



IAEA

60 Years

Atoms for Peace and Development

Report of Nuclear Data Section

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NRDC Meeting, May 4-7 2021, IAEA, Vienna

Contents

- NDS staff
- Some CRP's, networks and Data Development Projects
- Global EXFOR overview

NDS staff movements: 2018-2020



60 Years

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P-staff:

Kalle Heinola (AMDU): started in May 2018

Shin Okumura (NSDU): started in September 2018

Ludmila Marian (AMDU): started in April 2019

Vivian Dimitriou (NDDU): was rotated out in June 2019

Georg Schnabel (NDDU): started in January 2020

Andrej Trkov (NDDU): retired in January 2020

Vivian Dimitriou (NDDU): started in January 2021

G-staff:

Kira Nathani (NDDU): assignment in IAEA Publications Section, June 2019 to May 2020
was temporarily replaced by Mariam Yaney

Alex Oechs (NDSU): retired in October 2019

Charisse Monfero (NDSU): started in March 2020

NDS consultants and interns 2018-2020



Consultants (> 1 month):

2019 - Jan Malec: GANDR development

2018 - Svetlana Selyankina: EXFOR compilation

2020 - 2021 Daniel Lopez Aldama: ENDF libraries and processing

Interns:

2018 - Emanuel Chimanski: nuclear reaction modelling

2018 - Takanari Fukuda: Fission yield EXFOR testing

2018 - Testuaki Tada: EXFOR compilation

2018 - Daichi Imazato: openMC

2018 - 2019 - Natalie Gaughan: data for medical isotope production

2019 - Ingrid Vavtar: k-eff benchmarking

2019 - Mark Mawdsley: resonance parameters

2019 - 2020: Hiroki Kawada : photonuclear data

Int. ND Evaluation Network (INDEN)



INDEN Plan:

- One large TM on setting priorities and discussion of results (every 2.5-3 years)
- 3 CMs/year on evaluation issues and challenges
- Additional TMs as needed focusing on an identified issue



International
Network of
Nuclear
Data Evaluators

Three working groups operating through one CM/year
(9 CMs in three years)

- 1) INDEN-LE : Evaluation of light elements
- 2) INDEN-SM: Evaluated Data of structural materials
- 3) INDEN-RR : Actinide Evaluation in the resonance region

Each group met once in 2018,2019,2020 (last INDEN-LE CM shifted to 2021)

A first review INDEN TM is planned for 21-24 June 2021

Nuclear Data Development (CRPs)



#	Short title	Duration	Participant (contracts)	Project Officer	Status
I	Nuclear data for charged-particle monitor reactions and medical isotope production	2012–2017 F41029	14 (5) +3 SSA	Capote	nds.iaea.org/medical/therapeutic_2019.html -NDS 148 (2018) 338-382 -J.Rad.Nucl.Chem.319 (2018) 487-531 -J.Rad.Nucl.Chem.319 (2018) 533-566 -NDS 155 (2019) 56-74
II	Testing and improving the IRDFF	2013–2018 F41031	13 (5)	Capote (Trkov) (Simakov)	nds.iaea.org/IRDFF NDS 163 (2020) 1-107
III	Primary radiation damage cross sections	2013–2018 F44003	18 (1)	Sublet (Simakov)	Eur. Phys. J. Plus 134 (2019) 350
IV	Reference database for β -delayed neutron emission	2013–2018 F41030	12 (3)	Dimitriou	NDS 168 (2020) 1–mic NDS, April 2021–mic/mac
V	Updating the Photonuclear Data library and generating a reference database for PSF	2016-2020 F41032	15(9)	Dimitriou	nds.iaea.org/photonuclear -ADNDT 123-124(2018) 1 -NDS 163 (2020) 109 -Eur.Phys.J.A55 (2019) 172
1	RIPL for fission cross section calculations	2016-2021 F41033	10(4)	Capote	On-going, 3 rd RCM, 2021
2	Updating Fission Yield Data for Applications	2020-2025 F42007	18(4)	Capote	On-going, 1st RCM, 2020

Nuclear Data Development



Completed Coordinated Research Project (V)

