NATIONAL NUCLEAR DATA CENTER

David Brown, April 22, 2022.

Data Metric Collection

National Nuclear Data Center

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SC PuRe Data Resource:

National Nuclear Data Center

Steward:

Office of Nuclear Physics, Nuclear Data

Data Resource Access Procedures:

Summary description of the typical ways that users interact with the resource, including:

- o User access procedures

  - o Information collected for registered users, if applicable

    The GitLab server houses version-controlled collaborative projects, mainly those related to the ENDF library. There are currently 83 user accounts in this server; users must provide their full name, affiliation, address, e-mail and telephone number. Non-US citizens must also obtain a guest status at BNL and complete the yearly cybersecurity training. The number of users typically grows by 10 users during the summer to accommodate our summer interns.

  - o Information obtained for anonymous connections, if applicable

    From anonymous connections we obtain the IP address, browser type, time and date of query, database being queried, and a summary of the query executed.

- o Modes of data access and/or download

  Most of the NSR, XUNDL and ENSDF downloads are made through the website. For EXFOR, some of the downloads are made through the website while others are made through one of several open-source API's. For ENDF, the website downloads represent only a very small percentage of

its usage as most of its usage is through the MCNP, SCALE and GEANT4 codes suite. MCNP is developed by Los Alamos National Laboratory and is the premier neutron transport code, SCALE is developed by Oak Ridge National Laboratory and primarily used for NRC licensing purposes and GEANT4 is an open-source code (development coordinated by CERN) and is commonly used in high energy physics. Both MCNP and SCALE are available from the Radiation Safety Information Computational Center (https://rsicc.ornl.gov). Because ENDF is mainly distributed with these transport codes, it is sometimes difficult to assess how often and who uses the data.

o   Data access and/or download limits

Access to the GitLab server is restricted to registered users.   For web applications, there are currently no limits on access or downloads.

Data Resource Technical Metrics:

Summary of technical metrics used for planning and monitoring the operations of the resource, including:

o   Amount of data stored (in size, number of records, and/or other relevant formats). This includes indices and database views of the data. We note that these values differ dramatically from the NNDC's FY22 values because of the major upgrades made to several web applications. In addition, for cybersecurity reasons, the EXFOR+ENDF webapp was removed from the NNDC website.

Databases:
    NSR: 0.694 GB (Total articles: 242,120, Total keyworded abstracts: 196,773,
        Total authors: 108,272, Nuclides: 8,578, Reactions: 8,914, Decays: 382)
    EXFOR: 191.818 GB (Peer reviewed articles: 24,390, Datasets: 182,945,
            Article PDFs: 223,399)
    ENSDF + XUNDL: 0.947 GB Total
        ENSDF: Datasets:19591, Nuclides: 3,408,
          Decay Radiations: 4,447, Reactions: 10,813, Mass Chain: 300
        XUNDL: Total Datasets: 9,796, Nuclides: 2,796, Decay Radiations: 2,221,
            Reactions: 7,575, Publications: 5,620
    ENDF: 1.9182 GB (Sublibraries: 15, Total evaluations: 5,107, Full releases: 8)
    NuDat: 0.445 GB
Total Database: 195.822 GB
Web Applications:
    NSR: 0.0333 GB
    ENSDF + XUNDL: 3.027 GB
    ENDF + EXFOR: [removed]
    NuDat: 0.142 GB
    ENDF (sigma): 19 GB
Total Web applications: 22.2 GB
GitLab server: 883 GB (at least 230 separate projects)

The total size is 1,101 GB

o Amount of new data added

NSR: 3,284 new articles were added to the database in FY22, with keywords for 2,391
     of them. Keywords briefly describe the articles' contents.
EXFOR: Data from 158 articles were added and 210 articles updated in FY22.
XUNDL: Data from 335 articles were added in FY22
ENSDF: Recommended data for 230 nuclides were added in FY22
ENDF: In the last 15 years, new releases of ENDF have occurred in 2018, 2011 and 2007.
     We are preparing for our next release, scheduled for Feb. 2024.

