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High-sensitivity quantitative X-ray phase-contrast imaging for biomedical applications

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Phase-contrast X-ray imaging uses the refraction of X-rays to generate the contrast. It has been demonstrated to provide superior soft-tissue contrast in comparison to conventional attenuation-based X-ray imaging. However, quantitative imaging of biomedical soft tissue at high spatial resolution and high image quality still remains challenging. Some existing methods require assumptions on the composition of the specimen (e.g., single material and low attenuation) to retrieve the phase information and show less sensitivity in resolving small changes in electron density within the sample. Specimens violating these assumptions become impossible to image. Within a long-term proposal at the imaging beamline P05, we successfully designed and built an imaging setup based on 2D Talbot array illuminators (TAI) (Gustschin et al., 2021) and a speckle-tracking technique (Unified Modulated Pattern Analysis, UMPA) (Zdora et al., 2017), which overcomes these challenges. Our method accurately extracts the electron density distribution with higher sensitivity than comparable techniques and is compatible with a wide energy range. Here, we will review the potential of this new quantitative imaging method by highlighting the recent results on biomedical applications.

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