REPORT OF THE SIM COMPARISON SIM.RI(II)-K2.Zn-65

Carlos J. da Silva[a], M.A. Leobino da Silva[a], Ronaldo L. da Silva[a], José U. Delgado[a], E. M. de Oliveira[a], J. de A. Rangel[a], E. V. de Veras[a], Octávio L. T. Filho[a], Christian Balpardo[b], Mario Rossi[b], Eliana De Paoli[b], Felipe Perez[b], Raphael Galea[c], Kimberly Moore[c], Anuradha Ravindra[d], D.B. Kulkarni[d], Ritu Sharma[d], Lászió Szücs[e], Arunas Gudelis[f], Garcia Diaz[g], Olga C[g], Maldonaldo Velázquez[g], Martinez Ayala[g], Lucia[g], Justyna Marganiec-Galazka[h], Tomasz.Ziemek[h], Pawel Saganowski[h], Zbigniew Tyminski[h], Edyta Lech[h], Anna Listkowska[h], Ivana Vukanac[i], Jelena krneta Nikolic[i], Milica Rajacic[i], Ivana Bonková[j], Matej Krivošík[j], M.W. van Rooy[l], J. Lubbe[l], M. J. van Staden[l], Ana Isabel Sánchez-Cabezudo[m], Nuria Navarro[m], Marcos Mejuto[m], Virginia Peyrés[m], Miguel Roteta[m], Namik Kemal Sahin[n], Mustafa Vural[n], Abdulla Dirican[n], Ryan Fitzgerald[o], Lizbeth Laureano-Pérez, Morgan Di Giorgi[o], Ronald Collé[o], Denis E. Bergeron[o], Leticia Pibida[o]

Abstract

An International key comparison, identifier as SIM.RI(II)-K2.Zn-65, has been performed. The Instituto de Radioproteção e Dosimetria (IRD) served as pilot laboratory, distributing aliquots of a Zn-65 master solution. Results for the activity concentration C_A, of ^{65}Zn at reference date of 12h00 UTC 20 September 2022 were submitted by 14 laboratories, encompassing many variants of coincidence methods and liquid scintillation counting methods. Evaluation using the Power-Moderated Mean method resulted in a proposed Comparison Reference Value (CRV) of 120.65(32) kBq g^{-1}, based on 10 results obtained by primary methods. The degrees of equivalence and their associated uncertainties are evaluated for each participant.

[a]Laboratório Nacional de Metrologia das Radiações Ionizantes, Instituto de Radioproteção e Dosimetria, Rio de Janeiro, Brazil

[b]Laboratorio de Metrología de Radioisótopos, Comisión Nacional de Energía Atómica, Buenos Aires, Argentina

[c]National Research Council of Canada, Ottawa, Canada

[d]Bhabha Atomic Research Centre, Mumbai, India

[e]Metrological and Technical Supervisory Department, Budapest, Hungary

[f]Center for Physical Science and Technology, Vilnius, Lithuania

[g]Instiuto Nacional de Investigaciones Nucleares, Ocoyacac, Mexico

[h]National Centre for Nuclear Research, POLATOM, Otwock-Swierk, Poland

[i]Vinca Institute of Nuclear Science, National Institute of Republic of Serbia, Belgrade, Serbia

[j]Slovak Institute of Metrology, Bratislavia, Slovakia

[l]National Metrology Institute of South Africa, Cape Town, South Africa

[m]Centro de Investigaciones Energéticas Medioambientales y Tecnológicas, Madrid, Spain

[n]Turkish Energy, Nuclear and Mineral Research Agency, Turkiye

[o]National Institute of Standards and Technology, Gaithersburg, MD, USA

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* Corresponding author: Carlos J. da Silva

