AbstractID: 3807 Title: Optimization of energy in inverse planning process

Purpose:
To simultaneously optimize the photon beam energy, orientations (gantry, table), wedge filters and beam weights in aperture-based IMRT, a new inverse planning system has been developed. This system, *Ballista*, uses anatomy-based MLC fields as aperture. It is an alternative for beamlet-based IMRT. The aim of this study is to include the photon energy in the optimization process.

Method and Materials:
Ballista uses a fast simulated annealing algorithm to select the optimal configuration of beams with respect to the objectives specified by the planner. To include the energy as a free parameter in the existing overall optimization system, this variable is interpreted by the algorithm as an angle and competes with gantry and table angles. That is, each eligible energy is assigned to a circular section of the space of all possible solutions. In addition to varying the energy of the individual beams, an option was added to the process which allows associating a combination of energies to various segments of a single field. The coverage margin overlap of the fields is naturally adapted as a function of the energy used.

Results:
The effectiveness of energy optimization has been tested on several sites. The lung cancer, which is an interesting example, has provided good results. The value of V_{20} (29,6% vs. 35%) is reduced as well as the mean dose to the heart (14,5% vs. 21,5%). Also, a better tumor coverage (V95% = 97,8% vs. 96,6% and IH = 1,07 vs. 1,10) is obtained in the case of a non-coplanar plan realized with this new approach in comparison with a standard plan (only one energy for the whole plan, 23MV).

Conclusion:
The inclusion of energy gives the optimization process an additional advantage over standard planning, and better close the gap between the optimized approach and the clinical treatment methods.