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Contents

From the Editor

This issue of SSDL Newsletter (No 69) covers many IAEA activities performed in 2018. The IAEA has implemented the changes related to primary standards according to the ICRU 90 recommendations. This will have a small impact on provided calibration coefficients and uncertainties. A notification was sent to SSDL Network members and is published in this Newsletter (page 4). Last year new radiation qualities for mammography calibration were established and they were used in a research study (page 13).

In addition to calibrations, the IAEA Dosimetry Laboratory provides comparisons and a summary of comparisons performed in 2016-2018 is given (page 6). Bosnia Herzegovina has also participated in our comparison and this was one of the steps toward their SSDL Network membership (page 10).

In 2018, the IAEA organized many events. One of them was the SSDL training organized in December with more than 100 participants and experts (page 19).

Participants of the SSDL meeting organized at the IAEA in December 2018 (see page 21)

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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 dose 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 assurance 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). The IAEA Calibration and Measurement Capabilities (CMCs) have been reviewed and published in Appendix C of Comité International des Poids et Mesures (CIPM), Mutual Recognition Arrangement (MRA).

The IAEA CMCs can be found at the following web site: http://kcdb.bipm.org/AppendixC/search.asp?met=RI

The range of services is listed below.

Services	*Radiation quality*
Calibration of ionization chambers (radiation therapy, radiation protection, and diagnostic radiology including mammography)*	X rays and γ rays from ^{137}Cs and ^{60}Co beams
Comparison of ionization chamber calibrations coefficients (radiation therapy, radiation protection, and diagnostic radiology including mammography) for SSDLs*	X rays and γ rays from ^{137}Cs and ^{60}Co beams
Dosimetry audits (RPLD) for external radiation therapy beams for SSDLs and hospitals**	γ rays from ^{60}Co and high energy X ray beams
Dosimetry audits (OSLD) for radiation protection for SSDLs	γ rays from ^{137}Cs
Reference irradiations to dosimeters for radiation protection	X rays and γ rays from ^{137}Cs and ^{60}Co beams

* Technical procedures and protocols for calibrations and comparisons are available on our website https://ssdl.iaea.org/

**Thermoluminescence dosimeters (TLDs) were replaced by RPLDs in 2017.

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.

Notification of changes to the IAEA dosimetry standards according to ICRU Report 90

Introduction

This letter is to inform all the Secondary Standards Dosimetry Laboratories (SSDLs) of changes to IAEA dosimetry standards following the decision of the Consultative Committee for Ionizing Radiation (CCRI) [1] on the adoption of the ICRU recommendations [2]. The changes came into effect on 1st of January 2019.

The International Commission on Radiation Units and Measurements (ICRU) published the Report 90 "*Key Data for Ionizing-Radiation Dosimetry: Measurement Standards and Applications*" in October 2016 [2]. This report recommends revised values and uncertainties for some physical data required for realization of air kerma, reference air kerma and absorbed dose to water quantities of photon radiation by primary measurement standards. Details of these changes were published in 2018 [3].

Implementation of the changes at the IAEA

The Bureau International des Poids et Mesures (BIPM) implemented the change on 1st of January 2019 [4] and Physikalisch-Technische Bundesanstalt (PTB) on 1st of January 2018 [5]. The IAEA's dosimetry standards are traceable to BIPM and PTB and the changes to the IAEA standards have been calculated using the information provided and implemented for all calibrations performed after 1st of January 2019.

The changes to the calibration coefficients N of the IAEA standards are presented as a multiplicative factor k(2019) such that

N_Q(post 1 January 2019) = k(2019) N_Q(pre 1 January 2019),

where Q represents the calibration quantity for a specified radiation quality. The k(2019) values and the revised uncertainties for the IAEA calibration service claims are listed in Tables 1 - 3.

The changes will be fully implemented when the IAEA standards are recalibrated. In the meantime, the correction factors and revised uncertainties for calibration services given in Tables 1 – 3 will be used. If the uncertainty of the primary standard was decreased, the change is not implemented during the transfer period. The potential decrease of uncertainty will be considered after recalibration of the IAEA standard. For mammography calibrations a decision was made to use one k(2019) factor for all radiation qualities and the small uncertainty <0.05%, related to the variation within the radiation qualities, is included in the revised uncertainties.

Implementation of the changes in SSDLs

As a consequence, calibration coefficients issued from 1 January 2019 will differ from previous calibrations. The data given in Tables 1 - 3 enables the SSDLs, that are traceable to the IAEA, to correct their calibration coefficients N_Q and uncertainties, shown in certificates issued before 1 January 2019, for the changes in the primary standards. However, all IAEA/WHO SSDL network members are encouraged to implement the changes announced by the PSDLs or SSDLs to which they are traceable, and to inform the customers about the changes.

Distribution

The present note is distributed to all members of the IAEA/WHO SSDL Network and posted on the SSDL Network website. In addition, the attachments to the calibration certificates issued by the IAEA Dosimetry Laboratory after January 2019 are updated accordingly.

Table 1. *The k(2019) correction factors and revised uncertainties for the IAEA standards.*

Dosimetry scope	Quantity	Radiation quality	*k(2019)*	Uncertainty 2019 % ($k = 2$)
Radiation Therapy	Absorbed dose to water	^{60}Co	**0.9990**	1.0
	Air kerma	^{60}Co	**0.9918**	0.8
		10–250 kV	**Table 2**	1.1
Radiation Protection	Air kerma	^{137}Cs	**0.9920**	0.8
		^{60}Co	**0.9918**	0.8
		10–250 kV	**Table 3**	1.4
Diagnostic Radiology	Air kerma	IEC-61267 RQR, RQT, RQA	**0.9980**	1.4
	Air kerma	Mammography: RQA-M, Mo-Rh, W-Rh, W-Ag, W-Al	**0.9972**	1.6
	Air kerma	Mammography: RQR-M and W-Mo	**0.9972**	1.3

Table 2. *The k(2019) correction factors for the IAEA standards for the radiation therapy reference X-ray radiation qualities.*

Radiation quality	Tube voltage kV	1st HVL mmAl	1st HVL mmCu	*k*(2019)
T7	10	0.04		**0.9953**
T8	30	0.16		**0.9968**
T9	25	0.23		**0.9969**
T10	50	1.00		**0.9977**
T11	50	2.37		**0.9980**
T1	100	4.03		**0.9980**
T2	135		0.52	**0.9980**
T3	180		1.00	**0.9981**
T4	250		2.51	**0.9986**

Table 3. *The k(2019) correction factors for the IAEA standards for the radiation protection reference X-ray radiation qualities.*

Radiation quality	Tube voltage kV	1st HVL mmAl	1st HVL mmCu	*k*(2019)
N40	40	2.72		**0.9980**
N60	60		0.24	**0.9980**
N80	80		0.59	**0.9980**
N100	100		1.13	**0.9980**
N120	120		1.75	**0.9980**
N150	150		2.42	**0.9983**
N200	200		3.92	**0.9988**
N250	250		5.18	**0.9992**
N300	300		6.2	**0.9995**

References:

[1] Consultative Committee for Ionizing Radiation (CCRI) 2017 Report of the 26th meeting (29–30 June 2017)

[2] International Commission on Radiation Units and Measurements, Key data for ionizing-radiation dosimetry: Measurement standards and applications, Report No. 90: *J. ICRU* **14** (2016) 1-110, ICRU, Bethesda, MD

[3] Burns D., Kessler C., Re-evaluation of the BIPM international dosimetry standards on adaption of the recommendation of ICRU 90, Metrologia **55** (2018) R21-R26.

