ESRF	**Experiment title:** Phase-contrast tomography of tumor invaded tissue samples	**Experiment number**: MD-404
Beamline: ID19	**Date of experiment**: from: 8/7-2009 to: 13/7-2009	**Date of report**: 1/8-2010
Shifts: 15	**Local contact(s)**: Timm Weitkamp, Irene Zanette	*Received at ESRF:*

Names and affiliations of applicants **(* indicates experimentalists):**

- Dr. Martin Bech(*) and Prof. Franz Pfeiffer(*), from Technichal University Munich, Germany
- Prof. Robert Feidenhans'l(*), Mr Torben Jensen(*), Mr Arvid Böttiger(*), Prof. Dr Med Andreas Kjær, Ms. Tina Binderup, Prof. Dr Med Liselotte Højgaard, Ms Christine Hartmann(*) and Ms Tine Straasoe(*) from University of Copenhagen, Denmark
- Mr. Michael Kerschnitzki(*),Max Planck Institute of Colloids and Interfaces, Potsdam, Germany
- Dr. Tilman Donath(*), PSI, Swizerland

Report:

A medical case study was conducted on 23 axillary lymph nodes, from axillary dissection specimens from women with invasive ductal breast carcinoma. Using grating based differential phase contrast tomography[1,2] the aim was to visualize the state of metastatic deposits. The experiment worked very well and produced high quality and high contrast images. As a gold standard for comparison, the lymph nodes investigated have also been analysed with histology.

Of the 23 measured samples, six were excluded before final analysis as technical difficulties (the samples were too big to fit into the experimental setup). The x-ray phase contrast CT images of the remaining 17 samples were examined independently by two experienced paleonthologists in a double blind test. The outcome was very positive, as it was possible to distinguish benign from malignant tissue. Ten samples were correctly identified as malignant tissues and six samples were correctly identified as healthy. Only one sample was incorrectly identified by each of two examinators (false positive).

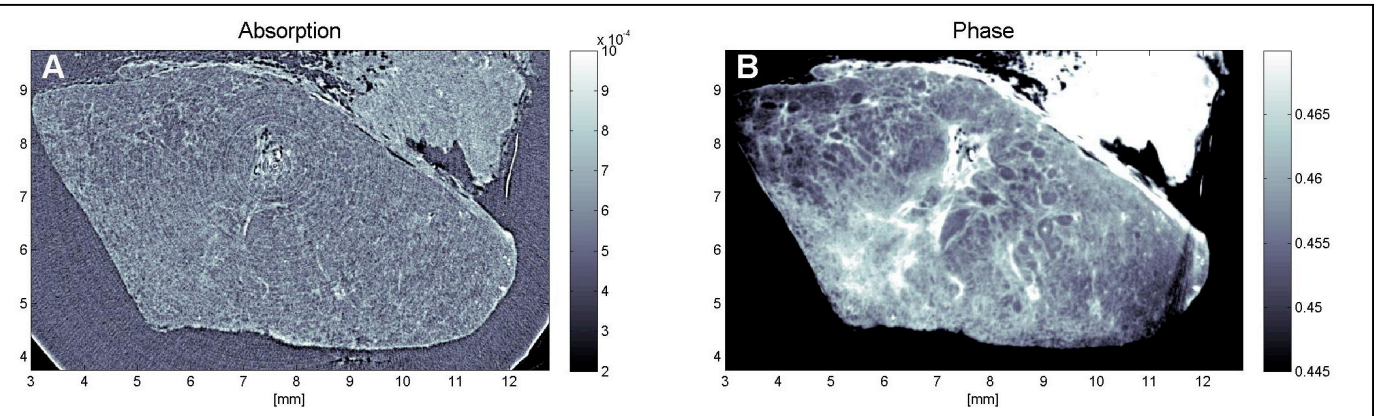

Illustration 1, Exemplary results: Virtual slices through the reconstructed absorption and phase tomography volume of a cancerous lymph node. (a) Slice through the absorption tomogram showing very little contrast in the internal structures of the lymph node. (b) Slice through the phase tomogram with high contrast, showing the internal structure of the lymph node. With the better image contrast it is possible to determine that this lymph node is cancerous.

An example of the imaging results obtained from this beamtime, Illustration 1, displays a slice through the standard absorption tomogram and a slice through the phase contrast tomogram. Compared to standard absorption images the phase images showed significant increase in image contrast.

Illustration 2 displays x-ray phase contrast images obtained at this experiment MD-404. The displayed lymph node is healthy, as can be seen from the clear groupings of cells (lymphoid follicles) around the edge of the node.

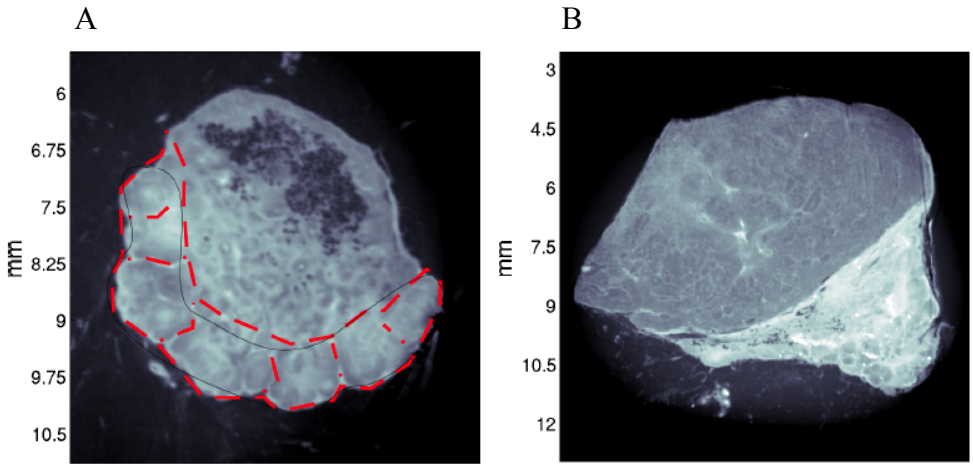

Illustration 2. Slices through phase contrast 3D volumes of two samples. (A) The lymphoid follicles (outlined) look normal, indicating that the lymph node is benign. (B) Great contrast in tissue density and lack of cell grouping indicate that this lymph node is malignant.

It is concluded that this method provides diagnostic results in agreement with the gold standard (histology). A publication of these results is currently in preparation [3].

[1] Momose A, Kawamoto S, Koyama I, Hamaishi Y, Takai K, Suzuki Y. Demonstration of X-ray Talbot Interferometry. *Jpn J Appl Phys* (2003);**42**:866–9.
[2] Pfeiffer F, Bunk O, David C, Bech M, Le Duc G, Bravin A, et al. High-resolution brain tumor visualization using three-dimensional x-ray phase contrast tomography. *Phys Med Biol* (2007); **52**(23):6923-30.
[3] Jensen TH, Bech M, Binderup T, Böttiger A, David C, Weitkamp T, Zanette I, Reznikova E, Mohr J, Rank F, Feidenhans'l R, Kjær A, Højgaard L, Pfeiffer F. Imaging of Metastatic Lymph Nodes by X-ray Phase-Contrast Micro-Tomography. Submitted to *Radiology* (2010).