# AbstractID: 7696 Title: Benchmark measurements in heterogeneous phantoms under conditions of electronic disequilibrium

**Purpose:** To perform systematic measurements of photon beam characteristics under conditions of electronic disequilibrium for the purpose of benchmarking dose algorithms.

**Method and Materials:** Slab phantoms consisted of styrofoam ($\rho$=0.03g/cm$^3$), lung-equivalent ($\rho$=0.21g/cm$^3$), and bone-equivalent ($\rho$=1.7g/cm$^3$) materials, embedded within solid water. Ion chambers with active volumes of 0.125cm$^3$ and 0.015cm$^3$ and EDR2 film were used to measure depth dose and off-axis photon beam characteristics within several phantom geometries. Experiments were conducted for field sizes from 2x2 to 25x25cm, for 6 and 23MV photon beams produced from a Siemens accelerator.

**Results:** In the styrofoam phantom, the average agreement between the two ion chambers was within 2% for both energies with maximum differences of 9% observed in the sharp dose falloff region for small field sizes due to chamber volume effects. The 0.125cm$^3$ chamber over-estimated dose in the sharp falloff regions within the low density heterogeneities at the smallest field sizes, due to increased volume averaging. Relative dose film measurements demonstrated sharper penumbral gradients than ion chambers. Dose reduction in the lower density phantoms was enhanced with reduced material density and field size, and increased beam energy. Depth dose calculations differed by up to 20% and 10% versus measurements in the lung phantom for the 6 and 23MV beams, respectively. These discrepancies were partly attributed to a poorer fitting beam model for 23MV photons. Calculations were on average within 4% of measurements in the bone phantom for the 6MV beam, but larger differences (~ 12%) were found for 23MV photons, likely due to increased pair production at this energy. Point dose calculations differed from measurements in a lung/tumor phantom by 6% for 3x3cm, 6MV photons.

**Conclusion:** Measurements under conditions of electronic disequilibrium are confounded by many factors and must be performed with utmost care for algorithmic verification at the $\pm$2% level.

Acknowledgement: NIH/NCI-R01CA106770