AbstractID: 10995 Title: Algorithm for accurate computation of doses from large-angle scattering of scanned proton pencil beams

Purpose: The purpose of this work was to find a technique to improve the accuracy of proton pencil beam dose computation for large scattering angles.

Methods: The computed dose from an elementary pencil beam in the scattering medium, like water in our study, comes from a convolution integral of the proton fluence in air and the scattering distribution function in the medium. The incident proton beam profile in air, just outside the target medium, was modeled with a sum of up to three Gaussians fitted with measured data. The proton scattering in the medium, assumed to proceed through Coulomb interactions, was described using the classic Moliere distribution. The convolution integration was performed by a combination of analytical and numerical methods leading to a numerically manageable expression.

Results: We compared measured and computed dose profiles at the 2 cm and at the Bragg peak depths for proton pencil beams with low and high energies. In all cases, profile calculations using just one Gaussian term for the beam fluence in air and the first Moliere term for the scattering distribution were in large disagreement with measurements at lateral distances beyond 10% profile falloff. At 2 cm depth in the water, the second and the third terms in Moliere distribution did not contribute significantly. On the other hand, the use of three Gaussians for the proton fluence in air produces nearly perfect agreement for lower energy protons and brings the agreement to within one order of magnitude for the higher proton energies. At Bragg peak depths, higher order Moliere terms are again insignificant for lower energy protons, but become important contributors for higher energy protons.

Conclusions: The proposed procedure was shown to achieve a dramatic improvement in the accuracy of computed doses from proton pencil beams at large proton scattering angles.