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^{134}Cs

Report of an international comparison of activity measurements

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Abstract

Samples of a solution of ^{134}Cs were distributed to 24 national and international laboratories for a comparison of activity measurements organized by the Bureau International des Poids et Mesures. The active material was purified and tested by Atomic Energy of Canada Limited (Chalk River). The Laboratoire de Métrologie des Rayonnements Ionisants (Saclay) carried out further purity tests, prepared and bottled the solution and distributed it to the participants in October 1978.

In most cases 4π proportional flow counters (at atmospheric or higher pressure) were used in coincidence or anti-coincidence with NaI(Tl) or Ge(Li) detectors. Details on source preparation and counting equipment are reported, mostly in tabular form. The application of efficiency extrapolation to a nuclide with complex decay scheme is discussed. The results and their uncertainties are presented in numerical and graphic forms. In view of the small spread a mean value for the activity concentration can be formed nearly independently of statistical weighting. The results are also compared with the values belonging to the international reference system for activity measurements of γ-ray emitting nuclides.

1. Introduction

The decision [1] to organize an international comparison of ^{134}Cs activity measurements was taken soon after the final report on the preceding (^{139}Ce) comparison had appeared [2]. As previous experience with this nuclide [3] gave no reason to expect any special difficulties nor surprising results, it was not deemed desirable to wait until some more exciting proposal would be ready. The keen interest manifested by the 24 laboratories ready to participate confirmed the expediency of this choice. It is noteworthy that, for the first time in the long series of such comparisons organized by the BIPM, all the participants (see Table 1) have submitted their results.

A circular letter explaining details of the organization and an extensive reporting form prepared according to previous experience were distributed in June 1978; the reference date chosen was 1978-10-15, 0 h UT.

Most measurements were finished by the end of February 1979 and a preliminary report containing the results and some other important data was distributed soon afterwards [4]. The forms filled in by the participants contain a wealth of valuable information. In addition, some participants have issued detailed reports on their equipment and measurements [5, 6, 7]. We have tried to collect and condense all this information and to make it available to all the persons involved or interested in the subject.

2. Description of the solution and the purity tests

The primary ^{134}Cs was procured and purified by AECL* which sent a sample of this solution to LMRI for purity assay, late in 1977; a similar sample served for additional checks at AECL. Both laboratories, using Ge(Li) detectors, failed to discover any other activity. The detection limits of their respective arrangements are illustrated in Fig. 1. In the range from 20 to 200 keV, LMRI used, in addition, a pure germanium detector.

The most likely impurity being ^{137}Cs, AECL carried out two further tests as follows. In a first experiment, the spectrum obtained from a $^{134}Cs/^{137}Cs$ source (ratio $10^4/1$) between 655 and 670 keV was compared with the spectrum of a "pure" ^{134}Cs source. In the second test, the spectrum from a previous standard of ^{134}Cs (one year older and from a different supplier) was subtracted from that of the present solution. As neither test revealed any foreign peaks, it was concluded that it is unlikely that more than 0.01 % of ^{137}Cs was present in the ^{134}Cs solution.

In March 1978, the stock solution was sent to LMRI which prepared a dilution and added carrier substance to obtain an aqueous solution of HCl (0.2 mol per dm^3) with 20 μg of CsCl per gramme and a radioactivity concentration of about 800 $Bq \cdot mg^{-1}$. In October 1978, each participant received two sealed LMRI ampoules containing about 5 cm^3 of solution each, without mass determination. Four NBS ampoules were filled with (3.6 ± 0.2) cm^3 for the AIEA and BIPM reference systems. Here, the mass of solution contained in the ampoules was determined accurately. All the ampoules except two arrived in good condition (IMM and NRC each reported one ampoule with a cracked glass seal). One participant (ASMW) discovered a large quantity of solid particles (filter paper?) in both ampoules.

The decay scheme of ^{134}Cs is shown in Fig. 2 with data taken from [8]. The recommended half-life was (753.1 ± 1.8) d.

3. Adsorption tests

It was to be expected that some activity would be adsorbed at the ampoule walls due presumably to ion exchange with sodium atoms of the glass. Six participants reported measurements of the residual activity of the empty ampoules; details are given in Table 2. It will be noted that the relative amount of adsorbed activity was about three times that observed with ^{139}Ce [2]. However, with so few and not too well agreeing checks we do not consider to apply a general correction which would only amount to a few parts in 10^4.

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* The full names of the laboratories may be found in Table 1.

4. Source preparation for measurements with proportional counters

The mean energy of β particles emitted by ^{134}Cs being 157 keV, it is not indispensable to prepare the thinnest possible sources. Nevertheless, the higher the initial β efficiency, the more accurate will be the result of an efficiency extrapolation. Table 3 summarizes the various techniques applied. Further details which would not fit in the table are described hereafter.

Five participants (AAEC, AIEA, NBS, NIM, UVVVR) dispensed the active solution onto pads of ion exchange resin, as was first described in [9]. NBS found it useful to conserve such sources in moist air. BCMN prepared thirteen sources on gold-coated VYNS films and two sources on carbon foils (19 $\mu g \cdot cm^{-2}$) which, however, did not show any advantage over the sources on VYNS backing. Three freeze-dried sources gave efficiencies typically 3 to 4 % higher than lamp-dried ones, but their activities were systematically low by about 1 % and therefore discarded. Loss of activity during the drying process seems to be the most probable reason for this discrepancy. NPL treated part of the sources used as described in [10]. To each such source 15 mg of a solution of $AlCl_3$ in HCl were added (50 μg of Al^{3+} per ml of 1 mol HCl per dm^3 of H_2O).

In order to improve source conductivity, AAEC applied on three of its sources some silver acetate which later was reduced to the metal. The silver acetate was first dissolved in a 1 : 3 mixture of water and ethylalcohol and electrosprayed onto the source dispensed on a reinforced VYNS or mylar foil. The results were encouraging but not fully conclusive.

5. Liquid scintillation counting

Four participating laboratories used liquid scintillation detectors, mostly $4\pi\beta$(LS)-γ coincidence counting (see Table 5). The results obtained fit well in the graph shown in Fig. 4. The fact that both the highest and the lowest of all the results are liquid scintillation measurements may be fortuitous.

NIM reported the successful application of a new extrapolation method without coincidences [25] which takes advantage of the observation that the β count rate is a smooth and nearly linear function of the inverse anode current of the phototube when the light transmission of the photocathode is varied by means of optical filters.

6. $4\pi\gamma$ counting with NaI well-type crystals

Four laboratories (IRK, LMRI, PTB, SCK) used this technique in which the efficiency of the detector for the ^{134}Cs radiations is calculated from the geometry and the properties of the thallium-doped sodium iodide. Details of the sources and detectors are summarized in Table 6. The results obtained are of a quality comparable to that of the coincidence measurements. The countings were integral above a threshold high enough to avoid the electronic noise which was typically lower than 8 keV.

PTB observed the pulse spectrum in the vicinity of the threshold and extrapolated the count rate linearly to zero energy. The block diagram of their arrangement is shown in Fig. 3.

7. Coincidence counting

The electronic counting circuits used in this and the preceding comparisons [2] were the same in most cases. Therefore, such descriptions will not be repeated here.

Several participants (AECL, BCMN, IEA) employed two independent electronic systems which could be connected in parallel, for mutual checking, or simultaneously, for data taking with two separate sets of counting conditions. UVVVR worked with a single β channel and two separate γ channels and coincidence circuits. The equipment of ETL permitted even to count simultaneously with three different γ-channel settings.

The relative delay δ between pairs of coincident β and γ pulses has been given special attention. Most of the participants tried to reduce the upper limit of δ so as to get a negligible effect on the final result. The value of the delay and the correction applied are presented in Table 7. A method described by Williams and Campion [11] was also used in some cases. Taylor and Gibson [12] have extended this method in order to provide a continual record of the extent to which the relative delay remains matched.

Table 7 also lists the coincidence formulae which the participants adopted in order to calculate the activity. It will be noted that over 40 % still prefer Campion's formula, although it has been demonstrated that it leads to too high activity values for high-count-rate sources [13]. A different approach is the use, by LMRI, of an efficiency chronometer [14] with linear multiparametric adjustment and pile-up rejection.

As indicated in Table 4, NRC made use of two Ge(Li) detectors in a narrowly gated γ channel, as an alternative to the conventional NaI detectors; LMRI employed Ge(Li) detectors exclusively.

8. Anti-coincidence counting

In addition to conventional coincidence counting, NBS and NRC used a technique which is known as "live-timed anti-coincidence counting with extending dead-time circuitry" [16]. The results obtained are in excellent agreement with each other and both are considered to be more accurate than the respective coincidence results.

9. Efficiency functions and polynomial fitting

The complexity of the decay scheme (see Fig. 2) suggests the use of various γ-channel settings by which different efficiency functions may be obtained. These functions are approximated by polynomials of the form $y = a_0 + a_1x + a_2x^2 + \ldots$,

where $y = \frac{N_\beta N_\gamma}{m N_c}$ and $x = \frac{1 - N_c/N_\gamma}{N_c/N_\gamma}$. Here N_β, N_γ and N_c are the count rates measured in the respective channels and corrected for background; m is the source mass. The order of the polynomial which best fits the experimental data may be found by χ^2 tests. The extrapolated value of y for $x \longrightarrow 1$ is then regarded as the most probable value of the activity concentration. Further remarks on this well-known method may be found in [2].

While uncertainties in the data for y may easily be accounted for, this is much more problematic for the abscissa x. Only two participants reported to have taken them into account. The effect on the final result is negligible: about zero for AECL, 0.002 % for NAC.

For a nuclide decaying via a single β branch, the efficiency function is often linear or very nearly so. The slope-to-intercept ratio is then independent of the detectors and the γ-channel setting and is a measure for the internal conversion coefficient of the subsequent γ-radiation, as explained in [2].

For a nuclide with a complex β decay, however, the course of each efficiency function depends on the particular γ-channel setting which determines to which extent the β events from the various branches will coincide with the photons registered. Since the β efficiencies depend on the detector system considered, the slope-to-intercept ratios (for linear adjustments) must be expected to vary from laboratory to laboratory. Moreover, for a polynomial of higher than first order, a slope is meaningful only for a short portion of the curve, whereas the intercept is obtained from a range long enough to distinguish the curve from a straight line. Nevertheless, it will be seen from the values in Table 8 that, for a given γ-channel setting, the slope-to-intercept ratios do not differ very much.

In order to determine the efficiency functions, most participants combined the data points from all the sources measured and obtained a mean adjustment of the coefficients a_0, a_1, a_2, ... IEA, IER and NPL used only a few sources for this adjustment and applied the slope-to-intercept ratio thus obtained to the measurements of the remaining sources carried out at fixed efficiency values. Two participants preferred to calculate a separate adjustment to the data from each single source (NPL, PTB) or from each of several runs, each run involving different sources and/or electronic systems (AECL). However, these details and the various methods for changing the β efficiency (see Table 3) are not expected to affect strongly the final results.

If we want to compare results stemming from different γ-channel settings, the comparison must be limited to three gate positions, namely around the 650 keV photopeak, or around the peaks at 796 and 802 keV or around the 1 365 keV peak. Let N_1 and N_2 be the reported numbers of results from first-order and second-order adjustments and let us compare these numbers with each other:

Gate (keV)	≈ 650	≈ 800	≈ 1 365
N_1	15	20	3
N_2	7	3	4
N_1/N_2	2.14	6.67	0.75

In general, with a gate around 800 keV, practically no slope of the efficiency function is observed and the standard deviation of the intercept with the γ axis is smallest. This fact induced AECL to consider the results from this gate only. For the 650 keV gate a majority of results were slightly higher than the average and a second order fit was preferred in about one third of the cases. As to the measurements with the highest gate, first- and second-order fits were used equally often; the intercepts were higher than those obtained with the 800 keV gate in five cases out of seven.

