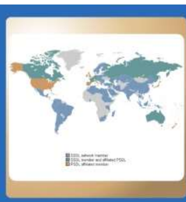
IAEA WHO

SSDL Newsletter



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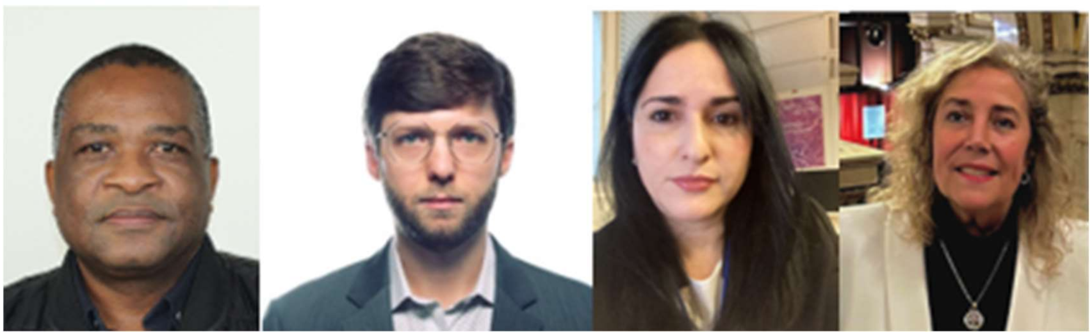
Contents

From the Editor

This issue of the Newsletter is dedicated to World Metrology Day (20 May) and celebrates its theme: We measure today for a sustainable tomorrow. Its articles are written by SSDLs and the CCRI Strategy Working Group. The Newsletter also includes a thought-provoking article by medical physicists on why the work done by dosimetry laboratories and on measurement uncertainties matter. And finally, it has a response to a letter from a medical physicists to a radiation metrologist published in Newsletter No. 78. We thank everyone for their contributions.

I also want to take this opportunity to welcome the new members to the DMRP team and those who are in new roles. We welcome Godfrey Azangwe (Radiotherapy Medical Physicist) who was previously the Quality Manager, Benjamin Kellogg (Associate Dosimetrist), Liset De La Fuente Rosales (Dosimetrist, Quality Audits), and Graciela Velez (Training Officer, Medical Physics) (see picture below).



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Services provided by the IAEA in DMRP Section

The IAEA's Dosimetry and Medical Radiation Physics Section focuses on services provided to Member States through the IAEA/WHO SSDL Network and on a system of dosimetry quality audits. The measurement standards of Member States are calibrated, free of charge, at the IAEA's Dosimetry Laboratory. The audits are performed through the IAEA/WHO postal dose audit service for SSDLs and radiotherapy centres by using radiophotoluminescence and optically stimulated luminescence dosimeters (RPLDs and OSLDs).

The Dosimetry Laboratory's Quality Management System has been reviewed and accepted by the Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB). Some of the IAEA Calibration and Measurement Capabilities (CMCs) are published in Appendix C of the BIPM key comparison database (KCDB).

The IAEA CMCs can be found at the following web site: https://www.bipm.org/kcdb/

The range of services offered by the IAEA's DMRP Section are listed below.

Services	*Radiation quality*
**Calibration of ionization chambers (radiation therapy, brachytherapy*, radiation protection, and diagnostic radiology including mammography)	X rays and g rays from ^{137}Cs and ^{60}Co beams ^{137}Cs, ^{60}Co, @linac photon beams* and ^{192}Ir brachytherapy sources
**Comparison of ionization chamber calibrations coefficients (radiation therapy, radiation protection, and diagnostic radiology including mammography) for SSDLs	X rays and g rays from ^{137}Cs and ^{60}Co beams
Dosimetry audits (RPLD) for external radiation therapy beams for SSDLs and hospitals	g rays from ^{60}Co and high energy X ray beams
Dosimetry audits (OSLD) for radiation protection for SSDLs	g rays from ^{137}Cs
Reference irradiations and blind dose checks for dosimetry audit networks (radiotherapy)	^{60}Co and high energy X ray and electron beams
Reference irradiations to dosimeters for radiation protection	X rays and g rays from ^{137}Cs and ^{60}Co beams

* Calibration services are not included in the IAEA CMCs published in the BIPM KCDB.
** Technical procedures and protocols for calibrations and comparisons are available on our website https://ssdl.iaea.org/
@ Service available only for SSDL's that have activities in this area.

Member States interested in these services should contact the IAEA/WHO SSDL Network Secretariat, for further details, at the address provided below. Additional information is also available at the web site: *https://ssdl.iaea.org*

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Note to SSDLs using IAEA calibration and audit services:

1. To ensure continuous improvement in IAEA calibration and audit services, SSDLs are encouraged to submit suggestions for improvements to the Dosimetry Contact Point.

2. Complaints on IAEA services can be addressed to the Dosimetry Contact Point.

3. Feedback can be provided using the form on our website: https://ssdl.iaea.org/

https://iris.iaea.org/public/survey?cdoc=DOL00100

World Metrology Day 2024

CCRI Strategy Working Group: Malcolm McEwen, Massimo Pinto, Lisa Karam, Haoran Liu, Andreas Zimbal, Neil Roberts, Vincent Gressier, Jan-Theodoor Janssen

At first sight, the theme for World Metrology Day 2024 – Sustainability – does not seem to have much overlap with the activities of primary and secondary standard dosimetry laboratories. However, when one considers the meaning of sustainability in the light of the 17 UN Sustainable Development Goals (SDGs) it becomes more obvious that ionizing radiation is not just relevant but also has an important role to play in supporting (and sustaining) various applications. Here are just a few examples.

Ionizing radiation metrology contributes to **"Ensure healthy lives and promote well-being for all at all ages" (SDG 3).** Ionizing radiation is one of humanity's main tools in the fight against cancer, with radiation therapy treatments becoming increasingly varied (both in terms of beams and methods) and tailored to the biological specificities of each patient. The growing cancer burden, identified by the IAEA over a decade ago, has driven the increased use of radiation-based diagnostic procedures. For their part, National Metrology Institutes/Designated Institutes (NMIs/DIs) have responded by developing novel systems for the accurate comparison of national standards for radiotherapy, brachytherapy, mammography, and other X ray imaging approaches. There is now strong clinical evidence that proton therapy has significant benefits in treating paediatric cancers and CCRI Section I has initiated discussions around the need for international comparisons of proton dosimetry standards. To leverage all the benefits of proton therapy, the effects of unwanted dose due to secondary high energy neutron radiation need to be investigated. CCRI Section III has recently convened a task group to investigate how high-energy neutron beams suitable for metrological applications can be produced and how the community can come together to use them in an efficient and sustainable manner. Ultra-high dose rate (FLASH) therapy is attracting significant attention and multiple research groups are investigating the technology required to accurately measure and deliver these almost-instantaneous treatments. Perhaps the most disruptive – and exciting – treatment technique is radiopharmaceutical therapy (RPT), and CCRI Section II has been leading an international effort to develop normative standards for clinical implementation and coordinate the necessary research into standardizing the various radioisotopes being investigated for RPT, as highlighted by a recent workshop on alpha-particle therapy (02/2024).

