

AbstractID: 4958 Title: Validation of Geant4's predictions on x-ray scatter and glandular dose in pendant-geometry cone-beam breast CT

Purpose: The Geant4 toolkit is a freely available, widely supported base package for the simulation of particles through matter. This study aimed to test Geant4's accuracy by comparing its predictions for glandular dose and x-ray scatter in pendant-geometry cone-beam breast CT against previously published experimental and simulated data.

Method and Materials: We performed Monte Carlo simulations using the Geant4 package [Agostinelli et al, Nucl Instrum Meth A 506: 250-303, 2003] to recreate the conditions of three previously published papers on breast CT dose and scatter. Geant4's scatter simulations are compared against experimental data [Kwan et al, Med Phys 32(9): 2967-2975, 2005], while the dose results are compared against Monte Carlo simulations based on other codes [Boone et al, Med Phys 31(2): 226-235, 2004; Thacker et al, Phys Med Biol 49: 5433-5444, 2004]. The compared scatter results include scatter-to-primary ratio profiles for breasts of different sizes, glandularity and incident x-ray spectra. For the dose comparisons, we compared Geant4's monochromatic results with the monochromatic results reported by the two previously published papers.

Results: Geant4 matches the reported experimental SPR profiles to an accuracy of 1.6-16.7% ($\mu=9.2\%$, $\sigma=5.4\%$). The sources for observed deviations include inexact re-creation of the experimental setup and lack of specific information on the x-ray spectra used in the experiments. The dose results agree with Boone's published results within 0.7-12.3% ($\mu=5.3\%$, $\sigma=4.2\%$) and with Thacker's to within 1.2-22.3% ($\mu=10.8\%$, $\sigma=8.8\%$).

Conclusion: The data comparison suggests that Geant4 can be used to predict x-ray scatter and dose deposition in low energy experiments such as dedicated breast CT. Given the availability, support and flexibility of the Geant4 toolkit, the use of this package for simulation of breast CT studies can be very useful to researchers in the field. Research supported in part by: NIH-NIBIB Grant RO1-EB002123 and the Georgia Cancer Coalition.