



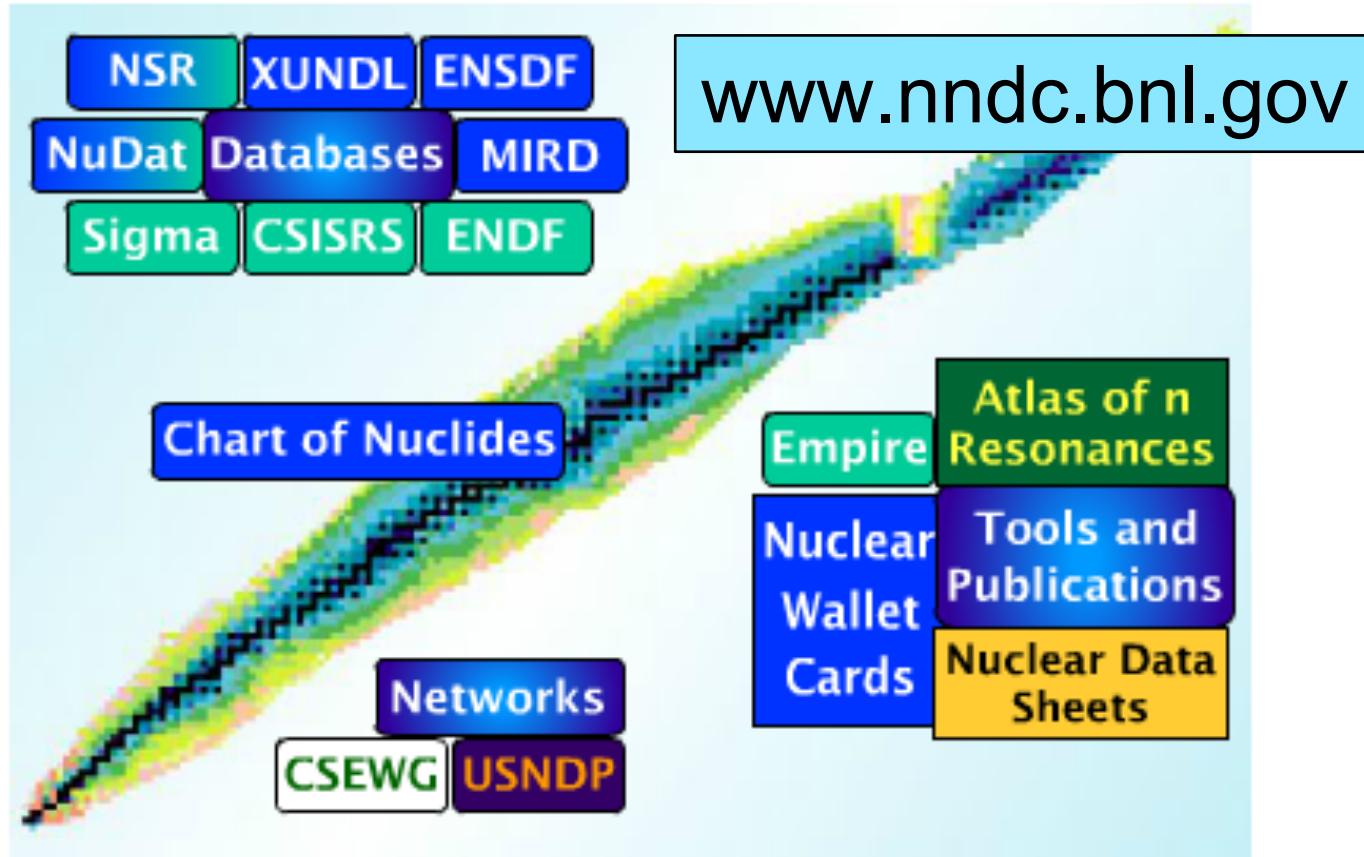
NSR/XUNDL/ENSDF

Libby McCutchan (NNDC,BNL)

mccutchan@bnl.gov



National Nuclear Data Center



How many downloads of nuclear data per day?
(just through the NNDC website)

