The solid sample scanning workflow at the European XFEL

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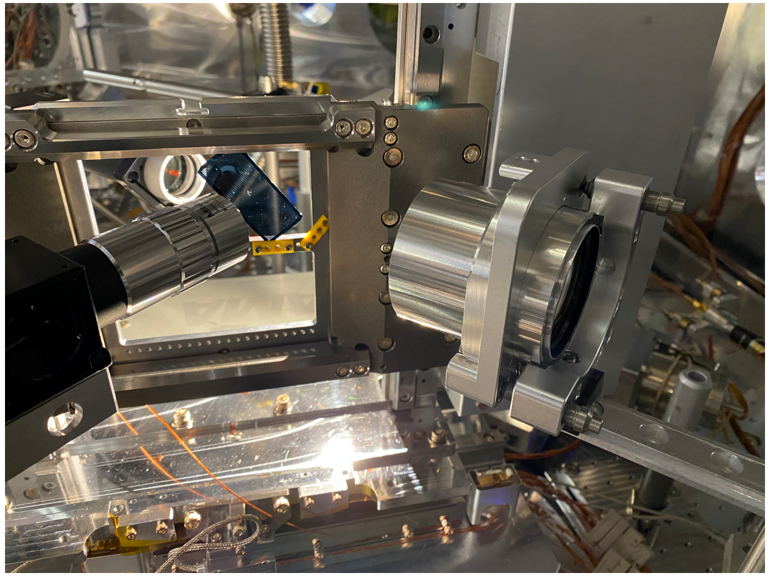
*ana.garcia-tabares@xfel.eu



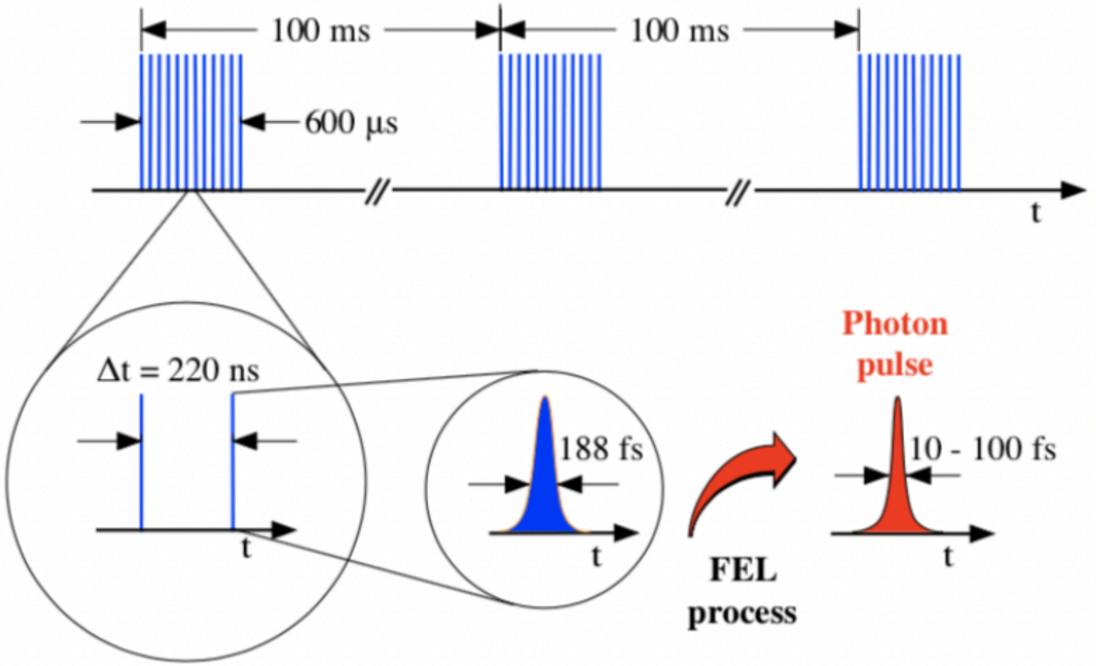
19TH INTERNATIONAL CONFERENCE ON ACCELERATOR AND LARGE EXPERIMENTAL PHYSICS CONTROL SYSTEMS (ICALEPCS 2023)

Outlook

- European X-ray Free Electron Laser
- Karabo: The European XFEL Control system
- The Fast Solid Sample Scanner @ European XFEL
  - Overview
  - Automation Opportunities
  - Workflow after automation
- Database and Karabo Integration
- Commissioning results
- Conclusions

European X-ray Free Electron Laser: Pulse structure and Peak Brilliance

- EuXFEL has a unique feature in the time structure of its X-ray pulses, generating a pulse train of up to 2700 X-ray pulses, 10 times per second. The pulses arrive with a maximum frequency of 4.5 MHz, with 220 ns between each pulse.
- Brilliance Peak $5 \cdot 10^{33}$ (photons / s / mm^2 / mrad^2 / 0.1% bandwidth).



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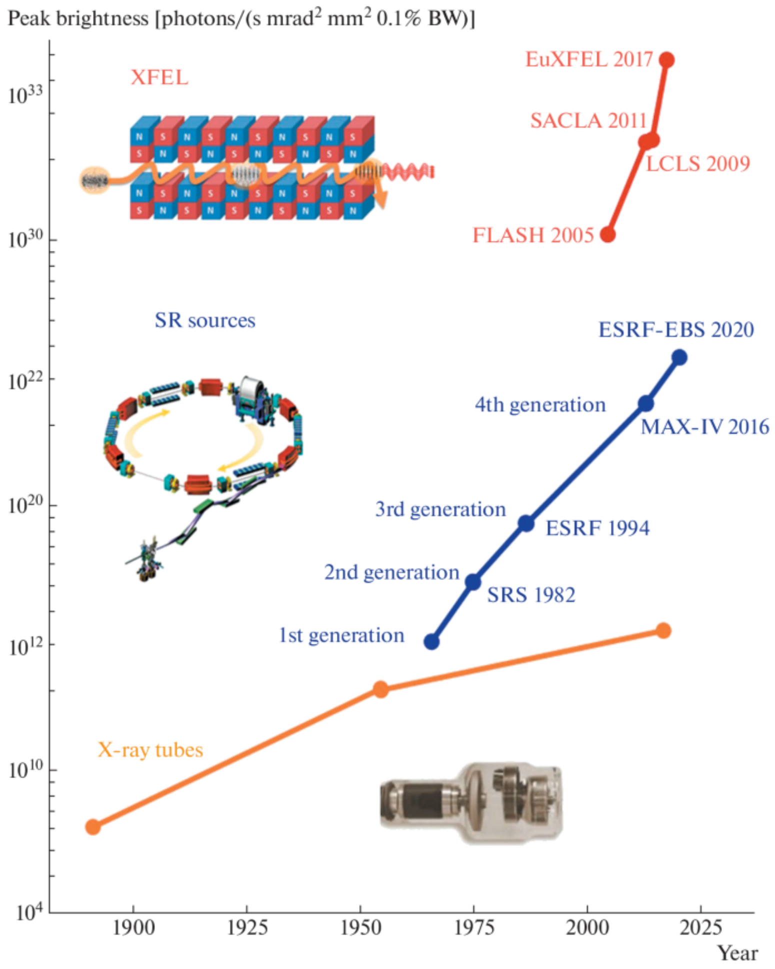
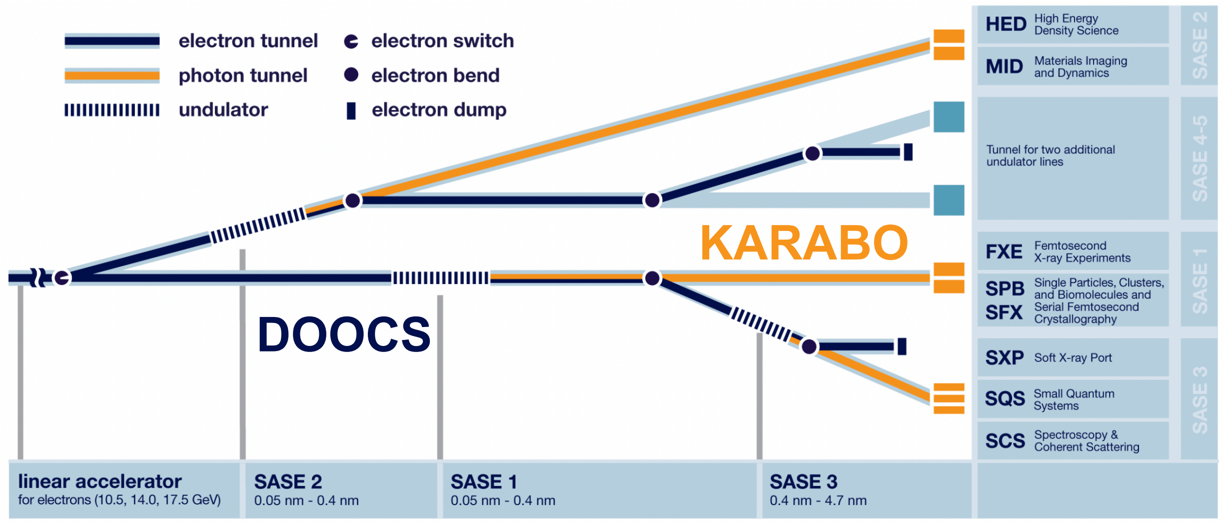


