Determination of the Spatial Variation of the Air Kerma Backscatter Factor on the ISO Phantom Surface

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Objectives

The assessment of effective dose is done with personal dosemeters which perform measurements of the operational quantity $H_P(10)$. The calibration of personal dosemeters is made by positioning the dosemeter in the test point, in front of a ISO water phantom, and determination of its response. On the front face can be positioned several dosemeters, inside an area delimited by the isodose contour of 98% of the dose in the centre of the front face. The diameter of this circular area, d_F, define the region where the radiation field is uniform.

The goal of this work is the determination of d_F, experimentally and by computational simulation, for ^{60}Co radiation quality. For this purpose, the spatial distribution of the air kerma backscatter factor, *B*, in the phantom surface, was determined.

$$B = \frac{K_a(\text{phantom present})}{K_a(\text{free in air})}$$

The experimental work was done with a 1 cm^3 ionization chamber, and positioned along the apothem and diagonal axis in the phantom surface and without phantom. The computational code used was the MCNPX, version 2.5.d. The air kerma was obtained from the photon flux, by applying conversion coefficients from photon fluence to air kerma. The photon flux was calculated in designed circular surfaces, with 1.0 cm diameter, along the apothem and diagonal axis, with the centres of these circles separated by 1.5 cm.

For ^{60}Co, the simulation spectrum corresponds to a spectrum of an Eldorado 6 radiotherapy unit. It must be emphasized that the energy average of this spectrum is significantly lower (1.006 MeV) than the average energy of the two lines of ^{60}Co (1.25 MeV)

Results

The computational results obtained can be seen on figure 1.

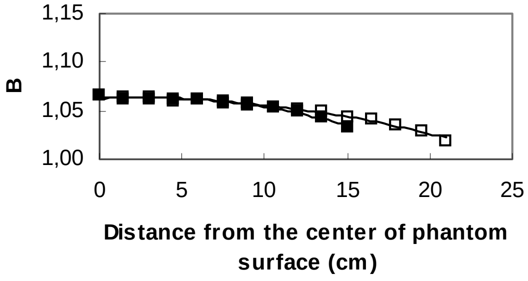

Figure 1: Computational results (■ for apothem axis and □ for diagonal axis) for B for the ^{60}Co radiation quality.

The similar behaviour of experimental and simulated *B* allows us to normalize the Monte Carlo simulation results relatively to the experimental *B* value on the centre of the phantom.

Both experimental and computational (normalized values) results can be seen on figure 2, for the radiation quality of the ^{60}Co.

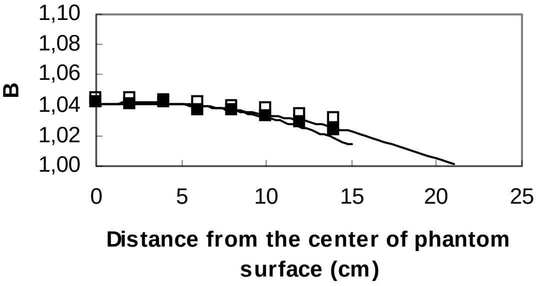

Figure 2: Experimental results ((■ for apothem axis and □ for diagonal axis) and normalised simulation results ( ) for ^{60}Co radiation quality.

The air kerma backscatter factor calculated for ^{60}Co radiation quality is 1.04 and for d_F it was obtained the value of 27 cm.

Published, accepted or in press work

"Determination of the Spatial Variation of the Air Kerma Backscatter Factor on the ISO Phantom Surface Using Monte Carlo Method" J. Cardoso, C. Oliveira, A. F. Carvalho. Proceedings of the Workshop Intercomparison on the Usage of Computational Codes in Radiation Dosimetry, Bologna, Italy (in press).

X Jornadas Portuguesas de Protecção Contra Radiações, Lisboa, 21-21 November 2003.

11th IRPA International Congress, Madrid, Spain, 23-28 May 2004.

MCNP studies for radiosurgery and endovascular radiotherapy problems

Chaves, A., Lopes, M. C., Alves, C. C., Oliveira, C., Peralta, L., Rodrigues, P. Trindade, A
Yoriyaz, H., Teixeira, N. Seabra Gomes, R. and Ferreira, P.

Objectives

To understand the mechanism of energy deposition in radiosurgery and endovascular radiotherapy problems.

