Status of the Decay Data Evaluation Project (DDEP)

Nuclear Data Week 2020 – USNDP | Xavier Mougeot

list
ceatech

LNHB
Laboratoire National Henri Becquerel

LABORATOIRE NATIONAL DE MÉTROLOGIE ET D'ESSAIS
LNE

INSTITUT CARNOT
CEA LIST

université
PARIS-SACLAY

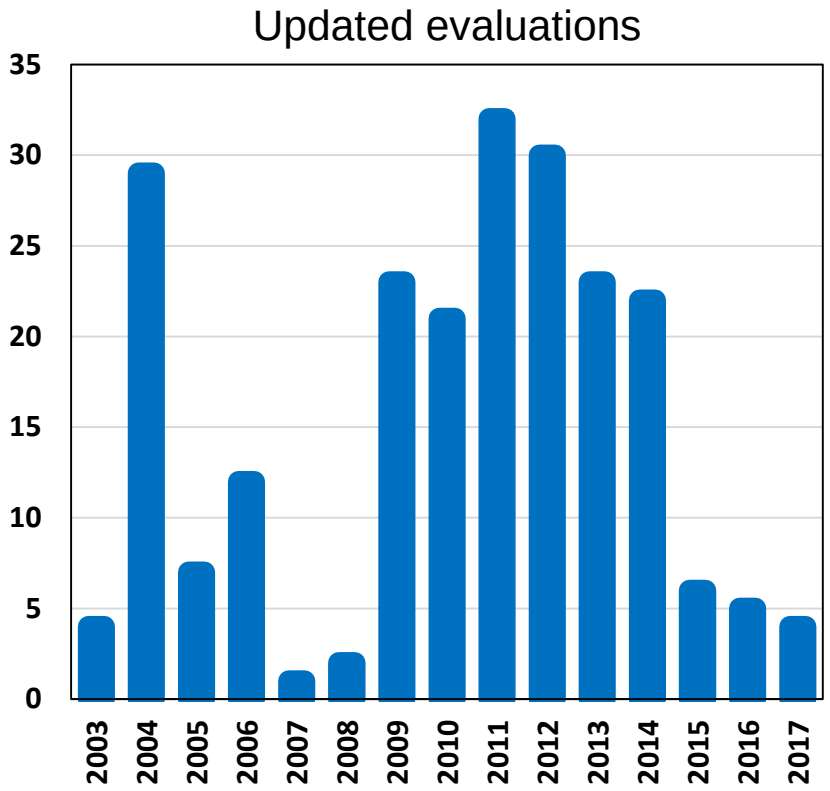
Decay Data Evaluation Project (DDEP)

- Decay data evaluations for the metrology community. Initiated by PTB (Germany) and LNHB (France) in 1993, joined by US evaluators in 1994.
- DDEP decay data are officially recommended by the BIPM.
- DDEP is also linked to the metrology community through the ICRM Working Group “Nuclear Decay Data”, coordinated by Mark A. Kellett.
- Latest DDEP meeting (online) on October 26, 2020. 34 attendees from 15 different countries.
- Change in the coordination: Mark A. Kellett (since 2016) → Xavier Mougeot.
- Since then, assessment of the current situation.

Evaluators

- **LNHB team** (part time)
  - Christophe Dulieu (IT support)
  - Mark A. Kellett (special advisor)
  - Yann Kergadallan (evaluations)
  - Sylvain Leblond (evaluations)
  - Xavier Mougeot (coordination, evaluations)
- **International**
  - **China**: Xiaolong Huang (CIAE) and Haoran Liu (Metrology Institute)
  - **Romania**: Aurelian Luca (IFIN-HH)
  - **Russia**: Nikolai Kuzmenko (KRI)
  - **UK**: Rob Shearman, Sean Collins, Andrew Fenwick (NPL)
  - **US**: Brian Zimmerman (NIST)
  - Additional support: Tibor Kibédi (ANU, **Australia**) – *BrIcc & BrIccMixing codes* and others from the wider community who help in the review process, e.g. Balraj Singh (McMaster, **Canada**)