Tel.: + 55 21 2173 2874; Fax: 55 21 2173 2874

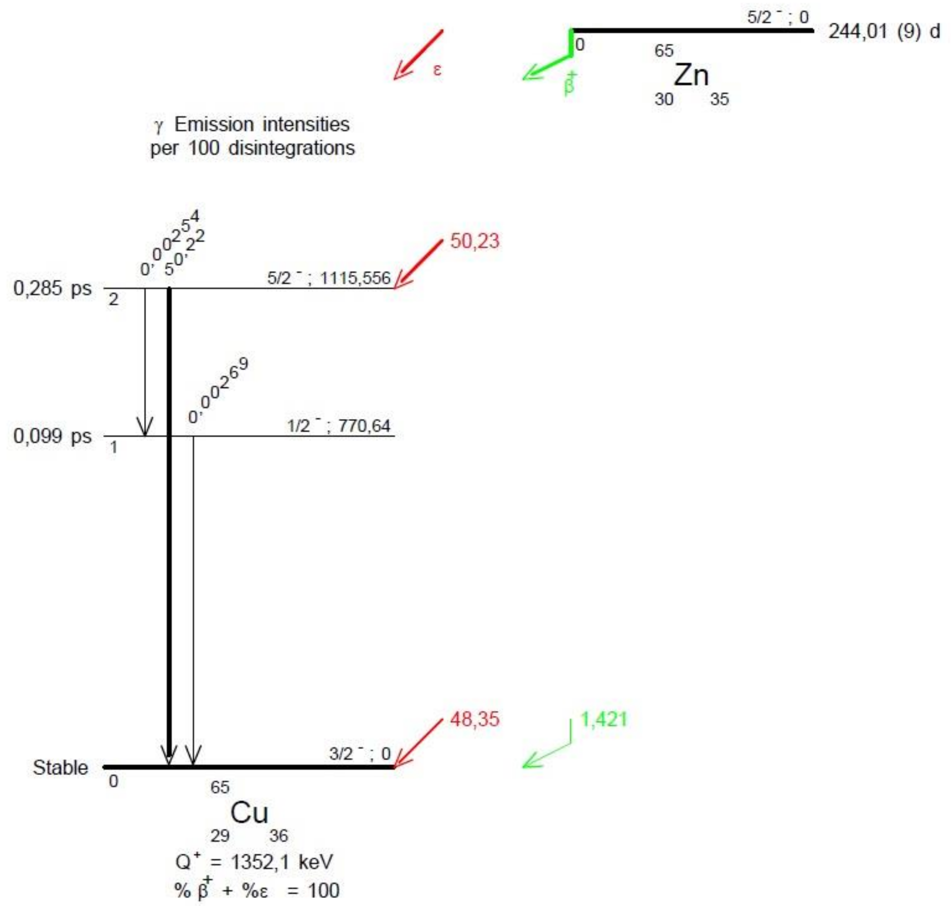
E-mail: carlos-jose.silva@ird.gov.br

1. Introduction

^{65}Zn is a radionuclide having an intermediate half-life of 244.01 (9) days (Bé et al. 2013). The nuclide decays mostly by electron capture with main gamma emission of 1115 keV and a significant annihilation photon emission. These characteristics make it a suitable radionuclide for Key Comparison exercises. The simplified decay scheme adapted from Bé et al. (2013) is shown in the Figure 1.

The proposal for a ^{65}Zn SIM comparison was made by Instituto de Radioproteção e Dosimetria in Ottawa during SIM meeting in 2017. The last comparison of ^{65}Zn was in 2003 (Michotte, 2015).

Figure 1- Decay scheme of ^{65}Zn



2. Organization of the Comparison

^{65}Zn master solution was purchased from Eckert & Ziegler, Inc. with a total activity of 37 MBq in a 1 mL solution. It was diluted with carrier to obtain 15 µg/g of ZnCl in 0.1 mol L^{-1} HCl. Table 1 lists the participating laboratories and their respective Regional Metrology Organization (RMO). Most of participating laboratories received the ^{65}Zn solution in 2022 with nominal activity of 500 kBq in NIST-1 (Collé-2019) ampoules and 3.6 g mass. The final results were received on July 01, 2023. All submitted activities were to be reported as ^{65}Zn massic activity at the reference time 20 September, 2022 at 12:00 UTC. The decay correction was to be made using the half-life of 244.01 (9) days (Bé et al. 2013).

Table 1 - Laboratories participating in the SIM.RI(II)-K2.Zn-65 comparison listed alphabetically by country.

NMI	Full name of participant	Country	RMO
LMR/CNEA	Laboratorio de Metrología de Radioisótopo/Comisión Nacional de Energía Atómica	Argentina	SIM
LNMRI/IRD	Laboratório Nacional de Metrologia das Radiações Ionizantes/Instituto de Radproteção e Dosimetria	Brazil	SIM
NRC	National Research Council of Canada	Canada	SIM
BARC	Bhabha Atomic Research Centre	India	APMP
BFKH	Metrological and Technical Supervisory Department	Hungary	EURAMET
FTMC	Center for Physical Sciences and Technology	Lithuania	EURAMET
ININ	Instiuto Nacional de Investigaciones Nucleares	Mexico	SIM
POLATOM	National Centre for Nuclear Research Radioisotope Centre POLATOM	Poland	EURAMET
VINS/NIRS	Vinca Institute of Nuclear Science/National Institute of Republic of Serbia	Serbia	EURAMET

NMI	Full name of participant	Country	RMO
SMU	Slovak Institute of Metrology	Slovakia	EURAMET
NMISA	National Metrology Institute of South Africa	South Africa	AFRIMETS
CIEMAT	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas	Spain	EURAMET
TENMAK	Turkish Energy, Nuclear and Mineral Research Agency	Türkiye	EURAMET, COOMET
NIST	National Institute of Standards and Technology	United States of America	SIM

3. Results and Discussion

The participant received recommendations to perform preliminary measurements to check the comparison ampoule for adsorption and to identify any radionuclid impurities. The results of measurements by participants are summarized in Table 2. No participants reported any significant photon-emitting impurities, with the majority of those measurements being made by the high purity germanium spectrometry method. The comparison solution can be considered free from measurable photon-emitting impurities.

