ESRF	**Experiment title:** In-line phase contrast imaging in radiology	**Experiment number**: MD-66
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Report:

The goal of the experiments was to detect small biological structures using phase contrast effects by means of the In-line holography technique. Three types of samples were considered:

1) Images of small vessels of cams at various growth stages
2) Images of a vascular tree of a cast
3) Images mosquito.

Results

Characterization of the spatial resolution of the camera

The spatial resolution of the camera is limited by the size of the pixel (3.8 µm) and by the diffusion of the light into the scintillator. The MTF was obtained from the response to edge function produced by placing (perpendicular to the beam) a 500 µm thick absorber made of tungsten. To avoid a loss of resolution due to diffraction of x-rays on the edge of the tungsten absorber, it was placed right in front of the scintillator. The edge function was deduced from a profile average over 50 pixels. From the edge function the MTF was calculated using a standard method. The MTF reaches 5 % at 60 pl/mm, the Nyquist frequency being located at 131 pl/mm.

Images of small vessels

Three types of biological structures have been imaged:

- A complete hen embryos at a stage of maturation in the range of 3 to 4 days.
- A complete hen embryos at a stage of maturation in the range 9 to 10 days.
- A vascularized membrane of hen embryos at a stage of 10 days development deposited on a thin plexiglas plate.

The samples were imaged 1/2 hour after the cut of the sample preparation. The sample exposure time to the beam was 60 s. No image of vessel have been obtained in spite of moving the sample and performing many image acquisitions. The problem being certainly that the difference in densities between the vascular structures and its environment was too small. Only small scattered structures were detected. Because of their dissimilarities with the vascular structures and of their random localization, these images are certainly images of some dust located in the preparation or on the plastic support.

Images of casts

Images of vascular structures (made of a synthetic resin: cast) were also imaged using similar conditions as above. Figure 1 shows the aorta of a mice heat. The phase contrast effects are quite visible on the edges of the structure. The diameter of the aorta is approximately 150 µm. Figure 2 shows the merging of several images of the same kind of sample but which is very thin. All images have been flat field corrected.

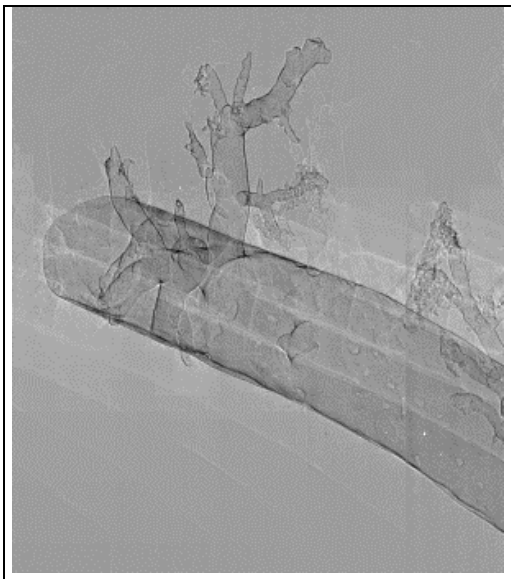

Figure – 1 cast of a heart

Figure – 2 cast of cam

Phase contrast imaging on a mosquito

Phase contrast Images of a mosquito have been obtained without any difficulty. These images prove that the set-up used was able to produce phase contrast effects. The exposure time of the sample was 60 s the width of the images corresponds to a field of view of 1 mm. As for the "casts", these images were obtained by merging several images in the vertical direction. The images show a significant contrast of phase which reveals very fine details which remain invisible by the traditional contrast of absorption, such as the structure of the eye, the details of the articulations or the hairs. The diameter of the legs was measured with approximately 250 µm whereas dimensions of the small structures present in the head are about 100 µm.

Conclusion

The images of the cast and the images of the mosquito confirm the potential of the technique to reinforce the contrast of the edges that allows the improvement of the detection of the small structures weakly absorbing. The drastic effects are due to transitions between air and structures. The small refraction index differences between the different biological tissues imaged did not allow to get any visible phase contrast effect. This study should be pursued to study theoretically the limit of phase contrast imaging when dealing with thin structures of low contrast.