1) Updating the Photonuclear Data library and generating a reference database for photon strength functions (PSF)

2016–2020, Dimitriou

Photonuclear Data Library (IAEA/PD-2019): <https://nds.iaea.org/photonuclear/>

- Evaluations of photonuclear cross sections: 189 new evaluations (JAEA, KAERI, CNDC, Moscow SU, IFIN-HH) + 20 from IAEA/PD-1999
- New measurements of photoneutron cross sections (NewSUBARU gamma-ray beamline)
- New GDR exp. parameters using SLO/SMLO:
Plujko et al, ADNDT 123-124, 1 (2018)
- Paper presented at ND2019
- **Final Publication: Kawano et al.,
Nuclear Data Sheets 163, 109 (2020)**



Nuclear Data Development



On-going Coordinated Research Project (2)

2) Updating Fission Yield Data for Applications

2020-2025, Capote, 1st RCM held (50+ participants)

Goals: Updated evaluations of Fission Product Yields including a full UQ will be developed for selected actinides in a broad range of incident neutron energies

- 1st RCM, IAEA, Vienna, 31st Aug.- 4th Sept. 2020 (virtual), **INDC(NDS)-0817**

<https://www-nds.iaea.org/index-meeting-crp/FissionYields2020/index.htm>

(50+ participants, 24 presentations)

Activities in four categories:

- a Availability of experimental fission product yield data for evaluations,
- b New fission product yield experimental data,
- c Fission product yield evaluation,
- d Fission product yield validation.

Coordinators

- a) Prytichenko
- b) Serot
- c) Capote/Mills (*)
- d) Cabellos
- * Minato: modeling SG

Medical isotope browser:

nds.iaea.org/mib



Medical Isotope Browser
IAEA Nuclear Data Section

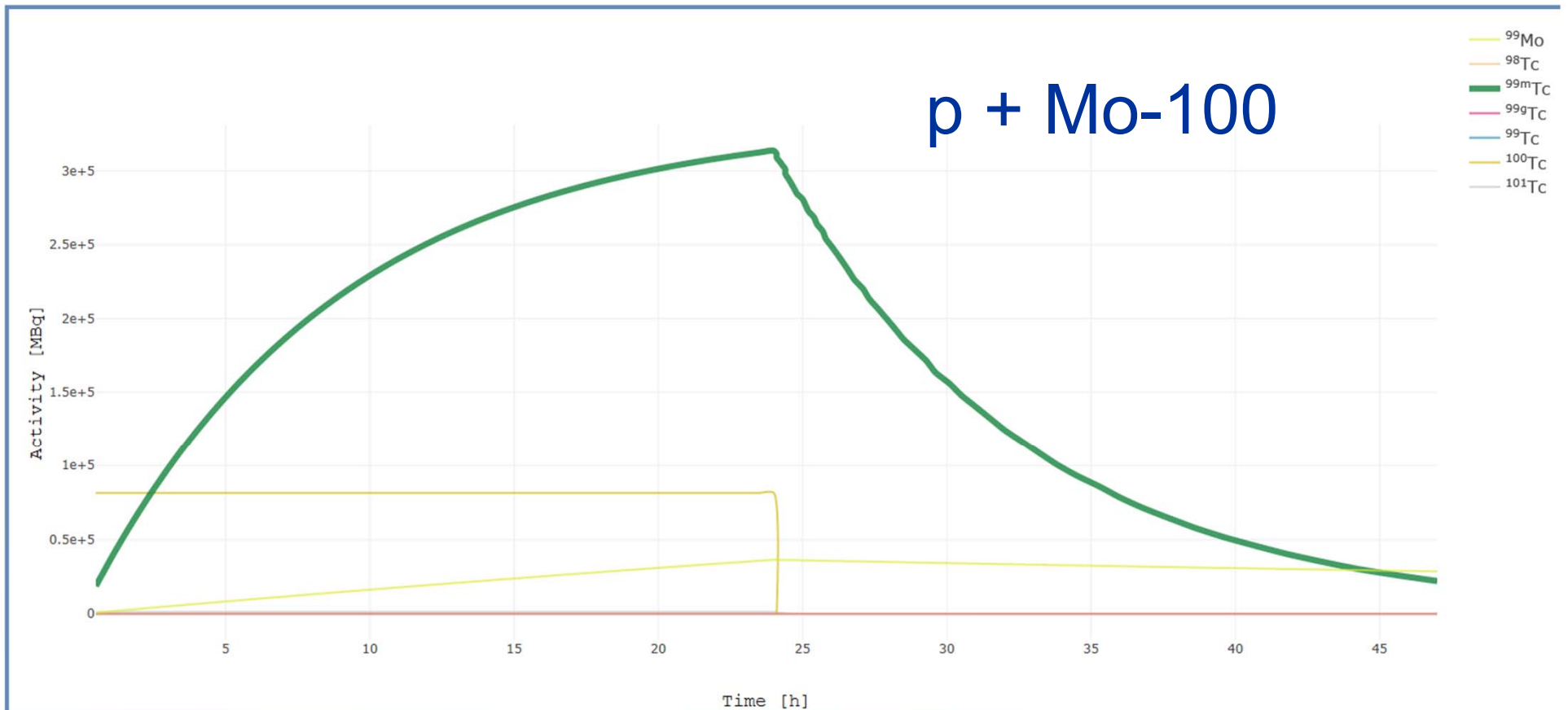
Examples 1 Incident - Exit energies
2 Incident energy - Thickness, and user σ
3 Energy scan 4 Composite target