- a)150
- b)1,500
- c)15,000



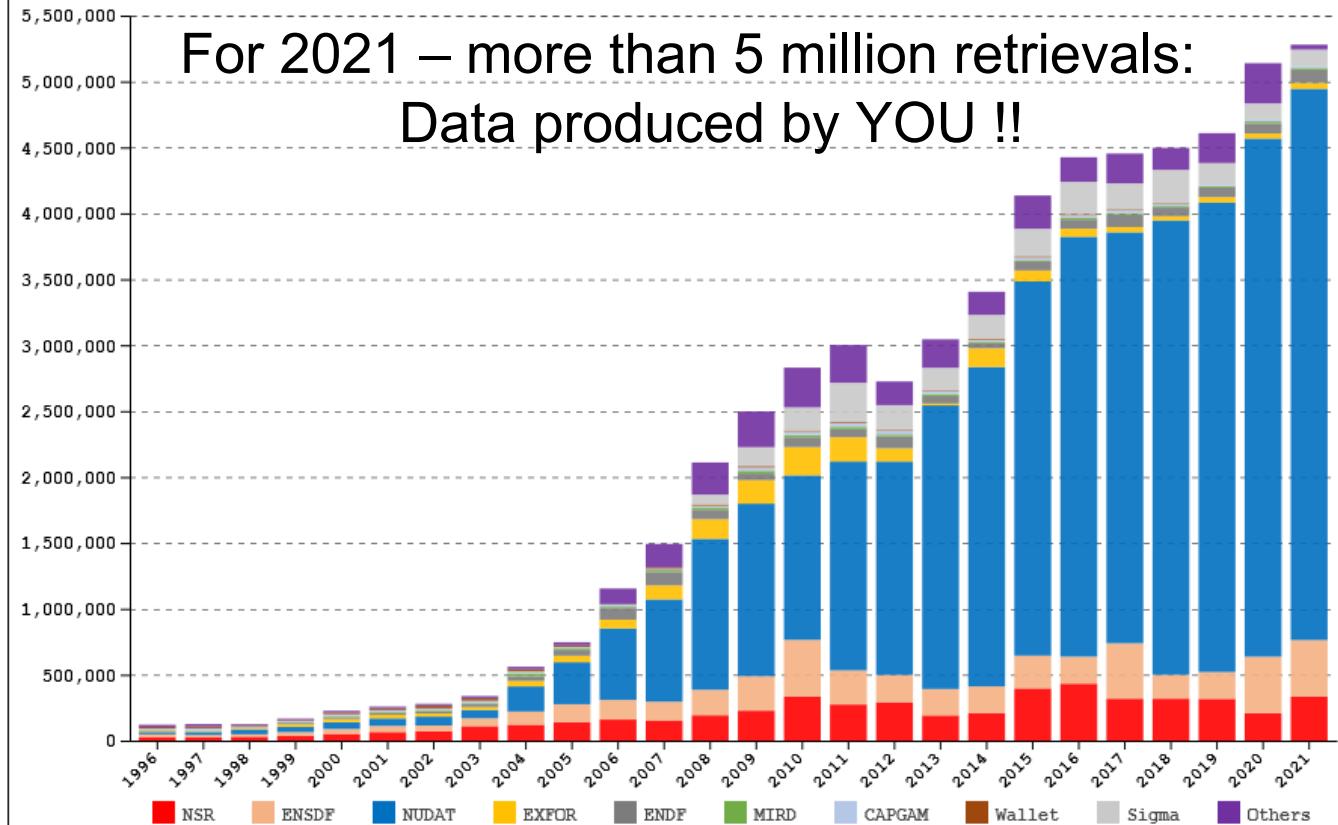
Open Data Web Downloads



The Taylor Swift of Nuclear Physics?

NNDC Web Retrievals 1996-2021

For 2021 – more than 5 million retrievals:
Data produced by YOU !!



Nuclear Data Program

Link between basic science and applications

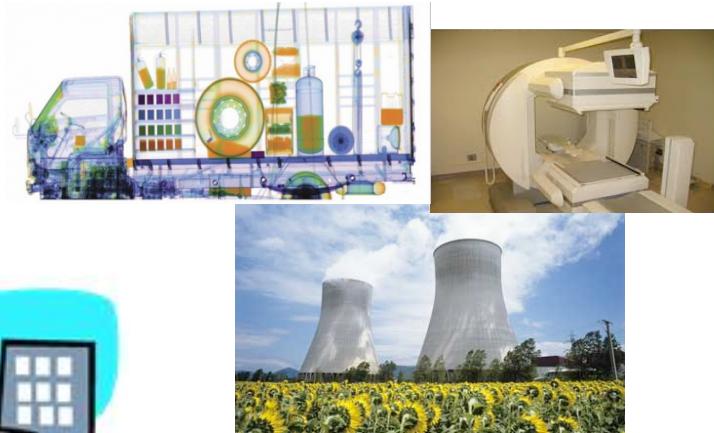
Nuclear Science Community

- experiments
- theory



Nuclear Data Community

- ◆ compilation
- ◆ evaluation
- ◆ dissemination
- ◆ archival



Applications Community

needs data:

- ◆ complete
- ◆ organized
- ◆ traceable
- ◆ readable

The Nuclear Data Pipeline



70+ years of nuclear data measurements available

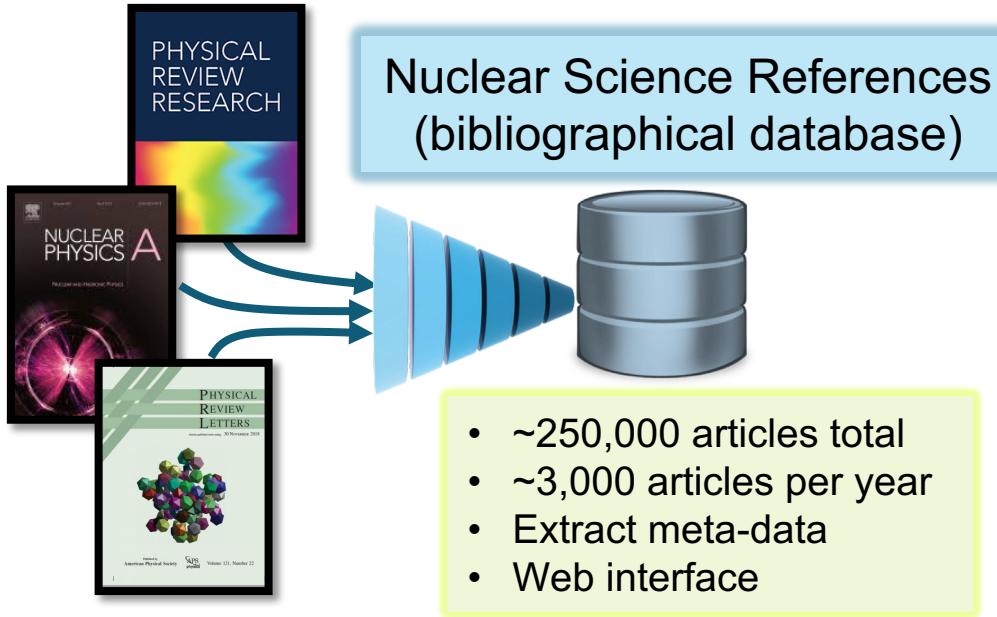


These are collected, processed, separated and shipped



In a convenient and usable form

Nuclear Data Pipeline



I want to know about measurements of the half-life of ^{141}Te

- Publications are 95% source of data
 - Journals
 - Lab Reports
 - Theses
- Literature scanned on weekly basis

Google Scholar

Te-141

About 862 results (0.12 sec)

Radiochemical studies on the use of modified resins in the isolation and separation of Ce (III), Zr (IV), Hf (IV), Te (IV) and Nb (V)

FH El-Sweify, EAA El-Shazly... - Arab Journal of Nuclear ..., 2007 - inis.iaea.org
[en] Comparative studies were carried out for further characterization of some modified resins and for the application of these modified resins in the isolation and separation of some ...
☆ Save 99 Cite Cited by 1 Related articles All 2 versions

