

**Activity measurements of the radionuclide ^{54}Mn
for the LNE-LNHB, France, NPL, United Kingdom and the MKEH, Hungary, in
the ongoing comparison BIPM.RI(II)-K1.Mn-54**

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Abstract

In 2006, the Laboratoire national de métrologie et d'essais -Laboratoire National Henri Becquerel (LNE-LNHB), France, the National Physical Laboratory (NPL), UK and the Magyar Kereskedelmi Engedélyezési Hivatal (MKEH), Hungary submitted samples of known activity of ^{54}Mn to the International Reference System (SIR). The range of the activities submitted was from 480 kBq to 1530 kBq. The key comparison results for these three national metrology institutes (NMIs) have replaced their previous results in the matrix of degrees of equivalence in the key comparison database that contains eleven results, identifier BIPM.RI(II)-K1.Mn-54.

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 (3.6 g) with the radionuclide in liquid form or a different standard ampoule for radioactive gases. The 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 reference 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 2007, the SIR has measured 905 ampoules to give 662 independent results for 63 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 realizations. These comparisons are described as BIPM ongoing comparisons and the results form the basis of the BIPM key comparison database (KCDB) that was set up under the CIPM Mutual Recognition Arrangement (CIPM MRA) [2]. The comparison described in this report is known as the BIPM.RI(II)-K1.Mn-54 key comparison.

2. Participants

In addition to the present four ampoules submitted by the LNE-LNHB, NPL and the MKEH, nine other NMIs, the BIPM, an international laboratory and one other laboratory have submitted 35 ampoules for the comparison of ^{54}Mn activity measurements since 1976. The details concerning the recent participants are given in Table 1 and the details of the other participants are given in [3].

Table 1. Details of the recent participants in the BIPM.RI(II)-K1.Mn-54 comparison

| NMI | Full name | Country | Regional metrology organization | Date of measurement at the BIPM YYYY-MM-DD |
|-----------------------|--|----------------|---------------------------------|---|
| LNE-LNHB ¹ | Laboratoire national de métrologie et d'essais - Laboratoire national Henri Becquerel | France | EUROMET | 1983-06-03 1992-12-18 1999-10-19 2006-07-18 2006-07-19 [†] |
| NPL | National Physical Laboratory | United Kingdom | EUROMET | 1976-12-29 2006-03-09 |
| MKEH ² | Magyar Kereskedelmi Engedélyezési Hivatal | Hungary | EUROMET | 1977-03-10 1982-11-02 1998-10-28 2006-06-22 |

¹ previously known as the BNM-LNHB

[†] second ampoule

² previously known as the OMH

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 any correlations are taken into account.

A brief description of the standardization methods for the laboratories, the activities submitted and the relative standard uncertainties ($k = 1$) for their present and past submissions are given in Table 2. The uncertainty budgets for the recent submissions are given in Appendix 1. The acronyms used for the measurement methods are given in Appendix 2.

The half-life used by the BIPM is 312.2 (3) days and this is in good agreement with the value of 312.13 (3) d as published in *BIPM Monographie 5* [4]. The half-life values given in Table 2 are those used by the participants.