Ionizing radiation can also help to **"Take urgent action to combat climate change and its impact" (SDG 13).** Within the context of global commitments to reduce greenhouse gases (GHGs), there is the requirement to accurately measure CO_2 and CH_4 emissions from different sources. The radioactive signature from C-14 can be used as part of this monitoring system. Other radioisotopes, like Be-7 and Na-22, produced by cosmic radiation in the atmosphere could also be useful tools to better understand key atmospheric processes and predict global warming. CCRI(II) has put several of these radioisotopes, in particular C-14, on the priority list for the upcoming activity comparisons with the new reference system (the extended SIR or ESIR) maintained by the BIPM. It has also started discussions with various specialists in this field to better match the needs pointed out at the last BIPM-WMO Metrology for climate action workshop (09/2022).

In addition, ionizing radiation contribute to ensuring **"Availability and sustainable management of water and sanitation for all" (SDG 6).** A range of radiation beams – primarily Co-60 and high-energy electrons – have been used for decades to sterilize single-use medical goods. The same techniques can also be applied to food, water, and waste treatment to eliminate pathogens and certain chemical contaminants. Within the field of high-dose dosimetry, CCRI partners with the ASTM international E61 committee, which is the primary forum worldwide for radiation processing standards.

Ionizing radiation metrology is also deeply involved in **"Ensuring access to affordable, reliable, sustainable and modern energy for all" (SDG 7).** Decarbonizing energy production will require multiple technologies, but – in the short term – fission-based nuclear power will be crucial for many countries. The safe operation of such facilities requires accurate radiation protection measurements and the calibration services that

NMIs/DIs provide to support the delivery of sustainable and affordable energy while assuring minimal environmental impact, e.g., through the measurement of radionuclides in natural matrices. Looking further into the future, small and new generation fission reactors as well as fusion technology have the potential to be a significant energy resource. All will need more accurate nuclear data (nuclear decay, neutron cross-sections, etc.), posing several challenges for and demands on ionizing radiation metrology. For example, since fusion mechanisms are sufficiently different from fission, new facilities will be needed to produce the reference neutron beams for metrological support.

A final example, **"Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation" (SDG 9)** is also part of ionizing radiation metrology's mission. Metrology can be viewed as the quantification of knowledge, with various leaders since the industrial revolution espousing its value. The techniques that NMIs/DIs develop to accurately measure ionizing radiation are focussed on industry/societal needs and therefore are directly relevant to this goal. Moreover, the ionizing radiation metrology community has a responsibility for personal sustainability. To that end, CCRI is actively reviewing how we can operate more efficiently, e.g., through simpler comparison protocols and CMC reviews, partnering with collaborators to make better use of radiation facilities, and continuing to engage with end-users on ensuring the rapid and accurate transfer of both knowledge and technology.

For more details on CCRI activities see https://www.bipm.org/en/committees/cc/ccri.

A Focus on Monitoring and Analyzing the Overall Performance of a National Secondary Standard Dosimetry Laboratory for a Better Sustainability in Ionizing Radiation Measurements

Institute of Applied Nuclear Physics, University of Tirana, Albania

Klotilda Nikaj

Measurements of ionizing radiation are fundamental for a wide array of applications, encompassing medical imaging to nuclear power plant safety. However, maintaining the sustainability of these measurements requires a thorough understanding and proactive management of various factors. Regular calibration against traceable standards ensures accuracy and reliability over time, provided to users within the country by our national Secondary Standard Dosimetry Laboratory (SSDL).

The SSDL at the Institute of Applied Nuclear Physics (IANP) at the University of Tirana (UT), established in 2004 through a Technical Cooperation Project with the IAEA [1,2], operates under the guidance of international standards, and is a member of the IAEA/WHO Network of SSDL. The most recent IAEA-coordinated postal audit for radiation protection level that the SSDL participated in was in 2022. This participation aimed to validate the calibration conducted by the SSDL using the Cs-137 beam.

IANP maintains its Cs-137 calibration capability by monitoring the data from measurements performed since 2018 to date. Any variations in chamber response from this data are investigated.

Ensuring sustainability in ionizing radiation measurements requires a comprehensive approach, which includes calibration and the continuous maintenance of the standards. IANP is committed to the sustainability of its laboratory services by maintaining the laboratory's standards and equipment and ensuring that postal dose audit results are always within acceptable limits.

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The History of Continuous Improvements for the Dosimetry Calibrations at SCK CEN Belgium

SCK CEN (Belgian Nuclear Research Centre), Boeretang 200, Mol, Belgium

L.C. Mihailescu, A.L. Lebacq, F. Vanhavere

Photon and neutron dosimetry calibrations are performed at the Laboratory for Nuclear Calibrations (LNK) of the Belgian Nuclear Research Centre (SCK CEN) since 1985. Supposedly, calibrations were even done in the so-called wooden tower since the 1960s. It started as an internal service for calibration of dosemeters and monitors. Slowly, the service extended to calibrations for external customers and to irradiations of samples for dosimetry, radiobiology, and radioecology research. The Laboratory obtained its first accreditation for compliance with ISO/IEC 17025 around 2004. In 2009, LNK started to perform calibrations of radiotherapy ionisation chambers in terms of air kerma (primary standard) and absorbed dose to water (secondary standard). In 2012, LNK became the Designated Institute (DI) for the metrology of ionizing radiation in Belgium, a member of BIPM and a member of the IAEA/WHO SSDL Network – all important milestones

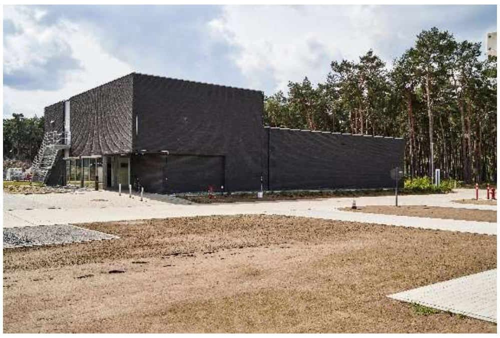
Due to increased demand and the need for diversification of calibrations, the old laboratory and its irradiators were not suitable anymore. Too many irradiation set-ups were situated in the same room, which caused planification conflicts. The failures of irradiators, lack of spare parts, and outdated safety and security system were also a convincing argument for an urgent refurbishment. Two options were considered: a refurbishment of the old calibration building or the construction of a completely new building. Since cost estimates and the associated difficulties of a refurbishment were significant, LNK opted for the latter.

The construction of the new LNK building started in October 2018 and was completed one year later. Several months were needed for the installation of sliding doors and irradiators, with source installation requiring another 6 months. By spring 2021, all calibration methods were re-validated and ready for an ISO/IEC 17025 accreditation audit. Six independent irradiation rooms are now available with multiple irradiators and radiation qualities: Cs-137, Co-60, X ray , Cf-252, Am-Be, and Sr-90/Y-90.

