Automation Developments at SOLEIL

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Summary

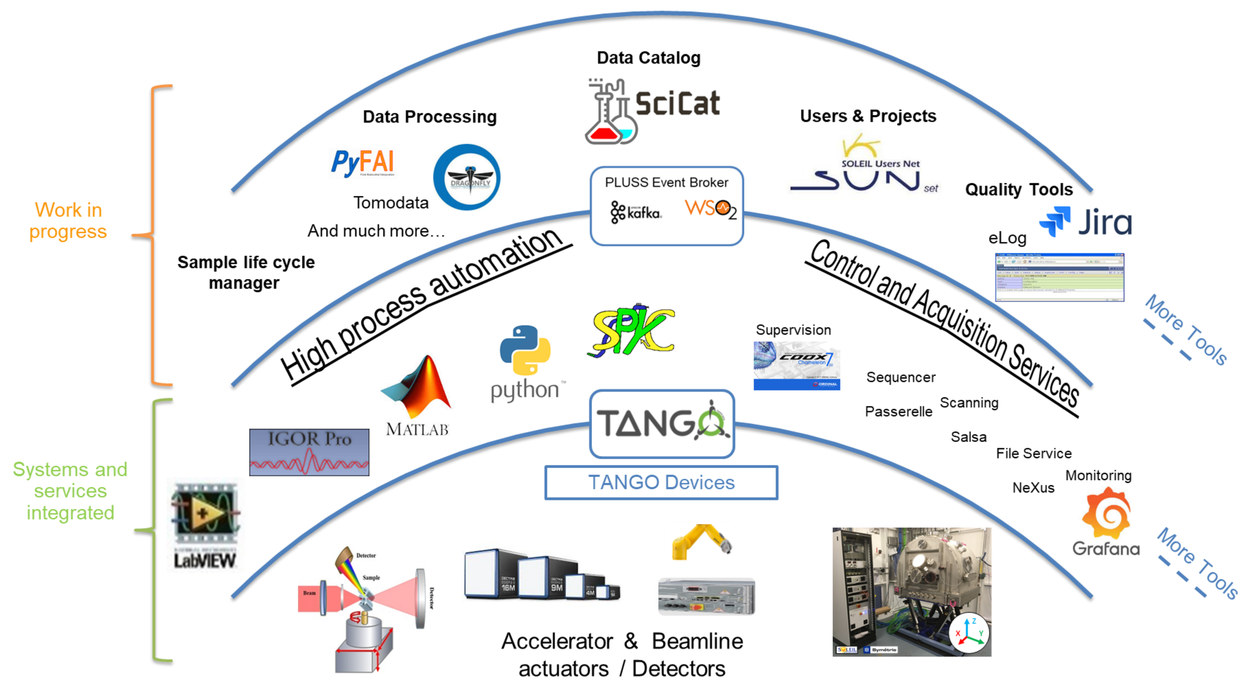
SOLEIL II project is set to commence in 2025. This project aims to develop an ambitious Diffraction Limited Storage Ring (DLSR) that will enhance brilliance, coherence, and flux. Additionally, the upgrade will include the improvement in the experimental techniques on the beamlines. Automation has been prioritized to address evolving requirements and simplify user experiences at the beamlines and accelerators operations. SOLEIL aims to develop systems for flexible control of instruments, ranging from manual to fully automated mode of operation. This approach involves optimizing experimental procedures, increasing beamline efficiency, and improving sample and data throughput.

As part of its strategic focus , SOLEIL is embracing robotics, with new applications based on 6-axis robot arms. The main purpose is on automating repetitive and time-consuming tasks, such as constant switching between measurements and sample replacements. Recent applications include automatic detector positioning for the NANOSCOPIUM beamline, liquid sample injection for the SWING beamline, and mechanical and magnetic adjustments for the insertion device modules. Through these advancements, SOLEIL is driving towards enhanced automation and operational efficiencies in its state-of-the-art research facilities.

