Update of the BIPM comparison BIPM.RI(II)-K1.Ga-67 of activity measurements of the radionuclide ^{67}Ga to include the 2023 result of the CMI (Czechia)

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Abstract Since 1978, 10 laboratories have submitted 18 samples of ^{67}Ga to the International Reference System (SIR) for activity comparison at the Bureau International des Poids et Mesures (BIPM), with comparison identifier BIPM.RI(II)-K1.Ga-67. Recently, the CMI (Czechia) participated in the comparison and the key comparison reference value (KCRV) has been fully revised. The degrees of equivalence between each equivalent activity measured in the SIR and the updated KCRV have been calculated and the results are given in the form of a table. A graphical representation is also given.

1. Introduction

The SIR for activity measurements of γ-ray-emitting radionuclides was established in 1976. Each national metrology institute (NMI) may request a standard ampoule from the BIPM that is then filled with 3.6 g of the radioactive solution. Each NMI completes a submission form that details the standardization method used to determine the absolute activity of the radionuclide and the full uncertainty budget for the evaluation. The ampoules are sent to the BIPM where they are compared with standard sources of ^{226}Ra using pressurized ionization chambers. Details of the SIR method, experimental set-up and the determination of the equivalent activity A_e, are all given in [1].

From its inception until 31 December 2023, the SIR has been used to measure 1054 ampoules to give 807 independent results for 72 different radionuclides. The SIR makes it possible for national laboratories to check the reliability of their activity measurements at any time. This is achieved by the determination of the equivalent activity of the radionuclide and by comparison of the result with the key comparison reference value determined from the results of primary standardizations. These comparisons are described as BIPM continuous comparisons and the results form the basis of the BIPM key comparison database (KCDB) of the Comité International des Poids et Mesures Mutual Recognition Arrangement (CIPM MRA) [2]. The comparison described in this report is known as the BIPM.RI(II)-K1.Ga-67 key comparison. The results of earlier participations in this key comparison were published previously [3–6].

Successful participation in this comparison by a laboratory may provide evidential support for Calibration and Measurement Capability (CMC) claims for ^{67}Ga measured using the laboratory's method(s) used in the comparison or methods calibrated by those used for the comparison. This comparison may also be used to support CMC claims for those radionuclides measured in the laboratory using the same method and having a degree of difficulty at or below that of the radionuclide measured in this comparison as indicated in the current Measurement Methods Matrix (MMM) [7]

2. Participants

Laboratory details are given in Table 1, with the earlier submissions being taken from [3–6]. The dates of measurement in the SIR given in Table 1 are used in the KCDB and all references in this report.

Table 1: Details of the participants in the BIPM.RI(II)-K1.Ga-67.

NMI or laboratory	**Previous acronyms or other institutes**	**Full name**	**Country**	**Regional Metrology Organization (RMO)**	**Date of SIR measurement** yyyy-mm-dd
BKFH	OMH, MKEH	Government Office of the Capital City Budapest	Hungary	EURAMET	1995-11-30
CIEMAT	-	Centro de Investigaciones Energéticas, Medioambientales y Tecnologicas	Spain	EURAMET	2003-03-19
CMI	UVVVR, CMI-IIR	Czech Metrology Institute	Czechia	EURAMET	1981-04-24 2023-09-18
LNE-LNHB	LMRI, LPRI, BNM-LNHB	Université Paris-Saclay, CEA, List, Laboratoire National Henri Becquerel	France	EURAMET	1981-11-10 2005-10-20
NIRH	-	National Institute of Radiation Hygiene	Denmark	EURAMET	1983-05-05
NIST	NBS	National Institute of Standards and Technology	United States	SIM	1978-03-21 1998-04-27 1999-04-28 2010-05-04

... Continuation of Table 1.

