EURAMET supportBSS pilot study

EURAMET project No.1593

Technical Protocol

Contact person and pilot laboratory: H. Zutz, Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany

01.09.2023.

1. Introduction

International Committee for Weights and Measures (CIPM) Mutual Recognition Arrangement (MRA) is a multilateral agreement between National Metrology Institutes (NMI) and Designated Institutes (DI). CIPM MRA provides mutual recognition of calibration and test certificates and national measurement standards. Key and supplementary comparisons are organized within CIPM MRA framework to support member Calibration and Measurement Capabilities (CMC) [1].
Pilot studies are the third category of comparisons normally undertaken to establish measurement parameters for a “new” field or instrument, or as a training exercise. The results of pilot studies alone are not normally considered sufficient support for CMC.

Ambient dose equivalent, $H^*(10)$, is an operational quantity used in ionizing radiation dosimetry for area monitoring. It was introduced by ICRU [2] and adopted by European Union in Council Directives 96/29/EURATOM and 2013/59/EURATOM. A supplementary EURAMET comparison of calibration coefficients for $H^*(10)$ for photon radiation, EURAMET.RI(I)-S18, was organized between 2019 and 2021, with 13 NMIs and DIs [3]. Besides NMI and DI intercomparisons, there is a need for intercomparisons for calibrations by other secondary standard dosimetry laboratories (SSDLs). These intercomparisons (ICs) are usually organized e.g. by EURADOS e.V. with a metrological reference, which is usually provided by an NMI.
This Pilot Study should demonstrate the possibility to provide a metrological reference to third party ICs by an inter-NMI IC using passive area dosemeters and train emerging NMIs or DIs to provide such reference irradiations. Additionally, it will be investigated if these intercomparisons can be used to increase confidence in existing CMCs beside the official EURAMET supplementary ICs.

The aim of this comparison is to compare ambient dose equivalent, $H^*(10)$, by performing photon irradiations of passive area dosemeters. For this purpose, passive area dosemeters will be provided by the dosemeter provider. The dosemeters will be shipped to the participants, irradiated and shipped back to the dosemeter provider. The dosemeter provider will process the dosemeters and report the doses to the pilot laboratory.

The comparison will be performed for 4 radiation qualities (1 mandatory and 3 additional) which are to be established in accordance with ISO 4037-1 [4].

The radiation qualities chosen for the comparison are:

- N-30
- N-150
- S-Cs (mandatory)
- S-Co

The recommended dose value is 10 mSv.

The dose and radiation qualities are selected in accordance with the IC2023calib IC by EURADOS to provide a metrological basis for this IC and compare the results reached by NMIs and DIs with the EURADOS participants (SSDLs).

The comparison will be coordinated by PTB as the pilot laboratory. IRSN will provide the passive area dosemeters. Results will be evaluated by PTB, with support of GUM, IMBiH, IRB, JSI, STUK and VINS. Final report will be sent to the TC-IR chair to be reviewed by CCRI(I).

This comparison protocol was prepared according to EURAMET guidelines [5].

2. Participants

Eight NMIs and DIs will take part in the comparison:

- CEA-LNHB, France
- CMI
- MIRS/IJS/F-2,O-2 - Metrology Institute of the Republic of Slovenia/Jozef Stefan Institute/Low and Medium Energy Physics F2, Environmental Sciences O2
- PTB, Physikalisch-Technische Bundesanstalt, Germany
- SCK CEN/LNK, Studiecentrum voor Kernenergie, Centre d'Étude de l'énergie Nucléaire / The Laboratory for Nuclear Calibrations
- SMU - Slovak Institute of Metrology
- STUK - Säteilyturvakeskus, Finland
- VINS - Institut za nuklearne nauke „Vinča“ – Institut od nacionalnog značaja za republiku Srbiju, Univerzitet u Beogradu

3. Transfer device

Passive area dosemeters are provided by the accredited service of IRSN.