Karabo: The European XFEL Control system

- Linear electron accelerator is run by DESY and it's controlled via DOOCS
  - Undulators creating X-ray laser photons are also controlled via DOOC
  - Photon beam steered through 3 tunnel to 7 instruments controlled via Karabo
- Karabo is a distributed control system designed and developed for:
  - control of hardware,
  - monitoring,
  - data acquisition
  - data analysis



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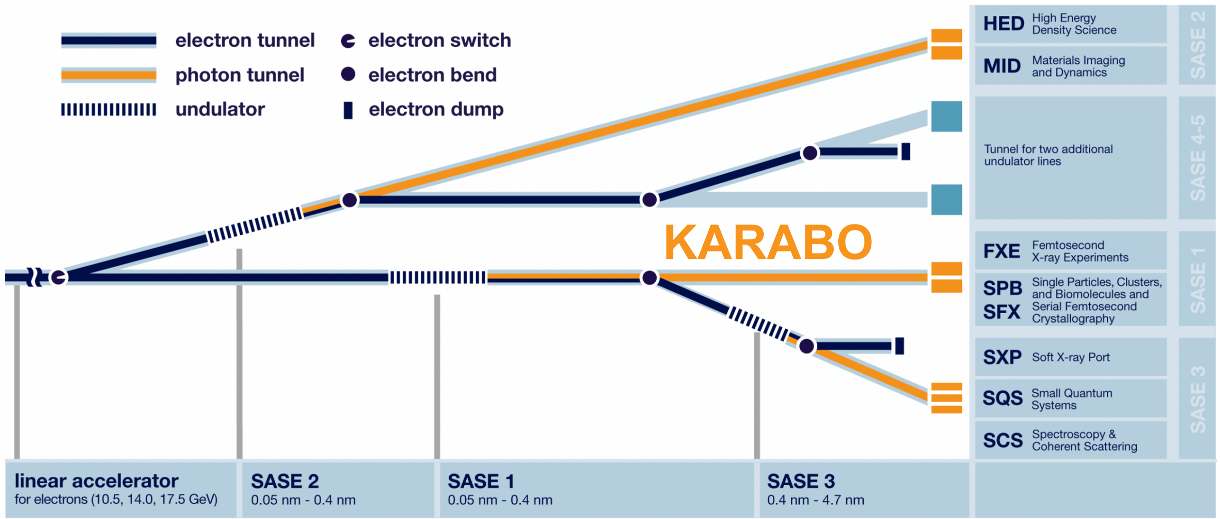

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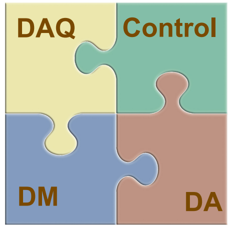

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DAQ
data readout
online processing
quality monitoring (vetoing)

Control
drive hardware and complex experiments
monitor variables & trigger alarms

DM
storage of experiment & control data
data access, authentication authorization etc.

DA
processing pipelines distributed and GPU computing
specific algorithms (e.g. reconstruction)

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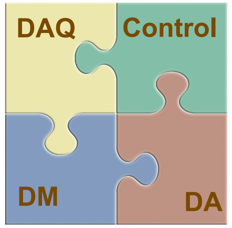

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MORE INFORMATION:

TH1BCO06: The Karabo Control System
Speaker: Steffen Hauf

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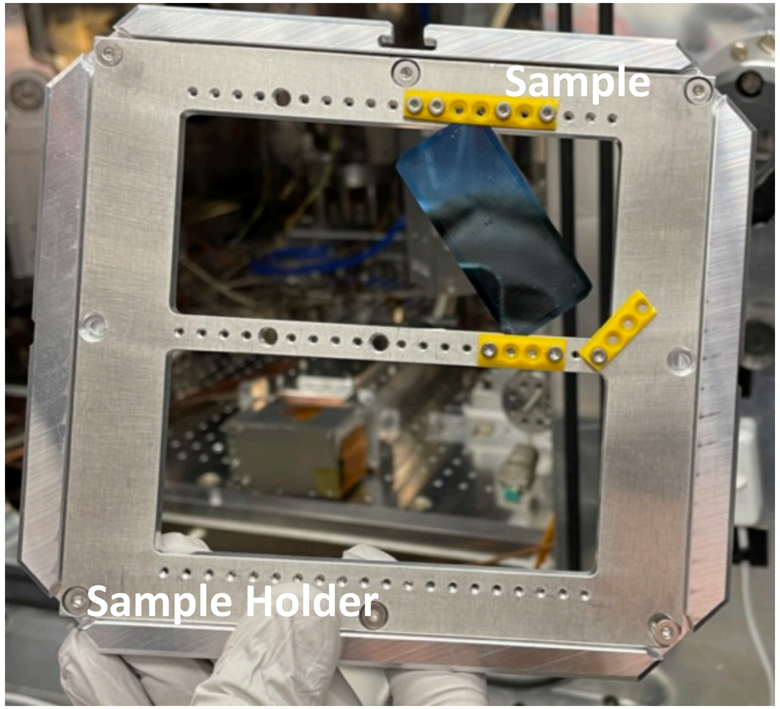
The Fast Solid Sample Scanner @ European XFEL: Overview

- Fixed targets are widely used among the instruments at the European XFEL, including foil targets, wires, structured samples, among others.
- To scan such solid samples, the Fast Solid Sample Scanner (FSSS), is used at 5 out of the 7 instruments.
- The FSSS has two perpendicular stepper motors, enabling precise scanning along both the X and Y axes, where the Z-axis represents the beam direction.



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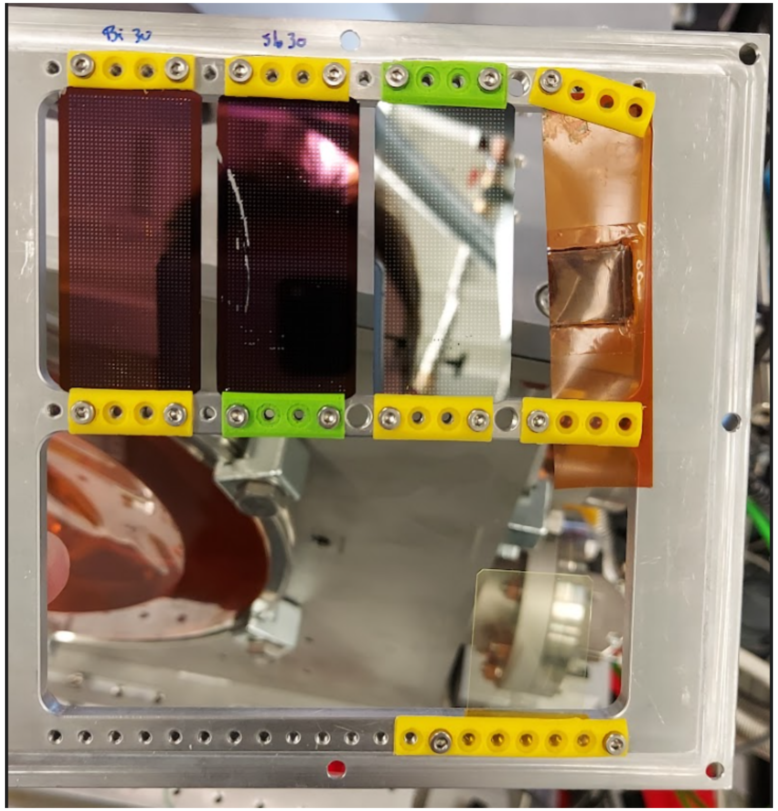