[4] Notification of changes to the BIPM dosimetry standards with effect from 1 January 2019 (23 November 2018).

[5] Buermann L., Changes to the magnitude of the unit of Gray according to ICRU Report 90, Physikalisch-Technische Bundesanstalt (PTB), (2018).

Summary of IAEA bilateral comparisons results 2017-2018

Toroi, P., Cardoso, J. and Czap, L.

Peer-reviewed by F. Gutt

Introduction

The IAEA's Dosimetry laboratory works as a central laboratory in the IAEA/WHO SSDL Network and provides calibrations, reference irradiations, comparison programmes and dosimetry audit services for the Member States, SSDLs and radiation therapy centres. To ensure that the calibration services provided by an SSDL Network member to end-users follow internationally accepted standards, the SSDL should participate in comparisons to demonstrate equivalence of measurements and calibrations, with the other laboratories worldwide [1].

The IAEA provides comparison programmes for radiation therapy, radiation protection and diagnostic radiology. The comparison services are open for all SSDL Network members. By including in such comparisons laboratories that have taken part in other international comparisons, the IAEA provides a strong link to the Mutual Recognition Arrangements of the International Committee for Weights and Measures (CIPM MRA) and to the International System of Units (SI) also for its Member States that are not members of the Metre Convention [2].

The comparison programme enables SSDL Network members to verify the consistency of their national standards and validate the calibration procedure applied at the SSDL. The results of the comparisons are confidential and are communicated only to the participants. This is to encourage participation of the laboratories and their full cooperation in the reconciliation of any discrepancy. Therefore, historical summaries of all results are only presented anonymously. The comparison results can also be used to support the *Calibration and Measurement Capabilities* (CMCs) of the SSDL. Therefore, we asked the SSDLs which participated in a comparison in 2017 – 2018 if they wish to publish their results with the name of the laboratory. If they agreed, the detailed results are presented in the tables.

Methods

The IAEA's Dosimetry Laboratory provides three comparison programmes in the areas of radiation therapy, radiation protection and diagnostic radiology in terms of absorbed dose to water D_w and air kerma, K_a. The comparison protocols are published and available from SSDL Network website. The comparison methodologies are described in the respective comparison protocols and summarized in the Table 1.

As a part of these programmes, calibrated IAEA transfer ionization chambers are sent to participating SSDLs to be calibrated using their own calibration procedure. The IAEA calibration coefficients, N_{ref}, are used as reference values. The result of the comparison is $R = N_{part}/N_{ref}$, where N_{part} is the calibration coefficient determined by the participant. The expanded uncertainty of the comparison result, U_R, is calculated as a square sum of the uncertainties of the calibration coefficients and potential correlations related to traceability are not considered. Differences in traceability chain and related degree of equivalence is taken into account by using the published data in radiation therapy (^{60}Co) and radiation protection (^{137}Cs) comparisons. The IAEA collects and evaluates the comparison results and prepares a confidential comparison report, which is then sent to the participant.

The percentage deviation of R from unity is used as an action level. This percentage deviation must be equal to or less than ±1.5 %, for radiation therapy, ±3 % for radiation protection and ±2.5 % for diagnostic radiology. Additionally, the U_R should cover the unit value. Deviations larger than tolerances described above are classified as major. Such deviations are reported to the SSDL immediately by the SSDL Officer.

***Table 1.** Brief description of methods and instrumentation used in the comparison programmes.*

	Radiation Quality	Quantity	Distance from the source/ focus	Field size	Transfer chamber
Radiation Therapy	^{60}Co	D_w K_a	1 m (5 cm depth in water) 1 m (in air)	10 cm x 10 cm	Wellhöfer FC65-G, PTW 30013
Radiation Protection	^{137}Cs ISO 4037 Narrow Spectra	K_a	3 m 2 m	Ø 80 cm Ø 26 cm	Exradin A6
Diagnostic Radiology **Mammography**	RQR, RQT RQR-M, RQA-M, W-Mo, W-Al	K_a	1 m	Ø 10 cm	Exradin A3 Radcal RC6M

In this summary, historical comparison data was collected and summarized without the laboratory details. In addition, comparison results from the last two years are shown with more details for those laboratories which provided their approval for the publication of their results.

Results on radiation therapy comparisons

The comparison programme for radiation therapy started in 1999. Since then, 154 comparison exercises for 64 laboratories were performed. The summary of results is presented in Figure 1 The uncertainties of the comparison results range from 0.9 % to 2.5 % (k = 2).

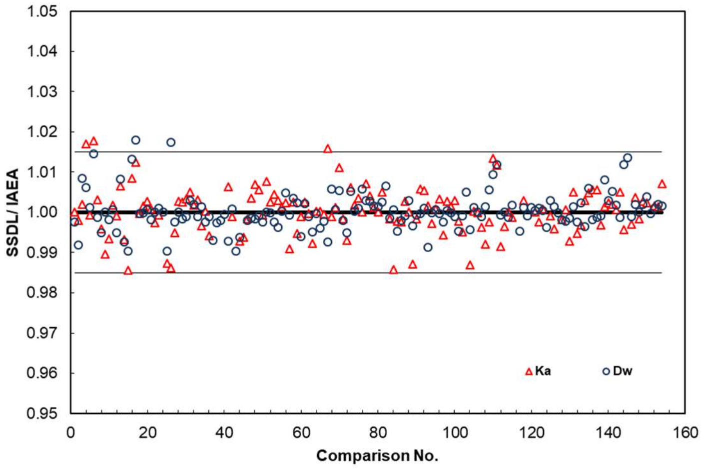

***Figure 1.** The summary of radiation therapy comparison programme results for air kerma K_a and absorbed dose to water D_w (1999 – 2018).*

Ten laboratories agreed to publish their comparison data from the last two years (2017 – 2018) and they are presented in Table 2. During this period, comparison results from one laboratory exceeded the acceptance limit and those results were excluded. Consequently, an expert mission was organized, and the cause of the non-acceptable comparison result was resolved.

***Table 2.** Radiation therapy comparison results R and expanded uncertainties U_R for air kerma K_a and absorbed dose to water D_w.*

Year	Country	Laboratory	***R (U_R)*** K_a	***R (U_R)*** D_w
2017	Germany	PTW	1.005(25)	0.999(24)
	China	SIMT	0.996(21)	1.012(25)
	Norway	NRPA	1.004(12)	1.002(14)
	Greece	GAEC	0.998(15)	1.000(16)
	Sweden	SRSA	1.003(10)	1.002(13)
	Kazakhstan	NCEC	1.002(15)	1.004(16)
	Finland	STUK		1.000(18)
	Israel	RCU	1.002(12)	1.001(14)
2018	Thailand	BRMD	1.002(09)	1.002(11)
	Slovakia	SMU	1.007(11)	1.002(12)

Results on radiation protection comparisons

The comparison program for radiation protection started in 2017. Since then, 8 comparison exercises for 5 laboratories were performed. All laboratories agreed to publish their results which are presented in Table 3.

Results on Diagnostic Radiology Comparisons

The air kerma comparison program started in 2014 for RQR, RQA and RQT diagnostic radiation qualities. Since then, 18 comparison exercises were performed in RQR radiation qualities for 17 laboratories and 14 comparison exercises in RQT radiation qualities for 14 laboratories. The summary of all results is shown in the Figure 2. Some results were already published [3] and therefore only the latest results, which were not yet published, are presented in table 4. During this period, comparison results from one laboratory exceeded the acceptance limit and those results were excluded.

