

IAEA Nuclear Data Section: Progress Report for period 2021-2022

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

April 2021 – May 2022

IAEA Technical Meeting, 14-17 June 2022

Vienna, Austria

Web: <https://nds.iaea.org/>

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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:

- Mark O'Connell (Information Systems Assistant) retired in April 2022.

2. Compilations

2.1 EXFOR transmission

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

- 10 neutron final TRANS tapes (3199–3207, V039) containing 67 new entries and 174 revised entries;
- 16 CPND final TRANS tapes (B031-B033, D130-D136) containing 96 new entries and 149 revised entries;
- 2 PhND final TRANS tapes (G047-G048) containing 13 new entries and 3 revised entries.

These include contributions from NDS (**50 new entries**), five other centres (ATOMKI, CNDC, KNDC, NDPCI, UkrNDC) as well as two compilers (Myagmarjav Odsuren, Timur Zholdybayev).

Timur Zholdybayev (Institute of Nuclear Physics, Almaty) is coordinating compilation of data measured in Central Asia (*e.g.*, Kazakhstan, Uzbekistan) for area 3, D and G

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

Two regular transmissions of the EXFOR/CINDA dictionaries (TRANS.9124–9125) were done in TRANS, DANIEL (backup) and archive format.

Number of new entries transmitted by final tapes since the NRDC 2021 meeting
(TZ: Timur Zholdybayev, MO: Myagmarjav Odsuren)

	NDS	ATOMKI	CNDC	KNDC	NDPCI	UkrNDC	TZ	MO	Sum
Neutron	20		19	4	23	1			67
CPND	30	7		6	32	7	3	11	96
PhND				3	0	10			13
Sum	50	7	19*	13	55	18	3	11	176

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

2.2 EXFOR quality control

During the reporting period, **108 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,

- Stanislav Simakov (NDS consultant) extracted neutron elastic scattering angular differential and integrated cross sections which may include contribution of inelastic scattering to lower excitation levels, and reviewed each case by checking the source article. See Memo 4C-3/0420 for further details.
- Ryosuke Shimizu (NDS intern) extracted questionable energies coded under the heading E-LVL, and reviewed each case by checking the source article and ENSDF library. See Memo CP-D/1043 for further details.

2.3 EXFOR coverage control

Under the EXFOR compilation control system, **38 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 18 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:
 - JENDL-5 Japanese evaluated nuclear data library 2021 (incl. Errata March-2022)
 - JENDL/DDF-2015 JENDL Decay Data File 2015, Japan
 - FENDL-3.2b Fusion Evaluated Nuclear Data Library, IAEA, 2022
 - IRDFF-II/DD: decay data sub-library of International Reactor Dosimetry and Fusion File, IAEA 2019
 - INDEN-Feb2022: evaluations produced by International Nuclear Data Evaluators Network (coordinated by the IAEA)
 - IAEA-Std17: IAEA Standard and Reference Cross Sections, 2017
 - UKDD-2020 : UK Decay Data Library, UK, 2020
 - software news:
 - radioactive decay data (MF8.MT457): output to JSON, plot, comparison data of different libraries from ENDF database and LARA files from DDEP-2021 and ENSDF-2021
 - plotting groupwise data running GROUPIE code on the fly on 175, 640, 725, 765 groups
 - API for search and download data of MF4, MF5, MF6 in JSON
- EXFOR:
 - new section “Evaluator”: search for ENDF users by <Target, Projectile, MF, MT>
 - automatic renormalization using decay data: intensity of lines (AR, DG, X from DECAY-DATA and DECAY-MON)
 - option: “cm2lab” for angular distributions
- EXFOR-NRS PDF database
 - updates: 85, added 3,092 PDF files
 - ready to open public Web access to Lab reports of JINR, Dubna (via INIS)
 - database content (PDF files):
 - total: +3,092 => 223,350
 - EXFOR-PDF: +1,081 => 26,904 (77.1% of 34,876)
 - NSR-PDF: +1,837 => 188,903 (~79.2% of 238,544)
- IBANDL: 4 database updates

- Web-ZVView: on-line translation (via intermediate JSON) and plot by Plotly-2.0

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

- MyExfor: 6 updates by new versions of ZCHEX and new Dictionaries
- MyEnsdf: added/upgraded codes: JAVA_NDS (+online LaTeX to PDF), GABS, GTOL, BrIcc, ALPHAD_RadD, ALPHAD

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

3.2 Packages for Web downloading (former CD/DVD-ROM’s)

New and updated packages:

- new release of GRUCON evaluated data processing code (V.Sinitsa, Kurchatov Institute, Moscow, Russia).
- new release of “X4Apps/X4Lite” EXFOR-CINDA database (SQLite) with GUI (Java) retrieval system for Windows, Linux, MacOSX. Provides scripts and utility codes for EXFOR data search, retrieval and conversion to: Html, XML, JSON, C5. Includes Endver/GUI package integrated with Prepro, EXFOR, ZVView.
- new product (to be released): “X4Pro” extends EXFOR Relational database (SQLite) with experimental data points in original and computational form; comes with demo on Python and Fortran with (a) retrievals of CS, DA, DAP, DE, DAE from local EXFOR and remote ENDF databases, (b) EXFOR data renormalization to new standards and decay data, (c) user’s modifications and (d) plotting with Plotly package. All works on Windows, Linux and MacOS.

