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Prepared by the Joint IAEA/WHO Secretariat of the Network of Secondary Standards Dosimetry Laboratories

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Contents

From the Editor

This issue of SSDL Newsletter is dedicated to a report of 17th Scientific Committee of the IAEA/WHO Network of Secondary Standards Dosimetry Laboratories. The meeting was held at the IAEA Headquarters in March 2016. The meeting report provides a good overview for the work of DMRP. The work done during the biennium 2014 – 2015 was summarized and the recommendations given by the committee will be used as a guideline for the future work.

This SSDL Newsletter is the last one which is published in hard copy. This issue of the SSDL Newsletter is also provided to you by email. If you do not receive the email, please check that you have updated your contact information for us. In order to improve the communication among all Network members a new web page "**Notice Board"** has been created on the IAEA/WHO SSDL Network web site. This page is used to provide topical information for the SSDL Network Members. Short **Information Notes** are published on this webpage when there are brief announcements about current topics related to the Dosimetry Laboratory of the IAEA and the SSDL Network. Please visit the Notice Board to read the first Information Note 1_2016.
http://www-naweb.iaea.org/nahu/dmrp/SSDL/noticeboard.asp

Participants and observers of the 17th Meeting of the Scientific Committee of the IAEA/WHO SSDL Networks Vienna, March 2016 (see page 4)

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Services provided by the IAEA in Dosimetry and Medical Radiation Physics

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 thermoluminescent and optically stimulated luminescent dosimeters (TLDs 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 (radiotherapy, diagnostic radiology including mammography*, and radiation protection including environmental dose level)	X rays (10–300kV) and γ rays from ^{137}Cs and ^{60}Co
Comparison of therapy, protection and diagnostic level ionization chamber calibrations coefficients for SSDLs	γ rays from ^{60}Co and ^{137}Cs and X rays
TLD Dose quality audits for external radiotherapy beams for SSDLs and hospitals	γ rays from ^{60}Co and high energy X ray beams
OSLD Dose quality audits for radiation protection for SSDLs	γ rays from ^{137}Cs
Reference irradiations to dosimeters for radiation protection	X rays (40–300 kV) and γ rays from ^{137}Cs and ^{60}Co beams

* The IAEA CMCs for diagnostic calibrations have been modified. In the updated list, new quantities of kerma-length and kerma-area product were added and the radiation qualities for mammography calibrations were modified. Please find more information from the information note 1/2016. http://www-naweb.iaea.org/nahu/dmrp/SSDL/noticeboard.asp

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:

http://www-naweb.iaea.org/nahu/dmrp/SSDL/default.asp

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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.

Scientific Committee of the IAEA/WHO Network of Secondary Standard Dosimetry Laboratories

Report of the Seventeenth Meeting of the SSDL Scientific Committee IAEA, Vienna, 14-18 March 2016

1. FOREWORD

The Scientific Committee of the IAEA/WHO network of Secondary Standards Dosimetry Laboratories (SSDLs) is a standing committee (SSC) within the framework of the International Atomic Energy Agency. It is tasked with conducting periodic reviews and evaluations of the Dosimetry and Medical Radiation Physics (DMRP) Subprogramme and reporting the results of the reviews to the Directors General of the IAEA and the WHO. The report of the sixteenth meeting (held in March 2014) of the previous SSC was published in the SSDL Newsletter No. 63 in December 2014.

The seventeenth meeting was held in Vienna at the Agency Headquarters from 14 to 18 March 2016. Opening remarks were made by Ms Adriana Velázquez Berumen, Co-Secretary of the IAEA/WHO SSDL Network (World Health Organization) and Mr Ahmed Meghzifene, Head of the Section of Dosimetry and Medical Radiation Physics and Co-Secretary of the IAEA/WHO SSDL Network. Members of the SSC-17 are: Ms María-Ester Brandan, Instituto de Física, National University of Mexico (UNAM), Mr David T. Burns, Ionizing Radiation Department, International Bureau of Weights and Measures (BIPM), Sèvres, Mr David S. Followill, MD Anderson Cancer Center, USA, Mr Konstantinos Hourdakis, Ionizing Radiation Calibration Laboratory, Greek Atomic Energy Commission, Greece, Mr Hans-Georg Menzel, (Chairman) ICRU Bethesda, Mr Carl Ross, (retired) Ionizing Radiation Standards Group, National Research Council, Canada and Mr George Sgouros, Division of Nuclear Medicine and Molecular Imaging, Johns Hopkins University, USA.

1.1 Introductions

Mr Ahmed Meghzifene, Head of the DMRP, opened the 17th biennial meeting of the SSC and welcomed all the members noting they were charged with providing advice to the Agency on the work programme of the DMRP. The Division Director, Ms May Abdel-Wahab, and the Deputy Director General, Mr Aldo Malavasi, were both on duty travel and unable to welcome the SSC members.

Ms Adriana Velázquez Berumen (WHO) spoke by telephone and expressed her regret at not being able to attend in person. She said that the WHO supported the many advances in health care using ionizing radiation over the past several years and that the treatment of non-communicable disease such as cancer is a special objective of the WHO. She continued by saying that the WHO is very supportive of the DMRP programme, as quality audits in medicine and particularly dosimetry lead to the highest standards of treatment. She was able to attend the last afternoon of the meeting and took an active role in discussing the recommendations.

Mr Meghzifene then introduced new staff members who have recently joined the DMRP. He outlined the structure of the meeting which would include presentations by the staff on the 2014/15 programme implementation and an introduction of the programme for 2016/17 that had been formulated with the advice of the SSC-16. All day Tuesday would be spent at the Seibersdorf Dosimetry Laboratory (DOL), where staff would give presentations of their work and SSC members would tour the laboratories. Finally he would present the outcome of the brainstorming session with DMRP staff for the SSC-17 to consider in their recommendations for the 2018/19 programme. He expressed his thanks to Mr Hans Menzel who would Chair the meeting.

Mr Menzel thanked Mr Meghzifene saying it was a pleasure, an honour and somewhat of a challenge to chair the SSC which has a long-standing association with the ICRU, of which he is currently Chairman. He pointed out that the ICRU will soon be publishing a report on key data for measurement standards for the dosimetry of ionizing radiation. Another report on small field dosimetry is also near completion, all of which illustrates the close relationship between the topics of interest to the ICRU and the IAEA.

The Chairman presented the agenda explaining that it represented a full week's work, and the agenda was then duly adopted.

1.2 General discussion

1.2.1 Programme of the Meeting

Mr Meghzifene began the meeting with an overview of the organization of the IAEA. There are six departments, each with a Deputy Director General. Each department manages several divisions, each of which operates a number of subprogrammes. The Dosimetry and Medical Radiation Physics (DMRP) Section is part of the Division of Human Health (NAHU) which in turn is part of the Department of Nuclear Sciences and Applications. This Department has a Standing Advisory Committee for Nuclear Applications (SAGNA) and one of the inputs to this Committee is the SSC Report. The mandate of NAHU arises from Article II of the IAEA Statute: "The Agency shall accelerate and enlarge the contribution of atomic energy to health."

Mr Meghzifene pointed out that the activities of the DMRP[1] are divided between three projects. The overall budget for the Subprogramme for 2014/2015 increased by about 2 % with respect to that for 2012/2013. This increase has permitted the addition of staff amounting to one half a position (for the Dosimetry Laboratory) for a team assistant and one scientific position (training coordinator).

Resources for the DMRP come primarily from its regular budget allocation. Extra-budgetary contributions, mainly from the Peaceful Use Initiative, are used to support education and training initiatives. The Section collaborates extensively with other groups within the Agency, such as the Applied Radiation Biology and Radiotherapy (ARBR) Section, the Nuclear Medicine and Diagnostic Imaging Section and the Radiation Safety and Monitoring Section (Division of Radiation, Transport and Waste Safety), international organizations, such as the BIPM, and professional societies, such as the IOMP and the AAPM. The DMRP is currently engaged with more than 200 TC projects. Coordinated Research Projects (CRPs) represent an important networking activity, funded by the Agency, which bring together scientists from both developed and developing countries to focus on a well-defined area of research.

Mr Meghzifene then reported on the actions following the SSC-16 recommendations. This was followed during the remainder of the first day of the meeting by the DMRP staff members presenting reports on the activities of the Section. On the second day, the SSC-17 was taken to Seibersdorf where presentations by laboratory staff continued and the SSC-17 was able to tour the laboratory facilities and discuss on-going activities. On the third day there was a wrap-up session on the DMRP activities in the morning and then the SSC-17 met in closed session, deliberating on the accomplishments and direction of the DMRP, and developing specific recommendations for the current DMRP projects/tasks and those projected to the next biennium. Discussion continued on the draft recommendations and their prioritization on the fourth day. The main draft recommendations were first discussed with Mr Meghzifene, and then presented to the DMRP staff on the afternoon of the last day.

Ms Velázquez Berumen attended the presentation of recommendations by the SSC-17 and drew attention to a number of recommendations that could benefit from the engagement of the WHO. These recommendations are summarized in Section 3.5 and the SSC-17 has added a specific recommendation on IAEA/WHO collaboration.

Mr Malavasi, Deputy Director General, met with the SSC-17 and the DMRP staff after the presentation of the recommendations. He was interested in the number of recommendations and how it reflected on the work of the DMRP. He spoke about the upgrades and expansion to the Seibersdorf laboratories and expressed optimism that a linac would be obtained for the Dosimetry Laboratory. He concluded by thanking the Committee for its work and was looking forward to the final Report.