Evaluations



Total: 221

Pending nuclei: 15

^{45}Ti, ^{52}Mn, ^{52m}Mn, ^{55}Co, ^{56}Co, ^{87}Rb, ^{124}I, ^{133}Xe, ^{135}Xe, ^{135m}Xe, ^{226}Th, ^{227}Th, ^{229}Th, ^{230}U, ^{233}U

First priority: reviewing and publishing

Revamped website

Previous website no longer maintained: ~~nucleide.org~~

DDEP decay data are now made available on the new LNHB website:

http://www.lnhb.fr/nuclear-data/nuclear-data-table/

This introduction presents a brief description of the radioactivity physical processes, the enumeration of the evaluation rules leading to the recommended values, and a summary of the symbols and terms used in all the publications.

Explanation on recommended data and their evaluation (in various languages):

Please cite our evaluations using the following references:

Vol.	Publication	Year	ISBN	NSR	BibTeX
99	CEA Report – Table de Radionucléides	1999	2-7272-0200-8	1999BeZO	TabRad_v0.bib
1	Monographie BIPM-5 – Table of Radionuclides, vol. 1	2004	92-822-2206-3	2004BeZR	TabRad_v1.bib
2	Monographie BIPM-5 – Table of Radionuclides, vol. 2	2004	92-822-2207-1	2004BeZO	TabRad_v2.bib
3	Monographie BIPM-5 – Table of Radionuclides, vol. 3	2006	92-822-2218-7	2006BeZL	TabRad_v3.bib
4	Monographie BIPM-5 – Table of Radionuclides, vol. 4	2008	92-822-2231-4	2008BeZV	TabRad_v4.bib

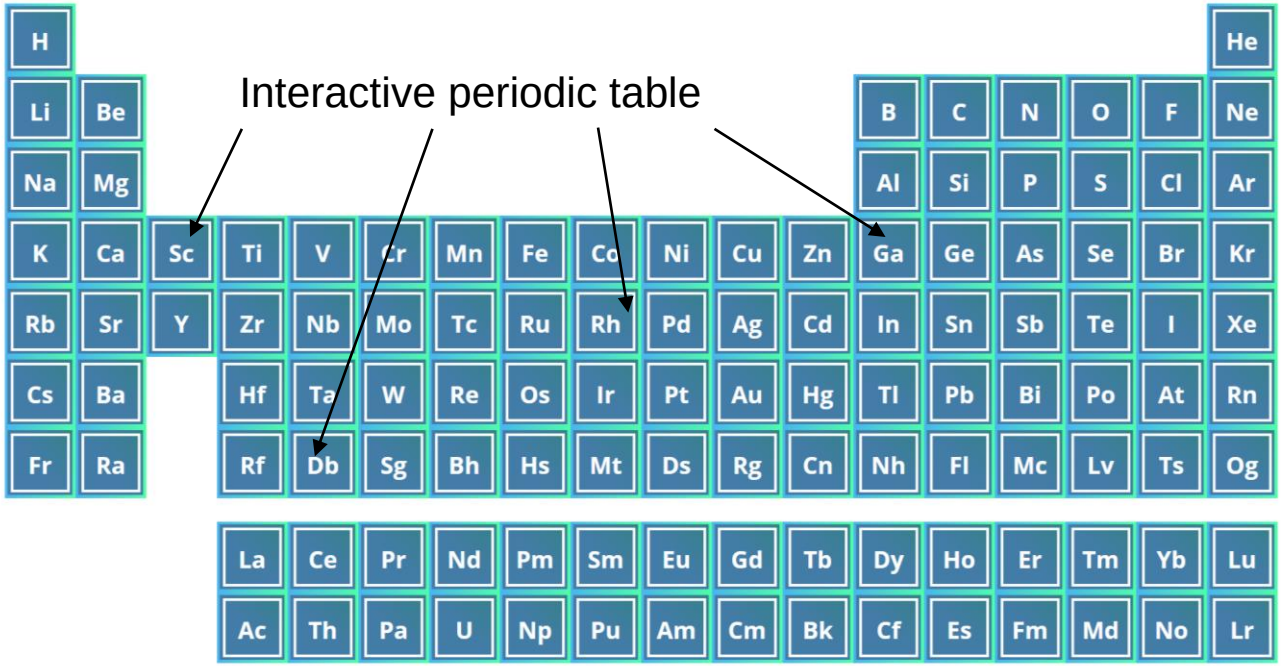
Vol.	Publication	Year	ISBN	NSR	BibTeX
5	Monographie BIPM-5 – Table of Radionuclides, vol. 5	2010	978-92-822-2234-8	2010BeZO	TabRad_v5.bib
6	Monographie BIPM-5 – Table of Radionuclides, vol. 6	2011	978-92-822-2242-3	2011BeZW	TabRad_v6.bib
7	Monographie BIPM-5 – Table of Radionuclides, vol. 7	2013	978-92-822-2248-5	2013BeZP	TabRad_v7.bib
8	Monographie BIPM-5 – Table of Radionuclides, vol. 8	2016	978-92-822-2264-5	2016BeZX	TabRad_v8.bib
9	Monographie BIPM-5 – Table of Radionuclides, vol. 9	2020	to be published	-	-

