EXFOR-X5json - all EXFOR Entries translated to X5-JSON, includes Python codes for indexing, reading, plotting and renormalizing data
 - EXFOR-C5 - all EXFOR Entries translated to computational format C5, six versions with and without automatic renormalization and automatically generated correlation matrices (include Python codes)
 - X5, C5 – extension, testing, debugging, improving
- EXFOR-ENDF:
 - plotting fission product yield from EXFOR and ENDF as a function of energy
- EXFOR-NSR PDF database:
 - updates: 42, added 2,208 PDF files
 - database content (PDF files):
 - total: +2,208 => 227,581
 - EXFOR-PDF: +763 => 28,519 (78% of 36,087)
 - NSR-PDF: +1,445 => 191,562 (~79% of 243,751)
- IBANDL:
 - 4 database updates (total: 4,537 Datasets)
 - Web-interface extended by CSV output for individual dataset
 - IBANDL-Archive on GitHub: trial version
- Web-Tools for EXFOR compilers, ENDF and ENSDF evaluators:
 - MyExfor: 3 updates by new versions of ZCHEX and new Dictionaries
 - MyEnsdf: upgraded code JAVA_NDS

3.2 Packages and databases for Web downloading

- “X4Pro” - universal, fully relational EXFOR database (professional ed.). Two releases.

- EXFOR-C5 – full EXFOR library translated to computational format C5 separated by Entries. Five versions with different options: converting C.M. to Lab. Rutherford-Ratio to B/SR, replaced Q-Value by E-Level, set MT51-90, ..., MT801-849 by MT+iLevel for partial reactions, auto-renormalized using modern monitor CS data, etc. Two releases.

3.3 Document 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 <https://nds.iaea.org>

Number of reports published between May 2023 and April 2024.

Report code	Country of origin	Reports
IAEA-NDS	Nuclear Data Section	6
INDC(EUR)	European Commission	1
INDC(GER)	Germany	1
INDC(JPN)	Japan	2
INDC(SPN)	Spain	1
INDC(NDS)	Nuclear Data Section	23

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 (February and August) 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 (75 and 76). Next one, No 77 is in preparation and will be published in August 2024. We currently have 73 recipients of hardcopies and 1178 recipients of electronic version.

4. Visits and Inter-centre Cooperation

- N. Otsuka (NDS) visited CNDC from 18 to 22 September 2023 to discuss finalization of EXFOR entries compiling data measured in China.
- N. Otsuka (NDS) visited JCPRG from 22 to 26 January 2024 to extend the web-based EXFOR editor (HENDEL) to support the new STATUS format.

5. Training Activities (Schools, Workshops)

- Joint ICTP-IAEA Workshop on “Simulation of Nuclear Reaction Data with the TALYS Code”, 16-20 October 2023, Trieste, Italy.

6. Nuclear Data Journal Publications (2023-2024)

The IAEA electronic stopping power database: Modernization, review, and analysis of the existing experimental data

C.C. Montanari, P. Dimitriou, L. Marian, A.M.P Mendez, J.P. Peralta, F. Bivort-Haiek, *Nucl. Instrum. Methods Phys. Res. B* **551** (2024) 165336.

Evaluated and recommended cross-section data for production of radionuclides with emerging interest in nuclear medicine imaging. Part 1: Positron emission tomography (PET)

A. Hermanne, F.T. Tárkányi, A.V. Ignatyuk, S. Takács, R. Capote, *Nucl. Instrum. Methods Phys. Res. B* **535** (2023) pp. 149-192.

Normalization of ToF (n,f) Measurements in Fissile Targets: Microscopic cross-section integrals

I. Duran, R. Capote and P. Cabanelas, *Nucl. Data Sheets* **193** (2024) pp. 95-104.

Evaluated and recommended cross section data for production of radionuclides with emerging interest in nuclear medicine imaging. Part 2: Single photon emission computed tomography (SPECT)

A. Hermanne, F.T. Tarkanyi, A.V. Ignatyuk, S. Takacs and R. Capote, *Nucl. Instrum. Methods Phys. Res. B* **544** (2023) 165119.