Table 11 lists all the results of the different adjustments. Further, for each method, a mean value was derived by each participant according to various criteria. We present in what follows the points of view of five selected laboratories.

AAEC - The curvature of ^{134}Cs efficiency functions seems to be due partly to experimental details (source backing, increasing asymmetry of the source with decreasing efficiency) and not only to decay-scheme characteristics. For all the three γ gates used, VYNS- and mylar-backed sources give linear plots in the efficiency ranges from 95 to 75 % and 82 to 63 %, respectively, but with different slopes and intercepts. A second-order fit to all points extrapolates to the same result as does the first-order fit to the results of only the VYNS-backed sources. However, no such effect was observed with ^{139}Ce. It is suggested that extrapolations be limited to β efficiencies above, say 80 %.

AECL - With the three gates used alternatively, first-order extrapolation led always to a higher result than second order. The 685 to 915 keV gate producing nearly no slope and by far the smallest uncertainty, the results obtained with the other gates were ignored.

BCMN - Similar results as AAEC : with all three gates good linear fits were possible for $90 \geqslant \varepsilon_\beta \geqslant 70$ %, but only the gate around 800 keV permitted a good linear fit down to $\varepsilon_\beta = 60$ %. A quadratic fit to points in the whole efficiency range was satisfactory for the 700 to 1 750 keV gate, but not for the one around 650 keV. The difference between intercepts resulting from a linear or a quadratic fit is not considered as a useful expression of the systematic uncertainty due to the extrapolation procedure, because this would take into account the result of an extrapolation recognized as unsuitable. It is rather advocated that this uncertainty is already contained in the standard deviation of the extrapolated value.

BIPM - When using the high or the low γ gate, a quadratic fit was definitely better than a linear or a cubic one. For the gate around 800 keV only the linear fit was satisfactory. In all cases χ^2 was considerably too high, but no reason for this could be found. The results obtained with different gates and efficiency ranges are listed below.

Gate (keV)	Range of ε_β (%)	Order of polynomial	Intercept ($Bq \cdot mg^{-1}$)	Standard deviation ($Bq \cdot mg^{-1}$)	Finally adopted
500 to 700	90 to 55	1	836.2	1.6	
		2	831.0	0.5	X
	90 to 70	1	833.4	0.5	
		2	830.4	1.4	
700 to 900	92 to 62	1	830.3	0.2	X
		2	830.6	0.4	
	92 to 71	1	830.5	0.3	
		2	830.1	0.8	
1 260 to 1 490	88 to 50	1	839.3	1.6	
		2	833.3	2.4	X

The three intercepts being in poor mutual agreement, simultaneous adjustments [22] were also applied and gave, in second order, a result only 0.07 % higher than the weighted mean of the three single adjustments, but with a standard deviation twice as large.

PTB - With a γ-channel gate around 800 keV, linear fits were always better than those of higher order. However, when setting only a discrimination threshold at 500 keV, curved efficiency functions were obtained. In these cases third-order polynomials having no quadratic term were adjusted, in order to account for the absence of curvature near the intercept.

From the findings of these five participants it is not useful, in the case of ^{134}Cs, to let an efficiency extrapolation start at values below $N_c/N_\gamma = 0.7$, unless the γ-channel gate is set around 800 keV. While it is not really surprising that an efficiency function above $N_c/N_\gamma = 0.9$ is not adequately defined by its behaviour below 0.7, it is more difficult to understand the systematic deviation between intercepts obtained with different channel settings. This inconsistency and the fact that, in many cases, the horizontal efficiency function gives the most precise result may have a common cause. This may be due to the increasing source thickness and its different effects on the attenuation of the three β branches.

10. Uncertainties

A discussion on the well founding of a distinction between random and systematic uncertainties is beyond the scope of this report. We follow here the procedure adopted in the past which consists in separating the "random" part due to counting statistics and adjustments from the "systematic" part which comprises all the other uncertainties. Combinations of the two sorts of error are avoided.

In Table 10 the random uncertainties are presented in the form of standard deviations. The number of data points used in an adjustment minus the degree of the polynomial augmented by one may be regarded as an upper limit of the number of degrees of freedom. Various kinds of correlations may further decrease this number. However, it is in general sufficient to know whether or not it can be considered as large. In combining the results from different γ-channel settings, the participants had to apply some sort of weighting in order to arrive at a mean result for every method used. The weights chosen were either all equal (10 cases) or proportional to the inverse variance (14 cases). Two participants considered one of their results as particularly reliable and ignored all the others. The random uncertainty of the mean was either a combination of the single uncertainties or simply the largest of them. In each case we considered it to be taken at a level of confidence of about 68 %, unless stated differently.

On the other hand, the so-called systematic uncertainties were estimated or determined by auxiliary measurements and presented either as maximum conceivable errors or at a level of confidence corresponding to that of the random uncertainty (see Table 10). The total systematic uncertainty was calculated by all the participants but one by taking the linear sum components (IRK : in quadrature). In order to get a uniform representation of the uncertainties in Table 11 and Fig. 4, the total values clearly recognized as maximum limits were divided by three.

11. Results and discussion

Twenty-four laboratories have submitted 35 different results obtained by using six different methods, namely :

Method	Number of laboratories
$4\pi\beta$(PC)-γ	22
$4\pi\beta$(PPC)-γ	4
$4\pi\beta$(AC)-γ	2
$4\pi\beta$(LS)-γ	3
$4\pi\beta$(LS)	1
$4\pi\gamma$(NaI)	4

The numerical results are listed in Table 11 and are graphically represented on Fig. 4 where random and systematic uncertainties are displayed by black and white rectangles, respectively, both centered on the corresponding result.

It is noteworthy that all the results lay within a band no wider than 0.68 % of the mean. This is by far the best agreement ever achieved in a large-scale comparison of activity measurements organized by the BIPM. It shows the high level of radionuclide standardization by coincidence techniques reached nowadays by national and international laboratories.

The present comparison was preceded by a preliminary one [3] between LMRI, NPL and BIPM which provided an excellent basis for organizing the full-scale undertaking. The preliminary results had a spread of about half a percent. Thanks to the international reference system for activity measurements of γ-ray emitting nuclides (SIR) [24], results obtained at different dates may be conserved for comparison in terms of the activity of a stable reference source (radium). Figure 5 shows the results of the present and the preliminary comparisons as well as some independent measurements carried out by six laboratories with their own solutions, samples of which had been submitted to the BIPM. We note again a small scatter and a remarkably close agreement between the mean results of the two comparisons for which standard deviations are indicated, whereas the uncertainties of the other measurements are overall values as used in the framework of SIR.

In former international comparisons we usually refrained from calculating a mean value of the radioactivity concentration. Such a mean might often be misleading due to the lack of uniformity in expressing systematic uncertainties and statistical weights. However, in view of the small spread of the present results, this danger is greatly reduced. If we take weighted means of the results from those laboratories which used more than one method, and then the arithmetic mean of 24 results we obtain 830.01 $Bq \cdot mg^{-1}$ with a standard deviation for a single measurement of 1.34 $Bq \cdot mg^{-1}$. With weights inversely proportional to the square of the random uncertainties a weighted mean is obtained which is lower by 0.18 $Bq \cdot mg^{-1}$ only. However, since the distribution of the results is closer to normal with the unweighted mean and standard deviation, we propose for the mean activity concentration on 1980-10-15, 0 h UT,

$$(830.0 \pm 1.4)\ Bq \cdot mg^{-1}\ (\pm 0.17\ \%).$$

In the last column of Table 11 the difference, measured value minus this mean, is indicated. It is found that this difference is larger than the total systematic uncertainty in thirteen cases out of 35, but not by more than the above 0.17 %, except for the liquid-scintillation results of IBJ and LMRI. For these two measurements, the systematic uncertainties seem to have been underestimated. Finally, it may be seen that the number of results lying further off than one standard deviation (0.17 %) is nine, but none is further off than 0.34 %, whereas a normal distribution would predict seven and one, respectively.

The preliminary report [4] contains two results obtained by IMM which differed from the mean by about 2 %. On request for a possible explanation, the participants of this laboratory mentioned a cracked ampoule seal. A later measurement by IMM, using the second ampoule, yielded a result in full agreement with the mean. In this report only the latter value was retained.

12. Conclusion

Twenty-four out of 40 invited national and international laboratories participated in this comparison. The high proportion shows once more the great interest which these laboratories attach to carefully organized comparative activity measurements.

A very pure ^{134}Cs solution was distributed in flame-sealed glass ampoules. Some participants observed a relatively high rate of adsorption of activity at the ampoule walls which, however, was still low enough to be neglected.

Thirty-one of the 35 results submitted were obtained by β-γ-coincidence techniques complemented by efficiency extrapolation. The complex decay scheme permitted a large variety of parameter values such as β efficiency and slope of the efficiency function. The differences between extrapolated activity values were in general quite small, but often statistically significant. With sources allowing a very high initial β efficiency, these differences might be reduced. Some participants reported initial efficiencies of up to 96 %. It is generally agreed that an efficiency function with zero slope gives the most precise result and is often linear whereas, for other efficiency functions, it is recommended not to extend the efficiency range below about 80 %.

The high level reached in the standardization of β-γ-emitting nuclides is evidenced by the total range of 0.68 % and the standard deviation of 0.17 %. The estimated systematic uncertainties were realistic in most cases.

Table 1

List of the participants

		Names of the persons who carried out the measurements
AAEC	Australian Atomic Energy Commission, Lucas Heights, Australia	G.C. Lowenthal, V. Page
AECL	Atomic Energy of Canada Limited, Chalk River, Canada	F.H. Gibson, L.V. Smith, A.R. Rutledge, J.S. Merritt
AIEA	Agence Internationale de l'Energie Atomique, Vienna, Austria	H. Houtermans, F. Reichel
ASMW	Amt für Standardisierung, Messwesen und Warenprüfung, Berlin, German Democratic Republic	E. Schönfeld
BARC	Bhabha Atomic Research Centre, Trombay, India	P.K. Srivastava, S. Kamboj
BCMN	Bureau Central de Mesures Nucléaires, Geel, Belgium	A. Nylandsted-Larsen, E. Celen
BIPM	Bureau International des Poids et Mesures, Sèvres, France	C. Veyradier, C. Colas
ETL	Electrotechnical Laboratory, Tokyo, Japan	O. Yura, Y. Kawada
IBJ	Instytut Badán Jadrowych, Świerk, Poland	A. Chyliński, T. Radoszewski, P. Zelazny
IEA	Instituto de Energia Atômica, São Paulo, Brazil	Cl. Renner, R. Pugliesi
IER	Institut d'électrochimie et de radiochimie de l'Ecole Polytechnique Fédérale, Lausanne, Switzerland	J.-J. Gostely, P. Comte
IMM	Institut de Métrologie D.I. Mendéléev, Leningrad, USSR	A. Konstantinov, S. Sepman, T. Sazanova
INPE	Institute of Nuclear Physics and Engineering, Bucarest, Romania	L. Grigorescu, M. Sahagia

Table 1 (cont'd)

