

FAN BEAM INTENSITY MODULATED PROTON THERAPY

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Abstract

A fan beam proton therapy is developed which delivers intensity modulated proton therapy using distal edge tracking. The system may be retrofit onto existing proton therapy gantries without alterations to infrastructure in order to improve treatments through intensity modulation.

A novel range and intensity modulation system is designed using acrylic leaves that are inserted or retracted from subsections of the fan beam. Leaf thicknesses are chosen in a base-2 system and motivated in a binary manner. Dose spots from individual beam channels range between 1 and 5 cm. Integrated collimators attempting to limit crosstalk among beam channels are investigated, but found to be inferior to uncollimated beam channel modulators.

A treatment planning system performing data manipulation in MATLAB and dose calculation in MCNPX is developed. Beamlet dose is calculated on patient CT data and a fan beam source is manually defined to produce accurate results. An energy deposition tally follows the CT grid, allowing straightforward registration of dose and image data. Simulations of beam channels assume that a beam channel either delivers dose to a distal edge spot or is intensity modulated. A final calculation is performed separately to determine the deliverable dose accounting for all sources of scatter.

Treatment plans investigate the effects that varying system parameters have on dose distributions. Beam channel apertures may be as large as 20 mm because the sharp distal falloff characteristic of proton dose provides sufficient intensity modulation to meet dose objectives, even in the presence of coarse lateral resolution. Dose conformity suffers only when treatments are delivered from less than 10 angles. Jaw widths of 1-2 cm produce comparable dose distributions, but a jaw width of 4 cm produces unacceptable target coverage when maintaining critical structure avoidance. Treatment time for a prostate delivery is estimated to be on the order of 10 minutes. Neutron production and dose estimates are found to be comparable to or slightly less than those found for existing passively scattered systems.