NMI or laboratory	Previous acronyms or other institutes	Full name	Country	RMO	Date of SIR measurement yyyy-mm-dd
NMIJ	ETL	National Metrology Institute of Japan	Japan	APMP	2001-11-26 2002-05-17
NMISA	NAC, CSIR-NML[a]	National Metrology Institute of South Africa	South Africa	AFRIMETS	1986-10-28
NPL	-	National Physical Laboratory	United Kingdom	EURAMET	1982-04-30
PTB	-	Physikalisch-Technische Bundesanstalt	Germany	EURAMET	2010-03-11

[a] NAC is another institute in the country now named iThemba LABS.

3. NMI standardization methods

Each NMI that submits ampoules to the SIR has measured the activity either by a primary standardization method or by using a secondary method, for example a calibrated ionization chamber. In the latter case, the traceability of the calibration needs to be clearly identified to ensure that appropriate correlations are taken into account.

A brief description of the standardization methods used by the laboratories, the activities submitted, the relative standard uncertainties and the half life used by the participants are given in Table 2. The uncertainty budget for the new submission is given in Appendix D attached to this report; previous uncertainty budgets are given in the earlier reports [3–6]. The list of acronyms used to summarize the methods is given in Appendix E.

The half life used by the BIPM is 3.261 3(5) days as published in BIPM Monographie 5 vol. 2 [8].

Table 2: Standardization methods of the participants for ^{67}Ga.

NMI or laboratory	Method used and the acronym	Activity A_i/kBq	Relative standard uncertainty /10^{-2}		Reference date	Half life /d
			A	B	yyyy-mm-dd	
BKFH	4π (e_A,x)-γ anti-coincidence (4P-PP-MX-NA-GR-AC)	6817	0.06	0.51	1995-12-01 00:00 UT	3.26154(54) [12]
CIEMAT	4πβ (PPC)-γ coincidence (4P-PP-AE-NA-GR-CO)	7916	0.7	0.52	2003-03-12 10:00 UT	3.259(10)

... Continuation of Table 2.

NMI or laboratory	Method used and the acronym	Activity A_i/kBq	Relative standard uncertainty /10^{-2}		Reference date	Half life /d
			A	B	yyyy-mm-dd	
CMI	4π(e,x)-γ coincidence (4P-PP-MX-NA-GR-CO)	22 750	0.05	0.87	1981-04-08 12:00 UT	3.261
	4π PPC-γ coincidence (4P-PP-MX-NA-GR-CO)	75 830	0.2	0.95	2023-09-11 10:00 UT	3.2613(5) [13]
LNE-LNHB	4π(e_A,x)-γ anti-coincidence (4P-PP-MX-NA-GR-AC)	4772[g] 4771	0.02 0.02	0.38 0.38	1981-11-13 12:00 UT	-
	4π LS-γ anti-coincidence (4P-LS-MX-NA-GR-AC)[a]	3269[g] 3253	0.25 0.25	0.08 0.08	2005-10-18 12:00 UT	3.2613(5) [13]
NIRH	ionization chamber (4P-IC-GR-00-00-00)	118 290	0.04	0.6	1983-05-04 12:00 UT	-
NIST	ionization chamber (4P-IC-GR-00-00-00)[b]	565 200	0.01	1.49	1978-03-15 19:00 UT	
	ionization chamber (4P-IC-GR-00-00-00)[b]	94 860	0.03	0.27	1998-04-27 12:00 UT	3.2614(6)
	ionization chamber (4P-IC-GR-00-00-00)[b]	53 990	0.01	0.3	1999-04-28 12:00 UT	
	4π LS-γ anti-coincidence (4P-LS-PE-NA-GR-AC)	7281	0.03	0.45	2010-04-30 17:00 UT	3.2613(5) [13]
NMIJ	ionization chamber (4P-IC-GR-00-00-00)[c]	21 850	0.06	0.41	2001-11-30 12:00 UT	3.2612
	ionization chamber (4P-IC-GR-00-00-00)[c]	36 650	0.06	0.36	2002-05-15 12:00 UT	
NMISA	4π LS (e,x)-γ coincidence (4P-LS-MX-NA-GR-CO)[d]	222 770	0.15	0.17	1986-10-24 10:00 UT	3.261
NPL	ionization chamber (4P-IC-GR-00-00-00)[e]	30 090	0.04	1.22	1982-04-28 00:00 UT	-
PTB	$4\pi\beta$(PC)-γ coincidence (4P-PC-MX-NA-GR-CO)[f] $4\pi\beta$(PPC)-γ coincidence (4P-PP-MX-NA-GR-CO)	62 378[h]	0.09	0.51	2010-03-11 12:00 UT	3.2612(6)