Table 3. *Radiation protection comparison results R and expanded uncertainties U_R for air kerma K_a and ^{137}Cs and ISO 4037 Narrow radiation qualities.*

Year	Country	Laboratory	R (U_R)				
			^{137}Cs	N-40	N-80	N-100	N-200
2017	Colombia	LMRI	1.003(29)				
2018	Bosnia and Herzegovina	IMBH	1.000(23)				
	Croatia	IRB	0.999(17)				
	Israel	RCU		1.004(20)	1.003(20)	1.001(20)	1.001(20)
	Macedonia	MIRCL	1.001(22)				

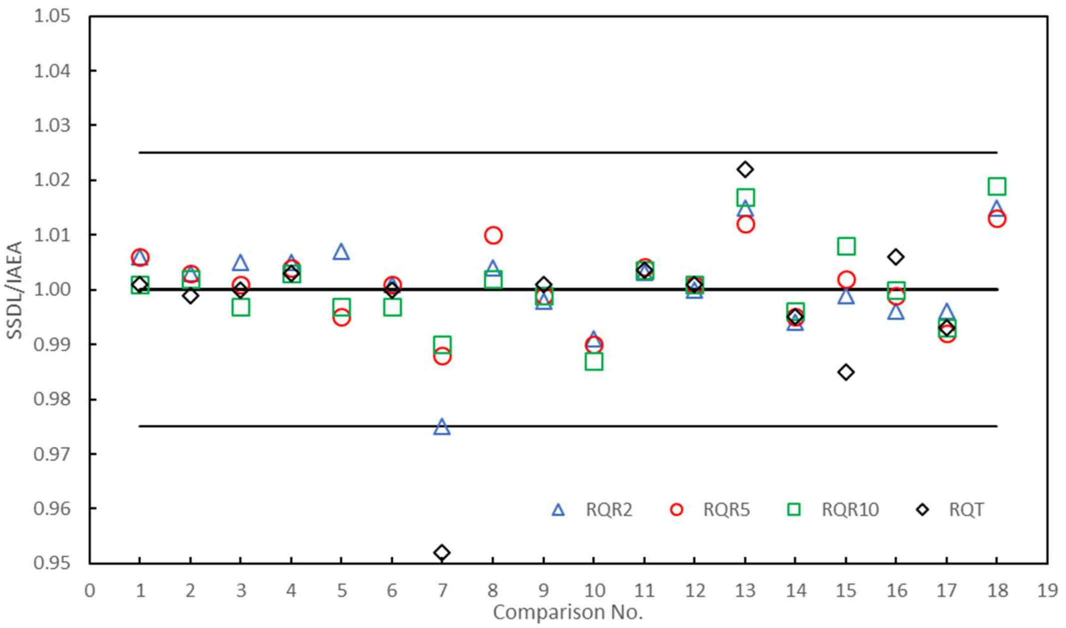

Figure 2. *The summary of diagnostic radiology comparison programme results for air kerma K_a and RQR and RQT radiation qualities (2014 -2018).*

Table 4. *Diagnostic radiology comparison results R and expanded uncertainties U_R for air kerma K_a and RQR and RQT radiation qualities.*

Year	Country	Laboratory	R (U_R)			
			RQR2	RQR5	RQR10	RQT9
2017	Cuba	CPHR	0.994(17)	0.995(17)	0.996(17)	0.995(17)
2018	Malaysia	MNA	0.999(17)	1.002(17)	1.008(17)	0.985(17)
	Norway	NRPA	0.996(17)	0.999(17)	1.000(17)	1.006(17)
	Serbia	VINCA	0.996(19)	0.992(19)	0.993(19)	0.993(19)
	Spain	CIEMAT	1.015(26)	1.013(26)	1.019(26)	

Results on mammography comparisons

The air kerma comparison programme started in 2015 for mammographic radiation qualities. Since then, 25 comparison exercises were performed with 13 laboratories for different mammographic radiation qualities. The summary of all results is shown in the Figure 4. Some of these results were already published [3] and therefore only the latest results, which were not yet published, are presented in table 5.

Table 5. *Mammography comparison results R and expanded uncertainties U_R for air kerma K_a radiation qualities.*

Year	Country	Laboratory	R (U_R)	
			W/Mo 30	W/Al 28
2017	Cuba	CPHR	1.001(17)	1.001(19)
	Norway	NRPA	1.000(13)	
2018	Serbia	VINCA		0.996(22)

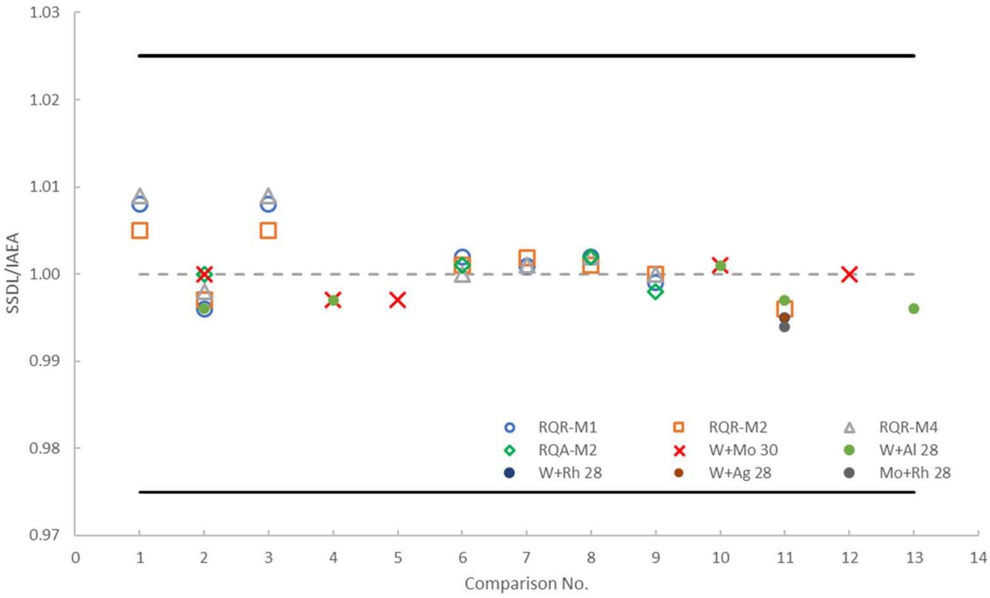

Figure 4: The summary of mammography comparison programme results for air kerma K_a and different mammography radiation qualities (2015 - 2018).

Conclusions

The comparison programme of the IAEA Dosimetry Laboratory is a valuable tool to ensure the precision and accuracy of the SSDL Network laboratories measurement capabilities and also the measurement and calibration equivalence between them. It demonstrates also its usefulness on the scientific and technical support to the Network laboratories. The acceptable results show that the laboratories belonging to the SSDL network have a high scientific and technical qualifications and the measurements and calibrations they provide are of high metrological quality.