		Names of the persons who carried out the measurements
IRK	Institut für Radiumforschung und Kernphysik, Vienna, Austria	H. Friedmann
LMRI	Laboratoire de Métrologie des Rayonnements Ionisants, Saclay, France	J. Bouchard, J.B. Adamo
NAC	National Accelerator Centre, Pretoria, South Africa	S.M. Botha, J. Steyn
NBS	National Bureau of Standards, Washington, D.C., USA	L.M. Cavallo, A.T. Hirshfeld, D.D. Hoppes, L.L. Lucas
NIM	National Institute of Metrology, Beijing, China	Yu Kuí-fāng, Zhōu Kè-qín, Song-Li, Fang Yu-Sheng, Li Gen-chang, Chen Di-an
NPL	National Physical Laboratory, Teddington, United Kingdom	S.P. Brown, D. Smith, M.J. Woods
NRC	National Research Council of Canada, Ottawa, Canada	G.C. Bowes, K. Munzenmayer, A.P. Baerg
OMH	Országos Mérésügyi Hivatal Budapest, Hungary	Á. Szörényi
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig, Federal Republic of Germany	K.F. Walz, E. Funck, U. Schötzig
SCK	Studiecentrum voor Kernenergie, Mol, Belgium	C. Ballaux, P. Willeborts
UVVVR	Ústav pro výzkum, výrobu a využití radioisotopů, Prague, ČSSR	J. Plch, P. Jasanovský

Table 2

Adsorption of activity at the ampoule walls

Laboratory	Procedure	Detector used	Activity adsorbed per g of solution (%)
AAEC	3 washings with 0.1 M HCl	Ionization chamber	0.03
ASMW	3 washings with H_2O dest.	" "	< 0.05
BIPM	3 " " " "	" "	$\leqslant 0.08$*
IER	3 washings with H_2O dest., then filled with 3.6 g of inactive solution	NaI detector	0.03
NAC	?	?	insignificant
SCK	5 washings with H_2O dest. 30 min in boiling " " 3 washings with " " the same ampoule: 2 washings with carrier solution 30 min in boiling " " 1 washing with " "	NaI well crystal	 $(1.5 \pm 0.5) \times 10^{-4}$* $(8 \pm 5) \times 10^{-5}$*

* These experiments were carried out after finishing the activity measurements.

Table 3

Source preparation for 4π(PC)-γ and 4π(PPC)-γ counting

Laboratory	Source backing 1. nature 2. number of films 3. " of metal layers 4. total mass ($\mu g \cdot cm^{-2}$)	Numbers of 1. dilutions 2. sources prepared	1. Range of source mass (mg) 2. was solution dispensed onto metal surface?	1. Wetting agent 2. Special treatment	Drying procedure	Range of N_c/N_γ (%)	Method used for varying N_c/N_γ *
AAEC	1. VYNS, Mylar 2. 1 or 2 3. 1; 2; 4 (Au-Pd) 4. 30 to 2 050	1. one 2. 15	1. 20 to 60 2. yes	1. electrosprayed ion exchange resin; Catanac 2. el. spraying of a Ag-acetate sol.	see [9]	95 - 63	3 different types of backing, different masses
AECL	1. VYNS 2. 2 3. 2 (Au-Pd) 4. ≈28	1. - 2. 17	1. 14 to 53 2. no	1. Catanac or Ludox SM or nothing 2. -	covered box at 40 °C	93 - 55	different wetting agents, varying amounts of carrier, adding foils
AIEA	1. VYNS 2. 1 3. 2 (Au-Pd) 4. ≈38	1. - 2. 20	1. 10 to 21 2. ?	1. Teepol + Ludox; ion exch. resin 2. see text	in open air	95 - 64	redissolving, sandwiching, adding films
ASMW	1. VYNS 2. 1 3. 2 4. 35	1. one 2. 20	1. 9 to 88 2. yes	1. Insulin in 0.01 N acetic acid 2. see text	air	94 - 57 main group: 94 - 82	addition of - exchange resin - carrier - metallized VYNS films
BARC	1. VYNS 2. 2 3. 2 4. 70	1. - 2. 20	1. 18 to 21 2. no	1. Teflon suspension 2. -	infrared lamp	92 - 45	not stated

Table 3 (cont'd)

Laboratory	Source backing 1. nature 2. number of films 3. " of metal layers 4. total mass ($\mu g \cdot cm^{-2}$)	Numbers of 1. dilutions 2. sources prepared	1. Range of source mass (mg) 2. was solution dispensed onto metal surface?	1. Wetting agent 2. Special treatment	Drying procedure	Range of N_c/N_γ (%)	Method used for varying N_c/N_γ *
BCMN	1. VYNS; Carbon 2. 1 1 3. 2 (Au) - 4. 50 19	1. - 2. 13 + 2	1. 9 to 15 2. yes	1. Catanac 2. -	under a lamp or freeze drying	90 - 60	metallized VYNS films and Al foils
BIPM	1. VYNS 2. 3 3. 2 + 3 (Au) 4. 130	1. - 2. 28	1. 8 to 51 2. no	1. Ludox SM 10^{-4} 1 drop 2. -	in air, under a lid	92 - 50	metallized VYNS films and Al foils
ETL	1. VYNS 2. 1 3. 2 (Au) 4. 30	1. - 2. 40	1. 7 to 16 2. yes	1. Ludox SM, some sources without 2. -	in a dry box with silicagel	94 - 60	a) addition of carrier b) with or without seeding agent
IBJ	1. VYNS 2. 1 3. 2 4. 80	1. - 2. 7	1. 5 to 10 2. yes	1. Ludox 2. -	in open air	88 - 75	changing voltage applied to photomultipliers
IEA	1. VYNS 2. 1, 2 for some 3. 1 (Au) 4. ≈ 30	1. 7 2. 52	1. 30 to 55 2. ?	1. Ludox; Catanac 2. -	in open air or warm nitrogen jet (for some)	96 - 72	not stated

Table 3 (cont'd)

Laboratory	Source backing 1. nature 2. number of films 3. " of metal layers 4. total mass ($\mu g \cdot cm^{-2}$)	Numbers of 1. dilutions 2. sources	1. Range of source mass (mg) 2. was solution dispensed onto metal surface?	1. Wetting agent 2. Special treatment	Drying procedure	Range of N_c/N_γ (%)	Method used for varying N_c/N_γ *
IER	1. VYNS 2. 1 3. 2 4. 50	1. - 2. 61	1. 10 to 86 2. yes	1. Ludox SM 10^{-4} 2. -	in weighing room conditions	93 - 71	not stated
IMM	1. x-ray film 2. 1 3. 2 4. 40	1. - 2. 5	1. 10 to 25 2. yes	1. Insulin + Ludox + NH_4OH 2. NH_3	in air and under a lamp	86 - 50	not stated
INPE	1. VYNS 2. 1 3. 2 4. 50 to 150	1. - 2. 12	1. 9 to 18 2. yes	1. - 2. -	free air	91 - 65	not stated
LMRI	1. Cellulose 2. 1 or 2 3. 2 4. 40 to 50	1. - 2. 23	1. 15 to 120 2. ?	1. Insulin 2. -	-	88 - 51	not stated
NBS	1. non-flex.collodion 2. 1 3. 1 4. 20 to 30	1. 2 2. 19	1. 14 to 49 2. yes	1. Ludox; ion-exchange resins 2. see text	dried in air	92 - 58	not stated (PPC)

Table 3 (cont'd)

Laboratory	Source backing 1. nature 2. number of films 3. " of metal layers 4. total mass ($\mu g \cdot cm^{-2}$)	Numbers of 1. dilutions 2. sources	1. Range of source mass (mg) 2. was solution dispensed onto metal surface?	1. Wetting agent 2. Special treatment	Drying procedure	Range of N_c/N_γ (%)	Method used for varying N_c/N_γ *
NIM	1. VYNS 2. 1 3. 1 4. 20	1. 5 2. 45	1. 25 to 60 2. no	1. Catanac SN; Ludox SM 2. electrosprayed pads of Catanac and Ludox	in an atmosphere of alcohol vapor	96 - 79	metallized VYNS films
NPL	1. VYNS 2. 1 3. 2 4. 60	1. - 2. 15	1. 27 to 32 2. yes	1. Catanac 2. Al^{3+} solution, see text	natural evaporation	94 - 58	not stated
NRC	1. VYNS 2. 1 3. 2 (Au-Pd) 4. ≈ 40	1. - 2. 10	1. 16 to 24 2. yes	1. Catanac SN 2. -	warm air stream	93 - 56	PPC
OMH	1. VYNS 2. 1 3. 2 4. 30 ± 5	1. - 2. 15	1. 10 to 33 2. yes	1. Teepol + Ludox SM 2. -	infrared lamp	94 - 70	not stated
PTB	1. VYNS 2. 1 3. 2 4. ≈45	1. - 2. 16	1. 10 to 12 2. yes	1. Ludox SM 10^{-4} 2. -	red light	93 - 40	PC : metallized VYNS films, Ar or Ar/CH_4

Table 3 (cont'd)

Laboratory	Source backing 1. nature 2. number of films 3. " of metal layers 4. total mass ($\mu g \cdot cm^{-2}$)	Numbers of 1. dilutions 2. sources prepared	1. Range of source mass (mg) 2. was solution dispensed onto metal surface?	1. Wetting agent 2. Special treatment	Drying procedure	Range of N_c/N_γ (%)	Method used for varying N_c/N_γ *
SCK	1. VYNS 2. ≥ 2 3. ≥ 3 4. 50	1. - 2. 10	1. 6 to 21 2. yes	1. Ludox SM30 10^{-4} 2. -	at temperature of balance room: 21.5 °C	92 - 63	not stated
UVVVR	1. VYNS 2. 2 or 3 3. 2 4. 40	1. 3 2. ≈ 100	1. 15 to 50 2. yes	1. ion exch. resin 2. -	see [9]	93 - 55	not stated

* As this question was not asked in the reporting form, some participants did not state the method used which may be identical with that stated in [2].

Table 4

Equipment for $4\pi\beta$(PC)-γ and $4\pi\beta$(PPC)-γ counting

Labo-ratory	Wall material	Height of each half (mm)	Anode of the 4pi proportional counter 1. nature 2. wire diam. (μm) 3. " length (mm) 4. distance from the source (mm) 5. voltage (kV)	Gas 1. nature 2. discr. level (eV) 3. pressure (MPa)	Gamma-ray counter 1. number of NaI(Tl) crystals 2. diameter (mm) 3. height (mm)
AAEC	Al and epoxy resin (Au coated)	27	1. Pt 2. 50 3. 35 4. 12 5. 3.05	1. CH_4 2. 300 3. atm.	1. 1 2. 75 3. 75
BARC	Al	26	1. st'l. steel 2. 13 3. 38 4. 13 5. 2.7	1. LPG (85 % butane + 15 % isobutane) 3. atm.	1. 1 2. 76 3. 76
IMM	Al	40	1. constantan 2. 100 3. 120 4. 20 5. 2	1. CH_4 2. 100 3. 0.1	1. 1 2. 40 3. 40
LMRI	perspex	22	1. W + Au 2. 20 3. 80 4. 10 5. 2.725	1. CH_4 2. 100 3. atm.	2. Ge(Li) diodes, true coaxial, 10 cm^3 FWHM = 3 keV (^{60}Co)
NIM	brass	36	1. st'l. steel 2. 20 3. 75 4. 18 5. 2.85	1. CH_4 2. 450 3. atm.	1. 2 2. 50 3. 50
NPL	Cu, perspex (Al coated)	23	1. Mo (Au coated) 2. 76 3. 76 4. 12 5. 2.174	1. Ar/CH_4 2. 200 3. atm.	1. 1 2. 75 3. 75

Table 4 (cont'd)