[a] see details in [9]
[b] calibrated by 4π (e_A,x)-γ coincidence (4P-PP-MX-NA-GR-CO) in 1977
[c] calibrated by 4π (e,x)-γ anti-coincidence (4P-PP-MX-NA-GR-AC) in 2001
[d] see [10]
[e] calibrated by 4π (e_A,x)-γ coincidence (4P-PC-MX-NA-GR-CO)
[f] see [11]
[g] Several samples submitted
[h] The final result is calculated as unweighted mean of the two methods with the larger uncertainty of the two single results.

Details regarding the solutions submitted are shown in Table 3, including any impurities, when present, as identified by the laboratories. When given, the standard uncertainties on the evaluations are shown.

Table 3: Details of each solution of ^{67}Ga submitted.

NMI or laboratory / **SIR year**	**Chemical composition**	**Solvent conc.** /(mol dm^{-3})	**Carrier conc.** /(µg g^{-1})	**Density** /(g cm^{-3})	**Relative activity of any impurity**[b]
BKFH 1995	Ga citrate in NaCl	-	NaCl: 8000	-	-
CIEMAT 2003	Ga citrate in HCl	0.1	$Na_3C_6Cl_3H_5$. $2H_2O$: 230	1	-
CMI 1981	$GaCl_3$ in HCl	1	$GaCl_3$: 50	-	<0.1 %
2023	$GaCl_3$ in HCl	0.02	$GaCl_3$: 1.26	1	None
LNE-LNHB 1981	Ga citrate and NaCl in HCl	0.1	$GaC_6Cl_3H_5$: ? NaCl: 180	1.006	^{57}Co: 5.1(10)x10^{-4} % ^{60}Co: 7.2(15)x10^{-4} %
2005	$GaCl_3$ in HCl	0.1	$GaCl_3$: 48	1	-
NIRH 1983	Ga citrate in NaCl	-	-	-	-
NIST 1978	Ga in HCl	2	-	1.032	-
1998	$GaCl_3$ in HCl	2.1	$GaCl_3$: 1950	1.036(2)	-
1999	$GaCl_3$ in HCl	2.1	$GaCl_3$: 805	1.035	-
2010	$GaCl_3$ in HCl	2	$GaCl_3$: 150	1.033	None[a]
NMIJ 2001	Ga citrate and NaCl in HCl	0.1	$GaC_6Cl_3H_5$: 200 NaCl: 9000	1.02	-
2002	$GaCl_3$ in HCl	0.1	$GaCl_3$: 100	1.002	-
NMISA 1986	Na citrate and Ga in HCl	1	$Na_3C_6Cl_3H_5$. $2H_2O$: 2600 Ga: 100	1.0143	-
NPL 1982	Ga in HCl	0.1	-	1.0015	-
PTB 2010	Ga_2O_3 in HCl	0.5	Ga_2O_3: 26	1.007	^{66}Ga: 4.8(8)x10^{-3} %

[a] Confirmed by HPGe measurements carried out at the BIPM
[b] The ratio of the activity of the impurity to the activity of ^{67}Ga at the reference date

4. Results

All the submissions to the SIR since its inception in 1976 are maintained in a dedicated database based on CSV formatted files controlled by the Git version control system [14]. Machine-readable versions of this report (XML and JSON documents) are attached to this document [15]. The latest submission has added 1 ampoule for the activity measurements of ^{67}Ga giving rise to 18 ampoules in total.