o Amount of data provided to users

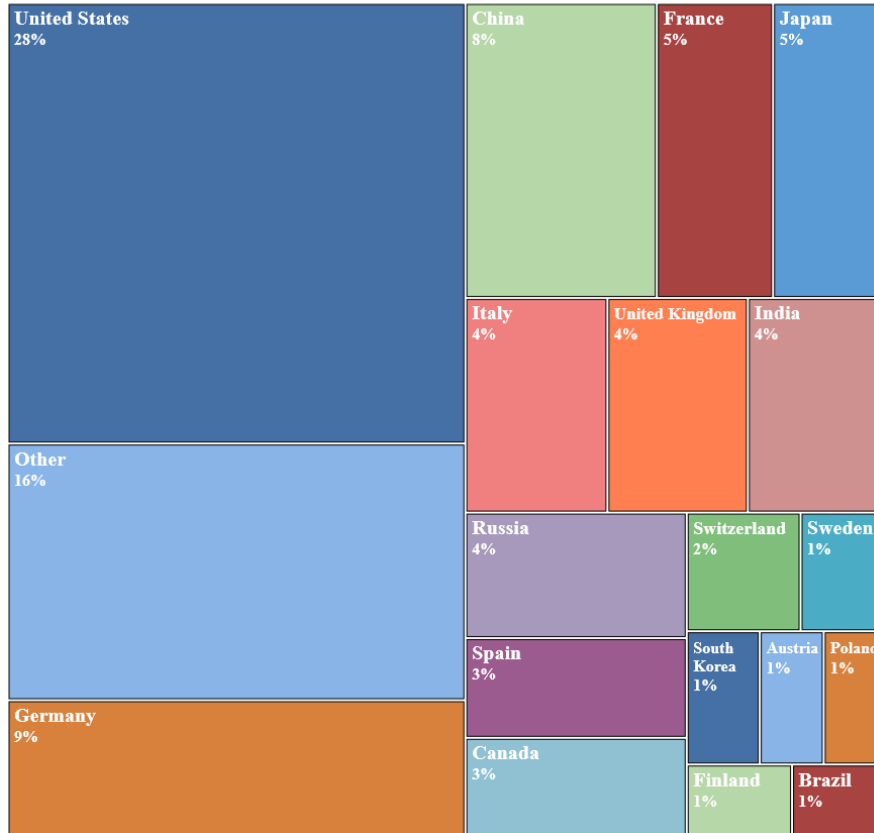The plot below gives the number of database retrievals in the 1996-2021 period.
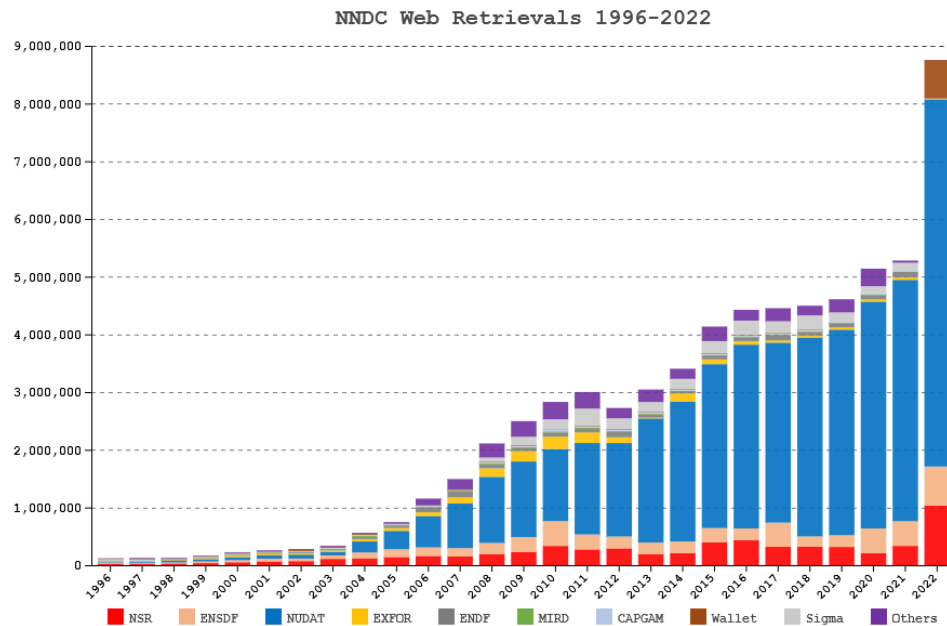
o Total number of users accessing data

NuDat had a major update starting in the latter part of FY21 and completing in FY22. A
conservative extrapolation of NuDat's Web user profile consists of approximately 82,000 distinct
IP addresses. The largest user accounts for about 0.2% of all retrievals. The total number of
ENDF users could be estimated in the thousands, as MCNP and SCALE are widely used around
the world.

o Geolocation and/or institutional affiliations of users accessing data

The following plot gives the geographic distribution of NNDC Database retrievals through NuDat during FY 2022.

