Microdosimetry for proton treatment planning

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Background: Microdosimetry studies the stochastics of energy deposition at a micrometric scale. This leads to better radiobiological predictions for densely ionizing radiation like protons. Exact simulation at this scale is too slow for treatment planning, and approximations need to be devised [1].

Material and Methods: This work attempts to implement microdosimetry for proton treatment planning via look-up tables. These tabulate the microdosimetric means of monoenergetic proton beams as a function of their kinetic energy. They can be built and validated via Geant4. Afterwards, during treatment planning via the RayStation TPS (or via Geant4 for validation), only protons and hadrons are simulated, and their kinetic energy distribution collected for relevant voxels. The look-up tables are applied to each distribution, giving the overall microdosimetric means for that voxel.

Preliminary results: A preliminary set of look-up tables has been built for protons (figure 1). Their validity has been tested via Geant4 by shooting a 150 MeV monoenergetic beam on a water phantom. The results appear excellent: the means obtained by applying the look-up tables to the kinetic energy distribution, and those calculated from the microdosimetric spectrum, agree within 10% throughout the whole Bragg curve. The only exception are voxels in the entrance channel, whose much higher discrepancies are being investigated.

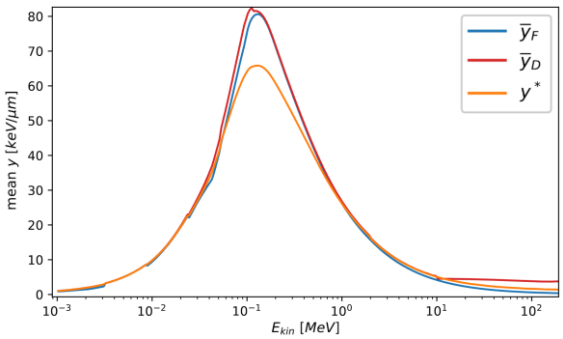

Figure 1: preliminary proton look-up tables. Each line correspond to a different microdosimetric mean as a function of a proton's kinetic energy.

[1] Y. Kase *et al.*, Phys Med Biol, 53 1 (2008) 37-59.