AbstractID: 4494 Title: Measurements of Secondary Radiation for Electron and Proton Accelerators

As new treatment modalities in Radiation Oncology such as Intensity Modulated Radiation Therapy (IMRT) and Proton Therapy (PT) become more widely used, improved target coverage and lower doses to surrounding normal tissues are achieved at the expense of higher out-of-field doses to distant normal tissues. These higher out-of- field normal tissue doses are the result of increased X ray leakage radiation from longer beam-on times associated with IMRT and neutron leakage radiation associated with high energy X ray beams (>10 MV) and protons. IMRT beam-on times can be 4-6 times that of conventional 3D treatments and neutrons produced by the high-energy X rays and protons striking a patient have a high relative biological effectiveness (RBE). Measurement of the increased X ray and neutron leakage radiation is crucial if one is to assess any additional risks to the patient that might result from the higher out-of-field radiation doses from these new treatment modalities. A variety of dosimeters, large volume ion chambers, diodes, survey meters, small volume ion chambers and thermoluminescent dosimeters (TLD), have been used to measure the X ray leakage in the treatment room and in the patient plane. TLD, because of its spatial resolution and ability to precisely measure low doses associated with leakage radiation, appears to be the preferable dosimeter. Neutrons are measured with bubble detectors, neutron meters utilizing a BF_3 proportional counter, ^{197}Au foil based activation either with a Bonner Sphere system/moderator or LiI dosimeters in Bonner Spheres. The gold activation technique has a calibration directly traceable to NIST and is the detector of choice for X ray produced neutrons. Due to the limited amount of neutron leakage measurement data around proton machines the ideal dosimeter has yet to be determined for this type of measurement. The measured dose-equivalent values in an anthropomorphic phantom for X ray leakage from an X ray accelerator decrease with increased distance from central axis (CAX) in the patient plane by a factor of 3 to 10, depending on the delivery mode and accelerator type. IMRT treatments on a Siemens machine results in higher dose-equivalents than the same energies on a Varian machine. Neutron measurements in the patient plane were approximately the same despite the distance from the CAX. Overall, the total dose-equivalent, X ray and neutron dose, decrease with distance from CAX with the Varian IMRT having the greatest decrease. Measured neutron dose-equivalents from proton therapy strongly depend on the delivery apparatus and decrease with distance from the nozzle. This lecture will provide an overview of the measurement techniques for X ray and neutron leakage radiation from both X ray and proton therapy machines and the resulting measured dose-equivalent values from which the risk of secondary cancers can be estimated.

Educational Objectives:

1. Understand the various techniques used to accurately measure X ray and neutron leakage radiation in the patient plane.
2. Understand the magnitude of the dose-equivalent in the patient plane from the various X ray accelerators and from proton therapy.