Time-resolved tomography by X-ray Talbot interferometry

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The time-resolved reconstruction of an object by tomography allows the visualization of the dynamic behaviour of its internal structures. We have demonstrated the first time-resolved tomography combined with the higher sensitivity of X-ray phase imaging, compared to absorption imaging. Amongst the existing X-ray phase imaging techniques, the use of a Talbot interferometer has the distinct advantage that it also functions with a broad energy bandwidth. The white synchrotron radiation can be used to achieve high-speed phase imaging. This allows the fast acquisition of tomographic data, so that time-resolved tomography has been achieved by the successive 3d reconstructions. Generated by the Talbot interferometer, moiré images of the sample rotating at 1 or 2 rps have been acquired at a frame rate up to 1000 fps. While a phase stepping technique is usually performed to retrieve the differential phase shift image from a set of raw images, the high speed nature of the experiment prevents us from using this. The differential phase information is extracted from a single raw image by the Fourier method, for a higher scanning speed. Consequently, a time resolution of less than one second has been achieved. In addition to the differential phase images, the fringes visibility reduction originated from small-angle scattering by unresolved microstructures can also be imaged by the Talbot interferometer, so that time-resolved tomography from the visibility information is also possible. The time-resolved phase tomography is presented for samples such as evolving air bubbles in glue as well as a living worm.

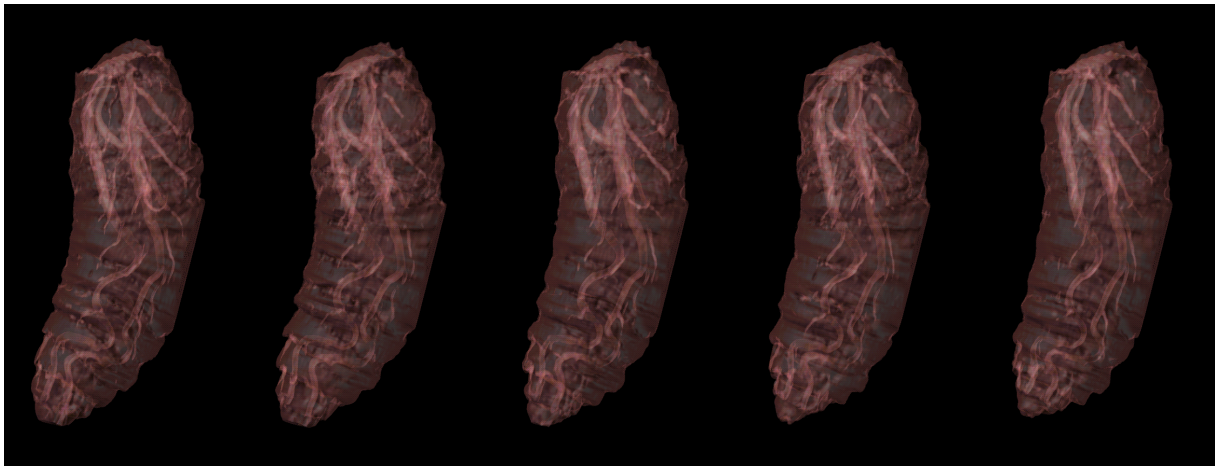

Figure 1: Time resolved phase tomography of a living worm (red maggot, 10mm long). Isosurface representation of selected tomograms during the 6 seconds of exposure by white synchrotron light.