A Holistic Approach to Improve Automation of Instruments/Processes

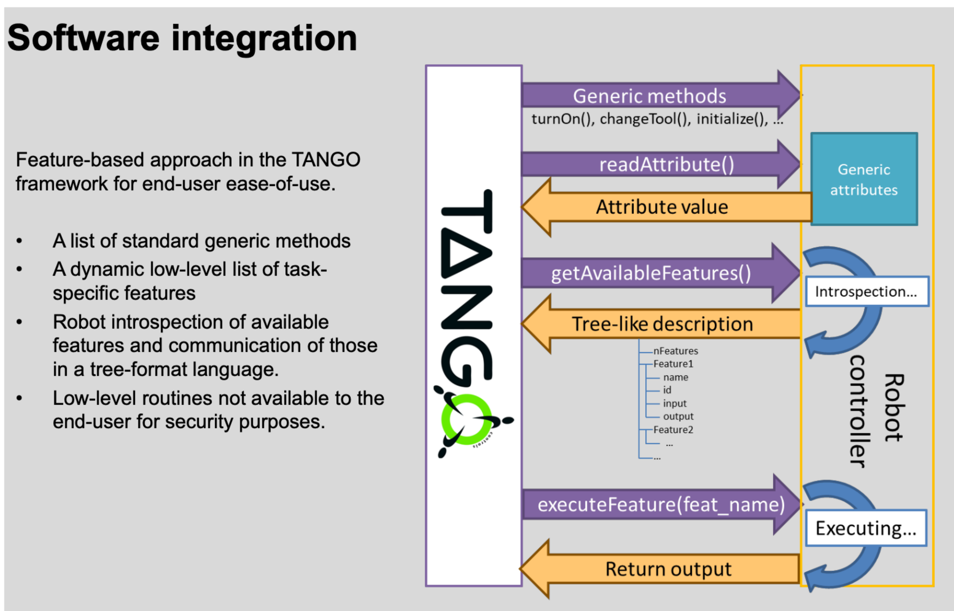
Goals of Automation

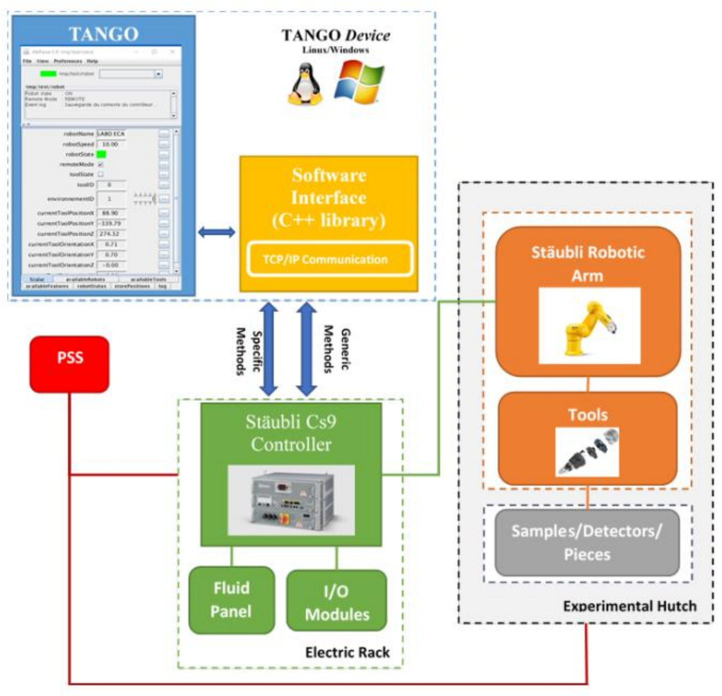
- Simplify the experimental procedures
- Improve sample throughput
- Reduce workload
- Accurately gather suitable experimental data
- Optimize the beam time



