Purpose: Fluence field modulated computed tomography (FFMCT) presents a new paradigm for CT imaging. Spatial modulation of the x-ray fluence field, whereby the fluence pattern can change independently for each projection, can potentially meet user-prescribed, regionally-varying image quality objectives, while reducing radiation exposure to the patient. This work studies the potential to meet image quality objectives while limiting dose to local regions of interest via FFMCT.
Methods: All experiments were carried out in simulation using cylindrical and anthropomorphic phantoms. Fluence patterns were optimized to meet prescribed signal-to-noise ratio (SNR) criteria using a simulated annealing method with dose constraints on locally defined regions of interest. Optimizations were repeated using different weighting factors on the local dose constraints. Resulting SNR and dose distributions were compared to those of a fixed bowtie filtered fluence pattern.
Results: Results using FFMCT had superior agreement with the target SNR objectives and resulted in integral dose reductions of up to 50% when compared to results using bowtie filtered fluence fields. Increasing the relative weight of the local dose constraint resulted in further dose reductions (30-40% integral dose) to local regions of interest, with some tradeoff in SNR where overlap between the target low dose regions occurred with target high SNR regions of interest.
Conclusions: These results support the hypothesis that FFMCT has the potential to meet prescribed image quality objectives, while decreasing radiation dose to the patient. They also indicate that fluence field modulation may be optimized to prioritize dose reduction to local regions of interest when attempting to meet particular noise objectives.