

Protocol for the SIM.RI(II). K2-Zn-65 comparison

Updated 8 August 2022

1. Introduction

The interest in the use of ^{65}Zn is due its application in calibration of gamma spectrometry and because there are many radionuclides used in nuclear medicine that have decay schemes by electron capture that are similar to ^{65}Zn .

^{65}Zn decays with a half-life of 244,01 (9) days [1] by electron capture to the 1115 keV excited level and beta plus emission to the ground state level of Cu-65. This decay scheme makes it suitable for analysis using a variety of techniques, including liquid-scintillation counting, coincidence counting, anti-coincidence counting and sum peak methods.

This proposal is initiated as an Action Item arising from the SIM meeting in NRC - Ottawa, 2017.

2. Comparison Protocol

2.1 Pilot Institute: Instituto de Radioproteção e Dosimetria (IRD), Brazil

2.2 List of Participants (to be confirmed):

- CNEA, Argentina
- NRC, Canada
- NIST, USA
- ININ, Mexico
- BFKH, Hungary
- FTMC, Lithuania
- VIN, Serbia
- SMU, Slovakia
- CIEMAT, Spain
- TAEA, Turkey
- POLATOM, Poland
- BARC, India
- NIM, China

2.3 Comparison Nuclide Solution: ^{65}Zn chloride containing nominally 0.4 MBq at time of shipment to be dispatched by LNMRI/IRD.

2.4 LNMRI/IRD will submit an ampoule to SIR/BIPM to link this K2 to SIM.RI(II). K2-Zn-65.

2.5 Mass: approximately 3.5 g

2.6 Chemistry: in carrier containing 15 μg ZnCl_2/g HCl 1 mol.L⁻¹.

- 2.7 Solution density: $1.001 \pm 0.001 \text{ g}\cdot\text{mL}^{-1}$ at 20 °C
- 2.8 Recommended Nuclear Data: BIPM Monographie BIPM-5, Vol 7, pp 33-45 (2013).
- 2.9 Measurand: The measurand for this exercise is activity of ^{65}Zn per unit mass.
- 2.10 Schedule:
- Starting date: September 20th, 2021.
- Preparation: August 7th, 2021.
- Distribution: From August 2022 to September 2022.
- Deadline for submission of all appropriate shipping, customs, and special handling information will be August 7th, 2022.
- Based on the sources being distributed in August and September the following schedule for reporting is proposed:
- Reporting opens:* IRD will announce the opening of the reporting period after IRD results are submitted to the BIPM (January 2023).
- Reporting deadline:* March 29th, 2023
- Draft A sent to participants:* May 31st, 2023
- Draft A acceptance deadline:* August 2nd, 2023
- Draft B sent to participants:* October 21st, 2023
- Draft B acceptance deadline:* December 1st, 2023
- 2.11 Reference Time: Participants shall report their results at a comparison reference date September 20th, 2022 12:00 UTC.
- 2.12 IRD shall be responsible for maintaining up-to-date key comparison status reports and shall transmit them to the executive secretary of CCRI(II) and KCDB Office.
- 2.13 Each participating institution is responsible for its own costs associated with the measurements, as well those for transportation and customs and any damage that may occur within its country. The costs associated with organization of the comparison, preparing, calibrating, and shipping the ^{65}Zn comparison solutions will be borne by IRD.
- 2.14 All results, method of standardization, associated uncertainties, and any additional requested information shall be transmitted to IRD using the reporting forms to be provided.
- 2.15 Participants must provide a list and evaluation of the principal components of the uncertainty budget based on the Guide to the Expression of Uncertainty in Measurement, published by ISO [2]. In addition to the principal components of the uncertainty, common to all the participants, individual institutes must add any other components they consider appropriate. Uncertainties are evaluated at a level of one standard uncertainty and information must be given on the number of effective degrees of freedom, required for a proper estimate of the level of confidence. Participants shall round their measured values and uncertainties following their own usual methods and are encouraged to report no more than 3 significant digits in their combined standard uncertainty. A form in excel file will be sent for each participation in order to make the collection measurement information.

- 2.16 Transport of the ^{65}Zn ampoules to the participants will be arranged by IRD using their normal radioactive shipment arrangements. Immediately after receipt, the participating institute shall check for any damage to the samples and report this to IRD.
- 2.17 If delays occur, IRD shall inform the participants and revise the schedule, if necessary.

