AbstractID: 6725 Title: A Monte Carlo Simulation and Deconvolution Study of Detector Response Function

Purpose: The purpose of this study is to determine the detector response function using Monte Carlo simulations of small radiation fields and simulations of detector responses to those fields. The results may be used to deconvolve the effect of finite size detectors on beam broadening in small field measurements.

Method and Materials: A Monte Carlo model of a linear accelerator was generated to simulate the characteristics of a clinically used photon beam. These simulations were used to create a true beam profile. Three clinically available radiation detectors and two theoretical detectors were modeled in the beam. Detector specific models of measured beam profiles were generated from simulated detector responses. Detector response functions were deconvolved from the models of simulated measured profiles and the true beam profile. The results were then analyzed using curve fitting method.

Results: The penumbra of the beam profiles generated by different cylindrical detectors demonstrated a significant linear relationship with detector radius. Detector response functions of cylindrical detectors can be approximately represented as a Gaussian curve dependent upon the radius of the detector. Fourier transform methods can be used to deconvolve the detector response function for the penumbral areas, but can introduce noise in the non-penumbral areas. Deconvolution methods can reduce, but cannot remove the effects of detector size.

Conclusions: Monte Carlo simulation can be used to model small radiation fields and detector responses. Detector response functions can be determined from the simulated fields and simulated detector responses. A deconvolution method based on a detector specific Gaussian response function can be used to reduce detector size effect in the penumbral areas.