

DE LA RECHERCHE À L'INDUSTRIE



RADIONUCLIDES DECAY DATA

NKS GammaUser 2014
Helsinki 6-8 October 2014

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RADIONUCLIDE DECAY DATA

International cooperation (Decay Data Evaluation Project) (DDEP)

initiated and coordinated by LNHB since 1994

LNHB (France), PTB (Germany), INEEL and LBNL (USA), KRI (Russia)

with the objective of providing carefully recommended data in the field of nuclear and associated atomic data related to the nuclear disintegration for use in applied research and detector calibrations

- defined methodology to be used in the evaluations,
- for specific data like Q-values or Internal Conversion Coefficients, to select a recommended set of values established by specialists in this field,
- written documentation of all data used and all decisions and calculations done during the evaluation process
- reviewing of each new evaluation by several members of the group.

The results of these DDEP evaluations are compiled and edited by the LNHB as a Monographie published under the auspice of the Bureau International des Poids et Mesures (BIPM).

Moreover the *International Committee for Radionuclide Metrology (ICRM)* formally approved the recommendation made by the Nuclear Data Working Group of using the DDEP evaluated decay data in all future nuclear data studies.

LNHB Publications

Monographie BIPM-5

Table of Radionuclides
(Vol.1 - A = 1 to 150)

M.-M. Bé, V. Chisté, C. Dulin
E. Browne
V. Chechev, N. Kuzmenko
R. Helmer
A. Nichols
E. Schönfeld, R. Dersch

2004

BUREAU INTERNATIONAL DES POIDS ET MESURES
Pavillon de Breteuil, F-92310 SÈVRES

BUREAU INTERNATIONAL DES POIDS ET MESURES
BIPM
Monographie
BIPM-5
Table of Radionuclides
Tables published in Vol. 1 & 2 and associated
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BNM

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Recommended data

This [production](#) 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):

Tables of evaluated data and comments on evaluation
Pages updated by the Laboratoire National Henri Becquerel
All questions about the data must be sent to the authors. See chapter [Addresses](#)

updated: 29th September 2014
newly added: 22-89
recently updated: 14-59
ASCI files updated on: 16/07/2014
(215 nuclides in table, sorted by alphabetical order / [atomic number](#) / [mass number](#) / [addition date](#))

[History of older evaluations](#), sorted by alphabetical order)

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(Type of updates: N - new evaluation, 1 - update in comments only, 2 - minor update in table, 3 - major update in table)

Nuclide	Tables	Comments	ENSDF	ASCII	In	Update	Type
Ac-225	225Ac	table	comments	ensdf	txt	2008/09/09	2
Ac-227	227Ac	table	comments	ensdf	txt	16/02/2009	2
Ac-228	228Ac	table	comments	ensdf	txt	23/01/2010	3
Ag-108	108Ag	table	comments	ensdf	txt	4/03/2006	2
Ag-109m	109mAg	table	comments	ensdf	txt	17/01/2012	2
Ag-110	110Ag	table	comments	ensdf	txt	12/03/2004	1
Ag-110m	110mAg	table	comments	ensdf	txt	24/03/2004	1
Al-26	26Al	table	comments	ensdf	txt	24/07/2003	1
Am-241	241Am	table	comments	ensdf	txt	20/09/2010	2
Am-242	242Am	table	comments	ensdf	txt	18/01/2011	2
Am-242m	242mAm	table	comments	ensdf	txt	18/01/2011	2
Am-243	243Am	table	comments	ensdf	txt	30/05/2010	2
Am-244m	244mAm	table	comments	ensdf	txt	18/01/2011	2
Ar-37	37Ar	table	comments	ensdf	txt	16/10/2012	2
Ar-41	41Ar	table	comments	ensdf	txt	4/05/2010	3
At-211	211At	table	comments	ensdf	txt	05/04/2011	4

Nuclide	Tables	Comments	ENSDF	ASCII	In	Update	Type
Be-9	9Be	table	comments	ensdf	txt	16/02/2009	2
O-15	15O	table	comments	ensdf	txt	1/06/2004	1
P-32	32P	table	comments	ensdf	txt	8/04/2004	1
P-33	33P	table	comments	ensdf	txt	8/04/2004	1
Pa-231	231Pa	table	comments	ensdf	txt	23/02/2011	3
Pa-233	233Pa	table	comments	ensdf	txt	11/01/2010	2
Pa-234	234Pa	table	comments	ensdf	txt	31/01/2011	3
Pa-234m	234mPa	table	comments	ensdf	txt	31/01/2011	3
Pb-203	203Pb	table	comments	ensdf	txt	30/09/2008	3
Pb-209	209Pb	table	comments	ensdf	txt	30/05/2011	4
Pb-210	210Pb	table	comments	ensdf	txt	17/01/2012	2
Pb-211	211Pb	table	comments	ensdf	txt	4/01/2013	1
Pb-212	212Pb	table	comments	ensdf	txt	2/05/2011	2
Pb-214	214Pb	table	comments	ensdf	txt	18/01/2011	2
Pd-109	109Pd	table	comments	ensdf	txt	22/01/2010	1
Pm-147	147Pm	table	comments	ensdf	txt	4/01/2013	2

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MINI TABLE DE
RADIONUCLÉIDES
2007

Versions
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Web site :
www.nucleide.org

<http://www.nucleide.org/NucData.htm>

DDEP works

Recommended data

Au-195	¹⁹⁵ Au	table	comments	ensdf	txt	7	4/01/2013	1
Au-198	¹⁹⁸ Au	table	comments	ensdf	txt	8	24/03/2014	3
Ba-133	¹³³ Ba	table	comments	ensdf	txt	1	9/07/2014	2
Ba-137m	^{137m} Ba	table	comments	ensdf	txt	99	24/07/2003	1
Ba-140	¹⁴⁰ Ba	table	comments	ensdf	txt	1	19/06/2008	2
Be-7	⁷ Be	table	comments	ensdf	txt	1	18/02/2004	1

Comments on evaluation

¹³³Ba

¹³³Ba - Comments on evaluation of decay data
by V. P. Chechev and N. K. Kuzmenko

This evaluation was done in May 1999, and revised in April 2000. The literature available by April 2000 was included. The half-life was revised in January 2004 using new references available by 2004.

