IAEA
International Atomic Energy Agency
Atoms for Peace and Development

IAEA Nuclear Data Section
Nuclear Data Development Unit:
Coordinated Research Projects (CRPs)

Roberto Capote
Deputy Section Head, NDDU head

33th Meeting of International Nuclear Data Committee,
March 2021, IAEA, Vienna (virtual)

Note: Slides with title …2018 were carried over from INDC 2018, kept for reference and clarity, but will be skipped during presentation

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, 3rd RCM, 2021
2	Updating Fission Yield Data for Applications	2020-2025 F42007	18(4)	Capote	On-going, 1st RCM, 2020

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Completed Coordinated Research Projects (I)

Charged-Particle Monitor Reactions and Nuclear Data for Medical Isotope Production, 2012-2017, Capote

New work: Publications finished, web page updated, data for Isotope Explorer

- A. Hermanne, A. V. Ignatyuk, R. C., B.V. Carlson et al, **(22 reactions)**
  Reference Cross Sections for Charged-particle Monitor Reactions
  Nuclear Data Sheets **148** (2018) 338-382
- F. T. Tárkányi, A. V. Ignatyuk, A. Hermanne, R. C. et al, **(21 reactions)**
  Recommended nuclear data for medical radioisotope production: diagnostic gamma emitters, JRNC **319** (2019) 487-531
- F. T. Tárkányi, A. V. Ignatyuk, A. Hermanne, R. C. et al, **(69 reactions)**
  Recommended nuclear data for medical radioisotope production: diagnostic positron emitters, JRNC **319** (2019) 533-666
- J.W. Engle, A. V. Ignatyuk, R. C., B.V. Carlson et al, **(~15 reactions)**
  Recommended nuclear data for the production of therapeutic radionuclides, Nuclear Data Sheets **155** (2019) 56-74
- A.L. Nichols, R. C., M.-M. Bé, B. V. Carlson et al., Selected and Recommended Nuclear Decay Data for Medical Radioisotope Production (in preparation)

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Completed Coordinated Research Projects (I)

Charged-Particle Monitor Reactions and Nuclear Data for Medical Isotope Production, 2012-2017, Capote

Monitor Reactions 2017

A. Hermanne et al., Nucl. Data Sheets 148 (2018) 338-382

Protons	Deuterons	^{3}He-particles	Alpha-particles
$^{27}Al(p,x)^{22}Na$	$^{27}Al(d,x)^{22}Na$	$^{27}Al(^{3}He,x)^{22}Na$	$^{27}Al(\alpha,x)^{22}Na$
$^{27}Al(p,x)^{24}Na$	$^{27}Al(d,x)^{24}Na$	$^{27}Al(^{3}He,x)^{24}Na$	$^{27}Al(\alpha,x)^{24}Na$
$^{nat}Ti(p,x)^{48}V$	$^{nat}Ti(d,x)^{48}V$	$^{nat}Ti(^{3}He,x)^{48}V$	$^{nat}Ti(\alpha,x)^{51}Cr$
$^{nat}Ti(p,x)^{46}Sc$	$^{nat}Ti(d,x)^{46}Sc$	$^{nat}Cu(^{3}He,x)^{66}Ga$	$^{nat}Cu(\alpha,x)^{66}Ga$
$^{nat}Ni(p,x)^{57}Ni$	$^{nat}Fe(d,x)^{56}Co$	$^{nat}Cu(^{3}He,x)^{63}Zn$	$^{nat}Cu(\alpha,x)^{67}Ga$
$^{nat}Cu(p,x)^{62}Zn$	$^{nat}Ni(d,x)^{61}Cu$	$^{nat}Cu(^{3}He,x)^{65}Zn$	$^{nat}Cu(\alpha,x)^{65}Zn$
$^{nat}Cu(p,x)^{63}Zn$	$^{nat}Ni(d,x)^{56}Co$		
$^{nat}Cu(p,x)^{65}Zn$	$^{nat}Ni(d,x)^{58}Co$		
$^{nat}Cu(p,x)^{56}Co$	$^{nat}Cu(d,x)^{62}Zn$		
$^{nat}Cu(p,x)^{58}Co$	$^{nat}Cu(d,x)^{63}Zn$		
$^{nat}Mo(p,x)^{96m+g}Tc$	$^{nat}Cu(d,x)^{65}Zn$		

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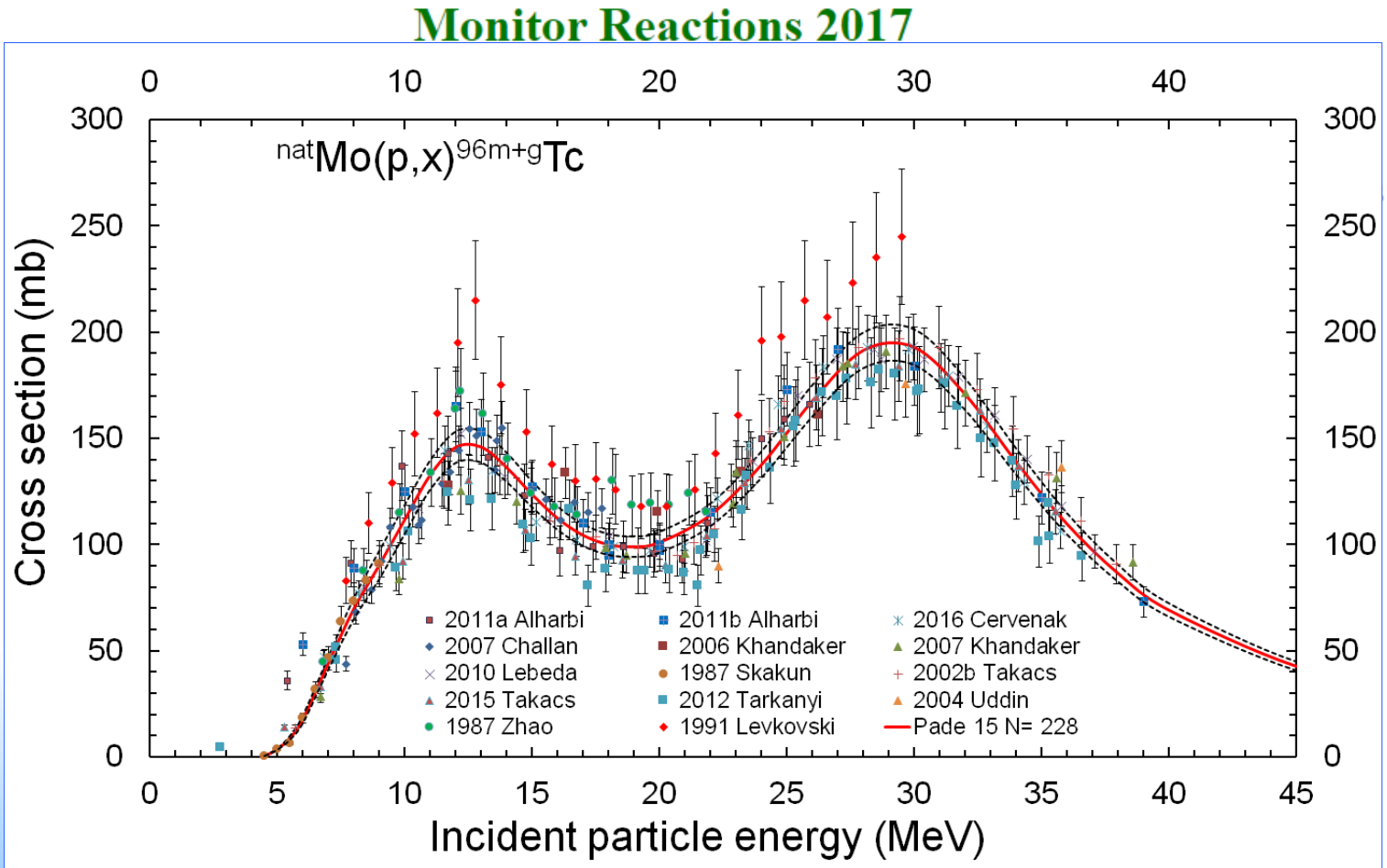
Charged-Particle Monitor Reactions and Nuclear Data for Medical Isotope Production, 2012-2017, Capote



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Completed Coordinated Research Projects (I)

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Intermediate-term Nuclear Data Needs for Medical Applications:

Cross Sections and Decay Data, TM, 22-26 August 2011, IAEA report INDC(NDS)-0596

Outputs of completed 2012-2017 CRP for medical isotope production

Predominantly charged-particle cross sections: CRP measurements and evaluations
Decay data: CRP mainly evaluations

Diagnostic gamma emitters:

- Cross sections – ^{51}Cr, ^{64,67}Cu, ^{90,90m}Y, ^{99}Mo/^{99m}Tc, ^{111}In, ^{123}I, ^{123}Xe, ^{123}Cs, ^{186,188}Re, ^{200,201,202m}Pb, ^{201}Tl
- Decay data – ^{99m}Tc (Auger electrons), ^{123}I (Auger electrons)

Positron emitters:

- Cross sections – ^{52m,52}Mn, ^{52}Fe, ^{55}Co, ^{61}Cu, ^{66,68}Ga, ^{72}As, ^{73}Se, ^{75,76}Br, ^{81,82m}Rb, ^{82}Sr, ^{86}Y, ^{89}Zr, ^{90}Nb, ^{94m}Tc, ^{110m}In, ^{120,121}I
- Decay data – ^{52m,52}Mn, ^{52}Fe, ^{64}Cu, ^{66}Ga, ^{72}As, ^{73}Se, ^{75,76}Br, ^{77}Kr, ^{81,82m}Rb, ^{83}Sr, ^{86}Y, ^{89}Zr, ^{94m}Tc, ^{120,121}I

Positron emitters, generator systems:

- Cross sections – ^{44}Ti/^{44}Sc, ^{52}Fe/^{52m}Mn (MRI+PET), ^{62}Zn/^{62}Cu, ^{68}Ge/^{68}Ga, ^{72}Se/^{72}As, ^{82}Sr/^{82}Rb, ^{110}Sn/^{110m}In, ^{118}Te/^{118}Sb, ^{122}Xe/^{122}I, ^{128}Ba/^{128}Cs, ^{140}Nd/^{140}Pr (radiotherapy+PET)
- Decay data – ^{44}Ti half-life, ^{52}Fe/^{52m}Mn (MRI+PET), ^{62}Zn/^{62}Cu, ^{72}Se/^{72}As, ^{140}Nd/^{140}Pr

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Charged-Particle Monitor Reactions and Nuclear Data for Medical Isotope Production, 2012-2017, Capote

Positron Emitters

K. Gul et al., IAEA TECDOC 1211, Vienna, 2001
F.T. Tarkanyi et al., J. Radioanalytical and Nucl. Chem. (2019) 319. 533-666

^{11}C
^{14}N(p,α)^{11}C

^{13}N
^{16}O(p,α)^{13}N

^{15}O
^{15}N(p,n)^{15}O
^{14}N(d,n)^{15}O

^{18}F
^{18}O(p,n)^{18}F
^{nat}Ne(d,x)^{18}F

^{44}Sc
^{44}Ca(p,n)^{44}Sc
^{44}Ca(d,2n)^{44}Sc
^{43}Ca(d,n)^{44}Sc
^{45}Sc(p,2n)^{44}Ti
^{45}Sc(d,3n)^{44}Ti

^{52m}Mn
^{nat}Ni(p,x)^{52}Fe
^{55}Mn(p,4n)^{52}Fe
^{50}Cr(α,2n)^{52}Fe
^{52}Cr(p,n)^{52m}Mn
^{52}Cr(d,2n)^{52m}Mn

^{52}Mn
^{52}Cr(p,n)^{52}Mn
^{52}Cr(d,2n)^{52}Mn

^{55}Co
^{58}Ni(p,α)^{55}Co
^{54}Fe(d,n)^{55}Co
^{56}Fe(p,2n)^{55}Co

^{61}Cu
^{61}Ni(p,n)^{61}Cu
^{60}Ni(d,n)^{61}Cu
^{64}Zn(p,α)^{61}Cu

^{62}Cu
^{63}Cu(p,2n)^{62}Zn
^{63}Cu(d,3n)^{62}Zn
^{nat}Ni(α,x)^{62}Zn
^{62}Ni(p,n)^{62}Cu
^{62}Ni(d,2n)^{62}Cu

^{66}Ga
^{66}Zn(p,n)^{66}Ga
^{63}Cu(α,n)^{66}Ga

^{68}Ga
^{68}Zn(p,n)^{68}Ga
^{65}Cu(α,n)^{68}Ga
^{nat}Ga(p,x)^{68}Ge
^{69}Ga(p,2n)^{68}Ge

^{72}As
^{75}As(p,4n)^{72}Se
^{nat}Br(p,x)^{72}Se
^{nat}Ge(p,x)^{72}As
^{nat}Ge(d,x)^{72}As

^{73}Se
^{75}As(p,3n)^{73}Se
^{72}Ge(α,3n)^{73}Se

^{76}Br
^{76}Se(p,n)^{76}Br
^{77}Se(p,2n)^{76}Br
^{75}As(α,3n)^{76}Br

^{82m}Rb
^{82}Kr(p,n)^{82m}Rb
^{82}Kr(d,2n)^{82m}Rb

^{82}Rb
^{nat}Rb(p,x)^{82}Sr
^{85}Rb(p,4n)^{82}Sr

^{86}Y
^{86}Sr(p,n)^{86}Y
^{88}Sr(p,3n)^{86}Y
^{85}Rb(α,3n)^{86}Y

^{89}Zr
^{89}Y(p,n)^{89}Zr
^{89}Y(d,2n)^{89}Zr

^{90}Nb
^{93}Nb(p,x)^{90}Nb
^{89}Y(α,3n)^{90}Nb

^{94m}Tc
^{92}Mo(α,x)^{94m}Tc
^{94}Mo(p,n)^{94m}Tc

^{110m}In
^{nat}In(p,x)^{110}Sn
^{108}Cd(α,2n)^{110}Sn
^{110}Cd(p,n)^{110m}In
^{110}Cd(d,2n)^{110m}In
^{107}Ag(α,n)^{110m}In

^{118}Sb
^{115}Sn(α,n)^{118}Te
^{116}Sn(α,2n)^{118}Te
^{nat}Sb(p,x)^{118}Te
^{nat}Sb(d,x)^{118}Te

^{120}I
^{120}Te(p,n)^{120}I
^{122}Te(p,3n)^{120}I

^{122}I
^{124}Xe(p,x)^{122}Xe
^{127}I(p,6n)^{122}Xe
^{127}I(d,7n)^{122}Xe

^{128}Cs
^{133}Cs(p,6n)^{128}Ba

^{140}Pr
^{141}Pr(p,2n)^{140}Nd
^{141}Pr(d,3n)^{140}Nd
^{nat}Ce(^{3}He,x)^{140}Nd

Nuclear Data Development

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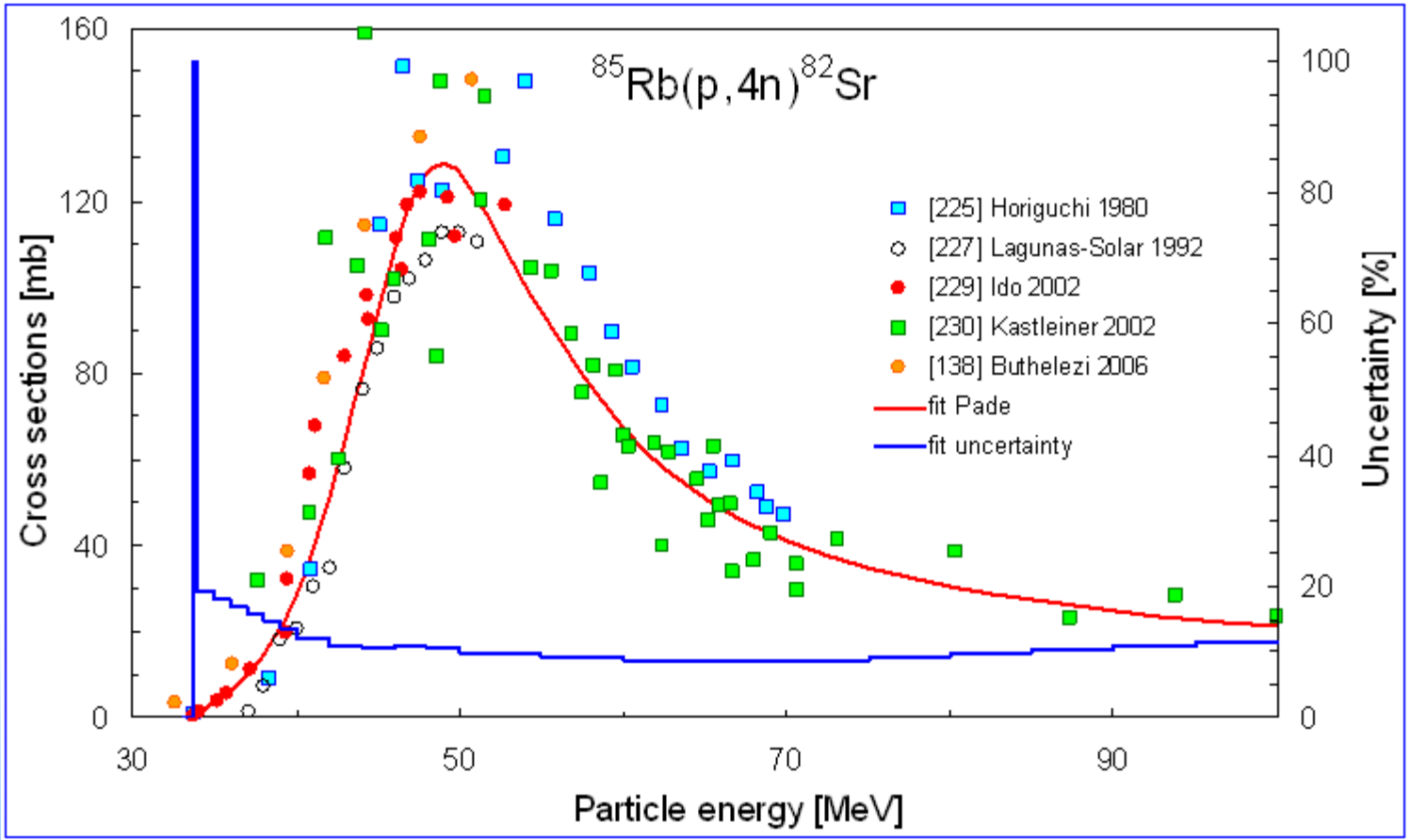
Completed Coordinated Research Projects (I)

Charged-Particle Monitor Reactions and Nuclear Data for Medical Isotope Production, 2012-2017, Capote

Positron Emitters



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Charged-Particle Monitor Reactions and Nuclear Data for Medical Isotope Production, 2012-2017, Capote

Gamma Emitters

K. Gul et al., IAEA TECDOC 1211, Vienna, 2001
F. T. Tarkanyi et al., J. Radioanal. Nucl. Chem. 319 (2018) 487-531

^{51}Cr

^{51}V(p,n)^{51}Cr
^{51}V(d,2n)^{51}Cr
^{55}Mn(p,x)^{51}Cr
^{55}Mn(d,x)^{51}Cr
^{nat}Fe(p,x)^{51}Cr
^{nat}Ti(α,x)^{51}Cr