Table 2. Standardization methods of the recent participants for ^{54}Mn

| NMI | Method used and acronym (see Appendix 2) | Half-life / d | Activity A_i / kBq | Reference date YY-MM-DD | Relative standard uncertainty / 10^{-2} by method of evaluation | |
|--------------|---|-------------------|-------------------------|-----------------------------------|--|------|
| | | | | | A | B |
| LNE- LNHB | 4 π (PPC)- γ coinc. 4P-PP-XR-NA-GR-CO | – | 2 881 2 923 † | 83-05-27 12 h UT | 0.10 | 0.09 |
| | 4 π (PPC) α - γ coinc. 4P-PP-XR-NA-GR-CO | – | 448.00 | 92-11-19 12 h UT | 0.15 | 0.06 |
| | 4 π (e,x)- γ coinc. 4P-PP-MX-NA-GR-CO | 312.16 (5) | 2 119 | 99-06-14 12 h UT | 0.10 | 0.24 |
| | 4 π (LS) β - γ coinc. 4P-LS-MX-NA-GR-AC | 312.13 (3) [4] | 1 500 1 529 † | 05-09-15 12 h UT | 0.24 | 0.07 |
| NPL | Pressurized IC * 4P-IC-GR-00-00-00 | – | 691.3 668.4 † | 76-12-20 0 h UT | 0.03 | 0.96 |
| | 4 π (PC)e,x- γ coinc. 4P-PC-MX-NA-GR-CO | [4] | 1 459 | 06-03-01 12 h UT | 0.08 | 0.27 |
| MKEH | 4 π (e,x)- γ coinc. 4P-PP-MX-NA-GR-CO | 312.3 (3) [5] | 2 013.7 2 014.7 † | 77-03-01 12 h UT | 0.15 | 0.32 |
| | 4 π (e,x)- γ coinc. 4P-PP-MX-NA-GR-CO | 312.3 (3) | 3 782 | 82-11-01 12 h UT | 0.02 | 0.27 |
| | 4 π (PPC)- γ coinc. 4P-PP-MX-NA-GR-CO | [6] | 3 314 | 98-10-27 0 h UT | 0.03 | 0.33 |
| | 4 π (PPC)e,x- γ coinc. 4P-PP-MX-NA-GR-CO | [4] | 479.9 | 06-07-01 0 h UT | 0.06 | 0.32 |

† two ampoules submitted

* calibrated by a primary measurement of the same radionuclide

Details regarding the solution submitted are shown in Table 3, including any impurities, when present, as identified by the laboratory. The BIPM has a standard method for evaluating the activity of impurities using a calibrated Ge(Li) spectrometer [7]. The CCRI(II) agreed in 1999 [8] that this method should be followed according to the protocol described in [9] when an NMI makes such a request or when there appear to be discrepancies. No routine impurity measurements were made for the recent submissions as the SIR results were in accord with the CCRI protocol.

Table 3. Details of the solution of ^{54}Mn submitted

| NMI / SIR Year | Chemical composition | Solvent conc. / (mol dm^{-3}) | Carrier: conc. / ($\mu\text{g g}^{-1}$) | Density / (g cm^{-3}) | Relative activity of any impurity [†] |
|----------------|--------------------------|--|---|----------------------------------|--|
| LNE-LNHB | MnCl ₂ in HCl | 0.1 | MnCl ₂ : 10 | 0.999 | ^{46}Sc : 0.032 (3) % |
| | Mn ⁺⁺ in HCl | 0.1 | Mn ⁺⁺ : 10 | 1.00 | ^{57}Co : 0.0023 (5) % |
| | MnCl ₂ in HCl | 0.1 | MnCl ₂ :41 | 1.001 | ^{154}Eu : 0.008 (1) % |
| | MnCl ₂ in HCl | 0.1 | MnCl ₂ :5 | 1.00 | ^{154}Eu : 0.010 (5) % |
| NPL | MnCl ₂ in HCl | 0.1 | MnCl ₂ : 100 | – | ^{65}Zn : 0.06 % |
| | MnCl ₂ in HCl | 0.5 | MnCl ₂ : 50 | 1.00 | – |
| MKEH | Mn in HCl | 0.1 | Mn : 25 | – | – |
| | MnCl ₂ in HCl | 0.1 | MnCl ₂ : 25 | – | ^{60}Co : 0.07 (2) % ^{65}Zn : 0.08 (2) % |
| | MnCl ₂ in HCl | 0.1 | MnCl ₂ : 25 | – | ^{60}Co : 0.009 (1) % |
| | MnCl ₂ in HCl | 0.1 | MnCl ₂ : 17 | – | ^{60}Co : 0.033 (4) % |

[†] the ratio of the activity of the impurity to the activity of ^{54}Mn at the reference date

4. Results

All the submissions to the SIR since its inception in 1976 are maintained in a database master-file. The previous activity measurements for ^{54}Mn arise from thirty-five ampoules and the SIR equivalent activity, A_{ei} , for each ampoule is given in [3] for each NMI, i . The SIR equivalent activities for the previous and new submissions of the recent participants are given in Table 4. The date of measurement in the SIR is given in Table 1 and is used in the KCDB and all references in this report. The relative standard uncertainty arising from the measurements in the SIR is also shown. This uncertainty is additional to that declared by the NMI for the activity measurement shown in Table 2. Although activities submitted are compared with a given source of ^{226}Ra , all the SIR results are normalized to the radium source number 5 [1].

