IAEA 60 Years
Atoms for Peace and Development

IAEA Nuclear Data activities

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WPEC-32 Meeting, May 14-15 2020, NEA, Boulogne-Billancourt

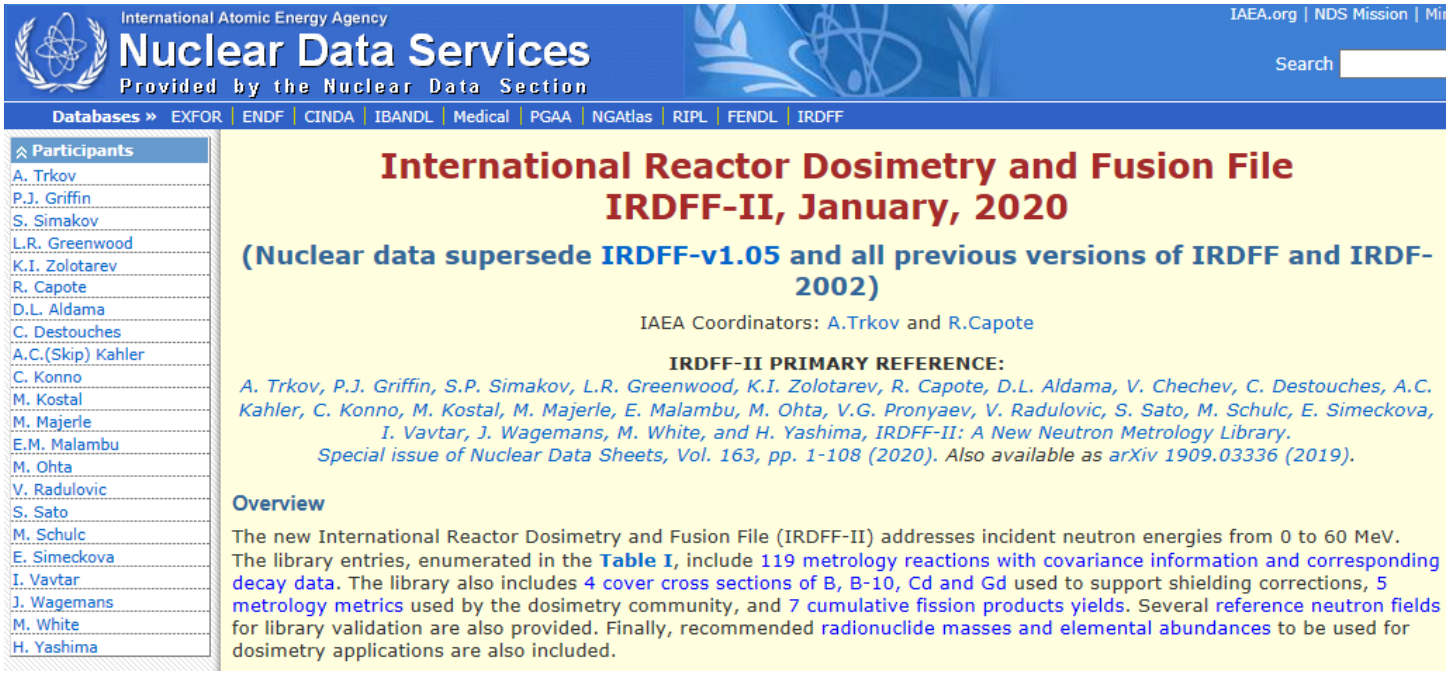
Contents

- Recent nuclear data library releases and nuclear data projects
- Upcoming meetings and projects

International Reactor Dosimetry and Fusion File (IRDFF)