Laboratory	Wall material	Height of each half (mm)	Anode of the 4pi proportional counter 1. nature 2. wire diam. (μm) 3. " length (mm) 4. distance from the source (mm) 5. voltage (kV)	Gas 1. nature 2. discr. level (eV) 3. pressure (MPa)	Gamma-ray counter 1. number of NaI(Tl) crystals 2. diameter (mm) 3. height (mm)
NRC	Al	25	1. st'l. steel 2. 25 3. 38 4. 12.7 5. 3.15	1. Ar/CH_4 2. 1 to 40 keV 3. 0.811 5	1. 2 2. 76 3. 76 also : 2 Ge(Li) detectors
OMH	Al	20	1. st'l. steel 2. 30 3. 40 4. 10 5. 2.5	1. CH_4 2. 220 3. atm.	1. 1 2. 76 3. 76
PTB	Al	22.5	1. st'l. steel 2. 50 3. 30 4. 12 5. 3.7	1. CH_4; Ar/CH_4 2. 500 3. atm.	1. 1 2. 76 3. 76
	Al	20	1. st'l. steel 2. 30 3. 40 4. 10 5. 4.5	1. Ar/CH_4 2. $\geqslant 500$ 3. 1	1. 1 2. 76 3. 76
	Al	20	1. st'l. steel 2. 100 3. 60 4. 10 5. 7.1	1. Ar/CH_4 2. 0.6 to 50 keV 3. 1.1	1. 2 2. 76 3. 76
SCK	brass Au coated	20	1. st'l. steel 2. 50 3. 55 4. 11 5. 3.1	1. CH_4 2. 300 3. atm.	1. 1 2. 102 3. 102
UVVVR	stainless steel	18	1. Mo (Au coated) 2. 50 3. 55 4. 9 5. 3.5	1. CH_4 2. 300 3. atm.	1. 2 2. 76 3. 51

Table 5

Equipment and source preparation for liquid scintillation counting

Laboratory	1. Material of counting cell 2. Volume " " " 3. Range of source mass	1. Composition of the liquid scintillator 2. Intermediate solvent	1. Number and type of phototubes for viewing the cell 2. Precautions taken against counting of spurious pulses 3. Upper limit of spurious pulse rate	Gamma-ray detector 1. Number of NaI crystals 2. Diameter; height (mm) 3. Year of purchase 4. Type 5. Resolution at 662 keV
IBJ	1. Low potassium glass 2. 22 cm^3 3. 5 to 10 mg	1. 4 g/dm^3 PPO + 0.08 g/dm^3 bis MSD 2. Toluene + Triton x 100; 2:1 10 cm^3 of scintillator with 0.7 g of 0.1 M HCl	1. Two EMI 9634 QR 2. Counting in coincidence 3. Nil	1. One 5. 85 keV 2. 45; 50 3. 1970 4. EMI 6097 B
LMRI	1. Glass 2. ≈3 cm^3 3. 2.3 to 2.5 g	1. 80 % toluene with butyl PBD 12.5 g/dm^3 2. Ethanol with CsCl carrier	1. Two RCA 8850 2. Threshold 3. Nil	1. One 4. - 2. 150; 150 5. - 3. -
NAC	1. Glass 2. 15 cm^3 3. 22.5 to 27 mg	1. "Insta-Gel" (Packard Instr. Corp), xylene based 2. -	1. Two new RCA 8850's 2. Correction determined by a gating technique [21] 3. 0.11 %	1. One 5. 63 keV 2. 76; 76 3. 1970 4. 9 531 KA
NIM	1. Glass 2. 14 cm^3 3. 25 to 45 mg	1. 750 ml (59 PPO + 0.59 POPOP) per dm^3 of toluene + 250 ml of ethyl alcohol (abs.) 2. Ethyl alcohol	1. One GDB 52-LD (made in China) 2. Threshold 3. 0.1 %	1. Two 5. 70 keV 2. 50; 50 3. 1977 4. GDB-44 (E)

Table 6

$4\pi\gamma$ measurements with NaI well-type crystals

Laboratory		IRK	LMRI	PTB	SCK
Sources					
Number of dilutions		2	2	-	-
Backing material		Polyethylene	?	VYNS sandwiched between polyethylene	lucite
" diameter	(mm)	15	?	26	10 and 15
" thickness	(mm)	0.1	?	2 x 0.2	2 x 1
Mass range	(mg)	7 to 26 of dilution	?	8 to 13	2.5 and 9
Number of sources used		10	12	3	2
NaI(Tl) detector				2 crystals	
Diameter	(mm)	127	125	150	127
Height	(mm)	127	100	100	127
Well diameter	(mm)	25	12	19	20
" depth	(mm)	74	50	50	70
Lining		Al	Be	?	Al
Resolution (keV at 662 keV)		75 (at 605 keV)	?	?	50
Calculated efficiency for ^{134}Cs		? [26]	0.954 2 $\pm$ 0.004 0	0.969 $\pm$ 0.004	0.961 1 $\pm$ 0.003 4
Counting					
Threshold	(keV)	22.1 (^{109}Cd K_{α_1})	?	15	22
Count rates	(s^{-1})	?	?	6 000 to 10 000	1 000 to 10 000
Background	(s^{-1})	?	?	52	35
Dead time	(μs)	8.0 $\pm$ 0.2	?	5	4.189 $\pm$ 0.002

Table 7

Delay between β and γ channels and coincidence formulae used

	Delay between β and γ channels δ (ns)	correction (%) of final result	Coincidence formulae used B [17]	C [18]	C - I [19, 20]	Others	Reference
AAEC	10	0		X			
AECL	$\leqslant 43$	$\leqslant 0.1$ to individual sources	X				
AIEA	0	0				X	similar to AECL [2]
ASMW	0 ± 15	0		X			
BARC	-	-		X			
BCMN	$\leqslant 50$	-			X		
BIPM	$\leqslant 10$	-			X		
ETL	0	-		X			
IBJ	- 25	-		X			
IEA	-	-	X				
IER	± 1	-			X		
IMM	not stated	-		X			
INPE	<100	-				X	[2]
LMRI	± 50	-				X	[14]
NAC	-	-				X	[15]
NBS	$+10 \pm 200$	-	X				
NIM	100	$\leqslant 0.08$		X			
NPL	0	0			X		
NRC	0	0	X			X	[16] AC
OMH	- 45	0.08 - 0.12		X			
PTB	30	0.02		X			
SCK	<50	-		X			
UVVVR	0 ± 30	-			X		
		Total	4	10	5	5	

Table 8

Coincidence counting data

Laboratory	γ-channel settings (keV)	Background count rates (s^{-1}) β	γ	c	Numbers of sources used	data points	Range of N_c/N_γ (%)	Mean measurement time per data point (s)	Slope-to-intercept ratio and standard deviation	
AAEC	530 - 650	0.8	1.35	0.003	15	17	94 - 73	4 000	0.172 (10)	All data points
	710 - 880		1.14		15	20	95 - 78	4 000	- 0.014	
	1 210 - 1 630		1.07		15	19	91 - 63	12 000	0.399 (22)	
	530 - 650		1.35		11	12	94 - 82	4 000	0.206 (5)	VYNS-backed sources only
	710 - 880		1.14		11	15	95 - 86	4 000	- 0.005	
	1 210 - 1 630		1.07		11	14	91 - 74	12 000	0.432 (7)	
AECL	500 - 685	0.3	0.8	<0.01	15	68	92 - 68	500	0.1 550 (14)	
	685 - 915		0.9	<0.01	17	176	93 - 73	500	- 0.002 0 (11)	
	730 - 1 520		1.5	0.02	15	64	92 - 67	500	0.119 2 (8)	
	1 280 - 1 535		0.5	<0.01	15	109	89 - 55	1 000	0.357 0 (24)	
AIEA	483 - 700	1.0	3.0	0.005	11	37	94 - 64	1 000	0.185 (6)	
	>483		9.16	0.16	11	38	94 - 65	1 000	0.163 (5)	
	700 - 910		1.76	0.006	11	37	95 - 70	1 000	0.015 7 (20)	
	>700		6.18	0.15	11	37	95 - 67	1 000	0.133 (6)	
ASMW	300 - 1 300	2.0	8.0	0.025	9	15	91 - 57	6 000	0.132 (3)	
	500 - 700	2.0	4.0	0.01	3	4	86 - 57	6 000	0.145 (9)	
	300 - 1 300	3.5	8.0	0.03	10	21	94 - 57	6 000	0.146 (3)	
BARC	480 - 700	2.5	1.7	0.12	7	44	90 - 45	1 200	0.103 3 (29)	
	>480		5.0	0.3	7	44	91 - 46	1 200	0.085 5 (26)	
	700 - 960		1.0	0.06	7	44	92 - 50	1 200	0.011 5 (11)	

Table 8 (cont'd)

Laboratory	γ-channel settings (keV)	Background count rates (s^{-1}) β	γ	c	Numbers of sources used	Numbers of data points	Range of N_c/N_γ (%)	Mean measurement time per data point (s)	Slope-to-intercept ratio and standard deviation	
BCMN	560 - 700	0.4	0.7	0.002	5	40	86 - 70	1 000	0.165 (6)	
	700 - 875		0.6	0.002	9	81	90 - 70	1 000	- 0.019 (5)	
	700 - 1 750		3.0	0.005	4	44	88 - 60	1 000	0.129 (2)	
BIPM	500 - 700	1.05	1.50	0.022	15	59	90 - 55	5 000	0.149 1 (15)	
	700 - 900	1.03	1.07	0.020	15	60	92 - 62	5 000	0.000 8 (10)	
	1 260 - 1 490	1.07	0.53	0.013	14	25	88 - 50	54 000	0.297 2 (37)	
ETL	500 - 700	4.22	2.34	0.002	32	40	92 - 65	1 800	0.177 (11)	
	700 - 900		1.72	0.006	32	40	94 - 70	1 800	0.014 7 (34)	
	1 200 - 1 500		1.64	0.001	31	38	90 - 60	1 800	0.345 (14)	
IBJ PC	315 - 1 400	2.5	4.0	0.3	7	6	88 - 75	300	0.132 2 (28)	1)
	460 - 1 400	2.5	6.0	0.3	7	6	88 - 75	300	0.131 3 (46)	1)
LS	135 - 1 400	6.7	8	0.6	7	7	89 - 77	300	0.083 4 (22)	
	324 - 1 400	6.7	7	0.4	7	7	88 - 76	300	0.126 0 (33)	
IEA	498 - 695	0.7	3.7	0.05	3	10	94 - 75	3 600	0.183 (5)	2)
	710 - 890	1.3	2.9	0.04	2	20	96 - 72	3 600	0.009 7 (11)	
IER	520 - 700	5.1	3.2	0.13	17	900	93 - 71	25 - 90	0.185 7 (16)	
	700 - 900	3.3	1.5	0.02	18	960	93 - 80	16 - 20	0	2)
	700 - 1 600	5.1	5.2	0.12	17	800	93 - 77	22 - 100	0.114 2 (21)	
IMM	550 - 820	10	5	0.03	5	15	86 - 50	2 000	0.116 (8)	

Table 8 (cont'd)

