AbstractID: 9801 Title: Proton Therapy Refresher Course, Part I: Basic Proton Physics

Proton beam radiation therapy is well suited to treating a wide variety of cancer patients. It has gained acceptance in the field of radiation oncology due to demonstrably superior normal tissue sparing as compared with external beam therapy using photons or electrons. The advantageous dose sparing, along with excellent dose uniformity achieved in the target volume, has yielded superior clinical outcomes for certain ocular tumors and several types of head and neck tumors. An additional advantage is that the radiobiology is simple: the relative biological effectiveness (RBE) of clinical proton beams is taken as having a constant value of 1.1 for all tumor types and dose/fractionation regimen. Hence, the clinical experience from external beam photon and electron therapy is directly comparable with that from proton therapy. That is in stark contrast to the case for most other heavy particle beams, *e.g.*, neutrons or carbon-12 ions, where both the transport physics and radiobiology are complex and dramatically different from those of conventional proton and electron beam therapy.

An understanding of proton radiation therapy therefore depends on a working knowledge of the basic proton interaction physics. This course presents: a review of the relevant radiometric quantities and units; introduces the basic physical interaction mechanisms of high-energy proton beams (energy loss and deposition, stopping power and range curves, multiple coulomb scattering, and nuclear reactions); a review of the characteristics of proton beam dose distributions as a function of depth or lateral position; and a review of techniques used to produce highly uniform and conformal dose distributions to a tumor volume. The latter includes proton beam spreading in depth based on energy and fluence modulation, *e.g.*, to produce a flat-topped spread-out Bragg peak (SOBP), lateral spreading techniques including passive scattering (with a single foil or with a pair of foils), distal edge range compensation, and field collimation. Beam delivery technique based on magnetically scanning a small pencil beam will also be presented.

Educational Objectives:

1. To understand the basic physical processes of proton beam interactions.
2. To clarify the physical basis for superior normal tissue sparing with proton beams.
3. To explain engineering techniques that are used to produce clinically useful proton beams.