AbstractID: 7662 Title: Scatter Measurements and Simulations in X-Ray Cone Beam CT Breast Imaging

Purpose: To compare and validate Monte Carlo simulation using the GATE software with experimental measurements for scattered radiation in X-ray cone beam CT breast imaging . In addition, to determine the scatter distribution for single-order, and multiple-order incoherent and coherent scatter using validated Monte Carlo simulation.

Methods: This study used a bench-top cone-beam CT breast imaging system using a flat-panel detector. A cylindrical phantom with equivalent composition of 50% fibro-glandular and 50% adipose tissues was used. Scatter distributions were measured by beam stop and aperture methods. A lead strip was positioned between the X-ray source and the breast phantom in the beam stop method. Its inverse version was used in the aperture method. We computed the scatter contribution in the breast phantom by subtracting background scatter. The background scatter fraction was measured without the phantom. The Geant4-based simulation package GATE was used to model X-ray photon interactions in the phantom and detector. Two implemented electromagnetic interactions packages, standard and low energy models, were compared for computing efficiency and physics ingredients. A structured breast phantom was used in GATE simulations to determine the characteristics of various scatter components which cannot be separated in measurements.

Results: Measurements by the two methods are consistent within 5% after background subtraction, and agree with the low energy model simulations. A hybrid model in GATE, with photoelectric process from the standard model and Compton and Rayleigh scattering processes from the low energy model, is computationally efficient while maintaining physics accuracy. The GATE simulations in the Bakic phantom show that the multiple-order scatter distribution, as well as single-order Compton scatter, has predominantly low-frequency characteristics. Single-order Rayleigh scatter was observed to be the primary contribution to the spatially variant scatter component.