

IAEA Nuclear Data Section: Progress Report for period 2015/16

Summary of Nuclear Data Activity by Staff of the IAEA Nuclear Data Section

April 2015 – May 2016

IAEA Technical Meeting, 7-10 June 2016
Beijing, China

Web: <https://www-nds.iaea.org/>
E-mail: nds.contact-point@iaea.org

1. Staff Changes

The authorized staff level of the Nuclear Data Section (NDS) consists of a total of 16.25 professionals and support staff. The latest staff changes include:

- Ann Jensby moved from Nuclear Data Development Unit to Secretariat of the Policy-making Organs in April 2015.
- Robin Forrest (Section Head) retired on 30 June 2015.
- Arjan Koning joined in July 2015 as Section Head.
- Malgorzata Rydeng joined in Nuclear Data Development Unit in April 2015, and moved to Soil and Water Management and Crop Nutrition Section in September 2015.
- Lidija Vrapcenjak returned from maternity leave to Nuclear Data Services Unit as Nuclear Data Services Assistant in September 2015.
- Kira Nathani returned from Nuclear Data Service Unit to Nuclear Data Development Unit as Team Assistant in September 2015.
- Stanislav Simakov (Head of Nuclear Data Services Unit) retired on 31 January 2016.

2. Compilations

2.1 EXFOR transmission

During the reporting period, the following final tapes have been transmitted:

- 5 neutron final TRANS tapes (3169 – 3173) containing 51 new entries and 79 revised entries;
- 7 CPND final TRANS tapes (D098 – D103, S019) containing 129 new entries and 58 revised entries;
- 3 PhND final TRANS tapes (G032 - G034), containing 24 new entries and 3 revised entries.

These include contributions from 5 other centres (ATOMKI, CNDC, KNDC, NDPCI, UkrNDC) as well as two compilers (Nurzat Kenzheybayev, Myagmarjav Odsuren).

Nurzat Kenzheybayev (Kazakh National University, Almaty) is compiling of data measured in Central Asia (*e.g.*, Kazakhstan, Uzbekistan) for area 3, D and G in collaboration with Timur Zholddybayev (Institute of Nuclear Physics, Almaty) and Feruzjon Ergashev (Institute of Nuclear Physics, Tashkent).

Myagmarjav Odsuren (National Univ. of Mongolia, Ulaanbaatar) is compiling heavy-ion induced reaction data measured in area 2 countries (e.g., France, Germany, Italy) for area D.

Also 65 final TRANS tapes have been received at NDS. These final TRANS tapes contain 622 neutron entries (95 new, 527 revised), 468 CPND entries (196 new, 272 revised), 164 PhND entries (54 new, 110 revised) during the reporting period.

Based on finalized TRANS tapes received at NDS, 14 EXFOR Master Files have been created and distributed.

Three regular transmissions of the EXFOR/CINDA dictionaries (TRANS.9111 - 9113) were done in TRANS, DANIEL (backup) and archive format.

Number of new entries transmitted by final tapes in May 2015 - May 2016

(NK: Nurzat Kenzhebayev, MO: Myagmarjav Odsuren)

	NDS	ATOMKI	CNDC	KNDC	NDPCI	UkrNDC	NK	MO	Sum
Neutron	32	-	-	3	16	-	-	-	51
CPND	15	18	30	11	26	11	7	11	129
PhND	5	-	-	8	6	5	-	-	24
Sum	52	18	30	22	48	16	7	11	204

2.2 EXFOR quality control

During the reporting period, 63 preliminary tapes (PRELIM) were transmitted for checking by NDS and other centres. Both ZCHEX and JANIS TRANS Checker are regularly used. The finalized tapes are also checked against comments from centres before uploading to the NDS open area. NDS also registers comments on EXFOR entries from users and centres to the EXFOR Feedback List (<https://www-nds.iaea.org/nrdc/error/>) and monitors the correction process by checking each preliminary tape against the feedback list.

2.3 EXFOR coverage control

Under the EXFOR compilation control system, about 60 journal titles are regularly scanned and registered to the EXFOR Compilation Control System. The list of newly published articles for compilation (<https://www-nds.iaea.org/exfor-master/x4compil/>) is updated every week. Since the last NRDC Meeting, about 650 journal issues have been scanned and added to the database for EXFOR compilation control system.