Previous run: • 1 • 2

Product TC99 M <input checked="" type="checkbox"/> show all products	Projectile <input checked="" type="radio"/> p <input type="radio"/> D <input type="radio"/> α <input type="radio"/> T <input type="radio"/> ^3He	Target MO100 composition	Density [g/cm ³] 0 < 10.3 < 100
<input type="radio"/> Thickness [mm] <input checked="" type="radio"/> [mg/cm ²] 0 < []	<input checked="" type="radio"/> Exit energy [MeV] 0 < 15.0 < 200	<input checked="" type="radio"/> Incident energy [MeV] 0 < 22 < 200	<input type="radio"/> Incident energy scan [MeV] [] ≤ E ≤ [] ΔE: []
Current [μA] 0 < 100 < 10 000	Irradiation time 1d 1 d 0 h 0 m 0 s	Post EOB time 1d 1 d 0 h 0 m 0 s	Cross section IAEA + TENDL User defined

Plots: log A σ Exit energy 3D Data: Summary Detail Guide

• Effective target thickness : 0.045 cm • # incident particles: 6.24151E+14 [s⁻¹] • Produced heat in target : 0.700 kW • Activities less than 1.0E-6 MBq are not displayed



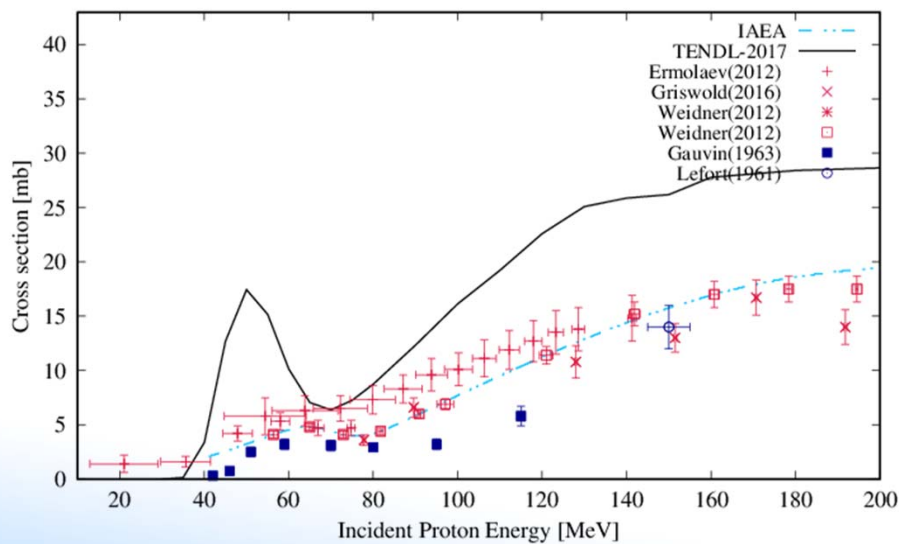
Medical isotope data library: combine the best with the most complete

