ESRF	**Experiment title:** Hard x-ray fluorescence microtomography and scanning microscopy with sub-micrometer resolution using refractive x-ray lenses	**Experiment number:** MI-704
Beamline: ID13	**Date of experiment:** from: Feb. 15, 2006 to: Feb. 20, 2006	**Date of report:** March 1, 2006
Shifts: 18	**Local contact(s):** M. Burghammer	*Received at ESRF:*

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Report:

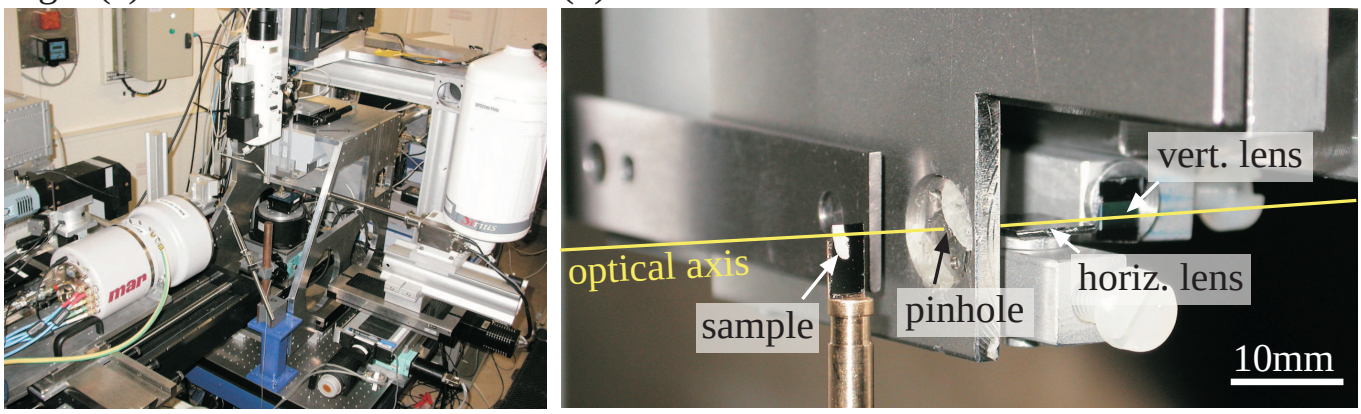
The fourth beam time of this long term proposal was dedicated to commissioning the improved scanning microscopy setup based on nanofocusing lenses (NFLs) and to verifying the performance in view of fluorescence imaging and tomography. In addition, the nanobeam was prepared for the following user experiment MI-791 that was based on the refractive nanoprobe. Since the previous experiment (MI-704-3) the setup has been optimized for mechanical stability. The lens support as well as the sample stage were redesigned. A vibration sensor was integrated into the setup, allowing one to monitor setup-motion during operation. Fig. 1 shows the new setup as integrated into the beamline ID13 and a detail of the optics-sample region. Further upgrades include active damping and interferometric control of the sample and optic position. The active damping table was tested, however, was not integrated into the setup during the experiment.

The control software was improved, fixing some bugs in the communication with the SPEC of the beamline. In addition, for some of the components of the setup, such as the high resolution x-ray camera, the PIN-diode, and the vibration sensor, TANGO device servers were implemented. For now, they were used in an independent TANGO environment, but in the future they may be integrated into the beamline control system more easily.

During the first part of the experiment, the nanobeam was characterized for $E = 21$keV. However, no reproducibly small focus could be obtained (typical focus around $300 - 400$nm). A variety of tests showed that the newly installed channel-cut Si monochromator did not perform according to expectations. The lateral coherence length of the beam incident on the setup was estimated by near field imaging of a

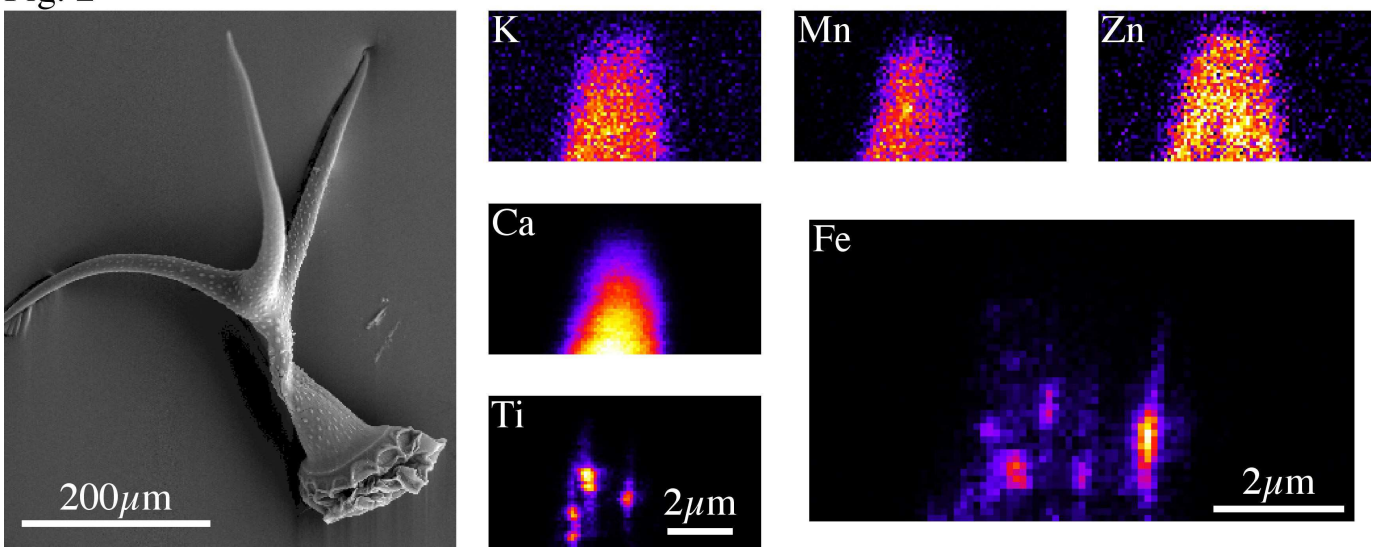
sharp edge. The effective source size was significantly larger than usual (several 100μm in both directions), in good agreement with the measured focus size. After switching back to the beamline's Kohzu monochromator ($E = 15$keV), foci in the (sub-)100nm range could be reached again.

Fig. 1(a) (b)



The remaining time in the experiment was too short to acquire a full fluorescence tomogram. Therefore, a two-dimensional fluorescence mapping was made, acquiring full fluorescence spectra of one of the tips of a trichome (leaf hair) of *arabidopsis Thaliana* (sample provided by W. Schröder, FZ Jülich) with a step size of 100nm and 5s dwell time per point. Element maps of P, S, Cl, K, Ca, Ti, Mn, Fe, and Zn were obtained, a few of which are shown in Fig. 2. The Fe and Ti distributions show fine features on the scale of single pixels (100nm). The results are currently evaluated in view of their plant physiological implications.

Fig. 2



For MI-791, a nanobeam was prepared at $E = 15$keV. During this user experiment, the nanobeam was fed into a wave guide. The resulting beam characteristics were determined by examining the far field wave front behind the wave guide. In addition, far field diffraction patterns were recorded of nanoparticles that were placed into the focus. From these particles, a speckle pattern could be observed. Details of this experiment will be given in the corresponding experimental report.