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International comparison of activity measurements of a solution of ^{137}Cs (May 1982)

Preliminary report

by A. Rytz

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Bureau International des Poids et Mesures
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The present report contains information enabling the participants to see how their own results are situated with regard to the others. It was found convenient to present the data in tabular form, without any discussion or interpretation. In a few cases minor omissions were unavoidable for reasons of space.

A full report with a thorough analysis of all the data will be published at a later date.

Table 1

List of participants

AAEC	Australian Atomic Energy Commission, Sutherland, Australia
AECL	Atomic Energy of Canada Limited, Chalk River, Canada
BCMN	Central Bureau for Nuclear Measurements, Geel, Belgium
BIPM	Bureau International des Poids et Mesures, Sèvres, France
ETL	Electrotechnical Laboratory, Ibaraki, Japan
IER	Institut d'électrochimie et radiochimie de l'EPFL, Lausanne, Switzerland
IFIN	Institut of Nuclear Physics and Engineering, Bucharest, Romania
LMRI	Laboratoire de Métrologie des Rayonnements Ionisants, Saclay, France
NAC	National Accelerator Centre, Faure, South Africa
NBS	National Bureau of Standards, Washington, D.C., U.S.A.
NIM	National Institute of Metrology, Beijing, China
NPL	National Physical Laboratory, Teddington, U.K.
NRC	National Research Council, Ottawa, Canada
OMH	Országos Mérésügyi Hivatal, Budapest, Hungary
PDS	National Atomic Energy Agency, Jakarta, Indonesia
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig, Federal Republic of Germany
SCK	Studiecentrum voor Kernenergie, Mol, Belgium
UVVVR	Institute for research, production and application of radioisotopes, Prague, Czecho-Slovakia

Table 2

Laboratory	Method	Dilution	Sources			β detector		γ detector	Dead times*		Typical count rates
			Mixing ratio $^{137}Cs/^{134}Cs$	Mass range (mg)	Backing mass (μg cm^{-2})	Gas	Pressure (MPa)	resol. at 662 keV (%)	τ_β τ_γ (μs) τ_c		N_β N_γ (s^{-1}) N_c
AAEC	4πβ(PC)-γ	yes	0.48	23 - 63	30	CH_4	0.1	8.8	9.15 18.2 1.145	(8) (1) (6)	7 000 75; 150; 0.6 65; 140; 0.45
AECL	"	no	1.18	12 - 27	12	"	"	7.3 - 7.6	1.935 1.916 0.698 3	(21) (20) (19)	12 900 630; 450 560; 410
BCMN	"	no	0.6 - 1.4	7 - 15	50	"	"	6.4	5.97 6.09 0.785	(6) (6) (16)	14 000 - 19 000 500 - 800 400 - 600
BIPM	"	no	1.08	26 - 96	60	"	"	7.5	4.432 4.425 1.06	(10) (10) (1)	30 000 800 670
ETL	"	no	1.00	9 - 19	30	"	"	7.5 - 8.0	4.35 2.11 0.688 7	(5) (5) (28)	7 000 150; 250 135; 225
IER	"	yes	1.0	20 - 70	50	"	"	9.6	3.201 3.196 1.075	(1) (1) (2)	16 800; 18 000 190; 293 168; 240
IFIN	"	no	0.64	5 - 11	100 - 150	"	"	12.8	10.0 10.0 1.090	(5) (5) (5)	8 000 150 120

* Between brackets: Uncertainty in units of the last digit

Table 2 (cont'd)

Laboratory	Method	Dilution	Sources: Mixing ratio $^{137}Cs/^{134}Cs$	Sources: Mass range (mg)	Sources: Backing mass ($\mu g\ cm^{-2}$)	β detector: Gas	β detector: Pressure (MPa)	γ detector resol. at 662 keV (%)	Dead times* τ_β τ_γ τ_c (μs)	Typical count rates N_β N_γ N_c (s^{-1})
LMRI	4πβ(PC)-γ	no	1.36; 0.55	15 - 27	40	CH_4	0.1	0.3	5 **	14 000
								[Ge(Li)]	5 **	40
									≈ 1	36
NAC	4πβ(LS)-γ	"	-	-	-	-	-	9.5	1.15 (2)	32 600
									1.19 (3)	197
									0.513 (1)	161
NBS	4πβ(PPC)-γ AC	yes	1.5; 0.67	21 - 34	30	Ar/CH_4	1.48	7.1	4.3	6 000
									10.0 (2)	155; 170
									-	14 - 30
NIM	4πβ(PC)-γ 1	"	1.09; 1.03	7 - 13	20	CH_4	0.1	8	5.98 (1);21.901 (1)	8 000; 11 695
	" 2	"	0.9	10 - 15	20	"	"	7.8	1.52 (1);21.869 (1)	90; 328
	4πβ(LS)	no	-	10 - 15	-	-	-		1.525(6); 1.2728(1)	80; 226
NPL	4πβ(PC)-γ	yes	1.0	14 - 15	30	Ar/CH_4	0.1	8.3	1.54 (1);18.70 (5)	15 000; 4 300
	4πβ(LS)-γ	"	1.01	15 - 30	-	-	-	9.8	2.80(50); 3.27 (4)	2 200; 75
									0.591(5); 0.300 (5)	1 600; 65
NRC	4πβ(PPC)-γ AC	no	0.95	13 - 16	40	Ar/CH_4	1.14	8.4	5.08 (5)	55; 17
									2.00 (2)	5-15; 3-7
									-	0.5