References

[1] International Atomic Energy Agency, SSDL Network Charter 2nd Edition, IAEA, Vienna (2018)

[2] P.J. ALLISY-ROBERTS, C. THOMAS, K. R. SHORTT, A. MEGHZIFENE, The operation of the CIPM mutual recognition arrangement and its relevance to the SSDL members of the IAEA/WHO Network, SSDL Newsletter No. 47, IAEA, Vienna

[3] Csete I., Toroi, P., Steuer, A., Hourdakis, C., Gabris, F., Jozela, S., Kosunen, A., Cardoso, J., Sochor, V., Persson, L., Glavic Cindro, D., Arib, M., Smekhov, M., *IAEA-SSDL bilateral comparisons for diagnostic level air kerma measurement standards*, Phys. Med. **47**, 9-15 **(**2018)

The Institute of Metrology of Bosnia and Herzegovina is a new member of the IAEA/WHO SSDL Network

Amra Šabeta, Vedrana Makaric

The Secondary Standard Dosimetry Laboratory of Institute of Metrology of Bosnia and Herzegovina (IMBIH SSDL) officially became a new member of IAEA/WHO SSDL Network on December 1st, 2018.

Until recently, Bosnia and Herzegovina was the only country in the region that did not have a metrology infrastructure in the field of ionizing radiation. Also, at the state level, there has not been established a standard base for measuring ionizing radiation, nor have any of the laboratories been designated or accredited in this metrology field according to ISO/IEC 17025.

IMBIH started developing this infrastructure through implementation of European Commission TC project - IPA 2008: ″Establishment of a calibration laboratory for the ionizing radiation (Secondary Standard Dosimetry Laboratory) in Bosnia and Herzegovina.″ The laboratory facilities are located in Banja Luka and have been designed to meet a national code of practice for the safe operation of radiation facilities and IAEA requirements for this type of laboratories. Accordingly, the IMBIH/SSDL consists of a single bunker, i.e. one irradiation/calibration room, control room and two mechanical rooms.

Irradiation room (9.5 m long and 6 m wide), with proper air conditioning system has concrete walls (thickness of 40 cm to 70 cm), lead protection ceiling and protective steel door. The entrance doors are composed also with lead to protect the control room and the surroundings against radiation.

In this room a Cs-137 irradiator (740 GBq) and an X-ray irradiator (40 kV to 320 kV) have been installed, using the same calibration bench, as shown in Fig. 1.

The operator control panel is located in the control room (Fig.2), while the air compressor of the irradiators and the X-ray high voltage transformer and the heat exchanger (water circulation) are stationed in mechanical rooms.

Figure 1. IMBIH/SSDL Irradiation room

Figure 2. IMBIH/SSDL Control room

Current infrastructure is dedicated to radiation protection and diagnostic radiology calibrations, but only radiation protection calibrations with the Cs-137 beam could be performed at the moment. In order to perform these activities, the laboratory has two reference standards: - PTW 32002 1 L Spherical ionization chamber (LS-01) and PTW 32003 10 L Spherical ionization chamber (LS-02) including PTW Unidos Webline reference electrometer type T10022.

After an IAEA field mission to IMBIH SSDL, the laboratory was granted with an approval to participate in the national TC project BOH6015 ″Establishing National Diagnostic Reference Levels in Diagnostic radiology″ from 2016 – 2017, which provided all essential elements for developing laboratory service for calibrations in radiation protection area in terms of: commissioning of Cs-137 irradiator, lead attenuators for achieving wider range of doses and training for laboratory personnel for calibrations in radiation protection.

The IMBIH SSDL reference standards have been calibrated at the IAEA and after successful completion of a bilateral comparison of Air Kerma measurements with the IAEA, the IMBIH SSDL fulfilled the necessary requirements to become a full member IAEA/WHO SSDL Network and is now able to provide calibration services in terms of air kerma and related radiation protection operational quantities with the Cs-137 beam.

The laboratory is currently working on developing a calibration service for diagnostic radiology calibrations with the support from IAEA TC BOH9009 project “Sustaining an Integrated Management System and Capabilities in the Regulatory Body and Strengthening Capabilities of the Dosimetry Laboratory”. Through this project, in the current year, the laboratory will receive necessary missing equipment for X-ray calibrations and support from IAEA in terms of training personnel and commissioning the X-ray system.

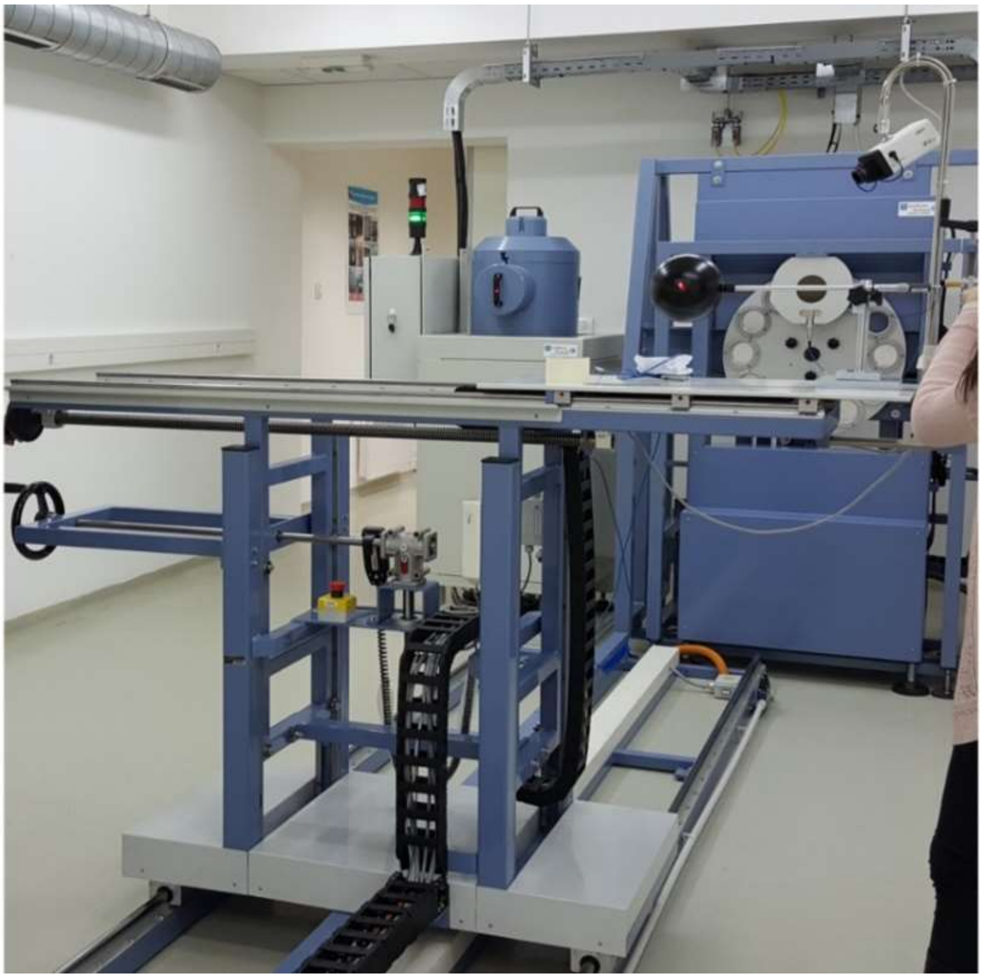

Figure 3. IMBIH/SSDL LS-01 Reference standard

Kishor Mehta

(1937 - 2018)

We are all deeply saddened by the sudden and unexpected death of our former colleague, Kishor Mehta. He passed away on Thursday 18 October 2018 in his home in Vienna.

Kishor worked at the IAEA from July 1992 until December 1999 in the Dosimetry and Medical Radiation Physics Section as a professional in charge of high-dose dosimetry, including the supervision of the operation of the International Dose Assurance Service (IDAS). During this period, Kishor contributed to research and development in high-dose dosimetry, jointly with the laboratory staff in Seibersdorf, consolidated the operation of IDAS through the development of standard operating procedures and managed Technical Cooperation projects to support implementation of high-dose dosimetry in IAEA Member States to ensure safe and effective sterilization of food and medical devices with radiation. During this period, Kishor was responsible and/or contributed to several IAEA publications in high-dose dosimetry (Proceedings, Technical documents and scientific publications).

