AbstractID: 3544 Title: Fast Inverse Dose Optimization (FIDO) for IMRT via Matrix Inversion without Negative Beamlet Intensities

Purpose: To optimize an IMRT treatment plan by a matrix inversion method that is very fast, robust and yields a global optimization minimum without negative intensities. Given the availability of online imaging tools, the conformal dose distributions obtained through IMRT and its dynamic delivery features, adaptive radiotherapy becomes an important factor to be considered. A fast and reliable optimization algorithm is crucial not only for designing good radiation treatment plans but also for the successful implementation of future interactive adaptive treatment techniques.

Method and Materials: The objective function for the optimization of a large number of beamlets is reformulated such that the optimization problem is reduced to a linear set of equations. The optimal set of intensities is found through a matrix inversion, and negative beamlet intensities are avoided without the need for externally imposed ad-hoc constraints. The objective function remains quadratic and the optimal result obtained corresponds to a single global minimum.

Results: The method has been demonstrated with a test phantom and a few clinical radiotherapy cases using primary photons in the dose calculation only. We have showed that the new method is not only faster but also gives better optimization results. Typical optimization times for a single anatomical slice (2D) (head and neck) using a standard LAPack matrix inversion routine in a single processor desktop computer, are: 0.03 sec. for 500 beamlets; 0.28 sec. for 1,000 beamlets; 3.1 sec. for 2,000 beamlets and 12 sec for 3,000 beamlets.

Conclusions: We have developed a fast and robust technique to find a global minimum of an objective function that yields excellent results for the inverse optimization problem for the radiation treatment of tumours with IMRT.