AbstractID: 7300 Title: Lateral Distribution of a Proton Pencil Beam which is Consistent with Range Straggling

Purpose: Pencil beam approach for proton beams is not accurate in the Bragg peak region because the multiple scattering theories are derived for monoenergetic particles and, therefore, can be applied only within CSDA range. We improve the pencil beam model to account for the range straggling in the Bragg peak region.
Method and Materials: Depth dose distribution from a monoenergetic proton beam can be calculated by folding a CSDA depth dose distribution with a function which describes range struggling. Performing the integration numerically, we obtain that the dose distribution from a proton beam can be presented as a linear combination of the CSDA depth dose distributions with weights which are defined by range straggling distribution. For particles traveling in each CSDA approximation, we can consistently apply multiple scattering theory. The final equation for 3D proton distribution covers entire range of a proton pencil beam.
Results: We have obtained an analytical expression for the 3D dose distribution from a proton pencil beam which covers entire penetration range. The equation consistently describes the depth dose distribution and the lateral spread due to range straggling in the Bragg peak region. This approach accounts also for proton loss from the beam at the end of the range.
Conclusions: 3D dose distribution from a proton pencil beam can be calculated using a simple analytical formula for entire proton range. This formula is convenient for use in treatment planning with therapeutic proton beams, particularly, in the heterogeneous compositions.