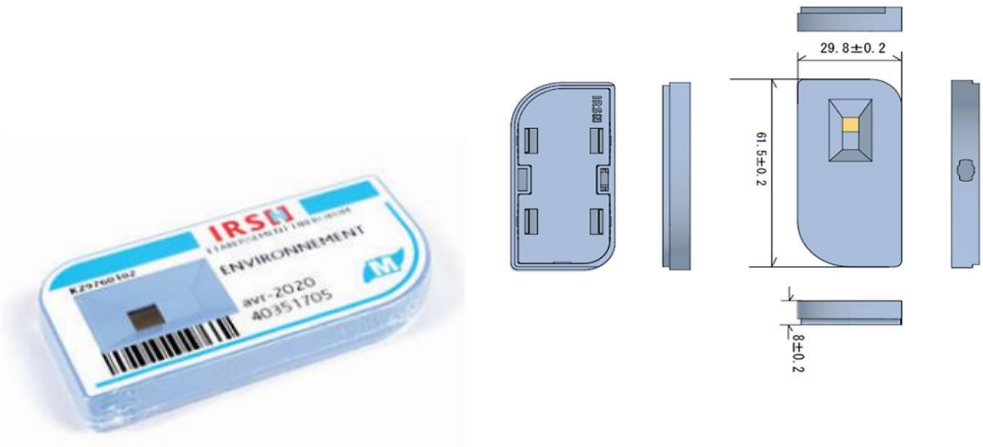

Figure 1 Passive RPL dosemeter provided by IRSN. The dimensions are approximately 29.8 mm x 61.5 mm x 8 mm.

4. Linearity and stability of the transfer dosemeters

An accredited passive area dosemeter is used. To keep the effect of dose linearity small, the required dose range is small. Within the expected dose rate range, the linearity correction is expected to be negligible.
The stability of the dosemeters is guaranteed by keeping the time between release from the dosemeter provider and read out within the accreditation time frame.

5. Advice on handling and organising the transport of the transfer dosemeter

Transport of the dosemeters will be organized together with the dosemeter provider. The transport and insurance costs including customs charges as well the service charge of the dosemeter provider will be covered by the participant. For each lost or destroyed dosemeter 18,34 EUR is charged.

After receiving the dosemeters, the irradiation must be carried out on or as close as possible to **11 October 2023**, at least within the time period 01 to 21 October. The dosemeters must be sent back to IRSN and must arrive not later than 31 October 2023.

6. Tests and procedures to be carried out before measurements

Each participant should receive 10 dosemeters per radiation quality and 10 transport/background dosemeters. The dosemeters should reach thermal equilibrium with the irradiation room before irradiation. All dosemeters (to be irradiated and transported) should be kept together except during irradiations.

7. Irradiation method, irradiation conditions

Comparison will be performed for up to four radiation qualities. The mandatory radiation quality is S-Cs. Additional radiation qualities are N-30, N-150 and S-Co. All radiation qualities will be realised in accordance with ISO 4037-1 [4]. Recommended dose per dosemeter is 10 mSv for all radiation qualities. Dose shall be within the range between 9.5 mSv and 10.5 mSv and participant shall state which dose was delivered.

The dosemeters should be irradiated free in air.
In accordance with the EURADOS protocol for IC2023calib it is advised:
For X-ray fields, to irradiated one dosemeter and
for S-Cs and S-Co two dosemeters per time.
The uncertainty budget should consider if one or two dosemeters are irradiated per time.

The dosemeters should be oriented in such a way that the reference point is at the point of test. For S-Cs and S-Co the appropriate build-up plate (3 mm PMMA) must be used.