Comment on ^{133}Ba half-life

The ^{133}Ba half-life values available from 1961 are, in days:

3908(73) 1961Wy01
2849(37) 1968La10 Rejected, large deviation from mean
3894(44) 1968Re04
3781(15) 1970Wa19 Rejected, revised in 1983Wa26
3981(37) 1972Em01 Rejected by Chauvenet's criterion
4127(260) 1973LI01 Rejected by Chauvenet's criterion
3850(55) 1979HaYC
3785(27) 1980RuZY
3848.0(11) 1980Ho17
3828(11) 1982HoZJ Rejected, revised in 1992Un01
3885.9(43) 1983Ki08
3842(18) 1983Wa26
3853.6(36) 1992Un01 Rejected, revised in 2002Un02
3848.9(7) 1997Ma75
3854.7(28) 2002Un02
3840.5(65) 2003Schrader

3849.7(22) Mean value

Comments on evaluation

^{133}Ba

Table 1. The experimental and evaluated values for γ -ray relative emission probabilities

	$\gamma 53$	$\gamma 80$	$\gamma 81$	$\gamma 161$	$\gamma 223$	$\gamma 276$	$\gamma 303$	$\gamma 356$	$\gamma 384$
1967B115	3,8(8)	3,8(4)	53(4)	1,1(3)	0,7(3)	11,0(7)†	30(2)	100	14,5(1)
1968Al16	3,3(5)	-	-	1,20(6)†	0,74(6)	12,0(4)†	30,6(9)†	100	14,2(5)
1968Bo04	4,2(2)†	4,0(4)	58,2(15)	1,07(5)	0,78(6)	11,8(3)	29,8(8)	100	14,3(10)
1968Do10	3,2(4)	5,5(7)†	52(7)	0,99(10)	0,72(8)	11,6(8)	29,4(2)	100	14,3(10)
1968No01	3,78(9)	4,9(6)	60(7)	1,21(5)†	0,80(3)†	11,61(17)	29,75(29)	100	14,18(26)
1969Gu15	2,91(5)	4,54(7)	53,7(17)	1,13(15)	-	11,2(3)	29,3(5)	100	14,03(26)†
1972Sc08	3,54(5)	3,9(2)	52,6(10)	1,16(5)	0,74(4)	11,4(3)	30,2(6)	100	14,4(3)
1973In06	-	-	-	0,98(7)	0,76(5)	11,6(5)	29,6(11)	100	14,9(6)†
1973Legrand	-	3,7(4)	56(6)	1,4(2)†	0,66(2)†	11,35(25)	29,4(6)	100	14,3(3)
1973Mc18	-	-	-	-	-	11,43(23)	29,3(6)	100	14,5(3)
1977Ge12	3,0(4)	5,6(15)†	52(4)	1,12(8)	0,85(7)†	11,7(8)	29,87(21)	100	14,4(11)
1977Sc31	3,49(8)	4,29(12)	55,8(16)	0,97(3)	0,73(3)	11,41(16)	29,4(3)	100	14,33(21)
1978He21	3,54(18)	3,1(3)†	49,2(26)	1,08(4)	0,745(25)	11,7(4)	29,8(4)	100	14,36(20)
1978Vylov	3,57(12)	4,16(18)	54,6(17)	0,98(8)	0,71(4)	11,4(3)	28,8(8)†	100	14,3(5)
1980Ro22	-	-	-	1,03(7)	0,72(5)	11,69(16)	29,9(4)	100	14,79(27)†
1983Yo03	-	-	-	1,035(28)	0,756(16)	11,57(7)	29,55(18)	100	14,36(9)
1987Lakshn	2,96(9)	4,67(14)	55,3(16)	-	-	-	-	100	-
1989Da11	3,6(5)	3,7(5)	52,3(7)	1,032(10)	0,713(8)	11,51(8)	29,51(23)	100	13,99(9)†
1990Fe15	3,48(7)	3,77(9)	51,2(4)	1,05(3)	0,71(2)	11,3(2)	29,2(3)	100	14,5(2)
1998Hw07	-	-	-	0,950(18)	0,715(10)	11,64(13)	29,31(40)	100	14,52(17)
CRP-1	-	-	-	1,11(9)	0,85(5)†	11,7(4)	29,9(11)	100	14,5(5)
CRP-2	3,56(14)	-	53,1(19)	0,99(4)	0,729(28)	11,7(3)	30,1(9)	100	14,4(5)
CRP-3	3,53(8)	4,20(12)	54,8(12)	1,031(24)	0,69(3)	11,51(14)	29,5(3)	100	14,37(16)
CRP-4	3,53(7)	4,18(11)	54,6(12)	1,037(20)	0,730(22)	11,48(14)	29,5(4)	100	14,41(16)
CRP-5	3,9(7)	4,00(15)	51,5(19)	1,020(27)	0,728(22)	11,5(3)	29,5(9)	100	14,2(5)
CRP-6	3,45(8)	4,73(12)	57,6(14)	1,020(25)	0,728(18)	11,68(28)	29,7(7)	100	14,5(4)
CRP-7	3,56(8)	4,73(12)	58,9(15)	1,070(27)	0,738(18)	11,50(28)	29,6(7)	100	14,3(4)
CRP-8	-	-	-	-	-	11,22(27)	29,3(6)	100	14,53(28)
CRP-9	-	-	-	-	-	11,22(24)	29,3(5)	100	14,26(25)
CRP-10	-	-	-	-	-	11,48(25)	29,3(5)	100	14,20(22)
CRP-11	-	-	-	-	-	11,57(19)	29,4(4)	100	14,34(26)
CRP-12	3,69(18)	4,37(16)	55,3(18)	1,050(19)	0,741(15)	11,53(16)	29,5(4)	100	14,36(20)
CRP-13	2,92(16)	-	-	-	0,75(3)	11,9(4)	30,2(11)	100	14,6(5)
CRP-14	3,53(8)	4,39(11)	55,9(12)	1,015(20)	0,735(10)	11,61(13)	29,6(4)	100	14,34(18)

KRI/V. P. Chechev, N. K. Kuzmenko

Jan. 2004

1998Hw07	-	-	-	0,950(18)	0,715(10)	11,64(13)	29,31(40)	100	14,52(17)
CRP-1	-	-	-	1,11(9)	0,85(5)†	11,7(4)	29,9(11)	100	14,5(5)
CRP-2	3,56(14)	-	53,1(19)	0,99(4)	0,729(28)	11,7(3)	30,1(9)	100	14,4(5)
CRP-3	3,53(8)	4,20(12)	54,8(12)	1,031(24)	0,69(3)	11,51(14)	29,5(3)	100	14,37(16)
CRP-4	3,53(7)	4,18(11)	54,6(12)	1,031(20)	0,719(22)	11,49(14)	29,5(4)	100	14,41(15)
CRP-5	3,5(7)	4,0(11)	51,1(19)	1,020(20)	0,718(22)	11,5(3)	29,5(9)	100	14,3(5)
CRP-6	3,45(8)	4,73(12)	57,6(14)	1,020(25)	0,728(18)	11,68(28)	29,7(7)	100	14,5(4)
CRP-7	3,56(8)	4,73(12)	58,9(15)	1,070(27)	0,738(18)	11,50(28)	29,6(7)	100	14,3(4)
CRP-8	-	-	-	-	-	11,22(27)	29,3(6)	100	14,53(28)
CRP-9	-	-	-	-	-	11,22(24)	29,3(5)	100	14,26(25)
CRP-10	-	-	-	-	-	11,48(25)	29,3(5)	100	14,20(22)
CRP-11	-	-	-	-	-	11,57(19)	29,4(4)	100	14,34(26)
CRP-12	3,69(18)	4,37(16)	55,3(18)	1,050(19)	0,741(15)	11,53(16)	29,5(4)	100	14,36(20)
CRP-13	2,92(16)	-	-	-	0,75(3)	11,9(4)	30,2(11)	100	14,6(5)
CRP-14	3,53(8)	4,39(11)	55,9(12)	1,015(20)	0,735(10)	11,61(13)	29,6(4)	100	14,34(18)