As defined in our Integrated Management System, the main goal of LNK is to sustainably provide accurate, consistent, and traceable calibrations to all our customers – the majority being end-users of ionizing radiation metrology in Belgium. With about a dozen ISO/IEC 17025 accredited Calibration and Measurement Capabilities (CMC), the SSDL covers most of the metrology aspects of ionizing radiation and serves the needs of all our customers – encompassing nuclear research, hospitals, and any industry branch that may use a dosemeter. This goal aligns well to SCK CEN's public utility status.

The SSDL consists of three person staff. The SSDL's objectives are to provide an unbroken chain of traceability to international standards, ensure the quality of laboratory results, maintain good records, and perform calibrations for all our customers in a timely manner. All of these aspects require considerable effort. With digitalisation and automation offering a solution to increase efficiency and productivity, SCK CEN adopted a common data acquisition system and database, automated tools for reporting, and a fully digital integrated management system. All of these require validation, but they significantly reduce manual work, risks and errors.

Now, SCK CEN has a modern and efficient installation that can be run in a sustainable way, hopefully for at least another 35 years and with minimum environmental footprint. SCK CEN should of course keep up with technological progress and continue evolving.



Facilities at SCK CEN Photographs by: SCK CEN

Metrology for Ionizing Radiation and Sustainability

Laboratório Nacional de Metrologia das Radiações Ionizantes (LNMRI), Brazil

Karla C.S. Patrao

World Metrology Day
World Metrology Day is the annual celebration of the signing of the Metre Convention on 20 May 1875. The Convention's original goal was worldwide uniformity of measurement, which remains as important today as it was in 1875 [1].

With a different theme each year, World Metrology Day in 2024 highlights Sustainability.

Sustainability
The word sustainable derives from the Latin *sustentare* which means to sustain, support, conserve, and care.

Sustainability can be achieved through Sustainable Development, defined as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [2].

And what contribution can metrology offer to the sustainability process?
Metrology, as the science of measurement, is one of the pillars of quality and innovation. Its performance favours sustainable development by enabling precise and reliable measurements, enabling opportunities for improvement and the identification of sustainable practices.

It is no different with the metrology of ionizing radiation. While it is being discussed whether nuclear energy is an ally of sustainability, ionizing radiation's applications play an important role in processes related to sustainability. They are present in several human activities, such as the irradiation of food to fight hunger and food security and the widespread use of radiation in the medical field to improve people's health through increasingly precise diagnoses and therapies.

One of the biggest concerns today is the water scarcity and degradation through the contamination of surface and groundwater. The failure to optimize water resources may in turn result in reduced economic growth as well as risks to human health and the environment.

For its part, isotopic hydrology allows us to understand the behaviour of waters. Through the use of tracers, origins can be determined as can flow speed, sources of contamination, and degradation processes.. Nuclear technology also allows for the desalination of seawater.

Soil contamination affects the food chain, especially with the common use of polluting fertilizers and pesticides. These products must be carefully tested before they are used to ensure they break down into components that pose no environmental risk. The application of isotopic techniques makes it possible to determine the decomposition of these products and their destination.

Ionizing radiation can also be used to combat insects that pose a threat to animal and human health. Insect infestation, for example, can destroy valuable food crops and bring epidemic diseases.

New methods for combating insects have emerged that do not pose a risk to the environment, such as the sterile insect technique, which consists of producing large quantities of insects in breeding sites sterilized with gamma radiation. These insects are then released. When they mate with wild insects, no offspring are produced. The hereditary sterility technique has similarly been used to eradicate moth pests.

None of this is effective without metrology, the basis for analysis and decision-making that can in turn make our activities more appropriate and sustainable. Without ensuring safe measurements, we cannot move forward.

While the concept of sustainability often seems utopian to us, the world's experience increasingly highlights the urgency to reflect on the ways in which we relate to the environment.

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Towards Sustainable Calibrations in Medical X ray Imaging

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The use of X ray imaging has increased worldwide during the last several decades. According to UNSCEAR, about 4.2 billion medical radiological examinations were performed annually from 2009 to 2018 [1]. The use of ionizing radiation in medicine undoubtedly saves countless lives and prevents the need for more invasive medical procedures. Despite these extensive benefits, there is a potential detriment to patients in line with associated radiation risks.

Relevant medical imaging exams are typically well justified but should be optimized, so that the radiation dose received by a patient is minimized and effectively targeted to ensure reliable diagnostics and acceptable image quality. The radiation doses are measured with different X ray imaging dosimeters which have to be calibrated at specific radiation qualities to ensure good operating performance as well as traceable and comparable measurement results. Therefore, the accurate and consistent quantification of patient radiation exposure with calibrated dosimetry equipment is essential to comply with Council Directive (2013/59/Euratom) [2] and to ensure safety to patients.

Historically, the typical dosimeters that have been used in the field of X ray imaging have been ionization chambers. Recent developments in dosimetry technology have brought into use the semiconductor-based X ray multimeters (XMMs) that are becoming more common and offer a wide range of applications. In addition to radiation dose measured in terms of air kerma, they provide further quantities and parameters such as X ray tube voltage, half-value layer, total filtration, and exposure time. Their response also has more pronounced energy dependence than in case of ionization chambers. However, there are no agreed performance limit characteristics or calibration guidance for XMMs used for these measurements.

Since dosimetry equipment response is radiation quality dependent, their calibration should be performed within an appropriate range of reference radiation qualities representing clinical conditions, as specified in IEC 61674 [3] and IAEA TRS-457 [4]. However, the difference in dosimeter response between calibration and clinical use is not well known and these documents do not fully consider the recent technical developments.

Currently, the number of calibrations for X ray imaging dosimeters does not correlate with their actual use. Considering the technological developments in medical X ray imaging and the number of X ray systems available, it is obvious that the number of calibrated dosimetry equipment should be much larger. In order to provide standardized and harmonized calibration services on top of support for the new technologies in this field, a sustainable calibration approach is needed.

A recently initiated EURAMET project – 22NRM01 TraMeXI: “Traceability in Medical X ray Imaging Dosimetry” – aims to update measurement and calibration procedures to ensure traceability and accurate dosimetry, thus creating a sustainable approach for X ray imaging dosimetry to provide the best support for the end-users. This will be done by: performing a review of relevant X ray radiation fields used by the calibration laboratories; investigating performance and updating requirements of several commercially available XMMs; defining harmonized calibration procedures for different parameters; validating established calibration procedures through an intercomparison; and providing inputs to the IAEA Coordinated Research Project, E24024: Evaluation of the Dosimetry Needs and Practices for the Update of the Code of Practice for Dosimetry in Diagnostic Radiology (TRS-457). As well, it will be done by proposing revisions to IEC 61674 [3], IEC 61676 [5] and IAEA TRS-457 [4].

Acknowledgements
The project 22NRM01 TraMeXI is a collaborative effort of the 22NRM01 TraMeXI consortium (www.tramexi.com) and has received funding from the European Partnership on Metrology, co-financed from the European Union’s Horizon Europe Research and Innovation Programme and by the Participating States.