1.2.2 Programme evaluation

In preparation for its report, the SSC-17 reviewed the activities reported by the DMRP for the 2014-2015 biennium and the outcome of the recommendations made by the SSC-16. The SSC-17 also reviewed the results of the DMRP's "brainstorming" for the biennium 2018–2019 and presented some suggestions for future activities. The SSC-17 evaluation was similar to that of previous SSCs and considered:

- The objectives of the sub-programme areas.
- The impact (benefit to the Member States).
- Opportunities to reduce costs or improve efficiency.
- The continuing relevance of Agency activities.

Specific recommendations from the SSC-17 are identified throughout the text, and are also listed in priority categories of high, medium and low at the end of the report. Comments regarding specific aspects of the DMRP sub-

[1] When there is no risk of confusion, we will use the simplified notation of "the DMRP" to refer interchangeably to either the Section or the Subprogramme.

programme are made throughout the text and the more important comments are also given at the end of the report.

2. INTRODUCTION

The SSC-17 expressed their thanks to the DMRP staff members for preparing a comprehensive report covering the activities of the sub-programme on Dosimetry and Medical Radiation Physics during the biennium 2014-2015. This report was provided well in advance of the meeting, enhancing the Committee's ability to develop relevant recommendations.

The SSC-17 report follows the format established by previous reports and begins with a general discussion of administrative items and collaborative ventures within the Agency. Selected projects are then discussed in turn. In general, the report mentions only those activities of the DMRP Section for which the SSC-17 has comments or recommendations at this time. It should be noted that when a particular service provided by the DMRP is not mentioned specifically, the SSC-17 strongly endorses its continuation and is particularly pleased to see the continuing support and involvement of the DMRP in appropriate TC projects. A list of acronyms is given in the Appendix.

The SSC-17 is honoured to assist in the evaluation of the DMRP's work for NAHU and the SSDL network, and was pleased to learn that its report will be perceived as useful in planning for the Agency programme and the 2018-2019 budget.

3. REPORT

3.1 General Organizational Items

The SSC-17 was pleased to learn that 21 of the 25 SSC-16 recommendations made in 2014 have been fully implemented or are in progress and nearly all of the comments made in the previous Report have been addressed. The quality and volume of work produced by the DMRP is impressive and the Deputy Director General, Mr Aldo Malavasi, and the Director of the NAHU, Ms May Abdel-Wahab, are thanked sincerely for the support they give to the DMRP Subprogramme.

The SSC-17 appreciated visiting the Dosimetry Laboratory (DOL) in Seibersdorf, having a full day dedicated to just the DOL presentations and activities. The SSC-17 felt that it was quite useful to continue this dedicated activity for future SSC meetings.

The SSC-17, during its discussions following the presentations, had several general recommendations that are believed will improve future SSC meetings and the general activities of the DMRP.

The SSC-16 had noted that the programme had reduced the number of DMRP projects from four to three by grouping all the Dosimetry Laboratory associated activities into one, combining all the research and development activities in dosimetry as a second project, and combining all the clinical medical physics activities, including imaging and radiation therapy, into a third project. Consequently, this new project grouping, as follows, is used in the present report:

- Project 2.2.4.1: Calibration and auditing services
- Project 2.2.4.2: Developments in radiation dosimetry
- Project 2.2.4.3: Clinical medical radiation physics for imaging and radiation therapy

The SSC-17 finds the new three-project structure to be a reasonable fit to the requirements of the DMRP.

[R21] The SSC-17 recommends that the current project structure of the DMRP Subprogramme be maintained.

The SSC-17 suggests that, for future SSC meetings, a thumb drive should be provided with all of the material presented during the meeting and that the hardcopy binder not be provided to the Committee. The SSC-17 also noted that more time should be allocated for questions to each speaker after each presentation.

The SSC-17 recognizes the importance of the DMRP's database development that has merged, or is in the process of merging, several unique databases into a single relational database that includes:

a) DIRAC
b) Dosimetry Audit Network (DAN)
c) Calibrations and comparisons
d) IAEA/WHO Dosimetry Audits
e) SSDL Network

The SSC-17, as did the SSC-16, continues to recognize that the DMRP databases are a unique resource for the IAEA,

the WHO and the Member States. It includes, among many other data sets, the Directory of Radiotherapy Centres (DIRAC), the only reasonably complete listing of radiation therapy sites and equipment around the world. In view of the fact that obtaining the relevant data from the Member States is often difficult and time-consuming, to fully utilize the data within the database to assist the DMRP and the Member States, there is the need to have a dedicated technical staff member who can work with the database administrator to enhance the capabilities of the databases.

[R5] The SSC-17 recommends that a technical staff member be assigned to the DMRP whose main role would be to interact with the DMRP database administrator to develop and enhance the databases established by the DMRP, especially the Dosimetry Audit Network (DAN) and DIRAC.

Note that this is not to be an IT person, but rather someone able to understand the radiotherapy community and processes to establish improved mechanisms for updating and expanding these important databases, such as obtaining more complete data from large countries.

The SSC-17 believes that an effective means of communication, education and training to the Member States and Radiation Oncology Community can be accomplished by providing documents, information and videos on an easily accessible web site. The SSC-17 noted that the IAEA web site is not very helpful in directing a user to the material of interest within the IAEA internet site, such as accessing the DMRP content. In addition, the built-in search engine is often not helpful in accessing the desired information. An external search using Google is generally the most effective way of accessing the relevant web pages.

[R47] The SSC-17 recommends that the DMRP works to provide better web links to the Dosimetry Laboratory or other IAEA web pages from, e.g., the IAEA Human Health Campus Website.

3.2 Project 2.2.4.1: Calibration and Auditing Service

This project covers the dosimetry audit services and dosimetry calibration services including related development and activities. The audit services are considered to be very important by the SSC-17, for example, the IAEA/WHO TLD audit programme helps hospitals in the Member States, either directly or through national audit networks, to have confidence that the doses they are delivering to their radiotherapy patients are accurate.

The DMRP, for many years, has published an SSDL Newsletter containing useful information that is a valuable resource to the SSDL Network and Radiation Oncology community within the Member States. The DMRP has indicated that it is considering changes to the SSDL Newsletter and the methods used to communicate with the SSDLs in the Network. Currently the interaction is based on e-mail contacts. This method of communication is limited and only provides a private interaction between a particular SSDL laboratory and the DMRP, but not to the SSDL Network and radiotherapy community within the Member States as a whole. An alternative approach would be to make the interaction available to the wider user community via open platform posting of questions and comments that are available for discussion to all SSDL members.

[R27] The SSC-17 recommends a pilot study of a social media-based feedback system (e.g., user community) be conducted by the DMRP. Furthermore, a transition to electronic distribution of the Newsletter is recommended.

FACILITIES

The Seibersdorf Dosimetry Laboratory (DOL) is in the process of converting from using TLD dosimeters to RPL glass dosimeters. The reason for this change is due to the age of the TLD readers and that the manufacturer has phased out the technology. In addition, the glass dosimetry system should be more efficient in terms of workflow and staffing needs. The DOL has conducted pilot studies indicating the advantages of implementing the glass dosimetry audit system. To effectively and efficiently implement this new dosimetry audit system, the appropriate functional database has to be developed and implemented. This will allow the storage of individual dosimeter calibration factors, calculation processes and report generation.

[R1] The SSC-17 recommends that the DOL implements the glass dosimetry audit system, including appropriate QMS requirements, as soon as possible dependent on the readiness of the required database.

The SSC-17 is also very pleased with the implementation of an electronic irradiation/data form to enable the data to be downloaded directly to the DMRP database for analysis and report generation.

The DMRP calibration services operate under a quality management system (QMS) that meets the requirements of ISO 17025. The last review of the DMRP QMS was carried out in March, 2016, just prior to the SSC-17 meeting, by the EURAMET Regional Metrology Organization (RMO). This is the second major audit carried out by EURAMET. Because of the international role of the DMRP, the SSC-17 believes that transparency and independence would be better served if QMS reviews were not always carried out by the same RMO.

[R26] The SSC-17 recommends that no more than two consecutive major reviews of the DMRP QMS be carried out by the same RMO.

The Renovation of the Nuclear Applications Laboratories (ReNuAL) project will renovate and upgrade the laboratories at Seibersdorf and the Dosimetry Laboratory of DMRP is included in the ReNuAL^{+} phase of the project. It is hoped that adequate funding, possibly through extra-budgetary contributions, will become available to acquire a clinical linear electron accelerator (linac) and also to construct a linac bunker as part of these upgrades. Such a machine will permit the DOL/DMRP to extend its work and provide dosimetry services to Member States for the most widely used technique for radiation therapy.

[R3] The SSC-17 recommends consideration for the addition of one full-time staff member so that adequate resources are available to exploit the new linac laboratory. Furthermore, funds must be available to support a service contract for the new linac.

The construction of the linac bunker and the related laboratory modifications will likely lead to disruptions in the operation of the dosimetry laboratory.

[R42] The SSC-17 recommends that the DMRP assesses the impact of the bunker construction and installation of the new linac on current DOL operations and services.