KRI/V. P. Chechev, N. K. Kuzmenko

Jan. 2004

Comments on evaluation

¹³³Ba

	γ_{53}	γ_{80}	γ_{81}	γ_{161}	γ_{223}	γ_{276}	γ_{303}	γ_{356}	γ_{384}
CRP-15	3,36(18)	-	-	1,05(4)	0,758(28)	11,7(5)	29,6(10)	100	14,3(4)
CRP-16	3,26(17)	-	-	1,05(4)	0,764(26)	11,7(4)	29,7(6)	100	14,3(3)
CRP-19	3,53(5)	-	-	1,063(17)	0,725(17)	11,61(12)	29,7(3)	100	14,53(13)
CRP-20	3,53(6)	4,05(8)	55,1(9)	1,05(5)	0,72(4)	11,49(21)	29,4(6)	100	14,51(22)
CRP-21	3,62(6)	4,15(12)	55,8(9)	1,039(15)	0,705(11)	11,57(17)	29,5(4)	100	14,40(20)
Number of input values	27	20	24	29	28	36	36		34
Reduced χ^2	7,21	5,54	4,08	1,68	0,79	0,37	0,29		0,20
Weighted average	3,45	4,27	53,4	1,032	0,726	11,54	29,55		14,41
Internal uncertainty	0,017	0,029	0,23	0,0048	0,0035	0,030	0,064		0,037
External uncertainty	0,046	0,068	0,47	0,0062	0,0031	0,018	0,035		0,016
Adopted value	3,45(5) ^a	4,27(8) ^a	53,1(5) ^b	1,028(8) ^c	0,730(5) ^c	11,54(7) ^a	29,55(18) ^a	100	14,41(9) ^a

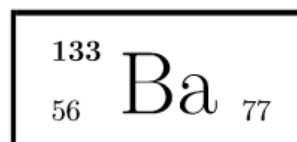
† Omitted as outliers

^a The least uncertainty of experimental values

^b Adopted value has been changed slightly from the weighted average for a precise ground state intensity balance to get. Such a small change only for one gamma-ray supports the adopted experimental value of 62,05(19) % for the 356 keV γ -ray absolute emission probability and confirms the decay scheme. The adopted uncertainty of 0,5 is external.

^c Computed using the absolute emission probability measured in 1996Mi26.

In that work a special precise measurements of the absolute emission probabilities only for the two weak 161 and 223 keV gamma-rays were made by using a $4\pi\beta(\text{ppc})\text{-}\gamma(\text{HPGe})$ coincidence system.



1 Decay Scheme

Ba-133 disintegrates by electron capture to Cs-133 via the excited states of 437 keV (86.1%) and of 383 keV (13.9%).

Le baryum 133 se désintègre par capture électronique vers des niveaux excités de 437 et 383 keV du césium 133.

2 Nuclear Data

$$T_{1/2}({}^{133}\text{Ba}) : 10,540 \quad (6) \quad \text{a}$$

$$Q^+({}^{133}\text{Ba}) : 517,4 \quad (10) \quad \text{keV}$$

2.1 Electron Capture Transitions

	Energy (keV)	Probability (%)	Nature	lg <i>ft</i>	<i>P_K</i>	<i>P_L</i>	<i>P_M</i>
$\epsilon_{0,4}$	80,4 (10)	86,2 (5)	Allowed	6,68	0,672 (5)	0,252 (4)	0,0612 (13)
$\epsilon_{0,3}$	133,6 (10)	13,7 (4)	Allowed	8,07	0,7734 (21)	0,1761 (15)	0,0408 (8)
$\epsilon_{0,2}$	356,8 (10)	< 0,3	2nd Forbidden	> 10,6	0,79 (3)		
$\epsilon_{0,1}$	436,4 (10)	< 0,7	2nd Forbidden	> 10,6	0,88 (4)		
$\epsilon_{0,0}$	517,4 (10)	< 0,0005	Uniq. 2ndForbidden	> 13,9			

5 Photon Emissions

5.1 X-Ray Emissions

		Energy (keV)	Photons (per 100 disint.)	
XL	(Cs)	3,8 - 5,7	16,0 (8)	
XK α_2	(Cs)	30,625	34,0 (4)	} K α
XK α_1	(Cs)	30,973	62,8 (7)	
XK β_3	(Cs)	34,92	} 18,2 (2)	} K' β_1
XK β_1	(Cs)	34,987		
XK β_5''	(Cs)	35,245		
XK β_5'	(Cs)	35,259		
XK β_2	(Cs)	35,818	} 4,6 (1)	} K' β_2
XK β_4	(Cs)	35,907		
XKO $_{2,3}$	(Cs)	35,972		

5.2 Gamma Emissions

	Energy (keV)	Photons (per 100 disint.)
$\gamma_{4,3}$ (Cs)	53,1622 (6)	2,14 (3)
$\gamma_{2,1}$ (Cs)	79,6142 (12)	2,65 (5)
$\gamma_{1,0}$ (Cs)	80,9979 (11)	32,9 (3)
$\gamma_{2,0}$ (Cs)	160,6121 (16)	0,638 (4)
$\gamma_{3,2}$ (Cs)	223,2368 (13)	0,453 (3)
$\gamma_{4,2}$ (Cs)	276,3989 (12)	7,16 (5)
$\gamma_{3,1}$ (Cs)	302,8508 (5)	18,34 (13)
$\gamma_{4,1}$ (Cs)	356,0129 (7)	62,05 (19)
$\gamma_{3,0}$ (Cs)	383,8485 (12)	8,94 (6)

Gamma and Alpha Library

<http://laraweb.free.fr/>

<http://laraweb.free.fr/>

- Practical tool for gamma and alpha spectrometry
- List of 400 nuclides (Nucleide database + NDS...)

NUCLÉIDE Gamma and Alpha Library

Nuclide list:
101Tc ▲
103Ru
103Rh-M ☰
103Pd
104Tc
106Ru EQUI ▼

Nuclide search: _____ or _____

Energy threshold (keV): _____

Intensity threshold (%): _____

Coincidence threshold (%): 10

Show γ - γ coincidences

Sort by decreasing intensity

Emission type: gamma alpha both

Show emissions

Nuclide search criteria:

emission type: gamma alpha both

energy range: _____ - _____ keV

intensity range: _____ - _____ %

mass range: _____ - _____

half-life range: _____ a ▼ - _____ a ▼

Reset this form **Show nuclides**

Reset all forms **Load last settings**

updated: 26/04/2013 (data) & 15/02/2013 (code)

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- Printed version (2007) available by [EDP Sciences](#)
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Simple use (consultation)

Display information on a particular nuclide

NUCLÉIDE Gamma and Alpha Library

Nuclide list:
152Sm
152Eu
152Eu-M
153Sm
153Gd
154Eu

Nuclide search: _____ or _____

Energy threshold (keV): _____
Intensity threshold (%): _____
Coincidence threshold (%): _____

Show γ - γ coincidences
Sort by decreasing intensity

Emission type: gamma alpha both

Show emissions

Nuclide search criteria:

emission type: gamma alpha both
energy range: _____ - _____ keV
intensity range: _____ - _____ %
mass range: _____ - _____
half-life range: _____ a - _____ a