IAEA maintains IRDFF via CRP's and Technical Meetings

IRDFF-II has been released in January 2020

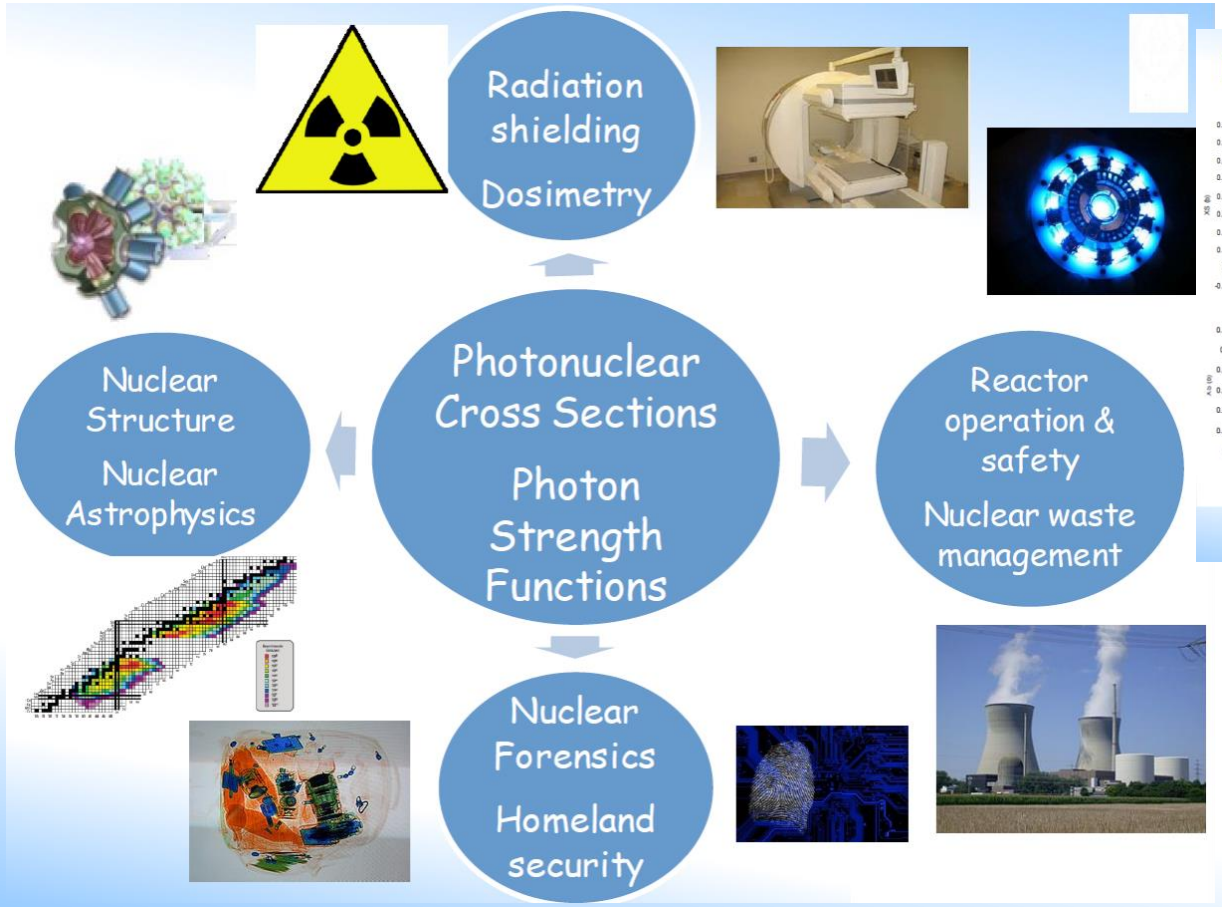


A. Trkov et al, IRDFF-II:
A New Neutron Metrology Library, Nuclear Data Sheets, Vol 163 (2020)

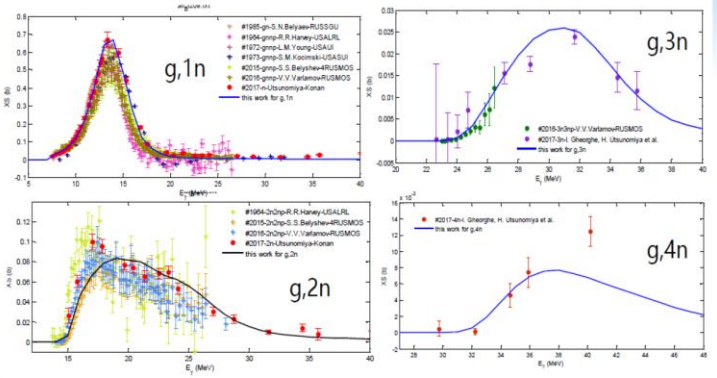
Available online at www.sciencedirect.com
ScienceDirect
Nuclear Data Sheets
Nuclear Data Sheets 163 (2020) 109–162
www.elsevier.com/locate/nds

IAEA Photonuclear Data Library 2019

T. Kawano,[1,*] Y. S. Cho,[2] P. Dimitriou,[3] D. Filipescu,[4] N. Iwamoto,[5] V. Plujko,[6] X. Tao,[7] H. Utsunomiya,[8] V. Varlamov,[9] R. Xu,[7] R. Capote,[3] I. Gheorghe,[4] O. Gorbachenko,[6] Y.L. Jin,[7] T. Renstrøm,[10] M. Sin,[11] K. Stopani,[9] Y. Tian,[7] G.M. Tveten,[10] J.M. Wang,[7] T. Belgya,[12] R. Firestone,[13] S. Goriely,[14] J. Kopecky,[15] M. Krtička,[16] R. Schwengner,[17] S. Siem,[10] and M. Wiedeking[18]



New results for ^{209}Bi(γ,xn)



New data: A.I. Gheorghe+ (2017)

Official release soon

Available online at www.sciencedirect.com

ScienceDirect

Nuclear Data Sheets 163 (2020) 191–227

Nuclear Data Sheets

www.elsevier.com/locate/nds

Unrecognized Sources of Uncertainties (*USU*) in Experimental Nuclear Data

R. Capote,[1,*] S. Badikov,[2] A.D. Carlson,[3] I. Duran,[4] F. Gunsing,[5] D. Neudecker,[6] V.G. Pronyaev,[7] P. Schillebeeckx,[8] G. Schnabel,[9] D.L. Smith,[10] and A. Wallner[11]

