Computational Models for Shielding Design of Particle Therapy Facilities*

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There are currently about twenty five operational particle therapy facilities worldwide with three facilities actually treating patients with carbon ions. Another 13 facilities or so are in the design or construction stage. Some of these facilities will also have carbon ions. A typical facility may consist of an injector, a cyclotron or a synchrotron, a high energy transport beam line, several treatment rooms including fixed beam and gantry rooms, and sometimes even a research area. Each of these areas requires shielding. At these facilities proton energies typically range from about 230 to 250 MeV, while carbon ions may have energies to a maximum of 320 MeV/u to 430 MeV/u.

Performing complete Monte Carlo calculations for a specific room design is time consuming and should be avoided during the preliminary design phase, since the room configuration and shielding thicknesses are susceptible to change and various iterations, as the layout is being finalized. Thus, shielding calculations can be facilitated if there are empirical models comprised of source terms and attenuation lengths that are independent of geometry[1]. Also since space is a premium, large thicknesses of concrete shielding can often be replaced by smaller thicknesses of laminated barriers, i.e., barriers consisting of a combination of metal (such as steel) and concrete.

Agosteo et al have derived such models for concrete shielding for 400 MeV/u carbon ions[2] and 100 – 400 MeV protons[2]. However, no data has been published for 430 MeV carbon ions, or for laminated barriers. In this paper empirical models for shielding design with laminated barriers are presented. The models are based on FLUKA[3] simulations for 250 MeV protons and 430MeV/u carbon ions incident on both tissue and iron targets.

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[1] S. Agosteo et al (1996), "Double Differential Distributions and Attenuation in Concrete for Neutrons Produced by 100-400 MeV protons on iron and tissue targets", NIM PHYs. Res. B114, 70-80

[2] S. Agosteo et al (2001), "Radiation Production at Medical Accelerators" Rad. Prot. Dosim. Vol.96, No. 4, 393- 406

[3] A. Fasso et al, "FLUKA: Status and Prospective for Hadronic Applications", invited talk in the Proceedings of the Monte Carlo 2000 Conference, Lisbon, October 23--26 2000, A. Kling, F. Barao, M. Nakagawa, L. Tavora, P. Vaz eds., Springer-Verlag Berlin, p. 955-960 (2001)