¹⁵²Eu emissions

Element: Europium (Z=63)
Daughter(s): (β^+ , ϵ) Sm-152, (β^-) Gd-152
Half-life ($T_{1/2}$): 13.522 (16) a \Leftrightarrow 426.7 (5) 10⁶ s
Decay constant (λ): 1.624E-09 s⁻¹
Mass activity (A_m): 6.436E+12 Bq.g⁻¹
Reference: USP, LBNL - 2004
Data evaluation files: [Table](#) - [Comments](#) - [ENSDF](#)

Results file (ASCII text format): [Eu-152.txt](#)

Gamma emissions (139 lines) sorted by increasing energy

Energy (keV)	Intensity (%)	Type	Origin	Levels	
				Start	End
6.395 (-)	13.0 (4)	X _L	Sm-152		
6.73255 (-)	0.177 (5)	X _L	Gd-152		
39.5229 (-)	20.8 (3)	X _{Kα2}	Sm-152		
40.1186 (-)	37.7 (5)	X _{Kα1}	Sm-152		
42.3093 (-)	0.243 (7)	X _{Kα2}	Gd-152		
42.9967 (-)	0.437 (12)	X _{Kα1}	Gd-152		
45.4777 (-)	11.78 (19)	X _{Kβ1}	Sm-152		
46.6977 (-)	3.04 (8)	X _{Kβ2}	Sm-152		
48.7687 (-)	0.138 (4)	X _{Kβ1}	Gd-152		
50.093 (-)	0.0363 (13)	X _{Kβ2}	Gd-152		
121.7817 (3)	28.41 (13)	γ	Sm-152	1	0
125.69 (13)	0.019 (6)	γ	Sm-152	5	3
148.010 (17)	0.035 (5)	γ	Sm-152	10	9
192.6 (4)	0.0068 (2)	γ	Gd-152	7	4
207.6 (3)	0.0059 (4)	γ	Sm-152	14	12
209.41 (13)	0.0055 (5)	γ	Gd-152	14	11
212.568 (15)	0.0196 (6)	γ	Sm-152	7	5
237.31 (5)	0.0025 (8)	γ	Sm-152	-1	0
239.42 (17)	0.008 (3)	γ	Sm-152	19	13
244.6974 (8)	7.55 (4)	γ	Sm-152	2	1
251.633 (10)	0.0671 (15)	γ	Sm-152	11	8
269.86 (6)	0.0060 (24)	γ	Sm-152	11	7

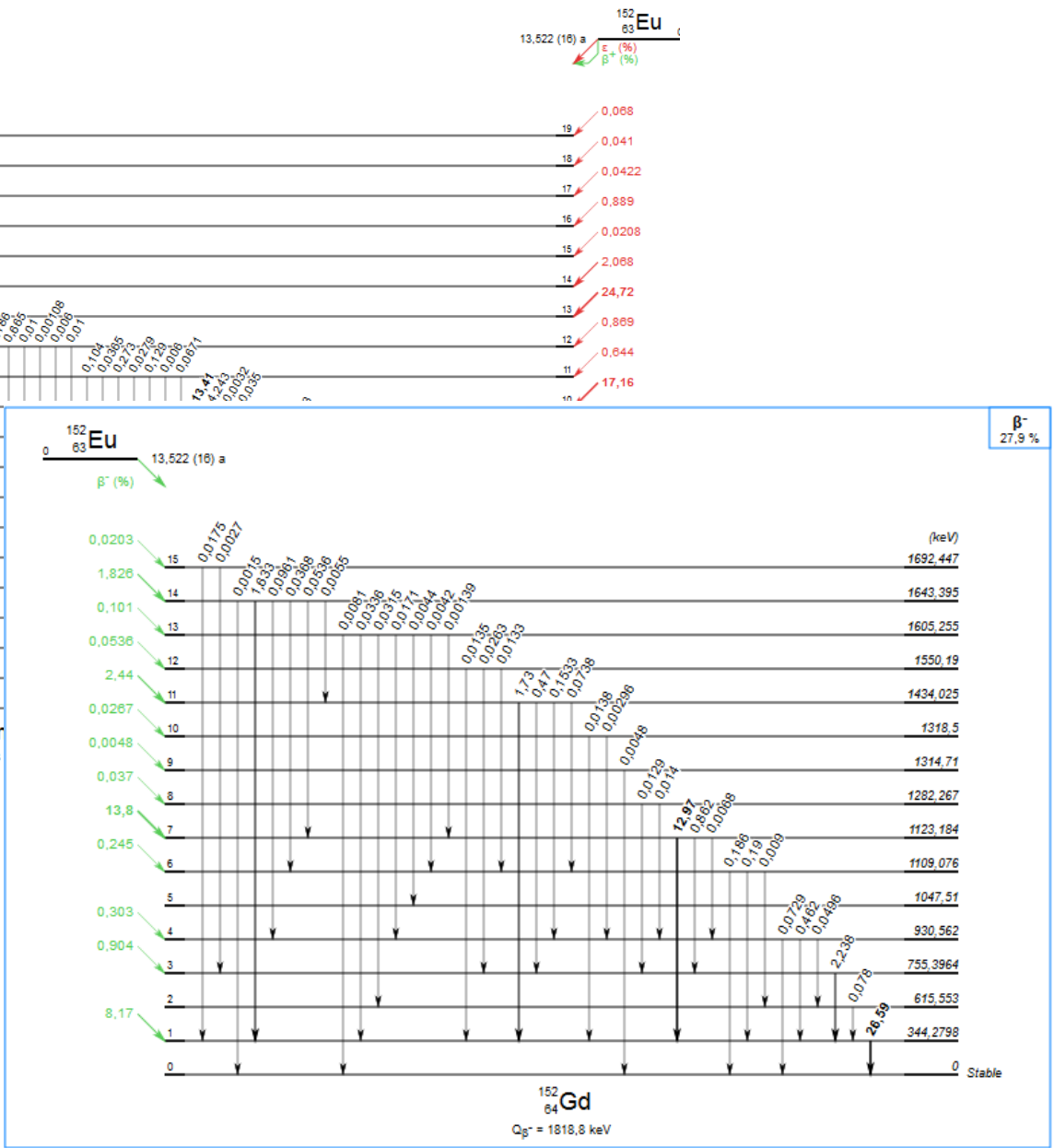
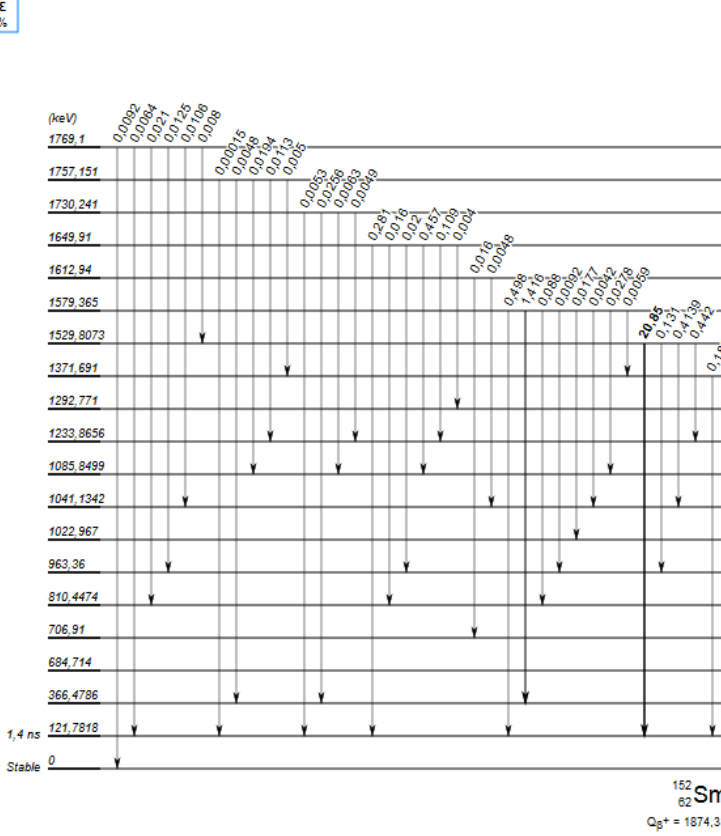
updated: 26/04/2013 (data) & 15/02/2013 (code)