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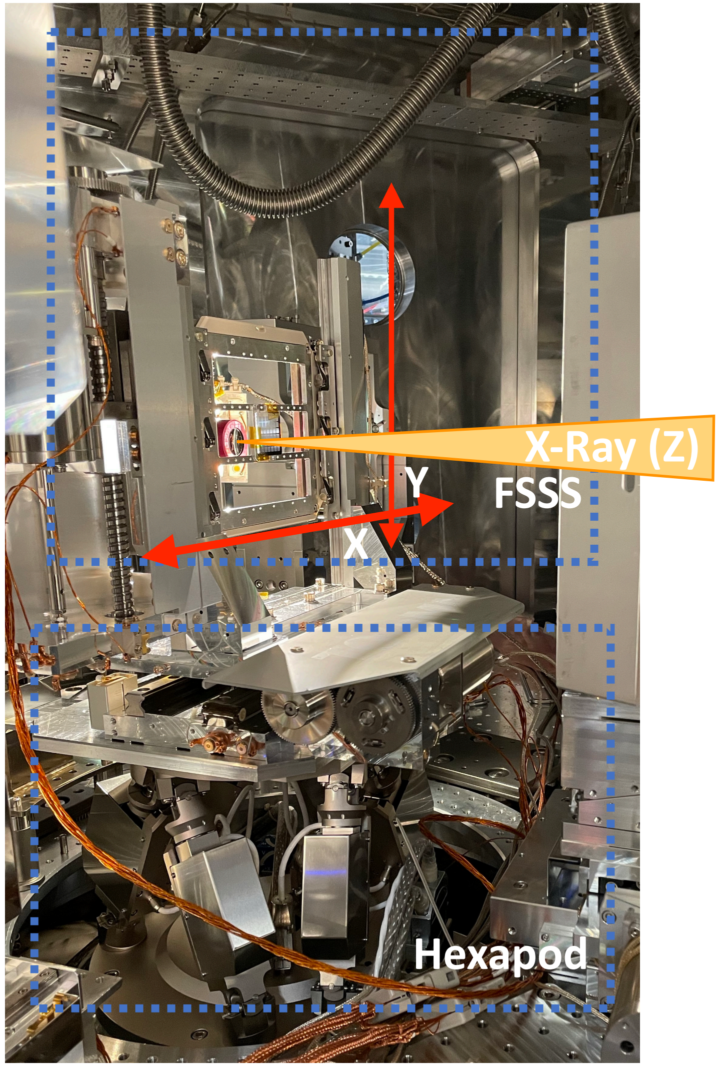
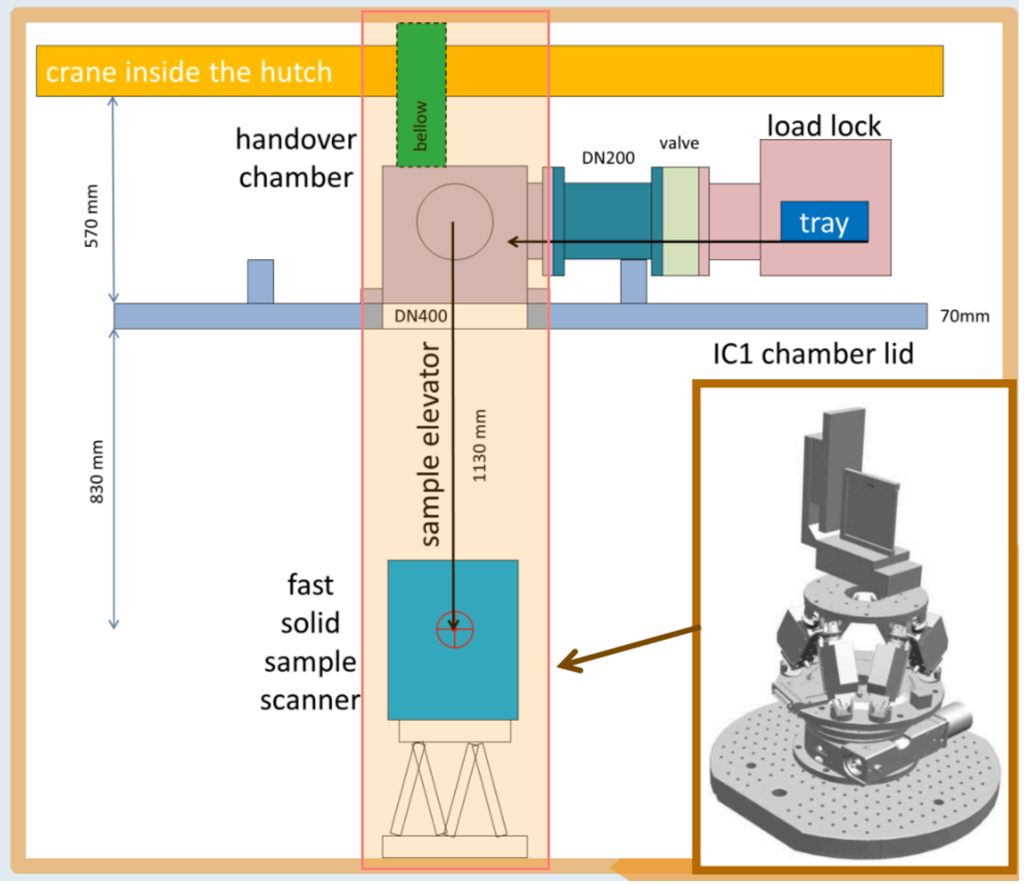


The Fast Solid Sample Scanner @ European XFEL: Automation opportunities

- Samples are loaded into a holder outside the vacuum chamber and then placed into the chamber without breaking the vacuum.
- Preparing the sample scanner for measurements can be a time-consuming process.
- HED workflow improved by implementing pre-characterization of samples and creating a database for storing sample information.



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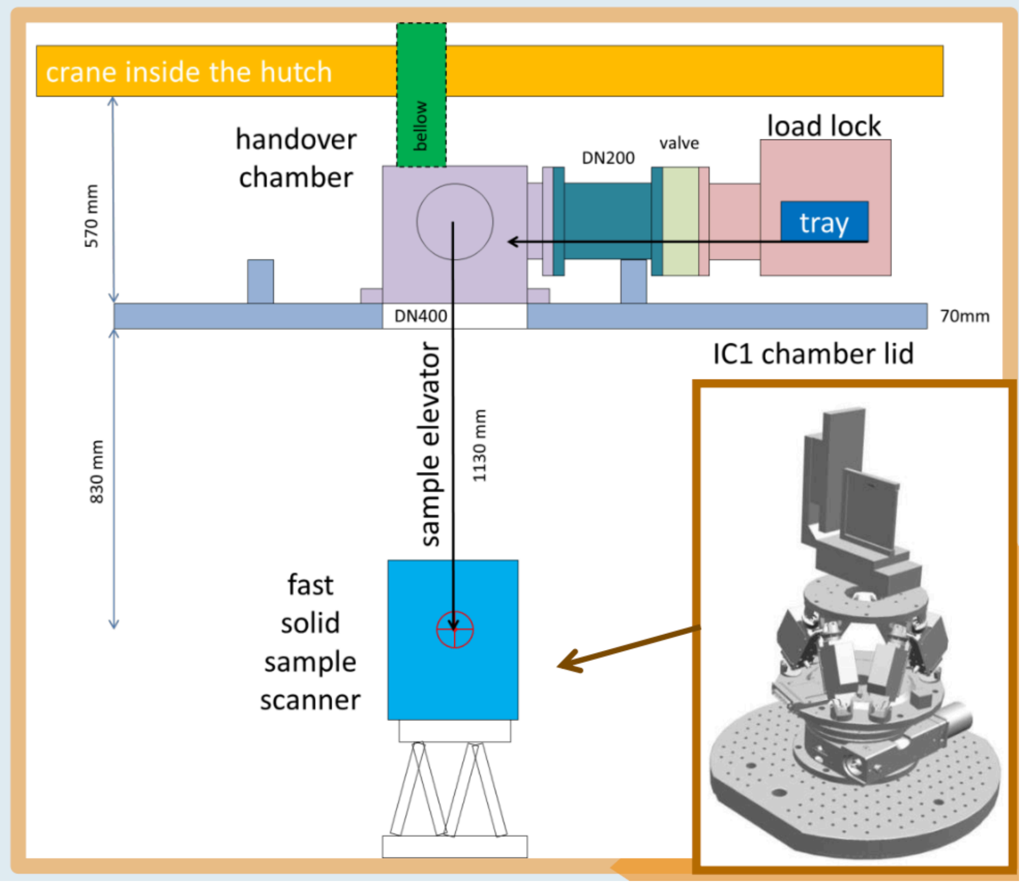

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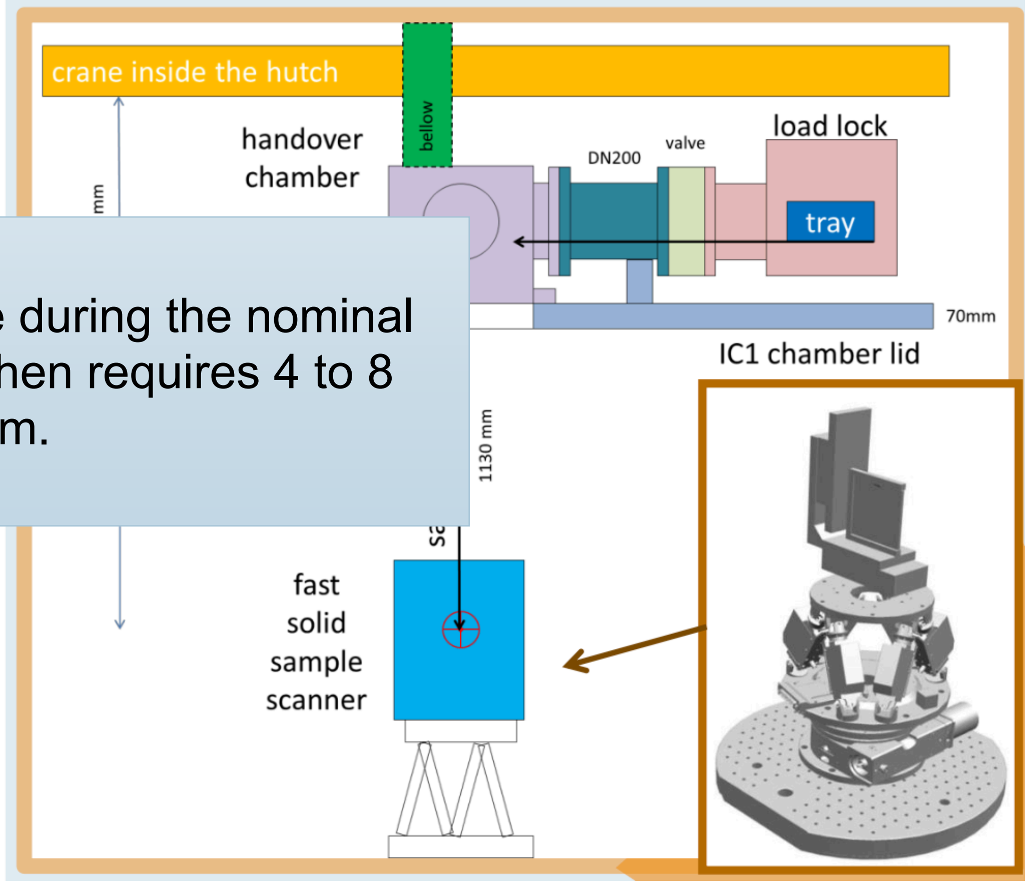
Sample characterization is done during the nominal beam time, usually at night. It then requires 4 to 8 hours to perform.



