

Nuclear Data

Chris Morse

6/25/2026

This material is based upon work supported by the U.S.
Department of Energy, Office of Science, Office of Nuclear
Physics under Contract No. DE-AC02-98CH10886

EBSS 2026

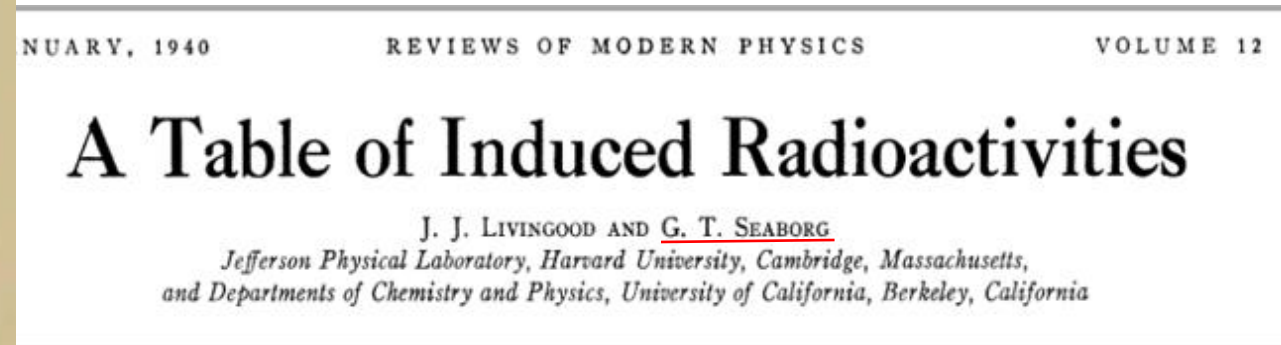
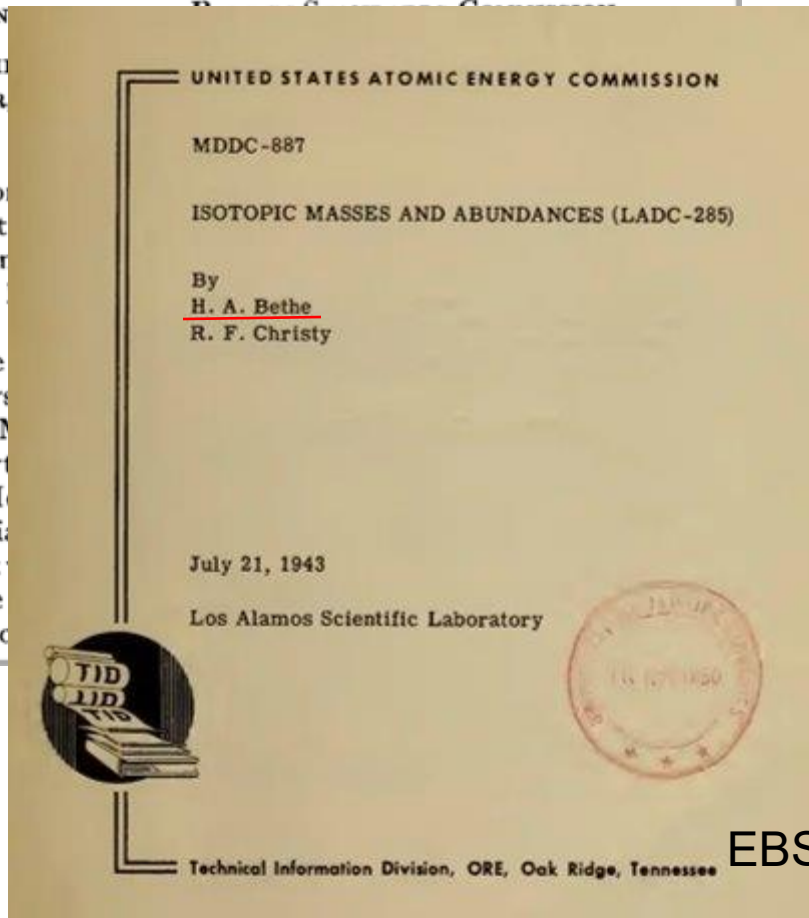
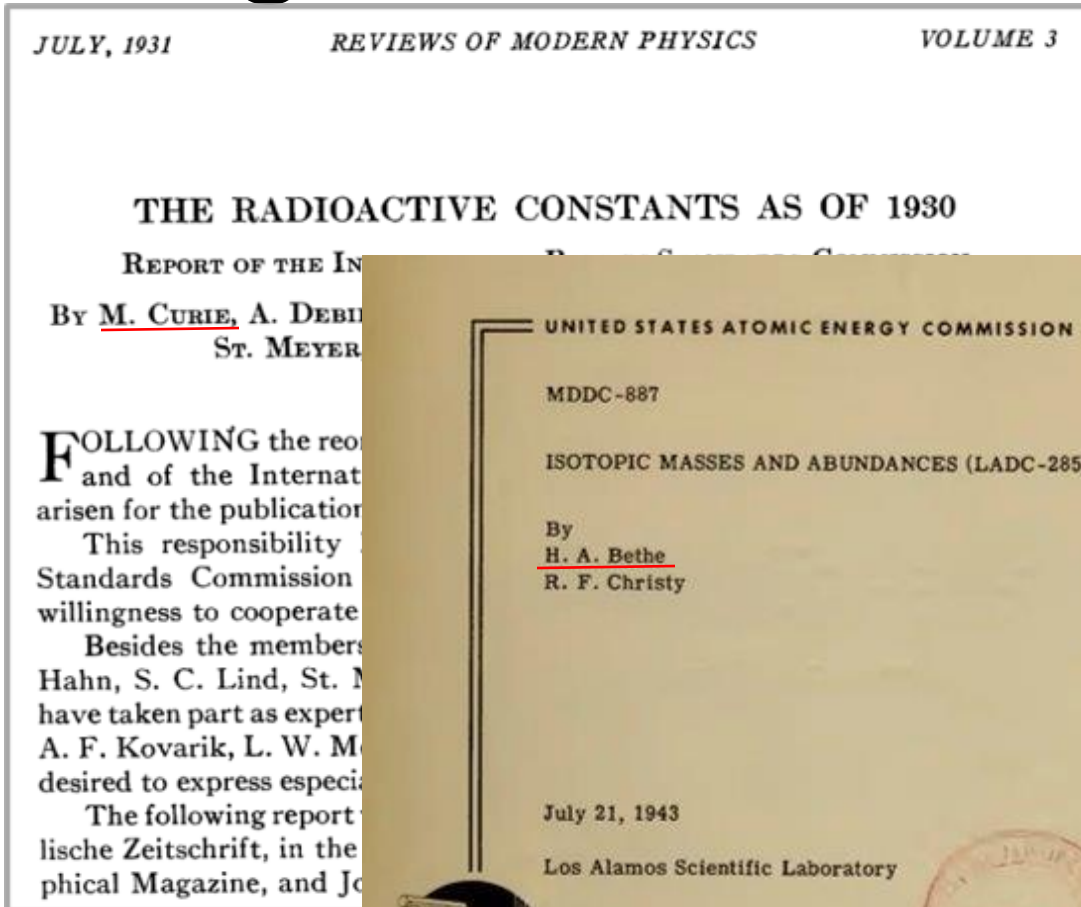
Outline

- Who and what is "the data program?"
- NNDC web services
- ENSDF API introduction

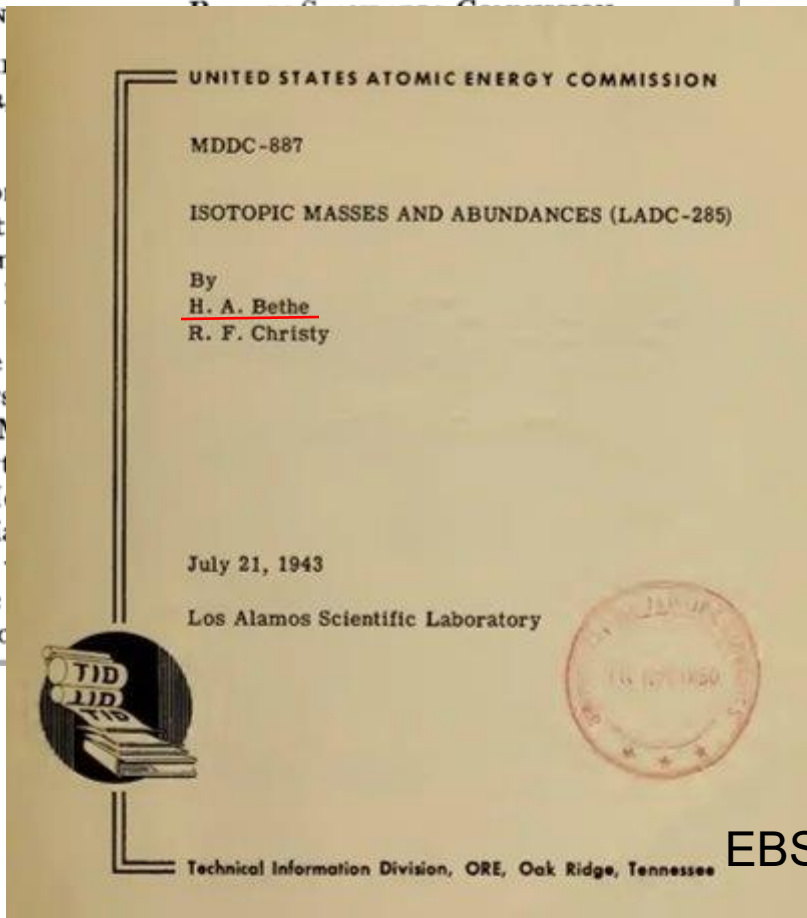
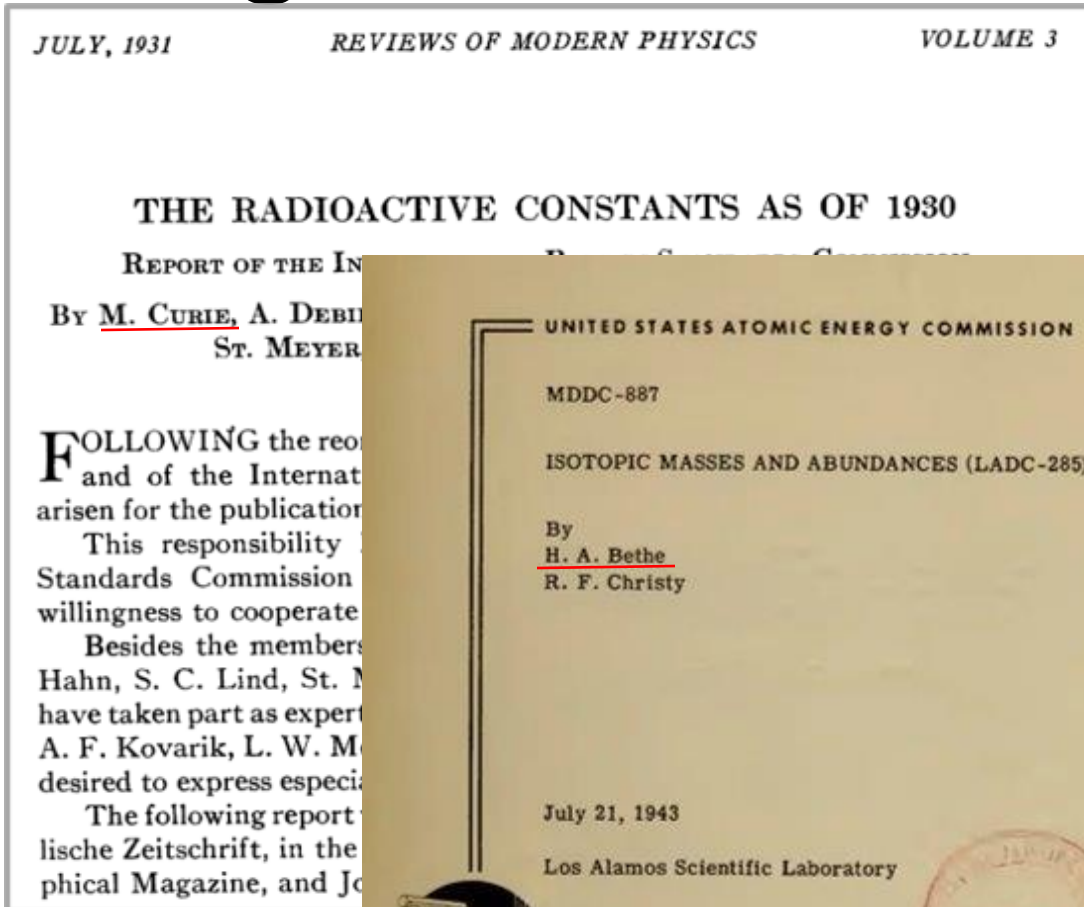
Many of the following slides
are c/o David Brown,
Elizabeth Ricard, and
Alejandro Sonzogni

Origins of the Data Program

The need for up-to-date information on the atomic nucleus has been recognized since the earliest days of nuclear science.