After his retirement in December 1999, Kishor continued to be professionally active and became involved with assisting first the IAEA Food & Environmental Protection Subprogramme with dosimetry for phytosanitary irradiation and later, the Insect Pest Control Laboratory with dosimetry for radiation sterilization of insects for the sterile insect technique.

From all your IAEA colleagues, and from those you strove to serve in IAEA Member States, we would like to say “Thank you Kishor for all you have given”. You will be sorely missed.

Current and former staff of the IAEA Dosimetry and Medical Radiation Physics Section.

Study on calibration of mammography dosimeters

Internship at the Dosimetry Laboratory: February 2017 – January 2018

Elisabeth Salomon, Paula Toroi[1]

The main purpose of the internship was to investigate the performance of semiconductor dosimeters which was also the topic of a master´s thesis. This is short summary of that study. More details can be found from the thesis:

http://katalog.ub.tuwien.ac.at/AC1502293

Introduction

The use of semiconductor-based dosimeters in diagnostic radiology is increasing. In addition to air kerma, they are used to measure other parameters like tube voltage and half-value layer (HVL). The response of semiconductors has more pronounced energy dependence than ionization chambers and manufacturers have developed different compensation methods to overcome this challenge. This sets additional challenge for SSDLs because the standard radiation qualities use for calibrations do not cover all the clinically used radiation qualities. Thus, the function of semiconductor dosimeters cannot be tested using all measurement setups.

Material and Methods

The thesis presents a study of eight semiconductor-based dosimeters which were calibrated in the IAEA Dosimetry Laboratory (DOL). Five different anode-filter combinations were used to cover the most common radiation qualities used in clinical mammography units (W-Al, W-Rh, W-Ag, Mo-Mo and Mo-Rh) and a tube voltage range from 25 kV to 35 kV. Calibration factors for air kerma, tube voltage and half-value layer were obtained.

The reference standard for this study is a Radcal 10X5-6M ionization chamber which is a working standard of the DOL. The DOL standard is traceable to primary standards for all the chosen radiation qualities.

The calibrations were performed with the substitution method according the procedure described in the IAEA calibration certificate appendix and Dosimetry in Diagnostic Radiology: An International Code of Practice [1]–[2]. The calibration factor N_K of the user dosimeter is the ratio of the air kerma rate $\dot{K}_a$ [mGy/s] obtained with the reference standard, and the reading $\dot{M}$ [mGy/s] of the user dosimeter. Equivalent, the calibration factors for HVL and tube voltage measurement were determined as the ratio of the reference value and the indication of the user dosimeter.

Results

The calibration factors N for air kerma, HVL and tube voltage measurements as a function of radiation quality of all dosimeters tested are shown in Figure 1, 2 and 3.

For five dosimeters the maximum variations of air kerma were within the ±5% required by the IEC 61674 [3] standard. The maximum error for HVL and tube voltage were 11% and 10%, respectively. Only two dosimeters tested comply with the manufacturer's own specifications for HVL measurements and none for tube voltage measurements.

Discussion and conclusions

This extended test demonstrates dependence of the response of semiconductor dosimeters on the radiation quality. Based on this study errors and uncertainties related to different measurement and calibration scenarios can be estimated.

With modern dosimeters the radiation quality compensation works well and the errors in measurements can be quite small <5%. However, when the dosimeters are used for a large range of clinical radiation qualities and scenarios, their performance should be verified using reference level equipment.

A procedure, which ensures appropriate calibration of equipment, should be followed. Either the hospitals should use their own reference instrument or a method to calibrate these dosimeters in SSDLs, in non-clinical conditions, should be established.

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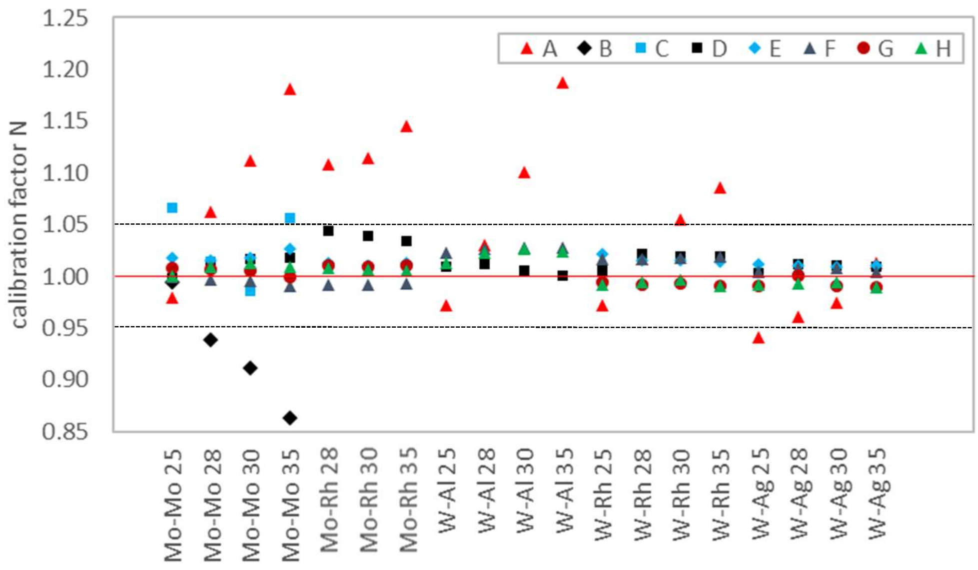