3.3 Document Services

Nuclear Data Services Unit (NDSU) continued supporting the Member States by providing documentation and data libraries as requested.

The documents produced by the Nuclear Data Section are now shared via links to our webpage, and hardly any hardcopies are being sent.

Due to technologies also constantly improving, the data libraries are now only downloaded from the we webpage <https://nds.iaea.org/cdroms/>. There were only two requests for the data to be sent out physically in the reporting period.

Any improvement suggestions should be sent to our contact address (nds.contact-point@iaea.org).

Number of reports published between April 2021 and May 2022

Report code	Country of origin	Reports
IAEA-NDS	Nuclear Data Section	3
INDC(JPN)	Japan	1
INDC(USA)	United States	1
INDC(NDS)	Nuclear Data Section	20
INDC(SEC)	NDS Secretariat	1

3.4 Nuclear Data Newsletters

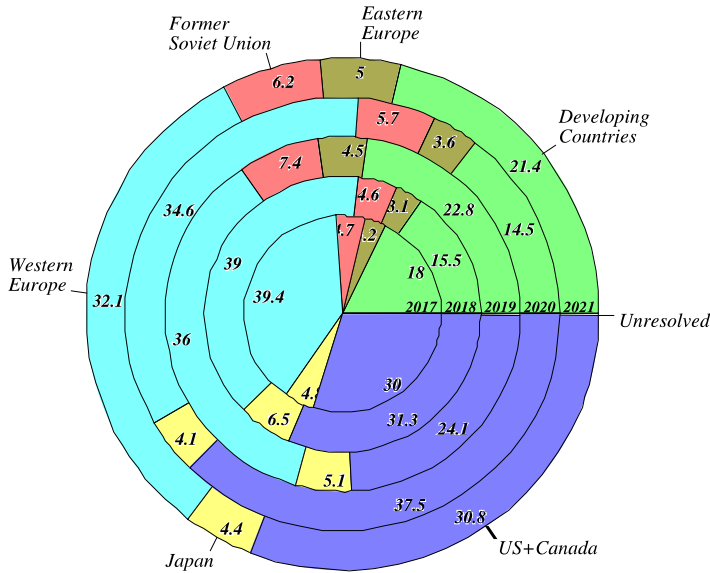
The Nuclear Data Newsletter is published biannually to inform the scientific community about actual NDS work, meetings held, projects, and new data libraries. During the reporting period, we published two issues of the Newsletter (71 and 72). Next one, No 73 is in preparation and will be published in August 2022. We currently have 94 recipients of hardcopies and 1288 recipients of electronic version.

4. Visits and Inter-centre Cooperation

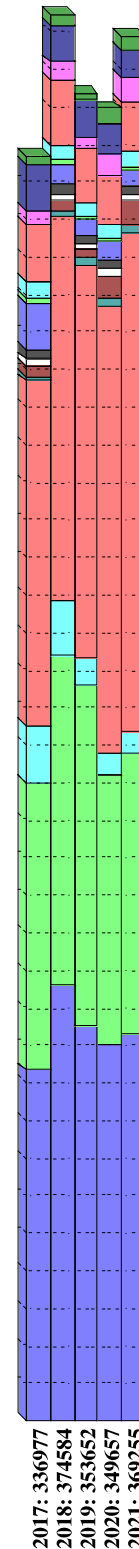
- V. Zerkin (NDS) visited NNDC from 1 to 19 May 2022 to deploy and further develop software for ENDF-EXFOR-PDF database management, Web retrieval system, tools and output formats; to extend schema and contents of EXFOR, ENDF and EXFOR-NSR PDF databases.

