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Phase contrast computed tomography: a different approach

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In contrast to conventional hard x-ray absorption radiography (or tomography) based on differences in absorption, phase imaging exploits the coherence of the source and differences in the real part of refractive index distribution of an object to form an image. This technique has two key advantages: first, light elements, showing poor contrast in absorption radiography, can be easily detected; second, phase-contrast radiography helps to reduce the radiation dose deposited on the object under investigation.

As far as phase tomography (quantitative reconstruction of the phase or the refractive index decrement in 3D from 2D phase images) is concerned, all non-interferometric phase retrieval methods [1] are based on a two step approach. First, the projections of the phase are retrieved and then the object function, i.e. the refractive index decrement is reconstructed by applying a conventional filtered backprojection algorithm.

On the other hand, the reconstruction algorithm suggested by Bronnikov [2] presents an alternative approach which eliminates the intermediate step of 2D phase retrieval and provides a direct 3D reconstruction of the object. The reconstruction algorithm is very interesting from the experimental point of view since for a pure phase object it requires only one single tomographic data set.

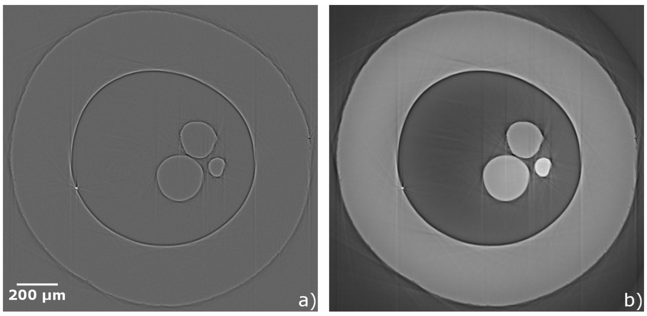

Fig. 1 Reconstructed slice of a polyethylene tube with polymer fibers inside: a) using filtered backprojection and b) using the Bronnikov method. The sample to detector distance was 15 cm and energy 13.5 keV.

We implemented Bronnikov's reconstruction algorithm and examined its performance experimentally and numerically. One reconstructed slice of the polyethylene tube with 2 polymer fibers and a hair inside is given in Fig. 1, using filtered backprojection (a) and using the Bronnikov algorithm (b).

The advantage of the Bronnikov algorithm compared to conventional filtered backprojection is evident: actually, in a) only the edges are visible while in b) weakly absorbing materials can be clearly differentiated. This indicates that the method can be used as a tool in imaging biologically relevant objects.

References:

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