Completeness checking of EXFOR against prompt fission neutron multiplicities and their distributions was performed against Norman Holden's compilation (Memo CP-D/867 and 871).

2.4 EXFOR workshops and meetings

- Consultants' Meeting on EXFOR Compilation of Thermal Neutron Scattering Data, 2 - 4 November 2015, Vienna, Scientific Secretary: V. Semkova). See <https://www-nds.iaea.org/index-meeting-crp/CM-THSC-2015/> for presentations etc. the meeting summary report was published as INDC(NDS)-0697. Following the meeting recommendations a new database for thermal neutron scattering evaluations was established.

2.5 IBANDL transmission and inclusion in EXFOR

- During the reporting period, 365 new datasets from 50 publications were transmitted to IBANDL. Their numerical data relevant to area D were compiled in EXFOR by NDS, and some data relevant to area O were sent to NEA DB.

2.6 CINDA

The CINDA Master File is available via the NDS compilers' Web site (includes all components and history). Automatic updates using the EXFOR and NSR databases have been carried out twice (June 2015, December 2015). Complete MySQL CINDA database was sent to NNDC (USA), BARC (India) and CNDC (China).

2.7 Evaluated data libraries, files and programs

Various new and revised evaluated data libraries, files and programs for data checking, processing and graphical presentation were added, developed and distributed via the NDS Web site and on DVD-ROM (see below).

3. Services

3.1 Web Services

Further improvements have been implemented in the Web EXFOR-CINDA-ENDF database retrieval systems since the last NRDC meeting:

- ENDF (Evaluated Nuclear Data Files):
 - New and updated evaluated libraries in the ENDF database:
 - JENDL-4.0u2: update 20160106 of Japanese evaluated nuclear data library 2010
 - IBA-EVAL: differential data for ion beam analysis, 2013 (generated using SigmaCalc, A.Gurbich)
 - JENDL-4.0/HE: JENDL-4.0 High Energy File 2015 (neutron, proton with energy up to 200 MeV)
 - JENDL-3.2 Japanese evaluated nuclear data library, 1994
 - EPICS-2014: Electron and Photon Interaction Cross Sections, 2014
- EXFOR:

- public Web tool for uploading non-EXFOR user's data to EXFOR Web retrieval system for constructing covariance matrix, calculating inverse reaction cross sections, plotting, comparing with ENDF data, etc.
- output links to NSR, Web and PDF publication for secondary references of an Entry
- display of original publication of the IAEA INDC Reports (PDF) was opened public access (for all users)
- PDF database (now in total: 52,362 PDF files)
 - EXFOR-PDF database: 22 updates (now in total: 25,633 PDF files)
 - NSR-PDF database: 14 updates (now total: 26,729 PDF files)
 - NSR-PDF files are made accessible via EXFOR web retrieval system
 - new web interface: database listing with information EXFOR and NSR databases and links to retrieval systems accessible from MyEnsdf, MyExfor and EXFOR web systems
- CINDA:
 - Web interface for CINDA was extended to display PDF files (for authorized users)

News in Web-Tools for EXFOR compilers, ENDF and ENSDF evaluators:

- MyEndf: GRUCON processing package was upgraded to the version "2016.00d, 14-Jan-2016"
- MyEnsdf:
 - added: chk_PARENT, RULER, GABS, XPQCHK, ALPHAD, BrIcc, BrIccMixing (codes from organizations-members of NSDD network), updated: FMTCHK
 - new Web-viewers: ensdf+ (ENSDF interpreted) and ensdf± (interactive tree)
 - Light ENSDF editor (Web-based, new)
- MyExfor: output to C5 and C5M added; Light EXFOR editor (under development)

The Web EXFOR-CINDA-ENDF-IBANDL retrieval system is functioning at NNDC (USA), BARC (India) and CNDC (China). Statistics for usage of the Web retrieval system are presented in figures below.

3.2 DVD-ROM

Most of NDS CD/DVD-ROMs are available via Web distribution (17 from 25). Important addition: since 2016 "ENDF Libraries" are available for downloading.

New and updated "CD/DVD products":

- EXFOR-CINDA for Windows: MS-Access database and retrieval system (on Java-2). Portable.