NuDat Web Retrievals by Country (FY2022)

|	
United States 28%	China 8% · France 5% · Japan 5% · Italy 4% · United Kingdom 4% · India 4% · Russia 4% · Switzerland 2% · Sweden 1% · Spain 3% · South Korea 1% · Austria 1% · Poland 1% · Canada 3% · Finland 1% · Brazil 1%
Other 16%	
Germany 9%	

o   Software and/or resource downloads

Currently, software is not available for download without access to the NNDC GitLab instance

o   Other relevant statistics

About 500 copies of the Nuclear Wallet Cards are distributed in a typical year. In FY22, 220 Nuclear Wallet Cards were distributed. As only 75 were distributed in FY21, we are returning to pre-pandemic distribution levels.

Nuclear Data Sheets is the primary venue for nuclear data related publications (especially ENSDF mass chains) and is edited by the NNDC. The graphs below show two publication parameters, Impact Factor and Number of Citations per year, for *Nuclear Data Sheets*, as well as the geographic distribution of downloads from the Elsevier Journal Citations Report.   There is a dip in the Impact Factor in 2015 that is not visible on the plot below; this dip was due to the publication of 250 conference proceedings.
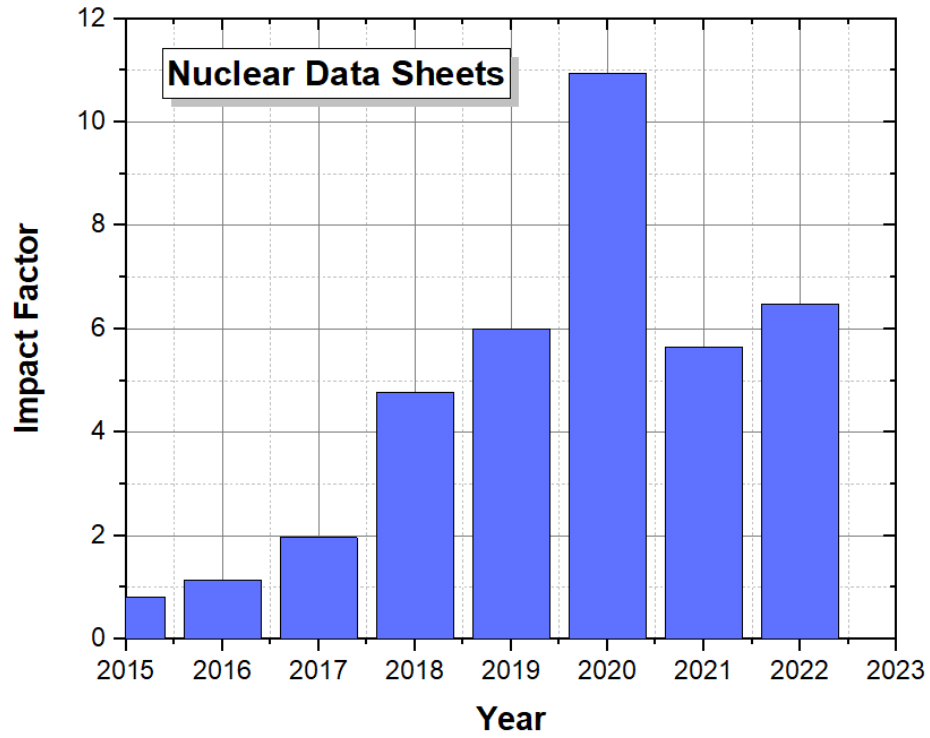
Nuclear Data Sheets Impact Factor.
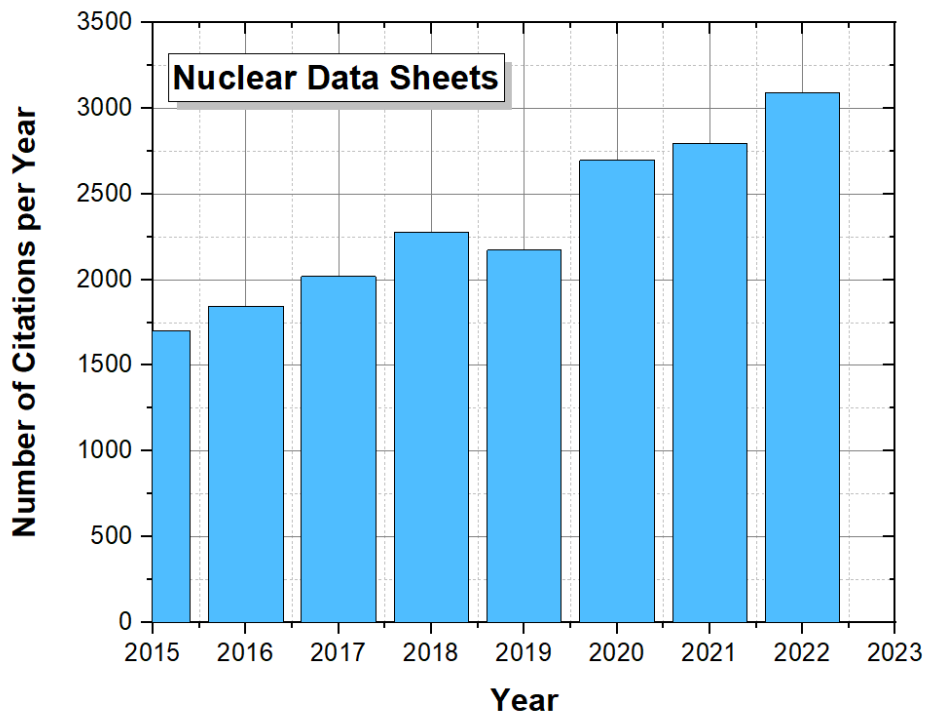
Nuclear Data Sheets Number of Citations per year.
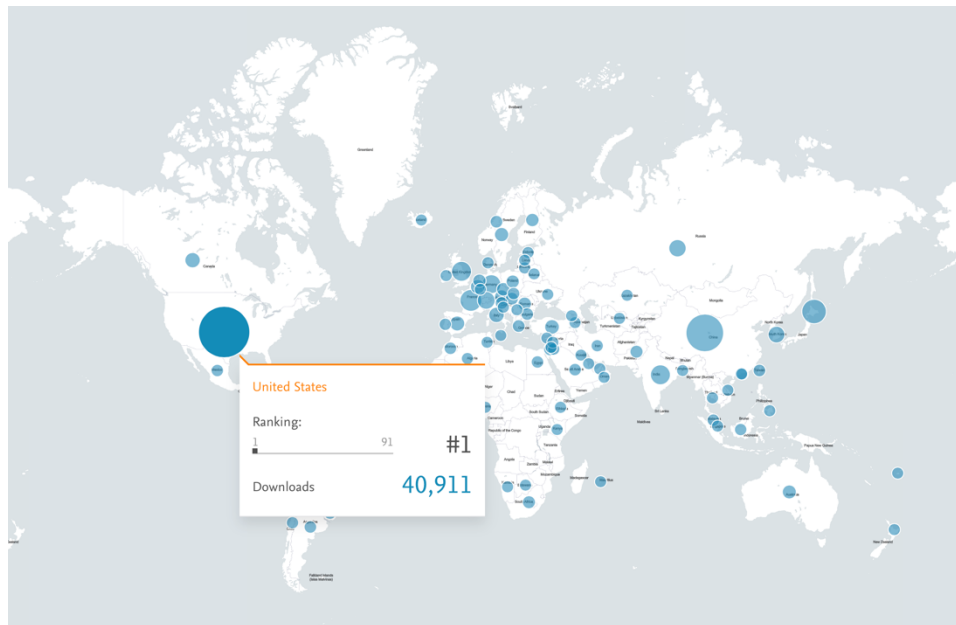
Geographical distribution of Nuclear Data Sheets downloads in the five year period 2018-2022 (from Elsevier website)

Data Resource Scientific Impact and Highlights:

Summary of scientific impact metrics and highlights reflecting the impact on the scientific community, including:

- o Number of publication citations
  The table below shows a few representative articles, books and reports, with the corresponding number of citations.