In order to test the homogeneity of solution all ampoules used in comparison were measured in the LNMRI ionization chamber system and the largest deviation from the mean value was 0.03 %.

Table 2 - Ampoules identification and impurities reported by participants.

NMI	Ampoule Number	Impurities
CNEA	25L21	-
LNMRI/IRD	22L21	No impurities identified[(a)]

NMI	**Ampoule Number**	**Impurities**
NRC	34L21	No impurities detected
BARC	24L21	-
BFKH	31L21	-
FTMC	21L21	No impurities detected
ININ	33L21	-
POLATOM	23L21	Co-60 traces
VINS	27L21	Co-60 and Cs-137 traces[(b)]
SMU	36L21	No impurities detected
NMISA	32L21	Co-60 traces[(c)]
CIEMAT	29L21	No impurities detected
TENMAK[d]	30L21	-
NIST	35L21	No impurities detected

[a] The LNMRI made three rinsings with 2 mL HCl and after obtained 107 Bq in the residual activity. The measurement was made in a calibrated NaI(Tl) detector.

[b] VINS found traces of ^{137}Cs and ^{60}Co six months after reference date but they seem insignificant in order to affect the ^{65}Zn activity.

VINS made the measurement of residual activity in ampoule after transfer the ^{65}Zn solution and estimated the correction due to adsorption of 1.001.

[d]TENMAK also estimated the correction for adsorption as 1.001.

[c] NMISA also found traces of ^{60}Co and it seems insignificant in order to affect the ^{65}Zn activity.

All submitted results comprising those reported for inclusion in the Key Comparison Database (KCDB) and reported confirmatory measurements, by primary methods, are listed in Table 3.

Table 3 - The Massic Activity, C_A, of ^{65}Zn at the reference time of 20 September 2022 at 12:00 UTC as reported by participating institutes. The uncertainties u_i, are the combined standard uncertainty, as reported by each participant. In the cases where more than one value was submitted, the final value indicated by laboratories is indicated in bold text. The acronyms used as reference in the methods description are similar to those used in KCDB. (Thomas, 2005).

Institute	C_A(kBq.g^{-1})	u_i(kBq.g^{-1})	Method
CNEA	119.13	0.76	2P-GH-XR-GH-GR-SC
	119.29	**0.50**	**2P-NA-XR-NA-GR-CO**
LNMRI/IRD	**120.95**	**0.77**	**4P-LS-MX-NA-GR-AC**
	120.82	0.91	4P-X-X-X-X-IC
NRC	121.4	0.5	2P-GH-XR-GH-GR-SC
BARC	120.46	2.0	4P-SP-BP-NA-GR-CO
BFKH	119.93	0.90	UH-GH-GR-00-00-00
FTMC	119.5	0.73	UH-GH-GR-00-00-00
ININ	115.88	1.93	UH-GH-GR-00-00-00
POLATOM	122.00	0.68	4P-LS-MX-NA-PH-CO
	123.06	0.68	4P-LS-MX-NA-PH-AC
	122.53	**0.68**	**Mean of above results**
VINS	120.7	1.3	2P-GH-XR-GH-GR-SC
SMU	120.44	0.51	4P-LS-BP-00-00-TD
NMISA	121.25	0.41	4P-LS-MX-NA-GR-CO
CIEMAT	118.97	1.4	4P-LS-MX-NA-GR-CO
	118.87	0.95	4P-LS-MX-00-00-CN
	119.37	**0.60**	**4P-LS-BP-00-00-TD**
	119.9	1.2	4P-NA-GR-00-00-00
TENMAK	126.8	0.8	4P-SP-BP-NA-GR-CO
NIST	**120.3**	**0.60**	**4P-LS-MX-NA-GR-AC**
	121.8	0.97	4P-LS-BP-00-00-CN
	121.13	0.9	UH-GH-GR-00-00-00
	118.8	1.3	4P-LS-BP-00-00-TD

As part of the comparison protocol, participants received instructions to indicate a method to be taken as their comparison result. The final value results from each laboratory are shown in Figure 2.