In preparing for the comparison report, the SIR measurements for the LNE-LNHB and MKEH submissions were each repeated, which is after a period of about 2 years. The SIR measurements of the MKEH ampoule gave consistent results that confirm the half-life and also the MKEH assessment of the impurity level. However, although the second result for the LNE-LNHB ampoule was significantly lower than the first measurement, a check made using the BIPM spectrometer confirmed the lack of impurity and consequently no change is recommended to the registered SIR result.

Normally, the most recent result of each NMI is eligible for Appendix B of the MRA. However, the result for the BIPM is now over 30 years old and so is no longer eligible for degrees of equivalence in the KCDB although it is included in the KCRV [3].

Table 4. Results of SIR measurements of ^{54}Mn for the recent participants

| NMI / SIR year | Mass of solution / g | Activity submitted/ kBq | N° of Ra source used | SIR $A_{e,i}$ / kBq | Relative uncertainty from SIR | Total uncertainty $u_{c,i}$ / kBq | |
|--------------------|----------------------|-------------------------|----------------------|---------------------|-------------------------------|-----------------------------------|----|
| LNE-LNHB / 1983 | 3.562 4 | 2881 | 4 | 19 173 | 5×10^{-4} | 27 | |
| | 3.615 3 | 2923 | | 19 175 | | 28 | |
| | 1992 | 3.609 7 | 448.0 | 2 | 19 125 | 7×10^{-4} | 34 |
| | 1999 | 3.574 29 | 2119 | 3 | 19 308 | 7×10^{-4} | 51 |
| | 2006 | 3.553 7 | 1500 | 2 | 19 187 | 12×10^{-4} | 53 |
| 3.623 1 | | 1529 | 2 | 19 211 [†] | 12×10^{-4} | 54 | |
| NPL 1976 | 3.690 8 | 691.3 | 2 | 19 179 | 9×10^{-4} | 190 | |
| | 3.568 7 | 668.4 | | 19 153 | 8×10^{-4} | 190 | |
| | 2006 | 3.61046 | 1459 | 3 | 19 268 | 6×10^{-4} | 55 |
| MKEH 1977 | 3.601 6 | 2013.7 | 3 | 19 232 | 5×10^{-4} | 69 | |
| | 3.603 4 | 2014.7 | | 19 244 | 6×10^{-4} | 69 | |
| | 1982 | 3.602 2 | 3782 | 4 | 19 145 | 7×10^{-4} | 54 |
| | 1998 | 3.612 6 | 3314 | 3 | 19 212 | 5×10^{-4} | 64 |
| | 2006 | 3.611 7 | 479.9 | 2 | 19 139 | 10×10^{-4} | 66 |

[†] the mean of the two A_e values shown for the same measurement period is used with an averaged uncertainty, as attributed to an individual entry [10]

4.1 The key comparison reference value

The KCRV for ^{54}Mn has been identified as 19 252 (20) kBq using the results from the ASMW, BIPM (1976), NPL, ANSTO, PTB (1977), NIST (1979), CMI-IIR (1979), AECL (1983), IRA, NMIJ (1993), MKEH (1998), LNE-LNHB (1999) and the BARC as given in [3]. Although the KCRV may be modified whenever an NMI participates, such modifications follow approved criteria [3] and are only made by the CCRI(II), normally during one of its biennial meetings.

4.2 Degrees of equivalence

Every NMI that has submitted ampoules to the SIR is entitled to have one result included in the CIPM MRA KCDB as long as the NMI is a signatory or designated institute listed in the CIPM MRA and the result is not more than thirty

years old. Normally, the most recent result is the one included. Any NMI may withdraw its result only if all the participants agree.