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Role of SSDL-BARC towards Quality Assurance in Medical Applications

Bhabha Atomic Research Centre, India
Sougata Rakshit, Sneha Chandrasekhar, Sathian V

Bhabha Atomic Research Centre (BARC) is the Designated Institute for Ionizing Radiation Metrology in India. It designs, develops, establishes, maintains, and disseminates various national standards for physical quantities of ionizing radiation. It is a member of the IAEA/WHO Network of Secondary Standards Dosimetry Laboratories (SSDL). SSDL-BARC provides traceable calibration to the users in the field of radiation therapy including brachytherapy, radiation protection, and diagnostic radiology.

SSDL-BARC maintains cylindrical ionization chambers of nominal volume 0.6 cm^3 (FC-65G, IBA Germany) as the national standard for absorbed dose to water and air kerma. The chambers are calibrated at BIPM for absorbed dose to water and air kerma in a ^{60}Co beam. Traceable calibrations are provided to the country’s radiotherapy hospitals in terms of absorbed dose to water. Annually, about 300 ionization chambers are calibrated.

To ensure quality patient care and elevate the practices of hospitals, periodic dose quality audits are provided by SSDL-BARC. This service has been provided since 1976. Postal dose quality audit provides a cost-effective methodology to verify dosimetry practices covering a large number of institutions and machines. These audits are useful for identifying incorrect dosimetry practices at the institutional level and for correcting them. Annually, about 100 radiotherapy centres are contacted about their participation in such an audit. Centres which express a willingness are provided datasheets, TLD capsules, and stands for irradiation. Upon their return, capsules are read, data analysed, and delivered doses evaluated. Deviations of up to 5% between the estimated dose and the delivered dose are considered acceptable. If larger deviations are observed, the audit is repeated. It is currently observed that 90% of hospitals irradiate capsules within 5 % of the reported dose – an improvement from the initial years when only 60% to 70% could achieve this. Deviations are often observed to be to the result of incorrect dose calculations. In these instances, they are informed of their error and advised to rectify. Onsite visits are carried out if it is not possible to identify errors from the datasheets and discussions over the phone to review potential errors in set ups.

A 1000cc graphite cavity chamber has been established as a standard for High Dose Rate (HDR) Brachytherapy using ^{192}Ir. The reference air kerma rate measured with this standard is used by the laboratory for the calibration of the well type chambers of hospitals. In addition, the ^{60}Co HDR Brachytherapy facility is used to calibrate well type chambers in a ^{60}Co source. About 100 well chambers are calibrated annually.

Various diagnostic X ray reference beam qualities have been established using the Free Air Ionization Chamber (FAIC) maintained at BARC. Calibrations of diagnostic chambers are provided to users and inter-laboratory comparisons are conducted with calibration laboratories providing diagnostic QA services to fulfil their accreditation requirements.

Technical support is provided to medical physicists to improve the dosimetry status at their radiotherapy centres. As part of this, workshops, training programmes, and lectures on dosimetry update the knowledge base of the country's medical physicist community. Staff of other calibration laboratories are similarly trained through lectures and practical demonstrations. With more than 600 radiotherapy and 80,000 diagnostic centres in the country, the services provided by SSDL-BARC ensure sustainability by providing local solutions to dosimetry requirements.

Secondary Standard Dosimetry Laboratory

INSTN Madagascar

Ralaivelo Mbolatiana Anjarasoa Luc, Rajaobelison Joël

Madagascar is not a nuclear country as we, at present, do not have a nuclear power plant. Nevertheless, several radioactive sources, emitting ionizing radiation devices, as well as a great number of Normally Occurring Radioactive Materials (NORM) are present – hence the use of several ionizing radiation detectors in the country.

Madagascar's SSDL was created in 1993 in the Dosimetry and Radiation Protection department of the Institut National des Sciences et Techniques Nucléaires (INSTN-Madagascar), an institute devoted to the promotion of nuclear technologies. Since then, this Laboratory annually calibrates around 20 detectors that used in different activity areas such as medical, industrial, mining, and research.

Apart from the detectors used at national level, the SSDL in Madagascar – a unique SSDL in the Indian Ocean –calibrates some of theequipment used by other countries in the region. Our SSDL's sustianability is based on three factors: training, intercomparison exercises, and the periodic updating of the Laboratory.

- Periodic training is provided to SSDL Madagascar staff in nuclear metrology techniques, particularly in dosimetry calibration. These training programmes are organized mainly by the IAEA and are followed by an exchange of information at the national level.

- Although SSDL Madagascar has not yet had the opportunity to be ISO 17025 accredited, we have actively participated in some international intercomparison programmes, particularly within the IAEA/WHO Network of SSDLs.

- A national safety project with the IAEA – MAG9007, which was initiated in 2022 – aims to upgrade SSDL-Madagascar so that it can address the decay of some of its radioactive sources, among other things.

The sustainability of our SSDL guarantees effective detection at the national level by ensuring that equipment in use can provide correct and reliable exposure values to ionizing radiation. Within the field of medicine such as radiotherapy, the support SSDL Madagascar provides is essential – it helps ensure that the doses delivered to patients are correct and that planned treatments can be effective. The sustainability of SSDL Madagascar closely contributes to the protection of all workers and patients alike who are exposed to ionizing radiation, offering a better quality of life for these populations. As such, this key result is the guarantor of the peaceful application of nuclear techniques in Madagascar and beyond.

Sustainability of Ionizing Radiation Measurements

SSDL IPEN, Peru

Enrique Rojas, Emerson Mendoza, Natali Palomino, Edith Lopez, Romel Castillo

The Secondary Standard Dosimetry Laboratory of the Peruvian Nuclear Energy Institute – SSDL IPEN PERU – is a member of the IAEA/WHO Network of SSDLs. The Laboratory has been accredited since 2022 by the national accreditation body (Instituto Nacional de Calidad – INACAL) for compliance with ISO/IEC 17025:2017 [1] standard requirements for:

- Absorbed dose to water, $N_{D,w}$;
- Ambient Dose Equivalent, $H^*(10)$;
- Air Kerma, K_{air}.

SSDL IPEN PERU performs measurements to ensure the validity of reference values and their results.

SSDL IPEN PERU assists with measurements required to ensure the sustainability of the country’s health and medical sectors as well as the nation’s various industries which use ionizing radiation.

The dosimetric calibration of ionization chambers allows medical centers to determine, the radiation dose delivered to patients receiving treatment for cancer with a high degree of accuracy. Through this facility, the ionization chambers of the local medical centers can be calibrated in our own country, minimizing costs and shipping times.

In terms of audits of absorbed dose to water measurements at radiation therapy centres, medical physicists nationwide attend SSDL IPEN PERU once a year with their dosimeters to participate in an absorbed dose measurement audit. This activity helps ensure the validity of results by evaluating the technical competence of participants and the condition of their radiation dose measurement instruments.

The calibration of multimeters used in diagnostic radiology enables the companies that provide X ray equipment maintenance services to guarantee the functioning of X ray emitting equipment within established parameters, such as air kerma, kV, and exposure time. Likewise, it enables the companies that sell X ray equipment to ensure that operating parameters are within established reference values. The first audit of air kerma measurement for medical physicists and personnel using these multimeters in the country is planned for 2024.

