AbstractID: 3947 Title: Target flattener combinations for combined therapy and high contrast megavoltage imaging

Purpose: To optimize target-flattener design in megavoltage (MV) x-ray beams for combined therapy and imaging purposes using Monte Carlo methods to quantify the effect of target-flattener material on treatment and imaging properties.

Method and Materials: Carbon, aluminum, stainless steel and tungsten were used in various target-flattener combinations. The BEAM/EGSnrc Monte Carlo system was used to design flatteners to achieve beam flatness, by the AAPM definition, of under 5% over 20 cm and 40 cm diameter fields. Further simulations were used to determine contrast improvement. Results were compared to experiment for the cases of the conventional tungsten target with stainless steel flattener, a small-field aluminum flattener, and no flattener. Contrast, contrast-to-noise ratio and MTF were measured using a variety of phantoms (aluminum plates, CIRS CT, Pips-Pro QC-3). A preliminary experimental investigation of contrast improvement in MV CT was also done, imaging the CIRS and Pips-Pro phantoms, and the head of RANDO.

Results: Measured treatment and imaging properties of the conventional flattener and small-field aluminum flattener validated the calculation approach. Calculated results demonstrate significant improvements in contrast using low-atomic-number targets or flatteners, using smaller flatteners that limit the field diameter to 20 cm, or removing the flattener altogether. The highest contrast is obtained with a carbon-carbon target-flattener combination. This combination results in a modest increase in the surface dose. The MV CT scans are visibly improved using the small-field aluminum flattener in place of the conventional flattener.

Conclusions: The Monte Carlo results for low-Z target and flattener combinations show significant improvement in imaging properties with minimal degradation of treatment properties. Clinical implementation would lead to improved contrast in localization and verification imaging with megavoltage beams. With small-field flatteners, the dose gradient outside the flattened region could be compensated with IMRT.

Conflict of Interest: This work is partially supported by Siemens Oncology Systems.