Support for a European Metrology Network on reliable radiation protection: Gaps in radiation protection metrology

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EMPIR 19NET03 supportBSS:

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To develop and establish a joint and sustainable European metrology network (EMN) based on stakeholder needs
➢ To meet the metrology needs of stakeholders

Virtual Workshop „Stakeholder mapping“, Caroline Pritchard, NML at LGC, EURAMET workshop, Jan 2021
Implementation of the EMN strategy in radiation protection (RP) metrology
➢ To meet the metrology needs of ionizing radiation (IR) stakeholders

IR Metrology community

Interactions

IR Stakeholder

WP5 (PTB):
Joint & sustainable European metrology infrastructure

WP1 (IMBiH):
Communication strategy

WP2 (CMI):
Web portal

WP3 (IST):
SRAs & Roadmaps

WP4 (NPL):
Knowledge sharing & capacity building

WP1 (IMBiH):
Identification of the Stakeholder and needs
Gaps in radiation protection metrology

- Virtual Workshop „Gaps in RP metrology“, 11th September 2020
  ➢ As an interaction between IR metrology and stakeholder communities
  ➢ As a part of 19NET03 supportBSS project activities
  ➢ To identify metrological gaps in 8 areas:

1. Activity standards
2. Reference fields
3. New operational quantities in radiation protection
4. Measuring devices for radiation protection in medical or industry applications of IR
5. Measuring devices for environmental monitoring
6. Type testing
7. Harmonized handling, transmission, storage and availability of measurement data
8. Education and training needs

Behnam Khanbabaee
ID: RAD9-178 June 14-18, 2021

- Lowered limits and reference values:
  - Activity range 100 Bq/m³ to 300 Bq/m³ for ²²²Rn indoor air
  - Activity too low for decaying gas standards
  - Activity range 1 Bq/m³ to 100 Bq/m³ for ²²²Rn outdoor air
  - Needed for radon tracer method in climate change observation (green house gas)

- ²²²Rn, ²³⁸U, ²³⁴U, ²²⁸Ra, ²²⁶Ra, ²¹⁰Pb, ²¹⁰Po and ³H in and over drinking water:
- Radiochemical procedure validation
- Lack of Certified Reference Materials for environmental samples
- Traceability for real chemical composition

Gaps in medical field

- More and complex “new” radionuclides e.g., in nuclear medicine:
  - Short half-life (high activities)
  - Impurities (huge dynamic range GBq to Bq)
  - Nuclear decay data (unknown, at least too large uncertainties)
Photon reference field
- Pulsed radiation with pulse durations in $\mu$s or shorter and with high dose rate during the radiation pulse
- Limitation of calibration fields that represent realistic conditions (pulsed fields, mixed fields, high energy, high dose rate)
- Traceable measurements and characterized dosemeters for radiation protection at accelerator facilities (linacs)

Neutron reference field
- Difficulties in neutron dosimetry due to lack of resources to characterize dosemeters in realistic fields
- No operating neutron reference field in high (20 MeV - 1 GeV) and epithermal (0.5 eV - 1 keV) energy region
- Simulated workplace neutron fields satisfying the requirements of ISO 12789
Metrology Gaps (area 3): New operational quantities

- Operational quantities in radiation protection
  - Many instruments are “blind” below 60 keV, but many workplaces in medicine will have lower mean energies
  - Modification of the dosemeters for new quantities
  - Instrument for beta radiation
  - Testing under Non-Charged Particle Equilibrium (Non-CPE)

- Risk of leaving a well performing system, without significantly improving radiation safety
  - Impact on instrument design
  - Need of legislative adaptations

Virtual Workshop „Gaps in radiation protection metrology“, Pete Burgess, Radiation Metrology Ltd, Sep 2020

Virtual Workshop „Gaps in radiation protection metrology“, Paula Toroi, STUK, Sep 2020
Measuring devices for radiation protection in medical or industry applications of IR
Pulsed radiation
- Development of suitable dose measuring devices for pulsed radiation and for low energies are missing.

Radon metrology
- Limited number of suppliers of primary Radon gas standard: in Europe recently LNHB, METAS, (PTB)
- In Europe, only 2 NMIs (Austria, Ukraine) realize the relevant measurand Radon-222 activity concentration in air
- Accredited calibration laboratories are suffering intercomparison on a similar metrological level.

Large variability of equipment a
- Need to confirm the minimal requirement (IEC, CE)-
- Issues related to the definition of “medical device”
- Guidance for the end-user

Virtual Workshop „Gaps in radiation protection metrology“, Paula Toroi, STUK, Sep 2020
Virtual Workshop „Gaps in radiation protection metrology“, Sebastian Feige, BfS, Sep 2020
Measuring devices for environmental monitoring

Developing innovative sensors for environmental water monitoring and management

Development of environmental sensors often takes years e.g., INTCATCH.

Thoron (Rn-220) - underestimated in the big shadow of Radon?