IAEA high-quality evaluations (150 reaction channels)

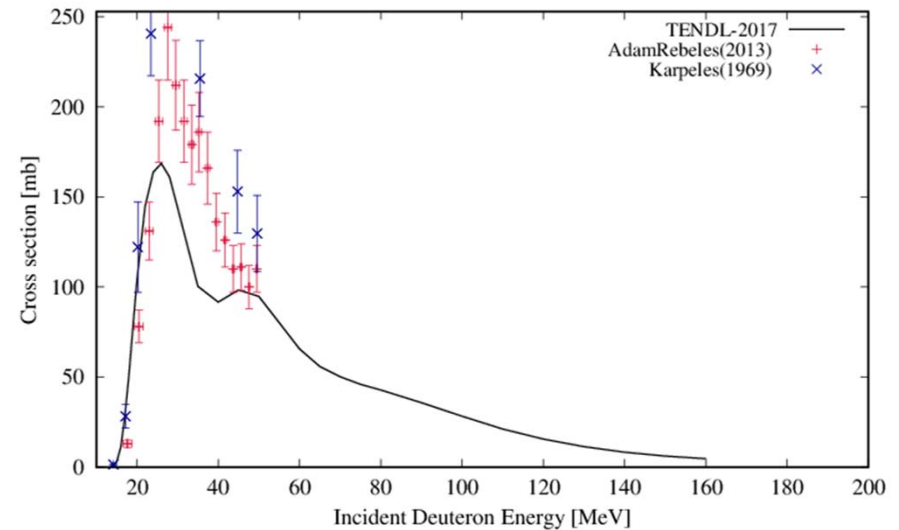
TENDL-2021

IAEA-201 Medical Isotope Data Library

$^{232}\text{Th}(p,x)^{225}\text{Ac}$



$^{\text{nat}}\text{Ga}(d,x)^{68}\text{Ge}$



Next: Add neutron reactions (for research reactors) and photonuclear route to Medical Isotope Browser

Towards a new NDS homepage



60 Years

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More modern look

Requires detailed inventory of everything that exists: historical meetings, data libraries, etc

Build on consistent metadata for data libraries, meetings, documents and. Restructure data files for future development (data portals etc)














Important engines, e.g. EXFOR-ENDF retrieval will remain intact

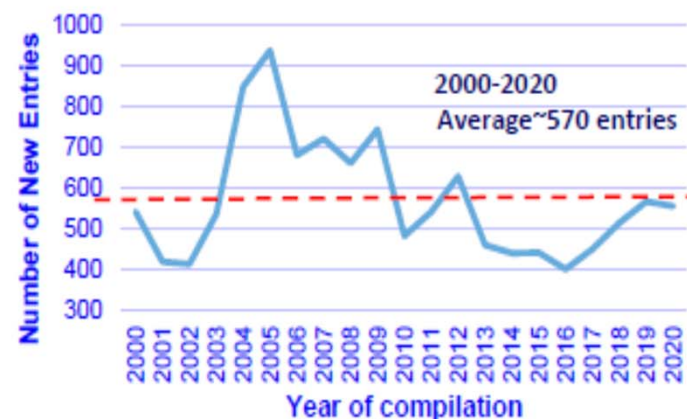
To be presented to INDC June 2022

An example from last week which has already changed in the meantime



New EXFOR Entries from Centres (2018 – 2020)

Centre	2018	2019	2020
NDS 	79	44	77
ATOMKI 	16	4	8
CDFE 	13	34	12
CJD 	13	24	40
CNDC 	29	18	21
CNPD 	48	31	23
JCPRG 	34	34	21
KNDC 	10	7	2
NDPCI 	23	79	33
NEADB* 	111	108	115
NNDC 	123	120	171
UkrNDC 	15	58	10
KAZMON 	(→NDS)	5	22
Total	514	566	555



* Including JAEA



TALYS-Related Software and Databases

TALYS and the TALYS-related packages are open source software and datasets ([GPL License](#)) for the simulation of nuclear reactions.

