AbstractID: 13438 Title: Computer aided design and Monte Carlo validation of a patient-specific Co-60 TBI treatment unit

Purpose: To modify and characterize a teletherapy ^{60}Co unit for total body irradiation (TBI) treatments at extended SSD using experiments and a Monte Carlo (MC) model and to propose the design of custom compensators based on MC dose in the patient.

Methods and Materials: An existing Eldorado T78 ^{60}Co teletherapy unit was stripped from its original collimator and equipped with beam-defining cerrobend blocks for extended SSD TBI treatments. An acrylic flattening filter was numerically designed based on detailed mapping of the dose distribution of the large open field at 10 cm depth in water and using a primary radiation attenuation calculation. An EGSnrc MC model of the resulting unit was developed and validated. Dose distributions measured using ionization chambers were compared to MC dose distribution in air and phantom. The validated model was used to calculate dose in a whole-body patient CT image. A compensator, designed to make the patient mid-plane dose uniform was proposed.

Results: The designed filter flattens the beam to within ±2% over an area of 200 x 70 cm^2 at patient mid-plane. The agreement between measured and calculated dose profiles in the open and the filtered beams is at the sub 2% and sub 1% level, respectively. Surface dose in the filtered beam is 78.5% and mean photon energy of the primary fluence is 0.94 MeV independent of position in the field. Patient-specific calculations show excess dose in lung and the area of neck and extremities relative to prescription dose, by up to 20% and 30%, respectively. These excess doses can be reduced by introducing compensators, designed from the mid-plane dose distribution, following similar techniques as for the design of the filter.

Conclusions: This work shows that extended SSD ^{60}Co irradiation equipment and patient-specific compensators designed based on realistic dose distributions, can improve TBI delivery.