Laboratory	γ-channel settings (keV)	Background count rates (s^{-1}) β	γ	c	Numbers of sources used	data points	Range of N_c/N_γ (%)	Mean measurement time per data point (s)	Slope-to-intercept ratio and standard deviation	
INPE	700 - 900	0.89	0.90	0.003	8	6	91 - 65	500	0.013 9 (24)	
	700 - 1 000		1.18	0.005	8	6	90 - 66	500	0.037 3 (20)	
	100 - 900		9.42	0.10	8	6	89 - 66	400	0.097 5 (39)	
	500 - 1 500		5.25	0.14	8	6	89 - 65	400	0.135 3 (49)	
LMRI PC	610 - 698	2.18	1.15	0.028	21	28	88 - 72	5 000		3)
	787 - 808		0.81	0.02	21	28	88 - 73	5 000		
LS	550 - 650	≈6	16	0.03	8	13	83 - 60	240	0.097 (1)	
	750 - 850		10	0.02	8	13	84 - 60	240	- 0.017 0 (3)	
	1 350 - 1 450		9	0.01	8	13	78 - 51	240	0.242 4 (97)	
NAC	>500	≈8	37.5	≈1.2	10	15	92 - 78	800	0.126 1 (19)	
	500 - 700		11.5	0.35	4	15	91 - 76	800	0.182 8 (21)	
	700 - 900		8.0	0.15	4	15	93 - 80	800	0.055 7 (28)	
	1 000 - 1 500		3.5	0.5	3	15	88 - 67	1 600	0.392 7 (26)	
NBS PPC	700 - 900	0.5-1.8	0.85	0.008	5	37	92 - 58	200	0.012 3 (8)	
NIM	520 - 680	1.4	1.3	0.013	22	220	95 - 79	1 200	0.197 (1)	5)
	720 - 880	1.4	0.8	0.01	24	240	96 - 82	1 200	0.01	4) 5)
	473 - 700	1.58	9.0	0.04	20	140	94 - 76	300	0.176 (19)	6)
NPL	715 - 873	1.89	0.48	0.007	15	33 + 12	94 - 63	1 200	- 0.025 69 (57)	set A, 3 sources
	715 - 1 500		1.18	0.031	15	37 + 12	93 - 58	1 200	0.126 5 (22)	set A, 3 sources
	715 - 873	1.31	0.42	0.003	11	37 + 7	94 - 67	1 200	- 0.014 31 (94)	set B, 4 sources
	715 - 1 500		1.08	0.015	11	36 + 7	93 - 63	1 200	0.141 9 (23)	set B, 4 sources

Table 8 (cont'd)

Laboratory		γ-channel settings (keV)	Background count rates (s^{-1}) β	γ	c	Numbers of sources used	Numbers of data points	Range of N_c/N_γ (%)	Mean measurement time per data point (s)	Slope-to-intercept ratio and standard deviation	
NRC	PPC	520 - 700	0.52	1.04	0.005	10	14	92 - 79	500	0.189 (2)	
		710 - 910	0.50	0.70	0.003	10	14	93 - 81	500	- 0.005 (1)	
		1 850 - 2 060	0.52	0.17	0.002	10	14	83 - 56	2 000	0.614 (2)	
		790 - 804	0.50	0.065	0.000 5	10	14	93 - 85	500	- 0.045 (5)	with Ge(Li)
	AC	520 - 700				10	14	93 - 82			
		710 - 910				10	14	93 - 63			
		1 850 - 2 060				10	14	93 - 82			
		790 - 804				10	14	93 - 82			with 2 Ge(Li)
OMH		500 - 700	1.74	2.01	0.006	15	30	94 - 70	1 250	0.141 (3)	
		700 - 930		1.77	0.006	15	15		1 250	0.010 (1)	
		500 - 1 540	1.79	9.16	0.05	14	14		1 250	0.119 (6)	
		750 - 1 540		5.83	0.03	14	14		1 250	0.124 (3)	
PTB	PC	>500	4.20	8.19	0.18	13 + 3	44	93 - 70	2 400	0.154 (5)	set A
		730 - 860	1.35	1.28	0.003	10	10	93 - 70	2 400	- 0.006 (1)	set A
		>500	0.43	2.82	0.15	13 + 3	44	93 - 70	2 400	0.162 4 (24)	set B
		730 - 860	0.36	0.22	0.003	10	11	93 - 70	2 400	0.000 (3)	set B
	PPC1	>500	3.02	3.43	0.22	4	206	92 - 65	3 600	+ 0.12 - 0.17	
		730 - 860	3.04	0.43	0.003	3	155	92 - 40	3 600	0.005 4 (1)	
	PPC2	720 - 880	0.5-6.5	0.2	0	11 + 1	117	95 - 75	2 000	- 0.739 (13)	7)
		>1 400		2.8	0.08			80 - 45		- 0.260 (12	7)
SCK		510 - 690	0.63	0.98	0.006	9	14	90 - 63	1 000	0.134 (40)	
						9	12	90 - 71	1 000	0.157 1 (55)	
		700 - 900		0.71	0.003	9	14	92 - 69	1 000	- 0.008 8 (22)	

Table 8 (cont'd)

Laboratory	γ-channel settings (keV)	Background count rates (s^{-1}) β	γ	c	Numbers of sources used	Numbers of data points	Range of N_c/N_γ (%)	Mean measurement time per data point (s)	Slope-to-intercept ratio and standard deviation	
UVVVR	>182	2.53	27.9	0.67	11	17	93 - 55	320	0.146 (3)	Dilution 1
	>500		12.5	0.48	11	17	93 - 55	320	0.191 (4)	
	>182	2.47	23.9	0.36	50	46	93 - 70	500	0.144 (4)	Dilution 2
	>500		12.2	0.49	50	46	93 - 70	500	0.176 (4)	
	>182	2.34	24.1	0.33	35	30	93 - 66	800	0.144 (6)	
	>500		12.0	0.42	35	30	93 - 66	800	0.176 (7)	Dilution 3
	>500	2.59	12.5	0.50	37	33	94 - 70	800	0.181 (5)	

1) All results contain a correction factor of 0.992 5 for afterpulses.

2) The slope-to-intercept ratios were determined with two or three sources and subsequently used to calculate the activity of all the others.

3) Multiparametric linear adjustment.

4) Two-dimensional linear adjustment, in addition.

5) This measurement was carried out in Peking.

6) " " " Chengtu.

7) Slope-to-intercept ratio determined with one source and two-dimensional linear adjustment and subsequently used to calculate the activity of the others.

Table 9

Comparison of results obtained with different γ-channel settings

Laboratory	Order of adjusted efficiency function for N_2	Intercept and standard deviation gate at 800 keV N_1 ($Bq \cdot mg^{-1}$)	s_1 (%)	gate at 1 365 keV N_1 ($Bq \cdot mg^{-1}$)	s_2 (%)	$\sqrt{s_1^2 + s_2^2}$ (%)	$\frac{N_2 - N_1}{N_1}$ (%)
AAEC	1	829.91	0.06	832.98	0.29	0.30	+ 0.37
	2	829.79	0.08	833.43	0.14	0.16	+ 0.44
AECL	1	830.11	0.02	832.80	0.05	0.05	+ 0.32
BIPM	2	830.32	0.03	833.3	0.29	0.29	+ 0.36
ETL	2	831.12	0.07	830.88	0.19	0.20	- 0.03
LMRI (LS)	2	834.8	0.17	831.2	0.25	0.30	- 0.43
NAC	1	829.44	0.10	833.9	0.12	0.16	+ 0.54

Table 10

Systematic uncertainties in the final results

Laboratory	% uncertainty due to 1) weighing, 2) dead time, 3) resolving time, 4) delay mismatch, 5) pile-up, 6) background, 7) fitting procedure, 8) others	How was it obtained? (remarks from participants)	Total systematic uncertainty (%)
AAEC	Combined effect 1) to 6) 0.10, 7) 0.15, 8) 0.15	7) γ-gate instability, 8) extrapolation	0.40
AECL	1) 0.003, 2) 0.002, 3) 0.004, 4) 0.018, 5) 0.02 6) 0.003 to 0.05, 7) 0.07 to 0.5, 8) 0.003	see [5] 8) decay	0.13
AIEA	1) 0.005, 2) to 6) no bias expected because of the large number of measurements, 7) 0.25, 8) -	7) dependency of extrapol. result on γ discrimination	0.25
ASMW	1) 0.04 2) 0.005 3) 0.025 4) 0.01 5) 0.01 6) 0.008 7) 0.08 8) 0.025	calibration with test weights 1 % of $\Delta\tau/\tau$ 2 % of $\Delta\tau_r/\tau_r$ estimated γ-background variation different fitting procedures $T_{1/2}$, dilution, impurities, error in N_c/N_γ	0.2
BARC	1) 0.10 2) 0.04 3) 0.41 4) - 5) - 6) 0.10 7) 0.10 8) 0.02	from accuracy of built-in weights from $\Delta\tau/\tau$ and $\Delta\tau_r/\tau_r$ maximum background variation polynomial of a degree higher by one decay correction	0.77

Table 10 (cont'd)

Laboratory	% uncertainty due to 1) weighing, 2) dead time, 3) resolving time, 4) delay mismatch, 5) pile-up, 6) background, 7) fitting procedure, 8) others	How was it obtained? (remarks from participants)	Total systematic uncertainty (%)
BCMN	1) 0.05 2) 0.01 3) 0.02 4) 0.05 5) - 6) 0.01 7) - 8) -	built-in weights with $\Delta m = 5\,\mu g$ by setting each parameter separately to its extreme value extreme mismatch = 50 ns $\Delta B/N'$	0.14
BIPM	1) 0.033 2) 0.001 3) 0.026 4) 0.021 5) not determined 6) 0.006 7) 0.032 8) 0.012	$\Delta m = 0.01$ mg, $\bar{m} = 30$ mg see [2] $(N_\beta - N_\gamma)\cdot\delta / [1 - (N_\beta + N_\gamma)\cdot\tau]$ see [2] time of the measurements, $\Delta T_{1/2}$	0.13
ETL	1) 0.1 2) 0.04 3) 0.011 4) 0.1 5) - 6) 0.06 7) 0.28 8) -	$\Delta m = \pm 10\,\mu g$ $N_{\beta max} \times 3\,\Delta\tau_\beta \times$ (slope/interc.) $+ N_{cmax} \times 3\,\Delta\tau_\beta$ $N_{\beta max} \times N_{\gamma max} \times 3\,\Delta\tau_r / N_{cmax}$ $(N_{\beta max} - N_{\gamma max}) \times \delta$, $\delta \leq 100$ ns $\Delta B_\gamma / N_{\gamma min}$ twice max difference between two extrapolations	0.59
IBJ	PC LS 1) 0.051 0.052 2) 0.002 0.001 3) 0.008 0.006 6) 0.010 0.010 7) - 0.320	$\sqrt{2}\,\Delta m / \sum m^{-1}$ $\Delta\tau \times N_c / t$ $\Delta\tau_r (N_\beta + N_\gamma - 2 N_\beta N_\gamma / N_c) / t$ $\Delta B / N$ spurious pulses, $\Delta J_w \times N_\gamma / N_c$	PC 0.07 LS 0.32

Table 10 (cont'd)

Laboratory	% uncertainty due to 1) weighing, 2) dead time, 3) resolving time, 4) delay mismatch, 5) pile-up, 6) background, 7) fitting procedure, 8) others	How was it obtained? (remarks from participants)	Total systematic uncertainty (%)
IEA	1) 0.05 2) 0.003 3) 0.007 6) 0.05 7) 0.02 (Syst. 1), 0.06 (Syst. 2)		Syst. 1 0.13 " 2 0.16
IER	1) 0.03 2) 0.007 3) 0.001 4) - 5) - 6) - 7) 0.107 8) 0.03 } positive only 0.1 }	$\Delta m/\overline{m}$ $\Delta m = 10\,\mu g$ $\Delta\tau \times N_{\beta max}/(1 - \tau \times N_{\beta max})$ $(\Delta\tau_r/\tau_r) \times (N_{acc}/N_{cmax})$ spread of 3 extrapolations adsorbed/total activity loss of material, estimated from shape of distribution of 44 individ. results	+ 2.8 - 1.5
IMM	method 1 1) 0.05 2) 0.005 3) 0.08 4), 5) - 6) 0.1 7) 0.1 8) 0.1	$\Delta m/M$ $\Delta\tau_d$ $\Delta\tau_r$ ΔB	0.44
INPE	1) 0.10 2) 0.015 3) 0.005 6) 0.02 7) 0.05 8) 0.1 0.1 0.014	experimentally and by estimation propagation of errors spurious pulses } estimations adsorption decay, $T_{1/2}$	