All final value results based on primary methods were plotted and visually analyzed for outlying data, and also examined for a Z-score larger than 3.0 with the reference value calculated with the Power Moderated Weighting Mean (PMM) methodology (Pommé, 2012) using the spreadsheet tool provided by Dr S. Pommé in 2023. Auto-selection of the alpha-parameter (power of uncertainty in weighing factors, see Pommé, 2015) setting was used. The CNEA, TENMAK and VINS results were initially identified as outliers on this basis. The next step for outlier identification results was made by the PMM methodology where the auto rejection, using criteria of 2.5 (CCRI(II) 2013), and auto-selection of alpha-parameter settings were used. The auto rejection did not identify any outliers using these parameters. However, Z-scores higher than 3.0 were reported on the PomPlot spreadsheet for the same results from CNEA, TENMAK and VINS as outliers (Pommé, 2006). The laboratories with outlying results were notified, without revealing the magnitude or direction of the difference from the CRV and given the opportunity to examine their results for numerical errors. After six weeks the laboratories reported new numeric values and updated uncertainties. After the corrections, the revised data set was reanalyzed by the PMM and Z-scores and both identified the TENMAK as an outlier.

The results from BFKH, ININ and FTMC are not included in the mean calculation because they are reported from secondary measurement methods.

A proposed CRV was calculated of 120.65(32) kBq g^{-1} at the reference time, based on 10 values. This proposed CRV, calculated by the PMM method, agrees with both the arithmetic mean 120.66(96) kBq g^{-1} and weighted mean 120.58(54) kBq g^{-1}.

Two Laboratories used sum-peak method for activity determination: CNEA and NRC and the basic information for this method can be found in Oliveira, 2011.

Three laboratories reported 4πLS anticoincidence counting LNMRI/IRD, POLATOM and NIST. This method has been used in many key Comparison (J. T. Cessna et al., 2017); (Coulon R. et al., 2023).

In the application of liquid scintillation counting techniques two laboratories used CIEMAT/NIST method, these laboratories are CIEMAT and NIST, and three laboratories work with TDCR method these laboratories are SMU, CIEMAT and NIST. These methods have been used in many key Comparison (Zimmerman et al, 2012); (J. T. Cessna et al., 2017); (Coulon R. et al., 2023) respectively.

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The diversity of methods in comparison exercises is necessary to provide robustness to the reference value obtained.

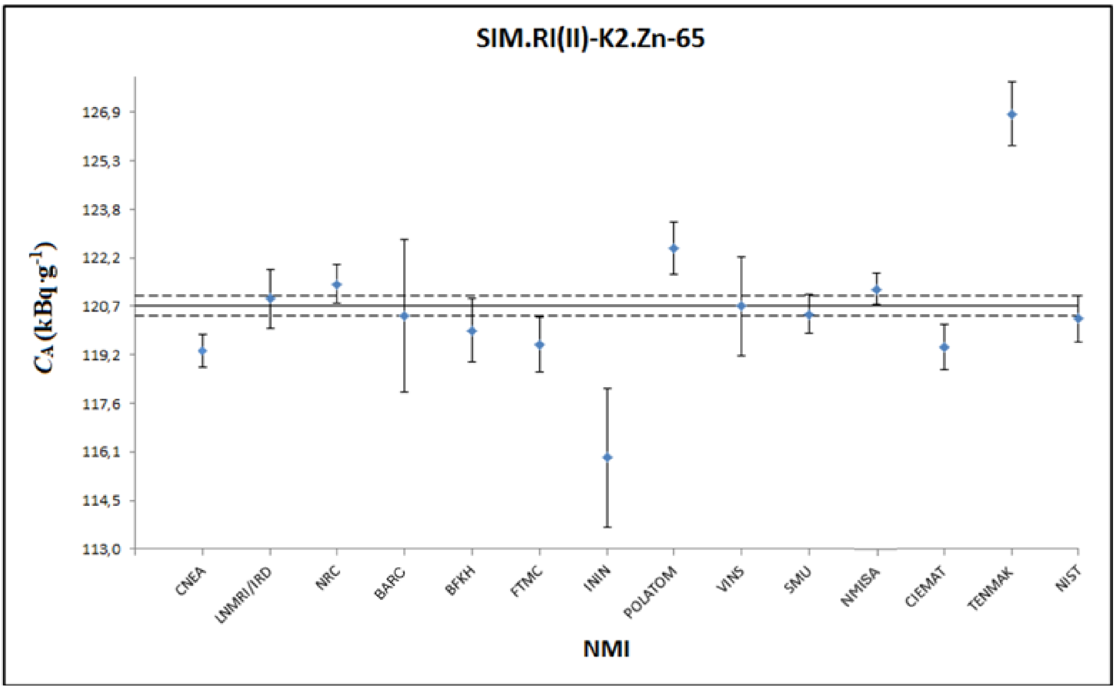

Figure 2 - Final results of international comparison of ^{65}Zn massic activity (C_A) of ^{65}Zn solution, one value for each participanting institute. The uncertainty bars correspond to

the combined standard uncertainty from each laboratory. The solid line represents the proposed Comparison Reference Value (CRV) of 120.65 kBq. g^{-1} and the dashed lines represent the combined standard uncertainty ± 0.32 kBq. g^{-1} on the CRV. The TENMAK measurement value does not contribute to the CRV. In Table 5 in Annex A the uncertainty budget for all methods used in this comparison exercise are presented.