The degree of equivalence of a given measurement standard is the degree to which this standard is consistent with the key comparison reference value [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 with the KCRV

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

$$D_i = A_{ei} - \text{KCRV} \quad (1)$$

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

$$U_i = 2u_{D_i}, \quad (2)$$

taking correlations into account as appropriate [11].

4.2.2 Comparison of any two NMIs with each other

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

$$D_{ij} = D_i - D_j = A_{ei} - A_{ej} \quad (3)$$

and the expanded uncertainty of this difference U_{ij} where

$$u_{D_{ij}}^2 = u_i^2 + u_j^2 - 2u(A_{ei}, A_{ej}) \quad (4)$$

where any obvious correlations between the NMIs (such as a traceable calibration) are subtracted using the covariance $u(A_{ei}, A_{ej})$, as are normally those correlations coming from the SIR.

The uncertainties of the differences between the values assigned by individual NMIs and the key comparison reference value (KCRV) are not necessarily the same uncertainties that enter into the calculation of the uncertainties in the degrees of equivalence between a pair of participants. Consequently, the uncertainties in the table of degrees of equivalence cannot be generated from the column in the table that gives the uncertainty of each participant with respect to the KCRV. However, the effects of correlations have been treated in a simplified way as the degree of confidence in the uncertainties themselves does not warrant a more rigorous approach.

Table 5 shows the matrix of all the degrees of equivalence as they will appear in the Key and Supplementary Comparisons section (Appendix B) of the CIPM MRA 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 first column of 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 1 where the black squares indicate results that are more than 20 years old. The graphical representation indicates in part the degree of equivalence between the NMIs but does not take into account the correlations between the different NMIs. However, the matrix of degrees of equivalence shown in yellow in Table 5 does take the known correlations into account.

Conclusion

The results for the LNE-LNHB, NPL and the MKEH in this ongoing comparison all agree with the KCRV at about the level of one standard uncertainty.

The BIPM ongoing key comparison for ^{54}Mn , BIPM.RI(II)-K1.Mn-54 currently comprises eleven results. These have been analysed with respect to the KCRV determined for this radionuclide, and with respect to each other. The matrix of degrees of equivalence has been approved by the CCRI(II) and is published in the CIPM MRA key comparison database.

Other results may be added as and when NMIs contribute ^{54}Mn activity measurements to this comparison or take part in linked comparisons such as the CCRI(II)-K2.Mn-54 comparison that was held in 2003.

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Table 5. Table of degrees of equivalence and introductory text for ⁵⁴Mn
Key comparison BIPM.RI(II)-K1.Mn-54

MEASURAND : Equivalent activity of ⁵⁴Mn

Key comparison reference value: the SIR reference value x_R for this radionuclide is 19.25 MBq, with a standard uncertainty, $u_R = 0.02$ MBq (see Section 4.1 of the Final Report). the value x_i is taken as the equivalent activity for laboratory i .