CALIBRATIONS AND COMPARISONS

During the 2014-2015 period, the DOL calibrated over 125 ionization chambers (about 60 – 70 annually), 46 % of those were calibrated for radiation protection, 35 % for radiotherapy dosimetry, 18 % for diagnostic radiology and 1 % for low dose rate brachytherapy. The increased number of calibrations for protection level may be related to the establishment of new SSDL laboratories through TC projects, which often start the service from protection calibrations and request traceable calibration from the IAEA.

The DOL currently provides over 500 calibration coefficients per year, for ionization chambers of the IAEA/WHO SSDL Network, as shown in Figure 1.

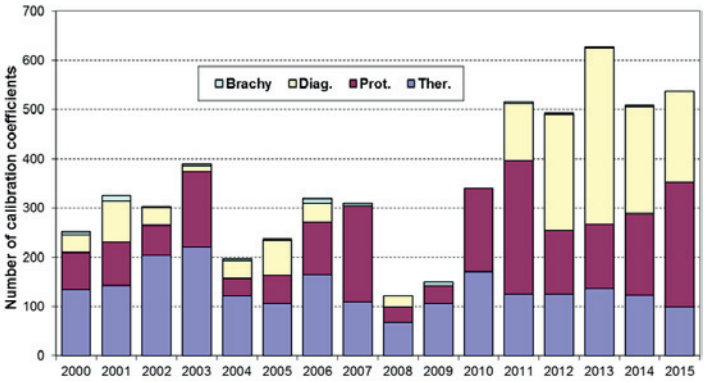

Figure 1. Distribution of IAEA calibration coefficients issued since 2000.

The SSC-17 recognized the heavy workload of the DOL, the increasing demands for calibration services from Member States and the fact that many SSDLs request several calibration points per ionization chamber and electrometer. The calibration of electrometers in terms of electrical quantities is expected to reduce the workload of the DOL. The SSC-17 acknowledged that substantial preliminary work has already been performed in this field.

[R2] The SSC-17 recommends that the DMRP completes the work to establish an electrometer calibration service. This service will provide the customer with added flexibility and will help to optimize the calibration workload of the DOL.

The SSC-17 acknowledged the progress for the installation of a new HDR brachytherapy afterloader at the DOL that can contain either an Ir-192 or Co-60 source. The need for brachytherapy calibration services to Member States for Ir-

192 or Co-60 beams is expected to increase; this is not the case for Cs-137 beams, since the use of MRD/LDR Cs-137 sources is diminishing.

[R11] The SSC-17 recommends that the DMRP implements within the DOL an Ir-192 and Co-60 well chamber calibration service (along with the necessary QMS requirements) for brachytherapy, while assessing the need to continue offering the service based on Cs-137.

As Figure 1 indicates, about 75% of the calibration coefficients were derived for radiation protection and diagnostic radiology level ionization chambers. Recently, the DMRP has taken part successfully in a computed tomography (CT) dosimetry EURAMET.RI(I)-S12 (project #1327) bilateral comparison (with PTB) and a EURAMET.RI(I)-S9 (project #1177) comparison, in the field of diagnostic radiology for air kerma area product, P_{KA}, and air kerma, K.

For many years, the DMRP has been offering a radiation protection postal dosimetry audit service for the SSDLs. The audit service based on TLDs had been provided until 2013, when it was replaced by the new service based on an optically stimulated luminescence dosimetry (OSLD) system. The aim of the audit service is to check the Cs-137 radiation protection calibrations provided by the SSDLs in terms of air kerma.

Several SSDLs provide reference irradiations for personal dosimeters to support dosimetry services. The reference irradiation conditions and dosimetric quantities differ from those used for air kerma measurements and therefore, a need for SSDLs to test and verify their capabilities in this field has been recognised.

[R46] The SSC-17 recommends that the DMRP implements a radiation protection $H_p(10)$ audit for SSDLs, supplementary to the existing TLD audit for radiation protection air kerma.

Radiation protection beta-ray calibrations are being offered by a few SSDLs, while there may be others intending to establish such calibration services. The DOL is not providing radiation protection beta-ray calibration services. The SSC-17 understands that this service requires new infrastructure, capabilities and human resources and therefore a feasibility study should be performed to assess the need of establishing this service.

[R48] The SSC-17 recommends that the DMRP assesses the need for the DOL to provide beta-ray calibration services to SSDLs.

ACTIVITIES OF DOSIMETRY LABORATORY AND SSDLS

Mammography X-ray beams have traditionally been based on Mo and Rh anodes used with Mo or Rh filters. However, clinical digital equipment is more suited to higher effective energies, efficiently produced by W anode tubes with Al, Ag and Rh filtration. At present, the DOL provides ionization chamber calibrations using W anodes filtered by Al or Mo.

[R38] The SSC-17 recommends that the DMRP investigates whether to expand the DOL mammography beam qualities to include W/Ag and W/Rh in order to cover clinical digital mammography beams.

In conjunction with this recommendation, the corresponding activities of the SSDLs should be considered:

[R37] The SSC-17 recommends that the DMRP analyses if it is appropriate for the SSDL Network to transition from the use of X-ray tubes with Mo and Rh anodes to W anode tubes for ionization chamber calibrations at mammography beam qualities.

The SSC-17 notes the success of the three series of comprehensive quality audits for radiation oncology (QUATRO), diagnostic radiology (QUAADRIL) and nuclear medicine (QUANUM), and considers that it would be beneficial to establish a similar series of comprehensive audits for the activities of SSDLs, as an extension of the existing dosimetry auditing activities. Such audits will enable SSDLs to review and assess their dosimetry standards, measurements and calibration capabilities and therefore to improve the quality of their services. An appropriate acronym commencing with QUA might be considered.

[R39] The SSC-17 recommends that the DMRP considers establishing comprehensive quality audits for SSDLs.

AUDITS

The DOL currently provides cost free postal dose audits to approximately 2200 radiotherapy centres in LMI countries (see Figure 2) per year evaluating ~600 beams/year. In view of the importance of correct radiotherapy dose delivery to patients to ensure safe and effective treatment, the SSC-17 encourages the DMRP in collaboration with the WHO to continue to investigate the 5 % of TLD-audited radiotherapy centre results who do not fall within the 5% acceptance criterion from the first irradiation. These investigations will require collaboration with radiotherapy staff. Of interest, which should be investigated by the DMRP, is the fact that 50% of the repeat TLD sent each year go to only 6 of the 132 countries that have centres that are audited in recent years.

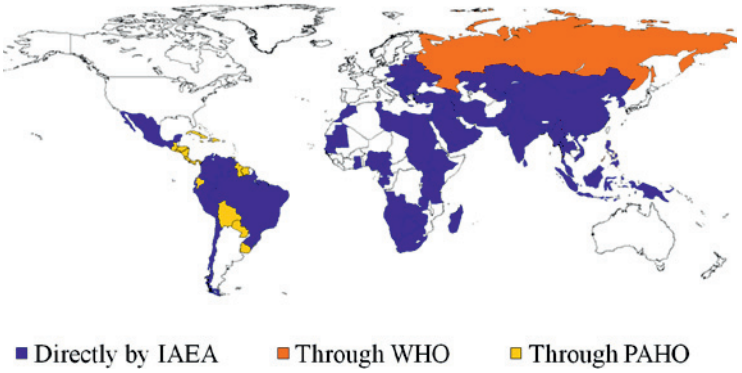

Figure 2. Countries where the TLD postal audits were sent.

The SSC-17 applauds the DMRP's effort to provide videos that show the proper setup of the TLD irradiation geometry.

The SSC-17 was particularly pleased to note the DMRP's effort to analyse the results and data from the postal dose audits. There appears to be an immense amount of information available for analysis, including dose discrepancies, countries of origin and reasons why. The SSC-17 was shown data indicating the number of discrepant results as a function of treatment machine age. The data show that the older the machine, the higher the probability of a TLD result falling outside the 5% acceptance criteria. In 2014-2015, 73 TLD deviations beyond the 5% level (43 linacs and 30 Co-60 units) had to be investigated as to the cause. This is particularly concerning for some countries in Eastern Europe where only ~75% of their Co-60 units audited had TLD results within the 5% criterion as noted in Figure 3.

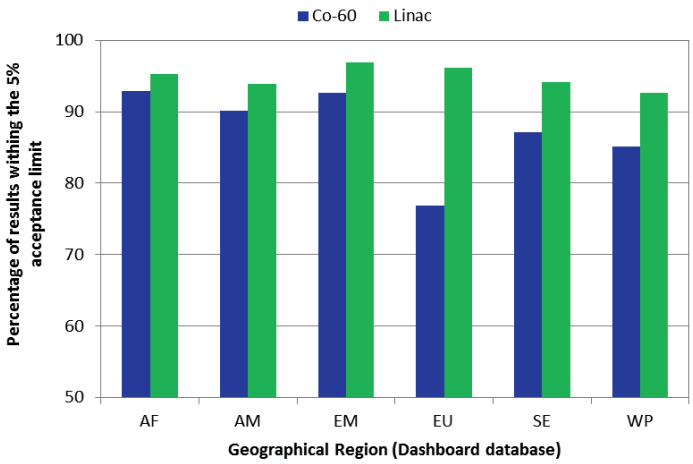

Figure 3. Percentage of TLD beam output audits within the 5% acceptance criterion by geographical region.