Sociodemografski profil sudionica u Kohortnoj studiji rođenih na istočnojadranskim otocima (CRIBS)

A Perinić Lewis, M Zajc Petranović, T Carić... - Hrvatski geografski ..., 2019 - hrcak.srce.hr
... Uzorak čini 286 trudnica (145 s otoka Brača i Hvara te 141 trudnica s kopna). Cilj je ove studije: 1) opisati glavna obilježja CRIBS uzorka, 2) usporediti uzorak s općom hrvatskom ...
☆ Save 99 Cite Related articles All 2 versions

Determination of the Debye temperature of SnTe using the Mössbauer effect in ^{119}Sn and ^{125}Te

S Bukshpan - Solid State Communications, 1968 - Elsevier
The temperature dependence of the recoilless fraction in SnTe has been measured in ^{119}Sn and ^{125}Te nuclei in the range $85 < T < 250$ K. Assuming a Debye model for the recoilless ...
☆ Save 99 Cite Cited by 27 Related articles All 3 versions

[HTML] Imaging patterns in elastofibroma dorsi

M Battaglia, D Vanel, P Pollastri, A Balladelli... - European journal of ..., 2009 - Elsevier
... Axial T1-weighted (TR/TE 141/7.5) spin echo MR images show a relatively well-defined homogeneous mass between the chest wall and the scapular tip with signal intensity similar to ...
☆ Save 99 Cite Cited by 70 Related articles All 13 versions

Web of Science

- 1 One-pot strategy for obtaining magnetic PMMA particles through ATRP using Fe(CO)(5) as co-initiator

Diacan, A; Rusen, E (...); Tutunaru, O
Jun 5 2021 | Apr 2021 (Early Access) | EUROPEAN POLYMER JOURNAL 152

The first aim of this study was to develop an ATRP process for methyl methacrylate (MMA) polymerization using Fe(CO)(5) as co-initiator. The second aim was to obtain magnetic PMMA particles with a core-shell structure characteristic of the polymerization reaction.



View full

- 2 Mechanism of poly(methyl methacrylate) terpolymerization induced by Fe(CO)(5) for microcrystal fabrication

Rusen, E; Mocanu, A
Apr 5 2021 | Jan 2021 | POLYMER 614



This study presents a mechanism for the formation of poly(methyl methacrylate) (NIPAM) microcrystals induced by Fe(CO)(5) in the presence of acrylamide (NIPAM) and acrylonitrile (AN).



View full



65
References

Related records ?

3
Citations

53
References

43
Related records ?

Nuclear Science References Search Result

2020WU04 Phys.Rev. C 101, 042801 (2020)

[J.Wu](#), [S.Nishimura](#), [P.Moller](#), [M.R.Mumpower](#), [R.Lozeva](#), [C.B.Moon](#), [A.wne](#), [R.Daido](#), [P.Doornenbal](#), [Y.F.Fang](#), [M.Haroon](#), [T.Isobe](#), [H.S.Jung](#), [atel](#), [S.Rice](#), [H.Sakurai](#), [Y.Shimizu](#), [L.Sinclair](#), [P.-A.Soderstrom](#), [T.Suzuki](#), [K.Tanaka](#), [T.Watanabe](#)

OP
Keyworded
description of the
article

β -decay half-lives of 55 neutron-rich isotopes beyond the $N = 82$ shell gap

RADIOACTIVITY $^{134,135,136,137,138,139}\text{Sn}$, $^{134,135,136,137,138,139,140,141,142}\text{Sb}$, $^{137,138,139,140,141,142,143,144}\text{Te}$, $^{140,141,142,143,144,145,146}\text{I}$, $^{142,143,144,145,146,147,148}\text{Xe}$, $^{145,146,147,148,149,150,151}\text{Cs}$, $^{148,149,150,151,152,153}\text{Ba}$, $^{151,152,153,154,155}\text{La}$ (β^-)

)[from $^9\text{Be}(^{238}\text{U}, \text{F})$, $E=345$ MeV/nucleon, followed by separation of fragments using BigRIPS separator at RIBF-RIKEN]; measured β and γ radiations, half-lives by (implant) β and (implant) $\beta\gamma$ correlations using the Wide range Active Silicon-Strip Stop per Array for Beta and ion (WAS3ABi) detection system and Euroball RIKEN Cluster Array (EURICA) of 84 Ge cluster detectors. Comparison with previously available experimental half-lives, and with theoretical calculations using FRDM+QRPA, KTUY+GT2, RHB+pn-RQRPA, and DF+CQRPA models. $^{141}\text{Te}(\beta^-)$; calculated half-life and Gamow-Teller strengths using FRDM+QRPA(2019) model, and compared with experimental data. Discussed and calculated effects of new half-life data on r-process abundance.

doi: [10.1103/PhysRevC.101.042801](https://doi.org/10.1103/PhysRevC.101.042801)

