Software development for measurements of sub-micrometer beam sizes at SwissFEL

ACHIP

The accelerator on a chip international program (ACHIP) studies the dielectric laser acceleration (DLA). The goal of this project is to shrink the size and cost of particle accelerators (like SwissFEL – Fig. 1) to the size of a shoebox. This is feasible by using laser powered chips. A very small electron beam is necessary to enter these novel developed micro structures. To enter these chips, a strongly focussed electron beam (< 1µm) is necessary. These experiments take place in the special designed ACHIP chamber (Fig. 2), installed in the Athos beamline.

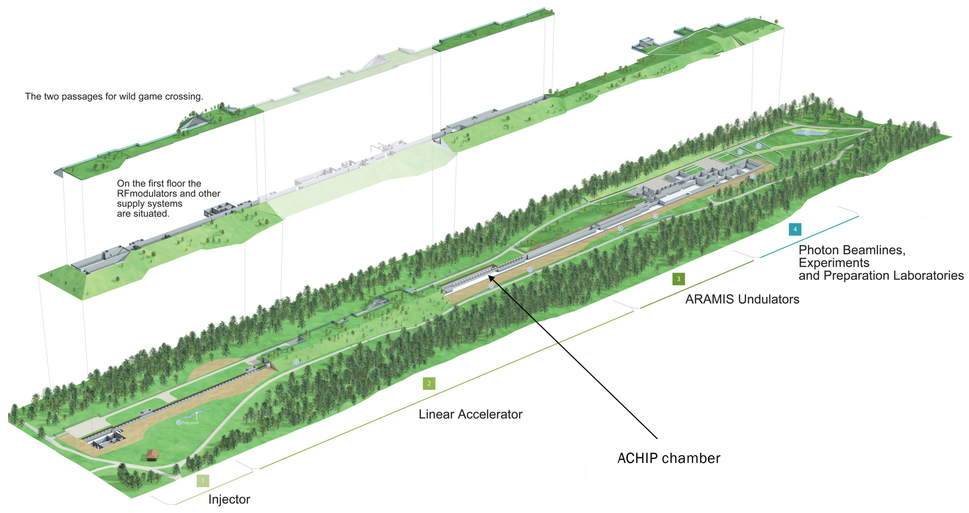

Fig. 1: Schematic of SwissFEL.

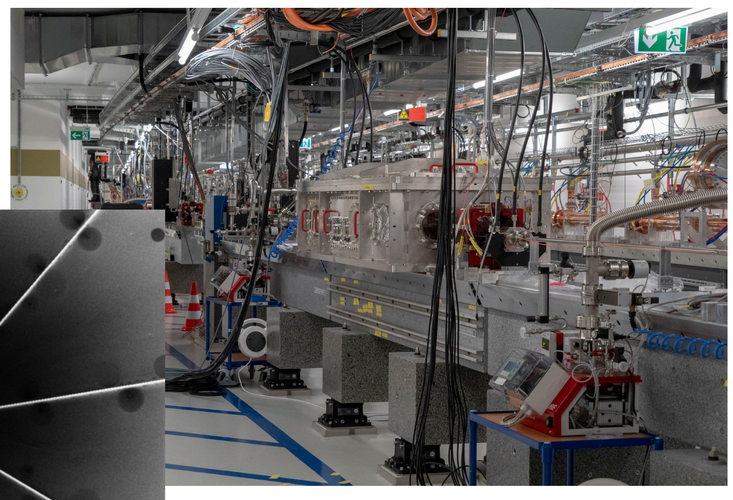

Fig. 2: ACHIP chamber in the Athos beamline.

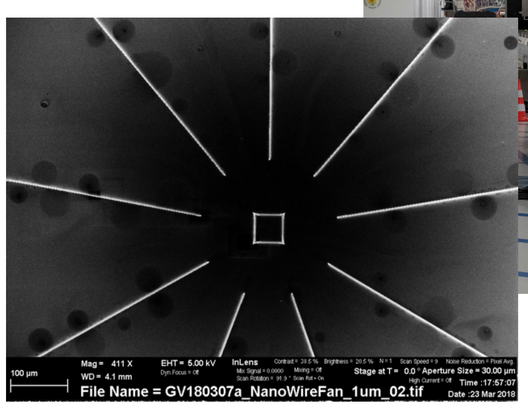

Fig. 3: New developed wire scanner on a membrane.

Wire scanners for electron beams at SwissFEL

Beam focussing to sub-micrometer sizes, brings along new challenges regarding beam instrumentation. A wire scanner (Fig. 3) was recently developed which it is driven through the beam using a hexapod. The interaction between the 1µm gold wire and the electron beam produces particle showers. These losses are detected and recorded. The resulting beam loss profiles can be used to calculate the size of the electron beam.

Software

An EPICS input output controller (soft IOC) was set up in order to remote control the hexapod (as well as linear stages for optical instruments). This piece of software was written mainly in Python and is now running on a Raspberry Pi, right below the beamline. The user interface (Fig. 5) shows the positions and the status of the devices. Furthermore it is possible to save and load positions and it provides three different scan modes.