Filter data:

Enter value

by Element by Atomic number (Z) by Mass number (A)

Revamped website



Sort by:

Atomic number

Additional files

E: ENSDF - **P**: PenNuc - **L**: Lara - **B**: BetaShape spectra

Nuclide		Z	Vol. (?)	UpDate	Type (?)	Table (?)	Comments (?)	ASCII files (?)
H-3	^{3}H	1	3	04/09/2006	1	T	C	E P L B
Be-7	^{7}Be	4	1	18/02/2004	1	T	C	E P L B

PenNuc

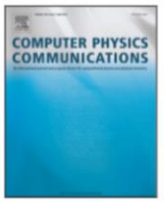
Radioactive decay module for the PENELOPE Monte Carlo code using DDEP data

Computer Physics Communications 245 (2019) 106849

Contents lists available at ScienceDirect

Computer Physics Communications

journal homepage: www.elsevier.com/locate/cpc



PENNUC: Monte Carlo simulation of the decay of radionuclides☆

E. García-Toraño [a], V. Peyres [a], F. Salvat [b,*]

[a] Laboratorio de Metrología de Radiaciones Ionizantes, CIEMAT, Avda. Complutense 22, 28040 Madrid, Spain
[b] Facultat de Física (FQA and ICC), Universitat de Barcelona, Diagonal 645, 08028 Barcelona, Catalonia, Spain

ARTICLE INFO

Article history:
Received 18 November 2018
Received in revised form 17 June 2019
Accepted 1 August 2019
Available online 7 August 2019

Keywords:
Nuclear decay
Atomic relaxation
Radioactive sources
Monte Carlo simulation

ABSTRACT

The Fortran subroutine package PENNUC that performs Monte Carlo simulation of the decay of radioactive nuclides is described. The adopted nuclear decay characteristics (possible disintegration modes and branching ratios, energies and half-lives of nuclear energy levels, types and energies of emitted particles) are from the NUCLEIDE evaluated database (http://www.nucleide.org/DDEP_WG/DDEPdata.htm) in the specific format PenNuc. The initial energies of electrons and positrons emitted in beta disintegrations are sampled from their continuous spectra by means of the RITA (rational inverse transform with aliasing) algorithm, which is described in the Appendix. Electronic relaxation of the residual ion after electron capture and internal conversion is simulated by using the data and sampling methods of the PENELOPE code system. At each call the subroutines deliver a list of state variables of the particles (photons, electrons, positrons and alphas) emitted in a random decay path of the considered radionuclide down to a metastable level or to the ground state of the daughter nucleus. The

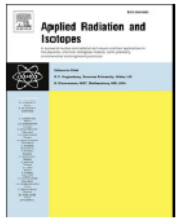
Nuclide++

Applied Radiation and Isotopes 156 (2020) 108964

Contents lists available at ScienceDirect

Applied Radiation and Isotopes

journal homepage: http://www.elsevier.com/locate/apradiso



Nuclide++: A C++ module to include DDEP recommended radioactive decay Data in Geant4