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[2] *Atomstandard, Rosatom State Corporation, Moscow, Russia*
[3] *National Institute of Standards and Technology, Gaithersburg, MD 20899, USA*
[4] *Universidade de Santiago de Compostella, 15782 Santiago de Compostela, La Coruna, Spain*
[5] *CEA Irfu, University Paris-Saclay, F-91191 Gif-sur-Yvette, France*
[6] *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
[7] *Contractor, NAPC–Nuclear Data Section, International Atomic Energy Agency, A-1400 Vienna, Austria*
[8] *Joint Research Centre - Geel, 2440 Geel, Belgium*
[9] *Uppsala University, Lagerhyddsvagen, 75120 Uppsala, Sweden*
[10] *Argonne National Laboratory, 1710 Avenida del Mundo, No. 1506, Coronado, CA 92118, USA*
[11] *Australian National University, Canberra ACT, Australia*

(Received 9 August 2019; revised received 14 November 2019; accepted 25 November 2019)

Technical Meeting on Nuclear Data for Anti-neutrino Spectra and Their Applications

23-26 April 2019, IAEA Headquarters, Vienna, Austria

The Nuclear Data Section of the International Atomic Energy Agency is holding a Technical Meeting on Nuclear data for anti-neutrino spectra and their applications, from 23 to 26 April 2019.

The idea is to bring together experts from the broad spectrum of physics, theory and measurements, related to anti-neutrino studies for basic sciences (mixing angle in neutrino oscillations) and for applications (reactor monitoring with anti-neutrino detection), to review the current status of:

-neutrino anomalies and the sterile neutrino hypothesis
-existing measurements of integral beta spectra
-recent Daya Bay, Double Chooz and Reno results on spectra measurements
-results from short baseline experiments Prospect, SoLid, Neutrino-4/DANSS, NEOS
-conversion method and uncertainties, corrections
-summation method and impact of nuclear data (beta decay data; fission yield data; uncertainties and correlations)
-nuclear data libraries (ENDF/B; JEFF; JENDL)

CRP on Updating Fission Yield data for applications

- Improve existing FY evaluations for U-235, Cf-252 and (hopefully) Pu-239
- Compilation of all new FFY and FPY experimental data
- Reliable uncertainty quantification
- Improve systematics and models
- Integral validation of new evaluations

First Meeting: Aug 31-Sep 4 2020, strong and broad participation, 16 partners

Fission yield experiments: Statistics of the completeness

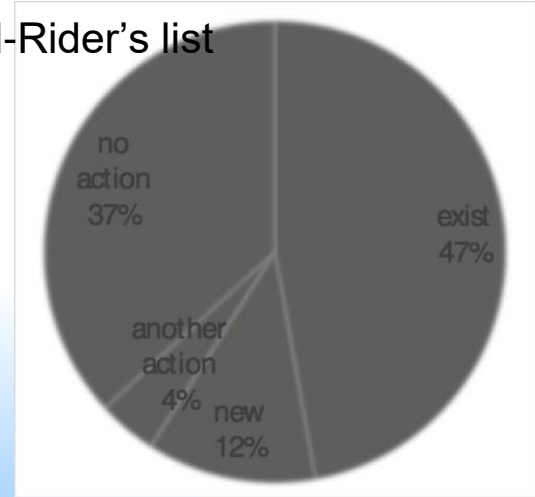
Start to compile by the NRDC network.

Area	E-R's list	Already in EXFOR	New entry	Another action	No action
1 United States	610	413	68	41	88
2 OECD countries	303	171	83	14	35
3 Others	155	103	24	8	20
4 Former Soviet Union countries	91	69	15	3	4
Not specified*	443				443
Total	**1602****	**756**	**190**	**66**	**590**

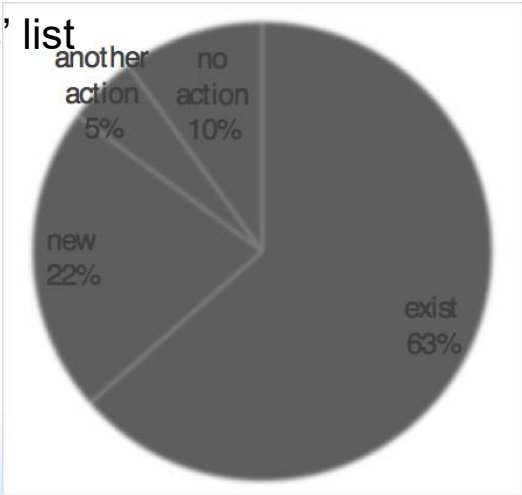
Area	Mills' list	Already in EXFOR	New entry	Another action	No action
1 United States	**321**	248	26	17	30
2 OECD countries	**149**	70	63	9	7
3 Others	**82**	53	22	3	4
4 Former Soviet Union countries	**73**	37	28	5	3
Not specified*	**20**				20
Total	**645**	**409**	**139**	**34**	**64**

*Not specified due to private communications, Ph.D. theses, or classified reports. Also includes under checking.
**Only 924 articles are referred in the numerical data table used in the evaluation of ENDF/B-VI.