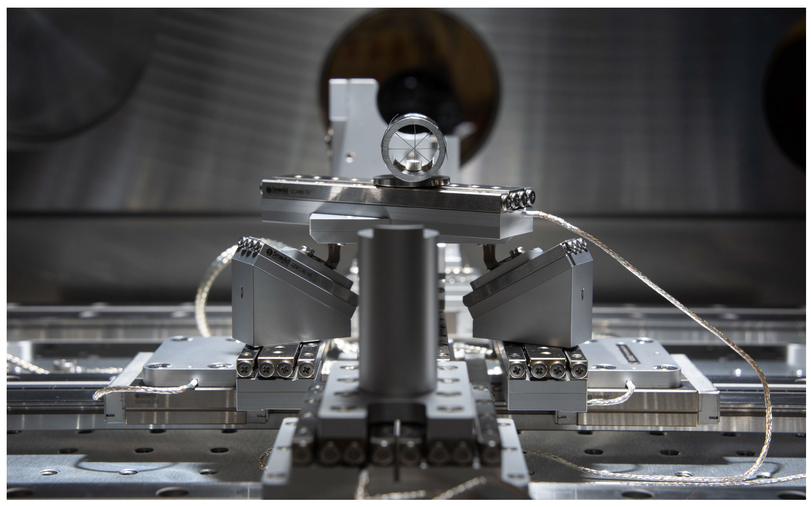

Fig. 4: Hexapod in the ACHIP chamber (with a test wire scanner).

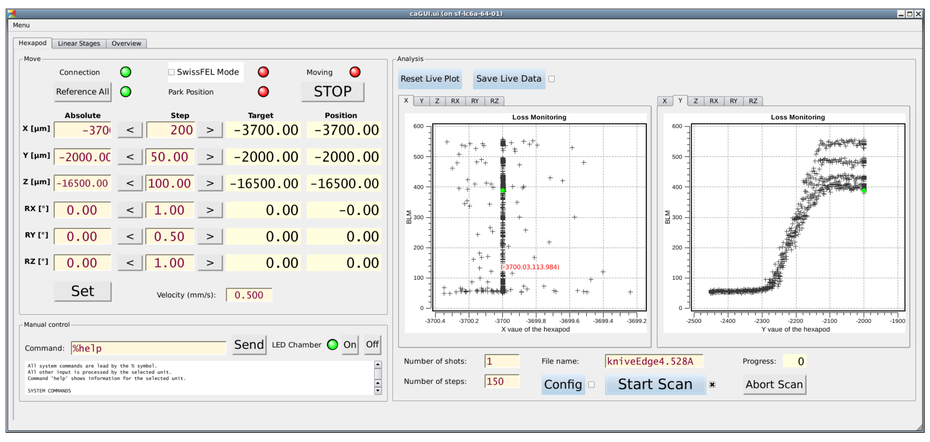

Fig. 5: Main panel of the user interface.

First measurement

The software was tested in a SwissFEL shift on the 20.12.2018 and the first sample holders mounted on the hexapod were moved through the beam. A beam size measurement was done (knife edge scan with the edge of the wire scanner on a membrane). The resulting beam size using a fit function (Fig. 6) is sigma = (46.9 ± 4.98) µm.

$$\frac{P_1}{2}\left[1 + erf\left(\frac{\sqrt{2}(X - P_2)}{P_3}\right)\right] + P_4$$

Fig. 6: Fitting function.

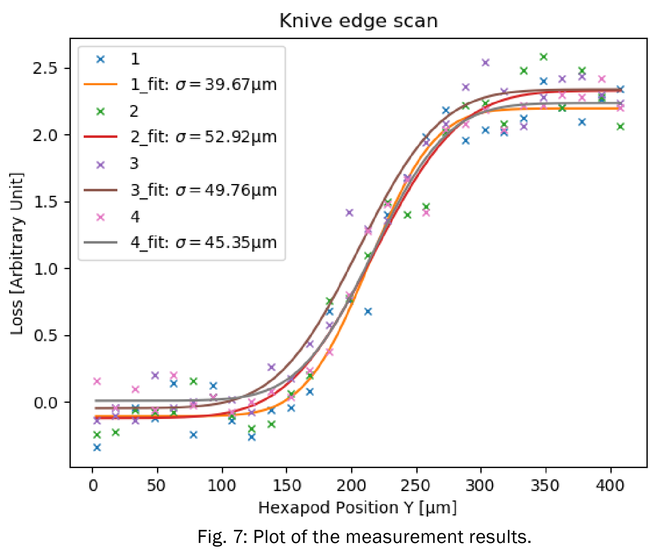

Fig. 7: Plot of the measurement results.

The hexapod and the linear stages can be operated safely and the main IOC as well as the user interface were tested successfully in real operation. The knife edge scan could be easily made using the Point-to-point scan mode. The performed beam size measurement was actually the first measurement of its kind performed in the Athos beamline of SwissFEL.

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Project

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