Figure 1 *Calibration factor N for air kerma as a function of radiation quality*

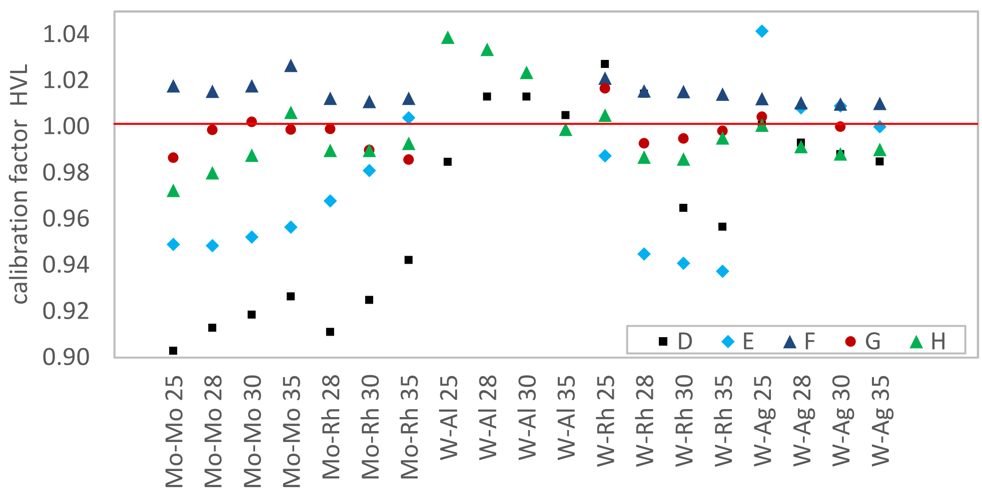


Figure 2 *Calibration factor N for HVL as a function of radiation quality*

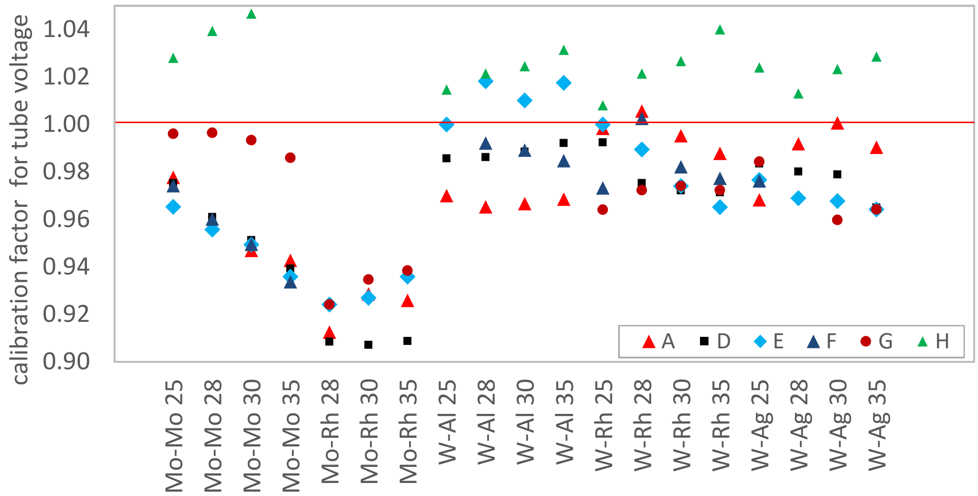


Figure 3 *Calibration factor N for tube voltage as a function of radiation quality*

References

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, *Appendix 2 DOLP.013: Appendix to IAEA calibration certificate, Calibration of reference dosimeters for diagnostic radiology at the IAEA Dosimetry Laboratory,* IAEA, 2016.

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, *Dosimetry in Diagnostic Radiology: an Internacional Code of Practice- Technical Report Series No 457*. IAEA, 2007.

[3] INTERNATIONAL ELECTROTECHNICAL COMMISSION, *Medical electrical equipment-Dosimeters with ionization chambers and/or semiconductor detectors as used in X-ray diagnostic imaging*, IEC 61474: 2012

***Figure 4** Elisabeth Salomon worked as an intern at the IAEA Dosimetry Laboratory.*

Consultancy Meetings to update the TRS 398

Consultancy Meeting to plan the update of TRS 398

24-27 September 2018, IAEA, Vienna

Experts: Malcolm McEwen (Canada), Pedro Andreo (Sweden), Stanislav Vatnitsky (Austria), Ralf-Peter Kapsch (Germany), David Burns (BIPM, France), Brendan Healy (Australia).

IAEA staff: Karen Christaki (Scientific Secretary)

Background

A key step in the radiotherapy process is the requirement for consistent reference dosimetry traceable to metrological primary standards and to enable common procedures within a country to be followed for reference dosimetry. For conventional radiotherapy this has been achieved by universally adopted Codes of Practice such as IAEA TRS 398 (IAEA, Vienna, 2000). However, the data in TRS 398 had been prepared from mid 1990s, since this date:

- ICRU report 90 on key data for measurement standards in the dosimetry of ionizing radiation provides a comprehensive set of new data for fundamental quantities that impact substantially on radiation metrology standards and reference dosimetry for radiotherapy beams.
- Since the development of TRS 398 a number of new technologies for radiotherapy have been implemented in the field on megavoltage (MV) photon beams, protons and heavier ions that require guidance and data for end users.
- In addition, new detectors are now commercially available that require data in their clinical practice.

Based on these 3 major elements it has been decided that IAEA TRS 398 should be updated to take into account the issues noted above.

In line with these recommendations the consultancy meeting worked on the update of TRS 398.

Consultancy Meeting to update the kV sections of TRS 398

14-17 May 2018, IAEA, Vienna

Experts: Pedro Andreo (SWE), Ludwig Bueerman (Germany), Robin Hill (Australia), Brendan Healy (Australia), Jan Seuntjens (Canada), David Burns (BIPM).

IAEA staff: Karen Christaki (Scientific Secretary)

Background

When TRS 398 was written in 2000 it was assumed that most standards laboratories would offer calibration coefficients for low and medium energy X-rays in terms of absorbed dose to water but this has not happened as most standards laboratories continue to offer calibration coefficients in terms of air kerma. This meeting consisted of experts in kilovoltage (kV) X-ray dosimetry who discussed how the kV sections of TRS 398 will be updated so that it includes all the parameters required by the clinical medical physicist.

Consultancy Meeting on a competency framework document for education and training of SSDL staff

5-8 November 2018, IAEA, Vienna

Experts: Ralf Kapsch (PTB, Germany), Sibusiso Jozela (NMISA, South Africa), Penelope Allisy (France), Liviu-Cristian Mihailescu (SCK-CEN, Belgium), Cecilia Kessler (BIPM, France), Philippe Roger (BIPM, France)

IAEA staff: Paula Toroi (Scientific Secretary), Ahmed Meghzifene, Giorgia Loreti, Joao Cardoso, Ladislav Czap, Debbie van der Merwe

Background

The 2nd Edition of the IAEA/WHO SSDL Network Charter addresses the issue of qualification and competencies of the Secondary Standards Dosimetry Laboratories (SSDL) staff requiring that: "The SSDL shall have technical and managerial personnel who have the authority, qualifications and competence to operate the specific equipment needed for radiation measurements, perform calibrations, evaluate the results and authorize calibration certificates. The personnel shall be qualified on the basis of appropriate education, training, experience or demonstrated skills, as required."

The ISO-17025 standard also states that "the laboratory management shall ensure the competence of all who operate specific equipment, perform tests and/or calibrations, evaluate results and sign test reports and calibration certificates." However, these competencies are not clearly spelled out in any published document.

Objective and outcome of the meeting

The aim of the consultancy meeting was to prepare guidance on education, training and qualification of radiation metrologist working in an SSDL. The objective of the guidance is to provide an effective, systematic and internationally harmonized approach to the competency requirements and training for radiation metrologists. During the meeting the content of the guidance was drafted and a workplan to finalize it was prepared.

Consultancy Meeting on the first draft of an International Code of Practice for Brachytherapy Dosimetry

10-14 December 2018, IAEA, Vienna

Experts: Mauro Carrara (Italy), Larry DeWerd (AAPM, USA), Christian Kirisits (Austria), Malcolm McEwen (Canada), Mark Rivard (USA), Thorsten Sander (UK), Thorsten Schneider (Germany)

IAEA staff: Paula Toroi and Siva Sarasanandarajah (Scientific Secretaries), Debbie van der Merwe, Joanna Izewska, Tomislav Bokulic

Background

A key step in the brachytherapy process is the requirement for consistent reference dosimetry traceable to metrological primary standards and establishment of common procedures within a country to be followed for reference brachytherapy dosimetry. IAEA-TECDOC-1274 Calibration of photon and beta ray sources used in brachytherapy was published in 2002 and since then, it has become a golden standard for brachytherapy dosimetry. However, since the TECDOC-1274 was prepared, a number of new developments have taken place. Following recommendations from the Scientific Committee of the IAEA/WHO Network of SSDLs meeting held at the IAEA in March 2018, it was decided to review and update TECDOC-1274 and prepare a new international Code of Practice for Brachytherapy Dosimetry.