* Between brackets: Uncertainty in units of the last digit

** Cumulative dead time, common to both channels

Table 2 (cont'd)

Laboratory	Method	Dilution	Sources: Mixing ratio $^{137}Cs/^{134}Cs$	Sources: Mass range (mg)	Sources: Backing mass ($\mu g\ cm^{-2}$)	β detector: Gas	β detector: Pressure (MPa)	γ detector resol. at 662 keV (%)	Dead times* τ_β τ_γ (μs) τ_c	Typical count rates N_β N_γ N_c (s^{-1})
OMH	$4\pi\beta$(PC)-γ	no	0.5 1	3 - 16	30	CH_4	0.1	8.2	3.067 (5) 3.021 (5) 1.022 (10)	11 500; 10 500 350; 230 290; 200
PDS	Ge(Li)γ	-	-	-	-	-	-	-	- - -	- - -
PTB	$4\pi\beta$(PC)-γ	no	0.97	5 - 60	60	CH_4	0.1	6.6	5.06 (5)	7 700; 6 600; 7 000
	$4\pi\beta$(PPC)-γ 1		"	"	"	Ar/CH_4	1.1	6.6	4.73 (5)	170; 103; 650
	$4\pi\beta$(PPC)-γ 2		"	"	"	"	1.1	8.9	1.01 (2)	160; 75; 550
SCK	$4\pi\beta$(PC)-γ	yes	0.85	4.5 - 9.5	50	CH_4	0.1	8.8	2.48 (1)	8 300 -
	4π(NaI)γ	"	-	7.5 - 11.3	-	"	-	7.5	2.46 (1) 1.014 3 (3)	295; 4 000 251 -
UVVVR	$4\pi\beta$(PC)-γ	yes	0.55	9 - 18	45	CH_4	0.1	7.3	5.724 (3) 5.710 (3) 0.992 (4)	5 840 486 387

* Between brackets: Uncertainty in units of the last digit

Table 3

Laboratory	Measured by ionization chamber		Efficiency tracing				Range of ε_β	Polyn.	$\varepsilon_{\beta\gamma}$	Radioactivity
	Adsorption* (Bq)	Activity concentr. 1982-05-01 (Bq mg^{-1})	β detector	γ-channel window (keV)	Data points number	Data points time per point (s)	(%)	order	(%)	concentration with combined uncertainty 1982-05-01 (Bq mg^{-1})
AAEC	780	603 ± 12	PC	795 – 900	50	1 700	95 – 85	1	0.1	608.8 ± 2.6
				755 – 1 445	20	1 200	94 – 83	1		
				1 250 – 1 500	10	4 000	86 – 68	1		
AECL	790	607.1 ± 1.0	PC	740 – 1 510	168	1 000	91 – 78	1	0.1	605.4 ± 2.4
				740 – 900	202	1 000	93 – 81	1		
BCMN	900	–	PC	> 750	≈ 130	1 000	93 – 69	1	0.11	604.5 ± 1.8
				> 740						
BIPM	7 430 **	604.9 ± 0.4	PC	700 – 900	51	7 000	91 – 80	2	0.3	606.7 ± 2.7
								2		
ETL	–	–	PC	760 – 930	34	2 100	94 – 80	2	0.25	607.0 ± 2.3
				760 – 1 500	28	2 100	92 – 77	2		
IER	612	–	PC	785 – 890	600	100	94 – 78	1	0.1	595.1 ± 2.8
				785 – 1 600	580	100	90 – 75	1		
IFIN	0.08	–	PC	750 – 980	49	1 000	91 – 64	1	0.54	620.0 ± 2.9
IMRI	–	604.2	PC	760 – 820	22	3 000	94 – 76	1	0.11	604.3 ± 1.3
NAC	390	603	LS	> 950	11	1 000	83 – 72	2	8.0	600.5 ± 5.2
NBS	535	603.3	PPC, AC	755 – 870	≈ 60	3 000	92 – 75	1	0.54	605.9 ± 1.9
				> 890				1		
NIM	–	596.8 ± 1.8	PC 1	740 – 867	190	900	97 – 80	1	0.4	599.2 ± 1.6
			PC 2	769 – 952	70	900	95 – 80	1 (2)	0.29	597.4 ± 1.1
			LS	–	–		–	1 (2)	5.6	593.1 ± 1.2

