

AbstractID: 14145 Title: Comparison of out-of-field neutron equivalent doses in scanning carbon and proton therapies for cranial fields.

**Purpose:** The purpose of this analysis is to compare the secondary neutron lateral doses from scanning carbon and proton beam therapies.

**Method and Materials:** We simulated secondary neutron doses for out-of-field organs in an 11-year old male patient. Scanned carbon and proton beams were simulated separately using Monte Carlo techniques. We have used circular aperture field of 6 cm in diameter as a representative field. The tumor was assumed to be in the cranium. The range and modulation width for both carbon and proton beams were set to 15 cm and 10 cm, respectively.

**Results:** In carbon therapy, absorbed neutron doses to tonsils and pharynx close to the field-edge were found to be  $5 \times 10^{-4}$  mSv/GyE and  $4 \times 10^{-4}$  mSv/GyE, respectively. Whereas, neutron equivalent doses to tonsils and pharynx were estimated to be 0.57 mSv/GyE and 0.55 mSv/GyE in scanned proton therapy, respectively. In heavy ion carbon beams neutrons produced inside the patient are emitted at small angles, predominantly in the forward direction, whereas in proton therapy, neutrons are emitted more isotropic. Therefore the absorbed neutron doses in carbon therapy lateral to the field edge are smaller compared to the corresponding proton fields. In forward direction though, the neutron doses from carbon ion therapy can be expected to be higher compared to proton therapy.

**Conclusions:** Secondary neutron doses received by tonsils (out-of-field organ) in scanned carbon and proton therapies are found to be  $5 \times 10^{-4}$  mSv/GyE and 0.6 mSv/GyE, respectively. Organs located laterally away from the field-edge receive much lower doses (thousand times smaller) in carbon therapy as compared to neutron doses in proton therapy. Whereas, on the distal side the neutron equivalent doses in scanned carbon therapy are a factor of 2 higher compared to similar scanned proton therapy fields.