COUNCIL DIRECTIVE 2013/59/EURATOM: indoor exposure to radon and thoron, in workplaces, dwellings and other buildings

No NMI realizes the measurands radon-220 activity concentration in air or potential alpha energy-concentration of radon-progenies

A traceability for a Thoron progeny atmosphere is yet not available (Experiences PTB, some recent activity at BfS and in frame of RadoNorm-Project)
Type testing: harmonization of national requirements with international standards (IEC and ISO) and radiation protection legislation

- Radon in regulation
- Risk evaluation
- Missing of mitigation standards
- Different conversion for works and public
- Different radon awareness
- Missing of standards for radon in soil activity concentration and radon exhalation rate

Should a metrological control be required for the approval of radon instruments (type test)?
- No technical infrastructure (independent inspection bodies) exist for carrying out type tests specified in IEC 61577
- No measurement instruments on the market available, which fulfill these requirements
Type testing: harmonization of national requirements with international standards (IEC and ISO) and radiation protection legislation

- ICRP and ICRU proposals for new operational quantities
  - Significant changes in nearly all related standards needed!

- The contribution is the most influential at the international level
  - Adoption as EN and national standards

- Standards for similar measuring tasks contain extremely different requirements
  - Harmonization needed!

### Virtual Workshop „Gaps in radiation protection metrology“
Rolf Behrens, PTB, Sep 2020

### Standards for dosemeters and dosim. systems

<table>
<thead>
<tr>
<th>Area dosemeters</th>
<th>Photons</th>
<th>Betas</th>
<th>Neutrons</th>
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<tbody>
<tr>
<td>Active</td>
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<tr>
<td></td>
<td>IEC 60846-1:2009 portable</td>
<td>$H'(0.07), H'^*(10)$</td>
<td>IEC 61005:2014 rate meters</td>
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<tr>
<td></td>
<td>IEC 60846-2:2015 portable, emergency</td>
<td>$H'(3)$</td>
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<td>IEC 61017:2016 environm. monitoring $H'^*(10)$</td>
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<td>IEC 60532:2010 fixed inst. in NPPs</td>
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<tr>
<td>Passive dosim. systems</td>
<td>IEC 62387:2020 all detector types</td>
<td>$H'(0.07), H'(3), H'^*(10)$</td>
<td>IEC 61322:2020 fixed installed</td>
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</tbody>
</table>

### Revision started

<table>
<thead>
<tr>
<th>Personal dosemeters</th>
<th>Photons</th>
<th>Betas</th>
<th>Neutrons</th>
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<tr>
<td>Active</td>
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</tr>
<tr>
<td>Passive dosim. systems</td>
<td>IEC 62387:2020 all detector types</td>
<td>$H_p(0.07), H_p(10), H_p(3)$</td>
<td>ISO 21909-1:2015 $H_p(10)$</td>
</tr>
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Harmonization needed!

Still missing!
- Harmonized handling, transmission, storage and availability of measurement data

- Emergency response
  - Data management: How to manage big data, artificial intelligence? There is no training or tools for that! Is it possible to map for food, environment and water the pollution?
  - Environmental transfer processes are important in emergency situations. Here there is a large research need (e.g., short term exchange from earth to sea, but also realistic as well as reliable $K_D$-values for modelling long-term radioecological behaviour).

  Virtual Workshop „Gaps in radiation protection metrology“, Paul Leonard, CRA, Sep 2020

- Radon metrology
  - No qualified central information platform on radiation protection institutes and calibration services with their capabilities

  Virtual Workshop „Gaps in radiation protection metrology“, Sebastian Feige, BfS, Sep 2020
Metrological Competence
- Education: Radiation metrological competence certification
- Basic education: for practise
- Expert education: like measurement uncertainty, E-Learning
- Practical training: It is essential!
- National / international qualification: Harmonisation needed!
- Share experience: International efforts are needed, especially under COVID-19

Emergency response
- Involve people with local knowledge: farm management, local representatives
- Utilization of scientists with a successful track record for practicality & rigour is essential.
- Designated institute (DI): Competence and capability to response, lack of staff, lack of resources (suitable equipment, calibration fit for purpose)

Virtual Workshop „Gaps in radiation protection metrology“, Paula Toroi, STUK, Sep 2020

Behnam Khanbabaee 9th International Conference on Radiation in Various Fields of Research
ID: RAD9-178 June 14-18, 2021
The aim of the supportBSS project is to support the establishment of the European Metrology Network (EMN) for Radiation Protection to provide new metrological solution for the future.

The implementation of a long-term ongoing dialogue between the metrology community and the relevant stakeholders is a basic requirement for the establishment of the EMN. This dialogue should help the EMN to engage the stakeholders by identifying their metrological needs and core interests.

The virtual workshop „Gaps in RP metrology“, which took place on September 11, 2020, deals with the so-called gaps in radiation protection metrology and capacities either in the scope of the Council Directive 2013/59/EURATOM or in some aspects of the EURATOM treaty.

The identified metrological gaps that were introduced by stakeholders during the workshop and by project partners consist of a variety of topics in the field of radiation protection.

Since the results of the gap analysis will in future guide the supportBSS and EMN in the development of the Strategic Research Agenda (SRA) and Roadmaps, a process for mapping and prioritizing the gaps will be taken into account.

The 2021 General Assembly of EURAMET e.V. approved EMN for Radiation Protection!
Thank you for your attention!

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