4- Linked BIPM SIR Reference Value

The results (*A/m*) of the SIM. RI(II)-K2.Zn-65 comparison have been linked to the BIPM.RI(II)-K1.Zn-65 comparison through the measurements in the SIR in September 2022 of one ampoule of the SIM.RI(II)-K2.Zn-65 solution standardized by the LNMRI/IRD. The linking factor *L* is defined to be:

$L = A_{e,\ \mathrm{LNMRI/IRD}} / (A/m)_{\mathrm{LNMRI/IRD}} = 245.65$ g,

where the equivalent activity (*A*e) measured in SIR for LNMRI/IRD is equal to 29 710(140) kBq (to be published) and $(A/m)_{\mathrm{LNMRI/IRD}}$ is the activity concentration of 120.95(77) kBq g^{-1} obtained by LNMRI/IRD in the SIM.RI(II)-K2.Zn-65 comparison. The relative standard uncertainty of *L* is 13 x 10^{-4}, the uncertainty from the SIR measurement of the linking ampoule combined quadratically with relative uncertainty of the mass solution in the ampoule, 5 x 10^{-4}.

The linked results for the participants *i* in SIM.RI(II)-K2.Zn.65 comparison are evaluated as

$$A_{ei} = (A/m)_i\, L$$

The uncertainties for the SIM.RI(II)-K2-Zn.65 comparison results linked to the SIR are comprised of the original uncertainties in the SIM comparison combined quadratically with the uncertainty in the link. In the Table 4 below we have the results linked to the SIR

(BIPM.RI(II)-K1.Zn-65) at the BIPM. The KCRV of the BIPM.RI(II)-K1.Zn-65 comparison is 29 730(39) kBq (C. Michotte et al., 2024). Figure 3 shows the SIM.RI(II)-K2.Zn-65 linked to *A*e SIR-BIPM reference value.

Table 4 - link with BIPM/SIR Reference System

NMI	**Measurement acronym (see Appendix 2)**	**Activity[*] Concentration measured $(A/m)_i$/(kBq g^{-1})**	**Standard uncertainty u_i/(MBq.g^{-1})**	**Linked Equivalent activity A_{ei}/kBq**	**Combined Standard uncertainty u_{ei}/kBq**
CNEA	**2P-GH-XR-GH-GR-SC**	**119.3**	**0.42**	**29 303**	**110**
LNMRI/IRD	**4P-LS-MX-NA-GR-AC**	**121.0**	**0.77**	**29 711**	**193**
NRC	**2P-GH-XR-GH-GR-SC**	**121.4**	**0.5**	**29 822**	**129**
BARC	**4P-SP-BP-NA-GR-CO**	**120.5**	**2.0**	**29 576**	**493**
BFKH	**UH-GH-GR-00-00-00**	**119.9**	**0.84**	**29 460**	**210**
FTMC	**UH-GH-GR-00-00-00**	**119.5**	**0.73**	**29 352**	**183**
ININ	**UH-GH-GR-00-00-00**	**115.9**	**1.9**	**28 470**	**468**
POLATOM	**4P-LS-MX-NA-PH-CO**	**122.5**	**0.68**	**30 099**	**172**
VINS	**2P-GH-XR-GH-GR-SC**	**120.7**	**1.3**	**29 650**	**322**
SMU	**4P-LS-BP-OO-OO-TD**	**120.4**	**0.51**	**29 586**	**131**
NMISA	**4P-LS-MX-NA-GR-CO**	**121.3**	**0.41**	**29 785**	**108**
CIEMAT	**4P-LS-BP-OO-OO-TD**	**119.4**	**0.6**	**29 330**	**152**
TENMAK	**4P-LS-MX-NA-GR-CO**	**126.8**	**0.8**	**31 148**	**201**

NMI	Measurement acronym (see Appendix 2)	Activity* Concentration measured $(A/m)_i$/(kBq g^{-1})	Standard uncertainty ui/(MBq.g^{-1})	Linked Equivalent activity A_{ei}/kBq	Combined Standard uncertainty u_{ei}/kBq
NIST	**4P-LS-MX-NA-GR-AC**	**120.3**	**0.6**	**29 551**	**152**