- EXFOR-CINDA for Applications: database retrieval systems (Linux, Windows and Mac OSX). Includes Endver/GUI package integrated with Prepro-2012 and full EXFOR/CINDA database. Portable.
- ENDF libraries: 34 Evaluated Data Libraries including ENDF/B-VII.1, JEFF-3.2, JENDL-4.0, CENDL-3.1, ROSFOND-2010, IRDFF-v1.05, etc.
- GRUCON: ENDF Data Processing Code. Distribution: 32-bit and 64-bit executables for Linux and Windows, Manual in English and Russian, examples with scripts (by V.Sinitsa, Kurchatov Institute, Moscow, Russia)

3.3 Document Services

Nuclear Data Services Unit (NDSU) continued supporting the Member States in providing the reports published, as well as distributing data libraries on CDs and DVDs as requested. Following the trends, most of data libraries which are available from CDs/DVDs are now also available from webpage (<https://www-nds.iaea.org/cdroms/>) for download to ensure quicker and easier service.

NDSU continues supporting the compilers around the world by collecting references required for compilation and research work as the availability of source articles is important for EXFOR quality control by NDS. Also papers presented by data centres and other laboratories in the "Sixth Workshop on Nuclear Reaction Database Development (Sapporo, 15–17 September 2015)" were published as INDC(JPN)-200.

Any other improvement suggestions should be sent to our contact address (nds.contact-point@iaea.org).

3.4 Nuclear Data Newsletters

The Nuclear Data Newsletter is published biannually to inform the scientific community about actual NDS work: # 59 was issued in May 2015; # 60 was issued in December 2015; #61 is in preparation and will be published in July 2016. We have currently 138 hardcopies to be distributed and 1713 electronically.

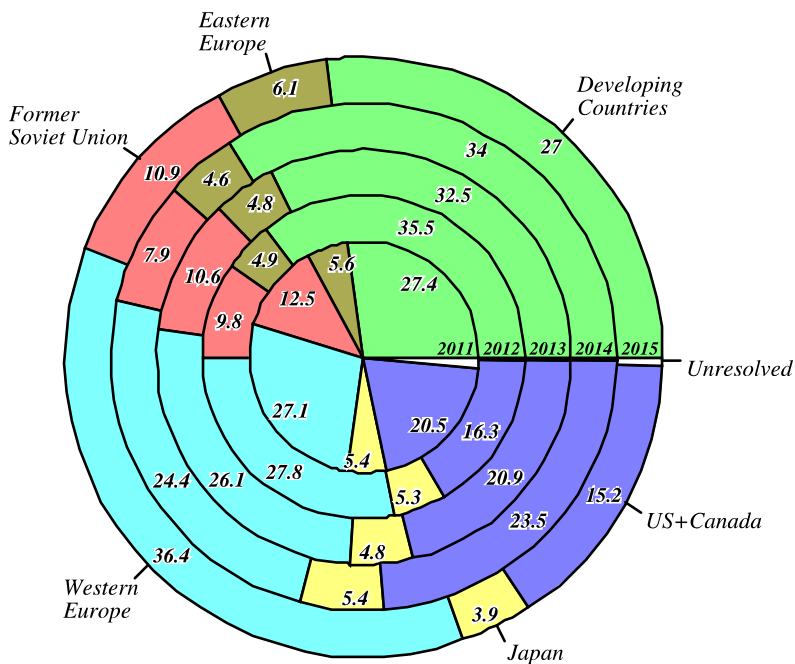
4. Visits and Inter-centre Cooperation

- V. Zerkin (NDS) visited NNDC from 7 to 25 September 2015 to deploy and further develop software for the management and the web retrieval of ENDF, EXFOR and CINDA databases.
- N. Otsuka (NDS) visited CNDC from 19 to 23 October 2015 to discuss compilation of Chinese experimental nuclear reaction data published in Chinese journals.
- N Otsuka (NDS) visited JCPRG from 14 to 18 December 2015 to upgrade the web-based EXFOR/NRDF editor (HENDEL).