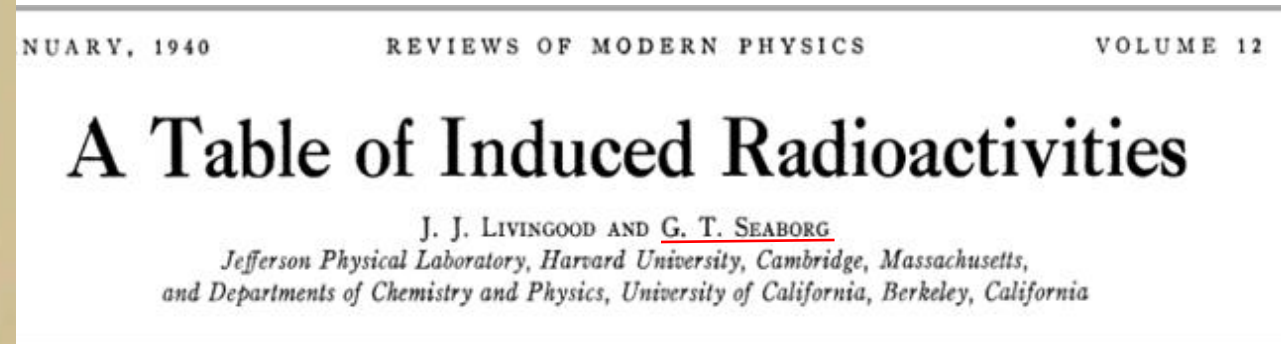
Origins of the Data Program



The need for up-to-date information on the atomic nucleus has been recognized since the earliest days of nuclear science.

In 1977, several programs coalesced to form the National Nuclear Data Center

See CSEWG 35th Anniversary Retrospective (BNL-52675) for a history of early US nuclear data efforts:
<https://doi.org/10.2172/15020989>



The Data Program today

The US Nuclear Data Program (USNDP)

- Formal program under the US Department of Energy, Office of Science – Nuclear Physics program
- NNDC is lead unit
- USNDP creates ENSDF, NSR, and is area #1 lead for EXFOR

The Data Program today

The US Nuclear Data Program (USNDP)

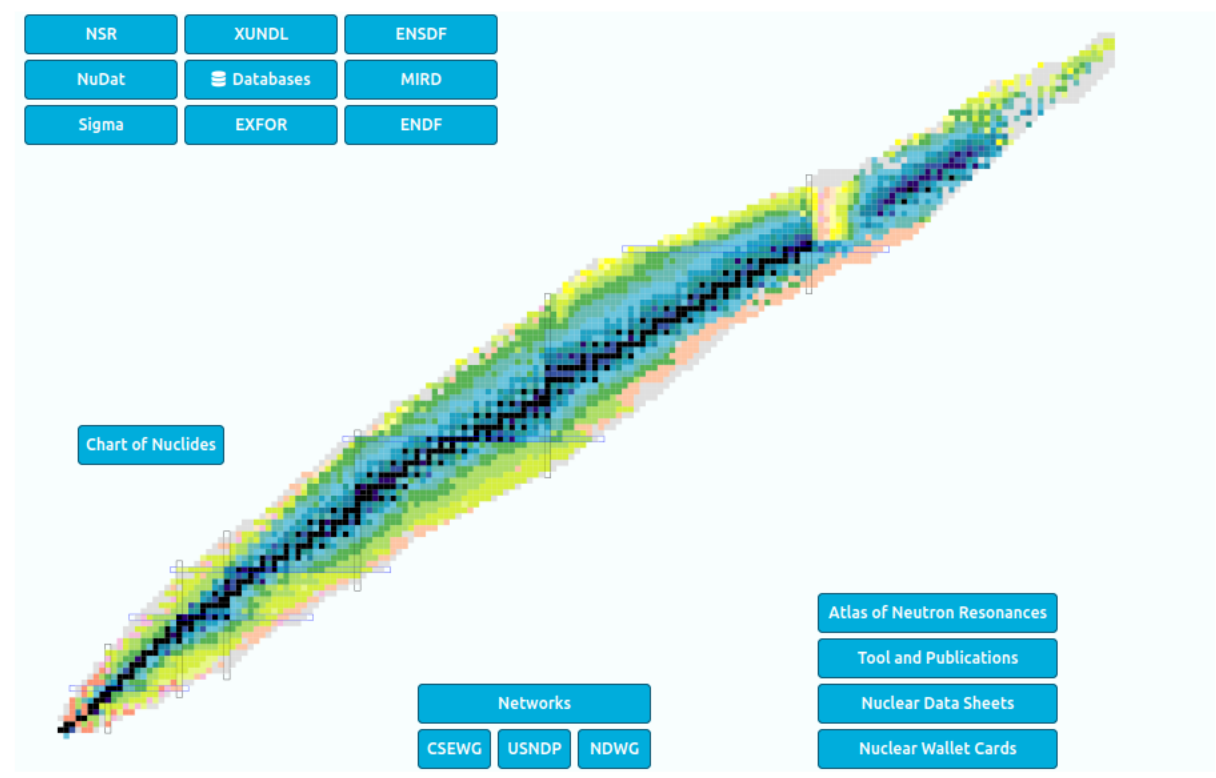
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- USNDP creates ENSDF, NSR, and is area #1 lead for EXFOR

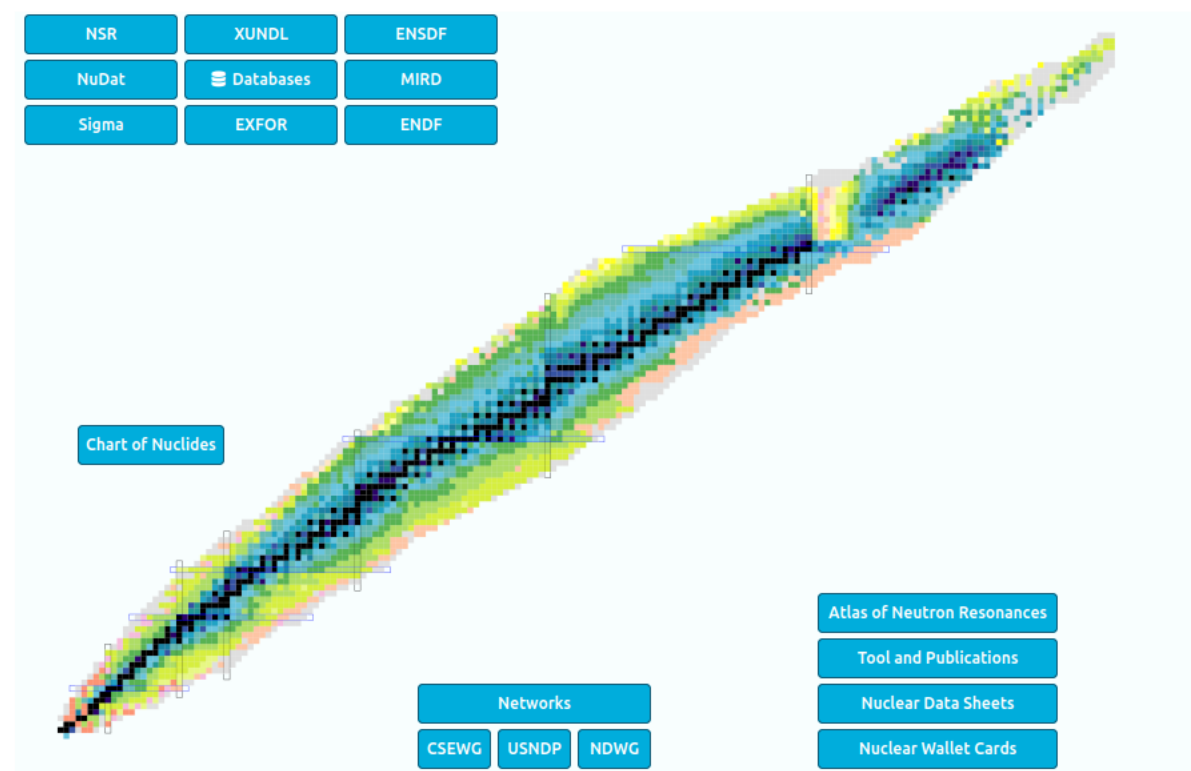
The US nuclear data programs

- The USNDP
- But also
 - The Nuclear Criticality Safety Program has ND interests
 - DOE Nuclear Energy Program
 - DOE Fusion Energy Program
 - Defense Nuclear Nonproliferation R&D Program
 - Defense Programs
 - NASA
 - ...



Part II: NNDC web services





The most important function on this website!



National Nuclear
Data Center



Databases

The most important
function on this website!

National Nuclear Data Center
Building 4
Brookhaven National Laboratory
Upton, NY 11973-5000
(631) 344-5590
nndc@bnl.gov

Contact Us

Contact Us

ENDF

Use the form below to contact us about the
Evaluated Nuclear Data File (ENDF)

☒ David Brown: dbrown@bnl.gov
Gustavo Nobre: gnobre@bnl.gov

Name

Email (Provide your email address if you want us to reply)

Your message

1000 characters remaining

Cancel

Submit



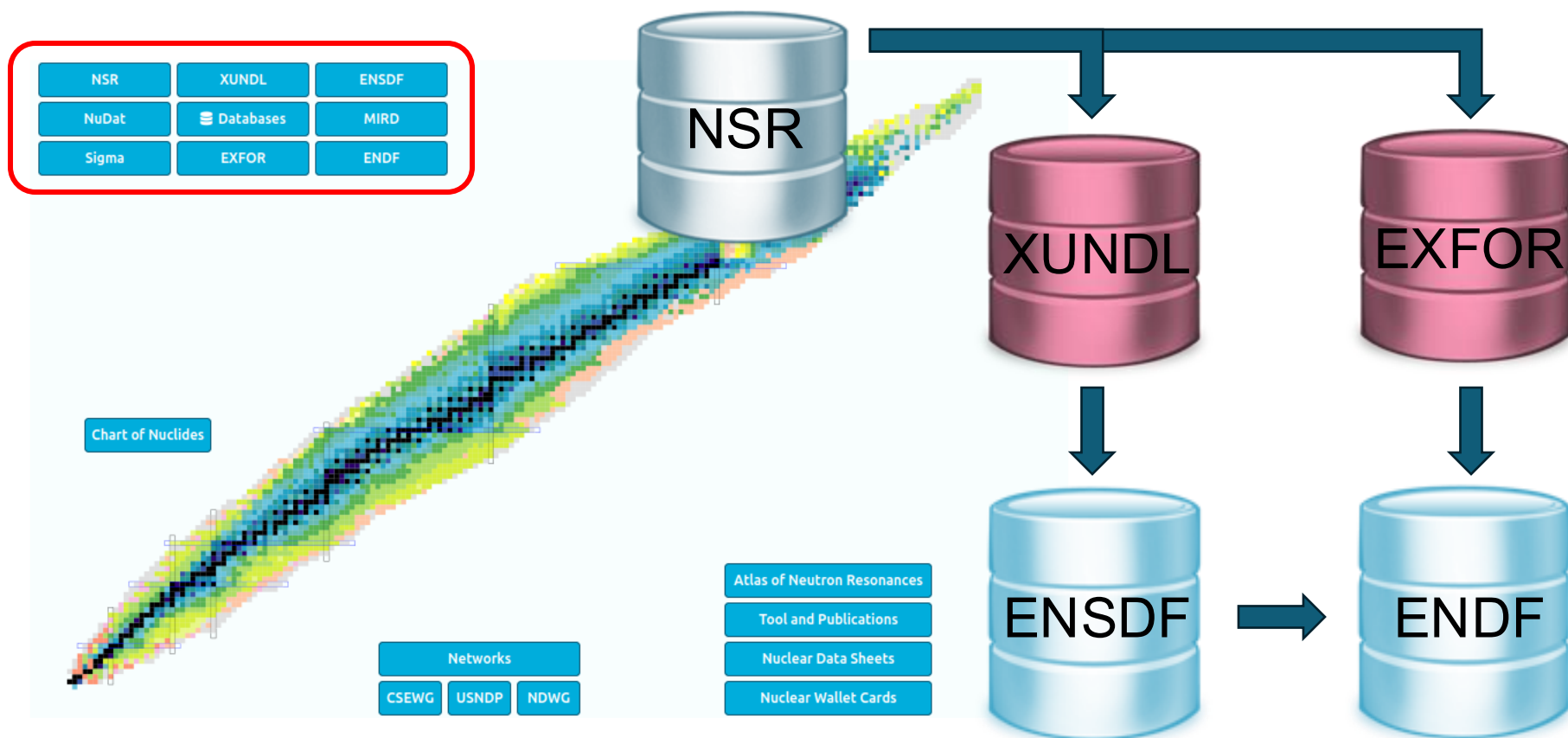
Resources



Brookhaven
National Laboratory

Nuclear Data Sheets
Acknowledgements
Disclaimer

- Bibliographic
 - NSR
- Reactions:
 - EXFOR
 - ENDF
- Structure
 - XUNDL
 - ENSDF
- Interactive
 - NuDat



National Nuclear Data Center

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 Brookhaven National Laboratory
 Upton, NY 11973-5000
 (631) 344-5590
 nndc@bnl.gov