The SIR equivalent activity, A_{ei}, for each ampoule received from each NMI, i, including both previous and new results, is given in Table 4. The relative standard uncertainties arising from the measurements in the SIR are also shown. This uncertainty is additional to that declared by the NMI ($u(A_i)$) for the activity measurement shown in Table 2. Although submitted activities are compared with a given source of ^{226}Ra, all the SIR results are normalized to the radium source number 5 [1]. Table 4 also shows the comparison results selected for the KCRV as explained in section 4.1.

Measurements repeated at the BIPM over a period of about one half-life later produced identical results for the CMI (2023).

In view of the ^{67}Zn meta-stable state (9 µs) populated by the ^{67}Ga decay, which makes the standardization of this radionuclide by the laboratories using the (anti)coincidence method rather challenging, additional information on the standardization method used by the participants is given in Tables 5 and 6.

Table 4: Results of SIR measurement of ^{67}Ga.

NMI or laboratory / SIR year	Mass m_i /**g**	A_i /**kBq**	^{226}**Ra source**	$A_{\mathbf{e}i}$ /**kBq**	**Relative uncert. from SIR /10^{-4}**	$u_{\mathbf{c}i}$ /**kBq**	$A_{\mathbf{e}i}$ **for KCRV /kBq**
BKFH 1995	3.639 4	6817	3	115 210	9	600	-
CIEMAT 2003	3.663	7916	1	117 960	13	1040	-
CMI 1981	3.457 4	22 750	1	118 800	19	1100	-
2023	3.605 30(72)	75 830	3	115 100	9	1100	115 100(1100)
LNE-LNHB 1981	3.612 5	4772	3	114 616	10	450	-
	3.611 9	4771	3	114 597	9	450	-
2005	3.557 1	3269	2	113 955	11	320	113 820(320)[a]
	3.539 5	3253	2	113 695	11	320	-
NIRH 1983	3.573 6	118 290	5	115 640	8	710	-
NIST 1978	3.689 38	565 200	5	115 600	8	1700	-
1998	3.746	94 860	5	116 090	8	330	-
1999	3.711 19	53 990	4	116 230	8	360	-
2010	3.726	7281	2	115 110	11	530	115 110(530)
NMIJ 2001	3.603 96	21 850	4	114 670	8	480	-
2002	3.607 28	36 650	4	115 210	8	430	-
NMISA 1986	3.605 65	222 770	5	116 430	8	280	-
NPL 1982	3.682 1	30 090	4	116 000	9	1400	-
PTB 2010	3.645 69	62 378	5	115 510	8	600	115 510(600)

[a] An average value and average uncertainty between all submitted samples is used for the KCDB [16].

Table 5: Details on coincidence measurements

SIR participation	Dead-time value in beta channel	Extendable ?	Live-time technique?	Count rate in beta channel / s^{-1}	Dead/live-time correction value in beta channel	Funck 1987 correction applied ?	Extrapolation to infinite dead-time?
NPL, 1982		No				N/A	Yes
NMISA, 1986	1.1 µs	No				N/A	
CIEMAT, 2003	50 to 107 µs	No	Yes				Yes
PTB, 2010	4 to 64 µs	No	No	40 to 11 500	1.001 to 1.1	Up to 3.5%	Yes
CMI, 2023	6 to 80 µs	No	No	5000-12 000		0.2 % to 2.2 %	21 % to 0.07 %

Table 6: Details on anti-coincidence measurements

SIR participation	Dead-time value in beta channel	Extendable ?	Live-time technique?	Count rate in beta channel / s^{-1}	Dead/Live-time correction value in beta channel	Funck correction applied ?	Extrapolation to infinite dead-time?
BKFH, 1995	120 µs	Yes	Yes			N/A	
NMIJ, 2002		No				N/A	
LNE-LNHB, 2005	120 µs	Yes	Yes	4000-12000	N/A	N/A	No
NIST, 2010	120 µs	Yes	Yes	800 - 3000	N/A	N/A	No*

* A test was carried out showing that the correction would be 0.01 %. A relative uncertainty of 0.05 % for effects of the delayed state have been included.