Objective of the meeting

The purpose of the meeting was to define the contents and prepare a work plan for the preparation of the International Code of Practice (CoP) for Brachytherapy Dosimetry. Consultants meetings convened by the IAEA have recommended that brachytherapy experts in metrology and clinical medical physics consider the need for a CoP. Suggestions on the proposed content of the CoP, and of expert contributors and co-authors, are welcome and can be submitted to dosimetry@iaea.org. In addition, a call for interest from international organizations, with a view to co-operation and possible endorsement of the CoP, is hereby disseminated.

Training Activity on the Establishment of an SSDL and a QMS

17-21 December 2018, IAEA, Vienna

Paula Toroi and Shiny Puthenkalam

Experts: Mehenna Arib (KFSHRC, Saudi Arabia), David Burns (BIPM, France), Istvan Csete (retired IAEA staff member, Hungary), Costas Hourdakis (EEAE, Greece), Steven Judge (BIPM, France), Stephen Keochakian (BIPM, France), Cecilia Kessler (BIPM, France), Zakithi Msimang (NMISA, South Africa), Penelope Allisy (retired BIPM staff member, rapporteur, France)

IAEA staff: Paula Toroi (Scientific Secretary), Andreas Baumgartner, Tom Bokulic, Joao Cardoso, Karen Christaki, Ladislav Czap, Harry Delis, Ales Fajgelj, Joanna Izewska, Debbie van der Merwe, Yaroslav Pynda, Sivananthan Sarasanandarajah, Debbie Gilley. Administration: Simona - Mihaela Ciortan, Shiny Puthenkalam

Participants:

In addition to experts, a total of 98 participants from 64 countries participated in this event (figures 1, 2, 5 and 6). The training was mainly aimed for 1) current IAEA/WHO SSDL members, 2) operational calibration laboratories planning to apply for membership, 3) institutes who are planning to establish an SSDL.

Figure 1. *Shiny Puthenkalam worked at the IAEA as an SSDL intern and supported the SSDL officer with the arrangements.*

Description of training course

The programme covered the following topics:

Monday: SSDL facilities, safety security

Tuesday: SSDL equipment: irradiators, calibration bench, measuring equipment, SSDL staff and training

Wednesday: calibration procedures, uncertainties and comparisons

Thursday: Quality Management System

Friday: visit to IAEA Dosimetry Laboratory in Seibersdorf

Evaluations:

Before the training course, the participants filled out a survey on their current knowledge and their estimation of the importance for a variety of topics. The programme was adjusted based on this information. In addition, an exam was conducted in the beginning and end of the course. The results were used to estimate the impact of the course. Finally, the participants were also asked to fill out a feedback form.

Analysis:

The results of self-evaluation and the test results can be found in figure 3. The participants found almost all topics important and the average of all scores was 4.3 in the scale of 1-5 (not important – very important). Excellent feedback was received, and a summary is given in figure 4.

Figure 2. *The room for the SSDL training was full.*

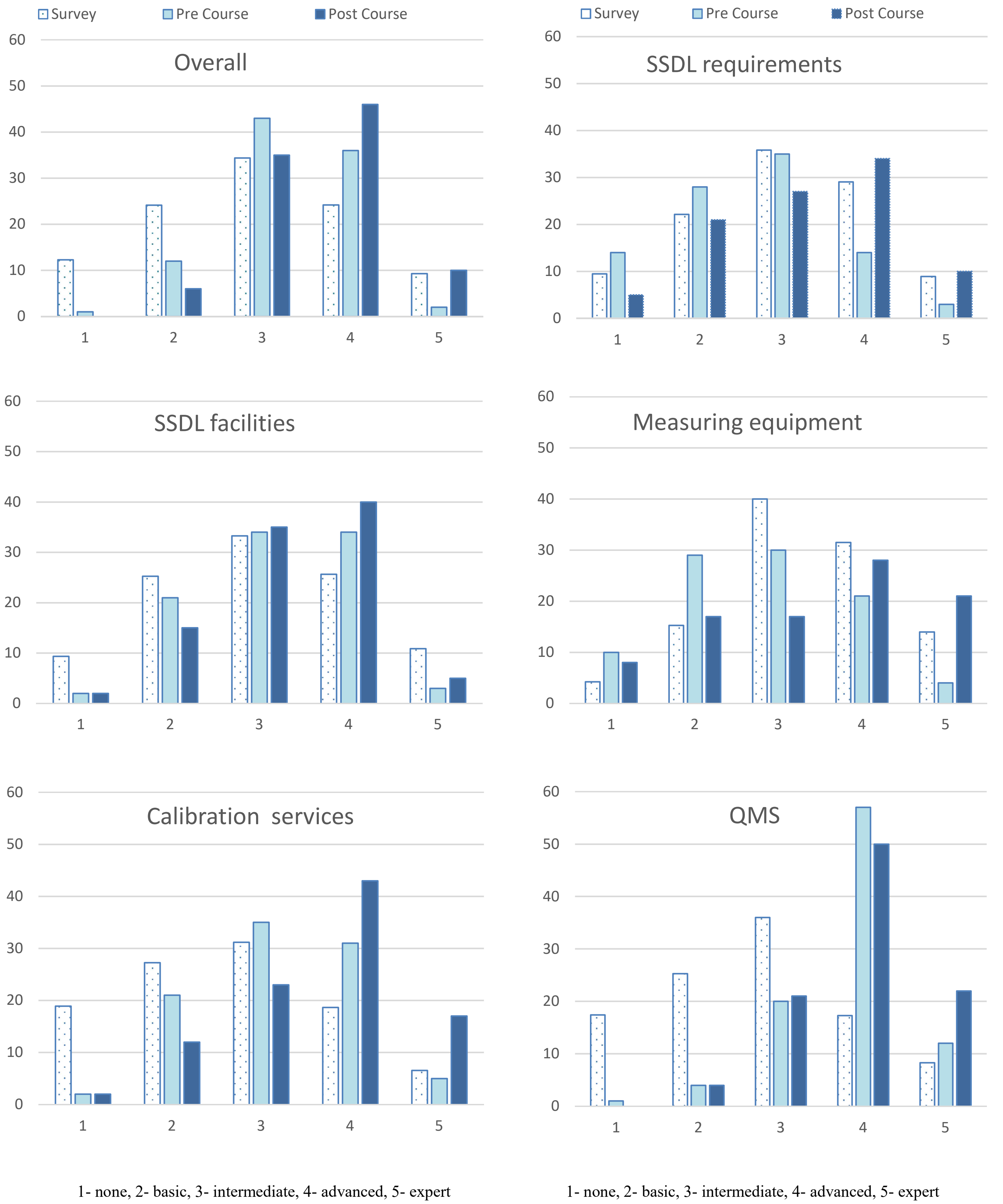
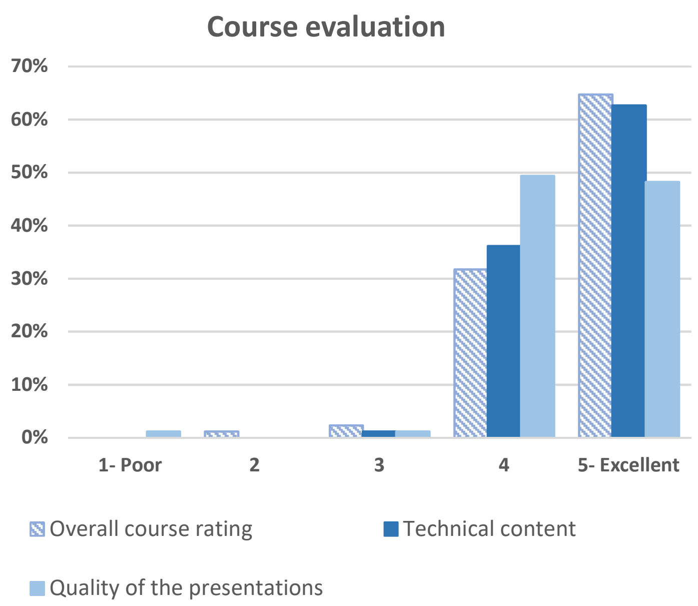


