Monte Carlo and Analytical Dose Calculations for Proton Spot Scanning

M. Bues, Ph. D., G. Ciangaru, Ph.D., and A. Smith, Ph. D.

Abstract

There are various proposed schemes concerning the delivery of Intensity Modulated Proton Therapy. In almost all of them, the desired dose distribution is a continuous or discrete superposition of quasi-monoenergetic dose spots. The proton fluence at the surface of the patient or phantom giving rise to these dose spots may in many cases be described by a two-dimensional Gaussian distribution in the plane perpendicular to the beam direction. In this paper we compare the results of analytic calculations based on Moliere's theory of charged particle transport[1] in media to Monte Carlo calculations using the MCNPX transport code[2]. We calculate dose distributions for Gaussian fluence distributions ranging in energy from 72 MeV to 220 MeV with full width half measure ranging from 26 mm to 11 mm. Results are presented for a homogeneous water phantom as well as for a parallel slab phantom composed of, tissue, air and bone. Our results indicate that the analytical model may serve as the basis for a dose calculation engine suitable for the clinic.

[1]H. A. Bethe, "Moliere's Theory of Multiple Scattering," Phys. Rev. 89 (6), 1256-65 (1953)
[2]J. S. Hendricks et al. MCNPX, Version 2.5.c, http://www.mcnpxworkshops.com/25crelease.pdf