Link to journal

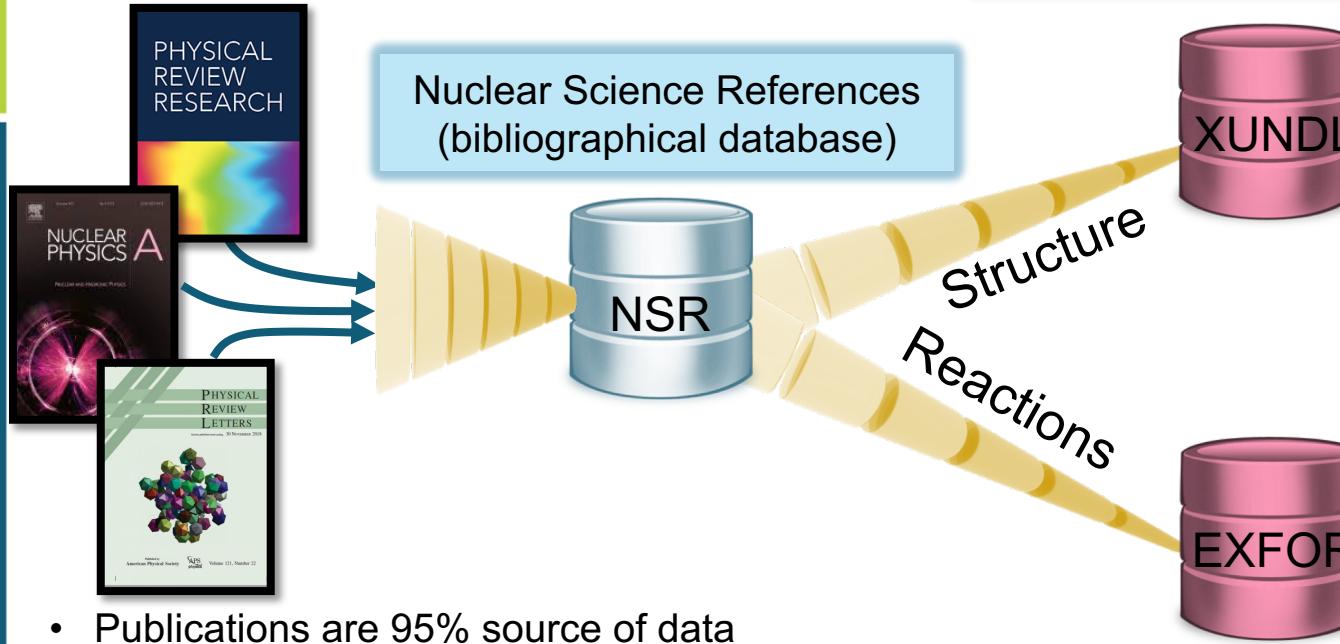
Citations: [PlumX Metrics](#)

Data from this article have been entered in the **XUNDL** database. For more information, click [here](#).

Link to compiled
data

Nuclear Data Pipeline

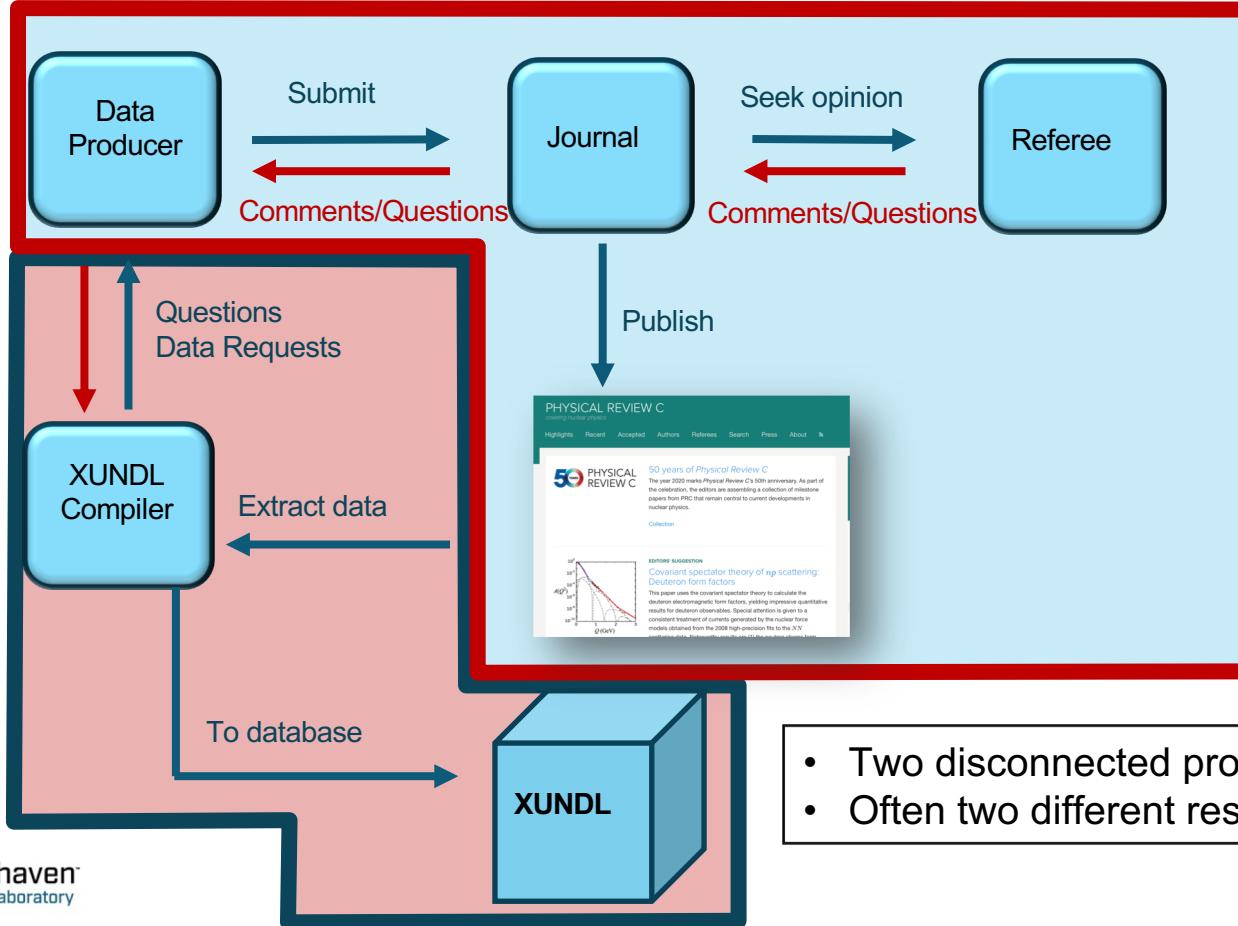
Compilation Databases



- Publications are 95% source of data
 - Journals
 - Lab Reports
 - Theses
- Literature scanned on weekly basis

- Extraction of meta- and numerical data
- Data converted to database format
- Several consistency checks of data