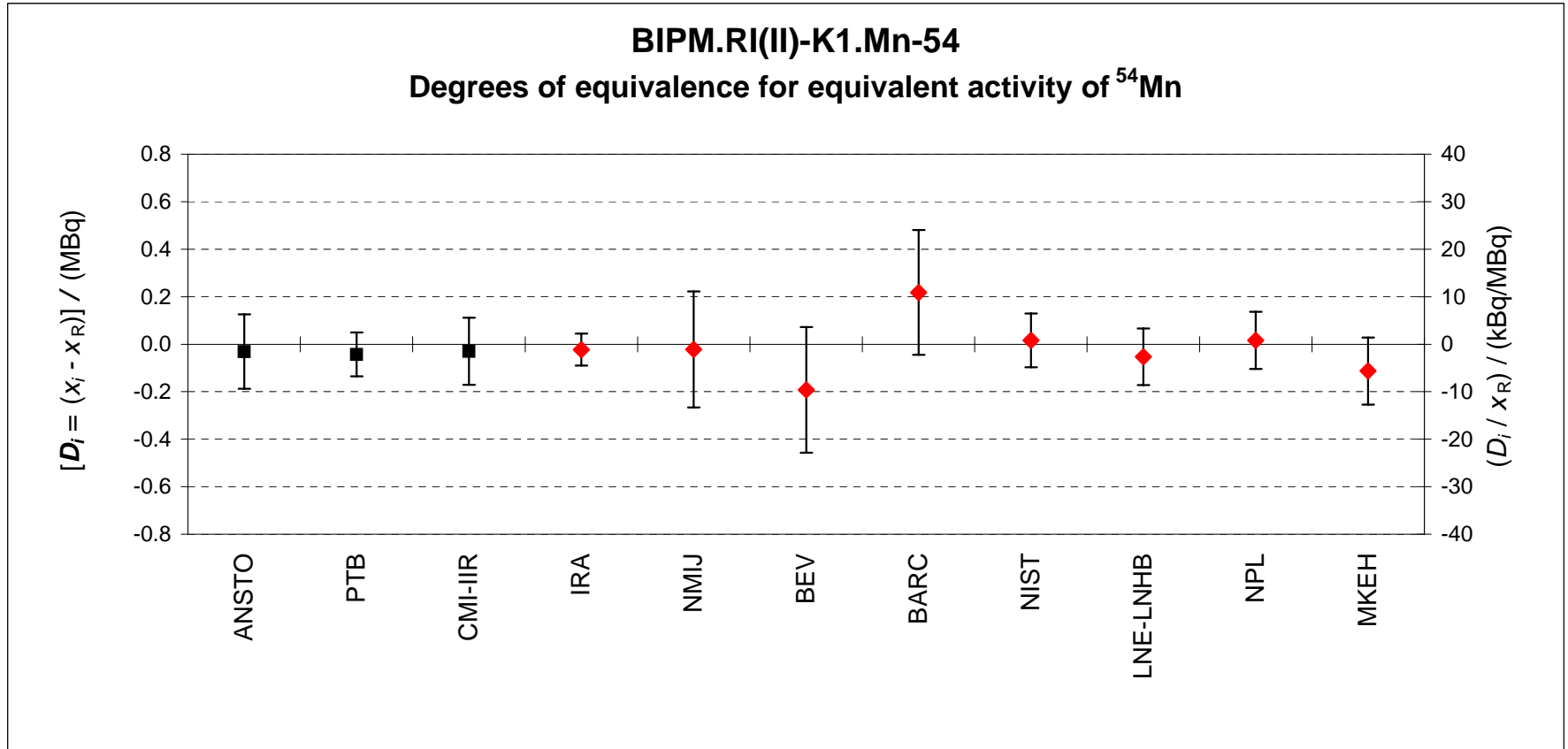
The degree of equivalence of each laboratory with respect to the reference value is given by a pair of terms: $D_i = (x_i - x_R)$ and U_i , its expanded uncertainty ($k = 2$), both expressed in MBq, and $U_i = 2((1 - 2/n)u_i^2 + (1/n^2)\sum u_i^2)^{1/2}$ when each laboratory has contributed to the calculation of x_R , with n the number of laboratories.

The degree of equivalence between two laboratories is given by a pair of numbers: $D_{ij} = D_i - D_j = (x_i - x_j)$ and U_{ij} , its expanded uncertainty ($k = 2$), both expressed in MBq. The approximation $U_{ij}^2 \sim 2^2(u_i^2 + u_j^2)$ is used in the following table.