C. Thiam [a,*], C. Dulieu [a], X. Mougeot [a], A. Nair [b], C. Bobin [a], M.A. Kellett [a]

[a] CEA, LIST, Laboratoire National Henri Becquerel (LNE-LNHB), Bât 602, PC111, CEA Paris-Saclay, 91191, Gif-sur-Yvette Cedex, France
[b] Department of Nuclear Science and Technology in Mody University of Science and Technology, Rajasthan, India

ARTICLE INFO

Keywords:
Radioactive decay
DDEP data
Geant4 simulation

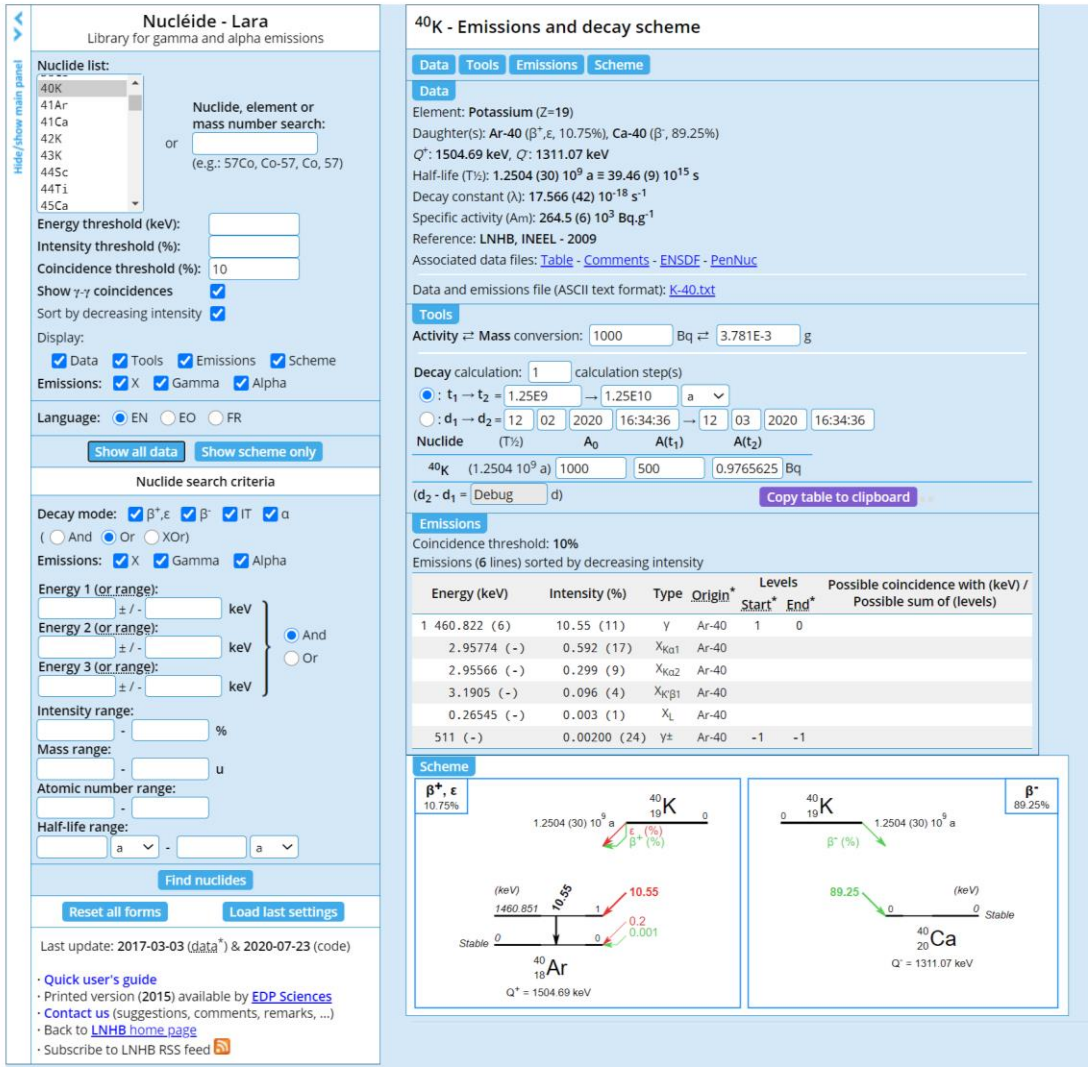
ABSTRACT

This article describes the Nuclide++ module developed at LNE-LNHB to simulate the decay schemes related to single or multiple radionuclides, by randomly selecting decay pathways. Written in C++, with respect of the Geant4 coding style, this module can be used transparently in Geant4-based simulation applications as an alternative to the existing Radioactive Decay Module (RDM). Nuclide++ takes advantage of the DDEP recommended data, accurate β-emitting spectra calculation and detailed description of the atomic rearrangement. This module can be useful in many applications, especially those involving radioactive sources. The reliability of the module was verified through comparisons with a while chosen radionuclides.

