ESRF	**Experiment title:** 2-D Element (K) Analysis of the Flower Stem of *Arabidopsis thaliana* by Means of Microfluorescence Using Compound Refractive Lenses	**Experiment number:** LS-1422
Beamline: ID18f	**Date of experiment:** from: 1.9.99 to: 7.9.99	**Date of report:** March 1, 2000
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Names and affiliations of applicants (* indicates experimentalists):
B. Lengeler, C. Schroer*, J. Tümmler*, B. Benner, T. F. Günzler*, II. Physikalisches Institut, RWTH Aachen, 52056 Aachen, Germany

W. H. Schröder*, IBI, Forschungszentrum Jülich, 52425 Jülich, Germany

A. S. Simionovici*, I. Snigireva, A. Snigirev, M. Drakopoulos, ESRF, BP 220, 38043 Grenoble, Cedex

Report:

The mayor goal of this experiment was the determination of the cross sectional distribution of potassium and other physiologically relevant ions in the flower stem of *Arabidopsis thaliana*. It was proposed to analyse micro sections of the stem (a few microns in thickness) by two-dimensional fluorescence mapping. Instead, we mapped the cross sections using a fluorescence microtomography technique currently under development. With this method it is possible to non-destructively measure the elemental distribution on a thin cross section inside a sample. For this method no micro sectioning is required, in which the chemical concentrations might be distorted or changed. Instead, the plant stem can be investigated as is, and its inner elemental distribution can be imaged non-destructively.

For fluorescence microtomography the sample is scanned through an x-ray microbeam in translation and rotation, and the fluorescence signal of the elements of interest is recorded by an energy dispersive detector. From this data, the elemental distribution on a two dimensional slice through the sample can be reconstructed. So far, standard filtered backprojection (FBT) has been used for the tomographic reconstruction. Tomographic reconstruction techniques taking selfabsorption inside the sample into account are currently under development.

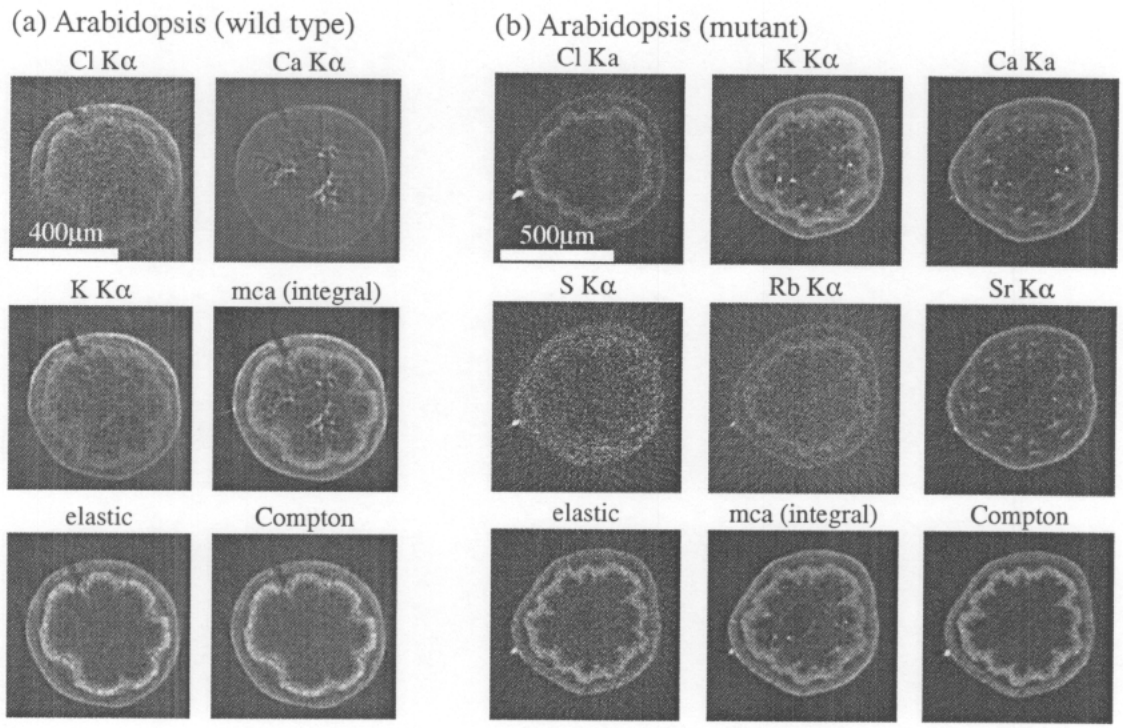
Using parabolic compound refractive lenses, the hard x-ray microbeam ($E = 19.5$keV, $\Delta E/E = 10^{-4}$), of high intensity required for this scanning technique was implemented at ID18F. The size of the microbeam was chosen to match the step size of the translational scan being 3μm to 6μm (FWHM) wide. In the vertical direction, the

beam was measured to be 1.4μm (FWHM) wide defining the thickness of the 2D slice recorded in the tomogram. Typically, fluxes above 10^{10} ph/s were measured in the microbeam.

Overall, ten samples were investigated: Seven stems of *Arabidopsis thaliana* six of which were freeze dried (4 wild type samples, 2 samples of a mutant) and one live plant (wild type) that as opposed to the freeze dried samples suffered radiation damage. In addition, a sprig of a spruce (3mm in diameter), a root of barley, and a root of the mahagony plant were successfully fluorescence tomographed.

The method prodved superior to other spectroscopy techniques in particular because no micro sectioning was required and because of the high signal to background ratio, and the low detection limit of fluorescence methods at the synchrotron. For the first time, very dilute concentration of ions were recorded, such as rubidium or strontium (10^{-3} to 10^{-4} times less concentrated than potassium) that are uptaken by the plant in a way similar to potassium and calcium, respectively.

While differences in the ion concentrations (see the figure below) were found between the wild type of *Arabidopsis thaliana* and a mutant, for which the K-ion channels have been genetically removed, more individuals of each type need to be investigated to come to a plant physiological conclusion. This is planned in a continuation of the project.



Publications: B. Lengeler, C. G. Schroer, M. Richwin, J. Tümmler, M. Drakopoulos, A. Snigirev, I. Snigireva, *Appl. Phys. Lett.*, **74 (26)**, 3924-3926 (1999), B. Lengeler, C. G. Schroer, J. Tümmler, B. Benner, M. Richwin, A. Snigirev, I. Snigireva, M. Drakopoulos, *J. Synchrotron Rad.*, **6 (6)**, 1153-1167 (1999), A. Simionovici, M. Chukalina, M. Drakopoulos, I. Snigireva, A. Snigirev, Ch. Schroer, B. Lengeler, K. Janssen, F. Adams, Devel. in X-Ray Tomography II, Ulrich Bonse, Ed., Proc. SPIE **3772**, 304-310 (1999)

A publication of the result of LS-1422 is in preparation. Some results will be published in the ESRF-Highlights.