AbstractID: 13190 Title: Trade-off between treatment plan quality and beam-on-time in IMRT using direct aperture optimization

**Purpose:** Beam-on-time is an important aspect of IMRT treatment efficiency, but optimization of this is usually postponed until the leaf sequencing phase of treatment planning. However, there exists a trade-off between treatment plan quality and beam-on-time. The aim of this study is to incorporate the beam-on-time into a direct aperture optimization model to explicitly quantify that trade-off.

**Method and Material:** A direct aperture optimization problem is formulated that includes a composite measure of treatment plan quality as well as a penalty for beam-on-time. An efficient method is developed to then obtain all treatment plans on the entire corresponding Pareto-efficient frontier. Starting with a very large beam-on-time penalty for which it is optimal not to treat, the beam-on-time penalty is reduced while simultaneously adding high-quality deliverable apertures while ensuring that the treatment plan remains Pareto efficient. The method can account for several MLC delivery constraints (row-convexity, interdigitation, connectedness, jaws-only). Using the set of Pareto-optimal treatment plans, gains in different measures of treatment plan quality that can be obtained when beam-on-time is increased are quantified. The analysis also identifies the range of beam-on-times for which a clinically acceptable treatment plan is obtained.

**Results:** For a set of ten clinical head-and-neck cases, the trade-offs between the treatment plan quality and beam-on-time are quantified. The impact of allowing for longer beam-on-times on the DVH criteria was investigated.

**Conclusion:** This work provides a direct aperture optimization model that explicitly incorporates beam-on-time. The model allows for studying the effect of beam-on-time on the treatment plan quality.