Propagation-based phase contrast tomography with synchrotron radiation

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Synchrotron X-ray beams have a very high photon flux density, which allows high-quality, high-resolution tomographic measurements to be made in less than a minute. They also have a higher degree of spatial coherence than laboratory X-ray sources, which allows the phase shifts induced by a sample to be converted into phase contrast. This allows imaging of soft tissues that do not provide sufficient absorption contrast. The possibility to scan a large number of samples in 3D with high resolution in a short time allows time-resolved 3D studies, which has many applications in materials research and life sciences. We will introduce the physics behind synchrotron X-ray image formation, the principles of tomographic measurements and describe the complete data acquisition scheme for high-throughput tomographic measurements. Then we will describe several approaches to perform phase retrieval and tomographic reconstruction. We will further focus on the filtered back projection algorithm that we use in practice and briefly describe its GPU-based implementation, which is fast enough to reconstruct the data online while the data acquisition is running. We will also discuss typical challenges and reconstruction artefacts and how they are dealt with. Finally, we will show several examples from different application fields.