Table 10 (cont'd)

Laboratory	% uncertainty due to 1) weighing, 2) dead time, 3) resolving time, 4) delay mismatch, 5) pile-up, 6) background, 7) fitting procedure, 8) others	How was it obtained? (remarks from participants)	Total systematic uncertainty (%)
IRK	1) 0.05 2) 0.02 6) - 8) 0.11 0.01	2) double-pulse generator is included in random uncertainty $\Delta\varepsilon/\varepsilon$ (efficiency) $T_{1/2}$	0.12
LMRI	PC / LS / $4\pi\gamma$ 1) 0.05 / 0.05 / 0.05 2) 0.01 / 0.01 / 0.03 3) 0.01 / 0.01 / - 6) - / 0.06 / 0.02 8) 0.03 / 0.03 / 0.40 0.05	8) PC : $T_{1/2}$, time jitter LS : $T_{1/2}$, measurement time $4\pi\gamma$: efficiency	PC : 0.10 LS : 0.16 $4\pi\gamma$ = 0.55
NAC	1) 0.01 2) 0.07 3) 0.001 4) - 5) - 6) 0.01 7) 0.11 8) 0.03	manufacturers' estimate estim. from uncertainties of these param. inaccuracy in measurement differences between extrapolations coincidence formula	0.23
NBS	PPC / AC 1) 0.1 / 0.1 2) 0.1 3) 0.05 / - 4) 0.05 / - 5) 0.1 / - 6) 0.05 / 0.05	from past results calcul. using measured uncertainty mean of delay curve compared to maximum compar. pulse width and τ_γ eff. from 2-source method at higher rates estim. from observed background variations and using background/count rate ratio	PPC : 0.67 AC : 0.40

Table 10 (cont'd)

Laboratory	% uncertainty due to 1) weighing, 2) dead time, 3) resolving time, 4) delay mismatch, 5) pile-up, 6) background, 7) fitting procedure, 8) others	How was it obtained? (remarks from participants)	Total systematic uncertainty (%)
NBS (cont'd)	PPC AC		
	7) 0.15 0.15	estim. from limits of least-squares fit and possible effect of second-order fit	
	8) 0.07 0.07	dilution, decay correction	
	0.005	incorrect live-time gating	
	0.02	γ precedes corresponding β	
	0.002	accidental Y events	
	PC1 PC2 LS		
NIM	1) 0.1 0.1 0.1	PC1 : $\Delta m = 4\ \mu g$, PC2 : $10\ \mu g$, LS : $4\ \mu g$	PC1 : 0.62
	2) 0.01 0.03 0.3	$\Delta\tau \times N_c/(1 - \tau N_c)$	
	3) 0.13 0.01 -	$(\Delta\tau_r/\tau_r) \times (N_{acc}/N_c)$	PC2 : 0.53
	4) - 0.08 -	experimentally	
	6) 0.08 0.06-0.21 -	$\Delta B_{\gamma max} = 0.08\ s^{-1}$	LS : 1.3
	7) 0.1 0.12 0.8	difference between 1st and 2nd order fit	
	8) 0.2 0.1 0.1	PC1 : dilution, PC2 : timing, LS : spurious pulses	
NPL	1) 0.006	max. uncertainty in overall source mass	+ 0.23
	2) 0.001 2 3) 0.012	by calculation	- 0.10
	4) 0.012 5) -	effect of 10 ns mismatch	
	6) 0.006	observed variations in background	
	7) + 0.20 - 0.064 8) -	max. effects of n $\pm$ 1 order polynomials	

Table 10 (cont'd)

Laboratory	% uncertainty due to 1) weighing, 2) dead time, 3) resolving time, 4) delay mismatch, 5) pile-up, 6) background, 7) fitting procedure, 8) others	How was it obtained? (remarks from participants)	Total systematic uncertainty (%)
NRC	PPC AC 1) 0.05 0.05 2) 0.004 - 3) 0.004 - 4) 0.01 - 6) 0.03 0.03 100 (slope) $\Delta B_\gamma / N_\gamma$ 7) 0.2 0.10 8) - 0.001	100 $\Delta m/m$ 100 m $[a_1 - (a_o - a_1) N_c^2/N_\beta N_\gamma] \Delta\tau$ 100 $m_{a1} (2 - N_c/N_\gamma - N_c/N_\beta) \Delta\tau_r$ see [23] $(1 - a_1/a_o) (B/t_B)^{1/2}/N_\gamma$ max. extrapolation difference live timing	PPC : 0.3 AC : 0.18
OMH	1) 0.01 2) 0.01 3) 0.03 4) 0.05 5) - 6) 0.01 7) 0.10 8) 0.01	By calculating the maximum values 8) $T_{1/2}$	0.22
PTB	PC PPC1 PPC2 $4\pi\gamma$ 1) 0.02 0.02 0.02 0.03 2) <0.01 <0.01 0.01 0.02 3) 0.03 0.02 0.01 - 4) 0.01 0.01 0.01 - 5) 0.01 0.01 0.01 - 6) 0.02 0.02 0.01 0.02 7) 0.05 0.04 0.02 0.04 8) - - - 0.35	2 $\Delta m/m$ $\Delta m = 2\ \mu g$ calculated from observed and estimated max. deviations $4\pi\gamma$: max. variation of b'gr. of 52 s^{-1} 20 % of the 0.2 % extrapol. to E = 0 Efficiency	PC 0.14 PPC1 0.12 PPC2 0.09 $4\pi\gamma$ 0.46

Table 10 (cont'd)

Laboratory	% uncertainty due to 1) weighing, 2) dead time, 3) resolving time, 4) delay mismatch, 5) pile-up, 6) background, 7) fitting procedure, 8) others			How was it obtained? (remarks from participants)	Total systematic uncertainty (%)
		PC	$4\pi\gamma$		
SCK	1)	0.1	0.17	$\Delta m/\overline{m}$ $\Delta m = 10\ \mu g$	
	2)	0.001	0.001	} relative uncertainty of mean	
	3)	0.001	-		
	4)	0.04	-	0.05 μs (mainly due to amplifier)	
	5)	0.001	0.001	estimation	
	6)	0.007	0.014	PC : mean from 2 γ-channel settings	
	7)	0.008	-	difference between 1st and 2nd order	
	8)	0.02	0.001	timing	
			0.34	efficiency ($\mathcal{E}$ = 0.961 1)	
			0.004		
		E_γ = 500 keV	182 keV		
UVVVR	1)	0.005	0.005	$\Delta m/\overline{m}$	0.15
	2)	0.006	0.053	} from measured uncertainty	
	3)	0.014	0.022		
	4)	0.021	0.016	from the delay curve	
	6)	0.008	0.004	random uncertainty and instability	
	7)	0.100	0.100	estimated from polynomial order $\pm$ 1	
	8)	0.051	0.007	accidental coincidences	

Table 11

Results

Laboratory	Method used (beta detector)	γ-channel setting (keV)	Number of data points	Order of polynomial	Radioactivity concentration 1978-10-15, 0 h UT ($Bq \cdot mg^{-1}$)	Standard deviation (1σ) ($Bq \cdot mg^{-1}$) (%)		Total systematic uncertainty of final result** ($Bq \cdot gm^{-1}$) (%)		Deviation off mean (%)
AAEC	PC	530 - 650	17	2	830.94	1.01				
			12	1	31.15	0.50				
		710 - 880	20	2	29.79	0.63				
			15	1	29.91	0.46				
		1 210 - 1 630	19	2	32.98	2.42				
			14	1	33.43	1.13				
					831.59	0.56	0.067	3.33	0.40	+ 0.19
AECL	PC	500 - 685	68	1	830.42	0.44				
		685 - 915	176	1	30.11	0.17				
		730 - 1 520	64	1	31.32	0.46				
		1 280 - 1 535	109	1	32.80	0.40				
					830.11	0.15	0.018	1.08	0.13	+ 0.008 4
AIEA	PC	>483	38	2	830.53	0.38				
		483 - 700	37	2	30.42	0.49				
		>700	37	2	28.27	0.45				
		700 - 910	37	1	27.75	0.27				
					829.24	0.20	0.024	2.07	0.25	- 0.10
ASMW	PC	300 - 1 300	15	1	829.2	0.6				
		500 - 700	4	1	29.0	2.0				
		300 - 1 300	21	1	30.1	0.5				
					829.5	0.2	0.024	1.7	0.20	- 0.065

Table 11 (cont'd)

Laboratory	Method used (beta detector)	γ-channel setting (keV)	Number of data points	Order of poly-nomial	Radioactivity concentration 1978-10-15, 0 h UT ($Bq \cdot mg^{-1}$)	Standard deviation (1σ) ($Bq \cdot mg^{-1}$)	(%)	Total systematic uncertainty of final result** ($Bq \cdot mg^{-1}$)	(%)	Deviation off mean (%)
BARC	PC	480 - 700	44	2	831.67	0.94				
		700 - 960	44	1	32.23	0.49				
		>480	44	2	32.5	1.3				
					832.1	0.4	0.048	2.1	0.25	+ 0.25
BCMN	PC	560 - 700	40	1	829.9	0.6				
		700 - 875	81	1	27.9	0.4				
		700 - 1 750	44	2	27.9	0.6				
					828.4	0.3	0.036	1.2	0.14	- 0.20
BIPM	PC	500 - 700	59	2	831.05	0.51				
		700 - 900	60	1	30.32	0.23				
		1 260 - 1 490	25	2	33.3	2.4				
					830.46	0.21	0.025	1.1	0.13	+ 0.051
ETL	PC	500 - 700	40	2	832.51	1.09				
		700 - 900	40	1	31.12	0.60				
		1 200 - 1 500	38	2	30.88	1.61				
					831.39	0.50	0.060	3.0	0.36	+ 0.16
IBJ	LS	324 - 1 400	7	1	828.4	0.7				
		135 - 1 400	7	1	26.8	0.8				
					827.56	0.64	0.077	0.58	0.07	- 0.30
	PC	315 - 1 400	6	2	827.8	2.6				
		460 - 1 400	6	2	27.5	1.3				
					827.65	2.6	0.31	3.2	0.39	- 0.29

Table 11 (cont'd)