4.1. The key comparison reference value

In May 2013, the CCRI(II) decided to calculate the key comparison reference value (KCRV) by using the power-moderated weighted mean [17] rather than an unweighted mean, as had been the policy. This type of weighted mean is similar to a Mandel-Paule mean in that the NMIs' uncertainties may be increased until the reduced chi-squared value is one. In addition, it allows for a power α smaller than two in the weighting factor. As proposed in [17], α is taken as $2 - 3/N$ where N is the number of results selected for the KCRV. Therefore, all SIR key comparison results can be selected for the KCRV with the following provisions:

(a) results for solutions standardized by only primary techniques are accepted, with the exception of radioactive gas standards (for which results from transfer instrument measurements that are directly traceable to a primary measurement in the laboratory may be included);

(b) each NMI or other laboratory may use only one result (normally the most recent result or the mean if more than one ampoule is submitted);

(c) results more than 20 years old are included in the calculation of the KCRV but are not included in data shown in the KCDB or in the plots in this report, as they have expired;

(d) possible outliers can be identified on a mathematical basis and excluded from the KCRV using the normalized error test with a test value of 2.5 and using the modified uncertainties;

(e) results can also be excluded for technical reasons; and

(f) the CCRI(II) is always the final arbiter regarding excluding any data from the calculation of the KCRV.

Although the KCRV may be modified when other NMIs participate, on the advice of the Key Comparison Working Group of the CCRI(II), such modifications are made only by the CCRI(II) during one of its biennial meetings, or by consensus through electronic means (e.g., email) as discussed at the CCRI(II) meeting in 2013. The CCRI(II) agreed to include (anti-)coincidence measurement results in the KCRV only when the appropriate corrections [18] [19] [20] [11] were applied and documented in Tables 5 or 6.

Consequently, using the recent result produces an updated KCRV for ^{67}Ga in 2023 of **114 780(420) kBq** with the power α =1.25 that has been calculated using the previously published results, selected as shown in Table 4, for the LNE-LNHB (2005), NIST (2010), PTB (2010), and the present CMI (2023) result. This can be compared with the previous KCRV values of 116 040(520) kBq published in 2003 [3] , 116 190(560) kBq published in 2006 [5] and 116 030(550) kBq published in 2020 [6].

4.2. Degrees of equivalence

Every participant in a comparison is entitled to have one result included in the KCDB as long as the NMI is a signatory or designated institute listed in the CIPM MRA and the result is valid (i.e., not older than 20 years). No recent submission has been identified as a pilot study so the most recent result of each NMI is normally eligible for inclusion on the KCDB platform of the CIPM MRA [2]. An NMI may withdraw its result only if all other participants agree.

The degree of equivalence of a given measurement standard is the degree to which this standard is consistent with the KCRV [2]. The degree of equivalence is expressed quantitatively in terms of the deviation from the key comparison reference value and the expanded uncertainty of this deviation ($k = 2$). The degree of equivalence between any pair of national measurement standards is expressed in terms of their difference and the expanded uncertainty of this difference and is independent of the choice of key comparison reference value.

4.2.1. Comparison of a given NMI result with the KCRV

The degree of equivalence of the result of a particular NMI, i, with the key comparison reference value is expressed as the difference D_i between the values

$$D_i = A_{\mathrm{e}i} - \mathrm{KCRV} \tag{1}$$

and the expanded uncertainty ($k = 2$) of this difference, U_i, known as the equivalence uncertainty; hence

$$U_i = 2u(D_i) \tag{2}$$

When the result of the NMI i is included in the KCRV with a weight w_i, then

$$u^2(D_i) = (1 - 2w_i)u_i^2 + u^2(\mathrm{KCRV}) \tag{3}$$

However, when the result of the NMI i is not included in the KCRV, then

$$u^2(D_i) = u_i^2 + u^2(\mathrm{KCRV}) \tag{4}$$

The introductory text in Appendix A is the one agreed by the CCRI(II) for all the K1 comparisons.