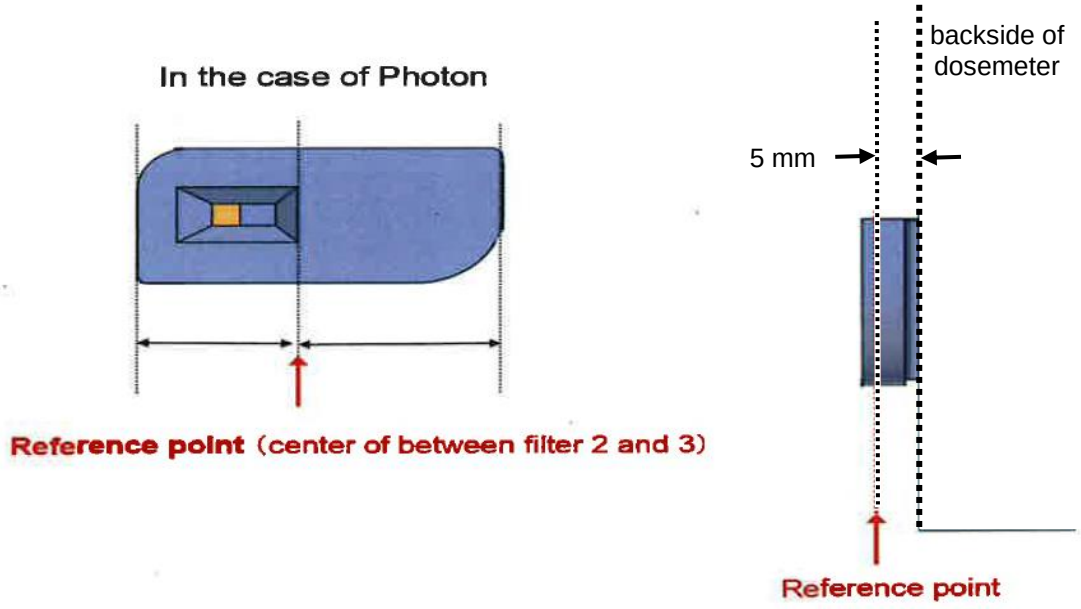

Figure 2 Definition of the reference point for the RPL dosemeters.

8. Necessary data and measurement uncertainty

Each participant will prepare the calibration report containing the following data: method of determination of reference $H^*(10)$ values including traceability, air density correction (if applicable), and uncertainties of the conversion coefficients from K_a to $H^*(10)$ (if applicable), description of the used equipment, description and picture of irradiation setup, irradiated dose, and the uncertainty budgets for each radiation quality and any corrections used.

The measurement results and uncertainty budgets will be reported in the excel form which will be provided by PTB. The uncertainty will be determined in accordance with the ISO Guide to the expression of uncertainties in measurements (GUM) [7]. Principal uncertainty components are shown in Table 1 and should be stated as relative uncertainty. Comparison participants should list all other significant contributions to the uncertainty. All relative contributions to the overall uncertainty which are lower than 0.1 % (k = 1) may be neglected. National/reference standard stability should be reported as calibration coefficient uncertainty type A.

Table 1: Uncertainty budget reporting form

*H*10 irradiations*				
Source of uncertainty	$u_{i,\mathrm{A}}$	$u_{i,\mathrm{B}}$	$u_{i,\mathrm{A}}^2 + u_{i,\mathrm{B}}^2$	Comment
Air density correction				
Source to dosemeter distance				
Conversion coefficient				
Other sources of uncertainty…				
Combined uncertainty, *H*(10)				
Combined uncertainty, N_H	$u = \sqrt{\sum_i \left(u_{i,\mathrm{A}}^2 + u_{i,\mathrm{B}}^2\right)} =$			

9. Evaluation and communication of the results

PTB and all participants that are performing evaluation ("evaluators") of the results will send their irradiation reports to EURAMET TC-IR chair electronically within 4 weeks after having finished the measurements.
IRSN will perform evaluation of the dosemeter readings and provide the results to PTB after having finished the measurements but not before PTB sends the irradiation report to EURAMET TC-IR chair.

The contact person at PTB shall inform other participants, when the PTB's results have been sent to EURAMET TC-IR chair, and other participant may send the results electronically to PTB.

Evaluators of the Pilot Study are PTB, with support from GUM, IMBiH, IRB, JSI, STUK and VINS, according to the activity A4.3.1 of the EMPIR project supportBSS.

PTB will send the irradiation reports from all comparison participants and results of dosemeter evaluation of IRSN electronically to the evaluator, but not before they have sent their own irradiation reports to the TC-IR chair.

The comparison reference value $C_i(D_H)$ will be determined for each radiation quality as the weighted mean of the evaluated doses reported by the participants which have traceability to their own primary standards for K_a or $H^*(10)$ according to the irradiation protocols. The results of the participants will be compared to this comparison reference value as a ratio of participant stated dose/comparison reference value.