England-Rider's list



Mills' list



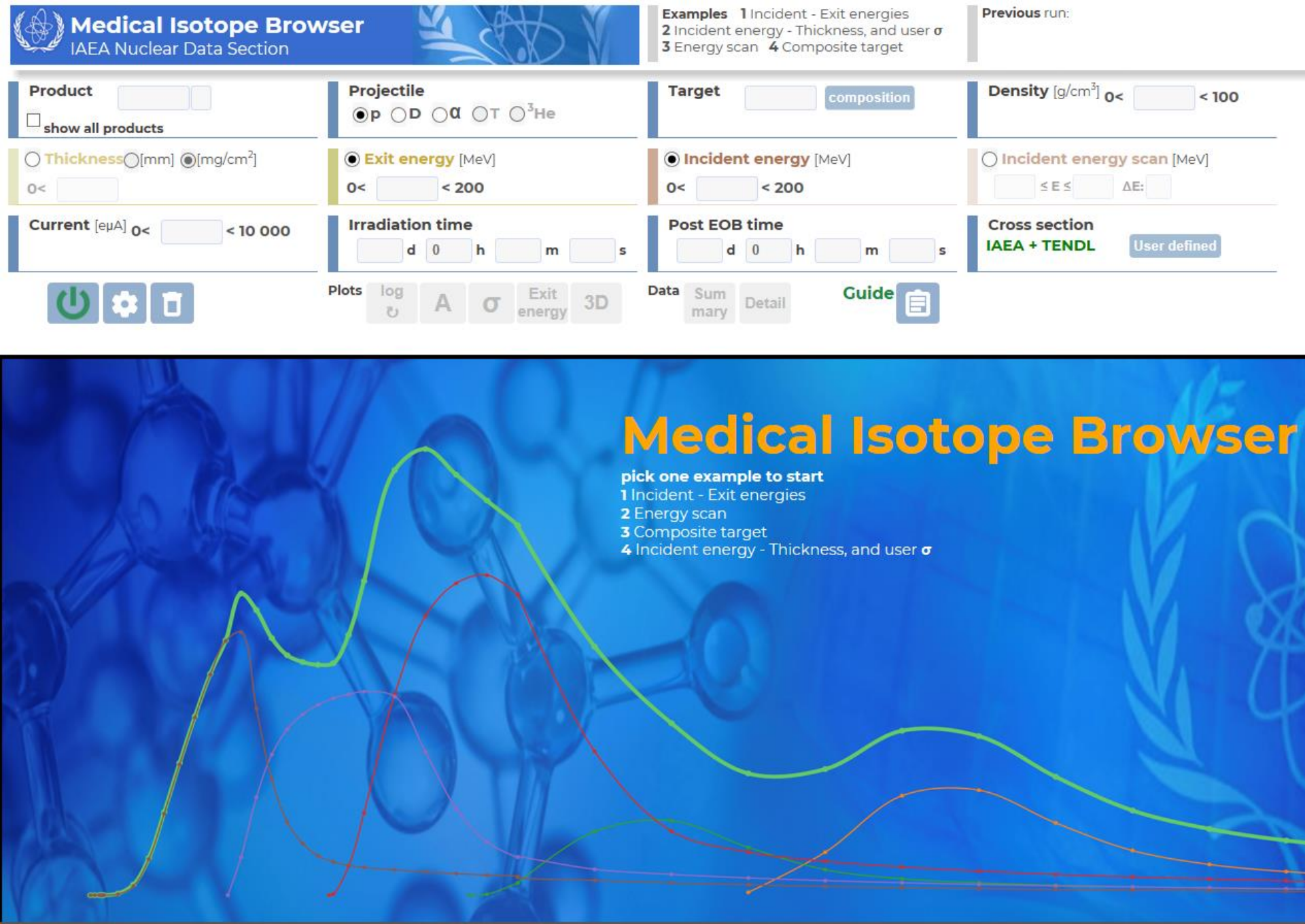
NSR (done by NNDC)