4.2.2. Comparison between pairs of NMI results

The degree of equivalence between the results of any pair of NMIs, i and j, is expressed as the difference D_{ij} in the values

$$D_{ij} = D_i - D_j = A_{\mathrm{e}i} - A_{\mathrm{e}j} \tag{5}$$

and the expanded uncertainty ($k = 2$) of this difference, $U_{ij} = 2u(D_{ij})$, where

$$u^2(D_{ij}) = u_i^2 + u_j^2 - 2u(A_{\mathrm{e}i}, A_{\mathrm{e}j}) \tag{6}$$

where any obvious correlations between the NMIs (such as a traceable calibration, correlations normally coming from the SIR, or from the linking factor in the case of linked comparison) are subtracted using the covariance $u(A_{ei}, A_{ej})$ (see [21] for more detail). However, the CCRI decided in 2011 that these pair-wise degrees of equivalence no longer need to be published as long as the methodology is explained.

Appendix B shows the matrix of all the degrees of equivalence as they will appear in the KCDB. It should be noted that for consistency within the KCDB, a simplified level of nomenclature is used with A_{ei} replaced by x_i. The introductory text is that agreed for the comparison. The graph of the results in Table 5, corresponding to the degrees of equivalence with respect to the KCRV (identified as x_R in the KCDB), is shown in Figure C1. This graphical representation indicates in part the degree of equivalence between the NMIs but obviously does not take into account the correlations between different NMIs. It should be noted that the final data in this paper, while correct at the time of publication, will become out-of-date as NMIs make new comparisons. The formal results under the CIPM MRA [2] are those available in the KCDB.

5. Conclusion

The presence of a meta-stable state in the ^{67}Ga decay necessitates additional corrections when (anti-)coincidence methods are applied. Consequently, the selection of results to be included in the KCRV of the BIPM continuous key comparison for ^{67}Ga has been fully reviewed by the CCRI(II), and has impacted the KCRV for ^{67}Ga in a non-negligible way.

The BIPM continuous key comparison for ^{67}Ga, BIPM.RI(II)-K1.Ga-67, currently comprises 4 valid results, including the latest result from the CMI (Czechia). The results have been analyzed with respect to the updated KCRV, providing degrees of equivalence for 4 national metrology institutes. The degrees of equivalence have been approved by the CCRI(II) and are published in the BIPM key comparison database. Other results may be added when other NMIs contribute ^{67}Ga activity measurements to this comparison or take part in other linked comparisons.

6. References

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Appendix A. Introductory text for ^{67}Ga degrees of equivalence

Key comparison BIPM.RI(II)-K1.Ga-67

MEASURAND: Equivalent activity of ^{67}Ga

Key comparison reference value: the SIR reference value x_{R} for this radionuclide is 114 780 kBq , with a standard uncertainty, u_{R} equal to 420 kBq (see Section 4.1 of the Final Report). The value x_i is taken as the equivalent activity for a laboratory i.

The degree of equivalence of each laboratory with respect to the reference value is given by a pair of terms: $D_i = (x_i - x_{\mathrm{R}})$ and U_i, its expanded uncertainty ($k = 2$), both expressed in MBq, and $U_i = 2((1 - 2w_i)u_i^2 + u_{\mathrm{R}}^2)^{1/2}$, where w_i is the weight of laboratory i contributing to the calculation of x_{R}.