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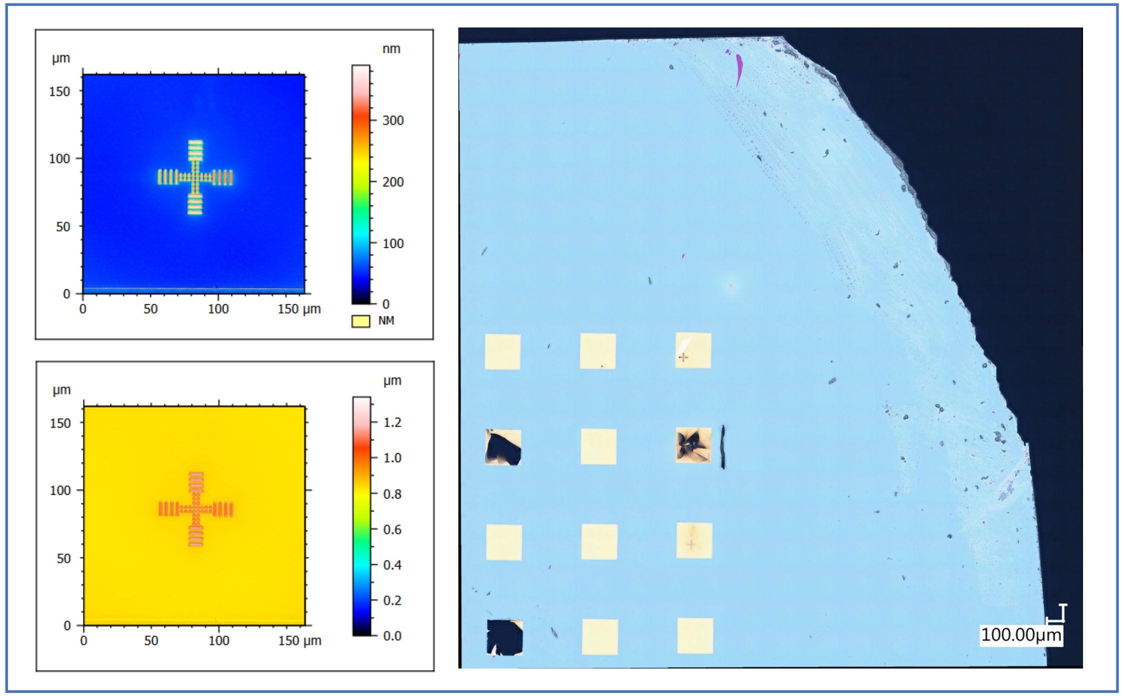

The Fast Solid Sample Scanner @ European XFEL: Workflow Automation

- The target coordinates are located along with the fiducials in the laboratory prior to the experiment.
- Relational database stores target and fiducial coordinates for easy management.
- Information is directly accessible via the Karabo control system.
- Fiducial measurements are performed in the instrument
- Target coordinates are transformed from the lab base system to the instrument base.
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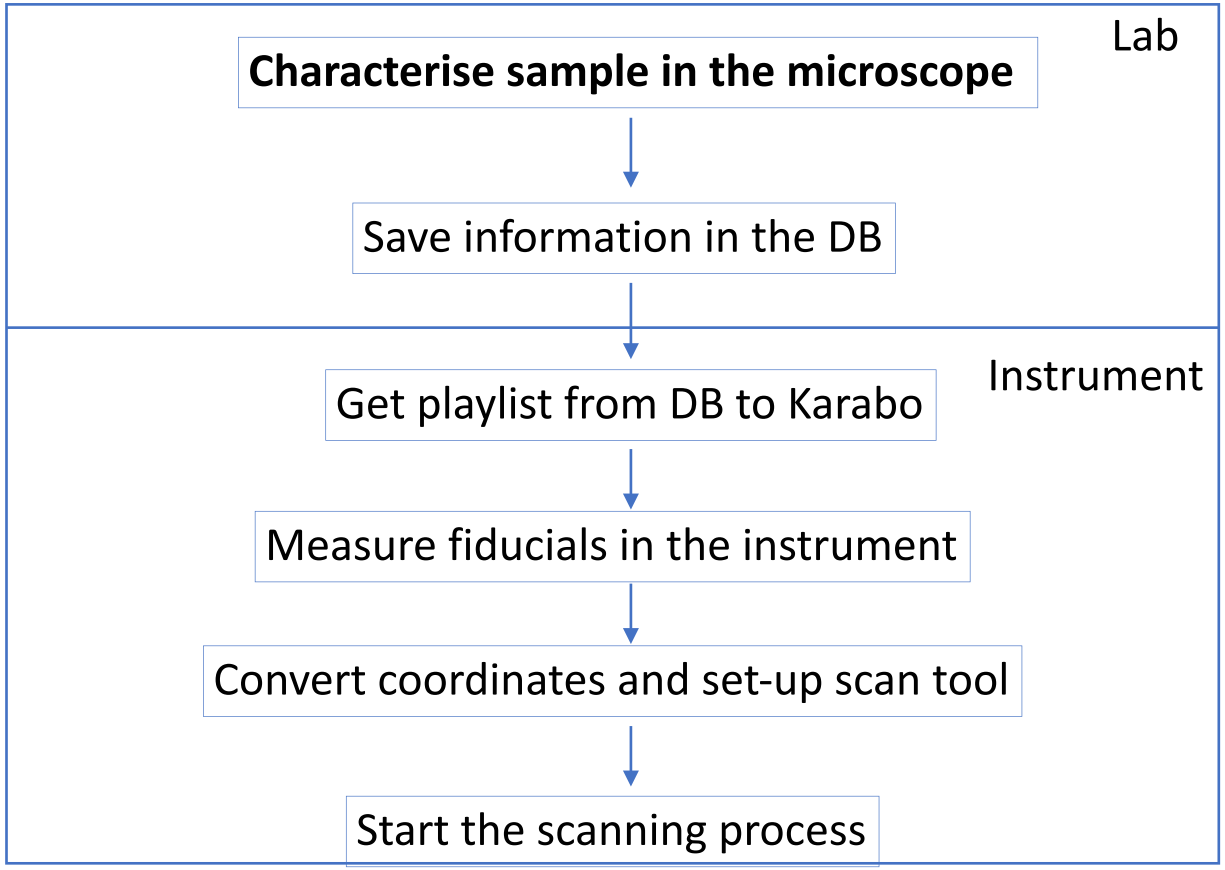