IAEA Nuclear Data Services: Web Statistics

2011-2015

Geographical Distribution (%)



Total per Year*

(Number of accesses + retrievals)

*2012: 9 Months

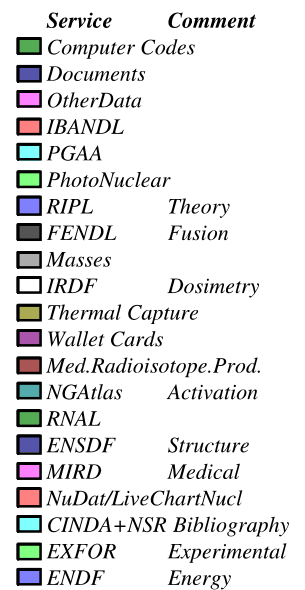
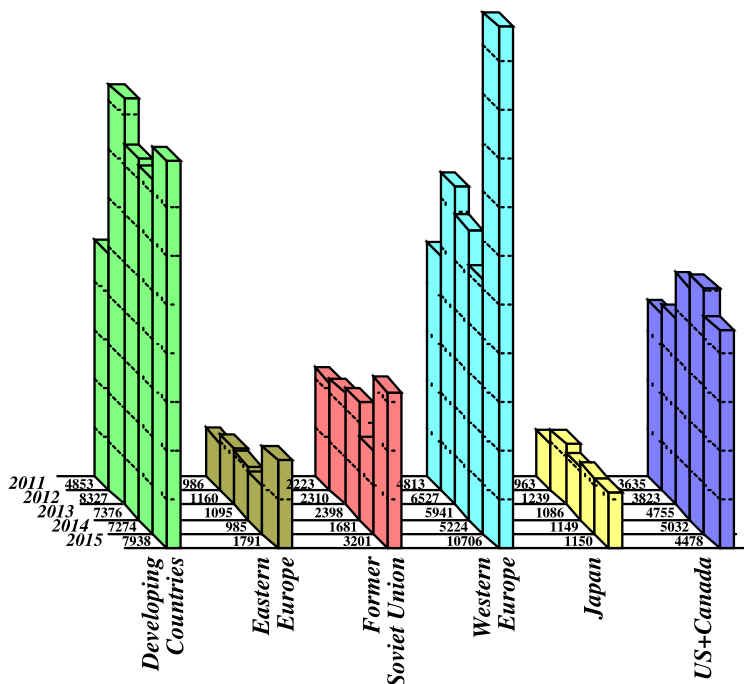
*2013: 11 Month

Average per Month

(Number of accesses + retrievals)

*2012: 9 Months

*2013: 11 Month



5. Nuclear Data Developments

The Nuclear Data Section undertakes long term nuclear data development by implementing Coordinate Research Projects (CRP) and Data Development Projects (DDP). The staff members of NDS who manage NRDC also follow the currently running CRPs and DDPs to observe the actual trends and needs for nuclear reaction data.

5.1. Coordinated Research Projects (CRP)

- Prompt fission neutron spectra of actinides (2009-2015)
- Development of a reference database for particle-induced gamma-ray emission (PIGE) (2011-2015)
- Nuclear data for charged-particle monitor reactions and medical isotope production (2012-2016)
- Testing and improving the IAEA International Dosimetry Library for Fission and Fusion IRDFF (2013-2017)
- Primary radiation damage cross sections (2013-2017)
- Reference database for beta-delayed neutron emission (2013-2017)
- Updating the photonuclear data library and generating a reference database for photon strength functions (2016-2020)
- RIPL for fission cross section calculations (2016-2021)

5.2. Data Development Projects (DDP)

- Maintain the international neutron cross section standards file and evaluation techniques
- CIELO collaboration: coordination and technical work
- Neutron data evaluation work up to 150 MeV: ^{55}Mn nucleus
- Ion Beam Analysis Nuclear Data Library (IBANDL)
- Development of evaluation methodology and nuclear reaction modelling systems
- Evaluation of charged-particle-induced reaction data in the resolved-resonance region for applications
- Improvement of analysis codes for nuclear structure and decay data evaluations
- Stopping power database
- Total absorption gamma-ray spectroscopy (TAGS): Decay data for decay heat calculations and other applications
- Data for Safeguards
- Nuclear Data Libraries for Advanced Systems: Fusion Devices (FENDL-3)
- Thermal scattering law data

5.3. Training Activities (Schools, Workshops)

- Joint ICTP-IAEA Workshop on "Nuclear Data for Neutron Dosimetry and Analytical Methods on Research Reactors", 20 -24 April 2015, Trieste
- Joint ICTP-IAEA School on "Nuclear Data Measurements for Science and Applications", 19 -30 October 2015, Trieste.

6. Nuclear Data Journal Publications (2015-2016)

Production cross-sections of radionuclides from α -induced reactions on natural copper up to 50 MeV

A.R. Usman, M.U. Khandaker, H. Haba, N. Otuka, M. Murakami, Y. Komori, *Appl. Radiat. Isot.* **114** (2016) pp. 104-113.