^{99m}Tc

^{100}Mo(p,x)^{99}Mo
^{100}Mo(d,x)^{99}Mo
^{100}Mo(p,2n)^{99m}Tc
^{100}Mo(d,3n)^{99m}Tc
^{100}Mo(γ,n)^{99}Mo
^{98}Mo(n,γ)^{99}Mo
^{100}Mo(n,2n)^{99}Mo
^{238}U(γ,f)^{99}Mo

^{123}I

^{123}Te(p,n)^{123}I
^{124}Te(p,2n)^{123}I
^{124}Te(p,n)^{124}I
^{127}I(p,5n)^{123}Xe
^{127}I(p,3n)^{125}Xe
^{124}Xe(p,2n)^{123}Cs
^{124}Xe(p,pn)^{123}Xe
^{124}Xe(p,x)^{123}Xe
^{124}Xe(p,x)^{121}I

^{201}Pb

^{203}Tl(p,3n)^{201}Pb
^{203}Tl(p,4n)^{200}Pb
^{203}Tl(p,2n)^{202m}Pb

^{67}Ga

^{67}Zn(p,n)^{67}Ga
^{68}Zn(p,2n)^{67}Ga

^{81}Rb

^{82}Kr(p,2n)^{81}Rb
^{nat}Kr(p,x)^{81}Rb

^{111}In

^{111}Cd(p,n)^{111}In
^{112}Cd(p,2n)^{111}In

^{178}W

^{181}Ta(p,4n)^{178}W
^{181}Ta(p,4n)^{178}W
^{181}Ta(p,4n)^{178}W

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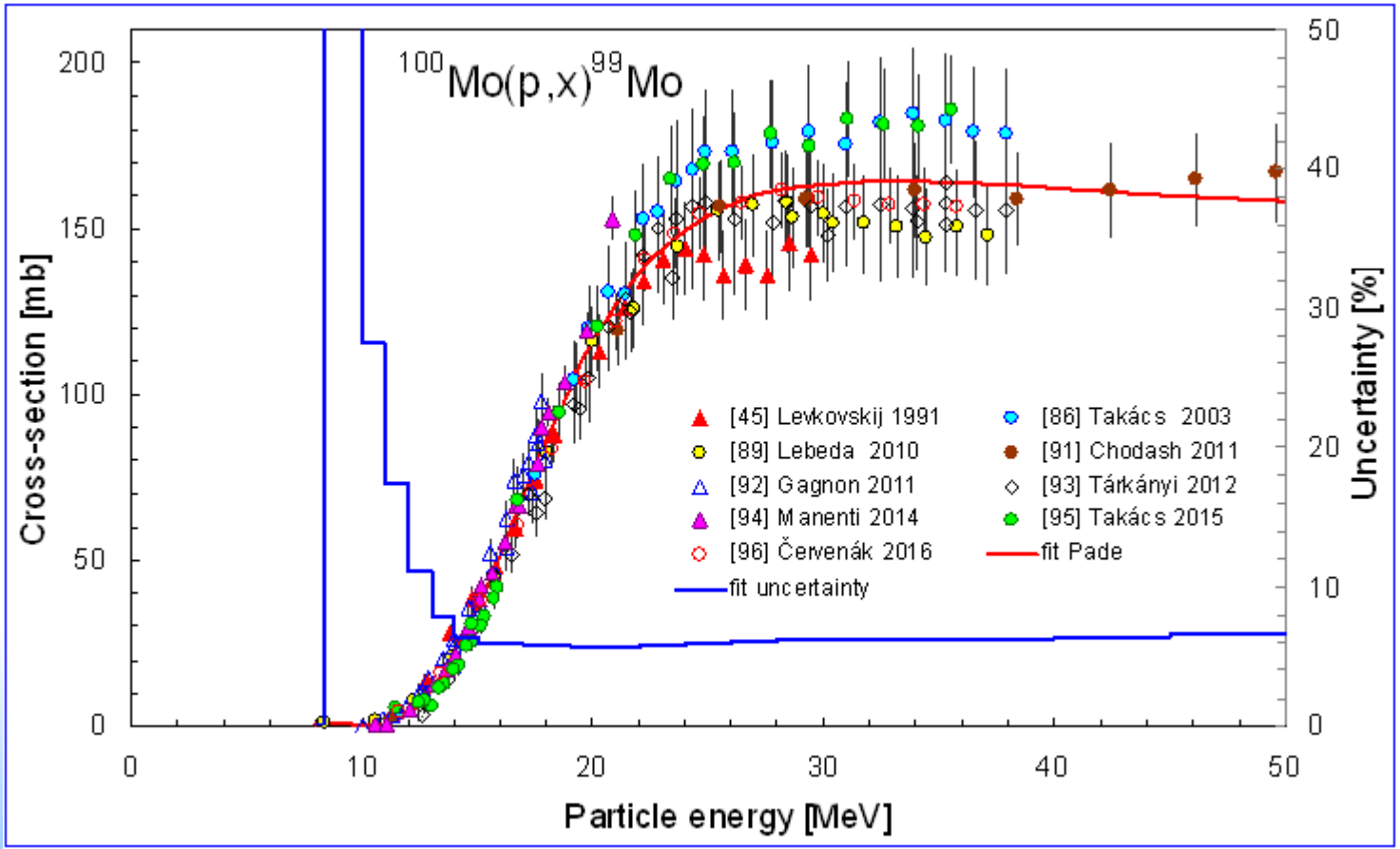
Gamma Emitters



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Charged-Particle Monitor Reactions and Nuclear Data for Medical Isotope Production, 2012-2017, Capote

Therapeutic Radionuclides

E. Betak et al., IAEA Technical Reports Series no. 473, Vienna, 2011
J.W. Engle et al., Nuclear Data Sheets 155 (2019) 56-74

^{64}Cu
^{64}Ni(p,n)^{64}Cu
^{64}Ni(d,2n)^{64}Cu
^{68}Zn(p,x)^{64}Cu
^{nat}Zn(d,x)^{64}Cu

^{67}Cu
^{68}Zn(p,2p)^{67}Cu
^{70}Zn(p,x)^{67}Cu

^{67}Ga
^{67}Zn(p,n)^{67}Ga
^{68}Zn(p,2n)^{67}Ga

^{86}Y
^{86}Sr(p,n)^{86}Y

^{103}Pd
^{103}Rh(p,n)^{103}Pd
^{103}Rh(p,x)^{102}Rh
^{103}Rh(d,2n)^{103}Pd
^{103}Rh(d,x)^{102}Rh

^{111}In
^{111}Cd(p,n)^{111}In
^{112}Cd(p,2n)^{111}In

^{114m}In
^{114}Cd(p,n)^{114m}In
^{114}Cd(d,2n)^{114m}In
^{116}Cd(p,3n)^{114m}In

^{124}I
^{124}Te(p,n)^{124}I
^{125}Te(p,2n)^{124}I
^{124}Te(d,2n)^{124}I

^{125}I
^{125}Te(p,n)^{125}I
^{124}Te(d,n)^{125}I

^{169}Yb
^{169}Tm(p,n)^{169}Yb
^{169}Tm(d,2n)^{169}Yb

^{177}Lu
^{176}Yb(d,n)^{177g}Lu
^{176}Yb(d,p)^{177}Yb
^{176}Yb(d,x)^{177g}Lu

^{186}Re
^{186}W(p,n)^{186}Re
^{186}W(d,2n)^{186}Re

^{192}Ir
^{192}Os(p,n)^{192}Ir
^{192}Os(d,2n)^{192}Ir

^{211}At
^{209}Bi(α,2n)^{211}At
^{209}Bi(α,3n)^{210}At

^{131}Cs
^{131}Xe(p,n)^{131}Cs
^{133}Cs(p,3n)^{131}Ba

^{225}Ac
^{232}Th(p,x)^{225}Ac
^{226}Ra(p,2n)^{225}Ac
^{232}Th(p,x)^{225}Ra

^{227}Th
^{232}Th(p,x)^{227}Th
^{232}Th(p,x)^{227}Ac

^{230}U
^{231}Pa(p,2n)^{230}U
^{231}Pa(d,3n)^{230}U
^{232}Th(p,3n)^{230}Pa

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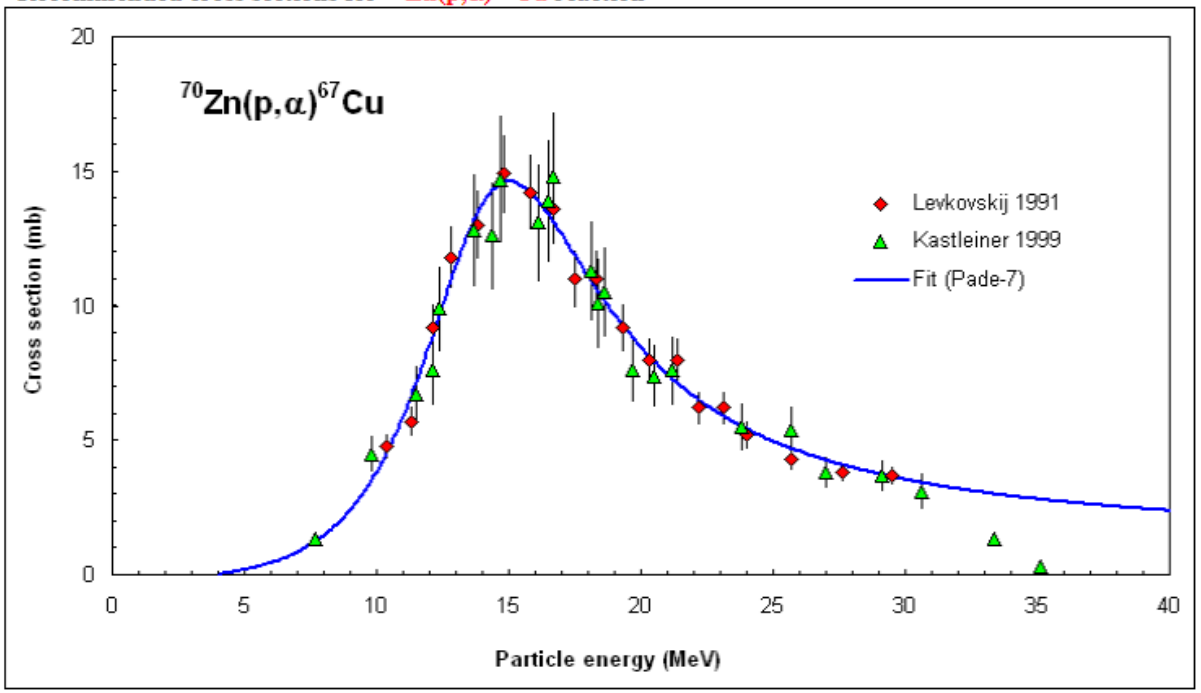
E. Betak et al., IAEA Technical Reports Series no. 473, Vienna, 2011
J.W. Engle et al., Nuclear Data Sheets 155 (2019) 56-74

Recommended cross sections for $^{70}Zn(p,\alpha)^{67}Cu$ reaction



Decay Data also studied !

