ESRF	**Experiment title:** Coping with mechanical stress – How Arabidopsis accommodates external mechanical stimuli in the nanostructural design of its cells	**Experiment number**: SC-4503
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Report:

Summary:

The aim of this experiment was to evaluate the impact of mechanical stimuli on the nanostructure of secondary cell walls in selected model systems (Arabidopsis and abies nordmanniana). To this end, specimens with a controlled load history have been scanned with a sub 500nm beam. Based on experience from previous experiments we favored flux over beamsize to limit the adverse effects of beam damage and to be able to scan representative areas on the sample to be able to catch long-ranged as well as short-ranged variations in the sample.

Samples and setup

Setup: We were able to use the newly commissioned fixed curvature nanofocus KB of ID13, resulting with a prefocusing scheme in $1.3x10^{11}$ ph/s at 13 keV with a beamsize of 300x350 nm^2. We chose this setup over the initially proposed experiment with the NFLs in EH3, as we experienced problems with beam damage when we tried to exceed 500nm in resolution in the past and thus favored flux over ultimate resolution. Furthermore, the setup in EH2 allowed for the usage of continous scanning with minmal exposure time (10ms), which is an additional benefit for the reduction of beam damage effects in the sample. We were in fact able to measure the same regions for up to three times before we could detect decay in signal intensity from beam damage. In order to reduce air scattering, we utilized a He flight tube with a small (250µm) beamstop that gave access to a combined WAXS range from 0.5 to 30 nm^{-1}.

Samples: Samples consisted of 10µm thick sections of Arabidopsis fibre tissue, stressed at three different magnitudes as well as the control plants without mechanical stress. In addition, we also included cell wall sections of abies nordmanniana, stressed in a static and dynamic way as an additional reference for stress-induced changes. Samples were mounted between two SiN membranes to ensure flatness of the sections.

Principal outcome

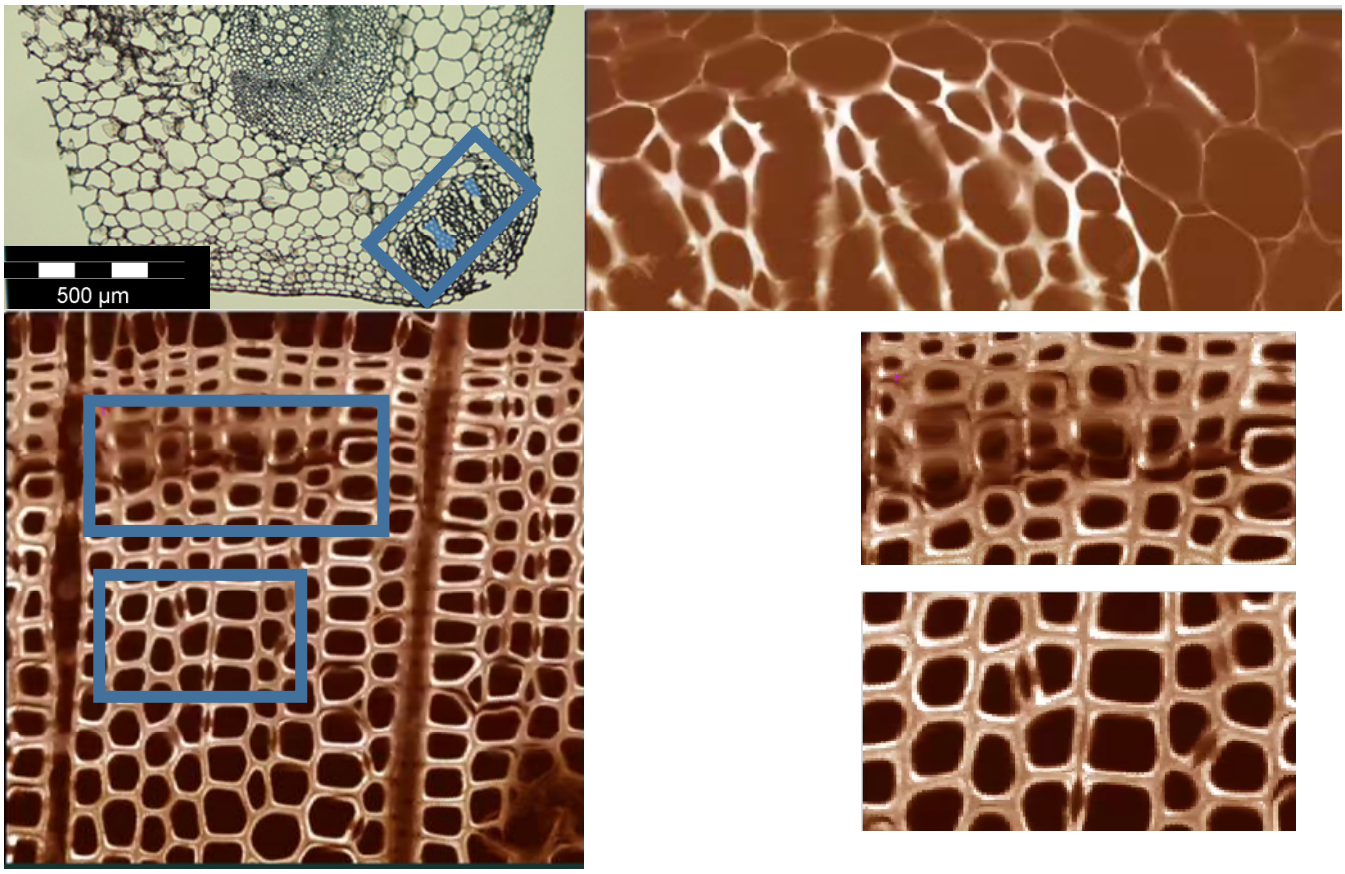

Figure 1 Overview of a mechanically stressed stem cross section. The affected regions are highlighted in blue. b) scanning diffraction map of the area in the blue rectangle. The bottom row shows a cross section through a mechanicall treated abies branch. The zoom-in of the treated and unaffected region shows clear differences.

Due to the surprisingly high flux we were able to extend our data acquisition on the samples. We managed to find the mechanically stressed parts of the cell cross sections and acquire a representative dataset. On the abies nordmannia samples we measured regions with static and dynamic loading, where we could already identify a different cell morphology and anticipate that an in-depth analysis of the data will help us to understand how the external stress is influencing the nanostructure of the cell.

Conclusions and further proceedings

In conclusion, we managed to collect valuable data of significant portions of our sample set. Due to the unexpectedly high flux, we were also able to map extensive areas on the sample to gain significantly more information, usually a major drawback for working with biological samples. As already described, we could identify the affected zones microscopically and we are positive that subsequent data analysis will help to understand the impact of mechanical stress on the nanostructure of the cell wall. We studied three different cell wall systems which will help us to draw more generalized conclusions, not hampered by the peculiarities of the individual species. It is expected to publish the data once the evaluation is finished in an appropriate journal. We would like to express our thanks for the ID13 team and our LC for the excellent support during our experiment.