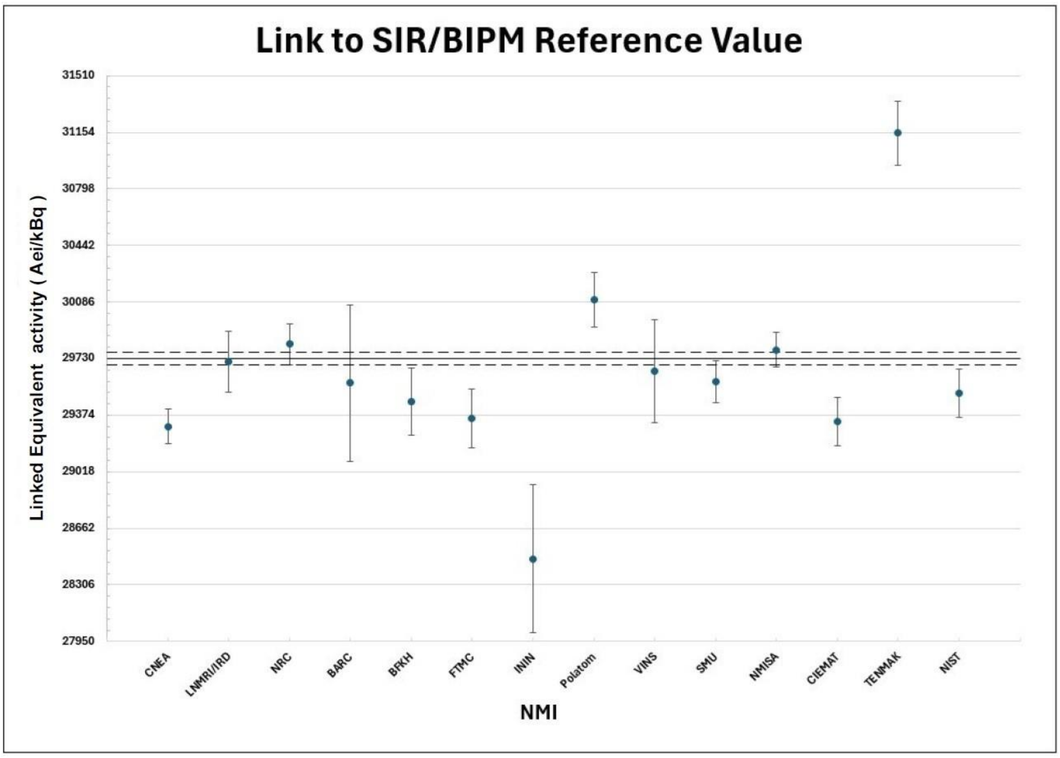

Fig.3 The results (A/m) of the SIM. RI(II)-K2.Zn-65 is linked to SIR KCRV reference value for ^{65}Zn solution. The solid line represents the SIR KCRV value 29730 kBq, the uncertainty bars represent the combined uncertainty and the dashed line the uncertainty of 0.13% in the KCVR value.

5- Preliminary degree of equivalence

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

$Di = A_{ei} - \text{KCVR}$

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

$U_i = 2u(D_i)$

When the result of the NMI I is included in the KCVR with a weight w_i, then

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

When the results of the NMI I is not included in the KCVR, then

$u^2(D_i) = u_i^2 + u^2(\text{KCVR})$

In annex B we state the preliminary degree of equivalence comparison for SIM. RI(II)-K2.Zn-65 to KCRV and uncertainty.

6. Conclusion

A key comparison of the ^{65}Zn activity concentration solution has been successfully carried out. Samples were distributed to 14 laboratories. Results were received from 14 participants. A Reference Value (CRV) of 120.65(32) kBq g^{-1} was preliminary proposed based in 10 values from primary methods. One result was identified as outlier and three results were not obtained by primary methods.

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Annex A:

Table A1 Uncertainty components and estimated relative values / 10-2.

CIEMAT, NMISA: 4P-LS-MX-NA-GR-CO

Item No.	**Function**	**CIEMAT**	**NMISA**
1	counting statistics	0.7	0.08
2	weighing	0.1	0.04
3	background	0.5	0.05
4	dead/live time	0.01	0.005
5	resolving time	0.05	0.02
6	pile-up		
7	decay data	0.22	
8	counting time		0.001
9	quenching		
10	tracer		
11	extra-/inter-polation of efficiency curve		
12	calibration factor		
13	decay correction	0.024	0.006
14	impurities		0.003
15	adsorption		0.08
16	Extrapolation of efficiency curve	0.8	0.28
17	After pulsing		0.13
Combined standard uncertainty		**1.2**	**0.34**

Table A2 Uncertainty components and estimated relative values / 10-2.