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New ! Decay scheme

PREPARED BY: ...

β^+ , ϵ
72,1 %



β^-
27,9 %

Energy or Intensity threshold

NUCLÉIDE Gamma and Alpha Library

Nuclide list:

- 151Sm
- 152Eu**
- 152Eu-M
- 153Sm
- 153Gd
- 154Eu

Nuclide search:

or

Energy threshold (keV):

Intensity threshold (%):

Coincidence threshold (%):

Show γ - γ coincidences

Sort by decreasing intensity

Emission type: gamma alpha both

Nuclide search criteria:

emission type: gamma alpha both

energy range: - keV

intensity range: - %

mass range: -

half-life range: a - a

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¹⁵²Eu emissions

Element: Europium (Z=63)

Daughter(s): (β^+ , ϵ) Sm-152, (β^-) Gd-152

Half-life ($T_{1/2}$): 13.522 (16) a <=> 426.7 (5) 10⁶ s

Decay constant (λ): 1.624E-09 s⁻¹

Mass activity (A_m): 6.436E+12 Bq.g⁻¹

Reference: USP, LBNL - 2004

Data evaluation files: [Table](#) - [Comments](#) - [ENSDF](#)

Results file (ASCII text format): [Eu-152.txt](#)

Energy threshold: 100 keV

Gamma emissions (129 lines out of 139) sorted by increasing energy

Energy (keV)	Intensity (%)	Type	Origin	Levels	
				Start	End
121.7817 (3)	28.41 (13)	γ	Sm-152	1	0
125.69 (13)	0.019 (6)	γ	Sm-152	5	3
148.010 (17)	0.035 (5)	γ	Sm-152	10	9
192.6 (4)	0.0068 (2)	γ	Gd-152	7	4
207.6 (3)	0.0059 (4)	γ	Sm-152	14	12
209.41 (13)	0.0055 (5)	γ	Gd-152	14	11
212.568 (15)	0.0196 (6)	γ	Sm-152	7	5
237.31 (5)	0.0025 (8)	γ	Sm-152	-1	0
239.42 (17)	0.008 (3)	γ	Sm-152	19	13
244.6974 (8)	7.55 (4)	γ	Sm-152	2	1
251.633 (10)	0.0671 (15)	γ	Sm-152	11	8
269.86 (6)	0.0060 (24)	γ	Sm-152	11	7
271.131 (8)	0.078 (3)	γ	Gd-152	2	1
275.449 (15)	0.0323 (17)	γ	Sm-152	9	5
285.98 (3)	0.0100 (6)	γ	Sm-152	12	9
295.9387 (17)	0.442 (3)	γ	Sm-152	13	10
315.174 (17)	0.0496 (17)	γ	Gd-152	4	2
316.2 (2)	0.0031 (10)	γ	Sm-152	7	4
320.03 (15)	0.0017 (6)	γ	Sm-152	-1	1
324.83 (3)	0.0738 (15)	γ	Gd-152	11	6
329.425 (21)	0.129 (6)	γ	Sm-152	11	6
330.54 (10)	0.0060 (17)	γ	Sm-152	12	8
340.40 (14)	0.031 (3)	γ	Sm-152	4	2
344.2785 (12)	26.59 (12)	γ	Gd-152	1	0
351.66 (4)	0.0140 (22)	γ	Gd-152	8	4
357.26 (5)	0.0040 (5)	γ	Sm-152	16	11

Energy or Intensity threshold

NUCLÉIDE Gamma and Alpha Library

Nuclide list:

- 151Sm
- 152Eu
- 152Eu-M
- 153Sm
- 153Gd
- 154Eu

Nuclide search: or

Energy threshold (keV):

Intensity threshold (%):

Coincidence threshold (%):

Show γ - γ coincidences

Sort by decreasing intensity

Emission type: gamma alpha both

Nuclide search criteria:

emission type: gamma alpha both

energy range: - keV

intensity range: - %

mass range: -

half-life range: a - a

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¹⁵²Eu emissions

Element: **Europium** (Z=63)

Daughter(s): (β^+ , ϵ) Sm-152, (β^-) Gd-152

Half-life ($T_{1/2}$): 13.522 (16) a \leftrightarrow 426.7 (5) 10^6 s

Decay constant (λ): 1.624E-09 s⁻¹

Mass activity (A_m): 6.436E+12 Bq.g⁻¹

Reference: USP, LBNL - 2004

Data evaluation files: [Table](#) - [Comments](#) - [ENSDF](#)

Results file (ASCII text format): [Eu-152.txt](#)

Intensity threshold: 10 %

Gamma emissions (11 lines out of 139) sorted by increasing energy

Energy (keV)	Intensity (%)	Type	Origin	Levels	
				Start	End
6.395 (-)	13.0 (4)	X _L	Sm-152		
39.5229 (-)	20.8 (3)	X _{Kα2}	Sm-152		
40.1186 (-)	37.7 (5)	X _{Kα1}	Sm-152		
45.4777 (-)	11.78 (19)	X _{Kβ1}	Sm-152		
121.7817 (3)	28.41 (13)	γ	Sm-152	1	0
344.2785 (12)	26.59 (12)	γ	Gd-152	1	0
778.9045 (24)	12.97 (6)	γ	Gd-152	7	1
964.079 (18)	14.50 (6)	γ	Sm-152	9	1
1 085.837 (10)	10.13 (6)	γ	Sm-152	9	0
1 112.076 (3)	13.41 (6)	γ	Sm-152	10	1
1 408.013 (3)	20.85 (8)	γ	Sm-152	13	1

NUCLÉIDE Gamma and Alpha Library

Nuclide list:

151Pm
151Sm
152Eu
152Eu-M
153Sm
153Gd

Nuclide search:

or

Energy threshold (keV):

100

Intensity threshold (%):

5

Coincidence threshold (%):

Show γ - γ coincidences

Sort by decreasing intensity

Emission type: gamma alpha both

Show emissions

Nuclide search criteria:

emission type: gamma alpha both

energy range:

- keV

intensity range:

- %

mass range:

-

half-life range:

a - a

Reset this form

Show nuclides

¹⁵²Eu emissions

Element: Europium (Z=63)

Daughter(s): (β^+ , ϵ) Sm-152, (β^-) Gd-152

Half-life ($T_{1/2}$): 13.522 (16) a \Leftrightarrow 426.7 (5) 10^6 s

Decay constant (λ): 1.624E-09 s⁻¹

Mass activity (A_m): 6.436E+12 Bq.g⁻¹

Reference: USP, LBNL - 2004

Data evaluation files: [Table](#) - [Comments](#) - [ENSDF](#)

Results file (ASCII text format): [Eu-152.txt](#)

Energy threshold: 100 keV

Intensity threshold: 5 %

Gamma emissions (8 lines out of 139) sorted by decreasing intensity

Energy (keV)	Intensity (%)	Type	Origin	Levels	
				Start	End
121.7817 (3)	28.41 (13)	γ	Sm-152	1	0
344.2785 (12)	26.59 (12)	γ	Gd-152	1	0
1 408.013 (3)	20.85 (8)	γ	Sm-152	13	1
964.079 (18)	14.50 (6)	γ	Sm-152	9	1
1 112.076 (3)	13.41 (6)	γ	Sm-152	10	1
778.9045 (24)	12.97 (6)	γ	Gd-152	7	1
1 085.837 (10)	10.13 (6)	γ	Sm-152	9	0
244.6974 (8)	7.55 (4)	γ	Sm-152	2	1

Coincidence summing information

NUCLÉIDE Gamma and Alpha Library		⁶⁰ Co emissions	
Nucl			
59Fe 59Ni 60Co 60Cu 63Ni 64Cu	3	2	826.10 (Σ=1 173.24); 2 158.57 (Σ=2 505.71)
Ener			
Inter	3	1	1 332.492 (Σ=2 505.720) (3→2)+(2→1)
Coin			
Show			
Sort	1	0	826.10 (Σ=2 158.59); 1 173.228 (Σ=2 505.720)
Emis			
	2	0	347.14 (Σ=2 505.71) (2→1)+(1→0)
Nucl			
emis ener	3	0	(3→2)+(2→0); (3→1)+(1→0)

Summing in contributors

Summing out -> resulting energy

Possible coincidence with (keV) / Possible sum of (levels)

826.10 (Σ=1 173.24); 2 158.57 (Σ=2 505.71)
347.14 (Σ=1 173.24); 1 332.492 (Σ=2 158.590)
1 332.492 (Σ=2 505.720) (3→2)+(2→1)
826.10 (Σ=2 158.59); 1 173.228 (Σ=2 505.720)
347.14 (Σ=2 505.71) (2→1)+(1→0)
(3→2)+(2→0); (3→1)+(1→0)

intensity range: - %

mass range: -

half-life range: a - a

Energy (keV)	Intensity (%)	Gamma	Nuclide	Level	Transition
1 173.228 (3)	99.85 (3)	γ	Ni-60	3	1
1 332.492 (4)	99.9826 (6)	γ	Ni-60	1	0
2 158.57 (3)	0.0012 (2)	γ	Ni-60	2	0
2 505.692 (5)	0.0000020 (4)	γ	Ni-60	3	0

Coincidence summing information

Based on decay scheme (energy levels) + photon emission intensities (threshold)

NUCLÉIDE Gamma and Alpha Library

Nuclide list:

59Fe
59Ni
60Co
60Co-M
63Ni
64Cu

Nuclide search:
 or

Energy threshold (keV):

Intensity threshold (%):

Coincidence threshold (%):

Show γ - γ coincidences

Sort by decreasing intensity

Emission type: gamma alpha both

Show emissions

Nuclide search criteria:

emission type: gamma alpha both

energy range: - keV

intensity range: - %

mass range: -

half-life range: a - a

Reset this form
Show nuclides

⁶⁰Co emissions

Element: Cobalt (Z=27)

Daughter(s): (β^-) Ni-60

Half-life ($T_{1/2}$): 5.2711 (8) a \Leftrightarrow 166.340 (25) 10⁶ s

Decay constant (λ): 4.167E-09 s⁻¹

Mass activity (A_m): 4.182E+13 Bq.g⁻¹

Reference: INEEL - 2006

Data evaluation files: [Table](#) - [Comments](#) - [ENSDF](#)

Results file (ASCII text format): [Co-60.txt](#)

Default coincidence threshold: 10 %

Gamma emissions (10 lines) sorted by increasing energy

Energy (keV)	Intensity (%)	Type	Origin	Levels		Possible coincidence with (keV) / Possible sum of (levels)
				Start	End	
0.84 (-)	0.0002 (-)	X _L	Ni-60			
7.46097 (-)	0.00334 (12)	X _{Kα2}	Ni-60			
7.47824 (-)	0.0065 (3)	X _{Kα1}	Ni-60			
8.2967 (-)	0.00136 (5)	X _{Kβ1}	Ni-60			
347.14 (7)	0.0075 (4)	γ	Ni-60	3	2	
826.10 (3)	0.0076 (8)	γ	Ni-60	2	1	
1 173.228 (3)	99.85 (3)	γ	Ni-60	3	1	1 332.492 ($\Sigma=2$ 505.720)
1 332.492 (4)	99.9826 (6)	γ	Ni-60	1	0	1 173.228 ($\Sigma=2$ 505.720)
2 158.57 (3)	0.0012 (2)	γ	Ni-60	2	0	
2 505.692 (5)	0.0000020 (4)	γ	Ni-60	3	0	(3 \rightarrow 1)+(1 \rightarrow 0)

Advanced use (search nuclides)

NUCLÉIDE Gamma and Alpha Library

Nuclide list:
151Sm
152Eu
152Eu-M
153Sm
153Gd
154Eu

Nuclide search: _____ or _____

Energy threshold (keV): _____
Intensity threshold (%): _____
Coincidence threshold (%): _____
Show γ - γ coincidences
Sort by decreasing intensity

Emission type: gamma alpha both

Show emissions

Nuclide search criteria:

emission type: gamma alpha both
energy range: _____ - _____ keV
intensity range: _____ - _____ %
mass range: _____ - _____
half-life range: _____ a - _____ a

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Find nuclides meeting multiple search criteria:

- Emission type: gamma or alpha,
- Energy range,
- Intensity range,
- Atomic mass range,
- Half-life range.