Data compilation for last 20+ years



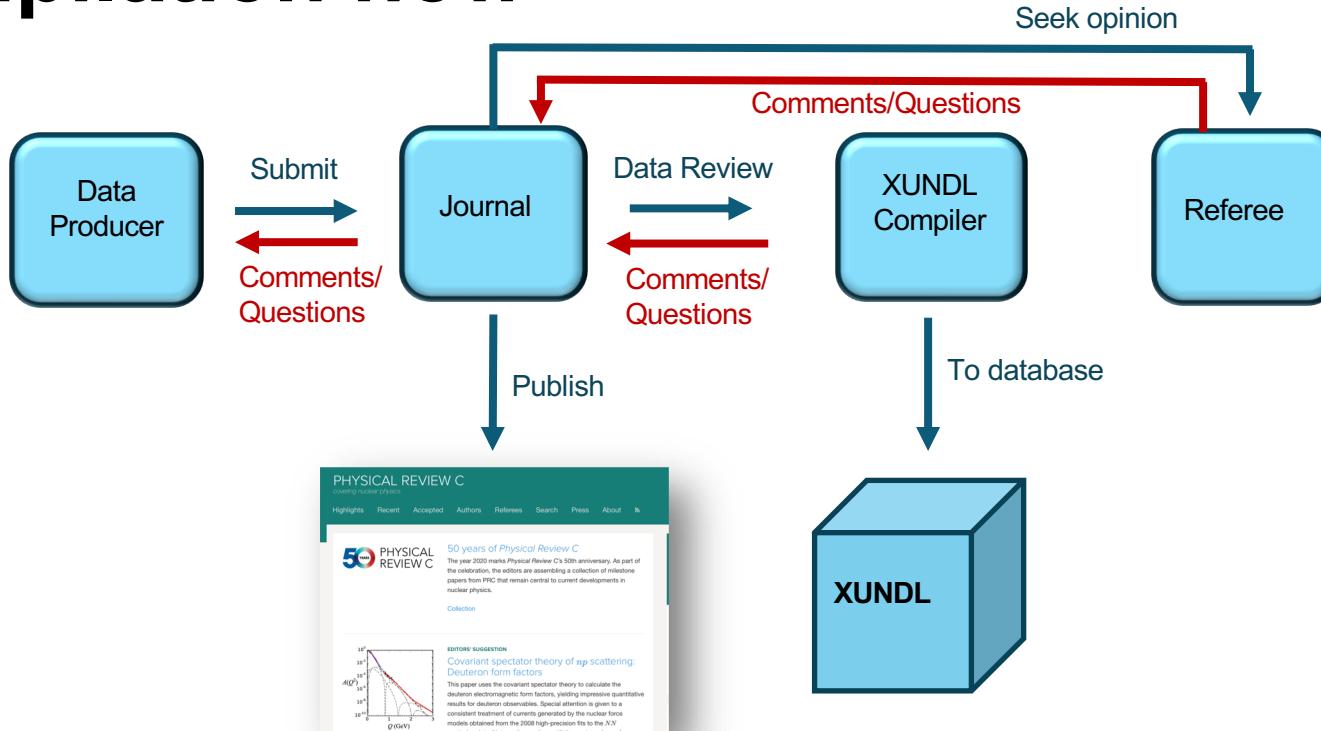
A better way ?

- To improve quality of published data
- To increase efficiency
- To foster collaboration

Not easy to change decades-long practice
... but we're getting there

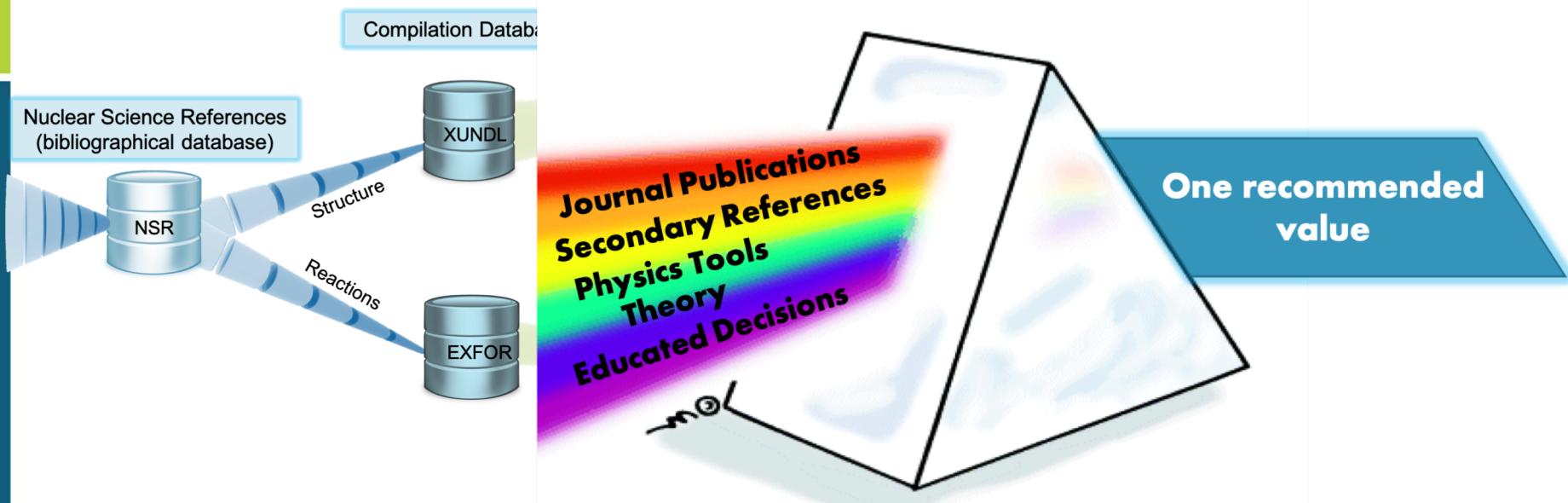


Compilation now



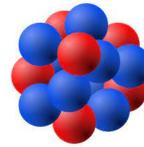
Data program integrated into the “data distribution” process.
Ensures literature and databases are identical.

