

AbstractID: 6510 Title: On the role of Landau tails in buildup effects of Bragg curves for proton energies beyond 140 MeV

Purpose: An improved version of the spot/raster scanning algorithm is being implemented in the proton dose model in ECLIPSE (Varian). Since the beam-line of this treatment modality is rather different from other modalities using wheels and nozzles, measured Bragg curves also significantly differ in the initial plateau, resulting from an energy spectrum with a manifest Landau tail, if the initial proton energy is $E \geq 140$ MeV (in particular, if $E \geq 200$ MeV).

Method and Materials: Proton Bragg curves have been delivered by different vendors and therapy centers, which show a significant buildup effect in the plateau region. The computational procedure is based on an analytical integration of Bethe-Bloch equation and on the inelastic cross-section of oxygen and some other materials (the transport of secondary protons is rigorously accounted for). The energy/range straggling of proton pencil beams used in scanning methods is described by a generalization of the composite Gaussian convolution kernel containing Landau tails in dependence of the energy (analytical representation of a Vavilov distribution function).

Results: The experimental data obtained by scanning methods can excellently be explained by the generalized convolution model, which is only a composite Gaussian convolution for proton energies $E \leq 140$ MeV. The buildup effect in the initial plateau region is accurately described. Proton beam-lines using range shifters provide Bragg curves with only very small indication of buildup effects, if $E \geq 200$ MeV.

Conclusion: An accurate description of Bragg curves including buildup effects is an important feature of therapy planning systems, since the calculation of SOBP and monitor units (MU, absolute dosimetry) are incorrectly described by fitting curves neglecting Landau tails.

Conflict of Interest: Varian Medical Systems