Advanced use (search): find nuclides meeting multiple search criteria

NUCLÉIDE Gamma and Alpha Library

Nuclide list:

59Fe
59Ni
60Co
60Co-M
63Ni
64Cu

or Nuclide search:

Energy threshold (keV):

Intensity threshold (%):

Coincidence threshold (%):

Show γ - γ coincidences

Sort by decreasing intensity

Emission type: gamma alpha both

Nuclide search criteria:

emission type: gamma alpha both

energy range: - keV

Intensity range: - %

mass range: -

half-life range: d - a

Selection results

23 gamma emissions from 22 distinct nuclides where Energy: $510 \leq E \leq 512$ keV Half-life: $T_{1/2} \geq 10$ d

Energy in keV (nuclide):

510	(226Ra EQUI)
510	(223Ra)
510	(154Eu)
510.7	(232Th EQUI)
511	(92Nb-M)
511	(207Bi)
511	(114In-M EQUI)
511	(152Eu)
511	(40K)
511	(126I)
511	(88Y)
511	(84Rb)
511	(48V)
511	(36Cl)
511	(26Al)

Nuclide (half-life):

40K	(1.2504E+09 a)
48V	(15.9735 d)
56Co	(77.236 d)
58Co	(70.83 d)
59Ni	(76000 a)
65Zn	(244.01 d)
68Ge EQUI	(270.95 d)
84Rb	(32.77 d)
88Y	(106.626 d)
92Nb-M	(10.15 d)
106Ru EQUI	(372.6 d)
114In-M EQUI	(49.51 d)
126I	(12.93 d)
152Eu	(13.522 a)
154Eu	(8.601 a)

⁵⁸Co emissions

Element: Cobalt (Z=27)
 Daughter(s): (β^+ , ϵ) Fe-58
 Half-life ($T_{1/2}$): 70.83 (10) d \Leftrightarrow 6.120 (9) 10^6 s
 Decay constant (λ): 1.133E-07 s⁻¹
 Mass activity (A_m): 1.176E+15 Bq.g⁻¹
 Reference: CEA/LNE LNHb - 1998
 Data evaluation file: [Table](#) - [Comments](#) - [ENSDF](#)

Results file (ASCII text format): [Co-58.txt](#)

Emissions (8 lines) sorted by increasing energy
Emissions meeting search criteria *Other significantly intense emissions*

Energy (keV)	Intensity (%)	Type	Origin	Levels	
				Start	End
0.7025 (-)	0.73 (7)	X _L	Fe-58		
6.39091 (-)	7.9 (2)	X _{Kα2}	Fe-58		
6.40391 (-)	15.6 (2)	X _{Kα1}	Fe-58		
7.0832 (-)	3.2 (1)	X _{Kβ1}	Fe-58		
511 (-)	30.0 (4)	γ	Fe-58	-1	-1
810.759 (2)	99.45 (1)	γ	Fe-58	1	0
863.951 (6)	0.69 (1)	γ	Fe-58	2	1
1 674.725 (7)	0.52 (1)	γ	Fe-58	2	0

Direct link to the
data evaluation
files:
Table of
radionuclides
(full information)
and comment
ENSDF



1 Decay Scheme

Co-58 disintegrates to Fe-58 excited levels by electron capture or by beta plus emission.
Le Co-58 se désintègre par capture électronique et émission bêta plus vers des niveaux excités de Fe-58.

2 Nuclear Data

$T_{1/2}({}^{58}\text{Co})$: 70,83 (10) d
 $Q^+({}^{58}\text{Co})$: 2307,4 (11) keV

2.1 β^+ Transitions

	Energy keV	Probability × 100	Nature	lg <i>ft</i>
$\beta_{0,1}^+$	474,6 (11)	15,0 (2)	Allowed	6,6
$\beta_{0,0}^+$	1285,4 (11)	0,00082 (23)	2nd Forbidden	12,7

2.2 Electron Capture Transitions

Energy keV	Probability × 100	Nature	lg <i>ft</i>	P_K	P_L	P_{M+}
---------------	----------------------	--------	--------------	-------	-------	----------

Advanced use (search): *find nuclides meeting multiple search criteria*

NUCLÉIDE Gamma and Alpha Library

Nuclide list:

59Fe
59Ni
60Co
60Co-M
63Ni
64Cu

or **Nuclide search:** 60Co

Energy threshold (keV):

Intensity threshold (%):

Coincidence threshold (%):

Show γ - γ coincidences

Sort by decreasing intensity

Emission type: gamma alpha both

Nuclide search criteria:

emission type: gamma alpha both

energy range: 510 - 512 keV

intensity range: - %

mass range: -

half-life range: 10 d - a

Selection results

23 gamma emissions from 22 distinct nuclides where
Energy: $510 \leq E \leq 512$ keV
Half-life: $T_{1/2} \geq 10$ d

Energy in keV (nuclide):

510 (226Ra EQUI)
510 (223Ra)
510 (154Eu)
510.7 (232Th EQUI)
511 (92Nb-M)
511 (207Bi)
511 (114In-M EQUI)
511 (152Eu)
511 (40K)
511 (126I)
511 (88Y)
511 (84Rb)
511 (48V)
511 (36Cl)
511 (26Al)

Nuclide (half-life):

40K (1.2504E+09 a)
48V (15.9735 d)
56Co (77.236 d)
58Co (70.83 d)
59Ni (76000 a)
65Zn (244.01 d)
68Ge EQUI (270.95 d)
84Rb (32.77 d)
88Y (106.626 d)
92Nb-M (10.15 d)
106Ru EQUI (372.6 d)
114In-M EQUI (49.51 d)
126I (12.93 d)
152Eu (13.522 a)
154Eu (8.601 a)

⁵⁸Co emissions

Element: Cobalt (Z=27)
Daughter(s): (β^+ , ϵ) Fe-58
Half-life ($T_{1/2}$): 70.83 (10) d \Leftrightarrow 6.120 (9) 10^6 s
Decay constant (λ): 1.133E-07 s⁻¹
Mass activity (A_m): 1.176E+15 Bq.g⁻¹
Reference: CEA/LNE-LNHB - 1998
Data evaluation files: [Table](#) - [Comments](#) - [ENSDF](#)

Results file (ASCII text format): [Co-58.txt](#)

Emissions (8 lines) sorted by increasing energy
[Emissions meeting search criteria](#) [Other significantly intense emissions](#)

Energy (keV)	Intensity (%)	Type	Origin	Levels	
				Start	End
0.7025 (-)	0.73 (7)	X _L	Fe-58		
6.39091 (-)	7.9 (2)	X _{Ka2}	Fe-58		
6.40391 (-)	15.6 (2)	X _{Ka1}	Fe-58		
7.0832 (-)	3.2 (1)	X _{Kβ1}	Fe-58		
511 (-)	30.0 (4)	γ^{\neq}	Fe-58	-1	-1
810.759 (2)	99.45 (1)	γ	Fe-58	1	0
863.951 (6)	0.69 (1)	γ	Fe-58	2	1
1 674.725 (7)	0.52 (1)	γ	Fe-58	2	0

Output of ASCII data

Nuclide ; Co-58

Element ; Cobalt

Z ; 27

Daughter(s) ; (B+, EC) ; Fe-58

Half-life (d) ; 70.83 ; 0.10

Half-life (s) ; 6.120E6 ; 0.009E6

Decay constant (1/s) ; 1.133E-07

Mass activity (Bq/g) ; 1.176E+15

Reference ; CEA/LNE-LNHB - 1998

Emissions (8 lines) sorted by increasing energy

Energy (keV) ; Ener. Unc. (keV) ; Intensity (%) ; Int. Unc. (%) ; Type ; Origin ; Lvl start ; Lvl end

0.7025 ; ; 0.73 ; 0.07 ; XL ; Fe-58 ; ;

6.39091 ; ; 7.9 ; 0.2 ; XKa2 ; Fe-58 ; ;