* Activity remaining in the "empty" ampoule after two rinsings
** Rinsings took place later, when the residue was dry

Table 3 (cont'd)

Labora-tory	Measured by ionization chamber		Efficiency tracing				Range of ε_β	Polyn.	$\varepsilon_{\beta\gamma}$	Radioactivity concentration with combined uncertainty 1982-05-01 ($Bq\ mg^{-1}$)
	Adsorption* (Bq)	Activity concentr. 1982-05-01 ($Bq\ mg^{-1}$)	β detector	γ-channel window (keV)	Data points number	Data points time per point (s)	(%)	order	(%)	
NPL	1 100	593.7	PC	745 - 905	34	1 000	83 - 70	2	0.32	601.5 ± 11.4
				> 745	28		78 - 63	2		
			LS	770 - 920	350	2 000	92 - 77	2	7.0	598.8 ± 4.5
				1 230 - 1 630			89 - 68	2		
				1 850 - 2 200			76 - 35	2		
NRC	500	-	PPC, AC	780 - 810	240	700-2 000	91 - 73	1	0.32	609.30 ± 0.97
				1 250 - 1 510			82 - 60	1		
OMH	580	601.8	PC	750 - 1 500	23	1 000	94 - 74	2	0.1	606.4 ± 1.0
					14	1 500	93 - 74	2		
PDS	-	-	Ge(Li)γ	?	-	-	-	-	-	616.6 ± 5.9
PTB	500	605.09	PC	750 - 880	59	10 000	93 - 65	4 ***	0.11	600.9 ± 2.2
			PPC	760 - 900	40	2 400	90 - 70	4	0.25	605.8 ± 2.2
			PPC	1 250 - 1 600	≈ 60	1 600	88 - 76	4	0.25	605.6 ± 2.0
SCK	357	-	PC	745 - 930	54	5 × 1 000	94 - 82	1	0.25	604.8 ± 1.2
				"	17	"	90 - 81	1		
				"	6	"	92 - 80	1		
			4π(NaI)γ	> (70 - 160)	100	2 000	-	-	-	604.6 ± 2.7
UVVVR	220	-	PC	> 715	56	400	91 - 63	2	0.32	596.6 ± 1.6