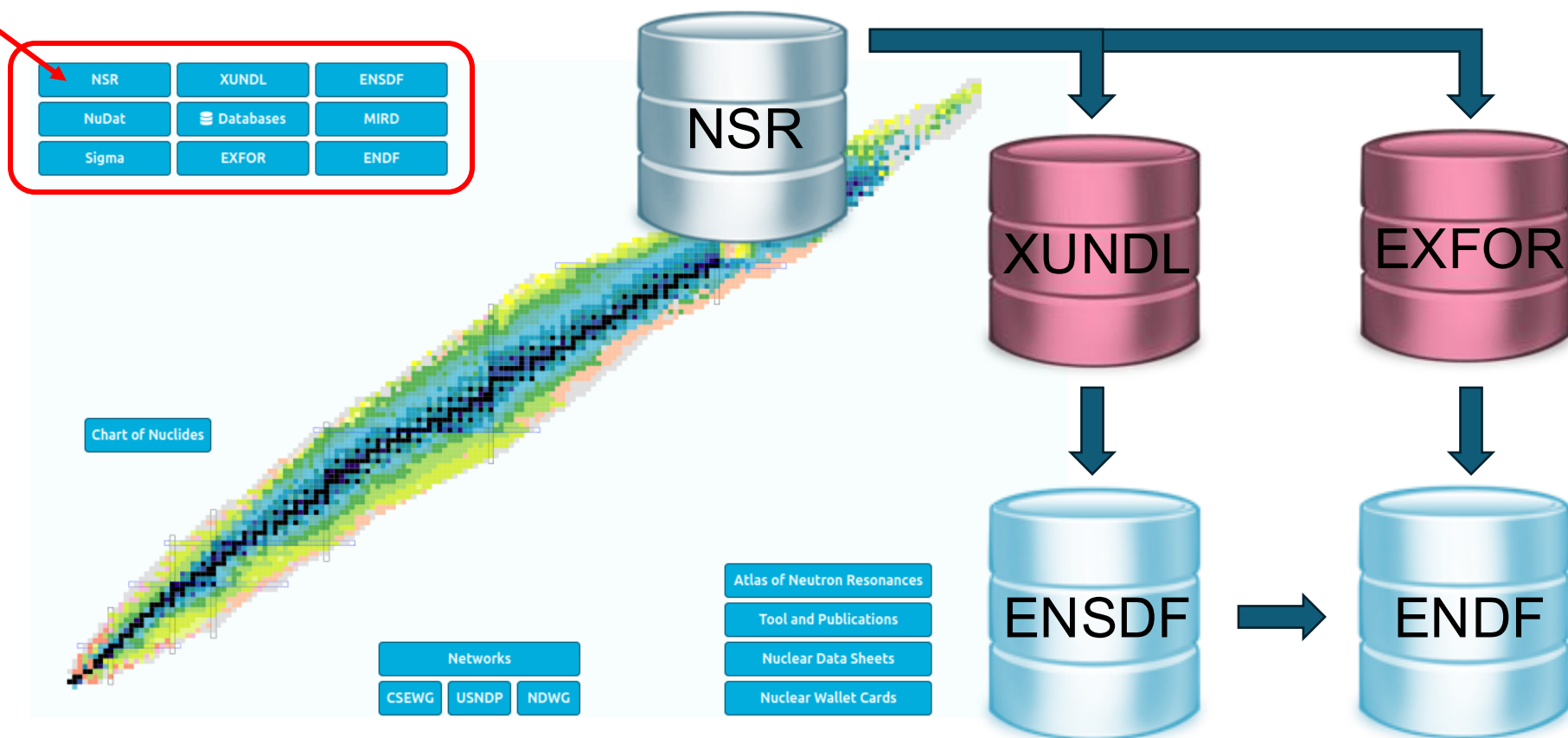
Contact Us

About
 History
 Databases

Networks
 Tools & Codes
 PuRe Data Resource

Nuclear Data Sheets
 Acknowledgements
 Disclaimer

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Nuclear Science References (NSR)

- Entry point to the nuclear-data pipeline
- ~250k bibliographic entries in database
- The "key number" is the primary key for the database
- Two kinds of reference:
 - Primary: 1967Al21
 - Secondary: 1988RuZZ

The screenshot displays the NSR search interface. At the top, there are five tabs: 'Quick Search' (selected), 'Text Search', 'Indexed Search', 'Keynumber Search', and 'DOI Search'. Below the tabs is a search form with three input fields: 'Author' (with examples 'Brown', 'B.A.Brown', 'Brown,B.A.'), 'Nuclide' (with examples '31Na, 144Xe, etc.'), and 'Reaction' (with examples 'n,g or (n,g) or (16O,16O)'). Below the search form is a 'Filters' section. It includes three checkboxes: 'Publication Year:' (with a date range selector), 'Entries added since:' (with a date selector), and 'Subject / Reference:' (with a dropdown menu showing 'Measured / Experimental'). There are also two checkboxes: 'Primary Only' (highlighted with a red box) and 'EXFOR Data Available'. Below the filters are two buttons: 'Search' (green) and 'Reset' (yellow). At the bottom, there is a row of buttons: 'Download', 'New Tab', 'Copy', and a dropdown menu 'Key Numbers Only'. Below this row is a 'Printer-Friendly' button.

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- Filters are extremely helpful
 - Err on the side of being too broad

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- More granular search terms can be found by using "Indexed Search"

Quick Search Text Search Indexed Search Keynumber Search DOI Search

+ Add Condition

Condition	Contains		
first-author	Morse,C.	Browse	×
journal	PRVCA	Browse	×
		Browse	×

Filters

☐ Publication Year: to

☐ Entries added since: mm / dd / yyyy

☐ Subject / Reference: Measured / Experimental

☐ Primary Only ☐ EXFOR Data Available

Search Reset

Download New Tab Copy Key Numbers Only

Printer-Friendly

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- More granular search terms can be found by using "Indexed Search"
- "Keywords" are a structured summary of the referenced work

[Download](#)
[New Tab](#)
[Copy](#)
NSR Exchange

[Printer-Friendly](#)

- search-type: 'quick'
- subject-type: 'measured'
- nuclide: '100Sn'
- page: '1'
- size: '100'

39 results found!

Page Size

100

First

Prev

1

Next

Last

Key #	DOI + Links	Authors	Reference
2025AP05	10.1103/ptfz-rf2c PlumX Metrics XUNDL Datasets	C.J.Appleton P.J.Woods A.Algora J.A.Victoria B.Rubio D.S.Ahn J.Agramunt	Phys.Rev. C 112, 034310 (2025)
Title Measurements of β-delayed proton emitters in the region of ^{100}Sn Keywords • RADIOACTIVITY $^{99,98}\text{In}$, $^{98,99}\text{Cd}$, ^{94}Ag, $^{92}\text{Rh}(\beta^-)$, $^{99,101}\text{Sn}$, $^{100,98,97}\text{In}$, $^{97,96,95}\text{Cd}$, $^{96,95,94}\text{Ag}$, $^{94,93}\text{Pd}$, $^{92}\text{Rh}(\beta^+)$ [from $^9\text{Be}(^{124}\text{Xe}, X)$, $E=345\text{ MeV/nucleon}$]; <u>measured</u> decay products, $E\beta$, $I\beta$, E_p, I_p, E_y, I_y, β-p-coin; deduced proton energy spectra, $T_{1/2}$, βp branching ratios. Comparison with shell model calculations. Advanced Implantation Detector Array (AIDA), the BigRIPS separator at the Radioactive Ion Beam Factory (RIBF) in RIKEN, Japan.			
2019XI06	10.1103/PhysRevC.100.034315 PlumX Metrics XUNDL Datasets	Y.Xiao S.Go R.Grzywacz R.Orlandi A.N.Andreyev M.Asai M.A.Bentley	Phys.Rev. C 100, 034315 (2019)

Nuclear Science References (NSR)

- Ideally, the DOI will be present, but not all references are journal articles
- Sometimes you will find citations to laboratory annual reports or similar documents.

Page Size 100 ▾ First Prev 1 Next Last			
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1978MOYW		E.Monnard J.Blachot J.P.Bocquet J.A.Pinston F.Schussler G.Jung K.D.Wunsch	CEA-N-2074, p.27 (1978)
Title Isomerie Nucleaire dans ^{146}La - Schema de Niveaux de ^{146}Ce Keywords RADIOACTIVITY ^{146}La; measured $\gamma\gamma$-coin. ^{146}La deduced isomer $T_{1/2}$, J, π. ^{146}Ce deduced levels, J, π, γ-branching, octupole band.			
1976MAZW		M.J.Martin	ORNL-5114 (1976)
Title Nuclear Decay Data for Selected Radionuclides Keywords			

Nuclear Science References (NSR)

- Ideally, the DOI will be present, but not all references are journal articles
- Sometimes you will find citations to laboratory annual reports or similar documents.
- There are a couple of places to look:
 - OSTI is actively digitizing legacy documents and making them available to the public

The screenshot shows the OSTI.GOV website interface. At the top, the header includes the OSTI.GOV logo, the U.S. Department of Energy Office of Scientific and Technical Information, and a search bar containing 'ORNL-5114'. Below the header is a navigation bar with links for Submit, Search Tools, Public Access, PID Services & Dev Tools, About, FAQs, and News. The main content area displays the title 'Nuclear decay data for selected radionuclides' and identifies it as a 'TECHNICAL REPORT' dated '01 March 1976'. It provides the DOI: <https://doi.org/10.2172/4015093> and the OSTI ID: 4015093. The author is listed as 'Martin, M. J. [1]' with a link to '+ Show Author Affiliations'. A descriptive paragraph states: 'Contained in this report are tabulations of the atomic and nuclear radiations emitted by 194 radioactive nuclides. The nuclei included comprise most of those currently of interest in medical practice or research, health physics, industry, nuclear power, environmental impact studies, and as reference standards. Listed in tabular form are recommended values for half-lives, energies, intensities (probabilities per decay), and equilibrium absorbed-dose constants for each of the atomic and nuclear radiations emitted by these radioactive atoms. (auth)'. At the bottom of the report entry, there is a green button labeled 'View Technical Report' and a row of action links: Cite, Export, Share, Save, and Print. Below this is a navigation bar with 'Details' and 'Similar Records / Subjects'.

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- There are a couple of places to look:
 - OSTI is actively digitizing legacy documents and making them available to the public
 - For documents from international organizations, the IAEA INIS system is a good place to look

Files

[49046866.pdf](#)

[Files](#) (10.4 MB)

Name

Size

[Download all](#)

[49046866.pdf](#)

md5:95491e0b5ecd896929eacb8d287ee5a6

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Additional details

Additional titles

Original title (French)

D.R.F. Departement de Recherche Fondamentale de Grenoble, Bulletin Semestriel No. 13, 1978 2eme Semestre

► Publishing Information

Imprint Pagination

162 p.

ISSN

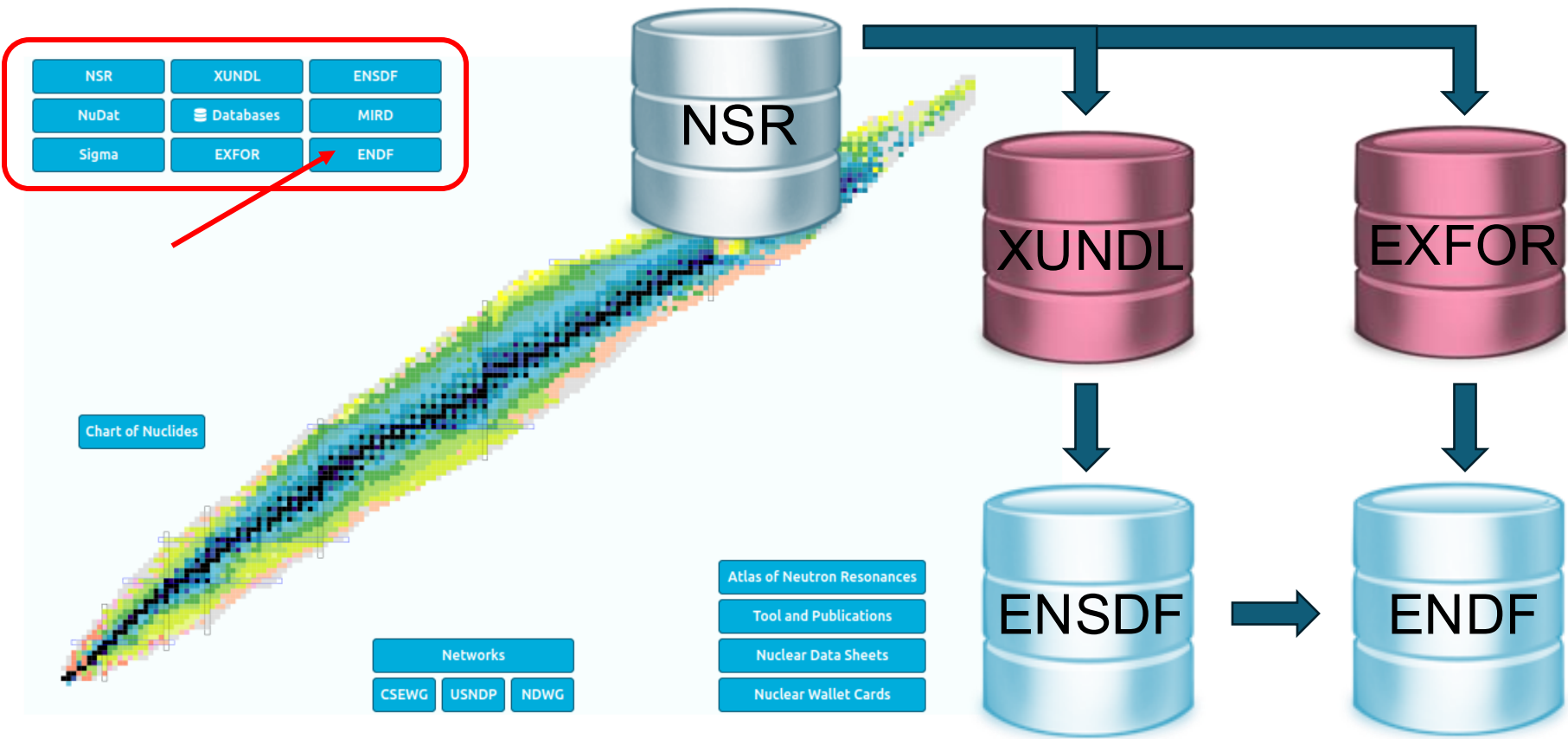
0180-6688

Report number

[CEA-N--2074](#)

Image screen-captured from <https://inis.iaea.org> June 5, 2026

- Bibliographic
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Evaluated Nuclear Data File

Evaluated Nuclear Data File (ENDF)

I highly recommend the new landing page!