Appendix B. Table of degrees of equivalence for BIPM.RI(II)-K1.Ga-67

Table B1: The table of degrees of equivalence for BIPM.RI(II)-K1.Ga-67

NMI i	D_i **/MBq**	U_i **/MBq**
LNE-LNHB	-0.96	0.91
PTB	0.7	1.2
NIST	0.3	1.1
CMI	0.3	2.0

Appendix C. Graph of degrees of equivalence with the KCRV for ^{67}Ga (as it appears in Appendix B of the MRA)

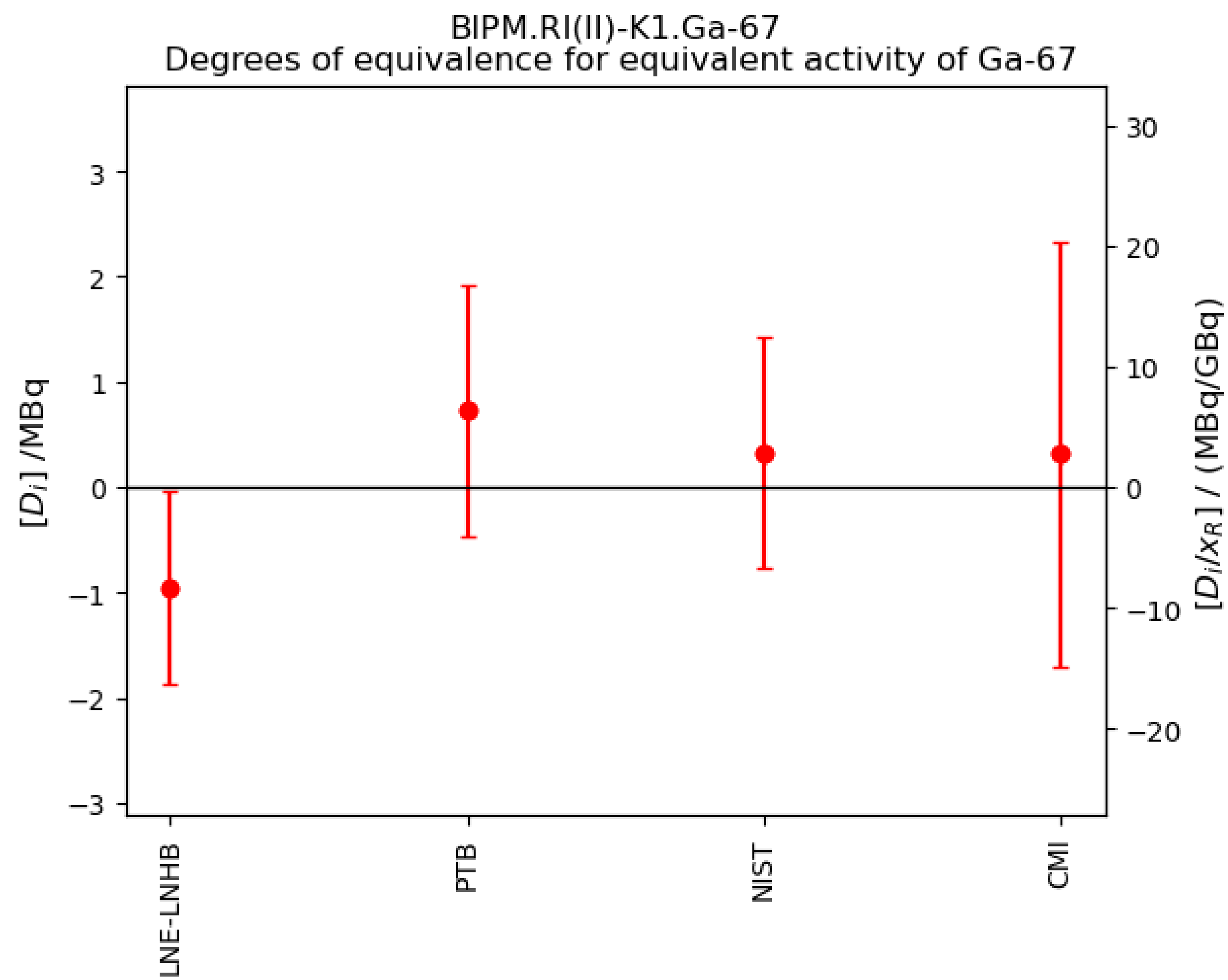

Figure C1. Degrees of equivalence for equivalent activity of ^{67}Ga.