Topic	Author	References	# Google Scholar citations
ENDF/B-VIII.0	D.A. Brown et al.	Nuclear Data Sheets 148, 1 (2018)	1,465
ENDF/B-VII.1	M.B. Chadwick et al.	Nuclear Data Sheets 112, 2887 (2011)	3,055
ENDF/B-VII.0	M.B. Chadwick et al.	Nuclear Data Sheets 107, 2931 (2006)	2,638
Atlas of Neutron Resonances	S.F. Mughabghab	Book published by Elsevier Science (2006)	3,017
EXFOR	N Otuka et al.	Nuclear Data Sheets, 120, 272, (2014)	729
ENSDF for A=43	B. Singh et al.	Nuclear Data Sheets, 126, 1, (2015)	566
E2 transition probabilities	B. Pritychenko et al.	Atomic and Nuclear Data Tables, 107, 1, (2016)	408
ENSDF for A=136	A.A. Sonzogni	Nuclear Data Sheets, 95, 837, (2002)	164

Maxwellian Cross Sections	B. Pritychenko et al.	Atomic and Nuclear Data Tables, 96, 645, (2010)	139
Nuclear Wallet Cards	J. Tuli	BNL report (1995)	1,446

- o Significant milestones for the resource

  For the last 20 years, we list the following:
  - o 2004: Release of new web services using novel server architecture and network infrastructure.
  - o 2006: ENDF/B-VII.0 was released, starting a tradition of publishing articles describing the ENDF library in Nuclear Data Sheets.
  - o 2008: Hosted a 3.5-day Covariance Workshop, with proceedings published in Nuclear Data Sheets.
  - o 2011: ENDF/B-VII.1 was released.
  - o 2013: The NNDC hosted the International Conference on Nuclear Data for Science and Technology in Manhattan, which was attended by 450 participants.
  - o 2014: A GForge server for collaborative projects was setup, this server would be replaced in 2019 by a GitLab server.
  - o 2015: First article on nuclear reactor antineutrinos was published.
  - o 2016: ^{82}Rb highly precise decay scheme was published, the first one in a series of experiments to improve the data of radioisotopes of interest in nuclear medicine.
  - o 2018:
    - ENDF/B-VIII.0 was released.
    - Collaboration between the NNDC and Physical Review C on XUNDL compilation starts.
    - 6th edition of the Atlas of Nuclear Resonances is published.
  - o 2019: Number of participants in Nuclear Data Week exceeded 120.
  - o 2020:
    - Proposal to modernize the ENSDF database was funded.
    - The number of participants in Nuclear Data Week exceeds 190.
  - o 2021:
    - The NNDC is designated a PuRe data resource.
    - The NNDC co-hosted WoNDRAM, the Workshop on Nuclear Data for Reactor Antineutrino Measurements.
  - o 2022:
    - Elizabeth McCutchan was elected an APS Fellow with the citation: "For innovative and distinguished contributions to understanding the evolution of collectivity in heavy nuclei, critical precision experiments to test ab initio methods in light nuclei, seminal analyses of antineutrino spectra, and the development of new database tools to understand nuclear data"

- Major scientific results that relied on use of the resource

  The following highly cited articles have made use of USNDP data:

  New "USD" Hamiltonians for the sd shell
  B.A. Brown, W.A. Richter, Physical Review C **74**, 034315 (2006), 835 citations in Google Scholar

  Reactor Decay Heat in ^{239}Pu: Solving the γ Discrepancy in the 4-3000-s Cooling Period
  A. Algora et al., Physical Review Letters **105**, 202501 (2010), 174 citations in Google Scholar

  Determination of antineutrino spectra from nuclear reactors,
  P.A. Huber, Physical Review C **84**, 024617 (2011), 1161 citations in Google Scholar

  The limits of the nuclear landscape
  J. Erler *et al*. Nature **486**, 509 (2012), 559 citations in Google Scholar