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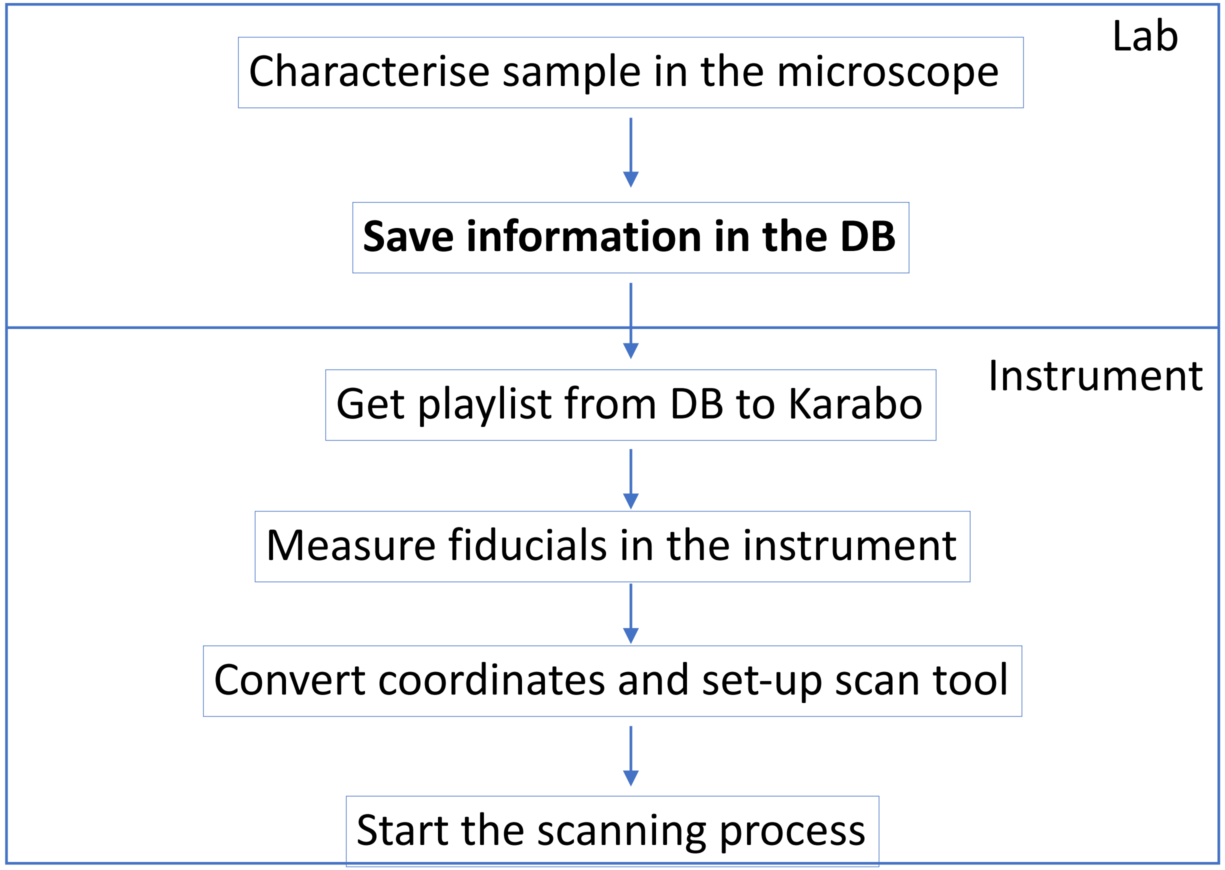

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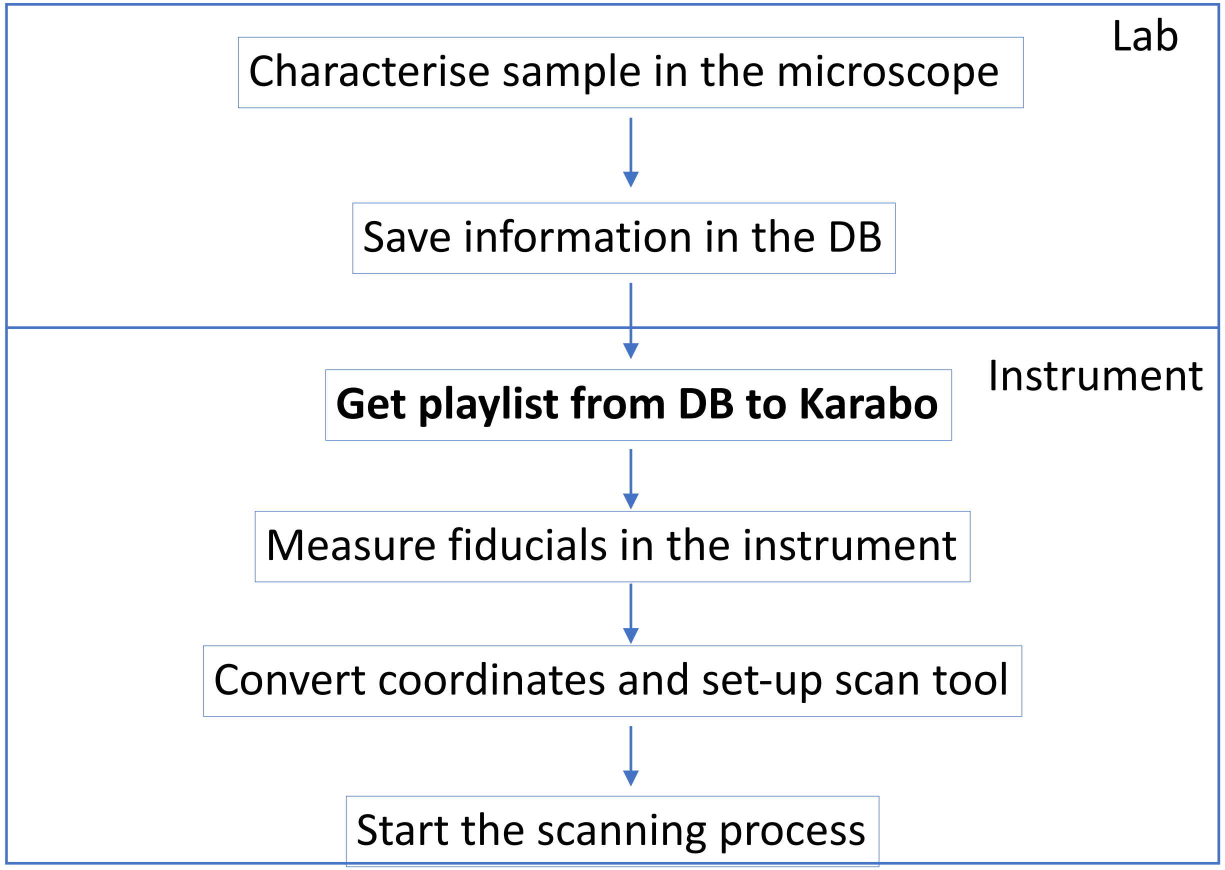

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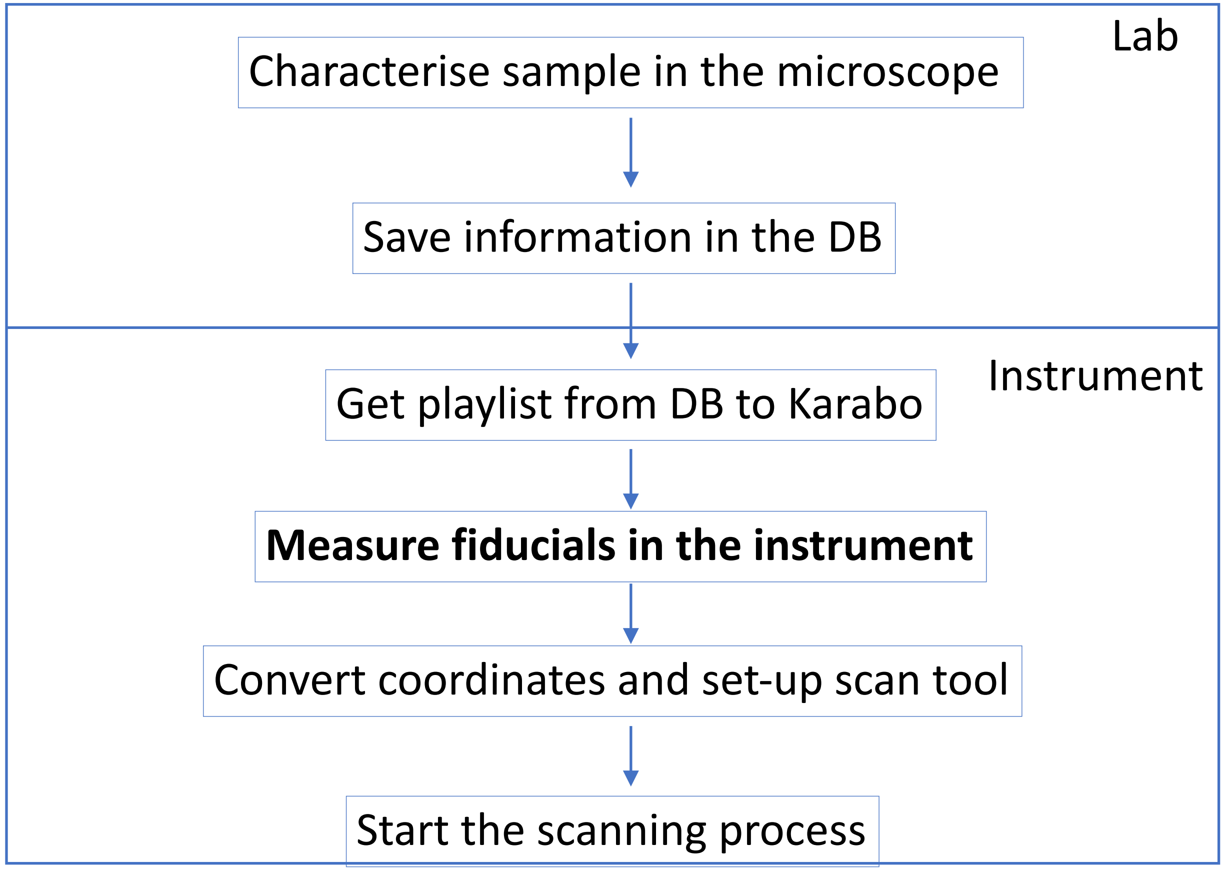

