

# X-ray Phase Contrast Imaging: Evaluating Clinical Utility

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Interest in phase sensitive x-ray imaging techniques has grown rapidly in recent years. Numerous techniques have been demonstrated to measure the phase shift of x-rays as they pass through matter. One such method, grating-based interferometry, has shown the most potential for clinical use. This dissertation continues our group's efforts at characterizing the Talbot-Lau interferometer, with the overall goal of determining the clinical utility of the system.

This work first covers the basics of x-ray phase contrast imaging with a grating interferometer. Phase contrast imaging with this method has the advantage over conventional absorption imaging in that it allows for the simultaneous measurement of multiple contrast mechanisms. This multi-contrast imaging modality has the potential to improve the diagnostic capabilities of traditional imaging systems. It has unique noise properties that allow it to move to higher spatial resolution at a lower dose penalty, as well as improved contrast for certain material combinations. However, questions still remain about where such a system would fit in the clinical realm.

This dissertation delves into new research demonstrating the effects of beam hardening, improving the phase retrieval technique, determining the best method for grating fabrication, and exploring the impact of the small-angle scattering, or dark field, contrast mechanism. Both traditional beam hardening artifacts and new ones are shown, and their implication for clinical systems is discussed. The improved phase retrieval techniques aim at reducing the temporal requirements for the current acquisition method. While most of them succeed at reducing the time requirements, they also all come with an associated cost to the final image. Along with improved signal extraction, improved grating fabrication is discussed. The design and construction of a new grating fabrication system is detailed, demonstrating its capability of both producing absorption gratings with greater metal deposition depths and using cheaper, alternative absorbers. Finally, the impact of the dark-field contrast mechanism is discussed, highlighting the interplay between high-quality, low-noise phase and dark-field images.