POLATOM: 4P-LS-MX-NA-PH-CO

Item No.	Function	POLATOM
1	counting statistics	0.278
2	weighing	0.007
3	background	0.039
4	dead/live time	0.010
5	resolving time	0.096
6	pile-up	
7	decay data	
8	counting time	
9	quenching	
10	tracer	
11	extra-/inter-polation of efficiency curve	
12	calibration factor	
13	decay correction	0.017
14	impurities	0.004
15	adsorption	0.040
16	Extrapolation of efficiency curve	0.178
17	measm. method	0.434
Combined standard uncertainty		**0.56**

Table A3 Uncertainty components and estimated relative values / 10-2.

BARC, TENMAK: 4P-SP-MX-NA-GR-CO

Item No.	**Function**	**BARC**	**TENMAK**
1	counting statistics		0.55
2	weighing	0.04	0.2
3	background	0.31	0.07
4	dead/live time	0.02	0.06
5	resolving time	0.22	0.04
6	pile-up		
7	decay data		
8	counting time		
9	quenching		
10	tracer		
11	extra-/inter-polation of efficiency curve		
12	calibration factor		
13	decay correction	0.001	0.04
14	impurities		
15	adsorption		
16	extrapolation of efficiency curve	1.61	0.08
17	afterpulsing		
Combined standard uncertainty		**1.7**	**0.6**

Table A4 Uncertainty components and estimated relative values / 10-2.

LNMRI-IRD, NIST: 4P-LS-MX-NA-GR-AC

Item No.	Function	LNMRI - IRD	NIST
1	counting statistics	0.35	0.24
2	weighing	0.05	0.07
3	background	0.22	0.08
4	dead/live time	0.01	0.01
5	resolving time		0.02
6	pile-up		
7	decay data		
8	counting time		
9	quenching		
10	Funk correction	0.14	0.16
11	extra-/inter-polation of efficiency curve		
12	calibration factor		
13	decay correction	0.04	0.02
14	impurities		
15	adsorption		
16	extrapolation of efficiency curve	0.46	0.37
17	afterpulsing		
Combined standard uncertainty		**0.64**	**0.49**

Table A5 Uncertainty components and estimated relative values / 10-2.

POLATOM: 4P-LS-MX-NA-GH-AC

Item No.	**Function**	**POLATOM**
1	counting statistics	0.308
2	weighing	0.007
3	background	0.043
4	dead/live time	0.01
5	resolving time	0.040
6	pile-up	
7	decay data	
8	counting time	
9	quenching	
10	Funk Correction	
12	calibration factor	
13	decay correction	0.017
14	impurities	0.004
15	adsorption	0.040
16	extrapolation of efficiency curve	0.135
17	m. method	0.434
Combined standard uncertainty		**0.55**

Table A6 Uncertainty components and estimated relative values / 10.

CIEMAT, NIST, SMU: 4P-LS-BP-00-00-TDCR

Item No.	**Funtion**	**CIEMAT**	**NIST**	**SMU**
1	counting statistics	0.4	0.24	0.21
2	weighing	0.1	0.05	0.05
3	background			0.1
4	dead/live time	0.01		0.1
5	resolving time	0.05		0.1
6	flutuation between sources		0.03	
7	decay data	0.1		0.2
8	counting time			0.01
9	impurities			0.05
10	adsorption			0.05
11	eficiency model		0.8	
12	decay correction	0.024	0.02	0.05
13	kB parameter	0.025		0.2
14	TDCR determination	0.25		
15	extrapolation of efficiency curve		0.59	0.1
16	Dilution factor	0.004		
Combined standard uncertainty		**0.50**	**1.0**	**0.42**

Table A7 Uncertainty components and estimated relative values / 10^{-2}.

CIEMAT, NIST: 4P-LS-BP-00-00-CN

Item No.	**Funtion**	**CIEMAT**	**NIST**
1	counting statistics	0.4	0.36
2	weighing	0.1	0.06
3	background		
4	dead/live time		0.06
5	resolving time		
6	decay correction 3H		0.002
7	decay data	0.1	
8	counting time		
9	quenching	0.5	
10	tracer	0.5	0.02
11	calibration factor		
12	decay correction 65Zn	0.024	0.00002
13	kB parameter	0.05	
14	TDCR determination		
15	Computed detecion efficiency for 65Zn		0.7
16	Dilution factor	0.004	
Combined standard uncertainty		**0.80**	**0.80**

Table A8 Uncertainty components and estimated relative values / 10^{-2}.