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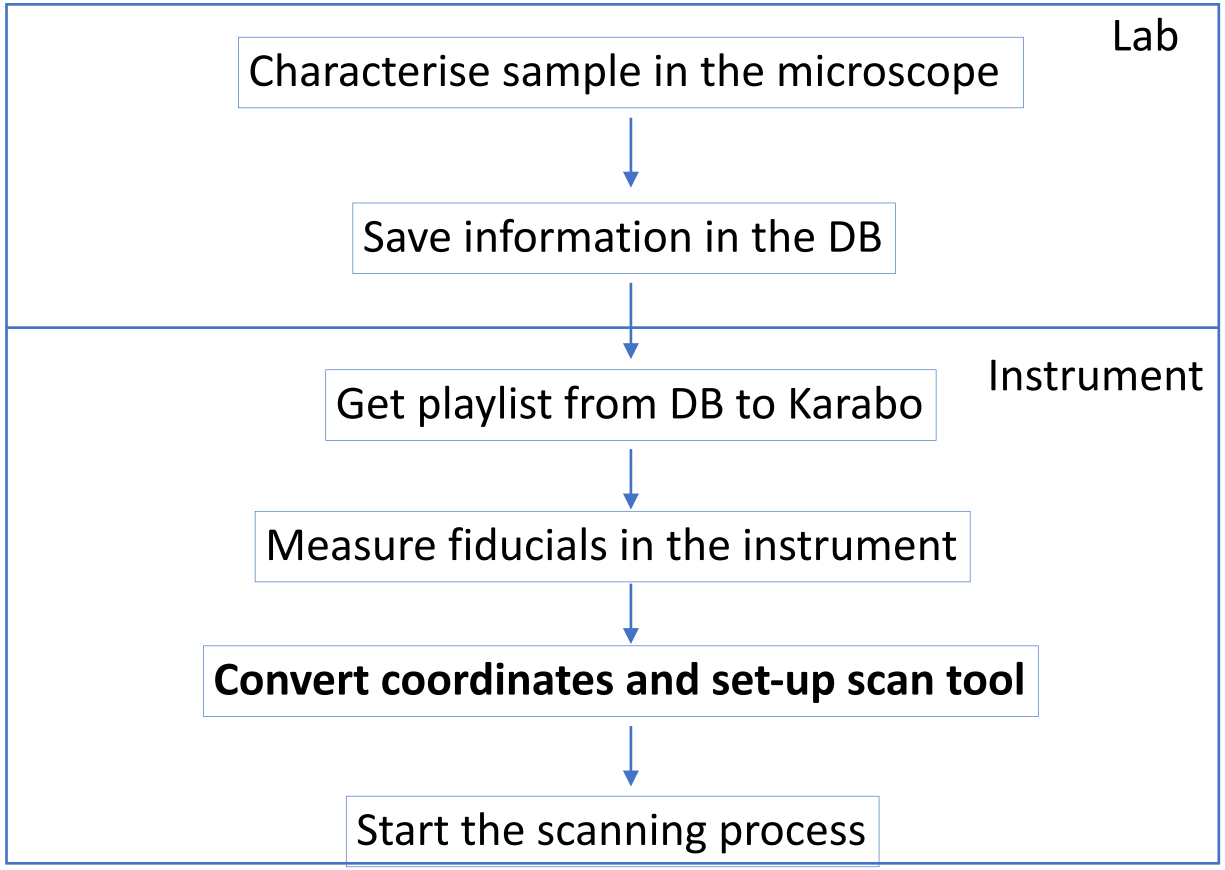

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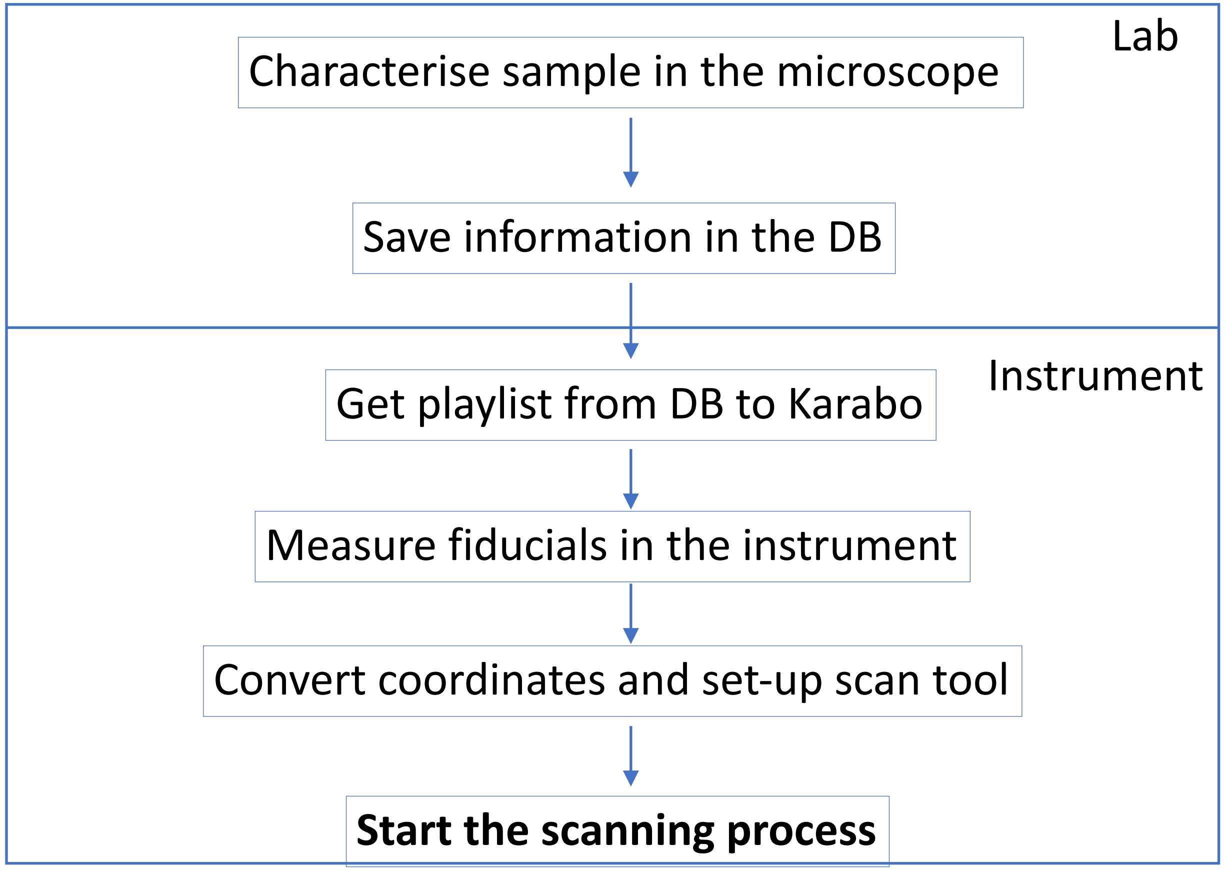