IAEA Nuclear Data Services: Web Statistics 2017-2021

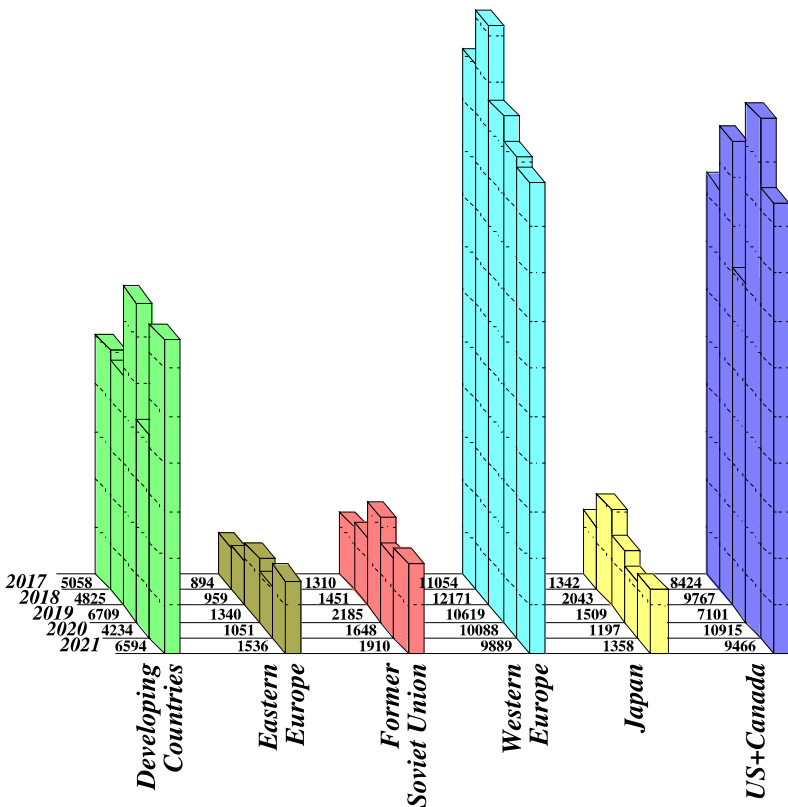
Geographical Distribution (%)



Total per Year (Number of accesses + retrievals) *2020 extrapolated 5 months



Average per Month (Number of accesses + retrievals)



- | Service | Comment |
|------------------------|--------------|
| Computer Codes | |
| Documents | |
| OtherData | |
| IBANDL | |
| PGAA | |
| PhotoNuclear | |
| RIPL | Theory |
| FENDL | Fusion |
| Masses | |
| IRDF | Dosimetry |
| Thermal Capture | |
| Wallet Cards | |
| Med.Radioisotope.Prod. | |
| NGAtlas | Activation |
| RNAL | |
| ENSDF | Structure |
| MIRD | Medical |
| NuDat/LiveChart | |
| CINDA+NSR Bibliography | |
| EXFOR | Experimental |
| ENDF | Energy |

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 “Atomistic Modelling of Radiation Damage in Nuclear Systems”, 2021, Trieste, Italy (virtual).

7. Nuclear Data Journal Publications (2021-2022)

EXFOR-NSR PDF database: a system for nuclear knowledge preservation and data curation

V.V. Zerkin, B. Pritychenko, J. Totans, L. Vrapcenzak, 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. A* **58** (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.

Nuclear data evaluation with Bayesian networks

G. Schnabel, R. Capote, A. Koning, D. Brown, *Arxiv preprint arxiv:2110.10322* (2021)

Development and application of marginal likelihood optimization for integral parameter adjustment

D. Siefman, M. Hursin, G. Schnabel, H. Sjostrand, *Ann. Nucl. En.* **159** (2021).

Application of JADE V&V capabilities to the new FENDL v3.2 beta release

D. Laghi, M. Fabbri, L. Isolani, M. Sumini, G. Schnabel, A. Trkov, *Nucl. Fusion* **61** Issue 11 (2021) 116073.

Investigating High-Energy Proton-Induced Reactions on Spherical Nuclei: Implications for the Pre-Equilibrium Exciton Model

Morgan B. Fox, Arjan J. Koning, et al., *Phys. Rev. C* **103** (2021) 034601.

Conception and software implementation of a nuclear data evaluation pipeline

G. Schnabel, H. Sjostrand, J. Hansson, D. Rochman, A. Koning, and R. Capote, *Nucl. Data Sheets* **173** (2021) 239-284.

Measurement and Modeling of Proton-Induced Reactions on Arsenic from 35 to 200 MeV

Morgan B. Fox, Arjan J. Koning, et al., *Phys. Rev. C* **104** (2021) 064615.

Improved modelling of alpha-particle emission in nucleon induced reactions

A.Yu. Konobeyev, D. Leichtle, A.J. Koning, *KIT Scientific Working Papers* **176** (2021).

Fast-neutron induced reaction cross section measurement of tin with dual monitor foils and covariance analysis

R.Pachuau, N.Otuka, C.V.Midhun, A.Gandhi, A.Mazumdar, H.Krishnamoorthy, A.Reza, V.Vatsa, S.V.Suryanarayana, B.K.Nayak, L.S.Danu, T.Patel, S.Bishnoi, I.Pasha, A.Kumar, V.Nanal, *Eur. Phys. J. A* **57** (2021) 268.

Activation cross section measurement of alpha-particle induced reactions on natural neodymium

M. Sakaguchi, M. Aikawa, N. Ukon, Y. Komori, H. Haba, N. Otuka, S. Takács, *Appl. Radiat. Isot.* **176** (2021) 109826.

Erratum to "Uncertainty propagation in activation cross section measurements" [Radiat. Phys. Chem. 140 (2017) 502-510]

N. Otuka, B. Lalremruata, M.U. Khandaker, A.R. Usman, L.R.M. Punte, *Radiat. Phys. Chem.* **184** (2021) 109440.