A Monte Carlo Pencil Beam Scanning model for proton TPS Quality Assurance using GATE/GEANT4

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Propose:

This study proposes an original method for Pencil Beam Scanning (PBS) system modeling, based on TPS acceptance measurements. The method has been applied and validated for an IBA proton-therapy system dedicated for PBS delivery. Preliminary comparisons of 3D dose distributions in patients between the Xio TPS and GATE/GEANT4 will be presented.

Materials & Methods:

Optical and energy parameters of the system have been modeled, based on a set of proton depth-dose profiles and spot sizes measured for 27 energies. Pristine Bragg peak simulations were evaluated in terms of mean point-to-point, dose-to-peak, range and spot size differences. The beam modeling accuracy was further validated by simulation of complexe 2D and 3D plans, like a Spread Out Bragg Peak (SOBP), a test pattern and field size factors.

Results:

Pristine Bragg peaks were reproduced with an accuracy of about 2% in dose, 0.7 mm in range and 0.2 mm for the spot size. The SOBP was reproduced with dose and range agreements of 2% and 0.8 mm respectively. 97% of the points passed the gamma comparison of the test pattern using a 2%/2m criterion. Field size factors were reproduced with an accuracy of about 2%.

Conclusion:

A generic modeling method for scanned ion beam delivery systems has been proposed and applied to an IBA protontherapy system. The advantage of such a method is not to require additional measurements other than those required by TPS manufacturers. From the validation tests performed so far, the beam model reaches clinical requirements and allows for TPS Quality assurance.