ESRF	**Experiment title:** Phase contrast-enhanced tomography of spiders mechano-sensors	**Experiment number**: SC 3442
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Report:

We investigate the structural design and arrangement of the cuticular mechano-sensors in spiders. The specific function of the organs as filters and transducers of mechanical stimuli are supposed to be related to the mechanical materials properties of their main component, i.e. cuticle,however, the working mechanism of these vibrational sensors is so far unknown.

The experiments were carried out at the ID19 beamline. Overall 47 complete µCT measurement cycles of two vibration sensitive slit-sensilla organs of the wandering spider *Cupiennius salei*, at different conditions were performed. These include measurements of samples at three different states, i.e. dry, wet, and fixed with formalin. For holotomographic imaging, three different sample-detector distances were chosen. The scan acquisition was performed in continuous mode in order to optimize the beam time. The operated energy was 19 keV and 31 keV. The scan reconstruction was performed using conventional tomographic reconstruction software PyHST. Since our samples contain mainly light-element organic material (chitin and protein), absorption contrast was rather low for all measured samples. Detailed analysis revealed the best image contrast at lower X-ray energies. The resolution and contrast were further improved by using the Paganin algorithm [1] for data analysis.

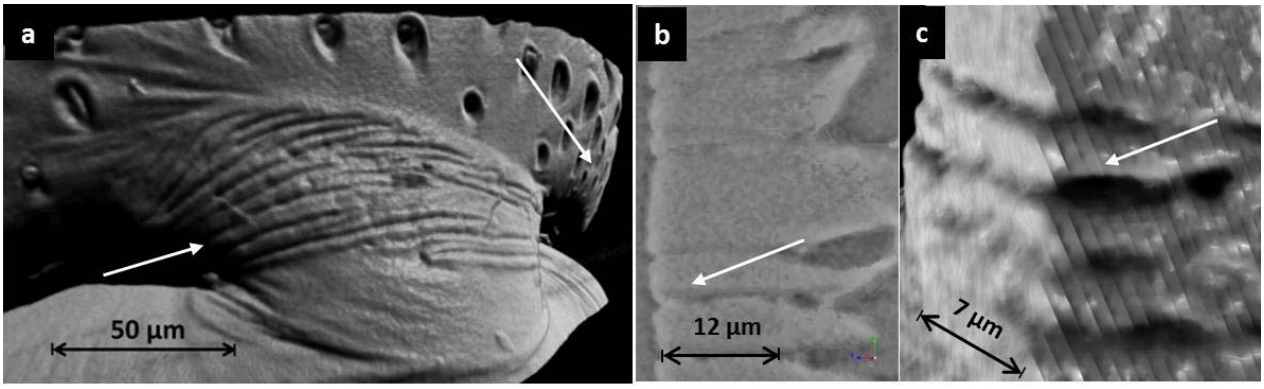

Figure 1: Micro-CT snapshots of one of the spider's vibration-sensitive slit organ situated on one end of the metatarsus, the arrows indicate one of the slits. a) Snapshot of the entire slit organ, reconstructed using Paganin phase reconstruction analysis [1]. b-c) Section of the organ perpendicular to the slits, where b) images the X-ray absorption contrast and c) shows the phase contrast using Paganin analysis [1], note that b) and c) have different length scales, vertical lines in c) are artefacts from the software analysis.

The obtained 3D images of the organ are of outstanding quality showing the orientation of the slits with respect to each other and to the longitudinal axis of the metatarsus. The morphology and the detailed internal structure of the slits could be visualized in high detail. Specifically these results show the fesibility of evaluating the internal volume of the slits at relaxed state. As continuation of this research we are now planning to perform measurements, at the established conditions, of the slits in working state, i.e. under compression. In addition, this data is now used for building 3D finite element models of the system and for structural characterization using XRD and SAXS.

[1] Weitkamp, T., Haas, D.,Wegrzynek, D., Rack, A., ANKAphase: software for single-distance phase-retrieval from inline X-ray phase contrast radiographs. Journal of Synchrotron Radiation **18** (2011).