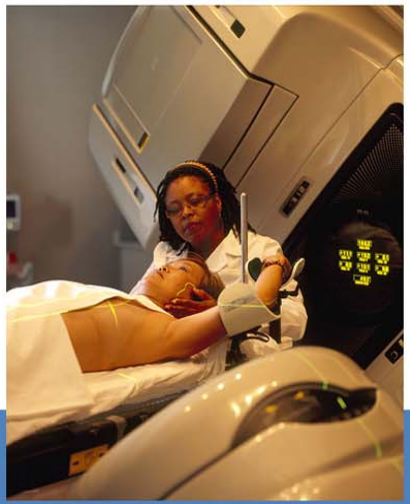
The BIPM Graphite Calorimeter used for Accelerator Dosimetry Comparisons



OBJECTIVE

For an effective treatment, radiotherapy patients must receive the prescribed radiation dose. To be sure of the dose, each hospital needs to be traceable to the SI via their national metrology institute.

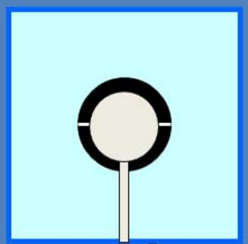
For this reason, the CCRI endorsed the BIPM on-going comparison of dosimetry for clinical-type accelerator photon beams, BIPM.RI(I)-K6, which started in 2009. Since then, eight comparisons have been carried out and another nine are planned.

$$D_{w} = D_{c} \frac{Q_{w}}{Q_{c}} C_{w,c}$$

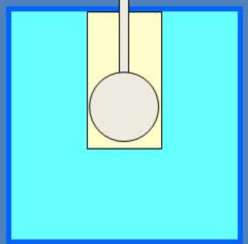
The absorbed dose to water D_W in a high-energy photon beam is determined *through three different measurements in the beam (1-3), combined with Monte Carlo calculations modelling these experimental configurations (1-3) and also the ideal configuration (4).*

METHOD

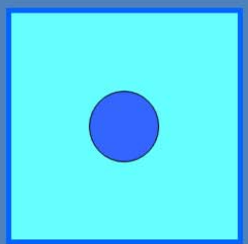
*1) Calorimetric **measurement** and **Monte Carlo simulation** in vacuum with the graphite core in the graphite jacket.*



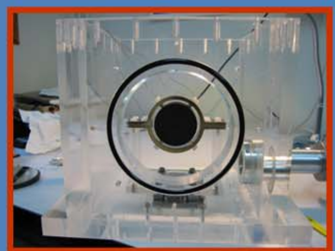
2) Ionometric measurement and MC simulation where the core is replaced by a parallel-plate ionization chamber.



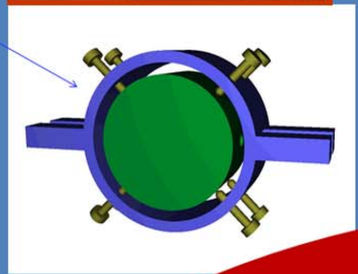
3) Ionometric measurement and MC simulation with the parallel-plate ionization chamber placed in a water phantom.



4) The fourth step is a Monte Carlo calculation to determine the absorbed dose in a homogeneous water phantom.



Calorimeter seen from the front, without the graphite window….

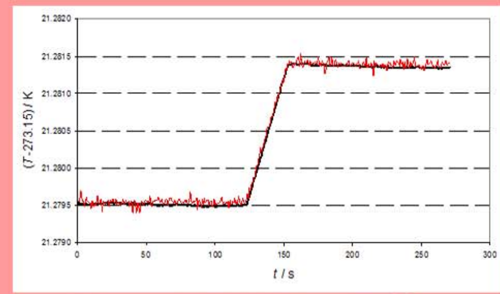


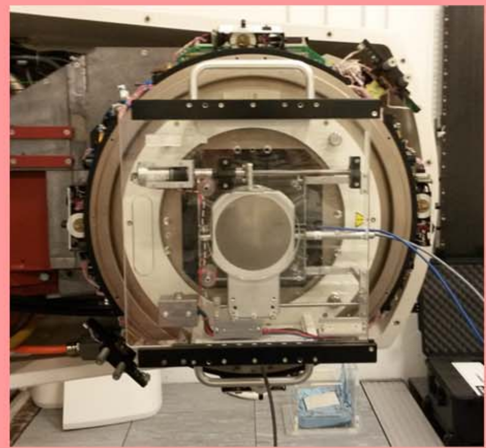
…and as a component of the Monte Carlo geometry constructed using the PENGEOM code of PENELOPE .

REALIZATION

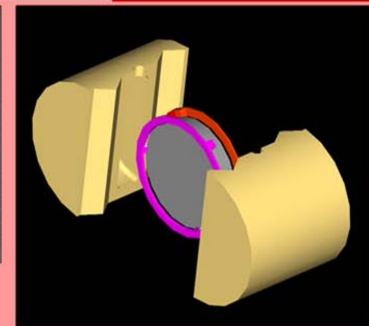
A primary calorimetric standard to measure the absorbed dose of ionizing radiation in ^{60}Co and in clinical accelerator photon beams, developed in the Ionizing Radiation Department at the BIPM, enables the standards of the NMIs to be compared.