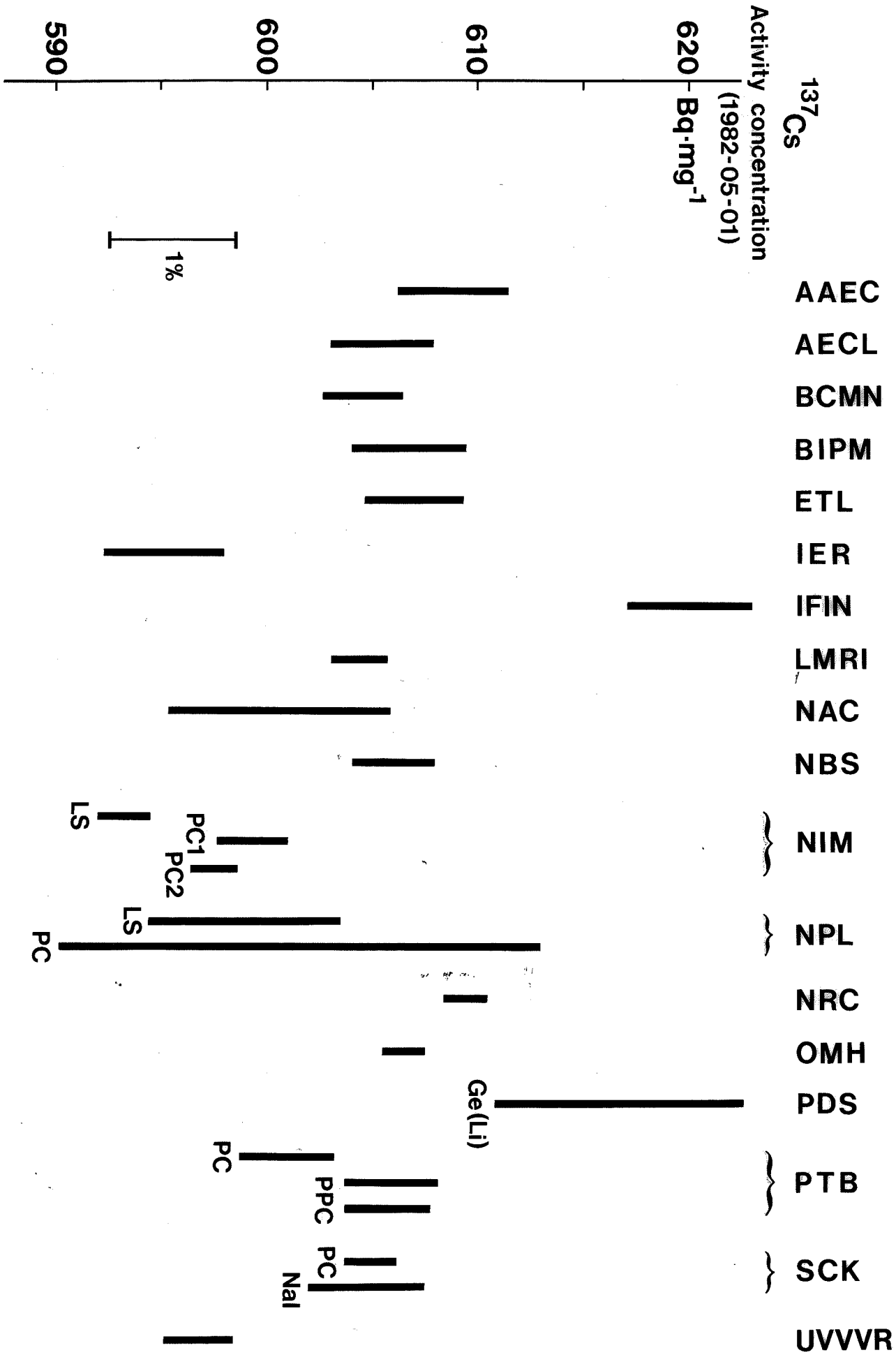
* Activity remaining in the "empty" ampoule after two rinsings

*** $a_2 = a_3 = 0$

Table 4 - Variables of the efficiency functions used

	x	y
AAEC	$1 - \varepsilon_\beta$	$(1/m)\ (\frac{N_\beta}{1 - \tau_\beta N_\beta} - B_\beta)$
AECL	$(1 - \varepsilon_\beta)/\varepsilon_\beta$	$(N_\beta N_\gamma)/N_c$
BCMN	$1 - N_c/N_\gamma$	N_β
BIPM	$1 - \varepsilon_\beta$	N_β^{tot}
ETL	$\frac{1 - N_c/N_\gamma}{N_c/N_\gamma}$	$\frac{N_\beta N_\gamma}{m N_c}$
IER	"	$(1/m)\ (\frac{N_\beta N_\gamma}{N_c} - A_{134})$
IFIN	$1 - N_c/N_\gamma$	N_β/m
LMRI	$(1 - \varepsilon_\beta)/\varepsilon_\beta$	?
NAC	N_γ/N_c	$N_\beta N_\gamma/N_c$
NBS	$(1 - \varepsilon)/\varepsilon$; $\varepsilon = (1 - Y)/N_\gamma$	$N_\beta/(1 - \varepsilon)$
NIM	$(1 - \varepsilon_\beta)/\varepsilon_\beta$; $1 - \varepsilon_\beta$; I_o/I_n*	$N_\beta N_\gamma/N_c$; $(N_\beta - \varepsilon_\beta A_{134})(1/m)$; N
NPL	$1 - N_c/N_\gamma$	$N_\beta - A_{134}\ f(N_c/N_\gamma)$
NRC	Y/N_γ	N_β^{tot}
OMH	$\frac{1 - N_c/N_\gamma}{N_c/N_\gamma}$	$\frac{N_\beta N_\gamma}{m N_c}$
PDS	-	-
PTB	$1 - \varepsilon$; $1 - N_c/N_\gamma$; $\frac{1 - N_c/N_\gamma}{N_c/N_\gamma}$	N_β/m
SCK	$1 - N_c/N_\gamma$	N_β^{tot}/m
UVVVR	$(1 - \varepsilon_\beta)/\varepsilon_\beta$; $1 - \varepsilon_\beta$	$N_\beta N_\gamma/N_c$; N_β/m

* I_n = anode current with optical filter, I_o = current without filter


590
600
610
620
Activity concentration
(1982-05-01)
Bq·mg-1
137Cs
1%
AAEC
AECL
BCMN
BIPM
ETL
IER
IFIN
LMRI
NAC
NBS
LS
PC1
PC2
NIM
LS
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