

AbstractID: 6644 Title: Monte Carlo study of x-ray beams produced by an on-board imager for image-guided radiation therapy

Purpose:

The purpose of this investigation is to characterize the kilovoltage x-ray beams produced by an on-board imager integrated into a linear accelerator for image-guided radiation therapy.

Method and Materials:

The Monte Carlo codes BEAMnrc/EGSnrc were used to study the characteristics of kV beams and the properties of photons scattered by the imaged target. The x-ray tube is capable of generating photon spectra with kVp values between 40 and 125 kV. The Monte Carlo results were benchmarked against measurements and excellent agreements were obtained. The investigation includes the effect of including the electron impact ionization (EII) and the simulation showed that the characteristic radiation is increased significantly in the energy spectra when EII is included.

Results:

The study found that the total spectrum of all photons including primary and scattered after passing through the phantom is not much different from that of original x-ray beams due to the competing factors of beam hardening and scattering. However there is a significant difference in the spectra and angular distributions between scattered and primary photons. Results show both the magnitude and the characteristics of scattered x-rays. The study also presents the photon fluence distributions and spectra of x-ray beams with open and two types of Bow-Tie filters used for acquiring cone-beam CT images.

Conclusion:

The results indicate that the combination of large cone-beam field size and large imaged target significantly increases scatter-to-primary ratios for photons that reach the detector panel. For 10 cm, 20 cm and 30 cm thick water phantoms placed at the isocenter, the scatter-to-primary ratios are 0.94, 3.0 and 7.6 respectively for an open 125 kVp CBCT beam. The Monte Carlo simulation has provided quantitative data showing that the amount of scatter increases with the imaged volume and this also applies to scatter-to-primary ratios.