ESRF	**Experiment title:**	**Experiment number**: MD-34
Beamline: ID17	**Date of experiment**: from: 24.09.2003 to: 27.09.2003	**Date of report**: 10.12.2003
Shifts: 8	**Local contact(s)**: Dr. Stephan FIEDLER	*Received at ESRF:*

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Report:

The purpose of the experiments was to explore the potential of the refraction and phase contrast imaging of biological tissues. Images of ten days fertilized eggs and of a fly were recorded on a FRELON camera with a pixel size of 1.4 µm. Images of 2048 x 2048 pixels were recorded at a defocusing distance of 5 m with a beam energy of 25 keV. The technique used was in-line holography.

Results

Although the refractive index of biological tissues differs from unity only a few parts per million at X-rays energies, and the difference between different tissues is about 100 times smaller, the phase shift cross section is in the order of 100 to 1000 times greater than the absorption cross section, resulting in a potentially much more sensitive imaging method. Because the differences in X-ray absorption coefficients of the structures in soft tissues are small, observation of blood vessels from differences in X-ray absorption is almost impossible in absorption contrast without use of contrast agents. To reveal the potential of in-line holography to image small biological structures, an egg membrane with vascular structures was removed and placed perpendicularly to the X-ray beam. Because the refractive index of blood is significantly different from the one of the surrounding tissue, it was expected that blood would generate phase contrast without using any contrast agents. The experiment was performed using a ten days fertilized egg. Figure 1 shows images of small vessels (ø 28 and 45 µm) of the egg filled with blood. The refraction effects of phase contrast images show edge enhancements, resulting in the clear depiction of the edge of the vessels. The edge enhancement effects due to phase contrast allow the visualization of small vascular structures in air. The entrance air kerma rate at the position of the sample was measured from the ionization chamber readings and was approximately of 27 mGy/s. The acquisition time was 60 s, so the dose for all images acquired is of the order of 1.62 Gy.

Figure 2 shows examples of fine structures of the head and of the leg of a fly. The complex eye structure, fly hair and a small portion of the tip of the fly's leg are small structures invisible by classical absorption contrast. The important edge enhancement contrast due to the important difference in refraction index between air and biological material such as hair allows the detection of weak structures unnoticeable with pure absorption contrast. The energy beam, acquisition time and dose rate were the same as those mentioned above.

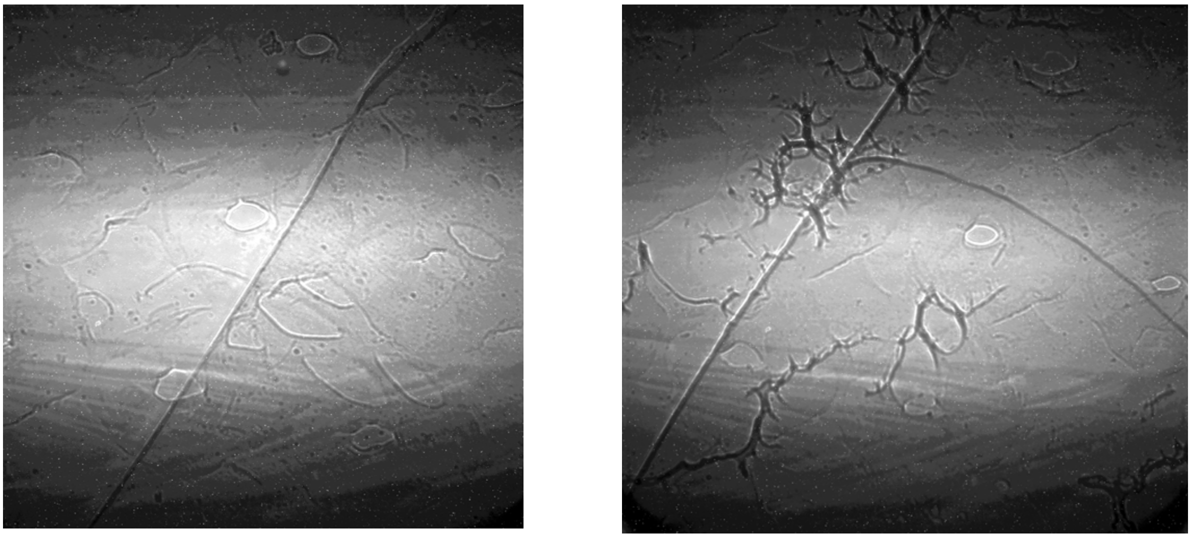

Figure 1 : Images of small vessels of fertilized eggs

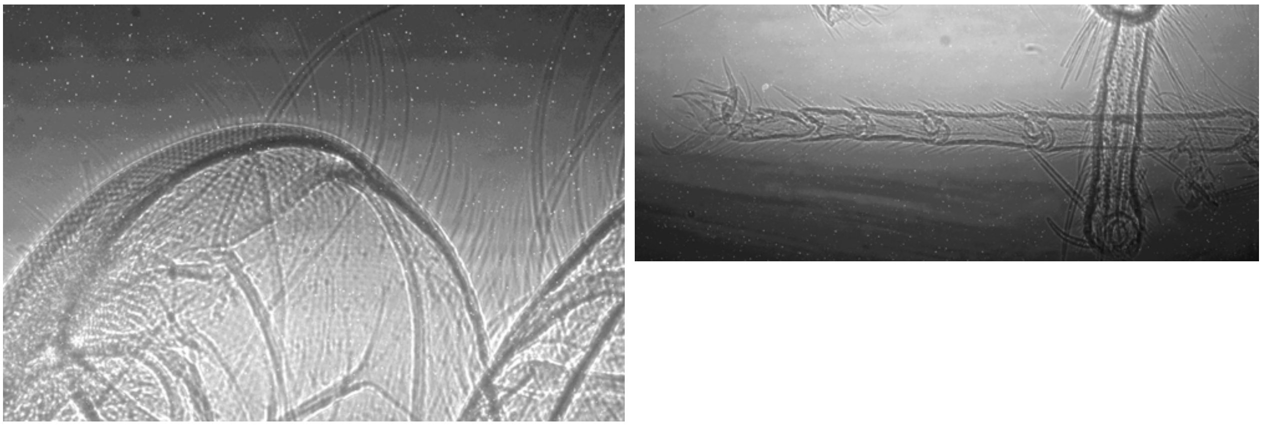

Figure 2 : Images of the complex structure of a part of the head and the leg of a fly