Results

In radiosurgery narrow photon beams, the depth of maximum dose dmax, in the beam central axis increases as the size of the additional collimator increases. To understand this effect, experimental depth dose curves of the additional collimators were obtained for a Siemens KD2 linear accelerator in 6 MV photon mode and the shift of dmax varied from 11.0 ± 0.6 mm for the 5 mm collimator to 14.5 ± 0.6 mm for the 23 mm collimator. Monte Carlo simulations showed that: *(i)* the photons that had no interactions in the additional collimators, contributing more than 90 % to the total dose in water, were responsible for the shift in dmax; *(ii)* electrons originated from these photons and contributing to the dose deposit in water in the beam central axis could be divided in two groups: those that deposit energy far away from their point of origin (the point of the first photon collision in water) and those that deposit energy locally (originated at the second photon collision in water).

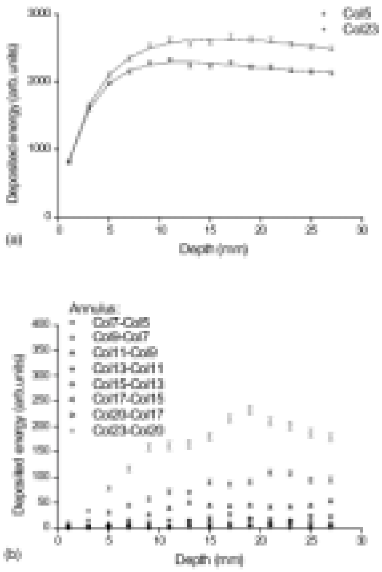

Fig. 1 Deposited energy versus depth (a) due to electron from photon collision for the 5 mm and the 23 mm additional collimator. (b) Contribution of electron from one photon collision for each annulus. In this approximation the 7 mm additional collimator can be represented by the 5mm ad. col. plus the annulus of int. diam 5mm and ext. diam. 7 mm.

The development of a multiple source model for radiosurgery narrow photon beam has been initiated.

Also new dosimetric aspects for the restenosis prevention in coronary artery disease have recently been studied. Among the current studies some clinically crucial aspects have also been addressed as the perturbation in the dose profile due to the atherosclerotic plaque. The methodology used in this work to obtain the dose distributions has been based on the Monte Carlo method. Simulations of radiation transport for dose estimation involve geometries with very small dimensions, of the order of few millimetres with highly gradient dose profiles along the tissue from the centre of the radiation source. The increase of the plaque density leads a decrease of the dose outside of the plaque region.

Published, accepted or in press work

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2. Chaves, A., Lopes, M. C., Alves, C. C., Oliveira, C., Peralta, L., Rodrigues, P. and Trindade, A., (2003) “Development and Validation of a multiple source model for radiosurgery”. 7th Biennial ESTRO Meeting on Physics and Radiation Technology for clinical radiotherapy. Set. 2003 Geneve.
3. Chaves, A., Lopes, M.C. and Oliveira, C. “Problems and solutions to face radiosurgery dosimetry and calculations”. Bioeng’2003. 7th Portuguese Conference on Biomedical Engineering. 2003. Lisboa.
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5. Oliveira, C. and Yoriyaz, H., (2003) “Endovascular radiotherapy problem.” ENEA publications. (*in press*).
6. Teixeira, N., Oliveira, C., Yoriyaz, H., Ferreira, P.; Gomes, R.S. “Intravascular brachytherapy: i) dose distributions; ii) the role of the physicist”. VIII Congresso da EFOMP. Maio 2003. Eindhoven. Holanda.

Services

Metrology of Ionising Radiations

Metrological control of instruments for measurement of ionising radiation is being carried out under a contract with Portuguese Institute of Quality and is the enforcement of Portaria 423/98 de 21 de Julho. Metrological control includes calibration and type testing. During 2003 were calibrated 77 dosimeters. About 500 TLD dosimeters were irradiated.

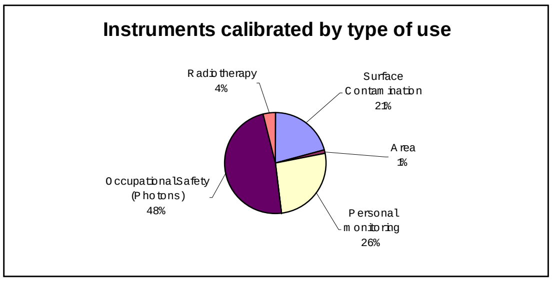

Figure 1: Instruments calibrated by user's activity

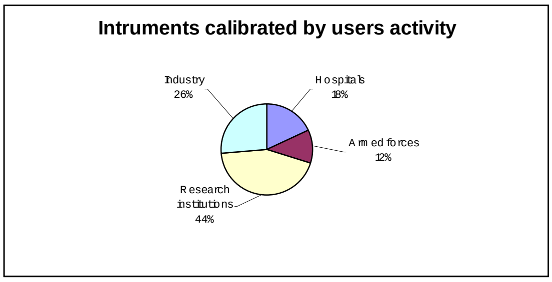

Figure 2: Instruments calibrated by monitoring type