new entry 212
44%

Including neutron-, photo- and spontaneous- fission

From: Shin Okumura

nds.iaea.org/mib 2020: Extend with (reactor) neutrons and photons



Essential 1: High-quality cross section data

1. E. Betak, A.D. Caldeira, R. Capote, B.V. Carlson, H.D. Choi, F.B. Guimaraes, A.V. Ignatyuk, S.K. Kim, B. Kiraly, S.F. Kovalev, E. Menapace, A.L. Nichols, M. Nortier, P. Pompeia, S.M. Qaim, B. Scholten, Yu. N. Shubin, J-Ch. Sublet, F. Tarkany et al, **Nuclear data for the production of therapeutic radionuclides**. In: S.M. Qaim, F. Tarkanyi, R. Capote (Technical editors) , IAEA Technical Reports Series no. 473, IAEA, scientific and technical report STI/DOC/010/473, IAEA Vienna, Austria (2011)
2. F. T. Tarkanyi, A. V. Ignatyuk, A. Hermanne, R. Capote, B. V. Carlson, J. W. Engle, M. A. Kellett, T. Kibedi, G. N. Kim, F. G. Kondev, M. Hussain, O. Lebeda, A. Luca, Y. Nagai, H. Naik, A. L. Nichols, F. M. Nortier, S. V. Suryanarayana, S. Takacs, and M. Verpelli**: Recommended nuclear data for medical radioisotope . production: diagnostic positron emitters**, J. Rad.Nucl.Chem. 319 (2019) 487-531.
3. A. Hermanne, A. V. Ignatyuk, R. Capote, B. V. Carlson, J. W. Engle, M. A. Kellett, T. Kibedi, G. N. Kim, F. G. Kondev, M. Hussain, O. Lebeda, A. Luca, Y. Nagai, H. Naik, A. L. Nichols, F. M. Nortier, S. V. Suryanarayana, S. Takacs, F. T. Tarkanyi, and M. Verpelli: **Reference cross sections for charged-particle monitor reactions**, Nucl. Data Sheets 148 (2018) 338-382.
4. F. T. Tarkanyi, A. V. Ignatyuk, A. Hermanne, R. Capote,B. V. Carlson, J. W. Engle, M. A. Kellett, T. Kibedi, G. N. Kim, F. G. Kondev, M. Hussain, O. Lebeda, A. Luca, Y. Nagai, H. Naik, A. L. Nichols, F. M. Nortier, S. V. Suryanarayana, S. Takacs, and M. Verpelli: **Recommended nuclear data for medical radioisotope production: diagnostic gamma emitters**, J. Rad. Nucl. Chem. 319 (2019) 533-666;
5. J. W. Engle, A. V. Ignatyuk, R. Capote, B. V. Carlson, A. Hermanne, M. A. Kellett, T. Kibedi, G. N. Kim, F. G. Kondev, M. Hussain, O. Lebeda, A. Luca, Y. Nagai, H. Naik, A. L. Nichols, F. M. Nortier, S. V. Suryanarayana,S. Takacs, F. T. Tarkanyi, and M. Verpelli: **Recommended Nuclear Data for the Production of Selected Therapeutic Radionuclides**, Nucl. Data Sheets 155 (2019) 56-74.

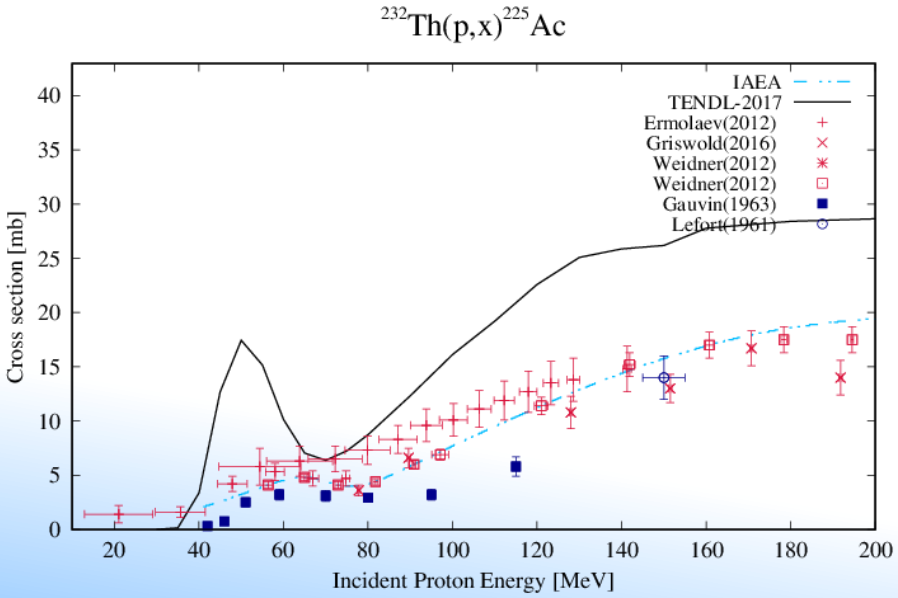
20 years of IAEA CRP's and other meetings led to ~150 high-quality nuclear reaction channels

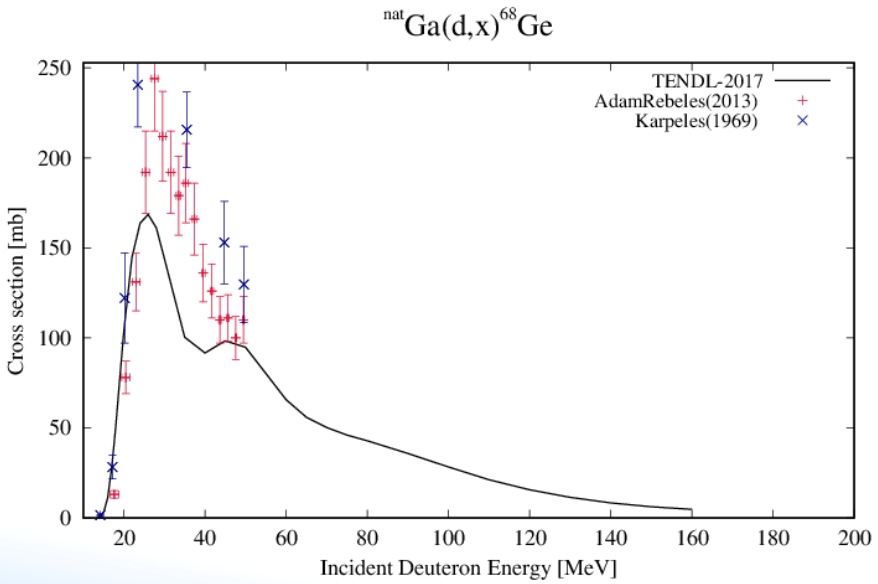
Medical isotope data library: combine the best with the most complete