Optical potentials for the rare-isotope beam era

C. Hebborn, J.W. Holt, F.M. Nunes, M.C. Atkinson, G. Potel, W.H. Dickhoff, R.B. Baker, G. Blanchon, M. Burrows, C. Barbieri, R. Capote, P. Danielewicz, M. Dupuis, Ch. Elster, J.E. Escher, L. Hlophe, A. Idini, H. Jayatissa, B.P. Kay, K. Kravvaris, J.J. Manfredi, A. Mercenne, B. Morillon, G. Perdikakis, G.H. Sargsyan, C.D. Pruitt, I.J. Thompson, M. Vorabbi, T.R. Whitehead, *J. Phys. G: Nucl. Part. Phys.* **50** (2023) 060501.

Benchmarking of Stainless Steel Cube Neutron Leakage in Research Center Rez

Michal Kostal, Zdenek Matej, Martin Schulc, Evzen Losa, Jan Simon, Evzen Novak, Frantisek Cvachovec, Vaclav Prenosil, Filip Mravec, Tomas Czako, Vojtech Rypar, Andrej Trkov, Roberto Capote, *Nucl. Sci. Eng.* **198** (2024) pp. 399-410.

Dispersive optical model analysis of nucleon scattering on ^{90}Zr

X. Zhao, W. Du, R. Capote, E.Sh. Soukhovitskii, *Phys. Rev. C* **107** (2023) 064606.

Progress in the Evaluation and Validation of $n+^{56,57}\text{Fe}$ Cross Sections

A. Trkov, R. Capote, D. Bernard, R. Beyer, Y. Danon, A. Daskalakis, A. Junghans, M. Kostal, P. Leconte, M. Schulc, S. Simakov, *EPJ Web of Conferences* **284** (2023) 12002.

Measurement of partial (n, n'gamma) reaction cross-sections on highly radioactive nuclei of interest for energy production

Francois Claeys, Philippe Dessagne, Maelle Kerveno, Cyrille De Saint Jean, Catalin Borcea, Marian Boromiza, Roberto Capote, Nicolas Dari Bako, Marc Dupuis, Greg Henning, Stephane Hilaire, Alexandru Negret, Gilles Noguere, Markus Nyman, Adina Olacel, Arjan Plompen, *EPJ Web of Conferences* **284** (2023) 01014.

GRAPhEME: performances, achievements (@EC-JRC/GELINA) and future (@GANIL/SPIRAL2/NFS)

Maelle Kerveno, Catalin Borcea, Marian Boromiza, Roberto Capote, Francois Claeys, Nicolas Dari Bako, Cyrille De Saint Jean, Philippe Dessagne, Jean Claude Drohe, Marc Dupuis, Greg Henning,

Stephane Hilaire, Toshihiko Kawano, Alexandru Negret, Markus Nyman, Adina Olacel, Carlos Paradela, Arjan Plompen, Ruud Wynants, *EPJ Web of Conferences* **284** 92023) 01005.

Measurement of $^{183}\text{W}(n, n'\gamma)$ and $(n, 2n\gamma)$ cross-sections (preliminary)

Greg Henning, Kerveno Maelle, Philippe Dessagne, Francois Claeys, Nicolas Dari Bako, Marc Dupuis, Stephane Hilaire, Pascal Romain, Cyrille de Saint Jean, Roberto Capote, Marian Boromiza, Adina Olacel, Alexandru Negret, Catalin Borcea, Arjan Plompen, Carlos Paradela Dobarro, Markus Nyman, Jean-Claude Drohe, Ruud Wynants, *EPJ Web of Conferences* **284** (2023) 01046.

Using the Monte-Carlo method to analyze experimental data and produce uncertainties and covariances.

Greg Henning, Maelle Kerveno, Philippe Dessagne, Francois Claeys, Nicolas Dari Bako, Marc Dupuis, Stephane Hilaire, Pascal Romain, Cyrille de Saint Jean, Roberto Capote, Marian Boromiza, Adina Olacel, Alexandru Negret, Catalin Borcea, Arjan Plompen, Carlos Paradela Dobarro, Markus Nyman, Jean-Claude Drohe, Ruud Wynants, *EPJ Web of Conferences* **284** (2023) 01045.