The SSC-17 recognizes the importance of conducting the postal dose audits of radiotherapy centres. The results of these audits continue to improve as discrepancies are identified and corrected with the assistance of DMRP staff. The DOL has historically used TLD to perform the audits, but is currently transitioning to the use of glass dosimeters, as mentioned above. These postal dose audits currently only verify photon doses from Co-60 or linacs. Two treatment modalities used by Member States include electron beam radiotherapy and brachytherapy.

The DMRP has indicated that audits for electron beam dosimetry will be offered, assuming increased resource availability after implementation of the glass dosimetry system. Data from the IROC Houston QA Center in the United Sates indicate that dosimetry deviations from electron beam reference calibration remote audits occur at a higher rate than for photon beams. The SSC-17 understands that implementing this remote electron dosimetry audit will require personnel resources not currently available.

[R32] The SSC-17 recommends that the DMRP implements an electron beam dosimetry audit service on a routine basis, beyond just for specific requests, if the efficiency improvements from implementing the glass dosimetry system allows additional personnel resources to be directed towards supporting such a service.

A natural extension of services provided by the DOL to audit radiotherapy modalities would be to develop an on-site audit system for brachytherapy to be used by National Audit Networks. The use of low dose rate (LDR) and high

dose rate (HDR) brachytherapy to treat gynecological cancer is high in Member States, yet there is currently no audit system of this dose delivery modality. As an extension to the CRP for QA audits of advanced methodology in radiation therapy dose delivery, attention to the delivery of brachytherapy doses using high dose rate (HDR) Co-60 or Ir-192 sources should be addressed.

[R24] The SSC-17 recommends that the DMRP investigates the need to develop a CRP on developing a QA audit for HDR brachytherapy that could be used by National Audit Networks.

The DOL has been conducting postal dose audits to Member States and has decades of data from its TLD audit activities. One of the key purposes of the auditing services is to assist in ensuring the quality of the dosimetric chain in Member States through an independent means of verifying the calibration of radiation beams used for the treatment of cancer patients. The SSC-17 is very impressed with the amount and quality of presented data and analysis such as that seen in Figures 4 and 5. It has been more than 10 years since the DOL published a manuscript detailing the findings of the TLD audit services.

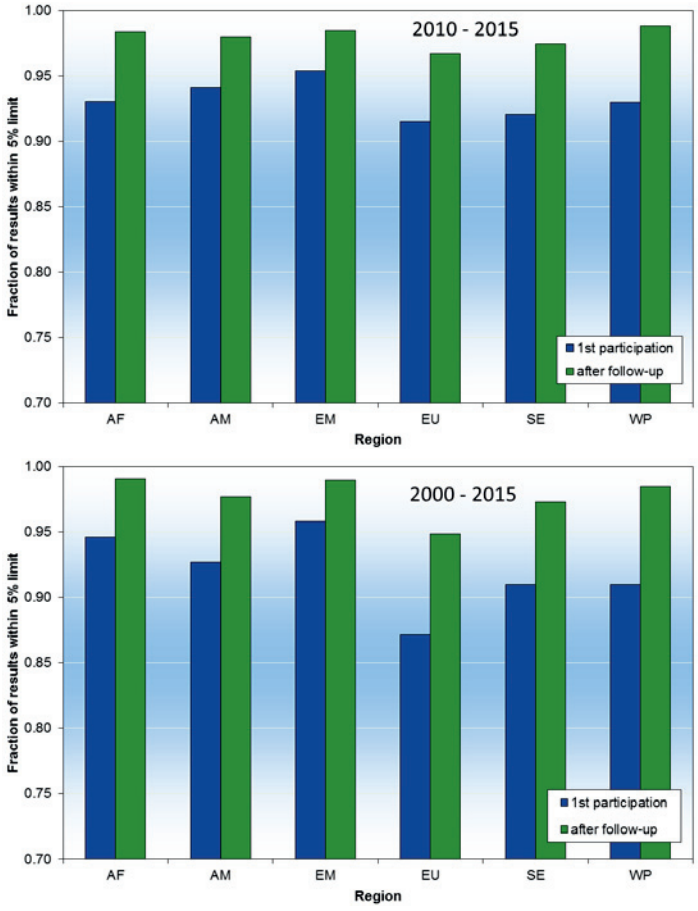

Figure 4. Analysis of TLD results by geographical region.

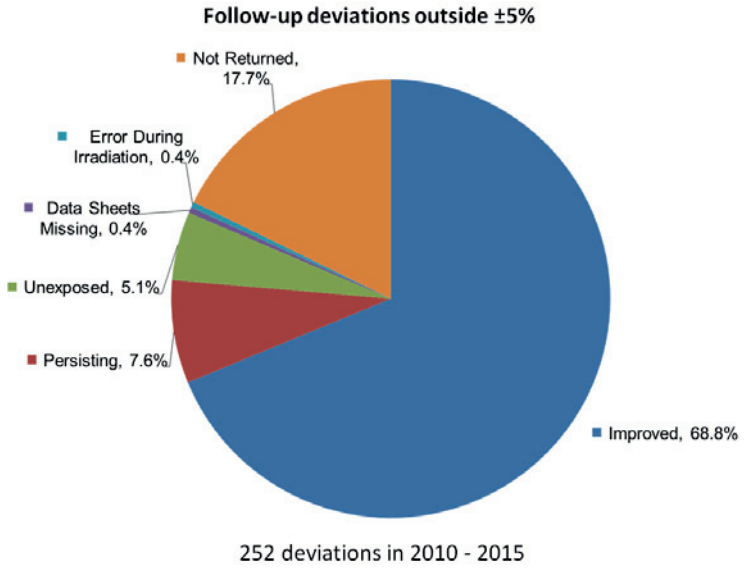

Figure 5. Follow-up for TLD result deviations.

[R16] The SSC-17 recommends that the DMRP produces a peer-reviewed publication summarizing the historic results of the TLD audit program that includes the appropriate statistical significance tests to support concluding statements and findings.

The SSC-17 was pleased to see that the DOL was exploring the use of Optically Stimulated Luminescent Dosimeters (OSLD) for radiation protection audits and encourages the DOL to continue to explore their use in its audit activities.

3.3 Project 2.2.4.2 Developments in Radiation Dosimetry

This project focuses on research and development activities in radiation dosimetry, contributing to international consistency in dosimetry and monitoring the dissemination of standards. It fosters research and development in medical radiation dosimetry and plays a role in educating SSDL staff, physicists and other healthcare workers working in ionizing radiation dosimetry. The main tasks under this project are the development and testing of dosimetry Codes of Practice and the production of new and updated guidelines.

The estimated uncertainty on a measured or calculated quantity is as important as the quantity itself. However, estimating an uncertainty is often found to be the most difficult part of establishing a result. In June 2014, the DMRP participated in a joint workshop with the International Centre for Theoretical Physics (ICTP) on the determination of uncertainties of measurements in medical radiation dosimetry. The SSC-17 commends the DMRP for

participating in this workshop and encourages similar initiatives.

[R40] The SSC-17 recommends that the DMRP continues training activities on the general evaluation of measurement uncertainty.

CODES OF PRACTICE

It is noteworthy that an increasing number of radiotherapy centres are now using absorbed dose to water protocols, largely due to the widespread and free distribution of the IAEA publications. The IAEA Code of Practice TRS-398: "Absorbed Dose Determination in External Beam Radiotherapy: An International Code of Practice for Dosimetry based on Standards of Absorbed Dose to Water" is widely used as the basis of reference dosimetry in the Member States. This protocol was prepared in the mid-1990s and published in 2000. A consultants meeting held in August 2015 reviewed the current status of TRS-398 and concluded that an update was required to take into account advances in a number of areas, such as the availability of new data and the use of new radiotherapy technologies and radiation detectors. The poor availability of $N_{D,w}$ calibrations for kV X rays is also a concern to be addressed in an update.

[R6] The SSC-17 recommends that the DMRP moves forward with its plans to update the Code of Practice for Dosimetry, TRS-398.

Ionization chamber k_Q factors are now known for a much wider range of chambers than were included in the original TRS-398. It may be desirable to establish an online database of k_Q factors to be used in conjunction with the dosimetry protocol. Such a database could be easily updated as new chambers become available or historical values are revised.

[R43] The SSC-17 recommends that the DMRP establishes a database of k_Q factors and guidelines for vetting new data, in collaboration with the AAPM.

The DMRP has put significant effort into the development of protocols for static radiation fields, most recently, in collaboration with the AAPM, the Code of Practice for the dosimetry of small (static) radiation fields. With the development of new technologies and modalities, there is an increasing need for a code of practice addressing composite fields.

[R23] The SSC-17 recommends that the DMRP initiates a code of practice for dynamic radiation therapy dosimetry.

With the code of practice for the dosimetry of small radiation fields now complete, an international workshop was held in December 2015 to teach the main practical aspects of the protocol. In addition, a CRP on the testing of the code of practice has been approved, with four research agreements and nine research contracts awarded, and the first RCM was held in November 2015.

[R12] The SSC-17 recommends that the DMRP reports on the implementation of the small field dosimetry Code of Practice, conducted through a CRP, and assess whether a specific small field dosimetry audit should be offered.

Initial efforts to gauge the need for a code of practice for brachytherapy met with a mixed response, with some feeling that it might have been premature at that time. Nevertheless, it is recognized that such a protocol will be required at some point in the near future. The protocol should include the use of Co-60 and other radioactive sources in clinical use, as appropriate.