New ^{67}Cu DD measurements and evaluation undertaken by F.G. Kondev (ANL, USA)

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Testing and Improving the Int. Reactor Dosimetry and Fusion File (IRDFF), 2013-2018, Capote/Trkov/Simakov

IRDFF-II library was released in January 2020, https://nds.iaea.org/IRDFF/ documented in A. Trkov *et al*, NDS **163** (2020) 1-107

All evaluated IRDFF-II data uploaded to the IAEA ENDF retrieval interfase.

- IRDFF-II cross-section and decay data files (119 reactions, 4 cover reactions)

  - **(updated)** IRDFF-II dosimetry cross sections in 4-column format (Energy in eV, cross section in barn, absol. uncert. in barn, rel. uncert. in %, compressed).
  - **(updated)** IRDFF-II dosimetry cross sections in pointwise ENDF-6 format (compressed).
  - **(updated)** IRDFF-II dosimetry group cross sections in ENDF-6 format, 640-groups (compressed).
  - **(updated)** IRDFF-II dosimetry group cross sections in ENDF-6 format, extending from 1.E-5 eV up to 60 MeV, 725-groups (compressed).
  - **(updated)** IRDFF-II dosimetry cross sections in ACE format (compressed).
    A summary of contents is given in the ACE list file. Activation cross sections for the excitation of isomeric states are identified by ACE reaction numbers MT*=(10+LFS)*1000+MT, where LFS is the final state (LFS=0 is the ground state, LFS=1 is the first isomeric state, etc.). Cross sections for the production of radionuclides are identified by ACE reaction numbers MT*=(50+LFS)*1000000+ZA where ZA identifies the product (ZA=1000*Z+A).
  - Recommended decay data are listed in Tables 7 and 8; these data are consistent with the cross-section evaluations. Latest decay data evaluations in ENDF-6 format are also available; these evaluations are consistent with recommended decay data for all nuclides but the half-life of Na-22. For more details please refer to the full IRDFF-II library documentation.

- Decay data include a recommended decay data file in ENDF-6 format

	$T_{1/2}$ (recomm.)	$T_{1/2}$ (DD eval)	
^{24}Na	14.997(12)	14.958(2)	h

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IRDFF-II library: https://nds.iaea.org/IRDFF/

- IRDFF-II Metrology (dosimetry) metrics: Damage cross sections (6 sets)

- **natSi(n,1-MeV)** ASTM E722-14 1-MeV(Si)-equivalent response function, ENDF-6 format (tabulated file=ASTM E722-14 standard, 1.E-10 to 20 MeV, README).
- **natFe(n,X)dpa** ASTM E693-17 displacement cross sections, NRT model, ENDF-6 format (tabulated file= ASTM E693-17 standard = IRDF-2002 MT900, 1.E-10 to 20 MeV, README).
- **natFe(n,X)dpa** EURATOM displacement cross sections NRT model, ENDF-6 format (tabulated file= IRDF-2002 library MT901, 1.E-10 to 20 MeV).
- **natFe(n,X)dpa** JEFF-3.3 damage cross sections, NRT model, ENDF-6 format (tabulated file = JEFF-3.3, 2017, ENDF-6 file, MT901, 1.E-10 to 200 MeV).
- **natFe(n,X)dpa** JEFF-3.3 damage cross sections, Arc model, ENDF-6 format (tabulated file = JEFF-3.3, 2017, ENDF-6 file, MT900; 1.E-10 to 200 MeV).
- **GaAs(n,1-MeV)** ASTM E722-14 1-MeV(GaAs)-equivalent response function, ENDF-6 format (tabulated file = ASTM E722-14 standard, 1.E-10 to 20 MeV, README).

- IRDFF-II Cumulative FPY data

TABLE 2. IRDFF-II thermal-neutron-induced fission yields (neutron energy $E_n = 0.0253$ eV).

Target	Fission Product	Cumulative Fission Yield
^{235}U	^{95}Zr	6.5042E-02 ± 1.00 %
	^{99}Mo	6.1399E-02 ± 1.30 %
	^{103}Ru	3.1118E-02 ± 2.10 %
	^{106}Ru	4.0958E-03 ± 2.30 %
	^{137}Cs	6.0897E-02 ± 1.04 %
	^{140}Ba	6.3444E-02 ± 1.00 %
	^{144}Ce	5.4781E-02 ± 0.90 %

TABLE 3. IRDFF-II fast-neutron-induced fission yields (neutron energy $E_n \approx 400 - 500$ keV).

Target	Fission Product	Cumulative Fission Yield
^{232}Th	^{95}Zr	5.4494E-02 ± 2.90 %
	^{99}Mo	2.8740E-02 ± 2.80 %
	^{103}Ru	1.5179E-03 ± 6.30 %
	^{106}Ru	5.3236E-04 ± 5.70 %
	^{137}Cs	6.1790E-02 ± 5.12 %
	^{140}Ba	7.6222E-02 ± 3.19 %
	^{144}Ce	7.6334E-02 ± 6.12 %

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IRDFF-II neutron spectra: https://nds.iaea.org/IRDFF/spectra.html

STD denotes Reference PFNS adopted by the Neutron Standard group

	9110	--	725 group	IPPE-BR1	IPPE-BR1	FMR001 (IPPE-BR1) 725-group
	9201	--	725 group	FNS-Grph-096mm	FNS-Grph-096mm	FNS-Graphite 096mm
	9202	--	725 group	FNS-Grph-293mm	FNS-Grph-293mm	FNS-Graphite 293mm
STD ->	9228	E.le.30MeV	725 group	U235_e80	U235_e80	U-235 thermal PFNS from ENDF/B-VIII.0
	9408	E.le.60MeV	235 group	Bedn16	Bedn16	Be(d,n) E_d=16 MeV
	9409	E.le.60MeV	220 group	Bedn40	Bedn40	Be(d,n) E_d=40 MeV
	9437	E.le.30MeV	725 group	Pu239_IAEA	Pu239_IAEA	Pu-239 PFNS (IAEA)
STD ->	9861	E.le.30MeV	725 group	Cf252_In	Cf252_In	Cf-252 spontaneous fission neutron spectrum
	9900	E.le.60MeV	725 group	Constant	Constant	Constant spectrum Phi=1
	9901	E.le.60MeV	725 group	MxwThrml	MxwThrml	Thermal Maxwellian at 293.6 K
	9902	E.le.60MeV	513 group	1oE2MeV	1oE2MeV	Pure 1/E between Ecd and E2 (0.55 eV < E < 2 MeV)
	9904	E.le.60MeV	515 group	1oE20MeV	1oE20MeV	Pure 1/E between Ecd and E2 (0.5 eV < E < 20 MeV)
	9905	E.le.60MeV	725 group	MxwFiss	MxwFiss	Maxwellian fission spectrum (T-2.03MeV)
	9910	E.le.60MeV	725 group	Linear	Linear	Linear spectrum Phi=E (1.E-5 eV < E < 20 MeV)
	9920	--	640 group	ThrmlPnt	ThrmlPnt	Thermal Point
	9925	E.le.60MeV	725 group	Mxw25keV	Mxw25keV	Maxwellian spectrum at 25 keV
	9930	E.le.60MeV	725 group	Mxw30keV	Mxw30keV	Maxwellian spectrum at 30 keV
	9932	E.le.60MeV	725 group	Mxw32keV	Mxw32keV	Maxwellian spectrum at 32 keV

Nuclear Data Development

IAEA International Atomic Energy Agency
Atoms for Peace and Development

Completed Coordinated Research Projects (II)

Testing and Improving the Int. Reactor Dosimetry and Fusion File (IRDFF), 2013-2018, Capote/Trkov/Simakov