Nuclear Data Pipeline



- Critical assessment of all available experimental data
- Provide recommended values
- Testing and Validation important component
- Structure and reaction data not independent

Nuclear Structure Database (ENSDF)



Quantum mechanical system with 1 to hundreds of interacting nucleons

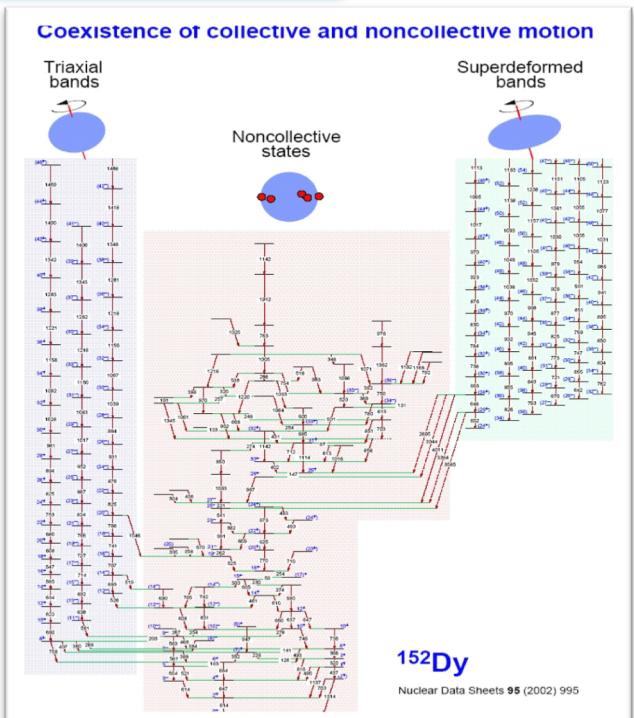
3,350 nuclei produced and studied

Discrete Quantized States

- Excitation Energy
- Half-life
- Angular Momentum
- Magnetic Moment
- Configuration
- ...

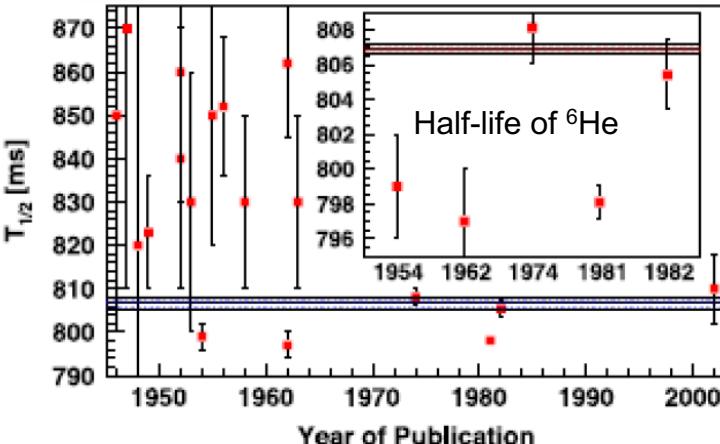
Emitted Radiation

- Energy
- Intensity
- Dipole, Quadrupole, ...
- ...



100+ years of experimental nuclear structure measurements

Arbiter of the “Truth”



ENSDF available through two web applications

NNDC National Nuclear Data Center BROOKHAVEN NATIONAL LABORATORY Home

NNDC Databases: NuDat | NSR | XUNDL | ENSDF | MIRD | ENDF | CSISRS | Sigma

ENSDF: Evaluated Nuclear Structure Data File Search and Retrieval

Last updated 2019-11-01
ENSDF provides recommended nuclear structure and decay information.
For more recent nuclear data which has not yet been evaluated, please visit [XUNDL](#).

253 new datasets added/modified in the last month!

Suggestions or comments? Please [let us know!](#)

Quick Search | By Nuclide | By Reaction | By Decay | Recently Added

Nuclide or mass: Search
(*208Pb, pb-208, 144, In (neutron), etc.*)

Check out the [Summary of ENSDF](#)!
A listing of when nuclides were last evaluated and recent XUNDL datasets

NuDat 2.7
Search and plot nuclear structure and decay data interactively. [More](#).
Color code: Half-life | Decay Mode | Q_β-2n | BE/A | (BE-LDM Fit)/A | Pair gap | E_{1st ex. st.} | E₂₊ | E₃₋ | E₄₊ | E_{4+/E₂₊} | β₂ | B(E2)42/B(E2)20 | S_{2n} | S_{2p} | Q_{β-n} | Q_{EC} | Q_{CP} | Q_{β+n}

Levels and Gammas Search | Nuclear Wallet Cards Search | Decay Radiation Search
Ground and excited states (energy, T_{1/2}, spin/parity, decay modes), gamma rays (energy, intensity, multipolarity, coinc.) | Latest Ground and isomeric states properties | Radiation type, energy, intensity and dose following nuclear decay

Interactive Chart of Nuclides

Zoom: 1 (NDS), 2 (Standard), 3, 4, 5, 6 (Narrow), 7 (Wide)
Uncertainty: 1 (NDS), 2, 3, 4, 5, 6, 7
Nucleus: go
Seconds: 10^-15, 10^-10, 10^-07, 10^-05, 10^-03, 10^-02, 10^-01, 10^-02, 10^-03, 10^-04, 10^-05, 10^-06, 10^-07, 10^-08, 10^-09, 10^-10, 10^-11, 10^-12, 10^-13, 10^-14, 10^-15, unknown
Tooltips: On, Off
NNDc

ENSDF Retrieval

¹⁴⁷Sm Levels
Cross Reference (XREF) Flags

A	¹⁴⁷ Pm β^- decay (2.6234 y)	F	¹⁴⁷ Sm(n,n'γ)	K	¹⁴⁷ Eu(μ^- ,4nγ)
B	¹⁴⁷ Eu ε decay (24.1 d)	G	¹⁴⁷ Sm(d,d')	L	¹⁴⁷ Eu(μ^- ,4nγ)
C	¹⁵¹ Gd α decay	H	¹⁴⁸ Sm(p,d)	M	Coulomb excitation
D	¹⁴⁸ Nd(³ He,4nγ), ¹⁴⁶ Nd(α ,3nγ),	I	¹⁴⁸ Sm(d,t)		
E	¹⁴⁷ Sm(p,p')	J	¹⁴⁸ Sm(³ He, α)		