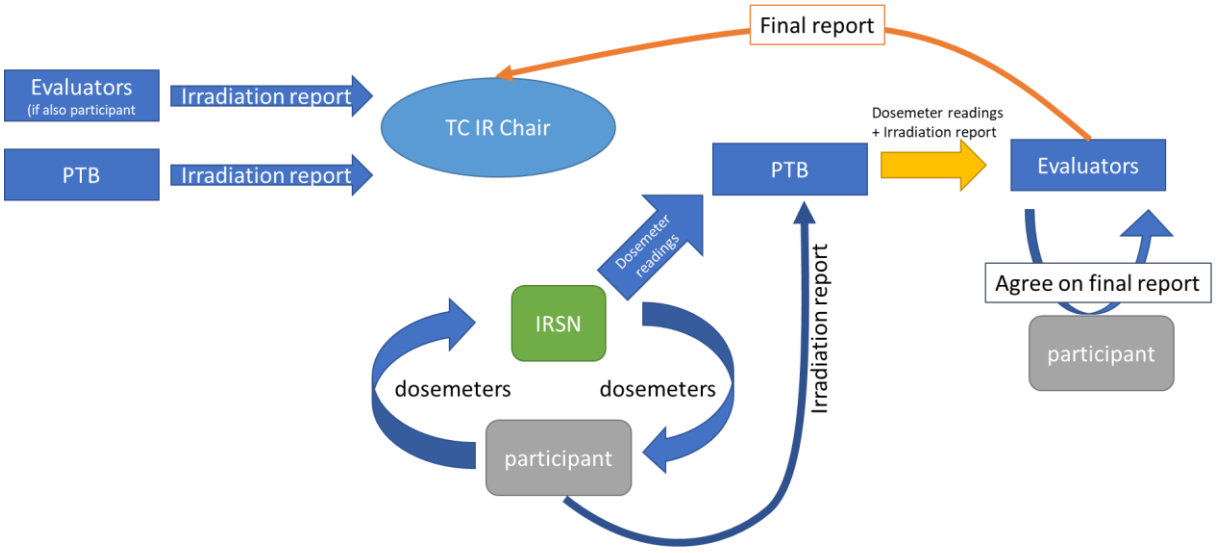

Figure 3 Flow chart depicting the information flow during the pilot study.

10. Organisation and time schedule

The comparison will have 8 participants in total. The shipping addresses are provided in Appendix A, along with the contact names, telephone numbers and e-mail addresses.

The comparison will start on 1st October 2023 and the irradiations are scheduled to finish on 21th October 2023.

After receiving the dosemeters, the irradiation should be performed between 1st to 21th October 2023, preferably on 11th October 2023.
The dosemeters have to be returned to IRNS before 31th October 2023.

11. Agreement on the presentation of the results

All the participating laboratories agree to keep the comparison results and all the measurement data confidential until the comparison is finished. The results and data can be submitted only for evaluation purposes as described in this protocol, or to the EURAMET TC-IR chair. Any publication, communication or oral presentation of the results will be considered breach of the confidentiality.

After the comparison is finished, all the data and the comparison results will be made available to all the participants. PTB will prepare the Draft A of the comparison report with the support of GUM, IMBiH, IRB, JSI, STUK, VINS, and other participants. Participants will have two months to comment on Draft A. Once all the participants agree with the Draft A, PTB will submit Draft B to EURAMET for review. The revised Draft B will be used as the report for EURAMET project.

Any presentation of the results is done in joint authorship.

12. References

[1] International Committee for Weights and Measures, 2003. Mutual recognition of national measurement standards and of calibration and measurement certificates issued by national metrology institutes

[2] International Commission on Radiation Units and Measurements, 1993. Quantities and Units in Radiation Protection Dosimetry, ICRU Report 51

[3] Miloš Živanović et.al., 2023. EURAMET DOSEtrace supplementary comparison in terms of the ambient dose equivalent/rate for photon radiation (EURAMET.RI(I)-S18), to be published

[4] International Organization for Standardization, 2019. X and gamma reference radiation fields for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy - Part 1: Radiation characteristics and production methods, ISO 4037-1.