IRDFF-II neutron spectra: https://nds.iaea.org/IRDFF/spectra.html

Some of spectra calculated for CONDERC, validated (C/E) in this project

MAT	ENDF	GENDF	RR_UNC	Spectrum	Description
9004	--	705 group	ISNF	ISNF	ISNF Reactor Spectrum 705-group
9005	--	460 group	CFRMF	CFRMF	CFRMF Reactor Spectrum from IRDF-2002
9007	--	431 group	Sigma-Sigma	Sigma-Sigma	Sigma-Sigma Reactor Spectrum from IRDF-2002
9010	--	641 group	ACRR-FF-32	ACRR-FF-32	ACRR-FF-32 Reactor Spectrum 640-group
9011	--	641 group	ACRR-CdPoly	ACRR-CdPoly	ACRR-CdPoly Reactor Spectrum 640-group
9012	--	641 group	ACRR-PLG	ACRR-PLG	ACRR-PLG Reactor Spectrum 640-group
				ACRR-LB44	ACRR-LB44 Reactor Spectrum 640-group
				SPR-III	SPR-III Reactor Spectrum 640-group
				FREC-II	ACRR-FREC-II external cavity 640-group
				Mol-BR1-MkIII	RB1_MarkIII Reactor Spectrum 640-group
				Rez-LR0	Rez-LR0 Central void 641-group
				TRIGA-JSI-PT	TRIGA-JSI-PT channel 641-group
				TRIGA-JSI-BN	TRIGA-JSI-BN cover 641-group
				TRIGA-JSI-B4C	TRIGA-JSI-B4C cover 641-group
				TRIGA-JSI-10B4C	TRIGA-JSI-10B4C enriched boron cover
				Godiva	HMF001 (Godiva) 725-group
				Flattop	HMF028 (Flattop) 725-group
				Big-Ten	IMF007 (Big_Ten) 725-group

Nuclear Data Development

IAEA International Atomic Energy Agency
Atoms for Peace and Development

Completed Coordinated Research Projects (III)

Primary Radiation Damage Cross Sections, 2013-2018, Sublet/Simakov

- 1st RCM , 4-8 November 2013, **INDC(NDS)-0648** (2014)
- 2nd RCM , 29 June-02 July 2015, **INDC(NDS)-0691** (2015)
- TM on “Nuclear Reaction Data and Uncertainties for Radiation Damage” held on 13-16 June 2016
- 3rd RCM , 23-25 October 2017
- 15+ technical papers in international Conferences and peer-review journals

Planned Outputs:

- Numerical databases of recommended damage response functions for selected materials with corresponding documentation
- New methods and metrics for defect simulations with corresponding documentation

See next presentation by J.-C. Sublet

Nuclear Data Development

IAEA International Atomic Energy Agency
Atoms for Peace and Development

Completed Coordinated Research Projects (IV)

Reference Database for Beta-delayed Neutron Emission 2013–2018, Dimitriou

- 1st RCM , 26-30 August 2013, **INDC(NDS)- 0643** (2014).
- 2nd RCM , 23-27 March 2015, **INDC(NDS)- 0683** (2015).
- 3rd RCM , 12-16 June 2017, **INDC(NDS)- 0735** (2017).

Microscopic data:

- All available published data on $T_{1/2}$, P_n compiled, evaluated and new systematics established
- Z<29: evaluations and systematics of $T_{1/2}$, P_n: **Birch et al, Nucl. Data Sheets 133 (2015)**
- Z>28: evaluations and systematics of $T_{1/2}$, P_n: **Liang et al, Nucl. Data Sheets 168 (2020)**
- Relativistic Density Functional model global calculations: **Marketin et al, PRC 93 (2016)**
- DN spectra in Brady's thesis (basis of DN spectra in ENDF/B) digitized and assessed

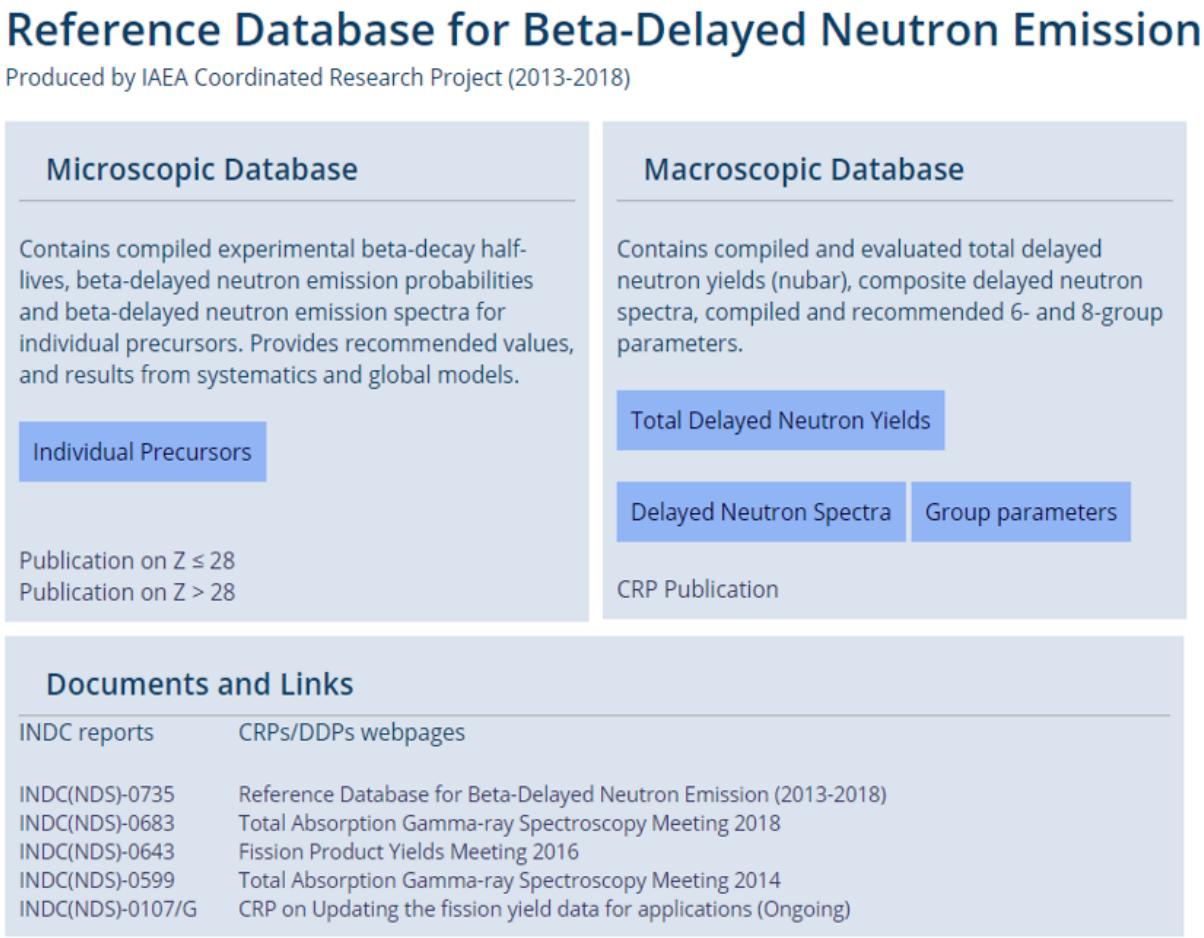
- Final CRP report arXiv:2102.01165 **[nucl-ex],** in Nucl. Data Sheets, April 2021
- All evaluated tables, systematics and digitized DN spectra uploaded on new bDN database (search engine, plotting tool, csv download) – M. Verpelli, P. Dimitriou

Nuclear Data Development

IAEA International Atomic Energy Agency
Atoms for Peace and Development

Completed Coordinated Research Projects (IV)

Reference Database for Beta-delayed Neutron Emission 2013–2018, Dimitriou



Reference Database for Beta-Delayed Neutron Emission

Produced by IAEA Coordinated Research Project (2013-2018)

Microscopic Database

Contains compiled experimental beta-decay half-lives, beta-delayed neutron emission probabilities and beta-delayed neutron emission spectra for individual precursors. Provides recommended values, and results from systematics and global models.

Individual Precursors

Publication on Z ≤ 28
Publication on Z > 28

Macroscopic Database

Contains compiled and evaluated total delayed neutron yields (nubar), composite delayed neutron spectra, compiled and recommended 6- and 8-group parameters.

Total Delayed Neutron Yields

Delayed Neutron Spectra | Group parameters

CRP Publication

Documents and Links

INDC reports	CRPs/DDPs webpages
INDC(NDS)-0735	Reference Database for Beta-Delayed Neutron Emission (2013-2018)
INDC(NDS)-0683	Total Absorption Gamma-ray Spectroscopy Meeting 2018
INDC(NDS)-0643	Fission Product Yields Meeting 2016
INDC(NDS)-0599	Total Absorption Gamma-ray Spectroscopy Meeting 2014
INDC(NDS)-0107/G	CRP on Updating the fission yield data for applications (Ongoing)

