Theme: Physics

PTCOG-AO2025-ABS-0048
Beam monitor calibration via quasi-infinitely large mono-energetic fields

Nicki Schlegel
Shanghai Proton and Heavy Ion Center, China

Background and Aims:

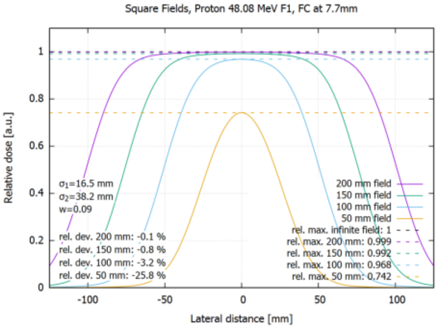
- Our proton beam monitor calibration is improved using quasi-infinitely large mono-energetic fields and a theoretical description of dose delivery physics applying first principles.

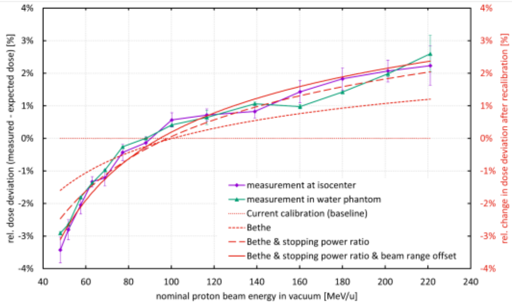
Methods:

- The dose of mono-energetic fields of 4 sizes is measured both at a fixed depth at isocenter and in a water phantom at a depth of one quarter of the beam range.
- Spot sizes sensed by the Farmer chamber during dose measurements are reconstructed and used to set the doses of isocentric measurements relative to the dose of an infinite field.
- The Bethe equation and the beam monitor gas-to-water stopping power ratio are fitted to the measurements via a cross-calibration factor and a beam range offset which corrects for the water-equivalent depth of the beam monitor while nominal vacuum beam energies are used for calculations.
- The dose of Spread-Out Bragg Peaks (SOBPs) is measured in a water phantom following IAEA TRS-398 and compared to TPS calculated doses.

Results:

- For lowest beam energy, merely a 20^2 cm^2 field is quasi-infinitely large. [left figure 1]
- Theory agrees within ±0.4% relative dose and 0.3mm beam range deviation with measurements. [right figure 2]
- After dose recalibration using theory, the dose to SOBPs is still 1.4% too low, requiring an additional dose recalibration.
- After this, various SOBPs are within ±1% of planned dose. 76% of proton patient QA measurements (n=175) agree within ±1% of the TPS dose, 97% are within ±2%.





Conclusions:

- The energy dependence inevitably introduced by the dose delivery system can be accurately described and corrected with basic physics applying first principles.
- For the calibration of a TPS though, also the dose to SOBPs is needed to obtain an additional energy independent calibration factor.