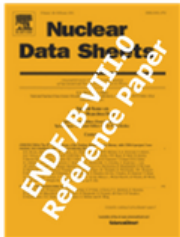
 Try the updated ENDF landing page

 ENDF Library

 ENDF/B
VIII.1

ENDF/B-VIII.1 released August 30, 2024

 Download Here



ENDF/B-VIII.0 fully incorporates the new Neutron Data Standards, includes improved thermal neutron scattering data and uses new evaluated data from the Coordinated International Evaluation Library Organization (CIELO) pilot project for neutron reactions on ^1H , ^{16}O , ^{56}Fe , ^{235}U , ^{238}U and ^{239}Pu .

Notable advances include updated evaluated data for light nuclei, structural materials, actinides, fission energy release, prompt fission neutron and gamma-ray spectra, thermal neutron scattering data, and charged-particle reactions.

These search functions
take you to the IAEA
EXFOR site

Basic Retrieval

Extended Retrieval

Advanced Retrieval

Help

 Retrieval

Target ☐

56fe; fe-56; 26-fe-56; fe*

Reaction ☐

n, *; n,tot; n,g; n,f; n,inl; n,nu*

Quantity ☐

sig; da; de; da/de; res; cov*

Library

☐ All ☒ Selected ☐ Reset

☒ ENDF/B-VIII.0 (USA, 2018)

☒ ENDF/B-VII.1 (USA, 2011)

☒ JEFF-3.3 (Europe, 2017)

☒ JENDL-5 (Japan, 2021)

☒ CENDL-3.2 (China, 2020)

☒ ROSFOND (Russia, 2010)

Submit

Reset

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EBSS 2026

Evaluated Nuclear Data File

- Library Releases page has all the sublibraries and tells you when they were last updated
- Sigma is a front-end for looking at cross-section data

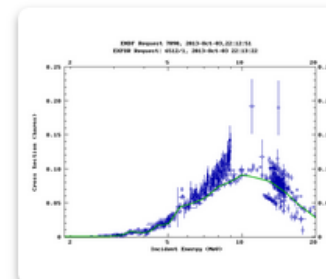
Evaluated Nuclear Data File (ENDF)



Library Releases

DOWNLOAD FULL RELEASES

- The ENDF/B-VIII.1 release is the newest evaluated nuclear data library produced, distributed, and recommended by CSEWG for use in nuclear science and technology applications.



Sigma

PLOT ENDF DATA

- Retrieving and plotting reaction evaluation data from multiple libraries (e.g., ENDF).



Cross Section Evaluation Working Group

CSEWG

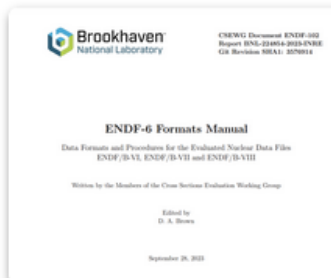
- A cooperative effort of the national laboratories, industry, and universities in the United States and Canada, responsible for the production of ENDF/B.



ENDF Formats

VIEW FORMAT MANUALS

- View and download format manuals for ENDF-6 from the current release ENDF-102 (2023) to ENDF/A BNL-8381 (1965). GNDS specifications are also provided.



Reports

FORMAL LABORATORY REPORTS

- The NNDC is responsible for assigning ENDF reference numbers for all formal laboratory reports associated with the ENDF system.



History

ENDF HISTORY & NAMING

- Discover the history and naming of the Evaluated Nuclear Data File (ENDF).

Evaluated Nuclear Data File

- Sigma gives you many choices!
 - Main library (ENDF, JEFF,...)
 - Sublibrary: neutrons, charged particles, decay...
 - Click on an element to select data on a specific isotope



Evaluated Nuclear Data File (ENDF) Retrieval & Plotting

[Periodic Table Browse](#)
[Directory Tree Browse](#)
[Basic Retrieval](#)
[Advanced Retrieval](#)
[Plot Cart](#)
[Computations](#)

Select first a library, then a sublibrary and finally click on a chemical element to obtain results.
Data are available for materials with a cyan background.

Library:
Sublibrary:

0 n	1 H																	2 He	Results for Z=26 54 56 57 58
3 Li	4 Be																	10 Ne	
11 Na	12 Mg																	18 Ar	
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr		
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe		
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn		
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg									
			58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu			
			90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr			

Version History:

New: (December 2011)

- ENDF/B-VII.1 evaluated neutron library.

New in version 3.1 (October 2009)

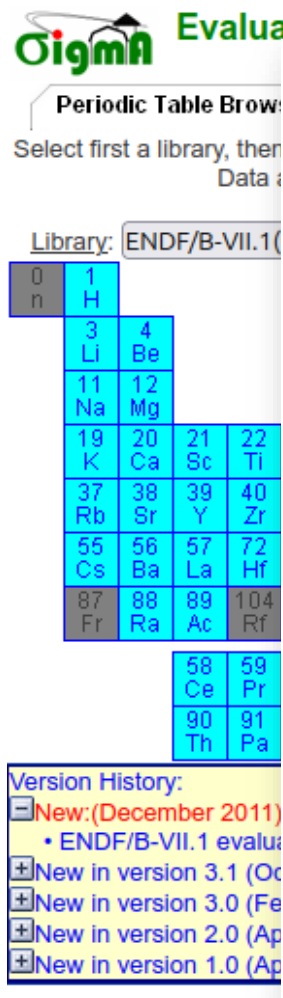
New in version 3.0 (February 2009)

New in version 2.0 (April 2008)

New in version 1.0 (April 2007)

Evaluated Nuclear Data File

- Sigma gives you many choices!
 - Main library (ENDF, JEFF,...)
 - Sublibrary: neutrons, charged particles, decay...
 - Click on an element to select data on a specific isotope
- Data are available in tabular form...
 - This is neutron-capture data just to serve as an example



Periodic Table Browser
Select first a library, then Data

Library: ENDF/B-VII.1

Version History:
 - New: (December 2011)
 • ENDF/B-VII.1 evaluation
 + New in version 3.1 (October 2011)
 + New in version 3.0 (February 2011)
 + New in version 2.0 (April 2010)
 + New in version 1.0 (April 2009)

Evaluated Nuclear Data File (ENDF) Retrieval & Plotting

Interpreted ENDF file for endf2htm-ei.in capture cross section

QM = 7.64609E+06 eV
 QI = 7.64609E+06 eV
 Interpolation table:
 50 2

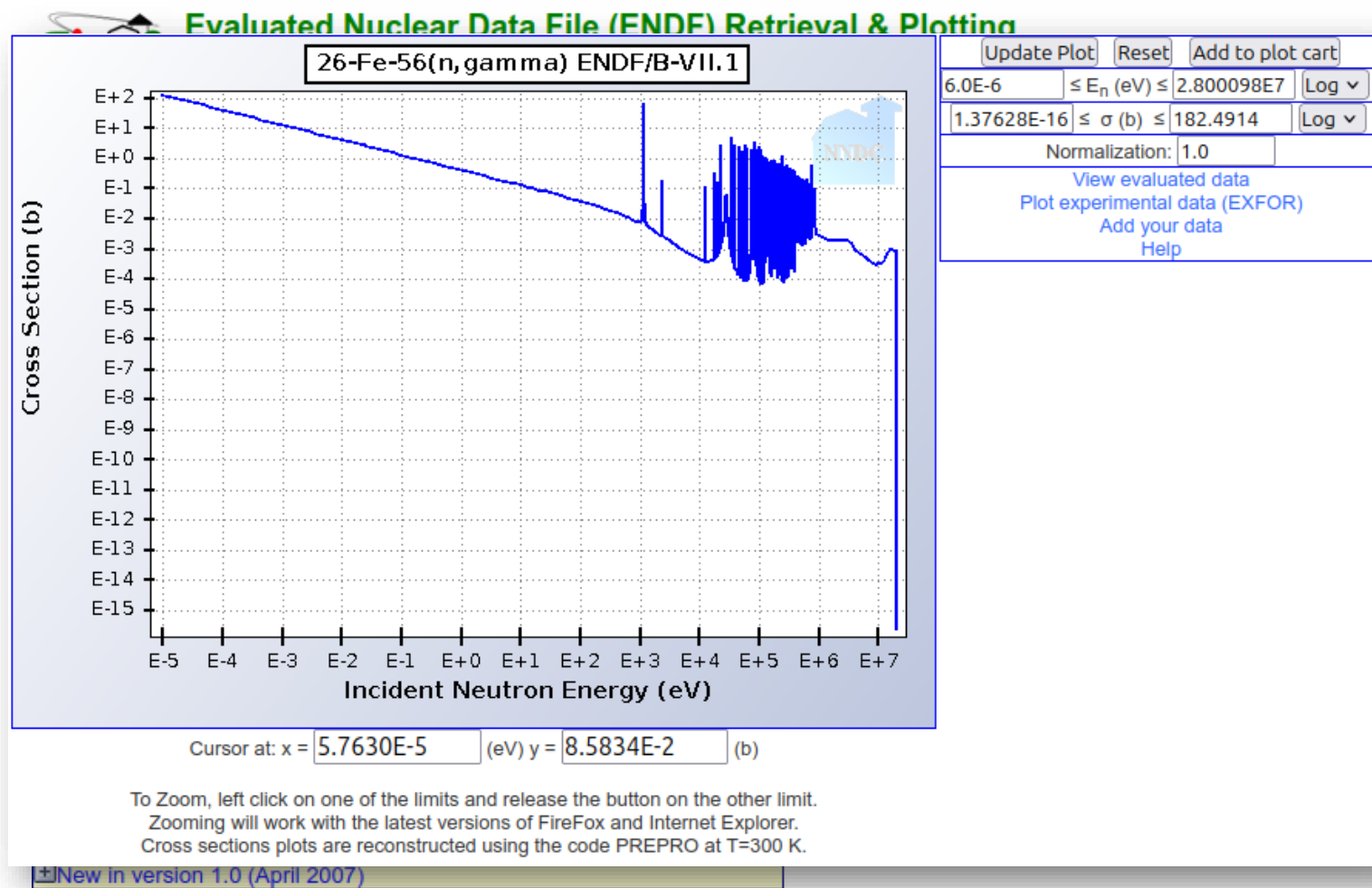
Cross section table:

eV	barns	eV	barns	eV	barns
1.000000-5	0.000000+0	4.000000+5	0.000000+0	4.010000+5	1.660000-3
4.500000+5	1.660000-3	4.510000+5	1.720000-3	5.000000+5	1.720000-3
5.010000+5	1.370000-3	5.500000+5	1.370000-3	5.510000+5	1.550000-3
6.000000+5	1.550000-3	6.010000+5	2.330000-3	6.500000+5	2.330000-3
6.510000+5	4.450000-3	7.000000+5	4.450000-3	7.010000+5	2.080000-3
7.500000+5	2.080000-3	7.510000+5	5.140000-3	8.000000+5	5.140000-3
8.010000+5	5.260000-3	8.500000+5	5.260000-3	8.500000+5	7.700000-3
8.510000+5	5.500000-3	8.622700+5	5.500000-3	8.800000+5	3.700000-3
9.250000+5	2.900000-3	1.000000+6	2.600000-3	1.250000+6	2.200000-3
1.500000+6	1.950000-3	2.000000+6	1.850000-3	2.500000+6	2.000000-3
3.000000+6	1.850000-3	3.500000+6	1.500000-3	4.000000+6	9.200000-4
5.000000+6	6.800000-4	6.000000+6	5.200000-4	7.000000+6	4.000000-4
8.000000+6	3.200000-4	9.000000+6	3.000000-4	1.000000+7	3.100000-4
1.100000+7	3.400000-4	1.200000+7	4.200000-4	1.300000+7	5.600000-4
1.400000+7	7.300000-4	1.500000+7	8.500000-4	1.600000+7	9.300000-4
1.700000+7	9.500000-4	1.800000+7	9.000000-4	2.000000+7	8.000000-4
2.000000+7	0.000000+0	1.500000+8	0.000000+0		

