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Towards high sensitivity and low dose medical imaging with laser X-ray sources

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Interferometric X-ray imaging based on refraction (differential phase contrast) can be much more sensitive to small soft tissue lesions than conventional X-ray imaging based on absorption, being a potential game changer for medical diagnostics. In addition, because interferometry uses the transmitted radiation, the radiation dose can be reduced by imaging at higher X-ray energy, where the tissues become transparent. The imaging technique best suited for clinical implementation is grating interferometry. Current grating setups utilize around 1 m long interferometers and relatively high radiation dose. We show that by using several meters long, few µm period interferometers, one can strongly increase the sensitivity and lower the dose in soft tissue imaging applications, such as mammography. Conventional X-ray tubes do not provide however sufficient X-ray flux for clinical imaging with such long interferometers. Instead, 100-TW class lasers may provide the highly directional and intense X-ray sources needed for high sensitivity medical interferometry. We present the X-ray source characteristics required for clinical interferometry, the advantages and disadvantages of betatron versus inverse Compton scattering mechanisms for clinical X-ray sources, and the Dr. LASER project at ELI-NP for the development of laser-based, high sensitivity and low dose interferometric mammography.

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