Neutron-induced fission cross section of ^{237}Np in the keV to MeV range at the CERN n TOF facility

M. Diakaki, D. Karadimos, R. Vlastou, M. Kokkoris, P. Demetriou, E. Skordis, A. Tsinganis, U. Abbondanno, G. Aerts, H. Alvarez, F. Alvarez-Velarde, S. Andriamonje, J. Andrzejewski, P. Assimakopoulos, L. Audouin, G. Badurek, P. Baumann, F. Becvar, E. Berthoumieux, M. Calviani, F. Calvino, D. Cano-Ott, R. Capote et al (n_TOF Collaboration), *Phys. Rev. C* **93** (2016) 034614.

Effects of Fission Yield Data in the Calculation of Antineutrino Spectra for $^{235}\text{U}(n,\text{fission})$ at Thermal and Fast Neutron Energies

A.A. Sonzogni, E.A. McCutchan, T.D. Johnson and P. Dimitriou, *Phys. Rev. Lett.* **116** (2016) 132502.

Benchmark experiment for the cross section of the $^{100}\text{Mo}(p,2n)^{99\text{m}}\text{Tc}$ and $^{100}\text{Mo}(p,pn)^{99}\text{Mo}$ reactions

S. Takács, F. Ditrói, M. Aikawa, H. Haba, N. Otuka, *Nucl. Instrum. Meth. B* **375** (2016) pp. 60-66.

Development of a Reference Database for Particle-Induced Gamma-ray Emission spectroscopy

P. Dimitriou, H.-W. Becker, I. Bogdanović-Radović, M. Chiari, A. Goncharov, A.P. Jesus, O. Kakuee, A.Z. Kiss, A. Lagoyannis, J. Räsänen, D. Strivay, A. Zucchiatti, *Nucl. Instrum. Meth. B* **371**(2016) pp. 33-36.

Validation of IRDFF in ^{252}Cf Standard and IRDF-2002 Reference Neutron Fields

S. Simakov, R. Capote, L.Greenwood, P. Griffin, A. Kahler, V. Pronyaev, A. Trkov and K. Zolotarev, *EPJ Web of Conferences* **106** (2016) 04011.

Toward a New Evaluation of Neutron Standards

A.D. Carlson, V.G. Pronyaev, R. Capote, G.M. Hale, F.-J. Hamsch, T. Kawano, S. Kunieda, W. Mannhart, R.O. Nelson, D. Neudecker, P. Schillebeeckx, S. Simakov, D.L. Smith, P. Talou, X. Tao, A. Wallner and W. Wang, *EPJ Web of Conferences* **106** (2016) 04002.

Systematic study of proton capture reactions in medium-mass nuclei relevant to the p process: The case of ^{103}Rh and $^{113,115}\text{In}$

S. Harissopulos, A. Spyrou, V. Foteinou, M. Axiotis, G. Provatas, P. Demetriou, *Phys. Rev. C* **93** (2016) 025804.

Updated Photonuclear Data Library and Database for Photon Strength Functions

P. Dimitriou, R.B. Firestone, S. Siem, F. Becvar, M. Krlicka, V.V. Varlamov, M. Wiedeking, *EPJ Web of Conferences* **93** (2015) 06004.

Nuclear Data Sheets for $A = 227$

B. Singh, F. Kondev, E. McCutchan, J. Tuli, et al. *Nucl. Data Sheets* **132** (2016) 257.

Measurements of deuteron-induced reaction cross-sections on natural nickel up to 24 MeV

A.R. Usman, M.U. Khandaker, H. Haba, M. Murakami, N. Otuka, *Nucl. Instrum. Meth. B* **368** (2016) pp. 112-119.

Excitation functions of deuteron-induced nuclear reactions on natural platinum up to 24 MeV

M.U. Khandaker, H. Haba, M. Murakami, N. Otuka, H.A. Kassim, *Nucl. Instrum. Meth. B* **362** (2015) pp. 151-162.