In terms of nuclear medicine, radioactivity calibration enables healthcare centers to determine with optimal accuracy, the radiation dose (^{131}I and ^{99m}Tc) delivered to patients undergoing various procedures.

The dosimetric calibration of detectors used for radiation protection purposes nationwide ensures proper protection for operators of gamma, X ray, and neutron-emitting sources. These radiation monitors are used by occupationally exposed personnel in clinics, hospitals, industrial radiography companies, and mining. They are also used to evaluate the absence or presence of ionizing radiation and to ensure radiation protection for the personnel working in those areas.

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The Intermediate Checks on the Working Standards Used for Routine Calibrations of Ionizing Radiation Dosimeters in the Context of the Sustainability of Measurements in Ionizing Radiation

Iwona Grabska, Wioletta Ślusarczyk-Kacprzyk, Marcin Szymański

Secondary Standards Dosimetry Laboratory, The Maria Sklodowska-Curie National Research Institute of Oncology, Poland

The Polish Secondary Standard Dosimetry Laboratory is accredited by the Polish Centre of Accreditation for conformity with ISO/IEC 17025 [1]. One of its requirements is the validity of measurement results.

According to the Scope of our Accreditation No. AP 155, the SSDL calibrates ionizing radiation dosimeters in a ^{60}Co gamma ray in terms of absorbed dose to water. Among other things, the SSDL monitors the validity of the calibration results through intermediate checks of the working standards used for the calibration of the customer dosimeters (electrometer with ionization chamber) from all radiotherapy centres in Poland. These checks are performed on the same day the working standard is used for the calibration of the customer dosimeter. Per IAEA Technical Reports Series No. 469 [2], our working standard is used routinely for the calibrations of customer dosimeters and is calibrated every two years against the reference standard which is not used for the routine calibrations of customer dosimeters. We have adopted Δ parameter as a measure of the intermediate check result. The Δ parameter value, as a percentage, is calculated according to the formula (1):

$$\Delta = \frac{|D_{\mathrm{mean}} - D_{\mathrm{cal,\,x}}|}{D_{\mathrm{mean}}} 100 \qquad (1)$$

where:
D_{mean} is the mean value of the absorbed dose to water in cGy calculated by the formula (2) [3]:

$$D_{\mathrm{mean}} = \left(\frac{\sum_{i=1}^{n} M_i}{n}\right) N_{D,\mathrm{w}} k_{Tp} \qquad (2)$$

where:
M_i is the charge measured, in nC, with the ionization chamber of the working standard in the i successive measurement; n = 10 and is the number of successive measurements of the charge M_i in a given measurement series; $N_{D,\mathrm{w}}$ is the calibration coefficient of the working standard, in cGy/nC, given in the calibration certificate; and $k_{T,P}$ is a factor to correct the response of an ionization chamber for the effect of the difference that may exist between the standard reference temperature and pressure specified by the standards laboratory and the temperature and pressure of the chamber in the user facility under different environmental conditions.

$D_{\mathrm{cal,x}}$ is the value of the absorbed dose to water, in cGy, calculated on a day of the intermediate check on the working standard taking into account the decay of the ^{60}Co with a half-life of 5.2711 years (1925.2 days) [4]. It is calculated according to the formula (3):

$$D_{\mathrm{cal,\,x}} = D_{\mathrm{cal,\,0}} e^{-\frac{\mathrm{x}\ln 2}{1925.2}} \qquad (3)$$

where:
$D_{\mathrm{cal,\,0}}$ is the value of the absorbed dose to water, in cGy, calculated according to Eq. (2) with the use of the reference standard for calibration of the working standard on day "0" and x is number of days since day "0" to the day of the intermediate check.

We adopted the value of 0.7% as an acceptance criterion of the Δ parameter [5]. From our long-term experience, Δ parameter reached values of less than 0.3%. All the values obtained for this parameter were within the acceptance criterion [5, 6].

The calibration of dosimeters within the acceptance criterion of the intermediate check result guarantees certainty for the end user of a correctly performed calibration. This results in sustainability for the end user, namely throughthe correctness of results of dosimetry measurements performed with calibrated dosimeters on radiation therapy devices, which in turn ensures the safety of treated patients.

Thus, intermediate checks on working standards contribute to ensuring the sustainability of measurements in ionizing radiation.

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The KFSHRC's SSDL: A Sustainable Calibration Service for End-users

King Faisal Specialist Hospital and Research Centre (KFSHRC)

Mehenna Arib, Alhanouf Aldosari, Hesham Alhamdan, Heba Alhumidan, Haya Alarifi

Established in 1980 and granted membership in the joint IAEA/WHO Network of SSDLs in 1988, the SSDL, affiliated with the King Faisal Specialist Hospital and Research Center (KFSHRC) in Saudi Arabia, has the distinction of being the region's first calibration laboratory. Its primary mission was establishing, maintaining, and disseminating national reference standards for air kerma for photon beams. Initially equipped with just one multisource gamma irradiator for radiation protection calibrations, the SSDL has significantly expanded its calibration capabilities – notably by installing new irradiation facilities in 2014 and 2020. The SSDL has also established procedures and practices to ensure the sustainability of measurements by implementing sustainable practices within the SSDL itself that, in turn, benefit the sustainability of its end users.

Currently, the SSDL offers regular calibration services for radiation protection, covering measurements such as air kerma, $H^*(10)$, $H_p(10)$, and $H_p(0.07)$ utilizing Alpha, beta, gamma, X ray, and neutron beams. These services include the calibration of ionization chambers and detectors used in diagnostic radiology (RQR, RQA, RQT, Mammo) and radiation therapy (Absorbed dose to water in Co-60, reference air kerma rate for HDR using Ir-192, air kerma in X ray CCRI beam qualities). Under the Saudi regulatory body's mandate, end users must recalibrate their radiation-measuring instruments periodically. For radiation protection, the SSDL's clients typically recalibrate their survey meters annually. In 2023 for example, over 2000 instruments were calibrated.

The SSDL implements rigorous quality control procedures. Secondary standards are periodically recalibrated at the IAEA and at PSDLs. A quality assurance program is maintained to ensure the best stability of dose quantities and dosimetry parameters (check source measurements, systematic measurement of absorbed dose to water values, periodic verification of HVLs, etc.). Facilitating accurate calibrations ensuring that equipment used by end users operates efficiently, minimizing errors, and reducing unnecessary radiation exposure are all achieved by followingthe procedures outlined in SSDL ISO/IEC 17025 compliant Quality Management System [3] and IAEA codes of practice [4, 5, 6].

SSDL staff regularly participate in specialized training courses, seminars, and webinars organized by the IAEA within the framework of national and regional projects as well as those organizedd by other entities (such as BIPM and GULFMET). Their expertise ensures accurate measurements and reliable services, contributing to the sustainability of the Laboratory's operations. the SSDL also engages in educational activities, workshops, and seminars that share knowledge and best practices with end users – empowering them to use dosimeters effectively and understand measurement uncertainties. As an example, a radiation safety officer course is organized quarterly that includes training programmes and educational resources for end users on the proper usage and calibration of radiation measurement equipment.