Laboratory	Method used (beta detector)	γ-channel setting (keV)	Number of data points	Order of polynomial	Radioactivity concentration 1978-10-15, 0 h UT ($Bq \cdot mg^{-1}$)	Standard deviation (1σ) ($Bq \cdot mg^{-1}$)	(%)	Total systematic uncertainty of final result** ($Bq \cdot mg^{-1}$)	(%)	Deviation off mean (%)
IEA	PC 1	498 - 695	10	1	831.7	0.3				
	PC 2	710 - 890	20	1	30.6	0.3				
					831.1	0.3	0.036	1.1	0.13	+ 0.13
IER	PC	520 - 700	900	1	829.14	0.28				
		700 - 900	960	0	29.30	0.18				
		700 - 1 600	800	1	28.41	0.30				
					829.09	0.14	0.017	+ 2.3 - 1.5	+0.28 -0.18	- 0.11
IMM	PC	550 - 820	15	1	829.4	0.8	0.096	3.6	0.44	- 0.072
INPE	PC	700 - 900	6	1	827.93	1.91				
		700 - 1 000	6	1	29.47	1.53				
		500 - 1 500	6	1	30.84	2.33				
		100 - 900	6	1	32.03	1.58				
					828.87	1.19	0.14	3.2	0.39	- 0.14
IRK	NaI	>22.1	-	-	828.3	0.8	0.097	1.0	0.12	- 0.21
LMRI	PC	*	28	1	829.6	0.80	0.096	0.83	0.10	- 0.053
	LS	550 - 650	13	2	834.2	1.7				
		750 - 850	13	2	34.8	1.4				
		1 350 - 1 450	13	2	31.2	2.1				
					833.2	1.0	0.12	1.3	0.16	+ 0.38
	NaI		-	-	830.0	0.2	0.024	4.6	0.55	- 0.005

Table 11 (cont'd)

Laboratory	Method used (beta detector)	γ-channel setting (keV)	Number of data points	Order of polynomial	Radioactivity concentration 1978-10-15, 0 UT ($Bq \cdot mg^{-1}$)	Standard deviation (1σ) ($Bq \cdot mg^{-1}$)	(%)	Total systematic uncertainty of final result** ($Bq \cdot mg^{-1}$)	(%)	Deviation off mean (%)
NAC	LS	>500	15	1	831.16	0.50				
		500 - 700	15	1	31.16	0.90				
		700 - 900	15	1	29.44	0.80				
		1 000 - 1 500	15	1	33.9	1.0				
					831.16	0.50	0.060	1.92	0.23	+ 0.14
NBS	PPC	700 - 900	≈35	1	830.33	0.46	0.055	1.85	0.22	+ 0.035
	AC	?	?	1	831.83	0.29	0.035	1.11	0.13	+ 0.22
NIM	PC 1	520 - 680	220	1	830.5	0.3				
		720 - 880	240	1	32.1	0.2				
			two-dimensional		30.7	0.3				
					831.0	0.2	0.024	1.7	0.21	0.12
	LS	?	?	2	832	1	0.12	3.7	0.44	0.24
	PC 2	473 - 700	7	1	830.00	0.51	0.061	1.4	0.17	0.005
NPL	PC A	715 - 1 500	37 + 12	2	829.58	0.25				
		715 - 873	33 + 12	1	28.89	0.16				
	PC B	715 - 1 500	36 + 7	2	28.63	0.22				
		715 - 873	37 + 7	1	29.27	0.16				
					828.93	0.20	0.024	+1.9 -0.8	+0.23 -0.10	- 0.13

Table 11 (cont'd)

Laboratory	Method used (beta detector)	γ-channel setting (keV)	Number of data points	Order of poly-nomial	Radioactivity concentration 1978-10-15, 0 h UT ($Bq \cdot mg^{-1}$)	Standard deviation (1σ) ($Bq \cdot mg^{-1}$)	(%)	Total systematic uncertainty of final result** ($Bq \cdot mg^{-1}$)	(%)	Deviation off mean (%)
NRC	PPC	520 - 700	14	1	832.04	0.17				
	2 NaI	710 - 910	14	1	30.34	0.29				
		1 850 - 2 060	14	1	32.70	0.64				
	2 Ge(Li)	790 - 804	14	1	31.48	0.44				
					831.7	0.4	0.048	2.5	0.30	+ 0.20
	AC									
	2 NaI $\varepsilon_\beta \geq 0.63$	520 - 700	14	1	831.42	0.56				
		710 - 910								
	$\varepsilon_\beta \geq 0.82$	520 - 700	14	1	31.29	0.32				
		710 - 910								
		1 850 - 2 060	14	1	32.11	0.60				
	2 Ge(Li)	790 - 804	14	1	31.36	0.40				
					831.43	0.21	0.025	1.5	0.18	+ 0.17
OMH	PC	500 - 700	30	1	833.02	0.25				
		700 - 930	15	1	29.57	0.42				
		500 - 1 540	14	1	32.29	0.26				
		750 - 1 540	14	1	32.01	0.27				
					832.15	0.37	0.044	1.8	0.22	+ 0.25
PTB	PC 1	>500	44	3	829.3	0.3				
		730 - 860	10	1	29.1	0.3				
	PC 2	>500	44	3	29.0	0.2				
		730 - 860	11	1	28.7	0.5				
					829.06	0.14	0.017	0.39	0.047	- 0.12

Table 11 (cont'd)

Laboratory	Method used (beta detector)	γ-channel setting (keV)	Number of data points	Order of polynomial	Radioactivity concentration 1978-10-15, 0 h UT ($Bq \cdot mg^{-1}$)	Standard deviation (1σ) ($Bq \cdot mg^{-1}$)	(%)	Total systematic uncertainty of final result** ($Bq \cdot mg^{-1}$)	(%)	Deviation off mean (%)
PTB (cont'd)	PPC 1	>500	206	3	829.18	0.22				
		730 - 860	155	1	29.02	0.02				
					829.10	0.22	0.027	0.33	0.040	- 0.11
	PPC 2	720 - 880	117	1	829.03	0.11	0.013	0.25	0.030	- 0.12
		>1 400	two-dimensional							
	NaI	>15	-	-	828.3	1.2	0.14	1.3	0.16	- 0.21
SCK	PC	510 - 690	14	2	827.72	1.72				
		700 - 900	14	1	27.98	0.41				
		510 - 690	12	1	29.37	0.95				
					828.19	0.38	0.046	1.5	0.18	- 0.22
	NaI	>22	-	-	829.10	0.97	0.12	4.4	0.53	- 0.11
UVVVR	PC									
	Dilution 1	>500	17	2	830.04	0.66				
		>182	17	2	29.94	0.41				
	2	>500	46	2	30.72	0.41				
		>182	46	2	29.73	0.33				
	3	>500	33	2	29.60	0.41				
		>500	30	2	29.38	0.66				
		>182	30	2	28.76	0.58				
					829.70	0.27	0.033	1.25	0.15	- 0.041

Table 11 (cont'd)

* Multiparametric linear adjustment with five different γ-channel settings

I	II	III	IV	V
610 - 698	787 - 808	565 - 573 799 - 808 1 360 - 1 373	484 - 478 1 032 - 1 047	557 - 565 1 164 - 1 175

** Corresponding to the confidence level of 1σ .

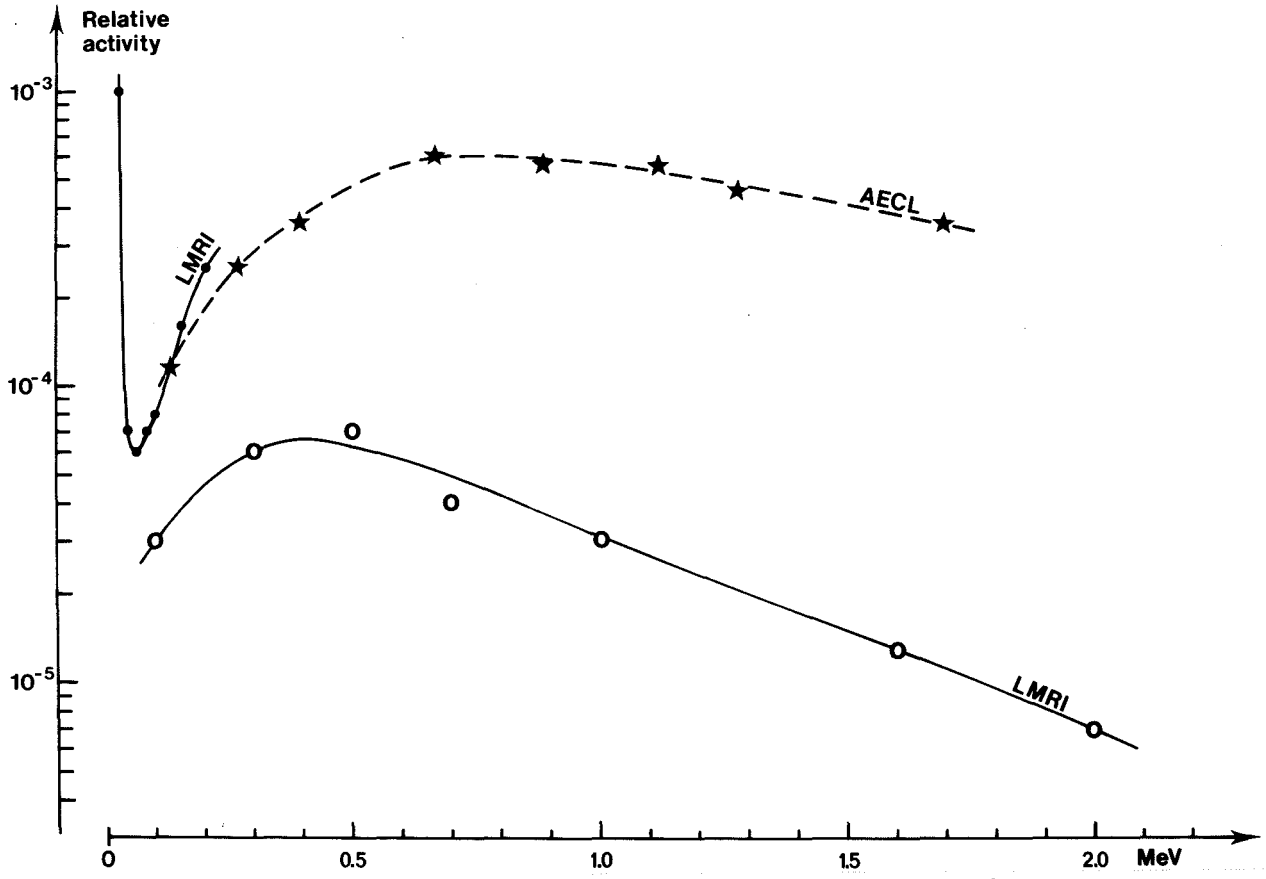

Figure 1 - Detection limits for purity tests. The limits of detectable activity versus γ energy are given relative to the ^{134}Cs activity at reference date.

