A Monte Carlo simulation was used to study the response of a Beam Imaging Phantom (BIP) designed to verify dose distributions for intensity-modulated radiotherapy (IMRT). The BIP consisted of a cylindrical water phantom containing a gadolineum oxysulfide scintillation screen in the transverse plane through its central waist. The x-ray induced luminescence of the screen was measured with a CCD camera. Our preliminary experimental results showed that the BIP had a spatial resolution of 0.6 mm x 0.6 mm and excellent spatial and dose-signal linearity. Differences between ionization chamber measurements and BIP measurements of up to 30% were attributed to a non-linear energy response of the scintillation screen. Monte Carlo simulations of 4, 6 and 15 MV photon beams were executed using the EGS4/BEAM code. Simulated beam data were used by EGS4/DOSXYZ to calculate dose distributions in the scintillation screen and in water for various field sizes. Good agreement (within 3%) was achieved between the Monte Carlo calculations and the BIP measurements, indicating that the light output is proportional to dose to the scintillation material. Dose distributions calculated in water by Monte Carlo agreed well (within 2%) with the ionization chamber measurements. We then calculated correction factors for the BIP, defined as the ratio of dose to water to dose to the scintillation material, for intensity-modulated fields, which enabled us to verify the dose distributions delivered by the dynamic beam delivery procedures prior to an IMRT treatment using the BIP.

This investigation was supported in part by grant CA43840 from the National Cancer Institute.