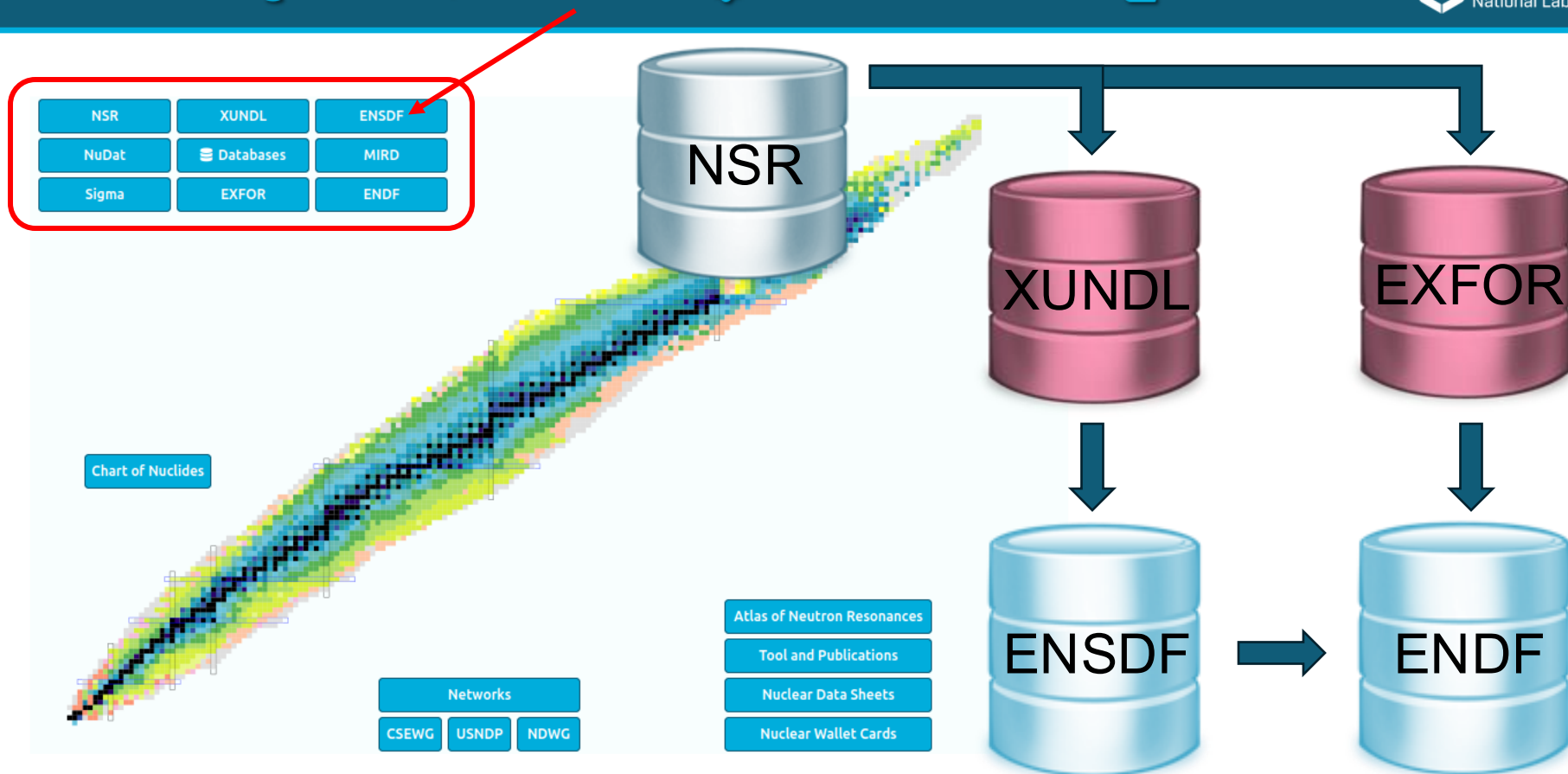
Generated with code ENDF written by R.E. MacFarlane

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 - This is neutron-capture data just to serve as an example
- ...and graphical form
- There is an API to access ENDF data available at <https://www.nndc.bnl.gov/endl-api/>



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Evaluated Nuclear Structure Data File

- Your go-to source for evaluated nuclear-structure data.
- Snapshots are archived monthly



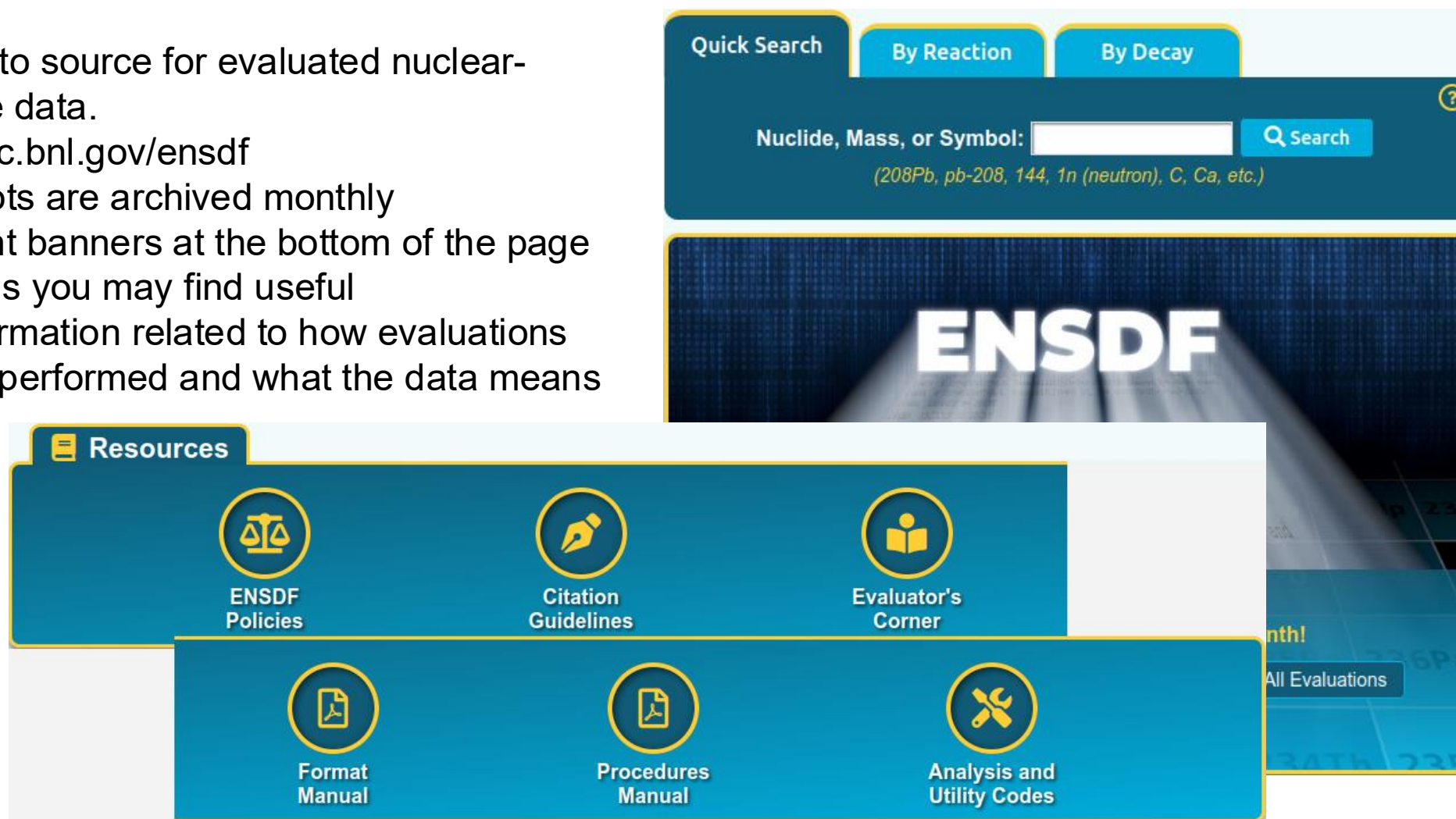
Evaluated Nuclear Structure Data File

- Your go-to source for evaluated nuclear-structure data.
 - nndc.bnl.gov/ensdf
- Snapshots are archived monthly
- Important banners at the bottom of the page
 - Tools you may find useful

The screenshot displays the ENSDF website interface. At the top, there are three tabs: "Quick Search", "By Reaction", and "By Decay". Below these is a search bar with the placeholder text "Nuclide, Mass, or Symbol:" and a "Search" button. A hint below the search bar reads "(208Pb, pb-208, 144, 1n (neutron), C, Ca, etc.)". The main content area features a large banner with the text "ENSDF" in white, set against a background of a blue grid with light rays. Below the banner, there is a "Tools" section with a grid of four tool cards: "CapGam | Thermal Neutron Capture γ -rays", "QCalc | Q-Value Calculator", "LOGFT | Analysis Program", and "Brice | Band-Raman Internal Conversion Coefficients". To the right of the tools section, there is a "Structure Data File" section with the text "added within the last month!" and two buttons: "ENSDF Archives" and "List of All Evaluations". At the bottom right, there is a "Contact Us" button.

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How to cite data from ENSDF

If data are used from 10 or fewer nuclides and the evaluation has been published in Nuclear Data Sheets, it is recommended that the citation is to the publication of the mass chain evaluation. This information can be found at the top of the ENSDF file.

Example:

Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	M. J. Martin	NDS 114, 1497 (2013)	31-Aug-2013

Citation should read: M.J. Martin, Nucl. Data Sheets 114, 1497 (2013).

If data are used from more than 10 nuclides or if the evaluation was published solely in the ENSDF database, it is recommended to cite the ENSDF database itself. An example of the latter case is:

Adopted Levels, Gammas

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh	ENSDF	28-Feb-2018

Citation should read: "From ENSDF database as of Month day, Year. Version available at <http://www.nndc.bnl.gov/ensarchivals/>"

EBSS 2 The date should correspond to the date on which the ENSDF database was consulted. 30

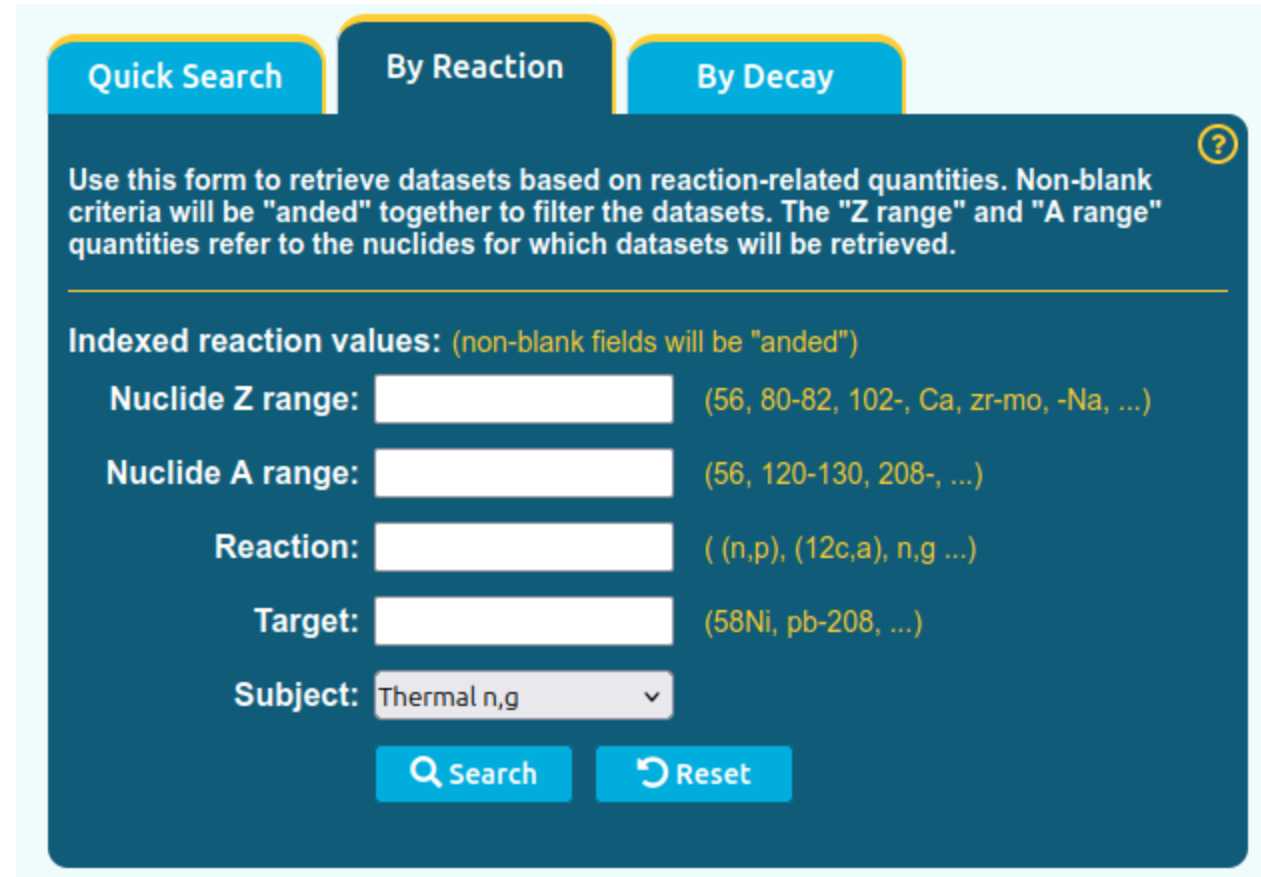
Evaluated Nuclear Structure Data File

- Examples of ENSDF datasets
 - Adopted Levels, Gammas
 - Beta decay
 - Transfer reactions
 - Not an exhaustive list!