6.40391 ; ; 15.6 ; 0.2 ; XKa1 ; Fe-58 ; ;

7.0832 ; ; 3.2 ; 0.1 ; XKb1 ; Fe-58 ; ;

511 ; ; 30.0 ; 0.4 ; g511 ; Fe-58 ; -1 ; -1

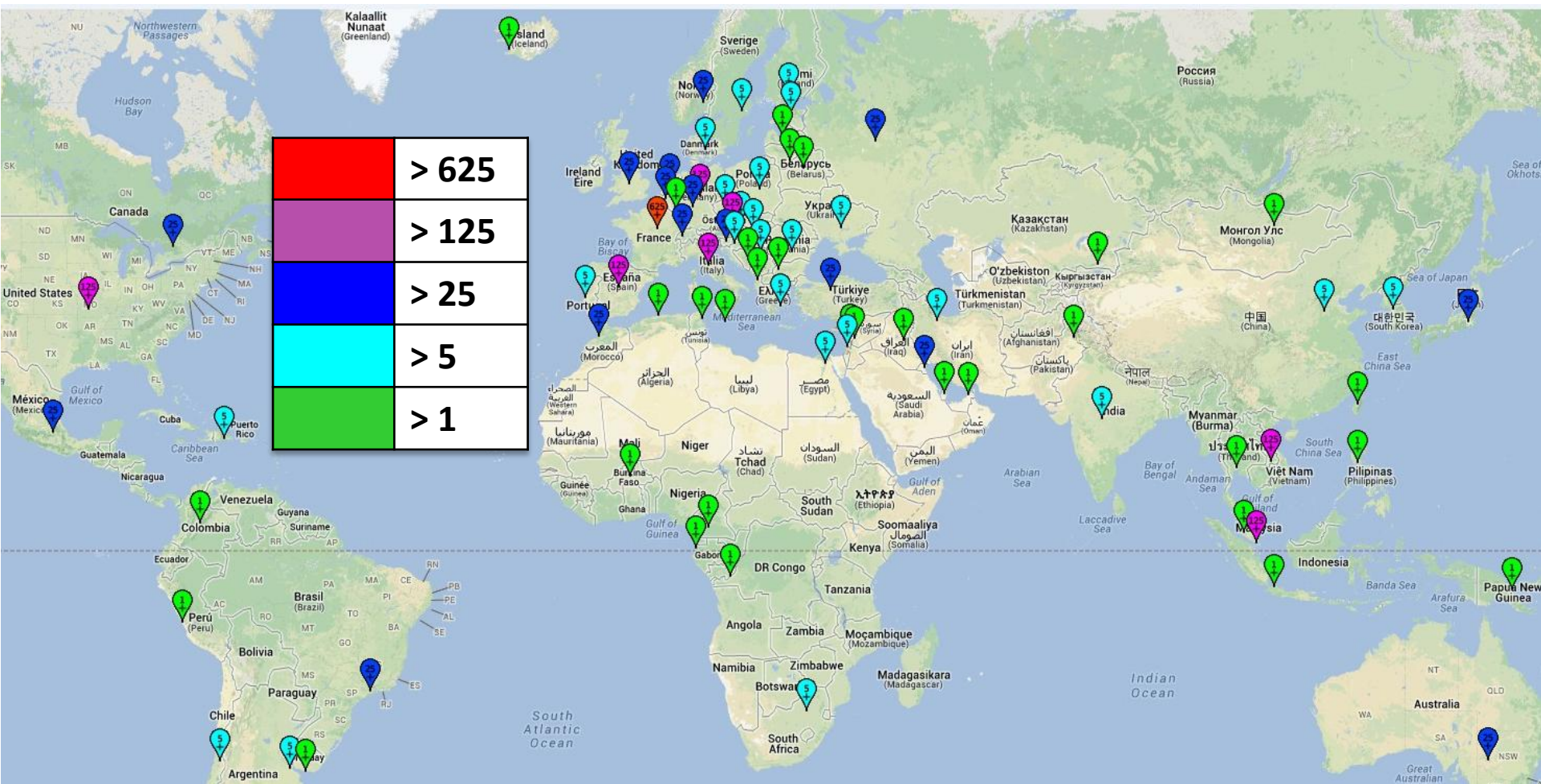
810.759 ; 0.002 ; 99.45 ; 0.01 ; g ; Fe-58 ; 1 ; 0

863.951 ; 0.006 ; 0.69 ; 0.01 ; g ; Fe-58 ; 2 ; 1

1674.725 ; 0.007 ; 0.52 ; 0.01 ; g ; Fe-58 ; 2 ; 0

=====

> 80 countries ≈ 5000 users
 ≈ 400 queries (10 new users) per day

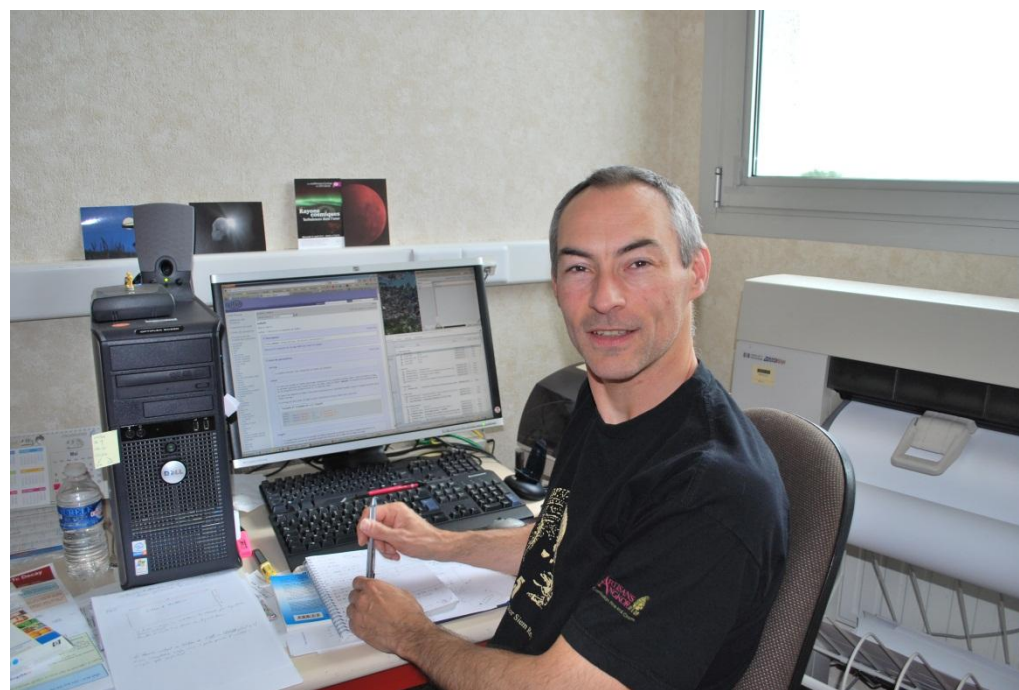


Most popular nuclides: ^{152}Eu , ^{137}Cs , ^{60}Co , U, ...

<http://laraweb.free.fr/>

Contact us

(suggestions,
comments,
remarks, ...)



Christophe DULIEU