  The impact of individual nuclear properties on r-process nucleosynthesis
  M.R. Mumpower et al., Progress in Particle and Nuclear Physics **86**, 86 (2016), 430 citations in Google Scholar

  Analysis of the Daya Bay Reactor Antineutrino Flux Changes with Fuel Burnup
  A.C. Hayes et al., Phys. Rev. Lett. **120**, 022503 (2018), 47 citations in Google Scholar

Community Engagement:

Summary of ongoing community engagement activities, including:

- Training for new or existing users

  - NNDC personnel have co-chaired ENSDF evaluation workshops every two years at the International Center for Theoretical Physics in Trieste, Italy, in collaboration with IAEA personnel. Participants of these two-week workshops become familiar with the NSR, XUNDL and ENSDF database, their format and evaluation policies.
  - Two NNDC scientists are regularly invited as lecturers at Nuclear Physics Summer schools to educate users on nuclear data evaluation and methods to retrieve data.
  - NNDC personnel have been lecturers at the Modeling, Experiment and Validation Summer School for nuclear engineers to educate users on the ENDF/B nuclear data library and the evaluation process.
  - NNDC personnel are organizing the summer school "JINA-CEE presents, Stellar Modelling for Nuclear Astrophysics" at Louisiana State University during the summer of 2022. This school is intended to teach the use of stellar models to examine nucleosynthesis in stars for those interested in theoretical and experimental stellar reaction rates.

- Educational/outreach activities

- o The NNDC has mentored more than 50 undergraduate students in the last 8 years, who have become familiar with experimental nuclear structure and decay efforts, the ENSDF and ENDF databases, and nuclear reaction models. In 2018, DoE recognized this effort publishing a short note in its web site: https://science.osti.gov/np/Community-Resources/National-Nuclear-Data-Center-Summer-Students
- o The NNDC has featured an exhibitor table at the American Physical Society Division of Nuclear Physics meetings. During these meeting, web applications were demonstrated, Nuclear Wallet Cards were distributed, NNDC staff gathered feedback and answered questions.
- o NNDC staff have chaired the Nuclear Data Working Group of the Low-Energy Community meeting, which takes place every summer. In that role, a session on nuclear data featuring about 10 speakers is organized, and in the past a survey on NNDC products took place.
- o NNDC people have helped to organize the Workshop on Applied Nuclear Data Activities series, contributed presentations, chaired sessions, and helped to write final reports.
- o In FY2023, NNDC staff started organizing and participating in a semi-annual outreach event under the Women in Science and Engineering program which attracted over 60 undergraduate and early graduate STEM students from Stony Brook University. During the one-day event, NNDC staff showcased the uses of Nuclear Data and of NNDC databases in basic and applied science through presentations and interactive experiments.

- o Other relevant community engagement activities

  - o The NNDC organizes the yearly Nuclear Data Week meeting, participates in technical meetings and Coordinated Research Projects at the IAEA, and in OECD's Nuclear Energy Agency WPEC Subgroups, including chairing the Generalized Nuclear Data Storage Expert Group.
  - o The NNDC hosted the 2013 International Nuclear Data Conference for Science and Technology, organized and chaired meetings on nuclear data covariances as well as nuclear reactor antineutrinos, and co-organized meetings on nuclear reaction theory.
  - o NNDC members are part of 2022 International Nuclear Data Conference for Science and Technology Local Organizing Committee hosted by LLNL.
  - o Approximately 5-10 seminars per year are given at the NNDC on topics of interest.
  - o The NNDC head made a presentation to the 2018 Nuclear Science Advisory Committee.
  - o One NNDC member serves as a member of ANL's ATLAS Users Executive Committee.
  - o One NNDC member is the editor of the Atomic Data and Nuclear Data Tables journal published by Elsevier.
  - o One NNDC person was a member of the American Physical Society Division of Nuclear Physics program committee through FY21; this person has also received a 2020 'Outstanding Referee' recognition from the Physical Review journals. Additionally, several NNDC members have chaired sessions in DNP meetings.

- The NNDC has formal collaborations with members of Argonne National Laboratory, Los Alamos National Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Oak Ridge National Laboratory, the University of Massachusetts at Lowell, the Nuclear Energy Agency (OECD) and the International Atomic Energy Agency.