[R7] The SSC-17 recommends that the DMRP continues with its efforts to develop a code of practice for brachytherapy dosimetry.

Document TRS 457 "Dosimetry in Diagnostic Radiology: An international Code of Practice" was published in 2007. This Code of Practice deals with issues of dosimetry in diagnostic radiology procedures, involving calibrations and measurements relevant to SSDLs and clinical users. The new techniques that have been implemented over the last 10 years (tomosynthesis, cone beam computed tomography, among others) justify investigating the need to revise the TRS 457 document.

[R18] The SSC-17 recommends that the DMRP assesses the need to update TRS 457.

GUIDANCE FOR SSDLs

The IAEA/WHO SSDL Network was first established in 1976. A formal Charter was published in 1999 with the

objective of "... explaining the privileges, rights and duties of members in the Network …". As the Network has expanded and matured over the past seventeen years, the SSC-17 believes it is time for the Charter to be reviewed and updated, one particular aspect being the extent to which quality can be assured.

[R13] The SSC-17 recommends that the DMRP updates the SSDL Network Charter. It should also consider adding a tier structure to the membership description for SSDLs so that a higher tier is associated with a greater level of quality control.

The SSC-17 recognizes that Member States are establishing new SSDLs or expanding activities in existing SSDLs and sees the utility in a guidance document to assist Member States in developing or enhancing SSDLs in areas such as physical infrastructure, management, safety, maintenance of quality and dosimetric techniques.

[R4] The SSC-17 recommends that the DMRP develops a guidance document for establishing a new SSDL.

Currently, a handbook for SSDLs is being prepared, which aims to provide a useful tool for the training of SSDL staff and more generally for those interested in ionizing radiation metrology.

[R36] The SSC-17 recommends that the DMRP completes the document entitled Training on Radiation Metrology: A handbook for SSDLs.

The SSC-17 observed that the web site for the SSDL Network provides only limited information to SSDL members and web visitors. Some information, e.g., calibration and measurement capabilities, is stated to be available upon request and could be made more readily available.

[R45] The SSC-17 recommends that the DMRP modifies the SSDL Network web site to include as much additional information as possible, while respecting confidentiality.

OTHER GUIDELINES

Following the completion of the CRP on dose optimization in pediatric imaging, there is a need for guidelines on how to implement strategies derived from the CRP. There are now harmonized European and US guidelines and the DMRP should consult with the relevant professional societies in developing IAEA guidance.

[R9] The SSC-17 recommends that the DMRP generates a guideline publication on how to implement strategies derived from the CRP on dose optimization in pediatric imaging.

An update of the 1991 IAEA publication TECDOC-602, Quality Control of Nuclear Medicine Instruments, is planned. There have been many substantial advances in imaging technology since 1991 and the majority of the update would appropriately focus on imaging instrumentation. There have also been advances in non-imaging devices essential for the proper practice of nuclear medicine.

[R29] The SSC-17 recommends that the DMRP updates TECDOC-602 to include updated QC/QA for currently used non-imaging devices (e.g., thyroid probes, dose calibrators, whole-body counters). It is also recommended that this document be translated into additional Member State languages.

In nuclear medicine, there are occasions of inadvertent delivery of radiation doses to infants from lactating women treated with radiopharmaceuticals.

[R33] The SSC-17 recommends that the DMRP and the NSRW, in collaboration with the WHO, investigate the need for a guidance document that provides estimates of the effective dose received by a nursing infant following a radiopharmaceutical procedure to the mother.

3.4 Project 2.2.4.3 Clinical medical radiation physics for imaging and radiation therapy

This project aims at developing guidelines and training material for best practice in clinical medical radiation physics. It also promotes comprehensive audits and research in the clinical environment through CRPs. The project includes diagnostic radiology and nuclear medicine imaging physics as well as radiotherapy physics.

The SSC-17 believes that one of the most valuable educational tools available to the Member States are the three handbooks developed for teaching Radiation Oncology Physics, Diagnostic Radiology Physics and Nuclear Medicine Physics. In addition to the handbooks,

the developed slide sets for the individual chapters within each handbook are an invaluable resource to the community. However, the slide sets associated with individual chapters of the three handbooks are presently freely available in only PDF format, making them difficult to use for lectures or training. The PowerPoint versions of the slide sets would allow for direct use in educating Member State medical physicists. However, to obtain a PowerPoint version of the slide sets, one must request it through a registration process that was not obvious to the SSC-17 or readily available on the IAEA website.

[R10] The SSC-17 recommends that the DMRP makes the registration form readily available/visible to Member States on the IAEA website so that the PowerPoint slide sets for each handbook chapter become more accessible.

Quality audits are an important mechanism for addressing how well Member State centres using ionizing radiation for patient therapy or imaging are achieving best practices in an effective and safe manner. The SSC-17 believes that the DMRP site visit audits conducted through the QUATRO, QUAADRIL and QUANUM programs to Member State radiotherapy centres, diagnostic radiology centres, and nuclear medicine centres, respectively, are outstanding programs that should be continued. QUATRO and QUANUM audit visits are used extensively and the SSC-17 expects to see an increased demand for QUAADRIL in the very near future.

[R28] The SSC-17 recommends that the DMRP continues its support for QUAADRIL, QUATRO and QUANUM and raise awareness of these programs and their benefits to Member States.

The SSC-17 recognized an opportunity for and an accomplishment by the DMRP. The assistance that the DMRP is providing to the training to nuclear emergency workers is admirable. In the case of a large scale nuclear or radiological emergency (NRE), there generally will not be enough trained nuclear emergency workers to deal with the disaster. Under an extra-budgetary contribution, the DMRP collaborated with Fukushima Medical University to develop training materials that can be used to help medical physicists carry out some of the duties in response to a nuclear emergency, if required. The ICRU is currently generating a document on NREs that does not consider the role of medical physicists. The DMRP is encouraged to exchange information on this topic with the ICRU as to the role a medical physicist can play during an NRE. The DMRP should work with the AAPM to propose a symposium during the 2017 AAPM summer meeting on this topic.

[R34] The SSC-17 recommends that the DMRP continues to be involved in the Nuclear or Radiological Emergency training and education of medical physicists.

The Doctoral contracts are a CRP activity awarded to institutions in developing low and middle income countries for the benefit of students enrolled in a Ph.D. program at a university of a Member State. The projects developed by these students are aimed at improving the care of cancer patients in Member States. The SSC-17 believes that a doctoral CRP is an efficient and sustainable activity that reduces the risk of "brain drain", strengthens the local expertise in medical physics research, and promotes the establishment of long-lasting academic collaborations.

[R19] The SSC-17 expresses enthusiasm for doctoral CRPs and recommends that the DMRP continues their implementation.

The Applied Radiation Biology and Radiotherapy (ARBR) and the Nuclear Medicine and Diagnostic Imaging (NMDI) sections are currently conducting multi-institutional clinical trials that involve the use of radiation therapy and/or diagnostic imaging. These trials are set up as Coordinated Research Projects (CRPs). It has been recognized by these two sections that there is a need for QA processes to be included in the trials to reduce the uncertainties of the clinical trial data. Including the appropriate QA processes within the trials such as benchmark cases, reference beam output verification, end-to-end credentialing of treatment processes, etc. will help to prevent possible trial outcomes from being obscured by data uncertainty. The DMRP has been asked to provide expert assistance in defining and coordinating the QA requirements of these and future trials. The SSC-17 believes this is a very appropriate use of the DMRP's expertise.

[R8] The SSC-17 recommends that the DMRP continues to support the QA efforts for the clinical trial CRPs of the ARBR and the NMDI, in a formalized systematic manner, by providing expert advice and coordinating required QA activities.

DIAGNOSTIC RADIOLOGY

Digital technologies are being adopted worldwide for medical imaging. When purchase cost is the decisive factor, countries do not always choose the most appropriate modality for a given application, but the least costly. In particular for screening mammography, there is an accelerated trend towards the acquisition and use of computed radiology (CR) equipment, technically proven as not equivalent to digital units, and complex to optimize for screening studies.

[R20] The SSC-17 recommends that the DMRP, jointly with the WHO, develops guidelines that are specific to the needs of CR technology, particularly if used in demanding applications such as screening mammography.

The SSC-17 is pleased that the DMRP has announced the publication of the document entitled "Guidelines for Automatic and Remote Quality Control in Diagnostic Radiology". Digital technology permits images for quality control to be acquired locally but analysed at a remote site with the relevant expertise. This approach has the potential to greatly improve image quality when qualified human resources are scarce. Operating the remote quality control site will require skills with digital tools and the handling of files. Online media resources are likely to be well received by those assigned to carrying out remote quality control.

[R41] The SSC-17 recommends that, subsequent to the publications already planned related to diagnostic radiology, online media resources be developed by the DMRP, in collaboration with the WHO, to facilitate implementation.

NUCLEAR MEDICINE

Support of dosimetry in nuclear medicine must cover both diagnostic imaging and radiopharmaceutical therapy. Historically, dosimetric methods developed for risk evaluation in the context of diagnostic imaging have been applied to estimate absorbed doses in the context of radiopharmaceutical therapy. As new radiopharmaceutical therapeutics emerge, guidelines on appropriate dosimetry methodologies for therapy are needed. To assure that regulation of such radionuclide based therapeutics is well founded, educational efforts directed towards the regulatory community are essential.