Karabo Integration

- Karabo integration guides users through an automated workflow:
  - Configure motors
  - Retrieve playlist
  - Save Fiducials
  - Transform data
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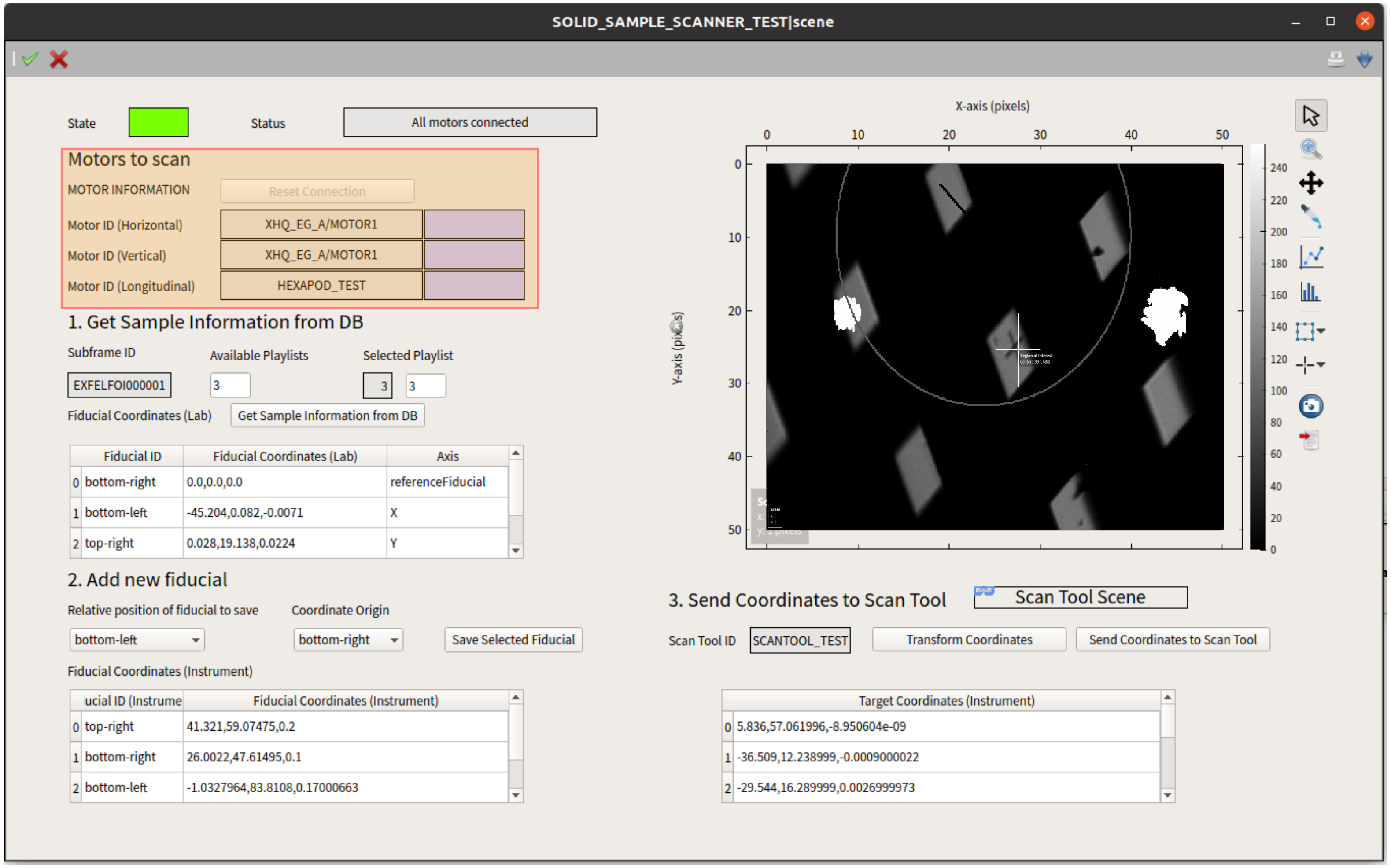

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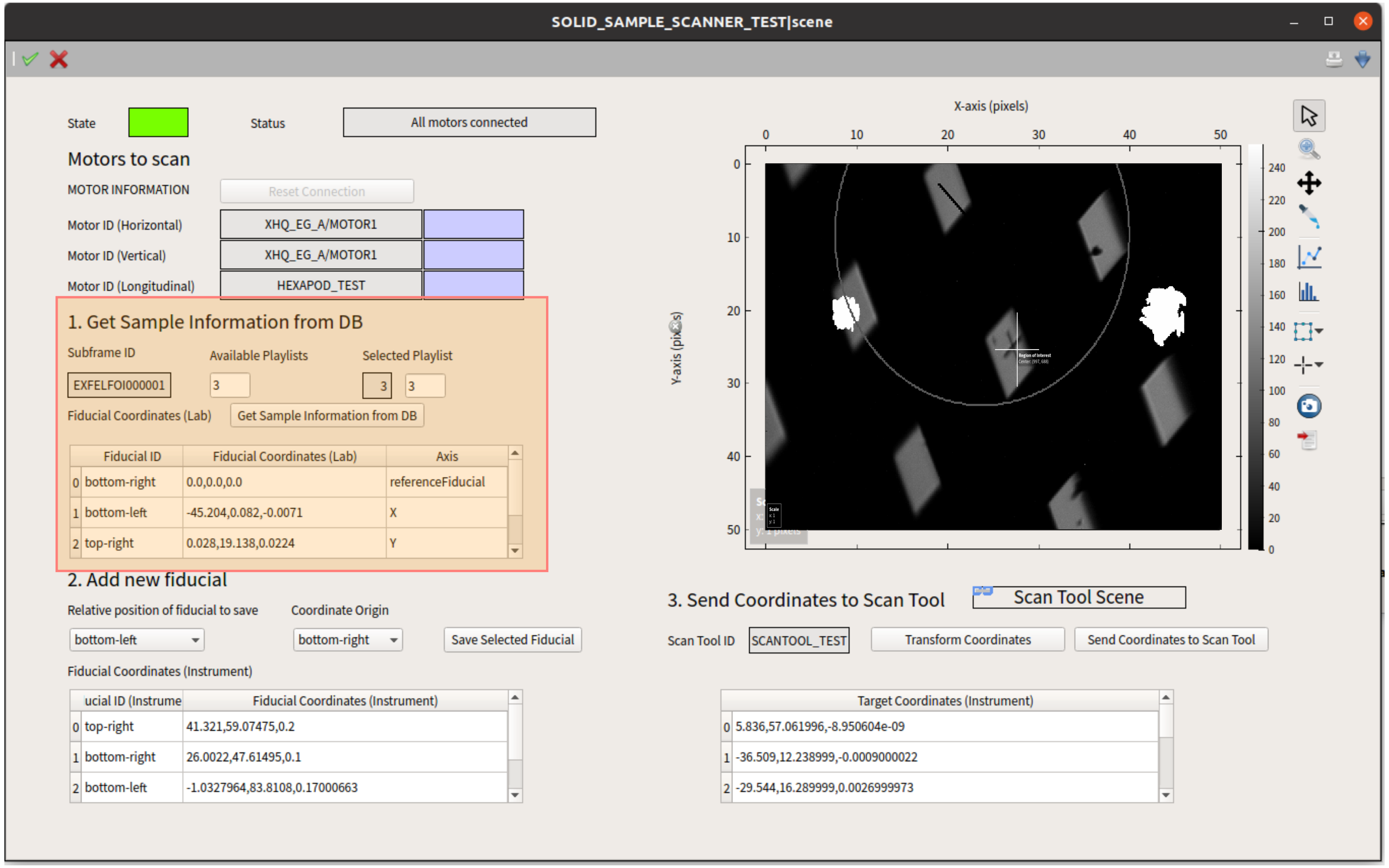

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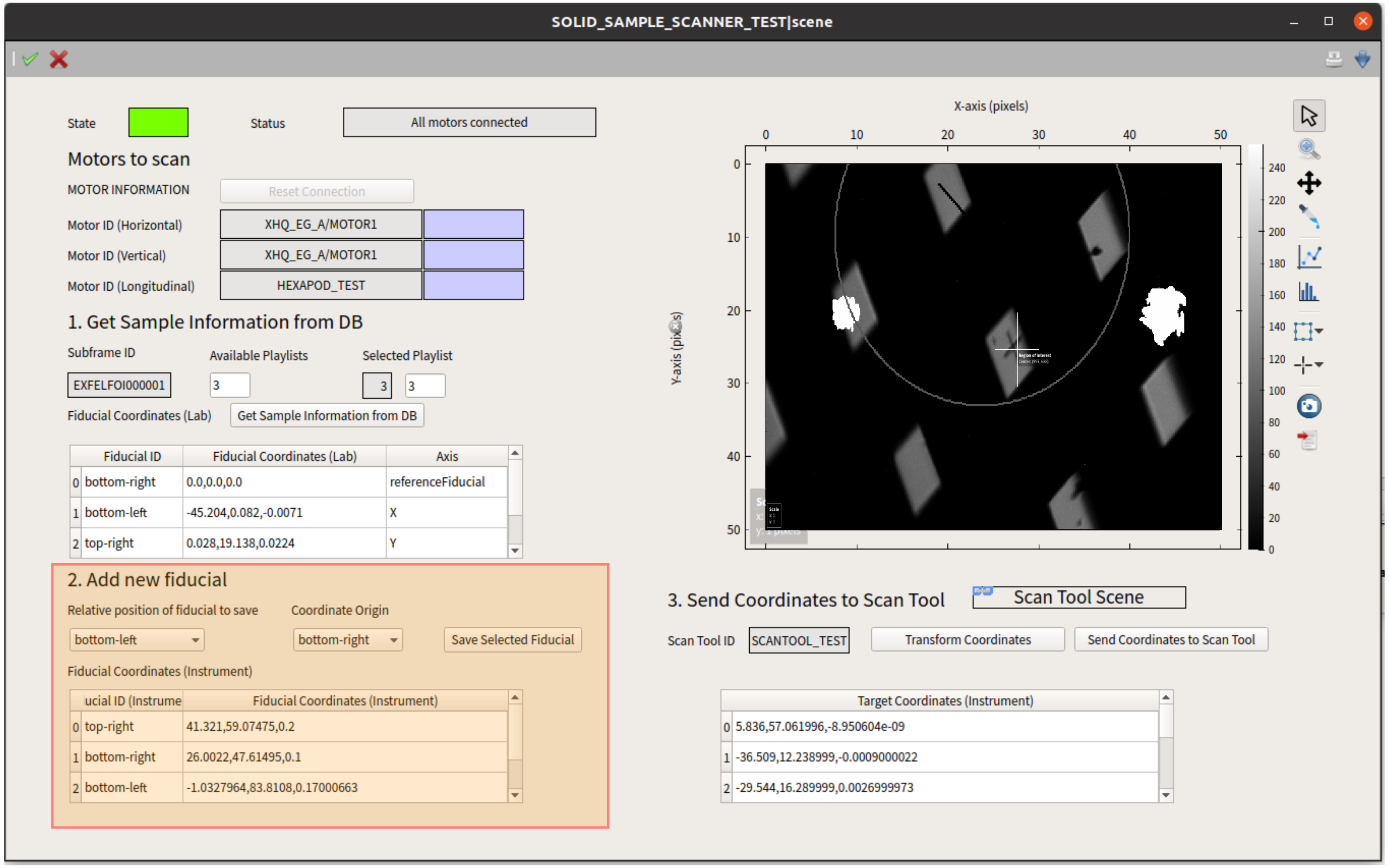