***Figure 3**. Knowledge evaluation results based on the pre-course survey, and the test, which was organized before and after the course.*



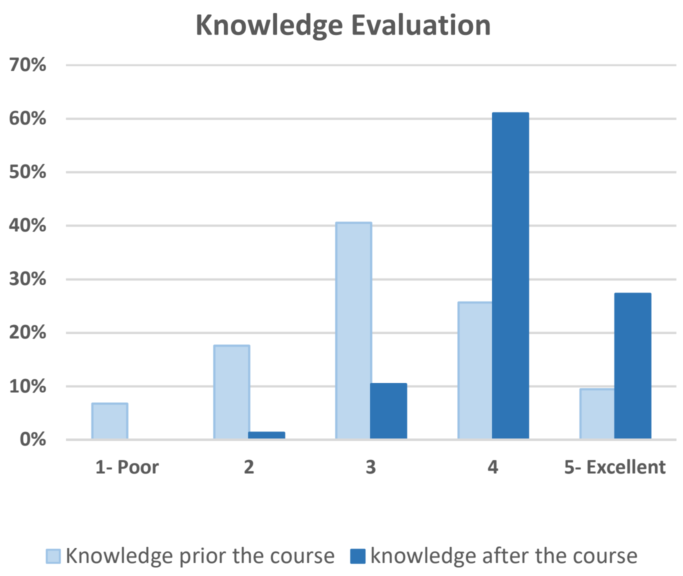
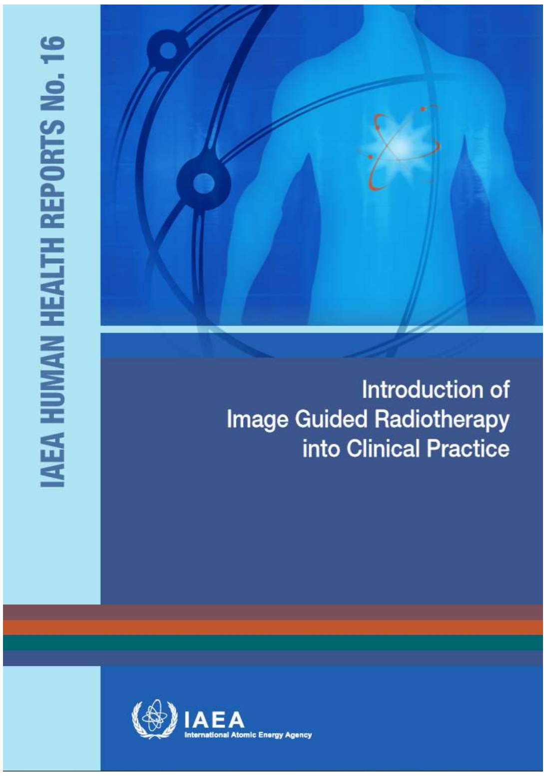


Figure 4. *A summary of main results from the feedback survey.*

Figure 5*. Participants (above) and experts David Burns, Steven Judge and Zakithi Msimang (below) of the SSDL training activity.*

Figure 6. *Photos taken from the visits to the Dosimetry Laboratory in Seibersdorf*

New IAEA Publication



This publication provides guidelines and highlights the milestones to be achieved by radiotherapy departments in the safe and effective introduction of image guided radiotherapy. Recent advances in external beam radiotherapy include the technology to image the patient in the treatment position, in the treatment room at the time of treatment. Since this technology and associated image techniques, termed image guided radiotherapy, are perceived as the cutting-edge of development in the field of radiotherapy, this publication addresses the concerns of personnel in radiotherapy departments as to the preparatory conditions and resources involved in implementation. Information is also presented on the current status of the evidence supporting the use of image guided radiotherapy in terms of patient outcomes. (*Information taken from www.pub-iaea.org*).

The new publication has been released on the Internet: https://www.iaea.org/publications/12264/introduction-of-image-guided-radiotherapy-into-clinical-practice

Courses, Meetings and Consultancies in 2019

TC Courses and Workshops related to DMRP activities

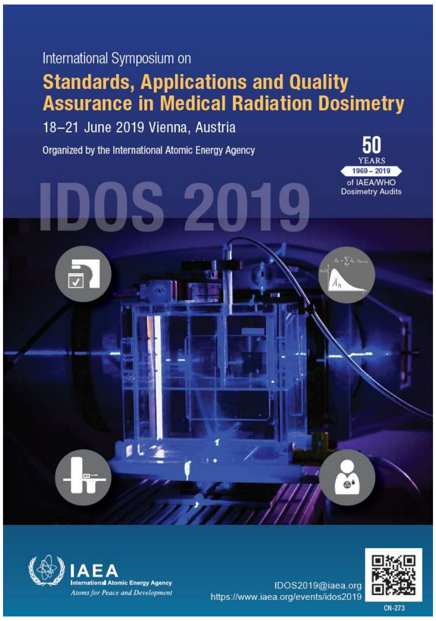
- Joint ICTP-IAEA Advanced School on Quality Assurance Requirements in the Digital Era of Diagnostic Radiology, Trieste, Italy, 11—15 November 2019
- Joint ICTP-IAEA Workshop on Uncertainty Estimations for Radiation Measurements in SSDLs and Hospitals, Trieste, Italy, 02—06 December 2019

ESTRO Courses

- SP-RER6036-1806747, IAEA/ESTRO Training Course on Target Volume Determination – from Imaging to Margins, Athens, Greece, 2—5 June 2019
- SP-RER6036-1806751, IAEA/ESTRO Training Course on IMRT and Other Conformal Techniques in Practice, Budapest, Hungary, 2—6 June 2019
- SP-RER6036-1806752, IAEA/ESTRO Training Course on Evidence Based Radiation Oncology, Montpellier, France, 24—29 June 2019
- SP-RER6036-1806755, IAEA/ESTRO Training Course on Advanced Treatment Planning, Budapest, Hungary, 22—26 September 2019
- SP-RER6036-1806757, IAEA/ESTRO Training Course on Best Practice in Radiation Oncology – Train the RTT (Radiation Therapists) Trainers, Part II, Vienna, Austria, 14—16 October 2019

DMRP Meetings and Consultancies

- Second Research Coordination Meeting of the CRP on Dosimetry in Radiopharmaceutical Therapy for Personalized Patient Treatment, Vienna, Austria, 13—17 May 2019
- International Symposium on Standards, Applications and Quality Assurance in Medical Radiation Dosimetry (IDOS-2019), Vienna, Austria, 18—21 June 2019
- Joint IAEA and Argonne National Laboratory Training Activity on Comprehensive Clinical Audits in Diagnostic Radiology under the Quality Assurance Audit for Diagnostic Radiology Improvement and Learning (QUAADRIL) Tool, Argonne, United States of America, 05—09 August 2019



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** Membership application in process

Collaborating Organizations Associated with the IAEA/WHO Network of SSDLs

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International Electrotechnical Commission (IEC)

Organisation Internationale de Métrologie Légale (OIML)

International Organization of Medical Physics (IOMP)

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