3. Preparation of the report on the comparison

- 3.1 IRD is responsible for the preparation of a report on the comparison. The report passes through a number of stages before publication, and these are referred to here as drafts A and B.
- 3.2 IRD will use Power-moderated mean including the removal of outliers for mean value determination of comparison reference value- PMMsol [3].
- 3.3 The degree of equivalence D_{sol} for each laboratory is defined as: $D_{\text{sol}} = A_{\text{sol}} - \text{PMMsol}$ with A_{sol} being the activity concentration reported by the laboratory.
- 3.4 During the comparison, as the results are received by IRD, they are kept confidential by IRD until all the participants have completed their measurements and all the results have been received, or until the deadline for receipt of results has passed.
- 3.5 A result from a participant is not considered complete without an associated uncertainty and is not included in the draft report unless it is accompanied by an uncertainty supported by a complete uncertainty budget. Uncertainties are drawn up following the guidance given in the technical protocol.
- 3.6 If on examination of the complete set of results, IRD finds results that appear to be anomalous, the corresponding institutes are invited to check their results for arithmetic, typographical or transcription errors but without being informed as to the magnitude or sign of the apparent anomaly. If no numerical error is found the result stands and the complete set of results is sent to all participants.
- 3.7 The first draft, draft A, is prepared as soon as all the results have been received from and, if necessary, confirmed by the participants. It includes the results, uncertainties, standardization methods and experimental details transmitted by the participants, identified by name.
- 3.8 Draft A of the report is sent as soon as possible after completion of the comparison to all the participants for comment, with a reasonable deadline for replies. The date at which this draft is sent to the participants is taken to be the end date for the comparison and is subsequently referred to as such.
- 3.9 If any controversial or contradictory comments are received by IRD, they will be circulated to all participants and discussion continues until a consensus is reached.
- 3.10 Draft A is considered as confidential to the participants. Copies are not given to non-participants, and graphs or other parts of the draft are not used in oral presentations at an external Conference without the specific agreement of all the participants. (The results may be the subject of an internal report if they are shown in relative terms and

the name of participants hidden. At this stage, a participant may publish experimental techniques of special interest or new developments of a measurement method made in the frame of the comparison, as long as no information or comments are made about the comparison results.)

- 3.11 Note that once all participants have been informed of the results, individual values and uncertainties may be changed or removed or the complete comparison abandoned, only with the agreement of all participants and on the basis of a clear failure of the comparison artefact or some other phenomenon that renders the comparison or part of it invalid [4].
- 3.12 An institute that considers its result unrepresentative of its standards may submit another solution to the SIR based on a new primary measurement. The subsequent comparison is considered as a new and distinct comparison.
- 3.13 On receipt of final comments from participants, the second draft, draft B, is prepared by the BIPM incorporating the agreed comments on the draft A, and also the SIR results.
- 3.14 As the comparison will be linked to the SIR, the KCRV (in terms of SIR Equivalent Activity) will be determined by the BIPM and the Appendix will be produced by the KCWG, including the comparison results in the SIR mother file, KCRV file and equivalence files.
- 3.15 The draft B is circulated through the participants. Once agreed, draft B is not considered confidential and may be the subject of a publication, with the exception of the Appendix containing proposals for the reference value and degrees of equivalence.
- 3.16 Draft B will be sent to the CCRI(II) for review and approval.
- 3.17 When the Comparison Report has been approved, the KCDB Office will be informed by the CCRI Executive Secretary or by the working group Chair Concerned. Final Reports shall be published into the KCDB 2.0, and also submitted for publication in the Metrologia Tech. Suppl. Series or in another scientific journal.
- 3.18 In the event that there is disagreement concerning the results or the interpretation of the results of a key comparison, and the disagreement cannot be resolved by the participants, by the key comparison working group or by the Consultative Committee, the matter is referred to the CIPM for decision.

4. References

[1] Bé M-M., Chisté V., Dulieu C., Browne E., Baglin C., Chechev V., Helmer R., Kondev F., MacMahon T. D., Lee K. B. , 2006. Table of radionuclides, Monographie BIPM-5, Vol 3.

[2] <http://www.bipm.org/en/publications/guides/gum.html>

- [3] Pommé S. and Keightley J., Determination of a reference value and its uncertainty through a power-moderated mean, *Metrologia*, 2015, **52(3)**, S200.
(<https://iopscience.iop.org/article/10.1088/0026-1394/52/3/S200>)
- [4] Measurement comparisons in the CIPM MRA: Guidelines for organizing, participating and reporting, Jan. 2021, 26 pp. (REF CIPM MRA-G-11
<https://www.bipm.org/documents/20126/43742162/CIPM-MRA-G-11.pdf/9fe6fb9a-500c-9995-2911-342f8126226c>)

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