The SSDL provides quality assurance support to end users, ensuring their radiation measurements' continued accuracy and reliability. This includes, but is not limited to, explaining how the calibration factor/coefficient should be used and providing troubleshooting assistance to identify and address any issues promptly. The performance of their dosimeters, radiation detectors, and other equipment are systematically checked before calibration.

By implementing these measures, KFSHRC SSDL has played a pivotal role in ensuring the sustainability of radiation measurement practices for its end users at the national and regional level.

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Sustainability Practices at the SSDL in Singapore

National Environment Agency (NEA), Singapore

Mr. Ang Kok Kiat, Ms. Soh Suat Hoon, Mr. Loo Howe Kiat and Mr. Deen Haqim.

As we commemorate World Metrology Day, it is imperative to reflect on our role in ionizing radiation measurement and how sustainability can be advanced. While discussions around sustainability often concern energy and water consumption, ionizing radiation measurement contributes significantly to broader sustainability goals outlined by the UN's 2030Agenda for Sustainable Development. In this article, SSDL Singapore would like to share some of our practices which contribute to the goal of sustainability in our own way as a metrology laboratory.

As addressing energy consumption is paramount in ionizing radiation metrology laboratories, the SSDL prioritises energy efficiency by optimizing operational temperatures and enhancing productivity. By maintaining operating temperatures at 21°C to 22°C, the SSDL strikes a balance between optimal environmental conditions and energy conservation, without compromising calibration quality.

To enhance productivity, the SSDL has invested in advanced equipment – such as an automatic Gamma Irradiator System – which has increased throughput efficiency by as much as 25%. This allows for the SSDL to complete more calibrations without consuming more electricity. Additionally, consolidating multiple instruments in a calibration setup allows for a doubling throughput and the optimization of energy utilization.

Operational sustainability entails prudent resource management and strategic decision making. In ensuring a continuous operation, the SSDL prioritises human resources by maintaining a skilled workforce pool capable of providing essential services while also ensuring a safe workplace environment. Since human resources are a valuable asset, the SSDL places an emphasis on workplace safety and health (WSH). Asode from trainings, safety work procedures and risk assessments are regularly conducted and reviewed. Safety signs are also displayed prominently in the premises. By providing officers with a safe working environment, staff are protected against workplace accidents which reduces time losses and down-time – in turn, leading to operational sustainability.

Rigorous deliberation processes also guide SSDL service expansion initiatives by ensuring both alignment with the stakeholder needs and cost-effectiveness.

In maintaining two sets of standards, the SSDL safeguards operational continuity while optimizing resource allocation. A close working relationship with the Personal Dose Monitoring Team exemplifies the commitment to sustainability, as the irradiation of dosimetry cards in-house not only reduces turnaround time but also minimises transportation-related carbon emissions and costs.

Through embracing energy-efficient practices, optimizing operational efficiencies, and fostering strategic collaborations, ionizing radiation metrology laboratories can contribute significantly to global initiatives that build a more resilient and sustainable future for all.

A New Member of the IAEA/WHO SSDL Network

Uzbek National Institute of Metrology, Uzbekistan
Azamat Taubaldiev, Sheroz Ismatullaev, Elyor Khikmatov

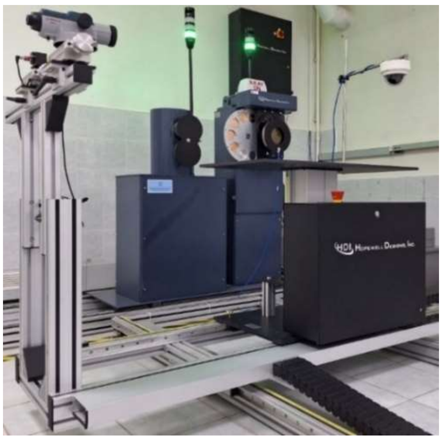
Radiation protection is an essential element for the safe use of radiation technologies in medical, nuclear, industrial, and academic settings [1]. Wherever accurate radiation dose measurements are needed wherever ionizing radiation is used, whether to ensure safety of the people and the environment, or to ensure proper diagnostic imaging and/or treatment outcome of a patient [2]. Any radiation protection needed, for them to be meaningful, they should be traceable to the International System of Units [1] and their uncertainties should be minimized.

To ensure traceability in dosimetry measurements and provide calibration services, a new Secondary Standards Dosimetry Laboratory (SSDL) was established in Uzbekistan through the IAEA's Technical Cooperation Programme. The SSDL is part of the Uzbek National Institute of Metrology (UzNIM).

The SSDL is equipped with a gamma irradiator model G10-1-12-E with a ^{137}Cs source and an X ray irradiator model X80-225-kV with radiation qualities of radiation protection and diagnostic radiology. National standards mantained are calibrated in terms of air kerma by the IAEA's Dosimetry Laboratory.

Establishing the SSDL not only helped introduce new services in line with relevant international guides and standards but also increased the quality of existing services. This has provided better access to local calibration services to all stakeholders, increasing the overall quality of radiation measurements and the sustainability of quality infrastructure.

In addition, the SSDL has become critical for the quality control of manufacturing processes in various industries. Accurate measurements have ensured product reliability, compliance with safety standards and the efficient use of resources. For health systems in particular, this has ensured the reliability of dosimetry systems for reference dosimetry and quality control in X ray diagnostic radiology – all of which helps to improve health outcomes.

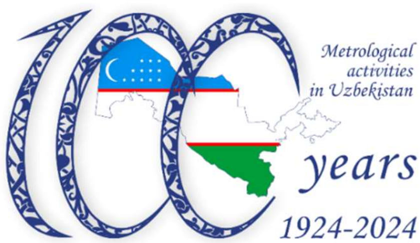


The Laboratory of Uzbek National Institute of Metrology (Photograph: Azamat Taubaldiev)

The SSDL is accredited for ISO/IEC 17025 compliance through the national accreditation body. Its quality management system is notably peer reviewed by COOMET, a regional metrology organization.

To validate the new SSDL's measurement capabilities for calibrations, a bilateral comparison with the IAEA's Dosimetry Laboratory in terms of air kerma for radiation protection level was performed. The results were in agreement within each laboratory measurment uncertainty.

In 2023, the SSDL became a member of the IAEA/WHO SSDL Network of SSDLs – a momentous event marking the centenary of metrological activities of UzNIM and the beginnings of the sustainable development of ionization radiation measurements in Uzbekistan.



100 years of metrological activities in Uzbekistan

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Measurement Sustainability of the Venezuela's Secondary Standard Dosimetry Laboratory

Instituto Venezolano de Investigaciones Científicas (IVIC), Venezuela
J. A. Durán; M. Colmenares; C. Soteldo; A. Briceño.