Database work for the new cross section standards evaluation

A. Carlson, R. Capote, D. Neudecker, V. Pronyaev, G. Schnabel, *EPJ Web of Conferences* **284** (2023) 14006.

From $^{232}\text{Th}(n, n'\gamma)$ cross sections to level production and total neutron inelastic scattering cross sections

Nicolas Dari Bako, Maelle Kerveno, Philippe Dessagne, Catalin Borcea, Marian Boromiza, Roberto Capote, Francois Claeys, Marc Dupuis, Greg Henning, Alexandru Negret, Markus Nyman, Adina Olacel, Eliot Party, Arjan Plompen, *EPJ Web of Conferences* **284** (2023) 08005.

Spectral averaged cross sections as a probe to a high energy tail of ^{235}U PFNS

Martin Schulc, Michal Kostal, Roberto Capote, Jan Simon, Tomas Czako, Evzen Novak, *EPJ Web of Conferences* **284** (2023) 04021.

On the need for precise nuclear structure data for high quality $(n, n'\gamma)$ cross section measurements

Greg Henning, Maelle Kerveno, Philippe Dessagne, Francois Claeys, Nicolas Dari Bako, Marc Dupuis, Stephane Hilaire, Pascal Romain, Cyrille de Saint Jean, Roberto Capote, Marian Boromiza, Adina Olacel, Alexandru Negret, Catalin Borcea, Arjan Plompen, Carlos Paradela Dobarro, Markus Nyman, *EPJ Web of Conferences* **284** (2023) 01022.

Experimental spectrum averaged cross sections (SACS) in $^{252}\text{Cf}(sf)$ neutron field and its impact on the evaluation of neutron standards

R. Capote, G. Schnabel, A.D. Carlson, V.G. Pronyaev, G. Noguere, D. Neudecker, *EPJ Web of Conferences* **281** (2023) 00027.

Cassini-oval description of the multidimensional potential energy surface for ^{236}U : Role of octupole deformation and calculation of the most probable fission path

K. Okada, T. Wada, R. Capote, N. Carjan, *Phys. Rev. C* **107** (2023) 034608.

Manhattan Project 1940s research on the prompt fission neutron spectrum

M.B. Chadwick, R. Capote, *Front. Phys.* **11** (2023) 1105593.

TENDL-based evaluation and adjustment of $p+^{111}\text{Cd}$ between 1 and 100 MeV,

E. Alhassan D. Rochman, A. Vasiliev, A.J. Koning, H. Ferroukhi, *Appl. Radiat. Isot.* **198** (2023) 110832.

FENDL: A library for fusion research and applications

G.Schnabel, D.L. Aldama, T. Bohm, U. Fischer, S. Kunieda, A. Trkov, C. Konno, R. Capote, A.J. Koning, S. Breidokaite, T. Eade, M. Fabbri, D. Flammini, L. Isolan, I. Kodeli, M. Kostal, S. Kwon, D. Laghi, D. Leichtle, S. Nakayama, M. Ohta, L.W. Packer, Y. Qiu, S. Sato, M. Sawan, M. Schulc, G. Stankunas, M. Sumini, A. Valentine, R. Villari, A. Zohar, *Nucl. Data Sheets* **193** (2024) pp.1-78.

Global comparison between experimentally measured isomeric yield ratios and nuclear model calculations

S. Cannarozzo, S. Pomp, A. Al-Adili, A. Gook, A. Solders, A. Koning, *Eur. J. Phys.* **A59** No. 12 (2023) 295.

Templates of Expected Measurement Uncertainties for (n,xn) Cross Sections

Jeffrey R. Vanhoy, Robert C. Haight, Sally F. Hicks, Michal Herman, Arjan Koning, Keegan J. Kelly, Matthew Devlin, Ian Thompson, *EPJ Nucl. Sci. Technol.* **9** (2023) 31.

Templates of Expected Measurement Uncertainties

Denise Neudecker, Amanda M. Lewis, Eric F. Matthews, Jeffrey Vanhoy, Robert C. Haight, Donald L. Smith, Patrick Talou, Stephen Croft, Allan D. Carlson, Bruce Pierson, Anton Wallner, Ali Al-Adili, Lee Bernstein, Roberto Capote, Matthew Devlin, Manfred Drosig, Dana L. Duke, Sean Finch, Michal W. Herman, Keegan J. Kelly, Arjan Koning, Amy E. Lovell, Paola Marini, Kristina Montoya, Gustavo P.A. Nobre, Mark Paris, Boris Pritychenko, Henrik Sjöstrand, Lucas Snyder, Vladimir Sobes, Andreas Solders, *EPJ Nucl. Sci. Technol.* **9** (2023) 35.