[R30] The SSC-17 recommends that the DMRP develops training slides as a part of the CRP activity on Dosimetry in Molecular Radiotherapy for Personalized Patient Treatments.

[R31] The SSC-17 recommends that during the next IAEA meeting of national regulators, the DMRP, in collaboration with NSRW and the WHO should disseminate educational material (or possibly organize a workshop) for radiation protection regulators (IAEA) and medical regulators (WHO) regarding the distinction between dosimetry for radiopharmaceutical therapy (such as for alpha emitters) and dosimetry for diagnostic imaging agents. Similar collaborative educational efforts in other areas are also encouraged.

RADIATION ONCOLOGY

The DMRP has a long history of supporting Quality Assurance Teams for Radiation Oncology (QUATRO) that use the document entitled Comprehensive Audits of Radiotherapy Practices: A Tool for Quality Improvement. To date there have been 87 missions in Member States with the intent to improve the radiotherapy practice and radiation dose delivery to patients treated at radiotherapy institutions (Figure 6).

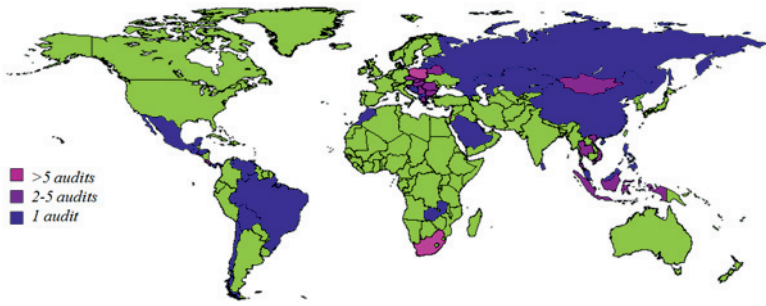

Figure 6. Countries having received one or more QUATRO missions.

These site visits have produced a large amount of data and useful information that could assist other radiotherapy institutions to improve their treatment of patients. An analysis of 31 QUATRO reports in the Europe Region indicated that 11 audited centres were designated as "Centres of Competence". A total of 759 recommendations were made in the 31 reports that when resolved, improved the quality of the patient care.

[R15] The SSC-17 recommends that the DMRP generates and publishes a peer-reviewed manuscript outlining the findings from the QUATRO site visits.

It is suggested that one possible result to be included in the manuscript would be an analysis and discussion of how the QUATRO site visit findings correlate with the IAEA's 2015 Human Health Reports No. 13 "Radiotherapy Staffing: An Activity Based Approach".

While the QUATRO site visits have proven to be a valuable tool in improving the quality of patient care, the QUATRO guideline were written some years ago in 2007. Since this publication, there have been numerous treatment and technological advances introduced into radiotherapy clinics throughout the Member States. The current QUATRO guidelines do not address how to review and evaluate these newly introduced technological advances involving imaging, treatment planning and dose delivery for IGRT, SBRT, SRS, on-board imaging, etc.

[R17] The SSC-17 recommends that the DMRP modifies the current QUATRO guidelines to account for the introduction of modern advanced technologies and new treatment modalities into radiation oncology clinics.

As a part of the introduction of new advanced technologies into cancer therapy in Member States, the SSC-17 is pleased to recognize the work accomplished thus far regarding advanced technologies. The SSC-17 would also like to efforts directed towards continuing to address the implementation of new radiotherapy processes in Member States. One of the most prominent advances in radiotherapy is the incorporation of image guidance in the delivery of daily radiotherapy doses to patients. As radiotherapy institutions in Member States continue to purchase new linacs that include onboard imaging capabilities, these imaging devices will play a greater role in guiding the accurate and safe treatment of patients. In view of these evolving imaging and treatment technique changes:

[R14] In view of these evolving imaging and treatment technique changes, the SSC-17 recommends that the DMRP investigates the need to develop a CRP on implementation, commissioning, image dosimetry, image quality and quality control testing of image guidance radiation therapy (IGRT) systems.

This effort towards IGRT is a logical continuation of the DMRP's focus on quality assurance for advanced technology in radiotherapy dose delivery. In addition to the need for improving these new technologies, there is also a need to provide guidance to radiotherapy centres who are upgrading their treatment machines from Co-60 to linear accelerators. Data from the DOL and within the DMRP's DIRAC database show a steady decline in the use of Co-60 units and a rapid increase in the use of linacs in the radiotherapy clinics of Member States. This change in treatment modality is encouraged and supported by the WHO. The introduction of linacs presents new opportunities as well as challenges to personnel using these units to treat cancer patients.

[R25] The SSC-17 recommends that the DMRP, with the cooperation of the WHO, establishes guidelines to assist radiotherapy clinics in making the transition from Co-60 based radiation therapy to that using linacs.

These guidelines should address issues such as installation changes, radiation protection requirements, equipment and staffing requirements, treatment option changes, changes in treatment planning and quality assurance requirements.

The SSC-17 was pleased to hear about two efforts undertaken by the DMRP addressing the quality of radiotherapy advanced technologies. The DMRP, in collaboration with consultants, established a methodology to perform an end-to-end QA test for Head and Neck (H&N) intensity modulated radiation therapy (IMRT) to be implemented during an on-site visit to a participating radiotherapy institution. The DMRP, as part of a CRP is also investigating the relationship between end-to-end accuracy in a radiotherapy procedure and the extent and depth of QA at participating radiotherapy institutions using specially designed end-to-end QA phantom for remote audits. To date, the newly developed auditing methodology has been pilot tested and data collection is expected to be completed by the end of 2016. Both of these efforts are underway and data are being gathered.

[R35] The SSC-17 recommends that the DMRP reports on the findings from the multicentre on-site head and neck IMRT audit pilot test.

[R44] The SSC-17 recommends that the DMRP reports on the implementation and findings of the CRP using end-to-end remote audits for advanced radiotherapy dose delivery (IMRT/VMAT).

An activity performed by the DMRP which is applauded by the SSC-17 is the DMRP's commitment to reach out to the radiation oncology community to disseminate information during conferences and symposiums. The SSC-17 congratulates the DMRP on past conferences and symposia such as the International Conference on Advances in Radiation Oncology (ICARO) and the International Symposium on Standards, Applications and Quality Assurance in Medical Radiation Dosimetry (IDOS) which deemed to be great successes. The DMRP is currently is the process of planning an ICARO-2 conference to be held in June 2017. The first IDOS symposium was held at the IAEA in 2010. Rapid advances arising from the use of new technologies and treatment modalities in radiation physics have put greater demands on dosimetry and the time is right for a symposium to be held outlining the new information.

[R22] The SSC-17 recommends that the DMRP makes the necessary plans to host a follow-up symposium (IDOS-2) in the biennium 2018-2019.

3.5 Collaboration with the WHO

The SSDL Network is a collaborative effort between the IAEA and the WHO. Adriana Velázquez Berumen, Co-Secretary of the Network, attended the closing meeting of the SSC-17 and drew attention to a number of recommendations that could benefit from the engagement of the WHO. In light of her comments, the SSC-17 recommends increased resources from the WHO to support Member States in order to improve the quality and safety of diagnostic and therapeutic procedures based on ionizing radiation technologies. Among the several potential joint projects listed below, a specific and immediate project that would benefit from input by the WHO is the provision of support to assist the DMRP in collecting data for the DIRAC database,

The SSC-17 recommendations that have a natural connection to the work of the WHO are summarized below:

[R5] The SSC-17 recommends that a more reliable method be established to keep the DIRAC database up to date. The WHO has expertise access to radiotherapy data, through national health authorities, that would be helpful for this exercise.

[R13] The SSC-17 recommends the development of a new SSDL Charter. This Charter is identified as an IAEA/WHO document. Efforts should be made to collaborate on the drafting of a new charter.

[R20] The SSC-17 notes that there are serious challenges in implementing computed radiology (CR) in diagnostic radiology in general and breast cancer screening in particular. The WHO is interested in promoting safe and effective techniques and might be able to help in solving this problem.

[R25] The DMRP has evidence that the number of therapy systems based on Co-60 is decreasing, as they are replaced by linacs. The WHO is interested in this transition and in helping Member States make the transition successfully.

[R29] The DMRP, jointly with ARBR and NMDI, runs several comprehensive audit services in radiation medicine. The WHO is interested in the results of these audits and should be able to help promote their application.

[R31]: The WHO is interested in helping regulatory agencies understand the differences between radiation protection for diagnostic imaging and that for radiopharmaceutical therapies.

[R33] The WHO is interested in helping establish material on the effective dose delivered to nursing infants if their mother has had radiopharmaceutical therapy.

[R41] Remote QA for diagnostic radiology is an important tool. The WHO is interested in helping develop suitable training materials.

In one of its comments, the SSC-17 has noted that a more robust system should be found to address the problem of audit results that lie far outside the acceptable range. The WHO might have access to contacts that can help to address these outliers.

The work of the DMRP is often carried out in collaboration with, or on behalf of, medical physicists in Member States. We note that the WHO is interested in promoting

knowledge of the qualifications needed to become a medical physicist. The profession of "medical physicist" is now formally recognized by the International Labour Organization. This helps in the development of medical physics services in developing countries and in collecting data on the number of physicists in health care.