The Secondary Standard Dosimetry Laboratory (SSDL), attached to the Nuclear Technology Unit of the Venezuelan Institute for Scientific Research (IVIC), is part of the IAEA/WHO Network of SSDLs. It aims to guarantee metrological and dosimetric traceability in order to establish and facilitate links between end users, members of the SSDL Network, and the International System of Units (SI) for radiation measurements; provide dosimetry services to improve precision in dose measurements; promote international recommendations on applied methods for calibrating and performing dosimetry to achieve consistency in measurements across countries; further promote the exchange of experiences between members and the metrology community; and provide mutual support when necessary [1].

Venezuela's SSDL complies with the SSDL Network Charter [1] and follows the international guidelines for external beam radiotherapy [2, 3], brachytherapy [4], nuclear medicine [5], diagnostic radiology [6], and radiation protection [7]. The standardization of measurement processes is not only carried out in a sustainable manner but also promotes the exchange of technical knowledge and scientific information in metrology with end users nationwide, so that the users can correctly develop their own procedures.

The SSDL of Venezuela is in the process of renewing its irradiators, through IAEA Technical Cooperation projects (VEN6019, VEN9013, and VEN9014). A dual X ray system for radiological protection and diagnostic radiology were procured along with a Gamma irradiator. The Gamma Beam Irradiator System will be used to calibrate equipment used for radiation protection purposes.

Once the aforementioned irradiation systems are in operation, traceability to SI will be guaranteed through the periodic calibration of the Laboratory's standards and its participation in IAEA-organized comparisons [9, 10]. A quality management system will be established following the ISO/IEC 17025 requirements. The Laboratory's capabilities will in turn contribute to the sustainability of user facilities.

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Does It Matter?

Godfrey Azangwe and Karen Christaki

I have always been interested in the physics of radiotherapy treatment. As I sit in a meeting at the IAEA in Vienna, listening to the conversation about 0.1 % or 0.2 % uncertainties from the dosimetry standards laboratory people, I feel very honoured to be here, but my mind starts to wander. I have an image of a patient on a couch being treated and hopefully breathing, even better if their tumour has shrunk during treatment. They had their tumour outlined on the treatment plan by eye by an oncologist on an image that isn't the best. On my end, I am not sure if I have done all my QA on the machines this month and if the beam output for reference conditions is confirmed to be within acceptable limits for the day. I can't help but wonder: *when did I last see a patient treated with a 10 cm × 10 cm standard field?* At this point, I haven't done an uncertainty analysis in my head, but I am sure that these and many more clinical uncertainties are tens of factors greater than those in the dosimetry standards laboratories. So, I say (not out loud!): *have these people ever been in a clinic? Does it really matter what happens in the dosimetry standards laboratories?* It must be after lunch as I can't think of the 0.1 % or 0.2 % uncertainties.

Well now that I have had a coffee, I feel a bit more awake. My mind goes back to the clinic, and I think: *"What would happen if we didn't have dosimetry standards and codes of practice for radiotherapy?"* For dosimetry codes of practice, it is a bit more obvious –if they did not exist, we would not know how to use our calibrated equipment in the clinic correctly and consistently. I always do a cross calibration and send my chambers for calibrations when my diary reminds me. It then suddenly dawns on me that I can trace the absorbed dose measured in the clinic for a 10 cm ×10 cm field all the way to the BIPM. Apart from being amazed at this route to Sèvres I still wonder, *does it matter?* Then I realize how different the dose would be in one part of the world from another. *Without this system, how could we use clinical protocols worldwide? What would be the point of international clinical trials? How would we know our limits for organs at risk?* Hmm. It begins to make sense to have consistency in the measurement of absorbed dose worldwide.

I still can't get my head around the 0.1 % or 0.2 %, but then I look in TRS 398 Rev. 1 and see that adding up all these components gives a 1 % uncertainty in my 10 cm × 10 cm field in the clinic if I have done the measurements correctly. Wow, if I want to keep the uncertainty in the dose to the patient at 5 % or less I don't have lots to play with considering all the uncertainties in the clinic. I have definitely learnt a lesson today: the people in the dosimetry standards laboratories do a great job and I should start looking at ways to reduce the uncertainties in the clinic. My mind wanders again: *how can the dosimetry standards laboratory people manage to keep their uncertainties so low?* Maybe I should listen to what they are discussing.

Letter to a Clinical Medical Physicist

From the Desk of a Radiation Metrologist in response to the letter from a clinical medical physicist in SSDL Newsletter Issue No. 78, December 2023 | IAEA

Maintaining links with the users of calibration services is of essential importance for radiation metrologists working in SSDLs. Such links are crucial both for strengthening confidence in radiation dosimetry and for ensuring quality and safety in medical imaging and therapy procedures. I am very keen to respond to your enquiries, by addressing challenges while identifying mechanisms and potential synergies.

Calibration services

I cannot emphasize enough how important calibration is for the accuracy of dosimetry in medicine and, consequently, for the quality of patient care. Medical physicists working in hospitals are responsible for all aspects of dosimetry, including the regular calibration of dosimetry equipment. In fulfilling their duties, they need to be able to access the calibration services offered by SSDLs. Ideally such services should be available at the national or regional level. However, in many instances, diagnostic radiology calibrations are not available in a country – be it partially or entirely – for a host of reasons (e.g. of a technical, economic, financial or legal nature).

A possible solution to this are regional designated centres. These are usually calibration laboratories, members of the IAEA/WHO Network of SSDLs, which act as regional designated centres that support the Network by coordinating the activities in a particular region. Alternatively, calibrations performed in manufacturers' dosimetry laboratories may be accepted, provided that the manufacturer operates a calibration facility that is accredited in line with ISO/IEC 17025 for that particular service and is traceable to an international measurement system. The calibration certificate should state the measurment uncertainty associated with the calibration coefficient provided.

Furthermore, the cross-calibration of some dosimeters, following the procedures outlined in international guidance documents, could be an option. In this case, the facility's reference dosimeter that has been calibrated is used by medical physicists to cross calibrate the other dosimeters. This is particularly important for field air kerma–area product meters. Cross-calibration can also be utilized as a constancy test as part of periodic quality control tests.

Dosimetry Audits:

Independent dosimetry audits are well established in radiotherapy, given the risk associated with this treatment modality. With the increased use of relatively high dose imaging modalities, e.g. CT or fluoroscopy guided interventional procedures, a dosimetry audit may equally contribute to the safety and quality of patient care in diagnostic and interventional radiology. This would entail independent measurements in which a medical physicist or radiation metrologist verifies the accuracy of the dose indices or X ray tube output in hospitals using different dosimetry equipment. The involvement of radiation metrologists working at SSDLs in this case would notably bring them closer to the medical physics community, improve communication and enable a better understanding of the nuances of the different approaches undertaken by these two professional groups. However, radiation metrologists performing audits need to be trained in the field they will audit. Working together on suitable audit methodology would be an interesting task and significant endeavour for both groups.