| | | Lab j \longrightarrow | | | | | | | | | | | | |
|----------------------|----------------------|---------------------------|-------|------|-------|------|---------|------|-------|------|-------|------|------|------|
| Lab i \downarrow | D_i U_i / MBq | | | | | | | | | | | | | |
| | D_{ij} / MBq | U_{ij} / MBq | ANSTO | | PTB | | CMI-IIR | | IRA | | NMIJ | | BEV | |
| ANSTO | -0.03 | 0.16 | | | | | | | | | | | | |
| PTB | -0.04 | 0.09 | -0.01 | 0.18 | 0.01 | 0.18 | -0.01 | 0.16 | -0.02 | 0.09 | -0.02 | 0.27 | 0.15 | 0.27 |
| CMI-IIR | -0.03 | 0.14 | 0.00 | 0.22 | 0.01 | 0.16 | | | -0.01 | 0.15 | -0.01 | 0.30 | 0.16 | 0.30 |
| IRA | -0.02 | 0.07 | 0.01 | 0.17 | 0.02 | 0.09 | 0.01 | 0.15 | | | 0.00 | 0.26 | 0.17 | 0.26 |
| NMIJ | -0.02 | 0.24 | 0.01 | 0.31 | 0.02 | 0.27 | 0.01 | 0.30 | 0.00 | 0.26 | | | 0.17 | 0.37 |
| BEV | -0.19 | 0.26 | -0.16 | 0.31 | -0.15 | 0.27 | -0.16 | 0.30 | -0.17 | 0.26 | -0.17 | 0.37 | | |
| BARC | 0.22 | 0.26 | 0.25 | 0.32 | 0.26 | 0.29 | 0.25 | 0.31 | 0.24 | 0.28 | 0.24 | 0.38 | 0.41 | 0.38 |
| NIST | 0.02 | 0.11 | 0.05 | 0.19 | 0.06 | 0.13 | 0.05 | 0.18 | 0.04 | 0.11 | 0.04 | 0.28 | 0.21 | 0.28 |
| LNE-LNHB | -0.05 | 0.12 | -0.02 | 0.19 | -0.01 | 0.13 | -0.02 | 0.18 | -0.03 | 0.12 | -0.03 | 0.28 | 0.14 | 0.28 |
| NPL | 0.02 | 0.12 | 0.05 | 0.20 | 0.06 | 0.13 | 0.05 | 0.18 | 0.04 | 0.12 | 0.04 | 0.28 | 0.21 | 0.28 |
| MKEH | -0.11 | 0.14 | -0.08 | 0.21 | -0.07 | 0.15 | -0.08 | 0.20 | -0.09 | 0.14 | -0.09 | 0.29 | 0.08 | 0.29 |

| | | Lab j \longrightarrow | | | | | | | | | | |
|----------------------|----------------------|---------------------------|-------|------|-------|------|----------|------|-------|------|-------|------|
| Lab i \downarrow | D_i U_i / MBq | | | | | | | | | | | |
| | D_{ij} / MBq | U_{ij} / MBq | BARC | | NIST | | LNE-LNHB | | NPL | | MKEH | |
| ANSTO | -0.03 | 0.16 | -0.25 | 0.32 | -0.05 | 0.19 | 0.02 | 0.19 | -0.05 | 0.20 | 0.08 | 0.21 |
| PTB | -0.04 | 0.09 | -0.26 | 0.29 | -0.06 | 0.13 | 0.01 | 0.13 | -0.06 | 0.13 | 0.07 | 0.15 |
| CMI-IIR | -0.03 | 0.14 | -0.25 | 0.31 | -0.05 | 0.18 | 0.02 | 0.18 | -0.05 | 0.18 | 0.08 | 0.20 |
| IRA | -0.02 | 0.07 | -0.24 | 0.28 | -0.04 | 0.11 | 0.03 | 0.12 | -0.04 | 0.12 | 0.09 | 0.14 |
| NMIJ | -0.02 | 0.24 | -0.24 | 0.38 | -0.04 | 0.28 | 0.03 | 0.28 | -0.04 | 0.28 | 0.09 | 0.29 |
| BEV | -0.19 | 0.26 | -0.41 | 0.38 | -0.21 | 0.28 | -0.14 | 0.28 | -0.21 | 0.28 | -0.08 | 0.29 |
| BARC | 0.22 | 0.26 | | | 0.20 | 0.30 | 0.27 | 0.30 | 0.20 | 0.30 | 0.33 | 0.31 |
| NIST | 0.02 | 0.11 | -0.20 | 0.30 | | | 0.07 | 0.15 | 0.00 | 0.15 | 0.13 | 0.17 |
| LNE-LNHB | -0.05 | 0.12 | -0.27 | 0.30 | -0.07 | 0.15 | | | -0.07 | 0.15 | 0.06 | 0.17 |
| NPL | 0.02 | 0.12 | -0.20 | 0.30 | 0.00 | 0.15 | 0.07 | 0.15 | | | 0.13 | 0.17 |
| MKEH | -0.11 | 0.14 | -0.33 | 0.31 | -0.13 | 0.17 | -0.06 | 0.17 | -0.13 | 0.17 | | |