Macroscopic data

Piksaikin et al
1) INDC(NDS)-0784
INDC-2775

2) INDC(NDS)-0689
INDC-2652

3) INDC(NDS)-0646
INDC-2593

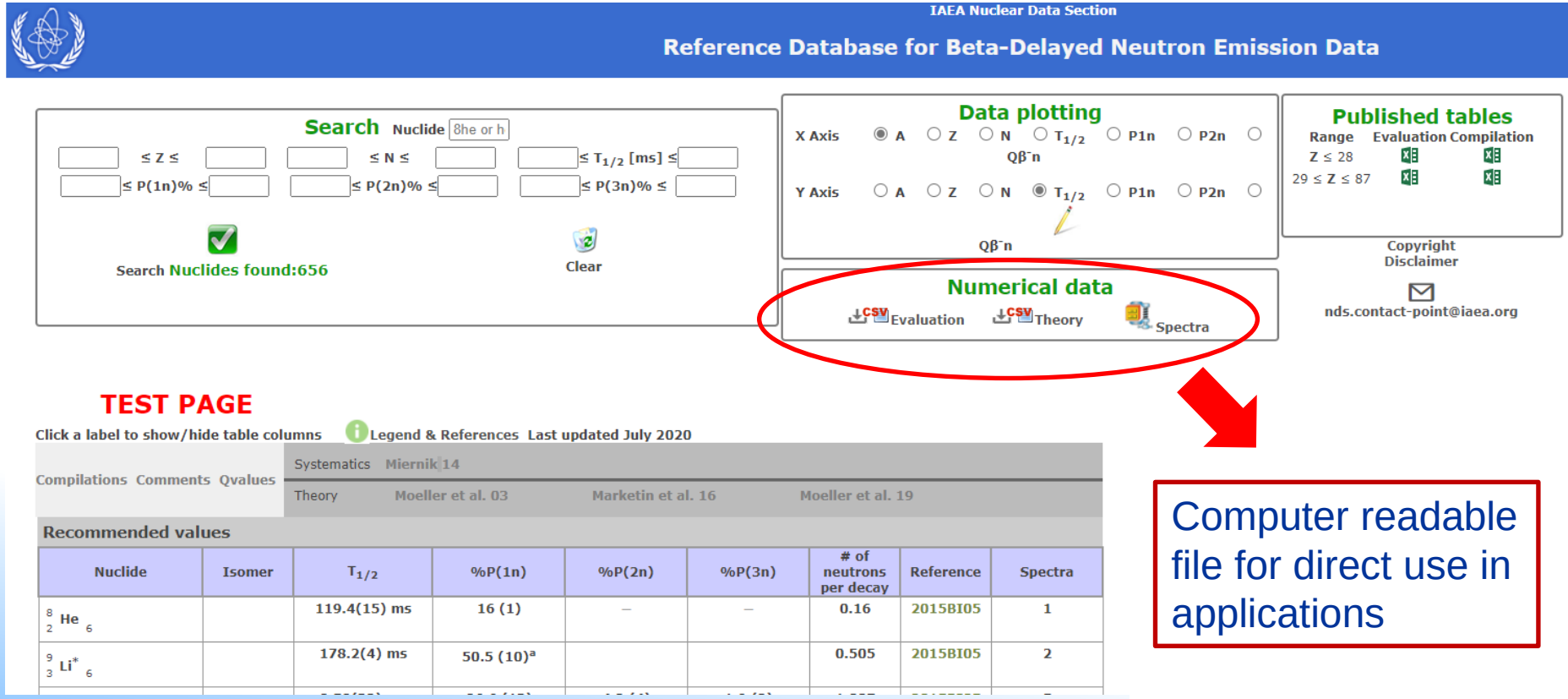
Nuclear Data Development

IAEA International Atomic Energy Agency
Atoms for Peace and Development

Completed Coordinated Research Projects (IV)

Reference Database for Beta-delayed Neutron Emission 2013–2018, Dimitriou

Beta-delayed neutron database



Computer readable file for direct use in applications

Nuclear Data Development

IAEA International Atomic Energy Agency
Atoms for Peace and 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

IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Completed Coordinated Research Project (V)

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

2016–2020, Dimitriou

https://nds.iaea.org/photonuclear/

IAEA Evaluated Photonuclear Data Library (IAEA/PD-2019)

IAEA Coordinator: Paraskevi (Vivian) Dimitriou **Library released on August 14, 2020** **(Last updated on August 14, 2020).**

CRP participants:

P. Oblozinsky (chair), P. Dimitriou, S. Goriely, Xu Ruirui, Tian Yuan, M. Krticka, R. Schwengner, T. Belgya, N. Iwamoto, H. Utsunomiya, Y.S. Cho, J. Kopecky, S. Siem, R. B. Firestone, T. Kawano, D. M. Filipescu, V.V. Varlamov, V. Plujko

IAEA/PD-2019 REFERENCE:

*T. Kawano, Y.S. Cho, P. Dimitriou, D. Filipescu, N. Iwamoto, V. Plujko, X. Tao, H. Utsunomiya, V. Varlamov, R. Xu, R. Capote, I. Gheorghe, O. Gorbachenko, Y.L. Jin, T. Renstrm, M. Sin, K. Stopani, Y. Tian, G.M. Tveten, J.M. Wang, T. Belgya, R. Firestone, S. Goriely, J. Kopecky, M. Krticka, R. Schwengner, S. Siem and M. Wiedeking, Nuclear Data Sheets **163** (2020) 109-162. Also available as a preliminary version at arXiv 1908.00471 (2019).*

Contents

The library contains evaluated photonuclear data for 219 isotopes for incident photons (gamma rays) with energies mostly up to 200 MeV. The list of the files are available here. The library includes cross sections and emission spectra in ENDF-6 format. The file format description is explained in the report IAEA-NDS-0232. The ENDF-6 formatted individual evaluations are available at IAEA Github site. The complete ENDF-6 library can also be downloaded as a compressed (tgz) archive. To untar the files, use the command `tar -zxvf filename.tar.gz` on Unix or MacOS.

Nuclear Data Development

IAEA International Atomic Energy Agency
Atoms for Peace and Development

Completed Coordinated Research Project (V)

1) Updating the Photonuclear Data library and generating a reference database for PSF, 2016–2020, Dimitriou

https://nds.iaea.org/photonuclear/

IAEA Evaluated Photonuclear Data Library (IAEA/PD-2019)

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IAEA/PD-2019 REFERENCE:

*T. Kawano, Y.S. Cho, P. Dimitriou, D. Filipescu, N. Iwamoto, V. Plujko, X. Tao, H. Utsunomiya, V. Varlamov, R. Xu, R. Capote, I. Gheorghe, O. Gorbachenko, Y.L. Jin, T. Renstrm, M. Sin, K. Stopani, Y. Tian, G.M. Tveten, J.M. Wang, T. Belgya, R. Firestone, S. Goriely, J. Kopecky, M. Krticka, R. Schwengner, S. Siem and M. Wiedeking, Nuclear Data Sheets **163** (2020) 109-162. Also available as a preliminary version at arXiv 1908.00471 (2019).*

Processing documented in IAEA-NDS-0732

Derived transport and activation libraries

The production of application libraries from the ENDF-6 formatted files was undertaken at the IAEA Nuclear Data Section by H. Kawada (Tokyo Institute of Technology, Japan), J.-Ch. Sublet and S. Okumura (IAEA), and T. Kawano (LANL, USA), and is described in the report on "Processing of the Evaluated Photonuclear Data Library (IAEA-PD2019)" available as IAEA-NDS-0232. The processed IAEA/PD-2019 transport libraries and the processed activation libraries can be also retrieved from the IAEA Github as individual files (*.endf, *.pdf, etc) and tar compressed file (*.tar.gz) as follows.

File type	Filename (.tar.gz)	List of files (Github)
ENDF-6 Library	iaea-pd2019.tar.gz	ENDF-6 list
ACE Application Library (NJOY2016*)	ace.tar.gz	ACE list iaeapd19ace.xs (XSDIR index file)
ACER check/plot (NJOY plots)	acerplot.tar.gz	ACE plot list
EVAPLOT check/plot (Activation)	graphs.tar.gz	Activation plot list
FISPACT-II 162 gprs files	gxs-162.tar.gz	Activation file list
Linearised ENDF file (PENDF)	hendf.tar.gz	PENDF file list

Updated on September 13, 2020. Note that the processing of the IAEA/PD-2019 for transport makes uses of a "patched version of NJOY2016", which is available under Github branch (feature/pn-iaea) of NJOY2016. With this version the evaluated data files can be processed, but the angular distributions in continuum spectra of emitted particles are converted to isotropic in the processing, when angular dependence of the emitted particle is represented by Legendre polynomials. See details in the NJOY2016 #issue. This deficiency is present in practically all IAEA/PD-2019 files, which as a rule represent the angular dependence of the emitted particle continuum spectra in this representation. As soon as a complete patch for NJOY2016 is released, the ACE transport library will be updated accordingly. The employed approximation in NJOY has no impact on the calculated

Nuclear Data Development

IAEA International Atomic Energy Agency
Atoms for Peace and Development

Completed Coordinated Research Project (V)

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

2016–2020, Dimitriou

Reference Database for Photon Strength Functions:

https://www-nds.iaea.org/PSFdatabase/

- Compilation of all existing Photon Strength Function data: (γ,abs), (n,γ), Average Resonance Capture, charged-particle reactions (Oslo), (γ,γ), (p,p), (p,γ), beta-decay (beta-Oslo)
- Global models: (QRPA+T-dependent, SLO/SMLO+T-dependent)
- Validation of PSF via Γ_γ, MACS, gamma-spectra
- New ATLAS of Average Capture Resonance Data (Kopecky, **INDC(NDS)-0738**)
- **Final publication: Goriely et al., Eur. Phys. Jour. A 55, 172 (2019)**

The entire experimental and theoretical database is available for downloading. Nicer interface will be developed.

Nuclear Data Development (2018)

On-going Coordinated Research Project (1)

2) RIPL for fission cross section calculations

2016-2021, Capote, 1st RCM held

- **CM** on "Recommended Input Parameters for Fission Cross Section Calculation"**,** 17-18 December 2013, Vienna, **INDC(NDS)-0654 (2014)**

Nuclear Data Development

IAEA International Atomic Energy Agency
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On-going Coordinated Research Project (1)

2) RIPL for fission cross section calculations

2016-2021, Capote, 1st/2nd RCMs held, 3rd RCM Dec. 2021

Goals

Improved RIPL database and documentation with focus on parameters for fission cross section calculations (Masses, fission barriers, transitional and class II/III states, discrete levels, level densities, fission reaction models).

- 1st RCM, IAEA, Vienna, 6-9 June 2017, **INDC(NDS)-0734** (January 2018)
- 2nd RCM, IAEA, Vienna, 7-11 October 2019, INDC(NDS)-0802
  https://www-nds.iaea.org/index-meeting-crp/RIPL-4/index_2RCM.htm
- R. C., S. Hilaire, O. Iwamoto, T. Kawano, M. Sin, EPJ Web of Conferences **146**, 12034 (2017), “Inter-comparison of Hauser-Feshbach model codes toward better actinide evaluations”, presented at NDST 2016, Brugges, Belgium.

