AbstractID: 4405 Title: Accurate dose measurements in heterogeneous phantoms

The human body consists of tissue types that have radiological properties that are different from water. These include, for example, lung, bone, and oral cavities. Presence of such tissue types and cavities in the treatment fields of high-energy photon beams creates potential dosimetric problems. For inhomogeneities with density less than that of water electronic disequilibrium situations can be severe. Lateral electronic disequilibrium is present for small field sizes (i.e., 5 cm x 5 cm) and high energy beams (i.e., 15 MV) in a low density inhomogeneity such as lung. Perturbations at air-tissue interfaces are complex to measure or calculate due to lack of electron equilibrium. The trend of data published in the literature show that for low density media i) dose generally increases beyond the depth of dose maximum; ii) build-up and build-down regions exist within tissue near the low density media-tissue interfaces; the severity of these effects increase with increasing energy and decreasing field size; iii) the penumbra increases with energy in the region of low density region. For high density media the dose is found to decrease beyond the depth of dose maximum.

The dosimetric effects of these heterogeneous tissues become even more complicated for IMRT beams. This is because i) small radiation beams are inherently difficult to measure; ii) standard ion chambers have dimensions that are large compared to the beam and do not have the spatial resolutions that are needed to resolve the narrow central region of uniform dose and the sharp dose gradient regions of the penumbra and iii) the chambers may have a dose rate dependence.

The dosimetric impact of the presence of heterogeneous tissues in megavoltage photon beams have been addressed with varying degrees of success by various investigators i) experimentally by the use of specially designed ionization chambers, film, TLD and other dosimeters in specially constructed phantoms, ii) theoretically by the development of various dose calculation algorithms and iii) by the use of Monte Carlo simulation.

Educational Objectives:

Develop an appreciation of

1. the challenges involved in accurate dose measurements in heterogeneous phantoms
2. the clinical implementation of the results of such measurements, various dose calculation algorithms and/or Monte Carlo simulations to various disease sites that involve the presence of various types of heterogeneous tissues.