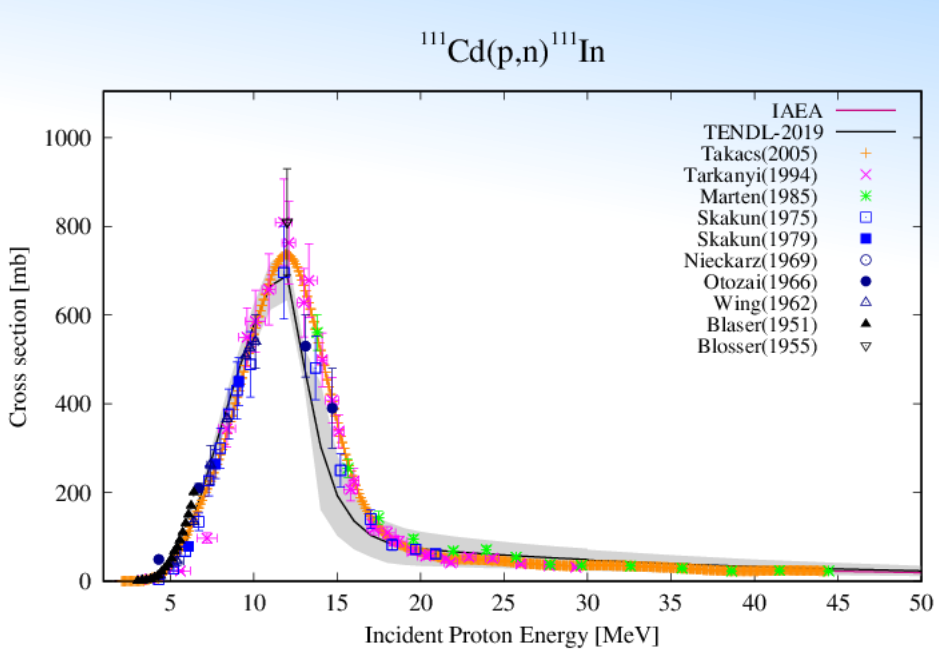
IAEA high-quality evaluations (150 reaction channels)