TALYS, EMPIRE, CoH, CCONE developers

Fission path calculations’ experts

Nuclear Data Development

On-going Coordinated Research Project (2)

2) Updating Fission Yield Data for Applications

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

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 Availabity 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

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IAEA Nuclear Data Section
Data Development Projects (DDPs)
9 projects

Data Development Projects

IAEA International Atomic Energy Agency
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1.- Intercomparison of PIGE analysis codes to calculate PIGE yields for the analysis of bulk samples (NDS staff, CVs, SSAs)

Results of inter-comparison presented at IBA 2019, France

ELSEVIER

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms

Volume 468, 1 April 2020, Pages 37-47

International Atomic Energy Agency inter-comparison of particle induced gamma-ray emission codes for bulk samples

N. Pessoa Barradas [a], J. Cruz [b], M. Fonseca [b, c], A.P. de Jesus [b], A. Lagoyannis [d], V. Manteigas [b], M. Mayer [e], K. Preketes-Sigalas [d], P. Dimitriou [a, 1]

2.- Evaluation of Nuclear Moments, N. J. Stone (SSAs)

following recommendations of the CM on Evaluation of Nuclear Moments, 27-30 March 2017, IAEA see INDC(NDS)-0732

- Table of Recommended Nuclear Magnetic Dipole Moments: Part I - Long-lived States, N. J. Stone, **INDC(NDS)-0816** (2020)
- Table of Recommended Nuclear Magnetic Dipole Moments - Part II, Short-lived States, , N. J. Stone, **INDC(NDS)-0794** (2019)

Data Development Projects

IAEA International Atomic Energy Agency
Atoms for Peace and Development

3.- Verification of data processing codes for generating ACE-formatted files (NDS staff, CVs and SSAs)

- **Public evaluated nuclear data processing capabilities requested by MS CM** on Nuclear Data Processing Codes 5-8 Oct 2015
  - ✓ **GRUCON code** (Russia Kurchatov Institute)
  - ✓ **PrePro/ACEMAKER being developed (IAEA/NDS)**
  - ✓ **FUDGE (LLNL/BNL)**
  - ✓ **NJOY family (USA)**
  - ✓ **FRENDY (Japan)**
  - ✓ **GALILEE (France)**
  - ✓ **NECP-Atlas (China)**

Participants of the TM on Nuclear Data Processing

  - ✓ **TM on ND processing and intercomparison of ACE produced libraries held on 23-26 September 2019, Vienna, IAEA (fast range)**

nds.iaea.org/index-meeting-crp/TM-Nuclear%20Data%20Processing/

  - ✓ **The Importance of Resonance Self-Shielding,** INDC(NDS)-0778**,** D.E. Cullen
  - ✓ **The Importance of Resonance Self-Shielding - Part 2,** INDC(NDS)-0814**,** D.E. Cullen, D.L. Aldama, A. Trkov,
  - ✓ **Processing La-139 in the unresolved resonance region for FENDL library,** INDC(NDS)-0825**,** D.L. Aldama and R. Capote

Data Development Projects

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4.- Stopping Power Database (SSA, CV and NDS staff)

The compilation of experimental electronic stopping powers that was created and maintained for decades by Prof. Helmut Paul, Univ. Linz, has been passed over to IAEA NDS in December 2015.

Claudia Montanari, an external consultant is being funded through SSAs to maintain and extend the Stopping Power database in collaboration with P. Dimitriou and L. Mariam.

The database and online retrieval interface have been updated and installed on the NDS web server and are now available at nds.iaea.org/stopping/

5.- Study of scission neutrons 2019-2020 (SSA, CV and NDS staff)

- Experimental Investigation of the Properties of Scission Neutrons In Thermal-Neutron Induced Fission of ^{233}U and ^{235}U, A.S. Vorobyev, O.A. Shcherbakov, **INDC(NDS)-0809**
- Scission Neutrons from Thermal Neutron induced Fission of ^{239}Pu and spontaneous Fission of ^{252}Cf, A.S. Vorobyev, O.A. Shcherbakov, **INDC(NDS)-0808**
- Scission Neutrons in Spontaneous and Neutron-Induced Fission: Effect on Prompt Fission Neutron Spectra, R. Haight, **INDC(NDS)-0807**

Data Development Projects

IAEA International Atomic Energy Agency
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6.- Nuclear Data Libraries for Advanced Systems: Fusion Devices (CM, SSAs and NDS staff work)

-Maintenance and update of the FENDL-3.x library. See nds.iaea.org/fendl/.
-CM on the FENDL library for fusion neutronics calculations, 15-18 Oct 2018
nds.iaea.org/index-meeting-crp/CM-FENDL-2018/
-TM on the FENDL library for fusion neutronics applications, 2-5 Sept. 2019
nds.iaea.org/index-meeting-crp/TM%20FENDL/

Participants of the CM on FENDL Library

FENDL-3.2 just released !

International Atomic Energy Agency
Nuclear Data Services
Section Données Nucléaires, AIEA

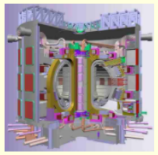
IAEA.org | NDS Mission | Mirro

Search

Databases » EXFOR | ENDF | CINDA | IBANDL | Medical | PGAA | NGAtlas | RIPL | FENDL | IRDFF

Documents
Processing (2021)
TM (2019)
CM (2018)
CM (2016)
Contents summary
Processing (2011)
Validation (Fischer et al., 2014)
Validation (Kopecky, 2012)
Validation (Kopecky, 2015)
Validation (Sublet et al., 2014)
3rd RCM (2011)
2nd RCM (2010)
1st RCM (2008)
TM (2007)
More documents

Links
FENDL-3.2
FENDL-3.1d
FENDL-3.1
FENDL-3.0
FENDL-2.1
FENDL-2.0
FENDL-1.0
CRP on FENDL-3.0
Nuclear Data Services
Nuclear Data Section



Fusion Evaluated Nuclear Data Library - FENDL-3.2, 26 March 2021

(Nuclear data supersede all previous versions of FENDL-2.x and 3.x libraries)

Coordinators: Georg Schnabel, and Roberto Capote, and Andrej Trkov **LAST WEBPAGE UPDATE:** March 26, 2021

FENDL-3.0 PRIMARY REFERENCE:
R. Forrest, R. Capote, N. Otsuka, T. Kawano, A.J. Koning, S. Kunieda, J-Ch. Sublet, and Y. Watanabe, INDC(NDS)-0628 (IAEA, Vienna, 2012).
(note: A new comprehensive documentation of the FENDL-3.2 library is in preparation).

The Fusion Evaluated Nuclear Data Library contains reaction data with a focus on the data requirements of fusion research facilities. Both operating and future facilities (e.g., ITER,DEMO, IFMIF) data needs are covered with current data extended up to 150 MeV. Development of FENDL libraries is described in the document links provided in the left column; links to previous FENDL releases are also listed.

The IRDFF-II library (International Reactor Dosimetry and Fusion File) released by the IAEA in January 2020 is recommended for neutron dosimetry in fusion facilities.

Library Contents: Transport

The FENDL-3.2 transport package contains evaluated nuclear data in ENDF-6 format as General Purpose files. Data are given for neutron-, proton- and deuteron-induced reactions up to a typical energy of 150 MeV. Data processing for transport applications has been undertaken (neutron data processing is similar to the processing of FENDL-3.0 library described in INDC(NDS)-0611 report). More details of the FENDL-3.2 data processing will be provided in the final FENDL-3.2 paper, which is in preparation. The following processed files for applications are given:

- FENDL/MC: Pointwise continuous-energy cross section data in **ACE** format for MCNP calculations; also includes probability tables (PT) in the unresolved resonance range.
- FENDL/MG: Contains multigroup cross section data in the 211n/42g Vitamin J+ energy structures (the 211n Vitamin J+ energy structure matches with the 175n Vitamin J energy structure below 19.64 MeV) for multigroup transport codes in two formats:
  - FENDL/MG (MATXS), which includes files in **MATXS** format from the NJOY module MATXSR.
  - FENDL/MG (GENDF), which contains data in **GENDF** format from the NJOY modules GROUPR and GAMINR.
- Data are available for 192 materials relevant for fusion at 293.6K. Additionally, the SIGACE package can be downloaded for Doppler broadening of ACE-formatted file - useful for generating ACE-formatted files at temperatures higher than 293.6K.

Notes on uncertainties: If covariance data are not available for a particular element of interest, covariance data of other libraries may be used (e.g., from TENDL-2019 library).