[5] EURAMET Guide No. 4, EURAMET Guide on Comparisons, Version 1.0 (05/2016)

[6] International Organization for Standardization, 2019. X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy - Part 3: Calibration of area and personal dosemeters and the measurement of their response as a function of energy and angle of incidence, ISO 4037-3.

[7] BIPM, JCGM 100:2008, Evaluation of measurement data - Guide to the expression of uncertainty in measurement (GUM 1995 with minor corrections)

Appendix A

Addresses of the participants

Pilot laboratory

PTB

Physikalisch-Technische Bundesanstalt
Working group 6.31 "Photon dosimetry"
Dr. Hayo Zutz
Bundesallee 100
38116 Braunschweig
Germany

contact person:	Hayo Zutz Tel.: +49 531 592 6310 e-mail: hayo.zutz@ptb.de
alternate contact:	Simone Janssen Tel.: +49 531 592 6214 e-mail: simone.janssen@ptb.de

Participants

CEA-LNHB

Shipping address:
CEA Saclay
LNHB-MD
Bâtiment 534
91191 Gif/Yvette cedex
France

contact person:	PLAGNARD Johann, Tel.: 33 1 69 08 41 78 johann.plagnard@cea.fr
alternate contact:	

CMI

Shipping adress:
Český metrologický institut
Oblastní inspektorát Praha
budova IZ
Radiová 1288/1a
102 00 Praha - Hostivař
Czech Republic

contact person:	Vladimír Sochor Tel.: +420 607 853 049 e-mail: vsochor@cmi.cz
alternate contact:	Jaroslav Šolc, jsolc@cmi.cz Jana Šmoldasová, jsmoldasova@cmi.cz

MIRS/IJS/F-2,O-2

Jožef Stefan Institute
Laboratory for dosimetry standards (NDS)
Jamova 39
SI-1000 Ljubljana
Slovenia

contact person:	Boštjan Črnič Tel.: +386 1 4773651, +386 31 638 622 e-mail: bostjan.crnic@ijs.s
alternate contact:	Denis Cindro, denis.cindro@ijs.si

SCK CEN/LNK

Shipping adress:
SCK CEN (Studiecentrum voor Kernenergie - Centre d'Etude de l'Energie Nucleaire)
LNK building
Boeretang 200
B-2400 Mol
Belgium
Tel. laboratory : +32 14 33 2005
e-mail: nuclearcalibrations@sckcen.be

contact person:	Cristian Mihailescu Tel.: +32 14 33 2005 e-mail: cristian.mihailescu@sckcen.be
alternate contacts:	Anne Laure Lebacq, Anne.Laure.Lebacq@sckcen.be Filip Vanhavere, filip.vanhavere@sckcen.be

SMU

Shipping adress:
SMU – Slovenský Metrologický Ústav
Karloveská 63
842 55 Bratislava
Slovakia

contact person:	Stanislav Sandtner Tel.: +421 2 602 94 494, +421 2 602 94 633 e-mail: sandtner@smu.gov.sk
alternate contact:	Andrej Javorník, javornik@smu.gov.sk

STUK

Shipping address:
STUK – Radiation and Nuclear Safety Authority
Jokiniemenkuja 1
01370 Vantaa
Finland

contact person: Jussi Huikari
Tel.: +358408225559
e-mail: jussi.huikari@stuk.fi
alternate contact: Reetta Nylund, reetta.nylund@stuk.fi

VINS / RS

Institut za nuklearne nauke „Vinča“ – Institut od nacionalnog značaja za republiku Srbiju, Univerzitet u Beogradu
Laboratorija za zaštitu od zračenja i zaštitu životne sredine – 100
Mike Petrovića Alasa 12-14
11351 Vinča, Belgrade
Serbia

contact person: Miloš Živanović
Tel.: +381 11 6308 438, +381 63 467 561
Fax: +381 11 6308 438
e-mail: milosz@vinca.rs
alternate contacts: Nikola Kržanović, krzanovic@vin.bg.ac.rs