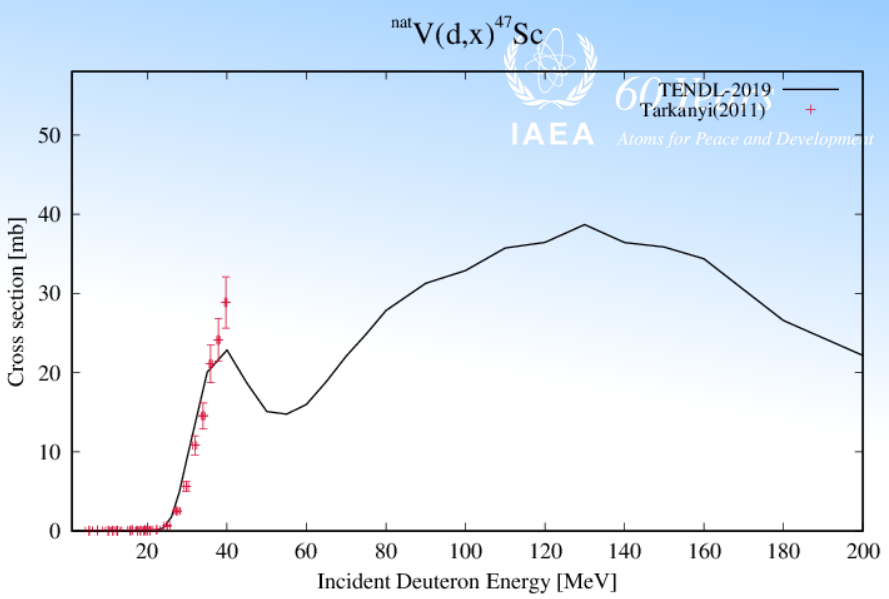
TENDL-2019

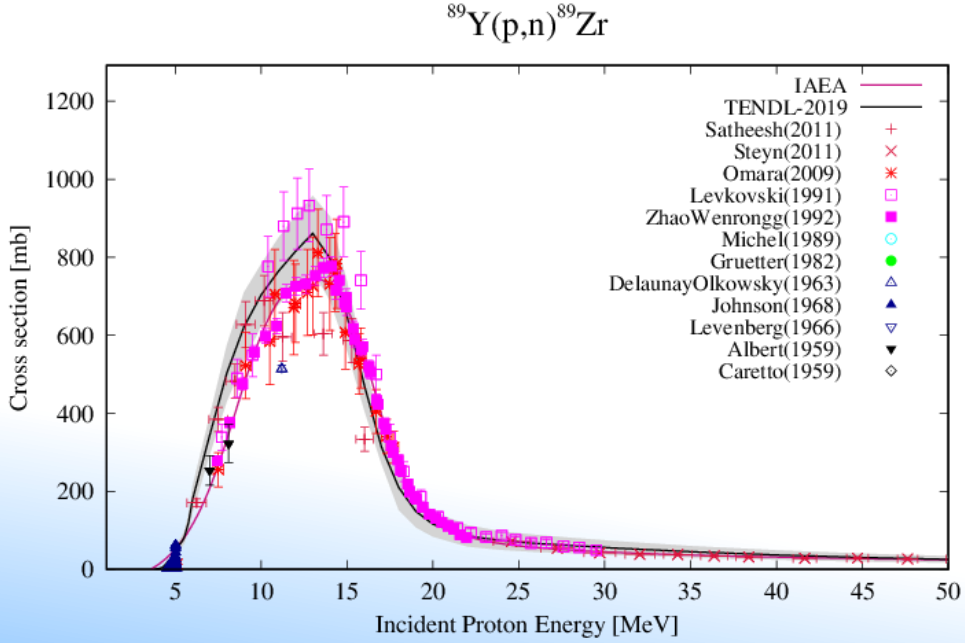
IAEA-2020 Medical Isotope Data Library

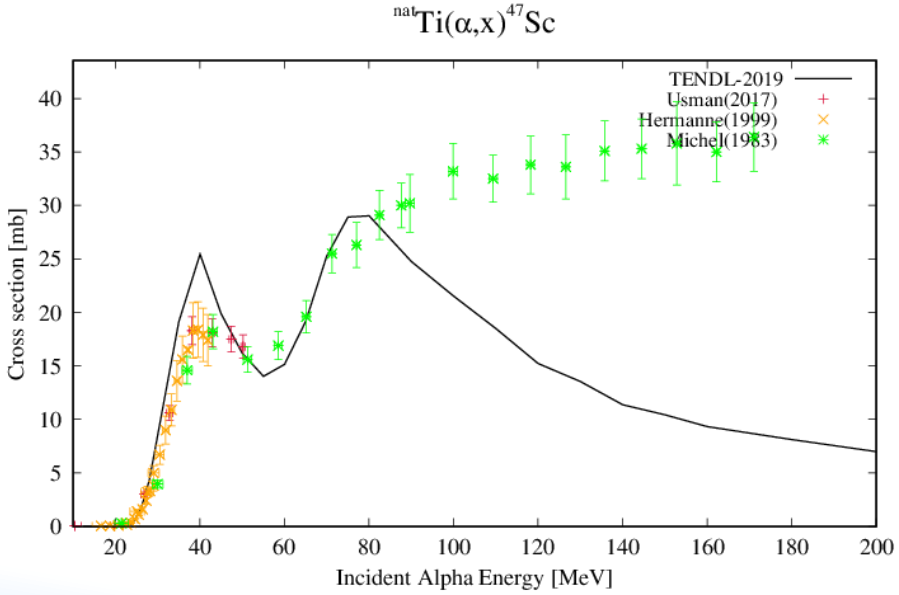





^{111}Cd(p,n)^{111}In
IAEA
TENDL-2019
Takacs(2005)
Tarkanyi(1994)
Marten(1985)
Skakun(1975)
Skakun(1979)
Nieckarz(1969)
Otozai(1966)
Wing(1962)
Blaser(1951)
Blosser(1955)
Cross section [mb]
Incident Proton Energy [MeV]


^{nat}V(d,x)^{47}Sc
TENDL-2019
Tarkanyi(2011)
Cross section [mb]
Incident Deuteron Energy [MeV]


^{89}Y(p,n)^{89}Zr
IAEA
TENDL-2019
Satheesh(2011)
Steyn(2011)
Omara(2009)
Levkovski(1991)
ZhaoWenrongg(1992)
Michel(1989)
Gruetter(1982)
DelaunayOlkowsky(1963)
Johnson(1968)
Levenberg(1966)
Albert(1959)
Caretto(1959)
Cross section [mb]
Incident Proton Energy [MeV]


^{nat}Ti(α,x)^{47}Sc
TENDL-2019
Usman(2017)
Hermanne(1999)
Michel(1983)
Cross section [mb]
Incident Alpha Energy [MeV]

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
☑ show all products

Projectile ◉p ○D ○α ○T ○^{3}He

Target MO100 composition

Density [g/cm^3] 0< 10.3 < 100

○ Thickness ○[mm] ◉[mg/cm^2]
0<

◉ Exit energy [MeV]
0< 15.0 < 200

◉ Incident energy [MeV]
0< 22 < 200

○ Incident energy scan [MeV]
≤ E ≤ ΔE:

Current [eμA] 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

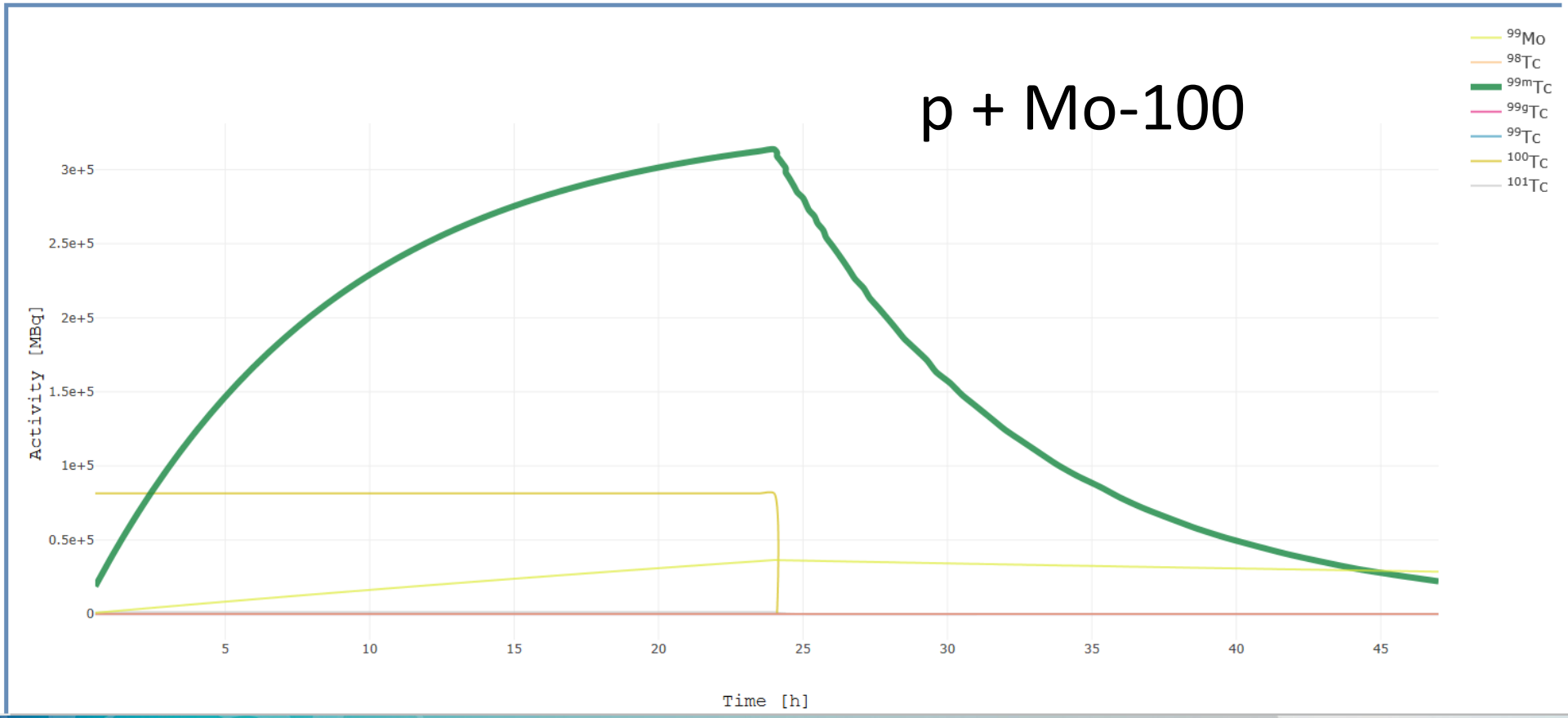
Cross section
IAEA + TENDL User defined

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

- Complete medical isotope data library for all particles, nuclides and energies including uncertainty quantification
- Based on 150 reaction channels from IAEA evaluations + TENDL for everything else
- Entire medical isotope data library in tabular format:
  - ENDF avoided (though consistent with TENDL) and not needed
  - Reactions by descriptive filenames, e.g. p-Th232-rp089225.iaea.2020
  - Origin of data is of course reported.
- 10-15 recent IAEA reaction evaluations to be included. Next: Public release of first version of the library
- 2020-2021: Parameter + model adjustment for TALYS using Bayesian optimization, EXFOR, Simulated Annealing and ML techniques → Global high-quality medical isotope database → TENDL-2021. Priority: protons, photons and deuterons.

Consultants' and Technical Meetings

#	Meeting dates	Project Officer	Title	Link
1	2-5 December 2019	A. Trkov/R. Capote Noy	CM of INDEN - International Nuclear Data Evaluation Network on Evaluated Nuclear Data for Structural Materials	Webpage
2	21-24 October 2019	R. Capote Noy	Technical Meeting of the International Nuclear Data Evaluation Network (INDEN) on Actinide Evaluations in the Resonance Region	Webpage
3	23-26 September 2019	A. Trkov	Technical Meeting on Nuclear Data Processing	Webpage
4	2-5 September 2019	A. Trkov	Technical Meeting on the FENDL Library for fusion neutronics calculations	Webpage
5	15-18 July 2019	A. Trkov	Technical Meeting on the Nuclear Data for Neutron Activation Analysis and Dosimetry	Webpage
6	27-30 May 2019	N. Otsuka	CM on Fission Product Yield Experimental Database	Webpage
7	15-17 May 2019	P. Dimitriou	CM of INDEN on Light Elements	Webpage
8	13-14 May 2019	P. Dimitriou	CM on R-matrix codes for Charged-particle Reactions in the Resolved-Resonance Region	Webpage
9	23-26 April 2019	P. Dimitriou	TM on Nuclear Data for Antineutrino Spectra and Their Applications	Webpage
10	9-12 April 2019	N. Otsuka	Technical Meeting of the NRDC	Webpage
11	8-12 April 2019	P. Dimitriou	23rd Technical Meeting of the NSDD network	Webpage

Other

- Completion of website/database of CONDERC: Compilation of Nuclear Data Experiments for Radiation Characterisation (reactor spectra, decay heat, reaction rates, integral activation data, etc.)
- Machine Learning techniques: applied to EXFOR compilation and use.
- Maintenance and extension of Livechart and Isotope Browser app

Thank you!