Coming soon, still available here

TALYS

Arjan Koning, Stephane Hilaire, Stephane Goriely

Nuclear reaction model code.

- Download TALYS-1.95
- Download previous versions
- Read Tutorial

Created at    UNIVERSITE LIBRE DE BRUXELLES 

EXFORTABLES

Arjan Koning

Experimental nuclear reaction database based on EXFOR.



- Download EXFORTABLES-1.0
- Read Tutorial

RESONANCETABLES

Arjan Koning, Dimitri Rochman

Database for thermal cross sections, MACS and average resonance parameters.

- Download RESONANCETABLES-1.0
- Read Tutorial

Created at  

ENDFTABLES

Arjan Koning

Code to translate ENDF nuclear data libraries into tabular format.

- Download ENDFTABLES-1.0
- Read Tutorial (Chapter 2)

Libraries-2020

Arjan Koning

Evaluated nuclear data libraries and EXFOR in tabular format.

- Libraries-2020 [15GB]
- Read Tutorial (Chapter 3)



nds.iaea.org/talys

TASMAN, TEFAL, and Tools for TALYS (“T6”, TENDL) soon to follow

Contribution to WPEC: SG49 on reproducibility of nuclear data Evaluation

SG50 on curated computer-readable experimental database (based on EXFOR)

Direct-access plotting tool under development

Alternative plotting tools



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LIBRARIES-2020 Data Explorer

File Download	Cross Section (Experiment vs Library)	Multiple Reaction Channels Cross Section	Residual Production Cross Section	Fission Yield
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Cross Sections in ENDFTABLES and EXFORTABLES