TALYS: modeling of nuclear reactions

Arjan Koning, Stephane Hilaire and Stephane Goriely, *Eur. J. of Phys.* **A59** (2023) 131.

STEK: A potential fast spectrum benchmark for fission product cross sections

Steven van der Marck, Arjan Koning, *Front. Energy Res.* **11** (2023) 1085857.

Templates of expected measurement uncertainties for neutron-induced capture and charged-particle production cross section observables

Amanda M. Lewis, Denise Neudecker, Allan D. Carlson, Donald L. Smith, Ian Thompson, Anton Wallner, Devin P. Barry, Lee A. Bernstein, Robert C. Block, Stephen Croft, Yaron Danon, Manfred Drosig, Robert C. Haight, Michal W. Herman, Hye Young Lee, Naohiko Otuka, Henrik Sjöstrand, Vladimir Sobes, *EPJ Nuclear Sci. Technol.* **9** (2023) 33

Templates of expected measurement uncertainties for total neutron cross-section observables

Amanda M. Lewis, Allan D. Carlson, Donald L. Smith, Devin P. Barry, Robert C. Block, Stephen Croft, Yaron Danon, Manfred Drosig, Michal W. Herman, Denise Neudecker, Naohiko Otuka, Henrik Sjöstrand, Vladimir Sobes, *EPJ Nuclear Sci. Technol.* **9** (2023) 34

Characterization of a HPGe detector response for activation cross section measurements: regression method versus Monte Carlo method

Valentina Semkova, Naohiko Otuka, Arjan J. M. Plompen, *J. Nucl. Sci. Technol.* **61** (2024) pp. 151-160.

Nuclear physics midterm plan at Legnaro National Laboratories (LNL)

M. Ballan, A. Koning, et al., *Eur. Physical J. Plus* **138** (2023) 709.

EXFOR-based simultaneous evaluation for fast neutron-induced fission cross section of thorium-232

Vidya Devi, Naohiko Otuka, S. Ganesan, *J. Nucl. Sci. Technol.* **61** (2024) pp. 44-56.

EXFOR-based simultaneous evaluation for neutron-induced fission cross section of plutonium-242

Riko Okuyama, Naohiko Otuka, Go Chiba, Osamu Iwamoto, *J. Nucl. Sci. Technol.* **61** (2024) pp. 57-67.

The difference between charge polarizations of fission fragments deduced by the static theoretical model and in the current data library

S. Ebata, S. Okumura, C. Ishizuka and S. Chiba, *Int. J. Mod. Phys. E* **32** (2023) 2350030.

Charge polarization calculated with a microscopic model for the fission fragments of U-236

S. Ebata, S. Okumura, C. Ishizuka and S. Chiba, *EPJ Web of Conferences* **284** (2023) 04008.

Consideration of memory of spin and parity in the fissioning compound nucleus by applying the Hauser-Feshbach fission fragment decay model to photonuclear reactions

T. Kawano, A. E. Lovell, S. Okumura, H. Sasaki, I. Stetcu, and P. Talou, *Phys. Rev. C* **107** (2023) 044608.

TALYS calculations of prompt fission observables and independent fission product yields for the neutron-induced fission of ^{235}U

K.Fujio, A.Al-Adili, F.Nordstrom, J.-F.Lemaitre, S.Okumura, S.Chiba, A.Koning, *Eur. Phys. J. A* **59** (2023) 178.

Compilation of isomeric ratios of light particle induced nuclear reactions

A. Rodrigo, N. Otuka, S. Takács, A.J. Koning, *At. Data Nucl. Data Tables* **153** (2023) 101583.

Simultaneous evaluation of uranium and plutonium fast neutron fission cross sections up to 200 MeV for JENDL-5 and its updates

N. Otuka, O. Iwamoto, *EPJ Web Conf.* **284** (2023) 08011.

Overview of the dissemination of n_TOF experimental data and resonance parameters

E. Dupont, N. Otuka, D. Rochman, G. Noguère, O. Aberle, V. Alcayne, S. Altieri, S. Amaducci, J. Andrzejewski et al., *EPJ Web Conf.* **284** (2023) 18001.

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E. Alhassan D. Rochman, A. Vasiliev, A.J. Koning, H. Ferroukhi, *Appl. Radiat. Isot.* **198** (2023) 110832.