Data Development Projects

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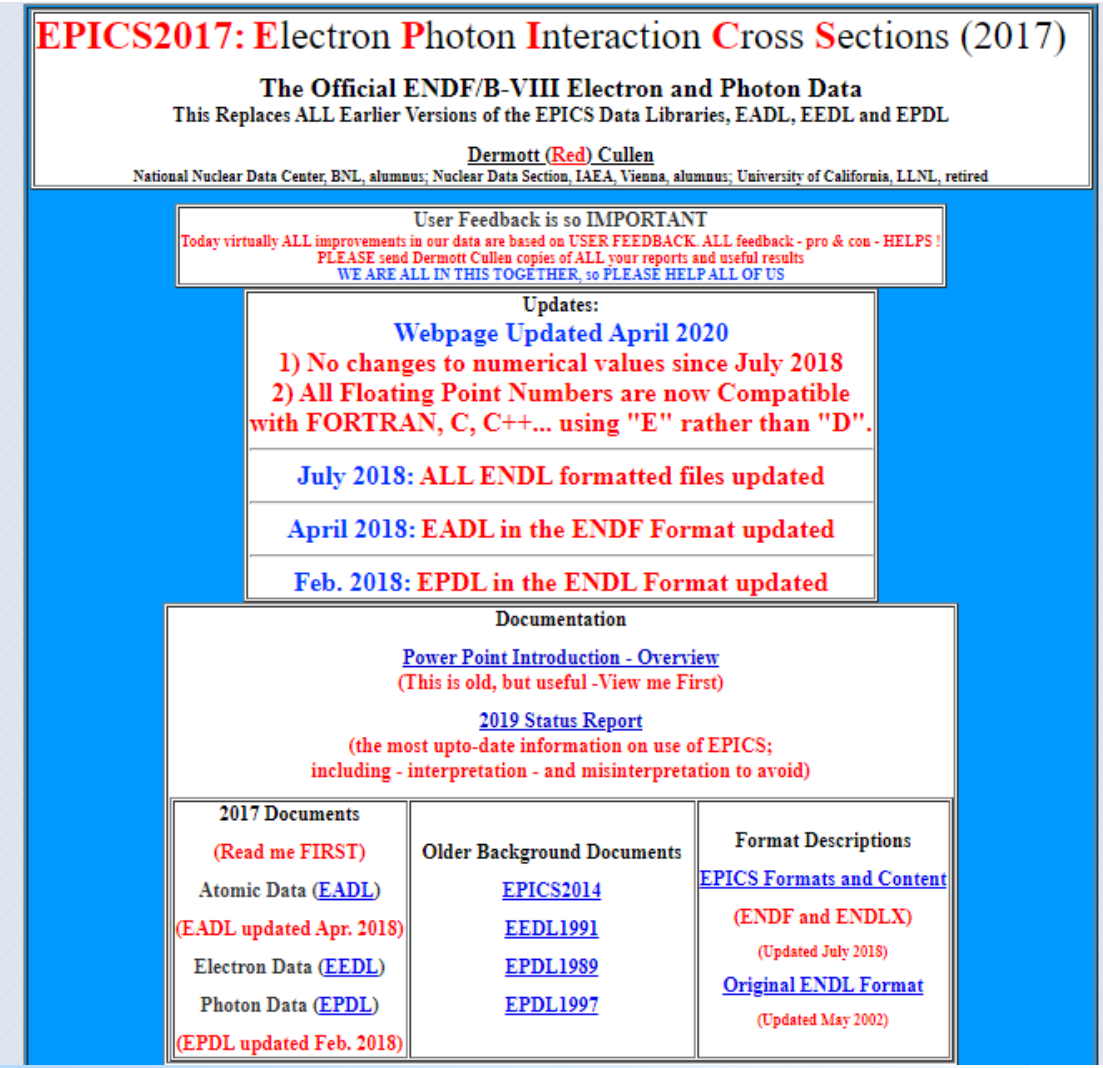
7.- EPICS revised (2019), webpage updated (NDS staff, D.E. Cullen)



EPICS2017: Electron Photon Interaction Cross Sections (2017)

The Official ENDF/B-VIII Electron and Photon Data
This Replaces ALL Earlier Versions of the EPICS Data Libraries, EADL, EEDL and EPDL

Dermott (Red) Cullen
National Nuclear Data Center, BNL, alumnus; Nuclear Data Section, IAEA, Vienna, alumnus; University of California, LLNL, retired

User Feedback is so IMPORTANT
Today virtually ALL improvements in our data are based on USER FEEDBACK. ALL feedback - pro & con - HELPS !
PLEASE send Dermott Cullen copies of ALL your reports and useful results
WE ARE ALL IN THIS TOGETHER, so PLEASE HELP ALL OF US

Updates:
Webpage Updated April 2020
1) No changes to numerical values since July 2018
2) All Floating Point Numbers are now Compatible with FORTRAN, C, C++... using "E" rather than "D".

July 2018: ALL ENDL formatted files updated

April 2018: EADL in the ENDF Format updated

Feb. 2018: EPDL in the ENDL Format updated

Documentation

Power Point Introduction - Overview
(This is old, but useful -View me First)

2019 Status Report
(the most upto-date information on use of EPICS;
including - interpretation - and misinterpretation to avoid)

2017 Documents	Older Background Documents	Format Descriptions
(Read me FIRST)		EPICS Formats and Content
Atomic Data (EADL)	EPICS2014	(ENDF and ENDLX)
(EADL updated Apr. 2018)	EEDL1991	(Updated July 2018)
Electron Data (EEDL)	EPDL1989	Original ENDL Format
Photon Data (EPDL)	EPDL1997	(Updated May 2002)
(EPDL updated Feb. 2018)		

Data Development Projects

IAEA International Atomic Energy Agency
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8. Nuclear Data for Medical Applications (data needs)

TM held on 10-13 December 2018, IAEA Headquarters

- 20 participants from 14 countries
- Report INDC(NDS)-0776
- Participants assessed future medical applications for the **next five to ten years** for many radionuclides based upon their existing and potential diagnostic and therapeutic properties.

Participants of the TM on Nuclear Data for Medical Applications

- Debate focused upon charged-particle induced reactions and their production cross sections, derivation of optimal yields, minimisation of radionuclidic impurities, and nuclear data needs for proton and heavy-ion radiotherapy, along with outstanding decay data requirements.

- Required cross-section measurements were identified for a reasonably wide range of targets and projectiles, along with decay data studies for specific radionuclides. Subsequent evaluations are expected.

Data Development Projects

IAEA International Atomic Energy Agency
Atoms for Peace and Development

9.- Maintain the international Neutron Standards file and evaluation techniques (NDS staff, SSAs, TMs, CVs)

Neutron Data Standards webpage: https://nds.iaea.org/standards

IAEA NEUTRON DATA STANDARDS (2017)

A.D. Carlson, et al., Nuclear Data Sheets 148 (2018) 143-188

#	Reaction	Energy Range	ENDF-6 formatted data	Free text format
1	H(n,n)	1 keV to 20 MeV	std17-001_H_001.endf	std17-001_H_001.txt
2	^{6}Li(n,t)	1e-5 eV to 4 MeV (Standard range up to 1 MeV)	std17-003_Li_006.endf	std17-003_Li_006.txt
3	^{10}B(n,α);(n,α$_1$γ)	1e-5 eV to 1 MeV	std17-005_B_010.endf	std17-005_B_010.txt
4	^{nat}C(n,n)	up to 6.45 MeV	std17-006_C_000.endf	std17-006_C_000.txt
5	^{197}Au(n,γ)	2.5 keV to 2.8 MeV	std17-079_Au_197.endf	std17-079_Au_197.txt
6	^{235}U(n,f)	150 eV to 200 MeV	std17-092_U_235.endf	std17-092_U_235.txt
7	^{238}U(n,f)	0.5 to 200 MeV	std17-092_U_238.endf	std17-092_U_238.txt
8	Thermal Neutron Constants: ^{233}U, ^{235}U, ^{239}Pu, ^{241}Pu, ^{252}Cf	0.0253 eV (2200 m/s)		Standards2017_TNC.txt
9	^{197}Au(n,γ)	MACS (30 keV)= 620(11) mb		
10	^{235}U(n,f)	Integral from 7.8 eV to 11 eV = 247.5(3.3) b*eV^{3}		

References

#	Reaction	Energy Range	ENDF-6 formatted data	Free text format
1	^{238}U(n,g)	150 eV - 2.2 MeV	rec17-092_U_238g.endf	rec17-092_U_238g.txt
2	^{239}Pu(n,f)	150 eV - 200 MeV	rec17-094_Pu_239.endf	rec17-094_Pu_239.txt

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High-Energy Reference Fission Cross sections (2015)

The neutron induced fission cross sections at high energies are recognised as a convenient reference for other reaction cross sections measurement where already established standards are not available yet. The reference (n,f) cross sections were evaluated for the following 5 nuclei (detailed information is available in Report INDC(NDS)-0681 "^{209}Bi and ^{nat}Pb neutron fission cross sections as new references and extensions of the ^{235}U, ^{238}U and ^{239}Pu(n,f) standards up to 1 GeV", B. Marcinkevicius, S. Simakov and V. Pronyaev). The ENDF-6 file with cross sections, energy-energy correlations and cross-reaction correlations for ^{209}Bi, ^{nat}Pb, ^{235}U, ^{238}U and ^{239}Pu (n,f) is available here: High-En-Ref.endf

Reaction	Energy Range	ENDF-6 formatted data	NJOY plot	Free text format
235U(n,f)	0.0253 eV - 1 GeV	235U-Ref-HighErg.endf	file.pdf	235U_nf_Reference_xs_data.txt
238U(n,f)	0.0253 eV - 1 GeV	238U-Ref-HighErg.endf	file.pdf	238U_nf_Reference_xs_data.txt
239Pu(n,f)	0.0253 eV - 300 MeV	239Pu-Ref-HighErg.endf	file.pdf	239Pu_nf_Reference_xs_data.txt
209Bi(n,f)	34 MeV - 1 GeV	209Bi-Ref-HighErg.endf	file.pdf	209Bi_nf_Reference_xs_data.txt
natPb(n,f)	34 MeV - 1 GeV	natPB-Ref-HighErg.endf	file.pdf	natPb_nf_Reference_xs_data.txt

Neutron (n,n'γ) Cross-section References (2017/2019)

The reference discrete γ-ray production cross sections (n,n'γ) were evaluated for target nuclei ^{7}Li (detailed information is available in Report INDC(NDS)-0739 by S. Simakov, R. Capote, R. Nelson and V. Pronyaev) and ^{48}Ti (Report INDC(NDS)-0740 by S. Simakov, R. Capote, R. Nelson and V. Pronyaev). The numerical data in the various formats in energy ranges recommended for use are presented in the following Table.

Reaction	Energy Range	ENDF-6 formatted data	NJOY plot	Free text format
^{10}B(n,aγ=478keV)	0.0253 eV - 1 MeV	std17-005_B_010.endf		std17-005_B_010.txt
^{7}Li(n,n'γ=478keV)	0.8 - 8.0 MeV	Li7nng478.endf	Li7nng478.pdf	Li7nng478.txt
^{48}Ti(n,n'γ=984keV)	3 - 16 MeV	Ti48nng984.endf	Ti48nng984.pdf	Ti48nng984.txt


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Thank you!