4. SSC-17 RECOMMENDATIONS

The recommendations are prioritized as high, medium or low but within each category are not in rank order. They were assigned to each category to reflect both their importance and the SSC-17's preference for time of completion.

4.1 High Priority Recommendations

[R1] The SSC-17 recommends that the DOL implements the glass dosimetry audit system, including appropriate QMS requirements, as soon as possible dependent on the readiness of the required database.

[R2] The SSC-17 recommends that the DMRP completes the work to establish an electrometer calibration service. This service will provide the customer with added flexibility and will help to optimize the calibration workload of the DOL.

[R3] The SSC-17 recommends consideration for the addition of one full-time staff member so that adequate resources are available to exploit the new linac laboratory. Furthermore, funds must be available to support a service contract for the new linac.

[R4] The SSC-17 recommends that the DMRP develops a guidance document for establishing a new SSDL:

[R5] The SSC-17 recommends that a technical staff member be assigned to the DMRP whose main role would be to interact with the DMRP database administrator to develop and enhance the databases established by the DMRP, especially the Dosimetry Audit Network (DAN) and DIRAC.

[R6] The SSC-17 recommends that the DMRP moves forward with its plans to update the Code of Practice for Dosimetry, TRS-398.

[R7] The SSC-17 recommends that the DMRP continues with its efforts to develop a code of practice for brachytherapy dosimetry.

[R8] The SSC-17 recommends that the DMRP continues to support the QA efforts for the clinical trial CRPs of the ARBR and the NMDI, in a formalized systematic manner, by providing expert advice and coordinating required QA activities.

[R9] The SSC-17 recommends that the DMRP generates a guideline publication on how to implement strategies derived from the CRP on dose optimization in pediatric imaging.

[R10] The SSC-17 recommends that the DMRP makes available the slide set for each chapter of the three Handbooks as a PowerPoint file so that a subset of the slides is easily accessible and can be linked to the relevant chapters of each of the three handbooks.

[R11] The SSC-17 recommends that the DMRP implements within the DOL an Ir-192 and Co-60 well chamber calibration service (along with the necessary QMS requirements) for brachytherapy, while assessing the need to continue offering the service based on Cs-137.

[R12] The SSC-17 recommends that the DMRP reports on the implementation of the small field dosimetry Code of Practice and assess whether a specific small field dosimetry audit should be offered.

[R13] The SSC-17 recommends that the DMRP updates the SSDL Network Charter. It should also consider adding a tier structure to the membership description for SSDLs so that a higher tier is associated with a greater level of quality control.

[R14] In view of these evolving imaging and treatment technique changes, the SSC-17 recommends that the DMRP investigates the need to develop a CRP on implementation, commissioning, image dosimetry, image quality and quality control testing of image guidance radiation therapy (IGRT) systems.

[R15] The SSC-17 recommends that the DMRP generates and publishes a peer-reviewed manuscript outlining the findings from the QUATRO site visits.

[R16] The SSC-17 recommends that the DMRP produces a peer-reviewed publication summarizing the historic results of the TLD audit program that includes the appropriate statistical significance tests to support concluding statements and findings.

[R17] The SSC-17 recommends that the DMRP modifies the current QUATRO guidelines to account for the introduction of modern advanced technologies and new treatment modalities into radiation oncology clinics.

[R18] The SSC-17 recommends that the DMRP assesses the need to update TRS 457.

[R19] The SSC-17 expresses enthusiasm for doctoral CRPs and recommends that the DMRP continues their implementation.

[R20] The SSC-17 recommends that the DMRP, jointly with the WHO, develops guidelines that are specific to the needs of CR technology, particularly if used in demanding applications such as screening mammography.

[R21] The SSC-17 recommends that the current project structure of the DMRP Subprogramme be maintained.

[R22] The SSC-17 recommends that the DMRP makes the necessary plans to host a follow-up symposium (IDOS-2) in the biennium 2018-2019.

[R23] The SSC-17 recommends that the DMRP initiates a code of practice for dynamic radiation therapy dosimetry.

[R24] The SSC-17 recommends that the DMRP investigates the need to develop a CRP on developing a QA audit for HDR brachytherapy that could be used by National Audit Networks.

[R25] The SSC-17 recommends that the DMRP, with the cooperation of the WHO, establishes guidelines to assist radiotherapy clinics in making the transition from Co-60 based radiation therapy to that using linacs.

4.2 Medium Priority Recommendations

[R26] The SSC-17 recommends that no more than two consecutive major reviews of the DMRP QMS be carried out by the same RMO.

[R27] The SSC-17 recommends a pilot study of a social media-based feedback system (e.g., user community) be conducted by the DMRP. Furthermore, a transition to electronic distribution of the Newsletter is recommended.

[R28] The SSC-17 recommends that the DMRP continues its support for QUAADRIL, QUATRO and QUANUM and raise awareness of these programs and their benefits to Member States.

[R29] The SSC-17 recommends that the DMRP updates TECDOC-602 to include updated QC/QA for currently used non-imaging devices (e.g., thyroid probes, dose calibrators, whole-body counters). It is also recommended that this document be translated into additional Member State languages.

[R30] The SSC-17 recommends that the DMRP develops training slides as a part of the CRP activity on Dosimetry in Molecular Radiotherapy for Personalized Patient Treatments.

[R31] The SSC-17 recommends that during the next IAEA meeting of national regulators, the DMRP, in collaboration with NSRW and the WHO should disseminate educational material (or possibly organize a workshop) for radiation protection regulators (IAEA) and medical regulators (WHO) regarding the distinction between dosimetry for radiopharmaceutical therapy (such as for alpha emitters) and dosimetry for diagnostic imaging agents. Similar collaborative educational efforts in other areas are also encouraged.

[R32] The SSC-17 recommends that the DMRP implements an electron beam dosimetry audit service on a routine basis, if the efficiency improvements from implementing the glass dosimetry system allow additional personnel resources to be directed towards supporting such a service.

[R33] The SSC-17 recommends that the DMRP and the NSRW, in collaboration with the WHO, investigate the need for a guidance document that provides estimates of the effective dose received by a nursing infant following a radiopharmaceutical procedure to the mother.

[R34] The SSC-17 recommends that the DMRP continues to be involved in the Nuclear or Radiological Emergency training and education of medical physicists.

[R35] The SSC-17 recommends that the DMRP reports on the findings from the multicentre on-site head and neck IMRT audit pilot test.

[R36] The SSC-17 recommends that the DMRP completes the document entitled Training on Radiation Metrology: A handbook for SSDLs.

[R37] The SSC-17 recommends that the DMRP analyses if it is appropriate for the SSDL Network to transition from the use of X-ray tubes with Mo and Rh anodes to W anode tubes for ionization chamber calibrations at mammography beam qualities.

[R38] The SSC-17 recommends that the DMRP investigates whether to expand the DOL mammography beam qualities to include W/Ag and W/Rh in order to cover clinical digital mammography beams.

[R39] The SSC-17 recommends that the DMRP considers establishing comprehensive quality audits for SSDLs.

[R40] The SSC-17 recommends that the DMRP continues training activities on the general evaluation of measurement uncertainty.

[R41] The SSC-17 recommends that, subsequent to the publications already planned related to diagnostic radiology, online media resources be developed by the DMRP, in collaboration with the WHO, to facilitate implementation.

4.3 Low Priority Recommendations

[R42] The SSC-17 recommends that the DMRP assesses the impact of the bunker construction and installation of the new linac on current DOL operations and services.

[R43] The SSC-17 recommends that the DMRP establishes a database of k_Q factors and guidelines for vetting new data, in collaboration with the AAPM.

[R44] The SSC-17 recommends that the DMRP reports on the implementation and findings of the CRP on remote audits for advanced radiotherapy dose delivery (IMRT/VMAT).

[R45] The SSC-17 recommends that the DMRP modifies the SSDL Network web site to include as much additional information as possible, while respecting confidentiality.

[R46] The SSC-17 recommends that the DMRP implements a radiation protection $H_p(10)$ audit for SSDLs, supplementary to the existing TLD audit for radiation protection air kerma.

[R47] The SSC-17 recommends that the DMRP works to provide better web links to the Dosimetry Laboratory or other IAEA web pages from, e.g., the IAEA Human Health Campus Website.

[R48] The SSC-17 recommends that the DMRP assesses the need for the DOL to provide beta-ray calibration services to SSDLs.

5. SSC-17 COMMENTS

5.1 General Comments

- The SSC-17 appreciated the day-long visit to the Dosimetry Laboratory (DOL) in Seibersdorf. The presentations to the SSC-17 were well made and much appreciated as was the layout of the printed copies of the presentations with two slides per page. The SSC-17 suggests that for future SSC meetings, a thumb drive be provided with all of the material presented during the meeting and that the hardcopy binder not be provided to the Committee. The SSC-17 also noted that more time should be allocated for questions to each speaker after their presentation.

5.2 Project 2.2.4.1 Comments

- The SSC-17 considers the problem of outliers in dosimetry audits and their failure to be resolved as an important threat to reliable and safe patient treatment. The DMRP, in collaboration with the WHO, should consider if there are any additional measures it can take to reduce these cases.