Evaluated Nuclear Structure Data File

- Examples of ENSDF datasets
 - Adopted Levels, Gammas
 - Beta decay
 - Transfer reactions
 - Not an exhaustive list!
- If you don't care about decay datasets, you can search by reaction



The screenshot shows a web interface for searching the Evaluated Nuclear Structure Data File (ENSDF). It features three tabs: 'Quick Search', 'By Reaction' (which is selected), and 'By Decay'. Below the tabs, a dark blue box contains instructions: 'Use this form to retrieve datasets based on reaction-related quantities. Non-blank criteria will be "anded" together to filter the datasets. The "Z range" and "A range" quantities refer to the nuclides for which datasets will be retrieved.' Below this, the section 'Indexed reaction values: (non-blank fields will be "anded")' lists five search criteria, each with a text input field and a list of example values: 'Nuclide Z range:' with examples (56, 80-82, 102-, Ca, zr-mo, -Na, ...); 'Nuclide A range:' with examples (56, 120-130, 208-, ...); 'Reaction:' with examples ((n,p), (12c,a), n,g ...); 'Target:' with examples (58Ni, pb-208, ...); and 'Subject:' with a dropdown menu currently showing 'Thermal n,g'. At the bottom of the form are two buttons: 'Search' with a magnifying glass icon and 'Reset' with a circular arrow icon.

Quick Search By Reaction By Decay

Use this form to retrieve datasets based on reaction-related quantities. Non-blank criteria will be "anded" together to filter the datasets. The "Z range" and "A range" quantities refer to the nuclides for which datasets will be retrieved.

Indexed reaction values: (non-blank fields will be "anded")

Nuclide Z range: (56, 80-82, 102-, Ca, zr-mo, -Na, ...)

Nuclide A range: (56, 120-130, 208-, ...)

Reaction: ((n,p), (12c,a), n,g ...)

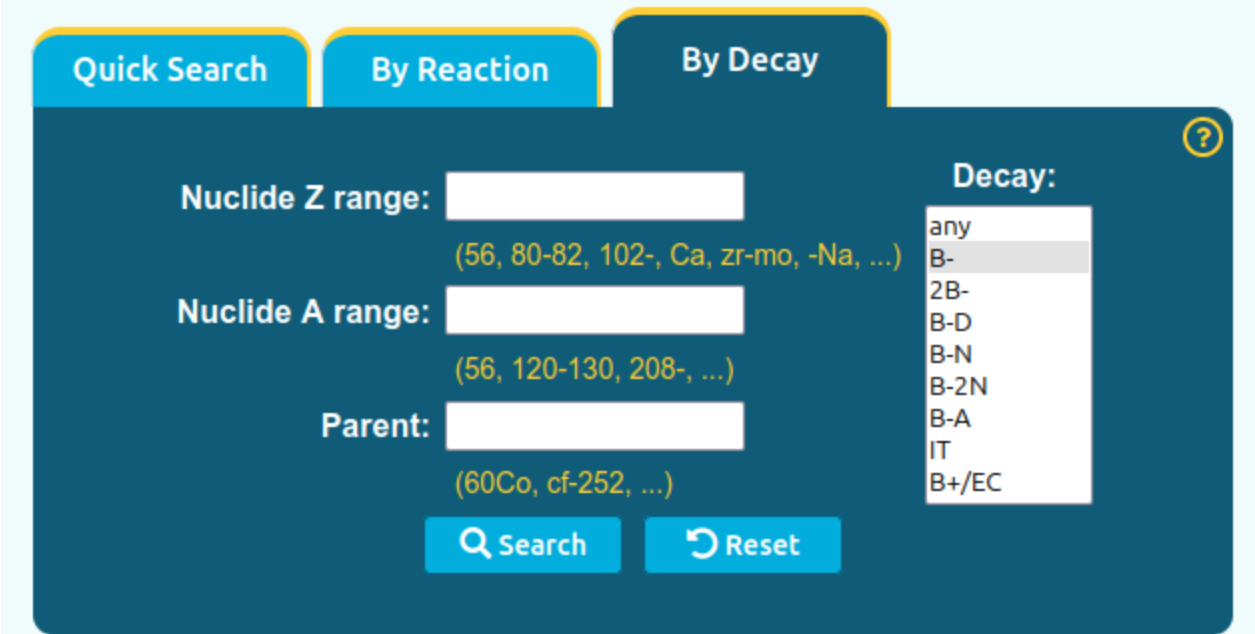
Target: (58Ni, pb-208, ...)

Subject: Thermal n,g

Search Reset

Evaluated Nuclear Structure Data File

- Examples of ENSDF datasets
 - Adopted Levels, Gammas
 - Beta decay
 - Transfer reactions
 - Not an exhaustive list!
- If you don't care about decay datasets, you can search by reaction
- Conversely, you can also search exclusively for decay datasets



The screenshot shows the ENSDF search interface with three tabs: 'Quick Search', 'By Reaction', and 'By Decay'. The 'By Decay' tab is selected. It features three input fields for search criteria: 'Nuclide Z range' with a dropdown menu showing '(56, 80-82, 102-, Ca, zr-mo, -Na, ...)', 'Nuclide A range' with a dropdown menu showing '(56, 120-130, 208-, ...)', and 'Parent' with a dropdown menu showing '(60Co, cf-252, ...)'. To the right of these fields is a 'Decay:' dropdown menu with a list of decay types: 'any', 'B-', '2B-', 'B-D', 'B-N', 'B-2N', 'B-A', 'IT', and 'B+/EC'. At the bottom of the form are two buttons: 'Search' and 'Reset'. A help icon (?) is located in the top right corner of the form area.

Evaluated Nuclear Structure Data File

Nuclide, Mass, or Symbol:

Datasets for ^{68}Ni

There are 18 corresponding XUNDL (unevaluated) sets 

Matching datasets in ENSDF

Retrieve selected ENSDF datasets:

Dataset	Last Revised	References
☐ Select All		
☒ ADOPTED LEVELS, GAMMAS	2012-06 	All references 
☐ 68CO B- DECAY (0.20 S)	2012-06	All references
☐ 68CO B- DECAY (1.6 S)	2012-06	All references
☐ 68NI IT DECAY (0.86 MS)	2012-06	All references
☐ COULOMB EXCITATION	2012-06	All references
☐ 70ZN(14C,16O)	2012-06	All references
☐ 70ZN(14C,16OG)	2012-06	All references
☐ 130TE(64NI,XG),208PB(64NI,XG)	2012-06	All references
☐ 198PT(70ZN,XG)	2012-06	All references
☐ NI(86KR,XG),58NI(70ZN,XG)	2012-06	All references

Retrieve selected ENSDF datasets:

 Scroll down...

Evaluated Nuclear Structure Data File

- If you are specifically interested in recent publications on the structure of a specific nuclide, XUNDL is a useful alternative to NSR.
- Important note: XUNDL is younger than ENSDF, and full coverage of new publications wasn't achieved until the 2000s

Here are the XUNDL datasets which came in after the cutoff date of the last ENSDF evaluation.

Nuclide	Dataset	Last Revised	References
⁶⁸ Ni	☐ Select All		
	☐ 238U(70ZN,XG):XUNDL-6	2012-10	All references
	☐ 238U(64NI,XG):DELAYED:XUNDL-7	2013-03	All references
	☐ 238U(64NI,XG):PROMPT:XUNDL-8	2013-03	All references
	☐ 208PB(70ZN,XG):XUNDL-9	2013-10	All references
	☐ 68CO B- DECAY:1.6 S:XUNDL-10	2014-02	All references
	☐ 4HE(68NI,4HE'):ISGMR:XUNDL-11	2015-08	All references
	☐ 68CO B- DECAY:1.6 S:XUNDL-12	2015-03	All references
	☐ 68NI IT DECAY:T1/2:XUNDL-13	2015-03	All references
	☐ 68CO B- DECAY:1.6 S:XUNDL-14	2018-09	All references
	☐ U(P,X):IS,RADIUS:XUNDL-15	2020-06	All references
	☐ COULOMB EXCITATION:XUNDL-16	2021-11	All references
	☐ 3H(66NI,PG):XUNDL-17	2022-12	All references
	☐ 68CO B- DECAY (1.6 S):XUNDL-18	2024-02	All references

Retrieve selected XUNDL datasets:

[PDF Version](#)

[ENSDF text format](#)

Adopted Levels, Gammas

Adopted Levels, Gammas

Publication

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	E. A. Mccutchan	NDS 113,1735 (2012)	1-Mar-2012

$Q(\beta^-)=2103\ 4$; $S(n)=7792\ 5$; $S(p)=15431\ 7$; $Q(\alpha)=-10919\ 6$ [2012Wa38](#)

Note: Current evaluation has used the following Q record 2103 4 7792 4 15431 7 -10919 6 [2011AuZZ](#).

$S(2n)=13600\ 3$; $S(2p)=27974\ 5$; $Q(\beta^-n) = -4216\ 3$ ([2011AuZZ](#)).

α : [Additional information 1](#).

^{68}Ni Levels

In addition to the levels given here, peaks are reported in $^{70}\text{Zn}(^{14}\text{C},^{16}\text{O})$ at 2700 40, with $L=0,2$, at 3280 50 with $L=2,4$, and at 3450 50 and 4120 50. The $^{70}\text{Zn}(^{14}\text{C},^{16}\text{O})$ level at 2200 30, with $L=2$ appears to correspond to the 2034 level but the large energy difference makes it difficult to give unique associations for any of the other peaks.

Cross Reference (XREF) Flags

Main data for
energy levels

A	$^{68}\text{Co}\ \beta^-$ decay (0.20 s)	F	$^{70}\text{Zn}(^{14}\text{C},^{16}\text{O}\gamma)$
B	$^{68}\text{Co}\ \beta^-$ decay (1.6 s)	G	$^{130}\text{Te}(^{64}\text{Ni},X\gamma), ^{208}\text{Pb}(^{64}\text{Ni},X\gamma)$
C	^{68}Ni IT decay (0.86 ms)	H	$^{198}\text{Pt}(^{70}\text{Zn},X\gamma)$
D	Coulomb excitation	I	$\text{Ni}(^{86}\text{Kr},X\gamma), ^{58}\text{Ni}(^{70}\text{Zn},X\gamma)$
E	$^{70}\text{Zn}(^{14}\text{C},^{16}\text{O})$		

Links to datasets with
supporting information

$E(\text{level})^\dagger$	J^π	$T_{1/2}$	XREF	Comments
0.0 $^{\pm}$	0 $^+$	29 s 2	A B C D E F G H I	$\% \beta^- = 100$ $T_{1/2}$: from 1998Fr15 . The authors also give this value in 2001Fr21 . Other: 19 s +3-6 (1988ScZH , 1988KoZT).
1770 30	0 $^+$	270 ns 5	E F I	$T_{1/2}$: from $\gamma(t)$ in $^{58}\text{Ni}(^{70}\text{Zn},X\gamma)$. Others: 211 ns 50 from $I(\text{ce})(t)$ and $I(e^+,e^-)(t)$ in $(^{14}\text{C},^{16}\text{O}\gamma)$, and 340 ns 30 from $\gamma(t)$ in $(^{86}\text{Kr},X\gamma)$. J^π : $L=0$ in $(^{14}\text{C},^{16}\text{O})$; E0 transition to 0 $^+$ g.s.

Adopted Levels, Gammas

$^{68}\text{Ni}_{40}^{28}$

Adopted Levels, Gammas (continued)

Conversion coefficient from Brlcc, T. Kibedi, NIM A 589, 202 (2008)

$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^{\dagger\dagger}$	E_f	J_f^π	Mult.	α	$I_{(\gamma+ce)}^{\dagger\dagger}$	Comments
1770	0^+	1770		0.0	0^+	E0		100	E_γ : from ($^{14}\text{C}, ^{16}\text{O}\gamma$). Mult.: from conversion electrons and pair production in ($^{14}\text{C}, ^{16}\text{O}\gamma$).
2034.08	2^+	2033.2 2	100	0.0	0^+	[E2]	0.000383 6		$\alpha(\text{K})=4.96\times 10^{-5}$ 7; $\alpha(\text{L})=4.81\times 10^{-6}$ 7; $\alpha(\text{M})=6.77\times 10^{-7}$ 10; $\alpha(\text{N}+..)=0.000328$ 5 $\text{B}(\text{E}2)(\text{W.u.})=3.2$ 7
2511.9	(0^+)	477.8 2	100 5	2034.08	2^+	[E2]	0.00191 3		$\alpha(\text{K})=0.001717$ 25; $\alpha(\text{L})=0.0001711$ 24; $\alpha(\text{M})=2.40\times 10^{-5}$ 4; $\alpha(\text{N}+..)=1.005\times 10^{-6}$ 1
		2511.9 ^{&}		0.0	0^+	(E0)		≤ 138	The source of the observed 511 γ 's in ^{68}Co β decay (1.6 s) may be from (e^+, e^-) from the 2512 state to the 0^+ g.s.; however, no 1511 γ -511 γ coincidences were observed.

