

# Evaluation of a Diffraction-Enhanced Imaging (DEI) Prototype and Exploration of Novel Applications for Clinical Implementation of DEI

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Conventional mammographic image contrast is derived from x-ray absorption, resulting in breast structure visualization due to density gradients that attenuate radiation without distinction between transmitted, scattered, or refracted x-rays. Diffraction-enhanced imaging (DEI) allows for increased contrast with decreased radiation dose compared to conventional mammographic imaging due to monochromatic x-rays, its unique refraction-based contrast mechanism, and excellent scatter rejection. Although laboratory breast imaging studies have demonstrated excellent breast imaging, important clinical translation and application studies are needed before the DEI system can be established as a useful breast imaging modality. This dissertation focuses on several important studies toward the development of a clinical DEI system.

First, contrast-enhanced DEI was explored using commercially available contrast agents. Phantoms were imaged at a range of x-ray energies and relevant contrast agent concentrations. Second, we performed a reader study to determine if superior DEI contrast mechanisms preserve image quality as tissue thickness increases. Breast specimens were imaged at several thicknesses, and radiologist perception of lesion visibility was recorded. Lastly, a prototype DEI system utilizing an x-ray tube source was evaluated through a reader study. Breast tissue specimens were imaged on the traditional and prototype DEI systems, and expert radiologists evaluated image quality and pathology correlation.

This dissertation will demonstrate proof-of-principle for contrast-enhanced DEI, establishing for the first time the feasibility of contrast-enhanced DEI. Further, it will show that DEI might be able to reduce breast compression, and thus the perception of pain during mammography, without significantly decreasing breast lesion visibility. Finally, this research shows the successful implementation of a DEI prototype, displaying breast features with approximately statistically equivalent visibility to the traditional DEI system. Together, this research is an important step toward the clinical translation of DEI, a technology with the potential to facilitate early breast cancer detection and diagnosis.