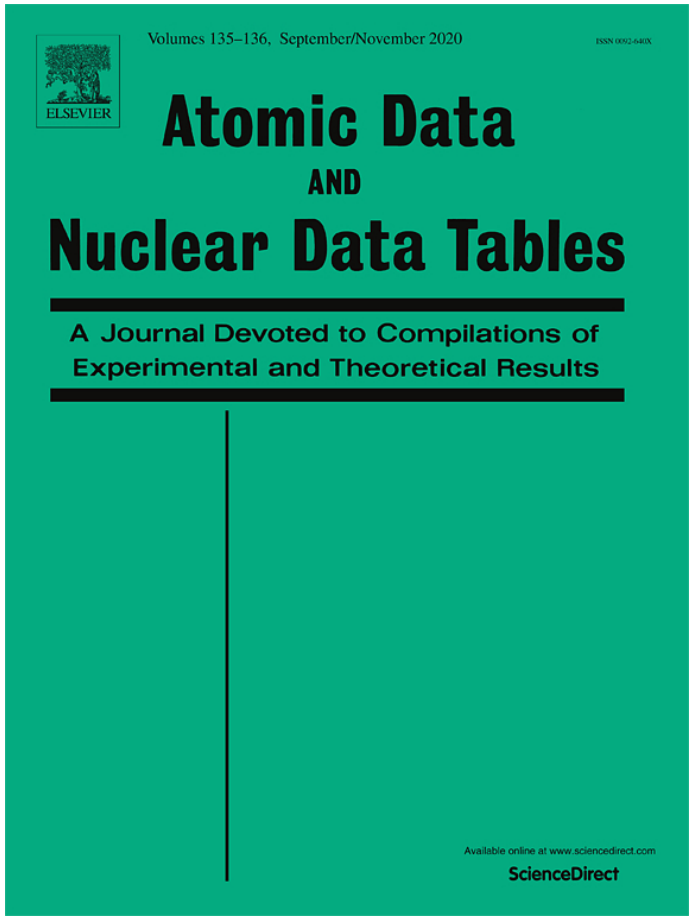
Laraweb

Web interface with many features

http://www.lnhb.fr/donnees-nucleaires/module-lara/



Publication of Lara Tables



Lara Tables: Library for alpha, X and gamma emissions sorted by increasing energy.

We would like to publish an updated version in Atomic Data and Nuclear Data Tables (open access).

We are waiting for the publication of the pending nuclei.

Measurements at LNHB: ^{103}Pd

Applied Radiation and Isotopes 167 (2021) 109298

Contents lists available at ScienceDirect

Applied Radiation and Isotopes

journal homepage: http://www.elsevier.com/locate/apradiso

Measurement of the absolute gamma-ray emission intensities from the decay of 103Pd

J. Riffaud, M.-C. Lépy *, P. Cassette, M. Corbel, M.A. Kellett, V. Lourenço

CEA, LIST, Laboratoire National Henri Becquerel (LNE-LNHB), Bât. 602 PC 111, CEA-Saclay, 91191, Gif-sur-Yvette Cedex, France

New measurement of ^{103m}Rh decay and evaluation of ^{103}Pd/^{103m}Rh scheduled in 2021.