CNEA, NRC, VINS: 2P-GH-XR-GH-GR-SC

Item No.	**Function**	**CNEA**	**NRC**	**VINS**
1	counting statistics	0.01	0.25	1,04
2	weighing	0.04	0.03	0.04
3	background	0.13		
4	dead/live time			
5	resolving time			
6	decay correction 3H			
7	decay data			
8	counting time			
9	quenching			
10	fitting functions		0.29	
12	calibration factor			
13	decay correction 65Zn		0.0002	0.04
14	kB parameter			
15	TDCR determination			
16	Computed detecion efficiency for 65Zn			
17	Standard desviation	0.62		
Combined standard uncertainty		**0.63**	**0.38**	**1.0**

Table A9 Uncertainty components and estimated relative values / 10^{-2}.

CNEA: 2P-NA-XR-NA-GR-CO

Item No.	**Function**	**CNEA**
1	counting statistics	0.01
2	weighing	0.04
3	background	0.05
4	dead/live time	0.01
5	resolving time	0.02
6	decay correction 3H	
7	decay data	
8	counting time	
9	quenching	
10	fitting functions	
11	extra-/inter-polation of efficiency curve	
12	calibration factor	
13	decay correction ^{65}Zn	
14	kB parameter	
15	TDCR determination	
16	Computed detecion efficiency for ^{65}Zn	
17	Standard desviation	0.40
Combined standard uncertainty		**0.42**

Table A10 Uncertainty components and estimated relative values / 10^{-2}.

CIEMAT: 4P-NA-GR-00-00-00

Item No.	**Function**	**CIEMAT**
1	counting statistics	0.27
2	weighing	0.43
3	background	
4	dead/live time	0.1
5	resolving time	
6	decay correction 3H	
7	decay data	0.22
8	counting time	
9	quenching	
10	fitting functions	
11	extra-/inter-polation of efficiency curve	0.03
12	calibration factor	
13	decay correction 65Zn	0.01
14	kB parameter	
15	TDCR determination	
16	MC model	0.7
17	repetibility	0.43
Combined standard uncertainty		**1.0**

Table A11 Uncertainty components and estimated relative values / 10^{-2}.

BFKH, FTMC, ININ, NIST: UH-GH-GR-00-00-00

Item No.	Funtion	BFKH	FTMC	ININ	NIST
1	counting statistics	0.46	0.34	0.2	0.37
2	weighing	0.03	0.05	1.3	
3	background				
4	dead/live time	0.2			
5	resolving time			0.01	
6	decay during run				0.026
7	decay data	0.086	0.037	0.04	
8	Full E. peak efficiency				0.58
9	pile-up			0.01	0.0006
10	fitting functions				
11	extra-/inter-polation of efficiency curve	0.5	0.5	1.0	
12	calibration factor				
13	decay correction 65Zn				0.014
14	distance s. detector			0.09	
15	TDCR determination				
16	Full peak efficiency				0.58
17	photon em. prob.	0.22			0.22
Combined standard uncertainty		**0.75**	**0.61**	**1.7**	**0.74**

Table A12 Uncertainty components and estimated relative values / 10^{-2}.

LNMRI/IRD: 4P-IC-GR-00-00-00

Item No.	**Funtion**	**LNMRI/IRD**
1	counting statistics	0.12
2	weighing	0.05
3	background	0.02
4	dead/live time	
5	resolving time	
6	decay correction 3H	
7	decay data	
8	counting time	0.05
9	quenching	
10	fitting functions	
11	extra-/inter-polation of efficiency curve	
12	calibration factor	0.71
13	decay correction 65Zn	0,04
14	longterm stability	0,21
15	TDCR determination	
16	Computed detecion efficiency for 65Zn	
17	Dilution factor	0.05
Combined standard uncertainty		**0.75**

Annex B: Table of degrees of equivalence for SIM.RI(II)-K2.Zn-65

Table B1 – The table of preliminary degrees of equivalence for SIM.RI(II)-K2.Zn-65

NMI	Aei/kBq	D_i/kBq	U_i/kBq
CNEA	**29 303**	**-427**	**233**
LNMRI/IRD	**29 711**	**-19**	**394**
NRC	**29 822**	**92**	**269**
BARC	**29 576**	**-154**	**989**
BFKH	**29 460**	**- 270**	**427**
FTMC	**29 352**	**-378**	**374**
ININ	**28 470**	**-1260**	**939**
POLATOM	**30 099**	**369**	**353**
VINS	**29 650**	**-80**	**649**
SMU	**29 586**	**-144**	**273**
NMISA	**29 785**	**55**	**229**
CIEMAT	**29 330**	**-400**	**314**
TENMAK	**31 148**	**1418**	**409**
NIST	**29 551**	**-179**	**312**