Monte Carlo simulation and analysis of photon beam characteristics for a new medical accelerator constructed in NCBJ.

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Monte Carlo simulations are widely known to be the most accurate method of modelling the complex physics involved in the transport of electrons and photons through matter. EGSnrc / BEAMnrc is the foremost Monte Carlo software able to provide the details of the beam characteristics that are necessary for accelerator design, and is widely used throughout our work.

The aim of this work was to investigate the photon beam characteristics of NCBJ's new medical accelerator. We aimed to find the relationship between the varying input electron energies incident on the target, and the percentage depth dose of the photon beam used for medical treatment.
The beam shaping system of the accelerator was modelled in EGSnrc / BEAMnrc in several stages. Each stage ends in a scoring plane, producing a phase-space file containing data relating to the energy, position, direction and charge for every particle crossing the plane.
Stage 1 simulated transport through the target, target housing and primary collimator. Stage 2 simulated the ionisation chamber, flattening filter and jaws.

These calculations were performed for several electron beams, some monoenergetic and some with a spectrum of energies close to 6, 7 and 8 MeV. The spectra were received from beam dynamics calculations for the accelerating structure of the linac.

Depth dose calculations were performed using DOSXYZnrc, in a water phantom with voxel size 1 cm in the x and y direction, and 0.1 cm for 30cm in the z direction.
Simulations were performed for different flattening filters, with beam field sizes of 5 x 5cm , 10 x 10cm and 20 x 20cm. Dose distribution profiles for these fields were calculated using DOSXYZnrc, in a water phantom with voxel sizes 0.2 cm in the x and y direction, and 1 cm in the z direction.
The results of our calculations will be used in the optimisation of the accelerating structure.