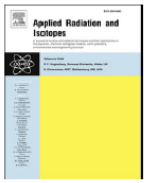
Measurements at LNHB: ^{147}Nd

Applied Radiation and Isotopes 166 (2020) 109349

Contents lists available at ScienceDirect

Applied Radiation and Isotopes

journal homepage: http://www.elsevier.com/locate/apradiso



Measurement of the absolute gamma-ray emission intensities from the decay of ^{147}Nd

M.A. Kellett [a,*], L. Vio [b], C. Bobin [a], L. Brondeau [a], M. Cardot-Martin [a], H. Isnard [b], D. Lacour [a], M.-C. Lépy [a], V. Lourenço [a], M. Marie [b], C. Thiam [a]

[a] CEA, LIST, Laboratoire National Henri Becquerel (LNE-LNHB), Bât. 602 PC111, CEA-Saclay, 91191, Gif-sur-Yvette Cedex, France
[b] CEA, DEN, Laboratoire de développement Analytique Nucléaire Isotopique et Elémentaire (LANIE), Bât. 391 PC33, CEA-Saclay, 91191, Gif-sur-Yvette Cedex, France

ARTICLE INFO

Keywords:
absolute gamma ray emission intensities
Nd-147
HPGe detector
4πβ–γ coincidence
4πγ counting
Radionuclide metrology

ABSTRACT

The 2011 Decay Data Evaluation Project (DDEP) evaluation for ^{147}Nd includes recommended absolute emission intensities for the two main gamma-rays at 91.105 (2) keV and 531.016 (22) keV of 0.284 (18) and 0.127 (9) respectively, i.e. with uncertainties of 6.3% and 7.1%. These large uncertainties stem from inconsistencies in the published data and are unfit for modern purposes, since the production of ^{147}Nd is used as an important neutron flux dosimeter.

The LNE-LNHB has undertaken new absolute gamma-ray emission intensity measurements. The results of these measurements will be presented, along with a full uncertainty budget, and their effect on the recommended data uncertainties will be discussed.

Pending update of the evaluation: waiting for Los Alamos and NPL new measurements.

DDEP data in the European JEFF database

Eur. Phys. J. A (2020) 56:181
https://doi.org/10.1140/epja/s10050-020-00141-9

THE EUROPEAN PHYSICAL JOURNAL A

Review

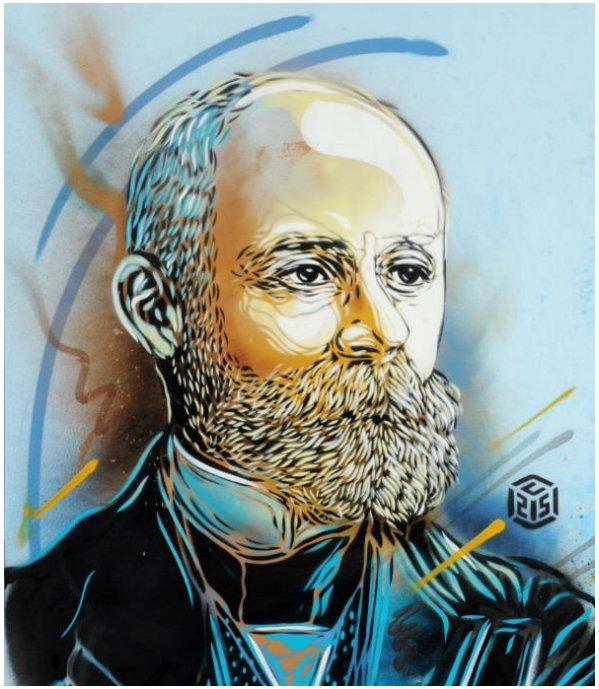
The joint evaluated fission and fusion nuclear data library, JEFF-3.3