For this purpose, small temperature increments of 1 mK or 2 mK, and small ionization currents of a few nA,are measured using the BIPM equipment.

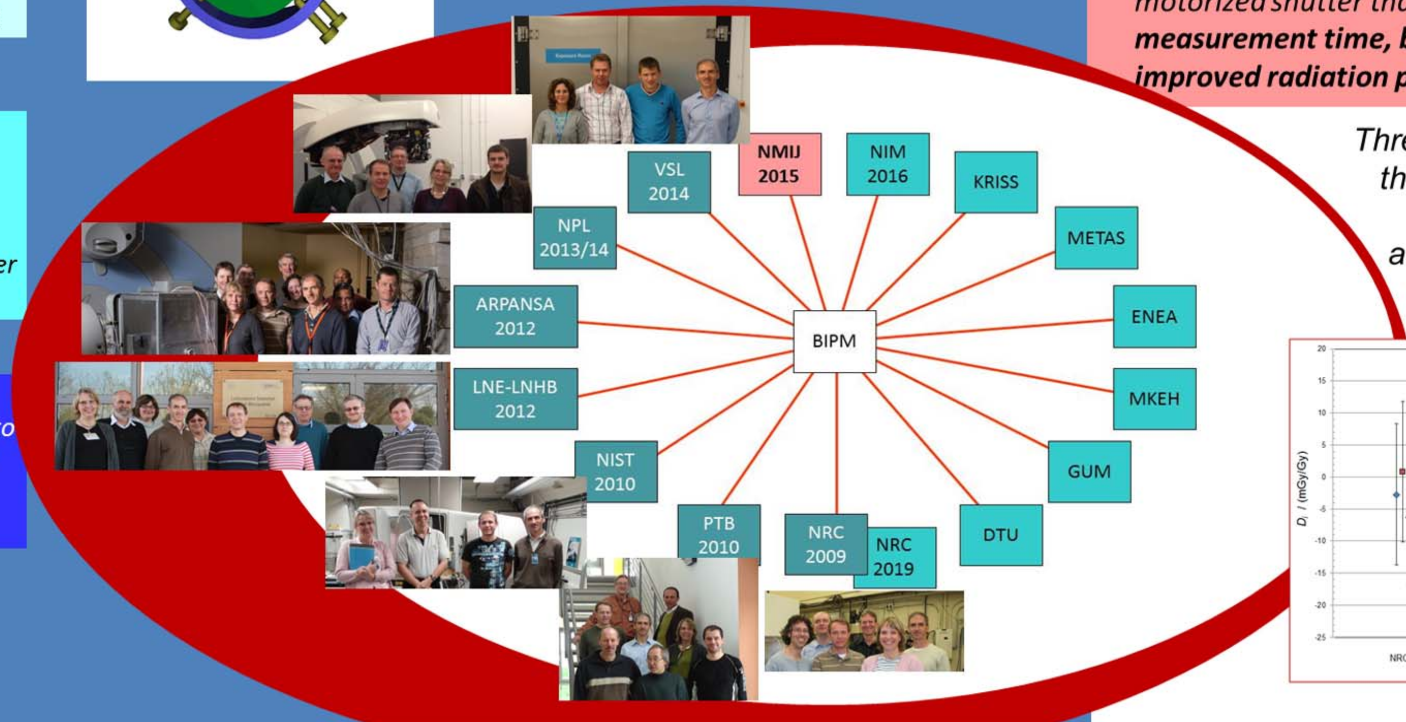




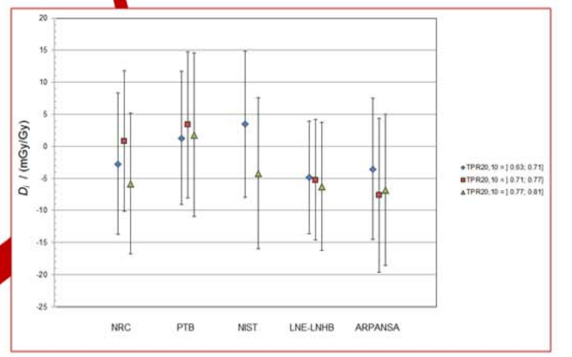
*As clinical accelerator beams show significant variations in output intensity, all comparison measurements are normalized for the comparison using two different types of ionization chamber monitor, for short- and long-term stability. The BIPM recently designed and constructed a motorized shutter that assures **reduced measurement time, better reproducibilty and improved radiation protection.***



The phantom design, a cylinder cut into left and right components, favours a homogeneous temperature distribution front to back.



Three beam qualities identified by their TPR(20,10) are compared. The BIPM determination is adopted as the key comparison reference value (KCRV).



RESULTS

Typical uncertainty components of $D_{w,BIPM}$ obtained in accelerator beams in the range from 6 MV to 25 MV

Uncertainty term	Range x 10^3
Calibration of thimble monitor in terms of D_c	[1.5 – 2.8]
Q_w/Q_c	[0.9 – 2.9]
$C_{w,c}$	[2.3 – 2.6]
k_{rn}	[1.0 – 5.0]

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