Cross Reference (XREF) Flags

Multipolarity

- [E2]: Inferred by evaluator
- (E2): Tentative assignment
- E2: Definite assignment

A	^{68}Co β^- decay (0.20 s)	F	$^{70}\text{Zn} (^{14}\text{C}, ^{16}\text{O}\gamma)$
B	^{68}Co β^- decay (1.6 s)	G	$^{130}\text{Te} (^{64}\text{Ni}, \text{X}\gamma), ^{208}\text{Pb} (^{64}\text{Ni}, \text{X}\gamma)$
C	^{68}Ni IT decay (0.86 ms)	H	$^{198}\text{Pt} (^{70}\text{Zn}, \text{X}\gamma)$
D	Coulomb excitation	I	$\text{Ni} (^{86}\text{Kr}, \text{X}\gamma), ^{58}\text{Ni} (^{70}\text{Zn}, \text{X}\gamma)$
E	$^{70}\text{Zn} (^{14}\text{C}, ^{16}\text{O})$		

$E(\text{level})^\dagger$	J^π	$T_{1/2}$	XREF	Comments
0.0 [‡]	0^+	29 s 2	ABCDEFGH I	$\% \beta^- = 100$ $T_{1/2}$: from 1998Fr15. The authors also give this value in 2001Fr21. Other: 19 s +3-6 (1988ScZH, 1988KoZT).
1770 30	0^+	270 ns 5	EF I	$T_{1/2}$: from $\gamma(t)$ in $^{58}\text{Ni} (^{70}\text{Zn}, \text{X}\gamma)$. Others: 211 ns 50 from I(ce)(t) and I(e^+, e^-)(t) in ($^{14}\text{C}, ^{16}\text{O}\gamma$), and 340 ns 30 from $\gamma(t)$ in ($^{86}\text{Kr}, \text{X}\gamma$). J^π : L=0 in ($^{14}\text{C}, ^{16}\text{O}$); E0 transition to 0^+ g.s.

Adopted Levels, Gammas

Adopted Levels, Gammas (continued)								
$E_i(\text{level})$	J_i^π	$E_\gamma^\dagger$	$I_\gamma^{\ddagger\ddagger}$	E_f	J_f^π	Mult.	α	$I_{(\gamma+ce)}^{\ddagger\ddagger}$
1770	0 ⁺	1770		0.0	0 ⁺	E0		100
2034.08	2 ⁺	2033.2 2	100	0.0	0 ⁺	[E2]	0.000383 6	
2511.9	(0 ⁺)	477.8 2	100 5	2034.08	2 ⁺	[E2]	0.00191 3	
		2511.9 ^{&}		0.0	0 ⁺	(E0)		≤138

The 80-column format is... dense. It is a relic of the halcyon days of FORTRAN and should be replaced by JSON "Soon™"

$E(\text{level})^\dagger$	J^π	$T_{1/2}$	XREF
0.0 [‡]	0 ⁺	29 s 2	ABCDEFGH I
1770 30	0 ⁺	270 ns 5	EF I

68NI ADOPTE LEVELS, GAMMAS 12NDS 201206
68NI H TYP=ERR\$AUT=E.A. McCutchan\$DAT=11-Jul-2012\$COM=changed DE for 1770 lev\$
68NI H TYP=FUL\$AUT=E.A. McCutchan\$CIT=NDS 113, 1735 (2012)\$CUT=1-Mar-2012\$
68NI Q 2103 4 7792 5 15431 7 -10919 6 2012WA38
68NI cQ \$Note: Current evaluation has used the following Q record
68NI2cQ 2103 4 {I7792} 4 {I15431} 7 -10919 {I6} 2011AuZZ
68NI cQ \$S(2n)=13600 {I3}; S(2p)=27974 {I5}; Q(|b{+-}n) = -4216 {I3}
68NI2cQ (2011AuZZ)
68NI cL E\$From least-squares fit to E|g's by evaluator; |DE=1 keV assumed
68NI2cL when not given.
68NI CL BAND(A)\$|ng{+2}{-9/2}|np{+2}{-1/2} configuration.
68NI2cL From comparison to the level spacings in {+70}Ni, the 6+ and 8+
68NI3cL states have a very pure |ng{+2}{-9/2}|np{+2}{-1/2} configuration
68NI4cL while the 4+ contains a significant admixture of other components,
68NI5cL likely the (|ng{+2}{-9/2}|nf{+2}{-5/2}){-4+} configuration.
68NI cL J(a)\$Low-lying J=1 states are not expected from the available neutron
68NI2cL fp orbitals. A strong |g to the g.s. indicates J|p=2+ for the 2744
68NI3cL state. Lack of a similar transition from the 2512 state and the
68NI4cL possible E0 transition to the g.s. supports a J|p=0+ assignment.
68NI cL \$In addition to the levels given here, peaks are reported in
68NI2cL {+70}Zn({+14}C,{+16}O) at 2700 {I40}, with L=0,2, at 3280 {I50} with
68NI3cL L=2,4, and at 3450 {I50} and 4120 {I50}. The {+70}Zn({+14}C,{+16}O)
68NI4cL level at 2200 {I30}, with L=2 appears to correspond to the 2034 level
68NI5cL but the large energy difference makes it difficult to give unique
68NI6cL associations for any of the other peaks.
68NI cG E,RI\$From {+68}Co |b- decay (1.6 s), except as noted.
68NI cG RI,TI\$Relative photon or I(|g+ce) branching ratio from each level.
68NI cG E(a),RI(b)\$From {+68}Co |b- decay (0.20 s).
68NI cG E(c),RI(d)\$From {+198}Pt({+70}Zn,X|g)
68NI D CC\$ FROM BrIcc v2.2b (20-Jan-2009) 2008Ki07, "Frozen Orbitals" appr.
68NI XA68CO B- DECAY (0.20 S)
68NI XB68CO B- DECAY (1.6 S)
68NI XC68NI IT DECAY (0.86 MS)
68NI XDCOULOMB EXCITATION
68NI XE70ZN(14C,16O)
68NI XF70ZN(14C,16O)
68NI XG130TE(64NI,XG),208PB(64NI,XG)
68NI XH198PT(70ZN,XG)
68NI XINI(86KR,XG),58NI(70ZN,XG)
68NI L 0.0 0+ 29 S 2 A
68NIX L XREF=ABCDEFGH I
68NI2 L %B=-100
68NI cL T\$from 1998Fr15. The authors also give this value in 2001Fr21. Other:
68NI2cL 19 s {I+3-6} (1988ScZH,1988KoZT).
68NI L 1770 30 0+ 270 NS 5
68NIX L XREF=EFI
68NI cL T\$from |g(t) in {+58}Ni({+70}Zn,X|g). Others: 211 ns {I50} from
68NI2cL I(ce)(t) and I(e{++},e{+-})(t) in ({+14}C,{+16}O|g), and 340 ns {I30}
68NI3cL from |g(t) in ({+86}Kr,X|g).
68NI cL J\$L=0 in ({+14}C,{+16}O); E0 transition to 0+ g.s.
68NI G 1770 E0 100
68NI cG E\$from ({+14}C,{+16}O|g)
68NI cG M\$from conversion electrons and pair production in ({+14}C,{+16}O|g)

Beta decay

^{68}Co β^- decay (0.20 s) 2000Mu10

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	E. A. Mccutchan	NDS 113, 1735 (2012)	1-Mar-2012

Parent: ^{68}Co : E=0.0; $J^\pi=(7^-)$; $T_{1/2}=0.20$ s 2; $Q(\beta^-)=1.155\times 10^4$ 13; $\% \beta^-$ decay=100.0

NB: ^{68}Co decay into ^{68}Ni

^{68}Ni Levels

E(level) [†]	J^π [‡]	$T_{1/2}$ [‡]	Comments
0.0	0 ⁺	29 s 2	$\% \beta^- = 100.$
2033.23 20	2 ⁺	0.31 ps 5	
2848.2 3	5 ⁻	0.86 ms 5	$\% \text{IT} = 100$
3120.1 3			
3443.6 3	(6 ⁻ , 7 ⁻) [#]		
3557.1 3	(6 ⁻) [#]		
3934.5 6	(7)		

J^π must be from
Adopted Levels!

[†] From a least squares fit to $E\gamma$'s by evaluator.

[‡] From the Adopted Levels.

[#] Suggested configuration $\nu f_{5/2}^{-1} \nu g_{9/2}^{+1}$. Assuming a simple δ interaction the 3444 state is most likely 7⁻ and the 3557 state is most likely 6⁻ (2000Mu10).

Intensities/log ft values
inform J^π assignments

β^- radiations

E(decay)	E(level)	$I\beta^-$ ^{†#}	Log ft	Comments
(7.62×10^3 13)	3934.5	1.5 2	5.95 9	av $E\beta=3527$ 64
(7.99×10^3 13)	3557.1	28 2	4.78 7	av $E\beta=3711$ 64
(8.11×10^3 13)	3443.6	62 5	4.46 7	av $E\beta=3766$ 64
(8.43×10^3 13)	3120.1	5 3	5.6 3	av $E\beta=3924$ 64
(8.70×10^3 13)	2848.2	<10	>5.4	av $E\beta=4057$ 64

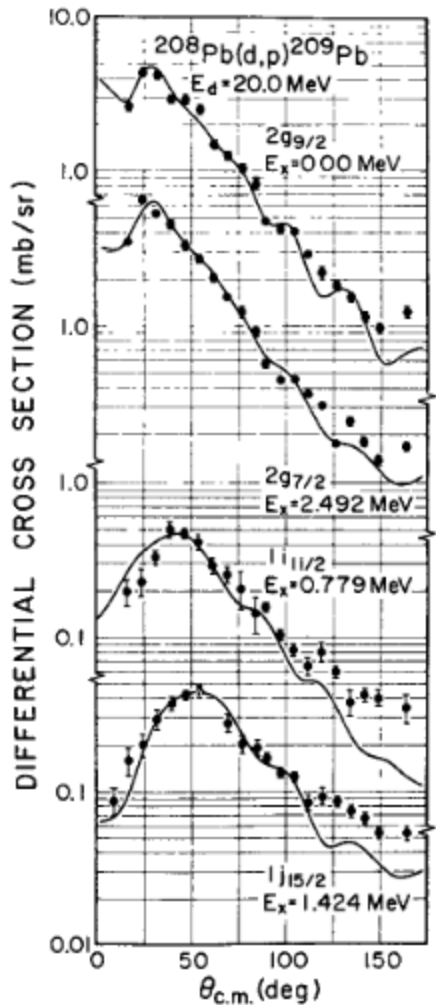
Transfer reactions

²⁰⁸Pb(d,p),(pol d,p) 1974Ko20,1973Vi06,1978Ba13

Orbital angular momentum

		Type	Author	History	Citation	Literature Cutoff Date
		Full Evaluation	J. Chen # and F. G. Kondev		NDS 126, 373 (2015)	30-Sep-2013
²⁰⁹ Pb Levels						
E(level) [†]	J ^π	L [#]	C ² S [@]	Comments		
0.0	9/2 ⁺	4	0.83	C ² S: for configuration= $\nu(2g_{9/2})^{+1}$.		
779.5	11/2 ⁺	6	0.86	C ² S: for configuration= $\nu(1i_{11/2})^{+1}$.		
1424.5	15/2 ⁻	7	0.58	C ² S: for configuration= $\nu(1j_{15/2})^{+1}$.		
1565.5	5/2 ⁺	2	0.98	C ² S: for configuration= $\nu(3d_{5/2})^{+1}$.		
2033.5	1/2 ⁺	0	0.98	C ² S: for configuration= $\nu(4s_{1/2})^{+1}$.		
2152.5		1		C ² S: 0.0067 if configuration= $\nu(3p_{1/2})^{-1}$, 0.0036 if $\nu(4p_{1/2})^{+1}$.		
2319.5		1		E(level): 2310 keV 5 (1969Je01).		

Spectroscopic factor: derived from ratio of experimental and (typically) DWBA cross sections



Adapted from Nucl. Phys A 231, 266 (1974)

Part III: ENSDF API

ENSDF API

<https://www.nndc.bnl.gov/ensdf-api/>

 The ENSDF API is in an early beta release status. Users are encouraged to report issues or provide feedback.

Welcome

This is the ENSDF REST API entry point. Use the links below to explore the API documentation or run interactive tutorials.

Interactive Docs (Swagger UI)

Browse endpoints, inspect schemas, and try out API calls directly from your browser.

[Open Swagger UI](#)

Reference Docs (ReDoc)

Read-only documentation view generated from the OpenAPI specification.

[Open ReDoc](#)

Tutorial Notebooks

Jupyter notebooks demonstrating how to use this API, runnable locally or in Google Colab.

