Comparison of air kerma measurements for tungsten anode based mammographic X-ray beam qualities

EURAMET project #1362 (EURAMET.RI(I)-S4.1)

Technical Protocol

1. Description of the project

The IAEA Dosimetry Laboratory at Seibersdorf, Austria, has been performing the calibration of the reference dosemeters of IAEA/WHO SSDL Network members (more than 83 laboratories in worldwide) free of charge. As member of the CIPM MRA, the IAEA laboratory maintain QMS complying with ISO 17025.The laboratory updated its dosimetry CMC claims in 2013, in the Appendix C of the CIPM MRA including the mammography X-ray beam qualities generated by X-ray tube having Mo anode. For the extension of this RAD-1018 CMC claim with tungsten anode based X-ray beam qualities used by digital mammography machines, dedicated comparison result as 'supporting evidence' is required in addition to the traceability of the measured quantity. The relevant IAEA secondary standard is traceable to the PTB in terms of air kerma. The comparison partner PTB has primary standard for air kerma having key comparison results BIPM.RI(I)-K7 for tungsten anode plus Mo filtration mammographic X-ray beam qualities.
For the comparison an IAEA reference-class transfer chambers have been selected. The technical details of the chamber are in the Table 1. Technical details of the selected qualities are in the Table 2.

2. Participants

Institute	Country	Contact	e-mail
IAEA DMRP	Austria	Igor Gomola Istvan Csete	i.gomola@iaea.org i.csete@iaea.org
PTB	Germany	Ludwig Buermann	Ludwig.Buermann@ptb.de

3. Procedure

3.1. Object of the comparison

Direct comparison is proposed between the air kerma standards of the IAEA and the PTB in the mammography x-ray range from 25 kV to 35 kV, using tungsten anode X-ray tube with Mo and AL filtrations. The comparison radiation qualities WMV 25, 28, 30, 35 and WAV 25, 28, 30, 35 (according to the PTB code), and the transfer ionization chamber type Radcal RC6M were selected. The outcomes of the comparison, i.e. the ratios of the calibration coefficients of transfer chamber, should be consistent within its stated uncertainty taking into account the correlations due to the IAEA secondary-standard chamber traceability to the PTB primary standards.
If this is the case, it can validate the calibration practice of the participants, supporting the extended CMC claim of the IAEA.

3.2 Transfer chambers

Table 1 Technical data of the transfer chamber

Type and serial number	Reference point	Nominal volume	*Polarizing voltage (V)	Wall thickness	Outer diameter (mm)
Radcal 10X5-6M # Parallel plate chamber	marked on chamber	6 cm^3	300	0.7mg/cm^2	43 30 (effective)

*) Polarizing voltage applied to the collector

3.3 Radiation qualities

Table 2 Technical data of the beam qualities

Quality	Tube voltage	Filtration	PTB HVL	IAEA HVL	BIPM HVL
	kV	µm	mm Al	mm Al	mm Al
WMV 25	25	60 Mo	0.36	0.340	0.342
WMV 28	28	60 Mo	0.37	0.357	0.355
WMV 30	30	60 Mo	0.38	0.367	0.364
WMV 35	35	60 Mo	0.41	0.393	0.388
WAV 25	25	500 Al	0.35	0.312	--
WAV 28	28	500 Al	0.40	0.354	--
WAV 30	30	500 Al	0.43	0.380	--
WAV 35	35	500 Al	0.51	0.435	--

3.4 Reference conditions

The calibration coefficients for the transfer chambers should be given in terms of air kerma per charge in units of Gy/C and refer to standard conditions of air temperature, pressure and relative humidity of T=295.15 K, P=101.325 kPa and h=50%. The recommended source to chamber distance is 1.0 m to ensure the homogeneity of the radiation field used by the transfer chamber. To avoid any corrrection for saturation effect, similar (~50 mGy/min) dose rate application is recommended. Corection factor for the different incident photon spectra will be considered in reflection of the energy response curve of the transfer chamber and other uncertainty components.

3.5 Course of comparison

The transfer chambers will be calibrated by both participants in their own respective x-ray beams. The IAEA will cover the cost of transportation of the chambers to the PTB and back to IAEA. For the purpose of constancy check, the IAEA laboratory will repeat determination of the calibration coefficients after return of the transfer chambers from the PTB to IAEA. The IAEA results together with the uncertainties will be reported to the CCRI Secretary and could be disclosed to both participants after completion of measurements at both laboratories.

3.6 Prospective schedule

Perform the measurements at both laboratories: May-June 2015
Evaluation of data and drafting the report: July 2015
Publication of the result in the Techn. Suppl. of Metrologia: September 2015

4. References:

1. IAEA Technical Report Series no. 457, Dosimetry in Diagnostic Radiology: An International code of Practice, 2007
2. I. Csete, L. Büermann, I. Gomola, R. Girzikowsky, *"Comparison of air kerma measurements between the PTB and the IAEA for X-radiation qualities used in general diagnostic radiology and mammography"* Metrologia 2013, 50, Tech. Suppl., 06008
3. C. Kessler, D.T. Burns, L. Büermann *Key comparison BIPM.RI(I)-K7 of the air-kerma standards of the PTB, Germany and the BIPM in mammography x-rays* Metrologia, 2011, 48, Tech. Suppl., 06011
4. Allisy P.J., Burns D.R., Andreo P., *International framework of traceability for radiation dosimetry quantities*, Metrologia, 2009, 46(2), S1-S8
5. ISO/IEC *Guide to the Expression of Uncertainty of Measurement*, JCGM 100:2008