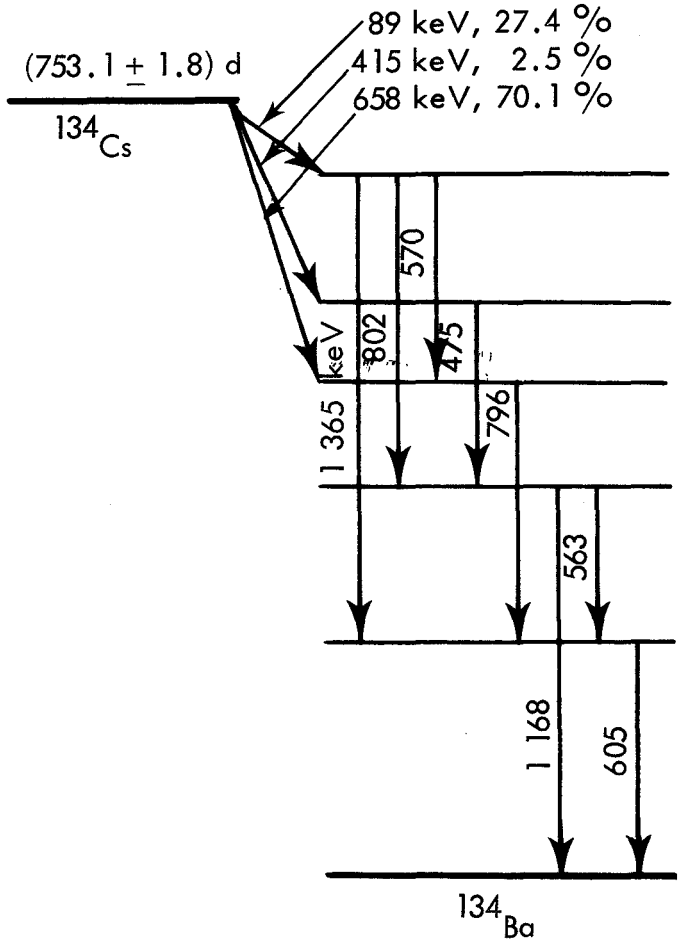

Figure 2 - Decay scheme of ^{134}Cs; data taken from [8]

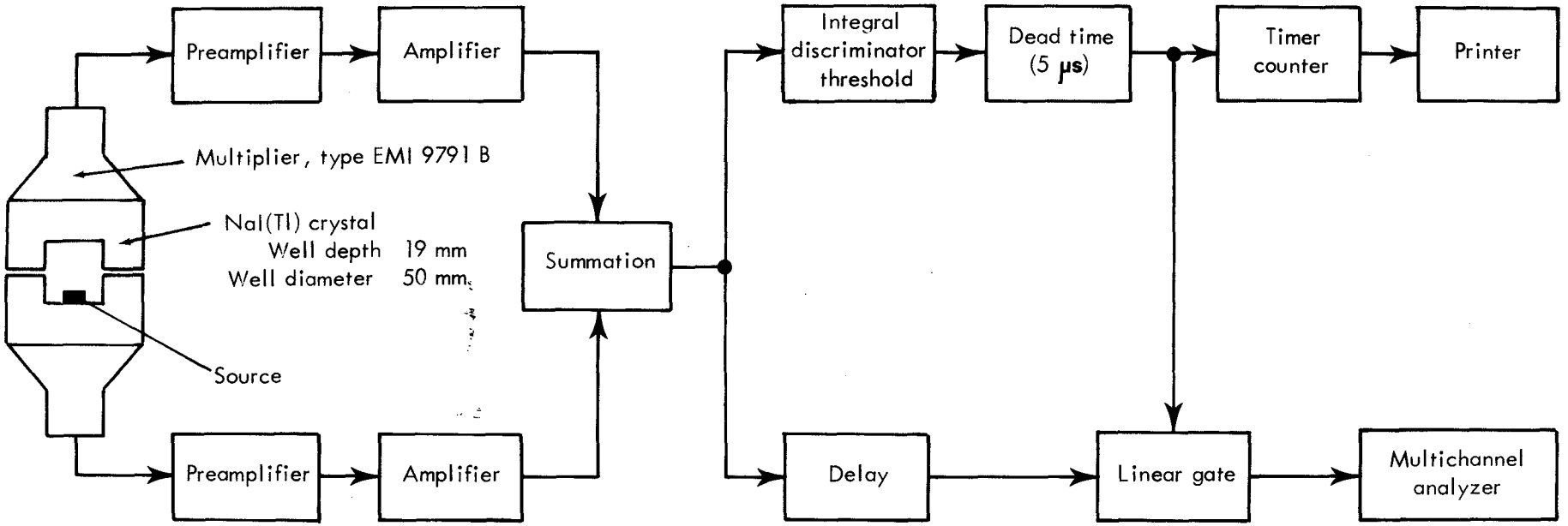

Figure 3 - Block diagram of a $4\pi\gamma$ arrangement (PTB)

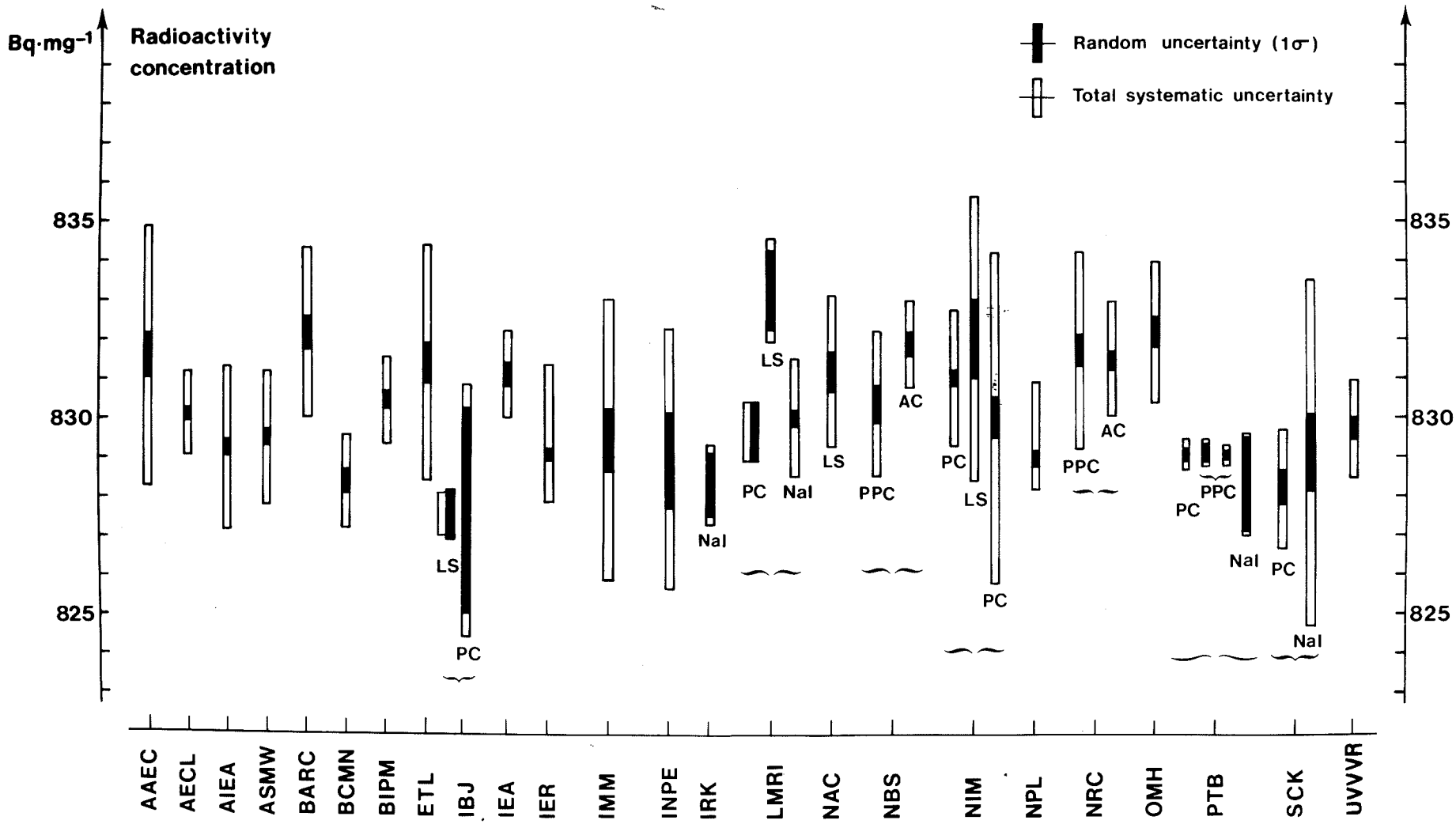

Figure 4 - Graphical representation of the results

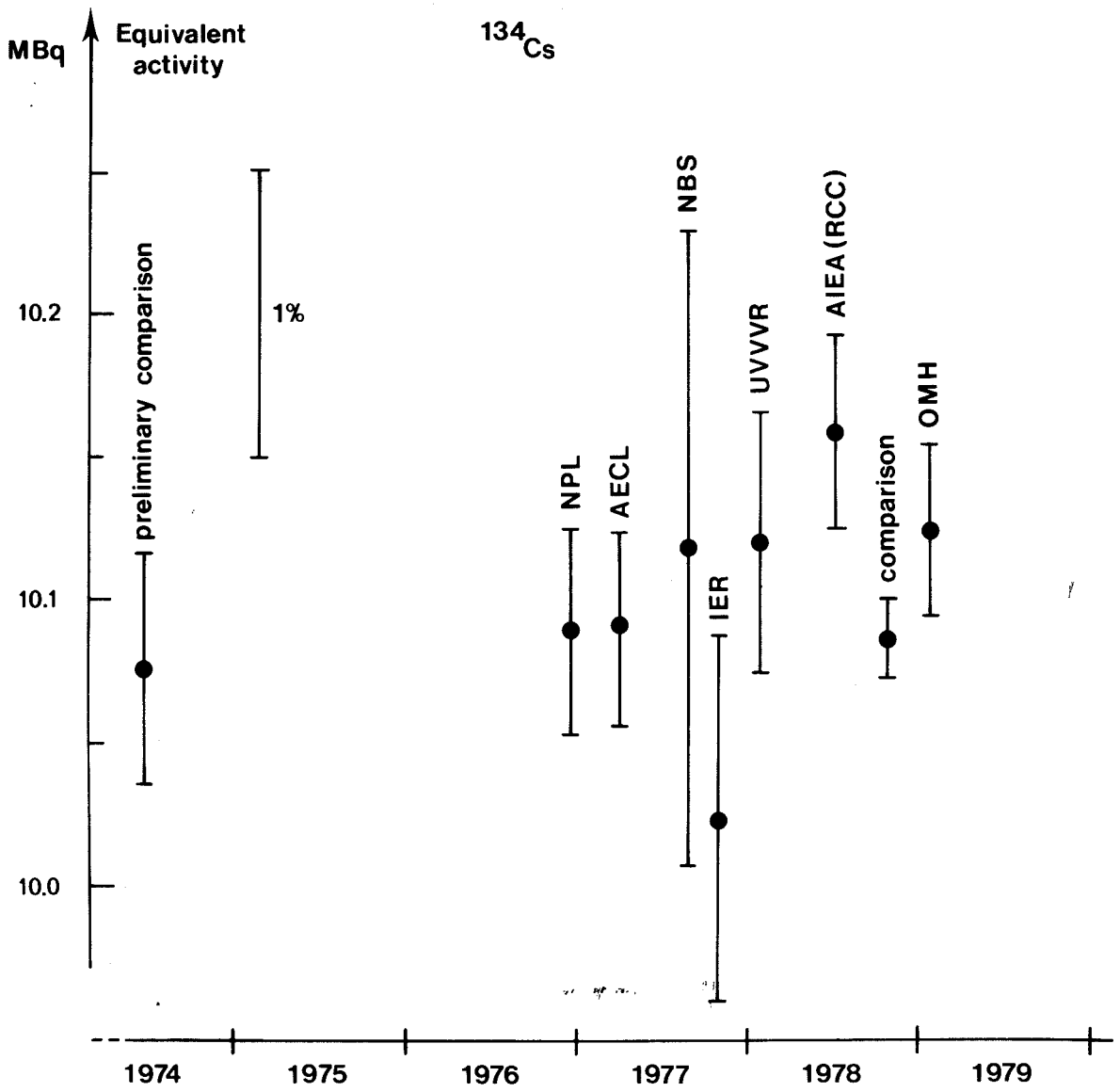

Figure 5 - ^{134}Cs measurements in the international reference system.
The results are indicated in terms of the activity necessary to produce the same ion current as the reference source (Ra) at a fixed date.
The vertical bars represent overall uncertainties.

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