Figure 1. Graph of degrees of equivalence with the KCRV for ^{54}Mn
 (as it appears in Appendix B of the MRA)



N.B. Results in black are more than 20 years old.
 The right hand axis shows approximate values only.

Appendix 1. Uncertainty budgets for the activity of ^{54}Mn submitted to the SIR**Uncertainty budget for the LNE-LNHB**

| Relative standard uncertainties | $u_i \times 10^4$ evaluated by method | |
|---|--|----------|
| | A | B |
| Contributions due to | | |
| extrapolation of efficiency curve | 23 | – |
| weighing | – | 5 |
| counting statistics | 5 | – |
| counting time | – | <1 |
| background | 5 | – |
| impurities | 4 | – |
| accidental coincidence in the β channel | – | 5 |
| Quadratic summation | 24 | 7 |
| Relative combined standard uncertainty, u_c | 25.4 | |

[Uncertainty budgets continued overleaf]

Uncertainty budget for the NPL

| Relative standard uncertainties | $u_i \times 10^4$ evaluated by method | |
|---|--|-------------|
| | A | B |
| Contributions due to | | |
| Extrapolation of efficiency curve | – | 25 |
| weighing* | – | 7 |
| dead time | – | 3 |
| counting time | – | 1 |
| background | – | 1 |
| pile-up | – | 5 |
| half-life | – | 0.1 |
| counting statistics | 8 | – |
| impurities | – | 0.1 |
| adsorption | – | 0.1 |
| Quadratic summation | 8 | 26.8 |
| Relative combined standard uncertainty, u_c | 28 | |

* included in extrapolation.

Uncertainty budget for the MKEH

| Relative standard uncertainties | $u_i \times 10^4$ evaluated by method | |
|---|--|-------------|
| | A | B |
| Contributions due to | | |
| extrapolation of efficiency curve | – | 30 |
| weighing* | – | 5 |
| dead time | – | 0.5 |
| counting time | – | 0.5 |
| background | – | 0.5 |
| resolving time | – | 3 |
| half-life | – | 3.5 |
| counting statistics | 6.3 | – |
| impurities | – | 0.4 |
| adsorption | – | 2 |
| delay mismatch | – | 10 |
| Quadratic summation | 6.3 | 32.4 |
| Relative combined standard uncertainty, u_c | 33 | |

* included in extrapolation.

Appendix 2. 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 |
|-------------------------------|---------|---|---------|
| 4π | 4P | proportional counter | PC |
| defined solid angle | SA | press. prop. counter | PP |
| 2π | 2P | liquid scintillation counting | LS |
| undefined solid angle | UA | Nal(Tl) | NA |
| | | Ge(HP) | GH |
| | | Ge(Li) | GL |
| | | Si(Li) | SL |
| | | CsI(Tl) | CS |
| | | ionization chamber | IC |
| | | grid ionization chamber | GC |
| | | bolometer | BO |
| | | calorimeter | CA |
| | | PIPS detector | PS |
| 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 | anti-coincidence | AC |
| gamma rays | GR | coincidence counting with efficiency tracing | CT |
| X - rays | XR | anti-coincidence 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 radiations | MX | digital coincidence counting | DC |

| Examples | method | acronym |
|---|--------|-------------------|
| $4\pi(\text{PC})\beta\text{-}\gamma$ -coincidence counting | | 4P-PC-BP-NA-GR-CO |
| $4\pi(\text{PPC})\beta\text{-}\gamma$ -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 |
| $4\pi(\text{PPC})\text{AX-}\gamma(\text{Ge(HP)})$ -anticoincidence counting | | 4P-PP-MX-GH-GR-AC |
| 4π CsI- 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 |