Systematic uncertainty budget for a novel diamond microdosimeter

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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. Lack of a code of practice and poor standardisation impede its adoptions in medical settings, where inaccurate RBE estimates are still used instead [1].

Material and Methods: This work attempts a systematic uncertainty budget for the diamond detector developed by Tor Vergata [2].

A clinical setup is simulated, whose geometry, physics, and statistics can be changed at runtime. Relevant changes have been committed to the official Radioprotection Advanced Example. With a simple Bash script several parameters' combinations can be simulated in parallel, quickly obtaining the corresponding uncertainty.

Preliminary results: For several positions along a Bragg curve, statistical uncertainty has been estimated. Further, the diamond's small thickness makes it excellent in the distal region, but its width increases the systematic error in the proximal region (up to 20%). The water scaling factor [2] leads to an error up to 30% due to its difficulty in accounting for the high LET tail. Position uncertainties (figure 1) cause up to 10% error around the peak. Strong differences in beam quality for equivalent dose along different Bragg curves have also been shown.

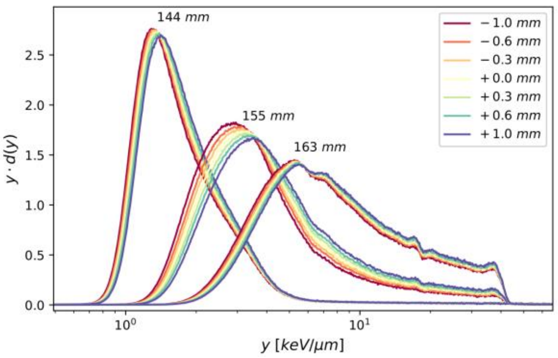

Figure 1: effect of small positioning errors on the dose-weighted probability density, shown for three depths along a 150 MeV Bragg curve.

[1] H. Paganetti *et al.*, Medical Physics, 46 3 (2019) e53-e78.
[2] C. Verona *et al.*, Radiation Measurements, 110 (2018) 25-31.