Purpose: To investigate the feasibility of quantification of volumetric breast density using photon-counting spectral mammography.

Methods: A computer simulation model using polyenergetic spectra from a tungsten anode x-ray tube and a Si-based photon-counting detector has been evaluated for breast density quantification. The figure-of-merit (FOM), which was defined as the signal-to-noise ratio (SNR) of the dual energy image with respect to the square root of the mean glandular dose (MGD), was chosen to optimize the imaging protocols, in terms of beam energy and splitting energy. A scanning multi-slit photon-counting spectral mammography system was used in the experimental study to quantitatively measure breast density using dual energy decomposition with glandular and adipose equivalent phantoms of uniform thickness. Four phantom studies were designed, which covered various thicknesses ranged from 2.0 to 8.5 cm and densities ranged from 0% to 100%. In addition to the standard calibration fitting function used for dual energy decomposition, a modified third order fitting function was also investigated.

Results: The optimal splitting energies for breast density quantification with clinically relevant beam energies were suggested from the FOM simulation for various breast thicknesses. In the physical phantom studies, the RMS errors in breast density quantification were approximately 1.54% and 1.35% for measurements using the standard and the modified calibration fitting function, respectively.

Conclusions: The results of the current study suggest that photon-counting spectral mammography can be implemented in screening exam to measure volumetric breast density with high accuracy, which can potentially have a high impact in the assessment of breast cancer risk.