[View Tutorials](#)

Root path: /ensdf-api

Look here for endpoints to access data

Contains boilerplate code I'll be including in a module called "boilerplate.py"

ENSDF API

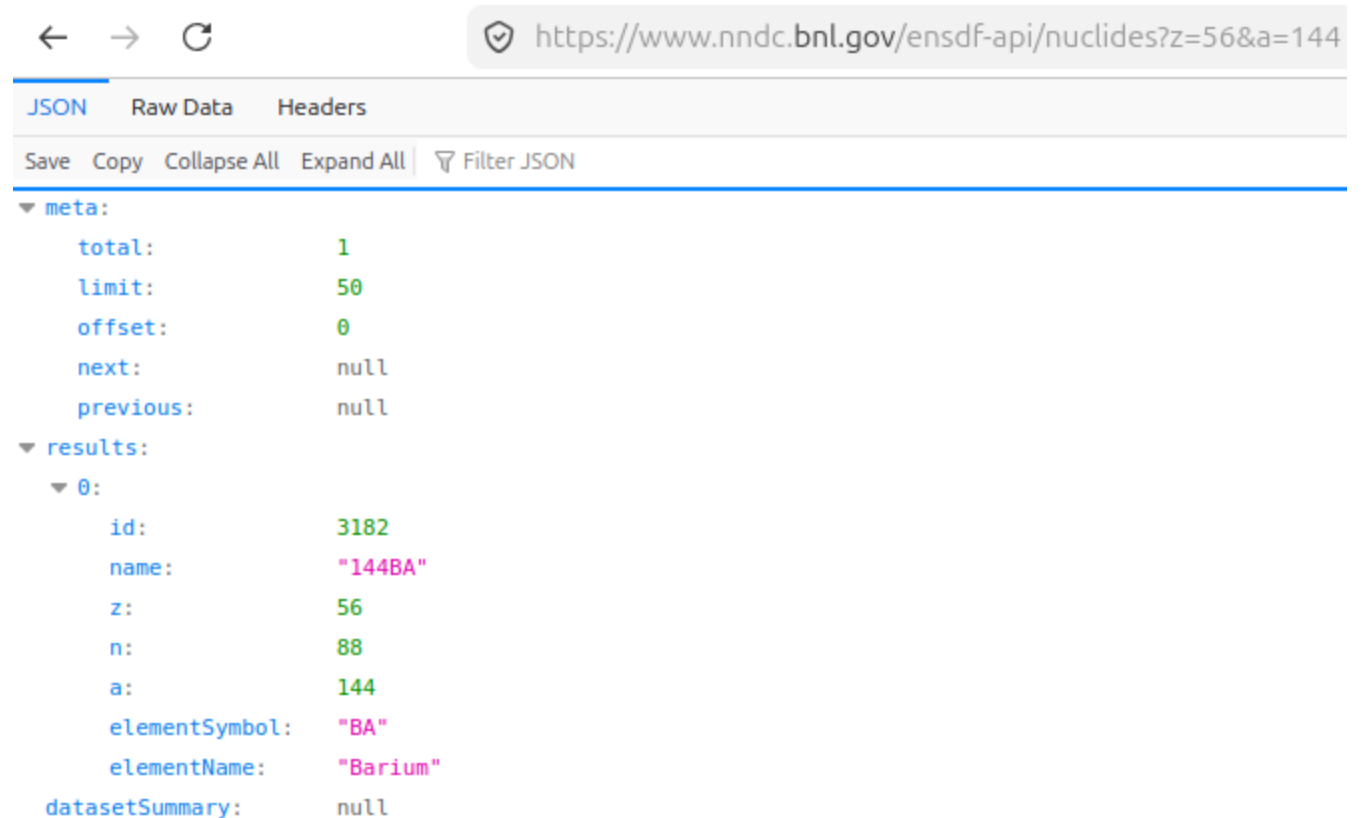
- The API is organized around a collection of "endpoints"
- /nuclides
- /datasets
- /levels
- /gammas
- ...

Each endpoint accepts filters to select specific results, e.g.

- /nuclides
 - a,z,n,symbol,...
- /datasets
 - dataset-type,...
- /levels
 - energy-min/max, halflife-min/max,...

ENSDF API

- How to use it? You could type directly into your address bar...
- You will get a JSON object back
 - Meta: details about the HTTP request/response
 - Results: the actual thing you want to inspect



```
← → ↻ https://www.nndc.bnl.gov/ensdf-api/nuclides?z=56&a=144
JSON Raw Data Headers
Save Copy Collapse All Expand All Filter JSON
▼ meta:
  total: 1
  limit: 50
  offset: 0
  next: null
  previous: null
▼ results:
  ▼ 0:
    id: 3182
    name: "144BA"
    z: 56
    n: 88
    a: 144
    elementSymbol: "BA"
    elementName: "Barium"
    datasetSummary: null
```

ENSDF API

- Better: use your programming language of choice
- These slides use python with the "requests" package to handle HTTP matters
- The "get()" method is just a convenient helper method to construct requests.
 - Find it in any of the Jupyter notebooks at the API site

```
>>> import boilerplate as bp
>>> bp.get("/nuclides",params={"z":56,"a":144})
GET https://www.nndc.bnl.gov/ensdf-api/nuclides?z=56&a=144
Status: 200
{'meta': {'total': 1, 'limit': 50, 'offset': 0, 'next': None,
'previous': None}, 'results': [{'id': 3182, 'name': '144BA',
'z': 56, 'n': 88, 'a': 144, 'elementSymbol': 'BA', 'elementN
ame': 'Barium'}], 'datasetSummary': None}
>>>
```

NB: The code on these slides isn't the point. The *brevity* of the code is the point!

ENSDF API

- A more interesting example: print info on an isotopic chain
- Use the `"/levels"` endpoint
- General approach:
 - Filter
 - Fetch
 - Process

```
import boilerplate as bp

def print_info(level):
    dataset = bp.get(f"/datasets/{level['datasetId']}", verbose=False)
    print('Nucleus: ', f"{dataset['a']}{dataset['elementSymbol']}")
    print('  Ex:', bp.quantity_label(level.get('energy')))
    print('  Jpi:', level.get('spinParityStr'))
    print('  T1/2:', bp.quantity_label(level.get("halflife")))

filters={
    "z":56,
    "document-type":"adopted",
    "level-index-max": 0
}

baria = bp.get("/levels", params=filters)["results"]
for barium in baria:
    print_info(barium)
```

ENSDF API

- A more interesting example: print info on an isotopic chain
- Use the "/levels" endpoint
- General approach:
 - Filter
 - Fetch
 - Process

```
import boilerplate as bp

def print_info(level):
    dataset = bp.get(f"/datasets/{level['dataset']}")
    print('Nucleus: ', f"{dataset['a']}{dataset['e']}")
    print('  Ex:', bp.quantity_label(level.get('energy')))
    print('  Jpi:', level.get('spinParityStr'))
    print('  T1/2:', bp.quantity_label(level.get('halfLife')))

filters={
    "z":56,
    "document-type":"adopted",
    "level-index-max": 0
}

baria = bp.get("/levels",params=filters)["results"]
for barium in baria:
    print_info(barium)
```

Nucleus:	150Ba
Ex:	0.0 keV
Jpi:	0+
T1/2:	0.259 s
Nucleus:	151Ba
Ex:	0.0 keV
Jpi:	None
T1/2:	0.167 s
Nucleus:	152Ba
Ex:	0.0 keV
Jpi:	0+
T1/2:	0.139 s
Nucleus:	153Ba
Ex:	0.0 keV
Jpi:	None
T1/2:	0.116 s
Nucleus:	154Ba
Ex:	0.0 keV
Jpi:	0+
T1/2:	53.0 ms

ENSDF API

- A real-life example: plot ground-state half-lives across the chart
- /levels/export endpoint is useful when you want global systematics (avoids limits on normal /levels endpoint)

```
import requests
import json

def get_all(endpoint, params):
    url = "https://www.nndc.bnl.gov/ensdf-api/"
    url += endpoint + "/export"
    with requests.get(url, params=params, stream=True) as r:
        r.raise_for_status()
        return [json.loads(line) for line in r.iter_lines()]
```

Note: this is a very quick demonstration method. Find more robust examples in the Jupyter notebooks on the API site

ENSDF API

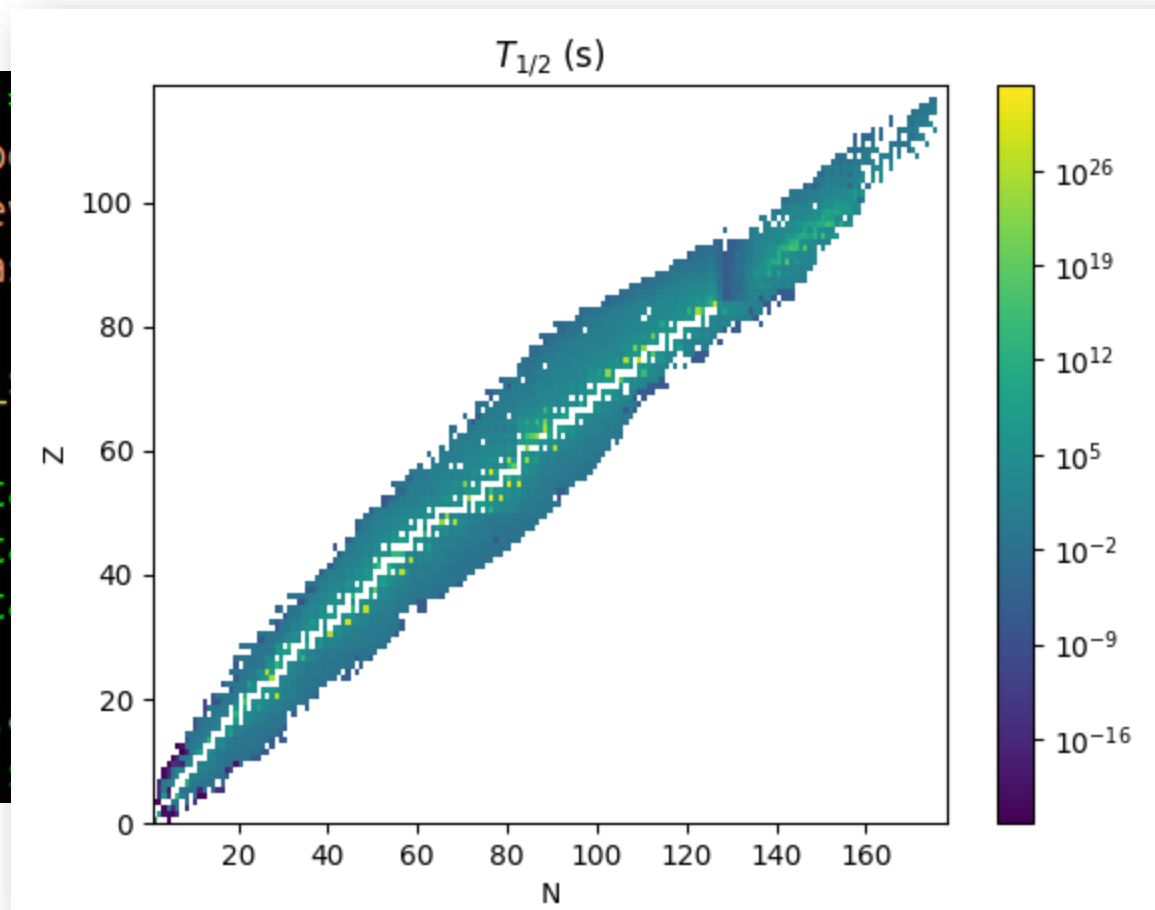
- A real-life example:
plot ground-state half-lives across the chart
- /levels endpoint is
useful when you want
global systematics
- Again:
 - Filter
 - Fetch
 - Process

```
params = {  
    'document-type': 'adopted',  
    'level-index-max': 0,  
    'has-half-life': True  
}  
ground_states = get_all("levels", params)  
  
Z = [state["datasetSummary"]["z"] for state in ground_states]  
N = [state["datasetSummary"]["n"] for state in ground_states]  
T = [state["halfLifeSeconds"] for state in ground_states]  
  
figure, axis = make_2dhist(N, "N", Z, "Z", T, "$T_{1/2}$ (s)")  
figure.show()
```

ENSDF API

- A real-life example: plot ground-state half-lives across the chart
- /levels endpoint is useful when you want global systematics
- Again:
 - Filter
 - Fetch
 - Process

```
params = {'do': 'do', 'le': 'le', 'ha': 'ha'}  
ground_ =  
Z = [st  
N = [st  
T = [st  
figure,  
figure.
```

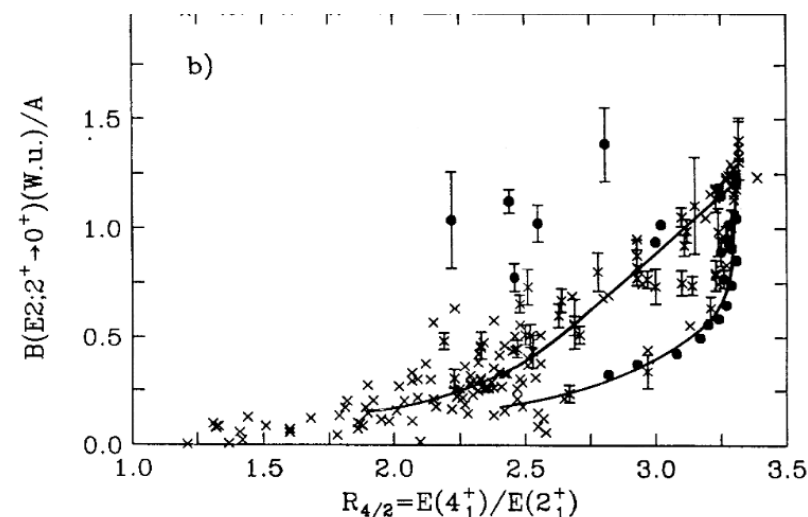


```
states]  
states]  
es]  
")
```

ENSDF API

- Final thoughts:
- The API is in very early beta – we want your feedback!
 - That also means endpoints, responses, and filters may evolve
- c.f. many tutorials at <https://www.nndc.bnl.gov/ensdf-api/tutorials>

A challenge: reproduce Fig. 4 from
Casten and Zamfir, PRL 70, 402 (1993)



Fin!

Questions?