High-accuracy determination of the $^{238}\text{U}/^{235}\text{U}$ fission cross section ratio up to ≈ 1 GeV at n_TOF at CERN

C. Paradela, M. Calviani, D. Tarrío, E. Leal-Cidoncha, L. S. Leong, L. Tassan-Got, C. Le Naour, I. Duran, N. Colonna, L. Audouin, M. Mastromarco, S. Lo Meo, A. Ventura, G. Aerts, S. Altstadt, H. Alvarez, F. Alvarez-Velarde, S. Andriamonje, J. Andrzejewski, G. Badurek, M. Barbagallo, P. Baumann, V. Bećares, F. Becvar, F. Belloni, B. Berthier, E. Berthoumieux, J. Billowes, V. Boccone, D. Bosnar, M. Brugger, F. Calvino, D. Cano-Ott, R. Capote, et al. (n_TOF Collaboration), *Phys. Rev. C* **91** 024602

TANGRA-Setup for the Investigation of Nuclear Fission induced by 14.1 MeV neutrons

I.N. Ruskov, Yu.N. Kopatch, V.M. Bystritsky, V.R. Skoy, V.N. Shvetsov, F.-J. Hamsch, S. Oberstedt, R. Capote Noy, P.V. Sedyshev, D.N. Grozdanov, I.Zh. Ivanov, V.Yu. Aleksakhin, E.P. Bogolubov, Yu.N. Barmakov, S.V. Khabarov, A.V. Krasnoperov, A.R. Krylov, J. Obhodaš, L.B. Pikelner, V.L. Rapatskiy, A.V. Rogachev, Yu.N. Rogov, V.I. Ryzhkov, A.B. Sadovsky, R.A. Salmin, M.G. Sapozhnikov, V.M. Slepnev, D. Sudac, O.G. Tarasov, V. Valkovic, D.I. Yurkov, N.I. Zamyatin, Sh.S. Zeynalov, A.O. Zontikov, E.V. Zubarev, *Physics Procedia* **64** (2015) pp. 163-170.

Evaluation of the Prompt Fission Neutron Spectrum of Thermal-neutron Induced Fission in U-235

A. Trkov, R. Capote, *Physics Procedia* **64** (2015) pp. 48-54.

Impact of the Normalization Condition and Model Information on Evaluated Prompt Fission Neutron Spectra and Associated Uncertainties

D. Neudecker, R. Capote, D.L. Smith, T. Burr, P. Talou, *Nucl. Sci. Eng.* **179** (2015) pp. 381-397.

Evaluation of the ^{239}Pu prompt fission neutron spectrum induced by neutrons of 500 keV and associated covariances

D. Neudecker, P. Talou, T. Kawano, D.L. Smith, R. Capote, M.E. Rising, A.C. Kahler, *Nucl. Instrum. Meth. A* **791** (2015) pp. 80-92.

Random Sampling of Correlated Parameters - a Consistent Solution for Unfavourable Conditions

G. Zerovnik, A. Trkov, I.A. Kodeli, R. Capote, D.L. Smith, *Nucl. Data Sheets* **123** (2015) pp. 185-190.

Preliminary Evaluation and Uncertainty Quantification of the Prompt Fission Neutron Spectrum of ^{239}Pu

D. Neudecker, P. Talou, T.N. Taddeucci, R.C. Haight, T. Kawano, H.Y. Lee, D.L. Smith, R. Capote, M.E. Rising, and M.C. White, *Nucl. Data Sheets* **123** (2015) pp. 146-152.

Current Issues in Nuclear Data Evaluation Methodology: ^{235}U Prompt Fission Neutron Spectra and Multiplicity for Thermal Neutrons

A. Trkov, R. Capote, V.G. Pronyaev, *Nucl. Data Sheets* **123** (2015) pp. 8-15.

Production cross-sections of long-lived radionuclides in deuteron-induced reactions on natural zinc up to 23 MeV

M.U. Khandaker, H. Haba, M. Murakami, N. Otuka, *Nucl. Instrum. Meth. B* **346** (2015) pp. 8-16.

Definitions of radioisotope thick target yields

N. Otuka and S. Takács, *Radiochim. Acta* **103** (2015) pp. 1-6.

Recent Work Leading Towards a New Evaluation of the Neutron Standards

A.D. Carlson, V.G. Pronyaev, R. Capote, G.M. Hale, F.-J. Hamsch, T. Kawano, S. Kunieda, W. Mannhart, R.O. Nelson, D. Neudecker, P. Schillebeeckx, S. Simakov, D.L. Smith, P. Talou, X. Tao, A. Wallner, W. Wang *Nucl. Data Sheets* **123** (2015) pp. 27-35