

Grating Based X-Ray Phase Contrast Imaging using Laboratory X-ray Sources

Manfred Schuster¹, M. Chabior^{1,5}, M. Engelhardt^{1,4}, J. Baumann¹, E. Hempel²,
T. Donath³, O. Bunk³, C. David³, F. Pfeiffer⁴, and C. Schroer⁵

1 Siemens AG, Corporate Technology, Otto-Hahn-Ring 6, D-81739 Munich, Germany,

2 Siemens AG, Healthcare, Forchheim, Germany,

3 Paul Scherrer Institut, Villigen, Switzerland,

4 Technical University Munich, Munich, Germany,

5 Technical University Dresden, Dresden, Germany

Advances in synchrotron instrumentation and x-ray techniques have opened the door for impressive new applications in phase contrast imaging. In general, however, these techniques cannot be adapted to laboratory x-ray sources, since the high coherence requirements ask for synchrotron sources. Only propagation based methods and recently developed grating based methods work well with broad energy spectra. In this paper, a grating interferometer with a polychromatic laboratory x-ray source in cone beam geometry is used to measure the phase shift. In contrast to propagation based methods, which essentially detect the phase shift's 2nd derivative, here, the phase shift's 1st derivative of the x-rays transmitted through matter can be determined quantitatively [1].

Grating based phase contrast techniques are applied for imaging industrial and biological objects. The quantitative determination of the phase shift allows to study small deviations concerning geometry or material composition on technical parts. Among the biological applications, a magnified phase contrast tomography of an insect has been reconstructed from a series of projections [2]. The computed tomograms show the high spatial resolution and the high contrast of thin and low-absorption structures of small biological objects. Phase contrast imaging on medical objects offers the capability to visualize details in soft tissues. The experimental results demonstrate the high potential of grating based differential phase contrast imaging with laboratory x-ray sources. Using numerical simulations based on Fresnel diffraction theory, the influence of physical parameters as source size and photon energy spectrum on the image formation is studied and the potential of grating based imaging is explored [3].

[1] F. Pfeiffer, T. Weitkamp, O. Bunk, and C. David, *Nature Phys.* 2 (2006) 258-261.

[2] M. Engelhardt, J. Baumann, M. Schuster, C. Kottler, F. Pfeiffer, O. Bunk, and C. David, *Appl. Phys. Lett.* 90 (2007) 224101.

[3] M. Engelhardt, C. Kottler, O. Bunk, C. David, C. Schroer, J. Baumann, M. Schuster, and F. Pfeiffer, *J. Microsc.* 232 (2008) 145-157.