Element

e.g., C, c, Pd, pd

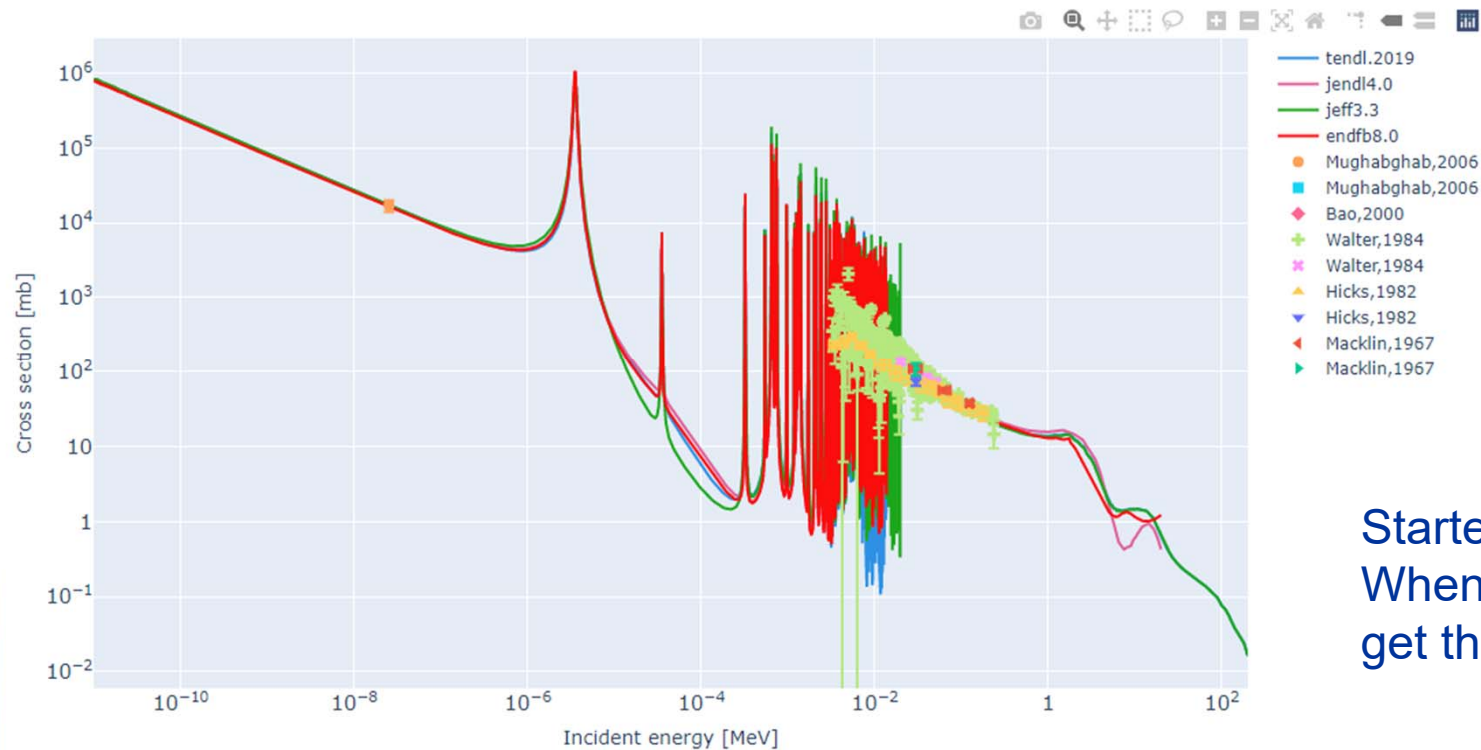
Mass

e.g., 0: natural, 242m: metastable state

Reaction

Plot for: Sr087(n,g) MF:3 MT:102, found 9 experimental data set(s).

X: Linear Log Y: Linear Log



Started in March 2021.
When we are ready you
get the URL

Add more data to the chart by selecting entries from following table. Use filter function e.g. >2000 in Year field

EXFOR and/or ENDF GUI's and API's



Request #2269 www.nds.iaea.org 2021-03-24,11:46:09
 Access-Level=2 /pdf/ /db/ [11]
 Results: Reactions: 7 Datasets: 41

Data Selection

Retrieve Selected Unselected All

Output: X4+ EXFOR Bibliography TAB C4 PlotC4

Plot: Quick-plot (cross-sections) Ungroup /product: Advanced plot [how-to] using C5 and convert ratios to

Narrow incident energy (optional), eV: Min: Max:


Apply Data re-normalization (for advanced users, results in: C4, TAB and Plots)

n	Display	Year	Author-1	Energy range, eV	Points	Reference	Subentry#	MSR-Key	Info+
1	41-NB-93 (N, EL) 41-NB-93,, DA C4: MF4 MT2								
Quantity: [DA] Differential c/s with respect to angle									
1	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> X4 <input checked="" type="checkbox"/> X4+ <input checked="" type="checkbox"/> X4± <input checked="" type="checkbox"/> T4	1999	E.G.Christodoulou+	1.40e7	16	[pdf]+ J, NSE, 132, 273, 1999	13804008 [4]	R33	/0 1999CH27 An[16]=16:161
2	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> X4 <input checked="" type="checkbox"/> X4+ <input checked="" type="checkbox"/> X4± <input checked="" type="checkbox"/> T4	1992	A.Takahashi+	1.41e7	16	[pdf]+ R, OKTAV-A-92-01, 1992	22136016 [2]	R33	/0 An[16]=15:160
3	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> X4 <input checked="" type="checkbox"/> X4+ <input checked="" type="checkbox"/> X4± <input checked="" type="checkbox"/> T4	1991	R.S.Pedroni+	7.95e6	1.69e7	148 [pdf]+ J, PR/C, 43, 2336, 9105	12995002 [4]	R33	/0 1991PE02 An[140]=18:162
4	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> X4 <input checked="" type="checkbox"/> X4+ <input checked="" type="checkbox"/> X4± <input checked="" type="checkbox"/> T4	1991	R.Finlay+	2.00e7	15	+ W, FINLAY, 9111	13532002 [4]	R33	/0 An[15]=15:154
5	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> X4 <input checked="" type="checkbox"/> X4+ <input checked="" type="checkbox"/> X4± <input checked="" type="checkbox"/> T4	1991	Wan Dairong+	1.47e7	6	+ W, WANDAIRONG, 199101	32523003 [6]	R33	/0 An[6]=3:14
6	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> X4 <input checked="" type="checkbox"/> X4+ <input checked="" type="checkbox"/> X4± <input checked="" type="checkbox"/> T4	1988	Cao Jianhua+	1.47e7	28	+ R, INDC (CPR) -011, 125, 198803	32521003 [6]	R33	/0 An[28]=6:151
7	<input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> X4 <input checked="" type="checkbox"/> X4+ <input checked="" type="checkbox"/> X4± <input checked="" type="checkbox"/> T4	1987	X.Wang+	7.00e6	9	[pdf]+ J, NP/A, 465, 483, 8704	12892003 [4]	R33	/0 1987WA08 An[9]=30:140

