AbstractID: 2523 Title: Photo-electric effect with a vengeance: Dosimetric and microdosimetric characterization of Contrast-Enhanced Radiation Therapy using kilovolt x-rays

Purpose: To quantify the dose enhancement (DE) in tumors labeled with contrast medium and irradiated by kilovolt x-rays in Contrast-Enhanced Radiation Therapy (kV-CERT). To study the microdosimetric changes in radiation quality in the same.

Method and Materials: DE in the presence of contrast media (CM, I or Gd-based) in slab geometries was studied with a Monte Carlo model (validated against measurements) as a function of photon energy and concentration. Two simulated clinical test cases were studied for a spherical tumor labeled with CM embedded in the brain or lung region. In both cases a CT-like arc was used as source geometry. To investigate microdosimetric radiation quality changes in the CM regions dose mean lineal energy, y_D, was calculated.

Results: In slab geometries irradiated with mono-directional x-ray beams maximum DE of about 6-8 for a I-based solution (50 mg/ml) or a Gd-based solution (79 mg/ml) were found to occur for 60 keV photons. Dose uniformity in the slab was found to depend strongly on the contrast medium concentration, the depth in the slab and the photon energy. For the brain and lung test cases dose enhancements of 4-6 were found when realistic x-ray spectra were used in an arc irradiation. A variable dose rate at different angles improved the dose uniformity in the target. For the lung test case kV-CERT was compared to a conventional 6 MV AP-PA plan. In addition to the large dose enhancement in the tumor, a dose decrease in the surrounding tissue by about 50% was noted. The changes in dose mean lineal energy in labeled tumors were limited to about 10%.

Conclusion: kV-CERT is a technique that has the potential to enhance the dose to tumors significantly while reducing the dose to the surrounding healthy tissues.

Conflict of interest: Work sponsored by Siemens Medical Solutions