E(level) [†]	J^π	$T_{1/2}$	XREF	Comments
0.0@	7/2 ⁻	1.060×10 ¹¹ # y 11	ABCDEFGHIJK M	%α=100 $\mu=-0.8148$ 7 (2005St24); $Q=-0.261$ 7 (2005St24) μ : measured by atomic beam magnetic resonance – thermal beam (1966Wo05). Q : measured by atomic beam magnetic resonance – thermal beam (re-evaluated data) (1992Le09). J^π : from 1976Fu06 , π from L(p,t)=0. rms charge radius: 4.9839 10 (2004An14). $\mu=-0.449$ 25 (1989Ra17); $Q=-0.45$ 19 (1989Ra17) μ, Q : measured by Mossbauer effect (1971Pa04); the values given by 2005St24 are the rounded-off values of 1989Ra17 ($\mu=-0.45$ 3, $Q=-0.5$ 2). $T_{1/2}$: weighted av. of 0.80 ns 4 (1968Bo47), 0.78 ns 3 (1970Ko38), 0.77 ns 4 (1971Be53), 0.83 ns 3 (1978VyZV), in ¹⁴⁷ Eu ε decay; 0.79 ns 14 from B(E2) \uparrow in Coulomb excitation.

E _f (level)	J_f^π	E_γ	L_γ^\dagger	E_f	J_f^π	Mult.	δ^\ddagger	a^c	Comments
121.212	5/2 ⁻	121.220\$ 17	100	0.0	7/2 ⁻	M1+E2&	-0.33 3	0.996 15	$\alpha(K)=0.814$ 12; $\alpha(L)=0.143$ 5; $\alpha(M)=0.0312$ 12; $\alpha(N+..)=0.0081$ 3 $\alpha(N)=0.00702$ 25; $\alpha(O)=0.00101$ 3; $\alpha(P)=5.06\times10^{-5}$ 8 B(M1)(W.u.)=0.00700 21; B(E2)(W.u.)=29 5 δ : -0.33 3 from ¹⁴⁷ Eu ε decay (1962Sc09); -0.278 20 (same dataset, 1989Ad10) not adopted because adopted $T_{1/2}$ would be different from $T_{1/2}(B(E2)\uparrow)$ (see $T_{1/2}$ comment in Coulomb excitation).

- Full version
- Values and extensive comments
- Two tables

NuDat Retrieval

ADOPTED LEVELS, GAMMAS for ^{147}Sm

Author: N. Nica Citation: Nucl. Data Sheets 110,749 (2009) Cutoff date: 14-Nov-2008

[Full ENSDF file](#)

$Q(\beta^-) = -1721.6 \text{ keV } 23$ $S(n) = 6341 \text{ keV } 3$ $S(p) = 7101 \text{ keV } 5$ $Q(\alpha) = 2311.2 \text{ keV } 10$

Reference: [2012WA38](#)

References:

- | | | | |
|---|--|---|--|
| A | ^{147}Pm β^- decay (2.6234 γ) | B | ^{147}Eu ϵ decay (24.1 d) |
| C | ^{151}Gd α decay | D | ^{148}Nd ($^3\text{He}, 4n\gamma$), $^{146}\text{Nd}(\alpha, 3n\gamma)$, |
| E | $^{147}\text{Sm}(p, p')$ | F | $^{147}\text{Sm}(n, n'\gamma)$ |
| G | $^{147}\text{Sm}(d, d')$ | H | $^{148}\text{Sm}(p, d)$ |
| I | $^{148}\text{Sm}(d, t)$ | J | $^{148}\text{Sm}(^3\text{He}, \alpha)$ |
| K | $^{149}\text{Sm}(p, t)$ | L | $^{151}\text{Eu}(\mu^-, 4n\gamma)$ |
| M | Coulomb Excitation | | |

- Simplified version
- Only values, no comments
- Single table

E(level) (keV)	XREF	Jπ(level)	T _{1/2} (level)	E(γ) (keV)	I(γ)	M(γ)	Final level
0.0	ABCDEFGHIJK M	7/2-	1.060×10 ¹¹ y 11 % α = 100				
121.212 5	AB DEFG I M	5/2-	0.798 ns 17	121.220 17	100	M1+E2	0.0 7/2-
197.284 5	AB DEFGHI M	3/2-	1.25 ns 3	76.073 10 197.299 12	3.44 11 100 3	M1+E2 E2	121.212 5/2- 0.0 7/2-

ADOPTED LEVELS, GAMMAS for ^{147}Sm

Author: N. Nica | Citation: Nucl. Data Sheets 110,749 (2009) | Cutoff date: 14-Nov-2008

[Full ENSDF file](#) | [Adopted Levels \(PDF version\)](#)

$Q(\beta^-) = -1721.6 \text{ keV } 23$ $S(n) = 6341 \text{ keV } 3$ $S(p) = 7101 \text{ keV } 5$ $Q(\alpha) = 2311.2 \text{ keV } 10$
 Reference: [2012WA38](#)

References:

- A $^{147}\text{Pm} \beta^-$ decay (2.6234 yr)
- B $^{147}\text{Eu} \varepsilon$ decay (24.1 d)
- C $^{151}\text{Gd} \alpha$ decay
- D $^{148}\text{Nd}(^3\text{He}, 4n\gamma)$, $^{146}\text{Nd}(\alpha, 3n\gamma)$,
- E $^{147}\text{Sm}(p, p')$
- F $^{147}\text{Sm}(n, n'\gamma)$
- G $^{147}\text{Sm}(d, d')$
- H $^{148}\text{Sm}(p, d)$
- I $^{148}\text{Sm}(d, t)$
- J $^{148}\text{Sm}(^3\text{He}, \alpha)$
- K $^{149}\text{Sm}(p, t)$
- L $^{151}\text{Eu}(\mu^-, 4n\gamma)$
- M Coulomb Excitation