Web interface very complete and detailed


But also API's under development for automated use

Goal: release command-line API's (also for use in WPEC SG50)




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2020-04-07



International Atomic Energy Agency
Nuclear Data Services
2004-2020



for Windows, Linux, Mac
SQLite

EXFOR for Applications

EXFOR-CINDA databases, retrieval systems, Endver/GUI package for Linux, Windows and MacOSX using SQLite

Run software packages:

Preparation. Install JDK "1.7" or higher, + on MacOSX: install XQuartz

Download: <https://www.nds.iaea.org/cdroms/#x4app2> ==> x4app-2020-04-07.tar.gz

Un-compress:

Windows: → Run → cmd.exe > cd c:\x4app >"c:\program files\7-zip\7z.exe" x x4app-2020-04-07.tar.gz >"c:\program files\7-zip\7z.exe" x -r x4app-2020-04-07.tar > cd x4app-2020-04-07	Linux: → Terminal MacOSX: → Finder → Applications → Utilities → Terminal \$ tar xvfz x4app-2020-04-75.tar.gz \$ cd x4app-2020-04-07
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Run:

	Windows	Linux	MacOSX
1 Interactive EXFOR retrieval system	run_x4cd.bat	./run_x4cd.sh	./run_x4cd-mac.sh
2 EndVer/GUI	run_endver.bat	./run_endver.sh	./run_endver-mac.sh
3 Non-interactive retrieval utility	cd app_example runme.bat	cd app_example ./runme.sh	cd app_example ./runme-mac.sh
4 EXFOR retrieval and converters	cd app_example2020 ./runme.sh	cd app_example2020 ./runme.sh	cd app_example2020 ./runme-mac.sh

General description: readme.txt
 How to use and setup: setup.txt
 IAEA Nuclear Data Services: <http://www.nds.iaea.org/>

EXFOR for Applications

EXFOR-CINDA databases and retrieval systems, ENDVER/GUI integrated tools for ENDF-Evaluators (Windows, Linux, MacOSX)

Version 2.1.1. April 2020

<ul style="list-style-type: none"> ✓ Does not need installation ✓ Integrated CINDA and EXFOR ✓ Advanced interactive search ✓ Help based on Dictionaries ✓ Interactive graphics with ZVView 	<ul style="list-style-type: none"> ✓ Can work with local and remote databases ✓ Non-interactive EXFOR retrievals ✓ Converter from EXFOR to C4, C5, X4+, JSON, XML. ✓ Examples of retrieval and converter scripts ✓ Real application: ENDVER/GUI package + EXFOR.
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EXFOR is a comprehensive library of experimental nuclear reaction data induced by neutrons, charged particles and photons.
 Contents (2020-03-05): 23038 Entries, 33092 publications, 158739 data tables

CINDA library contains bibliographical references to experimental nuclear reaction data and to calculations, reviews, compilations and evaluations of neutron, charged particle reactions and spontaneous fission data. Includes import from EXFOR.
 Contents (2020-03-09): 497717 lines, 68261 publications, 209927 blocks

Retrieval Systems on Java2: v1=2.1.1 (2020-04-02)

© The data on this CD are a product of the Network of Nuclear Reaction Data Centers.



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Thank you!