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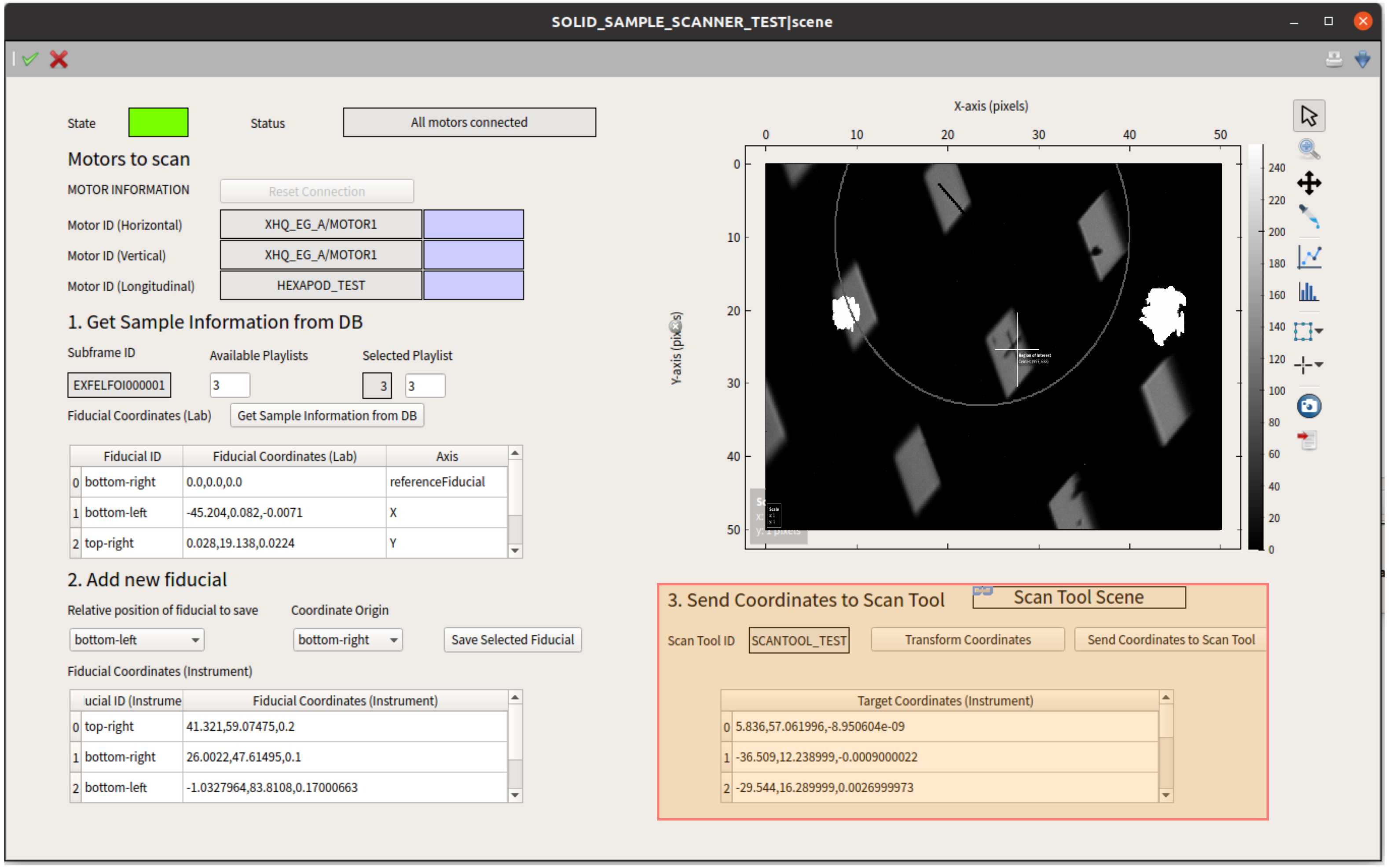
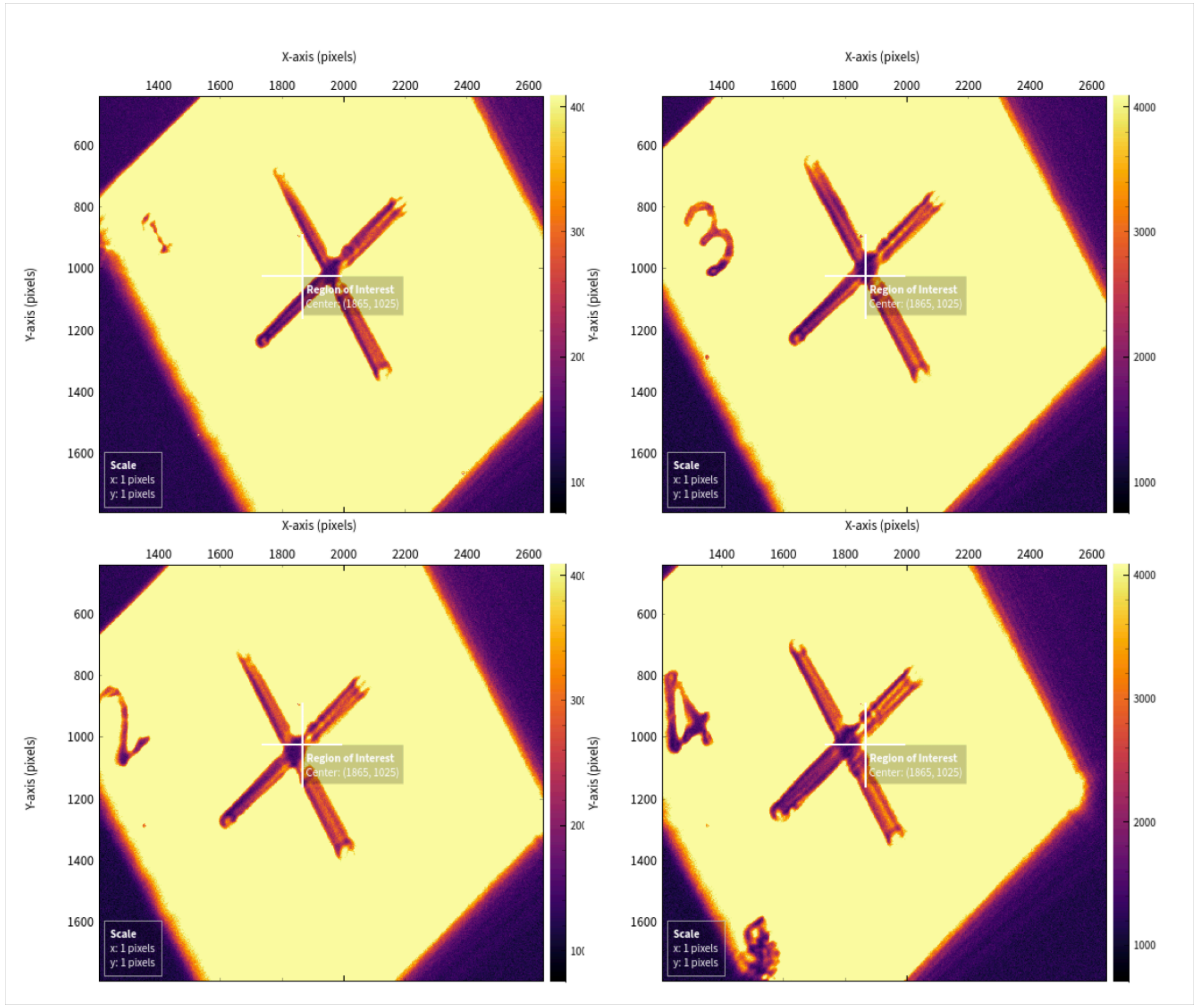


Commissioning Results (I): Accuracy

- After transforming coordinates, motors were driven to expected positions and the difference between expected and actual positions was measured to verify target positions.

	Horizontal [um]	Horizontal [%]	Vertical [um]	Vertical [%]
Average	8 +- 3	$(4{+-}2)10^{-3}$	5+-1	$(7{+-}2)10^{-3}$



Commissioning Results (II): Time

- Positions and acquiring target coordinate positions typically takes about 30 minutes.
- Approximately 25 extra minutes were dedicated to the thorough verification of the target positions.

Conclusions

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- The results of the calculation of the positions of the four targets within the sample were found to be accurate.
- The integration of the scanner into the facility's control system, Karabo, has been successfully tested.
- Data accessibility has been improved, the system now enables access to historical data values.

Thank you for your attention