Consultations

Dosimetry is a core competency of medical physicists and radiation metrologists alike. The two professions complement each other and share the common goal of ensuring quality patient care. In a dynamic and ever developing X ray imaging environment, it is even more important that both medical physicists and radiation metrologists bring their respective clinical and laboratory perspectives to dosimetry. In doing so, they are able to identify and define relevant irradiation conditions, instrumentation, and methods to provide the desired level of accuracy, robustness, and practicality that are so important for measurements within clinical contexts. This is only possible if these professionals work together. In that spirit, let's work together for the benefit of patients everywhere!

IAEA Publications in the Field of Dosimetry and Medical Physics (2023–2024)

Education of Radiation Metrologists for Secondary Standards Dosimetry Laboratories (**Training Course Series No. 76**), February 2023
Education of Radiation Metrologists for Secondary Standards Dosimetry Laboratories | IAEA

Handbook of Basic Quality Control Tests for Diagnostic Radiology, (**IAEA Human Health Series No. 47**), February 2023
Handbook of Basic Quality Control Tests for Diagnostic Radiology | IAEA
DOI: https://doi.org/10.61092/iaea.rhjo-8d0u

Establishing a Secondary Standards Dosimetry Laboratory (**IAEA Human Health Series No. 44**), March 2023
Establishing a Secondary Standards Dosimetry Laboratory | IAEA

SSDL Newsletter Issue No. 77, May 2023
SSDL Newsletter Issue No. 77, May 2023 | IAEA

Guidelines on Professional Ethics for Medical Physicists (**Training Course Series No. 78**), June 2023
Guidelines on Professional Ethics for Medical Physicists | IAEA

National Networks for Radiotherapy Dosimetry Audits IAEA (**Human Health Reports No. 18**), June 2023
National Networks for Radiotherapy Dosimetry Audits | IAEA

Worldwide Implementation of Digital Mammography Imaging (**Human Health Series No. 46**), October 2023
Worldwide Implementation of Digital Mammography Imaging | IAEA

Artificial Intelligence in Medical Physics: Roles, Responsibilities, Education and Training of Clinically Qualified Medical Physicists (**Training Course Series No. 83**), November 2023
Artificial Intelligence in Medical Physics | IAEA

SSDL Newsletter Issue No. 78, December 2023
SSDL Newsletter Issue No. 78, December 2023 | IAEA

Dosimetry in Brachytherapy – An International Code of Practice for Secondary Standards Dosimetry Laboratories and Hospitals (**Technical Reports Series No. 492**), December 2023
Dosimetry in Brachytherapy – An International Code of Practice for Secondary Standards Dosimetry Laboratories and Hospitals | IAEA

Absorbed Dose Determination in External Beam Radiotherapy (**Technical Reports Series No. 398 Rev. 1**), February 2024
Absorbed Dose Determination in External Beam Radiotherapy | IAEA
DOI: https://doi.org/10.61092/iaea.ve7q-y94k

Dosimetry for Radiopharmaceutical Therapy (**Non-serial Publications**), April 2024
Dosimetry for Radiopharmaceutical Therapy | IAEA
DOI: https://doi.org/10.61092/iaea.xlzb-6h67

Other educational materials relevant for the SSDL's may be found on DOLNET: https://ssdl.iaea.org/Home/EducationalMaterial

Courses, Meetings and Consultancies in 2024

TC Courses and Workshops related to DMRP activities

- RAF6060: Regional Training Course on Clinical Training in Diagnostic Radiology for Medical Physicists in English Language, Accra, Ghana, 6 – 10 May 2024
- RAF6060: First Coordination Meeting, Abuja, Nigeria, 13 – 17 May 2024
- RLA 9093: Regional Training Course on Calibration with X ray Beams (in Spanish), Rio de Janero, Brazil 26 – 30 August 2024
- RAS6112: Regional Training Course on Diagnostic Radiology Calibration, Seibersdorf, Austria, 21 – 25 October 2024
- RLA 9093: Regional Training Course on Implementation of Dosimetry Codes of Practice for Absorbed Dose Determination in External Beams (Technical Reports Series No. 398 (Rev.1)) and Brachytherapy (Technical Reports Series No. 492) (in Spanish), venue TBC, 7 – 11 October 2024

Training courses and ESTRO Courses

- Joint ICTP–IAEA Workshop on Quantitative Imaging and Analysis Methods in Modern Nuclear Medicine, Trieste, Italy, 29 April – 3 May 2024
- IAEA – ESTRO Course on Evidence Based Radiation Oncology, 20 – 24 May 2024 (online)
- Joint IAEA and Argonne National Laboratory Regional Training Course on Volumetric Modulated Arc Radiation Therapy (VMAT) and Image-guided Radiation Therapy (IGRT), Houston, TX, United States of America, 7 – 11 August 2024
- IAEA – ESTRO Course on Basic Clinical Radiobiology, Tallinn, Estonia, 7 – 11 September 2024
- Joint IAEA and Argonne National Laboratory Masterclass on Computed Tomography Clinical Physics and Optimization, Durham, NC, United States of America, 14 – 19 October 2024
- IAEA – ESTRO Course on Advanced Treatment Planning, Vilnius, Lithuania, 20 – 24 October 2024
- IAEA – ESTRO Course on IMRT and VMAT: Best practices and new trends, Bucharest, Romania, 10 – 13 November 2024
- Joint IAEA and Argonne National Laboratory Training Activity on Implementation of Dosimetry Codes of Practice for Absorbed Dose Determination in External Beams (Technical Reports Series No. 398 (Rev.1)) and Brachytherapy (Technical Reports Series No. 492), Houston, TX, United States of America, 2 – 7 December 2024
- IAEA – ESTRO Course on Best Practice in Radiation Oncology – A Workshop to Train the RTT (Radiation Therapist) Trainers, Vienna, Austria, 16 – 20 December 2024

DMRP Meetings and Consultancies

- Consultancy Meeting on Developing Guidelines on the Clinical Implementation of Medical Imaging-based Artificial Intelligence Tools – Guidelines for Medical Physicists, Vienna, Austria, 29 April – 3 May 2024
- Consultancy Meeting on "Medical Imaging Repositories", Vienna, Austria, 27 – 31 May 2024
- Consultancy Meeting on Update of Human Health Series 19 on "Quality Assurance Programme for Computed Tomography: Diagnostic and Therapy Applications", Vienna, Austria, 10 – 14 June 2024
- Consultancy Meeting on the Preparation of a Handbook on Foundations of Radiation Physics, Vienna, Austria, 10 – 14 June 2024
- Consultancy Meeting to produce the final draft of the supplement to TRS 398 (rev 1) on proton and light ion dosimetry, Vienna, Austria, 1 – 3 July 2024
- Consultancy Meeting on Review and Update of the SSDL Network Charter, Vienna, Austria, 9 – 13 September 2024
- Consultanncy Meeting on modernization of DMRP databases, Vienna, Austria, 7 – 11 October 2024
- First Research Coordination Meeting on Doctoral CRP in Advanced Dosimetry and Radiation Metrology, Vienna, Austria, 14 – 18 October 2024
- Third Research Coordination Meeting on Advanced Tools for Quality and Dosimetry of Digital Imaging in Radiology, Vienna, Austria, 2 – 6 December 2024

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International Electrotechnical Commission (IEC)

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