General Comments:

[Back to top](#)

[Main Table](#)

[Band
Transitions
Table](#)

[Additional
Gamma Data](#)

[Additional
Level Data](#)

[Additional
Gamma Comments](#)

[Download as .csv](#)

XREFs Jⁿ T_{1/2}/Decay E(γ) I(γ) M(γ) Final Levels

E(level) (keV)	XREF	J ⁿ (level)	T _{1/2} (level)	E(γ) (keV)	I(γ)	M(γ)	Final Levels
0.0	ABCDEFGHIJK M	7/2-	$1.060 \times 10^{11} \text{ yr } 11$ % α = 100				
121.212 5	AB DEFG I M	5/2-	0.798 ns 17	121.220 17	100	M1+E2	0.0 7/2-
197.284 5	AB DEFGHI M	3/2-	1.25 ns 3	76.073 10 197.299 12	3.44 11 100 3	M1+E2 E2	121.212 5/2- 0.0 7/2-
716.62 4	B DEFG I M	11/2-	2.35 ps 5	716.45 5	100	E2	0.0 7/2-
720	H	(1/2+)					
798.731 4	B DEFGHIJ M	3/2-	1.00 ps 21	601.450 4 677.516 7 798.729 5	60.2 19 100 3 49.6 16	M1(+E2) M1+E2 E2	197.284 3/2- 121.212 5/2- 0.0 7/2-
809.358 13	B D FG IJ M	9/2-	3.1 ps 5	688.15 4 809.380 16	25.0 19 100 4	E2 M1+E2	121.212 5/2- 0.0 7/2-
884	H	(1/2+)					

Nuclear Reactions Database (ENDF)

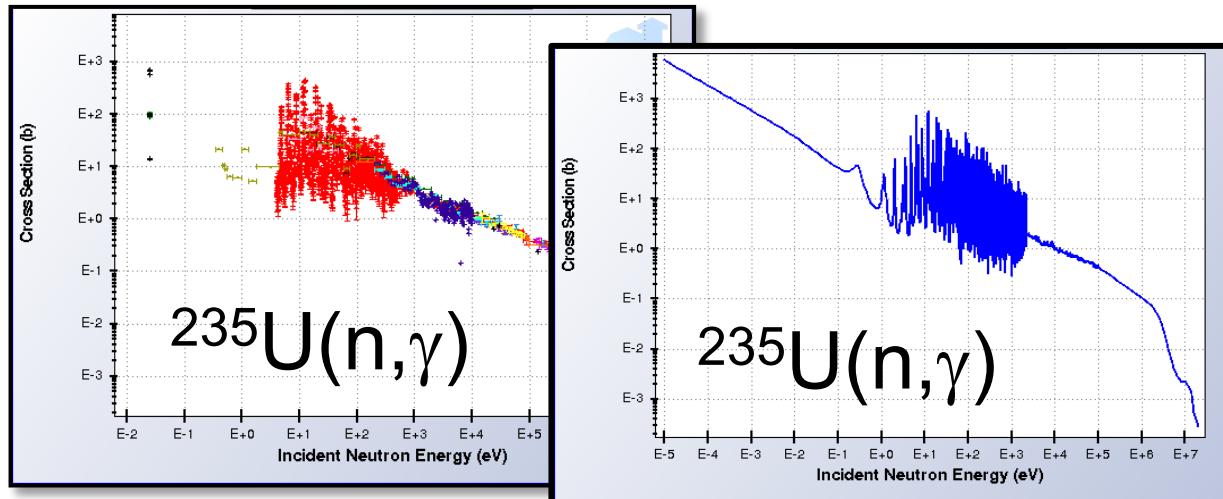


Cross section: related to the size of a nucleus

Probability of “hitting” the nucleus $\sim \pi R^2$

$$1 \text{ barn (b)} = 10^{-24} \text{ cm}^2$$

- Cross section as a function of incident particle energy
- Energy and angles of reaction products
- Neutron resonance parameters
- Neutron multiplicities
- Fission yields
- ...



- Not all reactions and all energies can be measured
- Application of physics-based models to describe experimental data²⁰

Data Dissemination

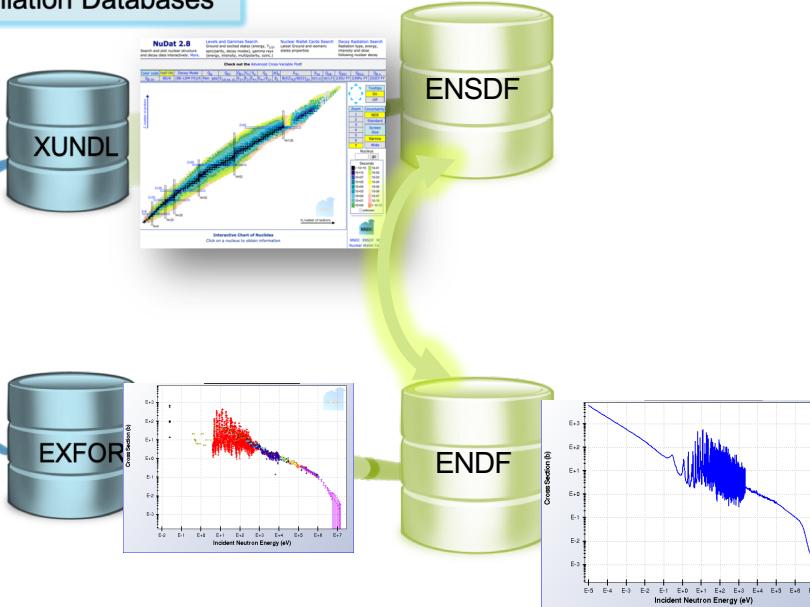
Evaluated Databases

Compilation Databases

Nuclear Science References
(bibliographical database)



Structure
Reactions



- Each database has web application to query and (plot) data
- Additional web applications for subsets of data