A. J. M. Plompen[1,a], O. Cabellos[2], C. De Saint Jean[3], M. Fleming[4,5], A. Algora[6], M. Angelone[7], P. Archier[8], E. Bauge[3], O. Bersillon[3], A. Blokhin[9], F. Cantargi[10], A. Chebboubi[8,11], C. Diez[12], H. Duarte[3], E. Dupont[13], J. Dyrda[4], B. Erasmus[14], L. Fiorito[4,15], U. Fischer[16], D. Flammini[7], D. Foligno[8], M. R. Gilbert[5], J. R. Granada[10], W. Haeck[17], F.-J. Hambsch[1], P. Helgesson[18], S. Hilaire[3], I. Hill[4], M. Hursin[19], R. Ichou[17], R. Jacqmin[8], B. Jansky[20], C. Jouanne[21], M. A. Kellett[22], D. H. Kim[23], H. I. Kim[23], I. Kodeli[24], A. J. Koning[25], A. Yu. Konobeyev[16], S. Kopecky[1], B. Kos[24], A. Krása[15], L. C. Leal[17], N. Leclaire[17], P. Leconte[8], Y. O. Lee[23], H. Leeb[26], O. Litaize[8], M. Majerle[27], J. I Márquez Damián[10], F. Michel-Sendis[4], R. W. Mills[28], B. Morillon[3], G. Noguère[8], M. Pecchia[19], S. Pelloni[19], P. Pereslavtsev[16], R. J. Perry[29], D. Rochman[19], A. Röhrmoser[30], P. Romain[3], P. Romojaro[31], D. Roubtsov[32], P. Sauvan[33], P. Schillebeeckx[1], K. H. Schmidt[34], O. Serot[8], S. Simakov[16], I. Sirakov[35], H. Sjöstrand[18], A. Stankovskiy[15], J. C. Sublet[25], P. Tamagno[3], A. Trkov[25], S. van der Marck[14], F. Álvarez-Velarde[31], R. Villari[7], T. C. Ware[29], K. Yokoyama[36], G. Žerovnik[1]

[1] European Commission, Joint Research Centre, 2440 Geel, Belgium
[2] Department of Energy Engineering, Universidad Politécnica de Madrid, 28006 Madrid, Spain
[3] CEA, DAM, DIF, 91297 Arpajon, France
[4] OECD Nuclear Energy Agency, 92100 Boulogne-Billancourt, France
[5] UK Atomic Energy Authority, Culham Science Centre, Abingdon OX14 3DB, UK
[6] Instituto de Física Corpuscular, CSIC-Universidad de Valencia, 46071 Valencia, Spain
[7] ENEA, Fusion and Technology for Nuclear Safety and Security Department, 00044 Frascati, Italy
[8] CEA, DEN, DER, SPRC, LEPh, 13108 Saint-Paul-lez-Durance, France
[9] Nuclear Safety Institute of the Russian Academy of Science, Moscow, Russia
[10] Neutron Physics Department, Centro Atomico Bariloche, San Carlos de Bariloche, Argentina
[11] LPSC, Université Grenoble-Alpes, CNRS/IN2P3, 38026 Grenoble Cedex, France
[12] Consejo de Seguridad Nuclear, Madrid, Spain
[13] CEA, IRFU, 91191 Gif-sur-Yvette, France

Link with NSDD

- Discussions during the latest DDEP meeting with Balraj Singh.
- Common rules for evaluating half-lives: guidelines from Alan L. Nichols and Balraj Singh to be circulated within DDEP.
- Possible joint evaluations: ^{137}Cs, ^{147}Nd, ^{194}Ir, ^{194m}Ir.
- If interest in some pending nuclei, help in reviewing is more than welcome.
- When published, DDEP can send the evaluation, e.g. to the coordinator of the corresponding mass chain.



Thank you for your attention

Commissariat à l'énergie atomique et aux énergies alternatives
Institut List | CEA SACLAY NANO-INNOV | BAT. 861 – PC142
91191 Gif-sur-Yvette Cedex - FRANCE
www-list.cea.fr

Établissement public à caractère industriel | RCS Paris B 775 685 019