Appendix D. Uncertainty budgets for the activity of ^{67}Ga submitted to the SIR

The CMI has submitted a detailed uncertainty budget as follows:

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BIPM.RI(II)-K1 or BIPM.RI(II)-K4

Measurement method	4π (PPC) X,e-γ coincidence	
ACRONYM	4P-PP-MX-NA-GR-CO	**Comments:**
Activity concentration at reference date / kBq g^{-1}	21034.0000	
Relative standard uncertainty / 10^{-2}	0.95	
Date of measurement at the NMI (YYYY-MM-DD)	2023-09-11	

For relative methods:

Primary methods or standards used for calibration	
Date of calibration	
Date of primary measurement	

Uncertainty budget

Uncertainty component	**Relative uncertainty / 10^{-2}**	**Evaluation type (A or B)**	**Comment**
Counting statistics	0.200	A	
Background	0.100	B	
Weighing	0.010	B	
Dilution	0.050	B	
Dead time	0.010	B	
Resolving time	0.020	B	
Pile-up, afterpulse			
Adsorption			
Impurities	0.030	B	
Decay correction			
Decay data			
Extra-/Inter-polation of efficiency curve	0.650	B	
Quenching, kB value			
Tracer			
Reproducibility			
pressure stability	0.200	B	
delay state correction	0.650	B	
Combined standard uncertainty	**0.950**		

Appendix E. Acronyms used to identify different measurement methods

Each acronym has six components, geometry-detector (1)-radiation (1)-detector (2)-radiation (2)-mode. When a component is unknown, ?? is used and when it is not applicable 00 is used.

Geometry	**acronym**	**Detector**	**acronym**
4 π	4P	proportional counter	PC
defined solid angle	SA	press. Prop. Counter	PP
2 π	2P	liquid scintillation counting	LS
undefined solid angle	UA	NaI(Tl)	NA
		Ge(HP)	GH
		Ge(Li)	GL
		Si(Li)	SL
		CsI(Tl)	CS
		ionization chamber	IC
		grid ionization chamber	GC
		Cerenkov detector	CD
		calorimeter	CA
		solid plastic scintillator	SP
		PIPS detector	PS
		CeBr3	CB

Radiation	**acronym**	**Mode**	**acronym**
positron	PO	efficiency tracing	ET
beta particle	BP	internal gas counting	IG
Auger electron	AE	CIEMAT/NIST	CN
conversion electron	CE	sum counting	SC
mixed electrons	ME	coincidence	CO
bremsstrahlung	BS	anticoincidence	AC
gamma rays	GR	coincidence counting with efficiency tracing	CT
x-rays	XR	anticoincidence counting with efficiency tracing	AT
photons ($x + \gamma$)	PH	triple-to-double coincidence ratio counting	TD
photons + electrons	PE	selective sampling	SS
alpha particle	AP	high efficiency	HE
mixture of various radiation	MX	digital coincidence counting	DC

Examples of methods	**acronym**
4π(PC)β-γ coincidence counting	4P-PC-BP-NA-GR-CO
4π(PPC)β-γ coincidence counting eff. trac	4P-PP-MX-NA-GR-CT
defined solid angle α-particle counting with a PIPS detector	SA-PS-AP-00-00-00
4π(PPC)AX-γ(GeHP)-anticoincidence counting	4P-PP-MX-GH-GR-AC
4πCsI-β,AX,γ counting	4P-CS-MX-00-00-HE
calibrated IC	4P-IC-GR-00-00-00
internal gas counting	4P-PC-BP-00-00-IG