X-ray phase-contrast imaging at Diamond I13 Beamline

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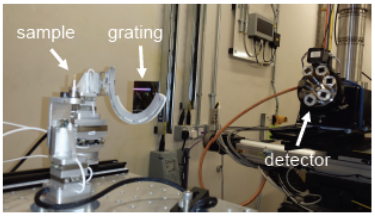
Introduction

X-ray phase-contrast imaging uses the phase shift of the incoming x-rays created by the sample to reveal its inner structure. Due to its much higher sensitivity to small density differences compared to conventional absorption imaging [1], this technique has become an established method for investigating samples such as biological soft tissues and alloys. Here, we present the first results of the implementation of grating-based phase-contrast imaging at Diamond-Manchester I13 imaging beamline [2], also in comparison with the propagation-based method commonly used at this beamline.

Techniques and Setup

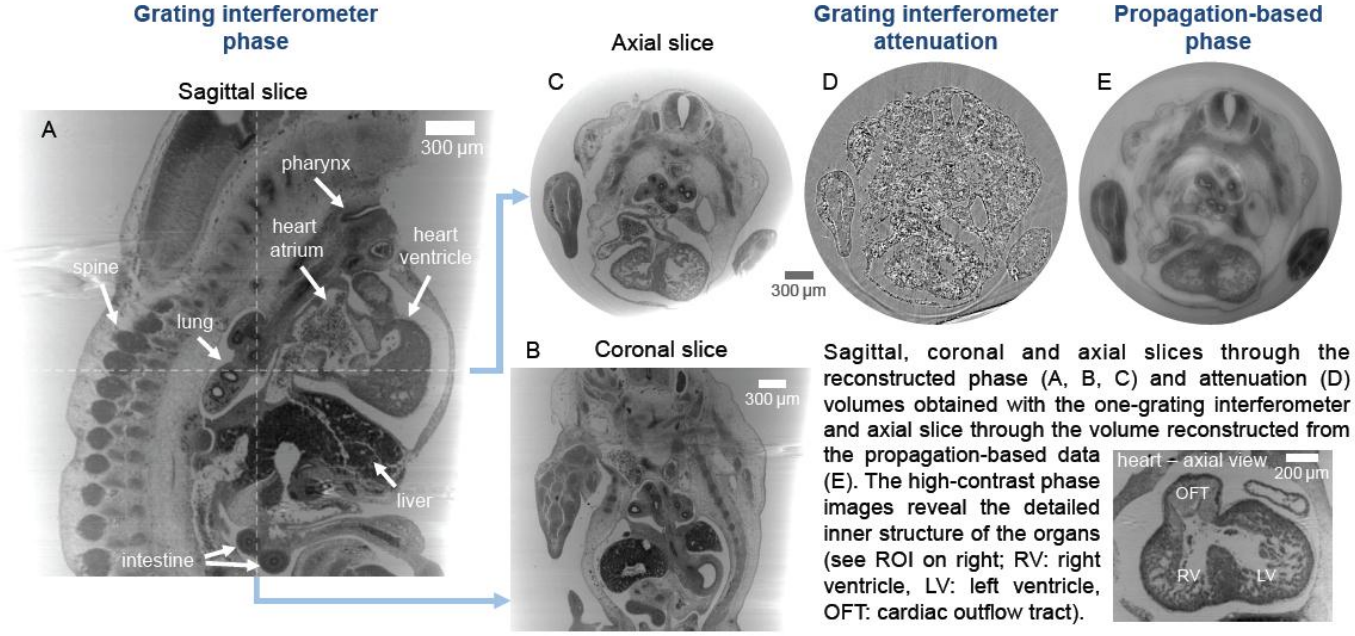
A. One-grating interferometry: A single phase grating produces a reference interference pattern that is directly resolved by the detector. The distortion of this pattern by the sample is analysed to retrieve the differential phase signal perpendicular to the grating lines [3].

B. Propagation-based imaging: There are no further optical elements in the setup. The phase reconstruction makes use of the propagation fringes at the edges of features. A single-distance phase-retrieval algorithm assuming a constant δ/β ratio was used [4].



Technique	X-ray energy	Distance	Effective pixel size	Optical elements
Grating interferometry	19 keV	grating-detector: 72 cm	1.1 µm	Ni grating period: 10 µm
Propagation-based	19 keV	sample-detector: 85 mm	1.1 µm	-

Results on a Mouse Embryo in Paraffin Wax



Sagittal, coronal and axial slices through the reconstructed phase (A, B, C) and attenuation (D) volumes obtained with the one-grating interferometer and axial slice through the volume reconstructed from the propagation-based data (E). The high-contrast phase images reveal the detailed inner structure of the organs (see ROI on right; RV: right ventricle, LV: left ventricle, OFT: cardiac outflow tract).

Conclusions and Future Work

- ✓ Successful implementation of grating interferometry at I13
- ✓ Excellent stability of the setup
- ✓ High visibility of the grating interference pattern (~ 30%)
- ✓ Phase images of histology-like quality
- ✓ Superiority of grating-based phase signal

- ➢ Implementation of other phase-contrast imaging methods such as speckle-based imaging [5] at I13
- ➢ Reduction of artefacts in propagation-based images
- ➢ Cone-beam setup for spatial resolution down to cellular level

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