Progress Report to 24th CCRI(I) meeting, BIPM, June 5-6, 2019

Activities in radiation dosimetry at the GUM

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Ionizing Radiation Laboratory offers routine calibration of measuring instruments for national accredited calibration laboratories in terms of air kerma and absorbed dose to water. GUM organizes inter-laboratory comparisons for national accredited calibration laboratories for proficiency of calibration services and proficiency in dose reading.

Following the recommendations of ICRU Report 90 "Key data for ionizing – radiation dosimetry: measurement standards and applications" and the subsequent decision of the CCRI(I), re – evaluation of the GUM standard for x – rays and gamma radiation air kerma and absorbed dose to water for ^{60}Co has been done since January 1st of 2019.

At the present part of laboratory premises are under renovation for the installation of new irradiators:

1. GI-06 Gamma Irradiator from VF with sources: ^{137}Cs (4 TBq), ^{137}Cs (37 GBq), ^{137}Cs (5 GBq), ^{60}Co (37 GBq), ^{241}Am (37 GBq).
2. TeraBalt T-100 Gamma High Dose Rate Calibration System from UJP PRAHA with source ^{60}Co – 150 TBq.
3. HDR with two sources gamma radiation ^{192}Ir and ^{60}Co (will be installed in the next phase).

Renovation is due to finish June 7th and the laboratory will be waiting for permission to install new irradiators from National Atomic Agency. The end of the project is foreseen at September 2019.

Ionizing Radiation Laboratory standards:

1. The primary standard for air-kerma of the GUM for low- and medium- energy x-ray (ranges below 10kV, from 10kV to 60kV, from 30kV to 320kV) are 3 parallel plate chambers constructed at the GUM.
2. The primary standard for air kerma of the GUM for ^{60}Co and ^{137}Cs is a cavity ionization chamber constructed at the Orszagos Mérésügyi Hivatal, Budapest, Hungary in 1983 (type ND 1005/A, serial number 8303).
3. The secondary standard for absorbed dose to water is ionization chamber type NE2571 is used, which is calibrated in the BIPM ^{60}Co radiation beam.

Ionizing Radiation Laboratory uses:

1. Monte Carlo simulation (EGSnrc, BEAMnrc, FLUKA/FLAIR, Geant4) on Microsoft Azure.

2. The finite element method (FreeFem++ is a language that allows the resolution of partial differential equation using the finite element method).

Ionizing Radiation Laboratory designs and manufactures electronic systems, measurement systems and ionizing radiation detectors (ionization chambers, graphite and water calorimeters).
Since last meeting cavity ionization chamber (type IGNAŚ-IC16A#001) for air kerma and cavity ionization chamber (type IGNAŚ-IC16B#001) and graphite calorimeter (type IGNAŚ-GC16#001) for absorbed dose to water were developed with goal to become GUM new primary standards.
Currently laboratory is developing ionization chamber for Hp(10) and Hp(3) which will be tested in July. The ionization chamber for brachytherapy is designed and will be manufactured next year. The primary standard extrapolation chamber for beta radiation absorbed dose to tissue measurements is being designed, too.
Our laboratory conducts research on new measurement methods in the field of ionizing radiation – optical calorimetry technique for radiation dosimetry. The fundamental principle for optical calorimetry is the temperature dependence of the refractive index of transparent media and particularly of water. An increase in the temperature of the water will produce a phase shift (PS) in light passing through the medium. This PS can be measured using interferometry and its proportional to the average temperature change along the beam path. An advantage of this technique in radiation calorimetry is that it does not require a mechanical probe within the radiation field acting as an unwanted source of heat. Optical calorimetry also has the capability of obtaining 2D and 3D temperature/dose distributions, which are useful for characterizing beams.

Comparisons

In November 2018 measurements for IAEA – GUM Protection (N40 – N300) and Diagnostic (RQR – 5, RQR – 10, RQT – 9) level comparison were made. We are waiting for report.

This year we would like to conduct comparison of the air kerma standards of the GUM and the BIPM for ^{60}Co and ^{137}Cs gamma radiation and absorbed dose to water for ^{60}Co gamma radiation for new standards developed and constructed in GUM. This comparisons depend on BIPM availability and resumption of measurements in our laboratory after renovation and installation of new irradiators.

Next year laboratory would like to conduct comparison of air kerma standards of GUM and the BIPM for low, medium and mammography (W – Mo) X-rays.

Conferences and Publications:

1. Tulik P. Knyziak A.B. Derlaciński M., Development and characterization of graphite ionization chamber at Ionizing Radiation Laboratory at GUM, SIXTH INTERNATIONAL CONFERENCE ON RADIATION AND APPLICATION IN VARIOUS FIELDS OF RESEARCH RAD 2018, Macedonia, 18.06 – 22.06.2018.
2. M.M.Szymko, L.Michalik, A.B.Knyziak, A.W.Wójtowicz: Development and characterization of air kerma cavity standard, Measurement, Volume 136, March 2019, Pages 647-657.