- The TLD (or RPL glass dosimetry in the future) postal dose audit should be extended to identify, together with DIRAC, the percentage participation of hospitals within each country, as well as further in-depth analysis of unacceptable results (recurrence, identification of possible transmission of errors to patients).
- The SSC-17 encourages the DMRP to continue having SSDL network staff come to the DOL to perform comparisons of calibration coefficients as there is a significant transfer of knowledge and expertise.
- The SSC-17 encourages the DMRP to examine challenges encountered by SSDLs when calibrating non-reference class instruments, e.g., solid state detectors for diagnostic radiology and portable survey meters for radiation protection.

5.3 Project 2.2.4.3. Comments

- Funds from TC should continue to be used for medical physics support of cancer management in all regions.
- The SSC-17 suggests that the DMRP continues to follow developments related to dosimetry standards based on absorbed dose to water for kV X-rays and brachytherapy.

5.4 Project 2.2.4.3 Comments

- The SSC-17 is pleased to see that the DMRP is participating, in collaboration with the ARBR, in the organization of the International Conference on Advances in Radiation Oncology, ICARO-2, in June 2017.
- The SSC-17 encourages the DMRP to update the IAEA Safety Report Series SRS 16 for Radiation Protection. However, the DMRP should wait until the new ICRU report on radiation protection quantities is available.
- The SSC-17 suggests that the DMRP investigates and gathers data to determine whether there is a need to develop guidelines for radiation therapy centres to go paperless. This is most probably a project for the 2020/2021 biennium.
- The SSC-17 suggests that the DMRP asks the AAPM and the SNMMI to send out an email burst advertising the three handbooks and slide sets prepared by the IAEA on radiation therapy, diagnostic imaging and nuclear medicine physics.

Figure 7. 17th Meeting of the Scientific Committee of the IAEA/WHO SSDL Networks Vienna, March 2016

Acronyms used in the Report

AAPM	American Association of Physicists in Medicine
ARBR	Applied Radiation Biology and Radiotherapy Section of the Agency
BIPM	Bureau International des Poids et Mesures
CIPM	International Committee of Weights and Measures (BIPM)
CMC	Calibration and Measurement Capability

CoP	Code of Practice
CRP	Coordinated Research Project of the Agency
CT	Computed tomography
DG	Director General (of the Agency)
DIRAC	Directory of Radiotherapy Centres
DMRP	Dosimetry and Medical Radiation Physics Section of the Agency
DOL	Agency's Dosimetry Laboratory
EURAMET	European Association of National Metrology Institutes
HDR	High dose rate
IAEA	International Atomic Energy Agency
ICARO	International Conference on Advances in Radiation Oncology
ICRU	International Commission on Radiation Units and Measurements
ICTP	International Centre for Theoretical Physics
IDOS	International Symposium on Standards, Applications and Quality Assurance in Medical Radiation Dosimetry
IGRT	Image-guided radiation therapy
IMRT	Intensity modulated radiation therapy
IOMP	International Organization for Medical Physics
ISO	International Organization for Standardization
KAP	Kerma-area-product
LMI	Low and middle-income countries
MRA	Mutual Recognition Arrangement of the CIPM (CIPM MRA)
MRI	Magnetic resonance imaging
NAHU	Division of Human Health of the Agency
NMDI	Nuclear Medicine and Diagnostic Imaging
NSRW	Division of Radiation Transport and Waste Safety
PET/CT	Positron Emission Tomography/Computed Tomography
QA	Quality assurance
QUADDRIL	Quality assurance audit for diagnostic radiology improvement and learning
QUANUM	Quality assurance in nuclear medicine
QMS	Quality management system
QS	Quality system
QUATRO	Quality Assurance Team for Radiation Oncology
RMO	Regional Metrology Organization
RPL	Radiophotoluminescence
SNMMI	Society of Nuclear Medicine and Molecular Imaging
SPECT	Single photon emission computed tomography
SSC	SSDL Scientific Committee
SSDL	Secondary Standards Dosimetry Laboratory
TC	Department of Technical Cooperation of the Agency
TL	Thermoluminescent, or thermoluminescence
TLD	Thermoluminescent dosimeter, or thermoluminescence dosimetry
TRS	Technical Reports Series (an Agency publication series)
WHO	World Health Organization

Courses, Meetings and Consultancies in 2016 and 2017

TC Courses and Workshops related to DMRP activities

- RAS6072: Regional training course on intensity modulated radiotherapy for prostate cancer and other urological cancers, Manila, Philippines, 6 - 10 September 2016
- RAS6081: Workshop on Developing a Quality Framework to Enhance Patient Care in Diagnostic Radiology, Bangkok, Thailand, 3 - 11 October 2016
- RER6033: Regional Training Course on Medical Physics for Clinical Radiotherapy, Moscow, Russian Federation, 3 - 21 October 2016
- RER6033: Regional Training Course on Brachytherapy Physics, Moscow, Russian Federation, 24 - 28 October 2016
- RER6033: Regional Workshop on Quality Assurance Teams for Radiation Oncology, Vienna, Austria, 31 October - 4 November 2016
- RER6033: Regional Hands-on Training Course on VMAT Treatment Planning, Haarlem, The Netherlands, 31 October - 4 November 2016
- RAS6085: Regional training course on clinical applications of Stereotactic Body Radiotherapy (SBRT) in oligometastasis, pancreatic, and recurrent cancers needing re-irradiation, Singapore, 14 - 18 November 2016
- RAS6084: Regional Training Course on Radiation Protection Calibrations for Secondary Standards Dosimetry Laboratories, Vienna, Austria, 14 - 18 November 2016
- Joint ICTP-IAEA Workshop on "Internal Dosimetry for Medical Physicists Specializing in Nuclear Medicine", Trieste, Italy, 21 - 25 November 2016
- RER6032: Regional Training Course on QA/QC and dosimetry in Interventional Radiology, Udine, Italy, November 2016 (tentative)
- RER6033: Training Course on the Role of Imaging in Clinical Radiotherapy, Moscow, Russian Federation, 5 - 9 December 2016
- RER6033: Training Course on Transition from 3D Conformal Radiation Therapy to Intensity Modulated Radiation Therapy, Moscow, Russian Federation, 12 - 16 December 2016
- RAS6084: Regional Training Course on Quality Management Systems for Secondary Standards Dosimetry Laboratories (SSDLs), Vienna, Austria, 12 - 16 December 2016
- RAS6072: Regional training course on intensity modulated radiotherapy for pancreas, anorectal and breast cancers Maebashi, Japan, 6 - 10 March 2017
- ICTP-IAEA Joint workshop on image guided radiotherapy, Trieste, Italy, 8 - 12 May 2017
- RAS6072: Regional training course on intensity modulated radiotherapy for lung and esophageal cancers, Bangkok, Thailand, 21 - 25 May 2017
- RER6032: Workshop on the Implementation QA program – QUAADRIL, Athens, Greece, 29 August - 2 September 2016
- RER6032: Regional Training Course on QA/QC in Diagnostic Radiology in a digital era, Ljubljana, Slovenia, 19 - 23 September 2016
- RAS6072: Regional training course on quality audits for intensity modulated radiotherapy, Singapore, September 2017 (no fixed date yet)

ESTRO Courses

- RER6033: IAEA/ESTRO Course on Dose modelling verification for external beam radiotherapy, Warsaw, Poland, 2 - 6 April 2017
- RER6033: IAEA/ESTRO Advanced treatment planning, Barcelona, Spain, 3 - 7 September 2017

DMRP Meetings and Consultancies

- Consultants' Meeting on the review of the results of the CRP E24018 on the development of quality audits for advanced technology in radiotherapy dose delivery and generating the final report, Vienna, Austria, 3 - 7 October 2016
- Consultancy Meeting to Finalize the Pocketbook for Medical Physicists in Support of Nuclear or Radiological Emergency (NRE) Response, National Institutes for Quantum and Radiological Science and Technology (QST), Chiba, Japan, 5 - 7 October 2016
- 3rd Research Coordination Meeting of the Doctoral Coordinated Research Project on Advances in Medical Imaging Techniques, E2.40.19, Vienna, Austria, 10 - 14 October 2016
- Consultants' Meeting on the Development of guidance on resources, infrastructure and equipment required for setting up a dosimetry audit network, Vienna, Austria, 28 November - 2 December 2016
- Consultants' Meeting to Prepare the Call for Proposals of the Coordinated Research Project on Dosimetry in Molecular Radiotherapy for personalized patient treatments, Vienna, Austria, 29 November - 2 December 2016
- Consultants' Meeting to Prepare the first draft of a guide Establishment of an SSDL, Vienna, Austria, 5 - 9 December 2016
- Consultants' Meeting to Finalize the draft of the guidance document on SPECT/CT Atlas of Quality Controls and Image Artefacts, Vienna, Austria, 12 - 16 December 2016
- Consultants' Meeting to Finalize the publication on Remote and automated QC for diagnostic radiology, Vienna, Austria, 12 - 16 December 2016
- Workshop on Uncertainties in Radiation Dosimetry, Vienna, Austria, 3 - 7 April 2017
- 2nd Research Coordination Meeting of Coordinated Research Project on Evaluation and Optimization of Paediatric Imaging, Vienna, Austria, 22 - 26 May 2017
- 3rd Research Coordination Meeting of Coordinated Research Project E24017 Investigating the relationship between the end to end accuracy and quality assurance extent and depth in radiotherapy, Vienna, Austria, 19 - 23 June 2017 (tentative date)
- International Conference on Advances in Radiation Oncology (ICARO-2), Vienna, Austria, 19 - 23 June 2017

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