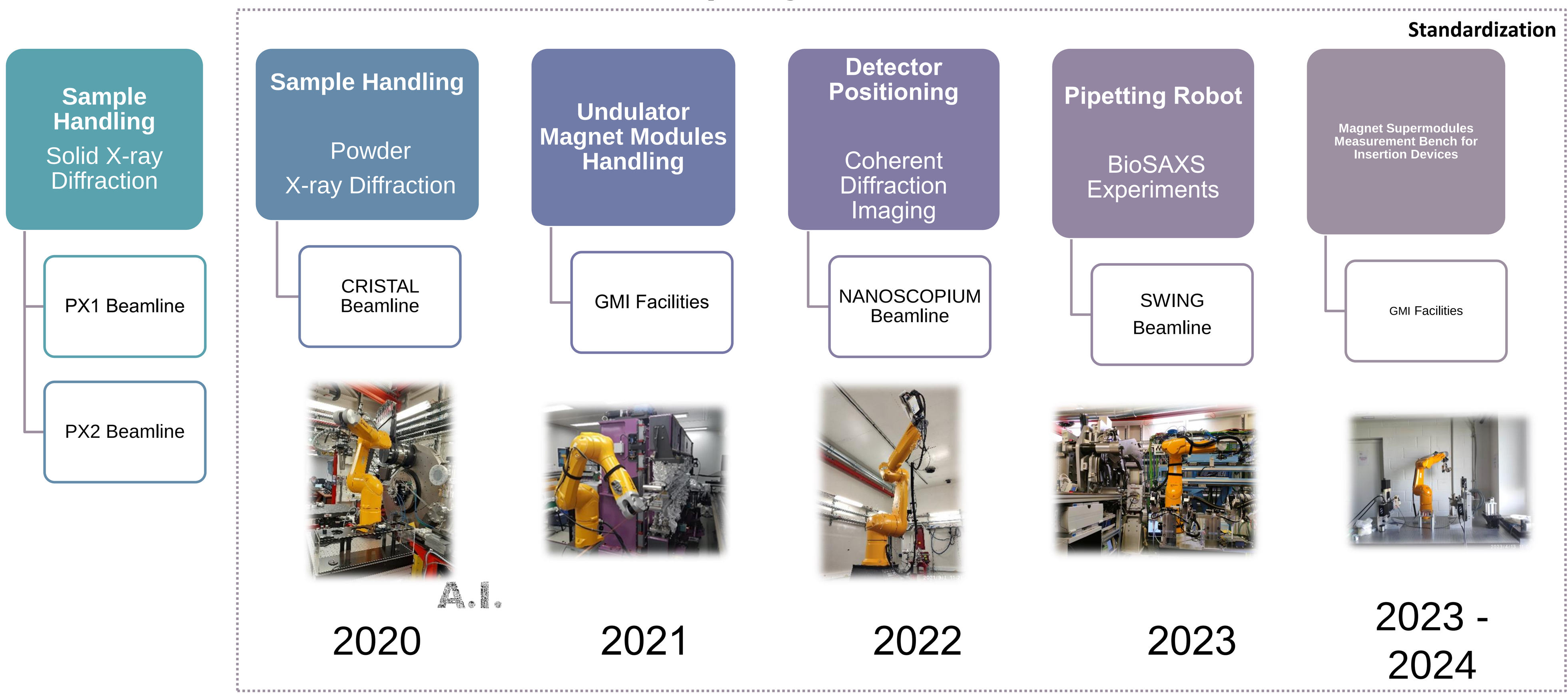
Robot Integration into the Beamline Control

A standard approach

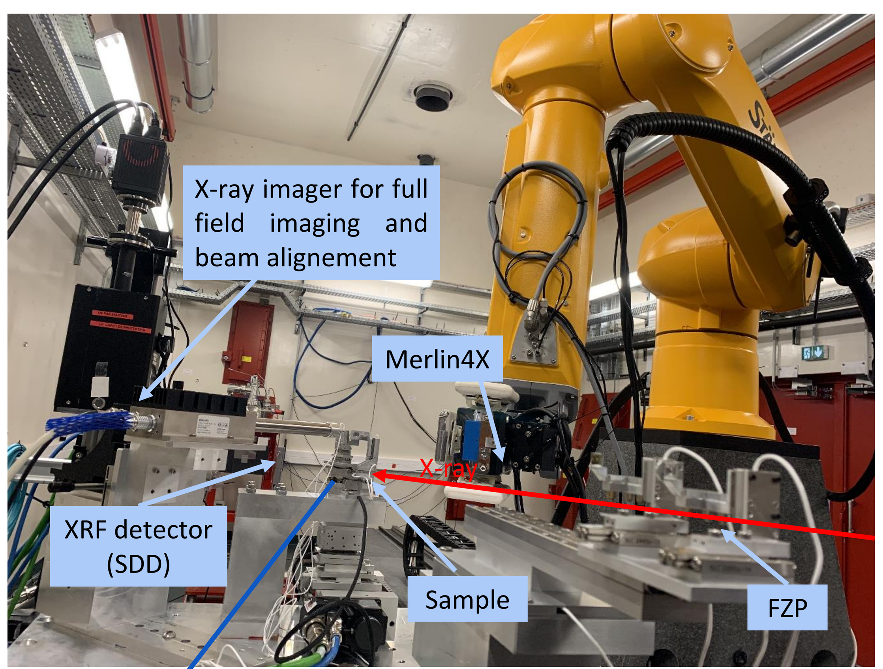


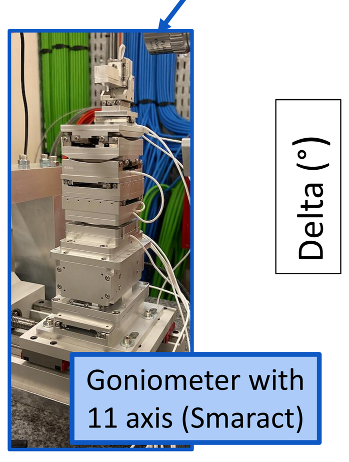


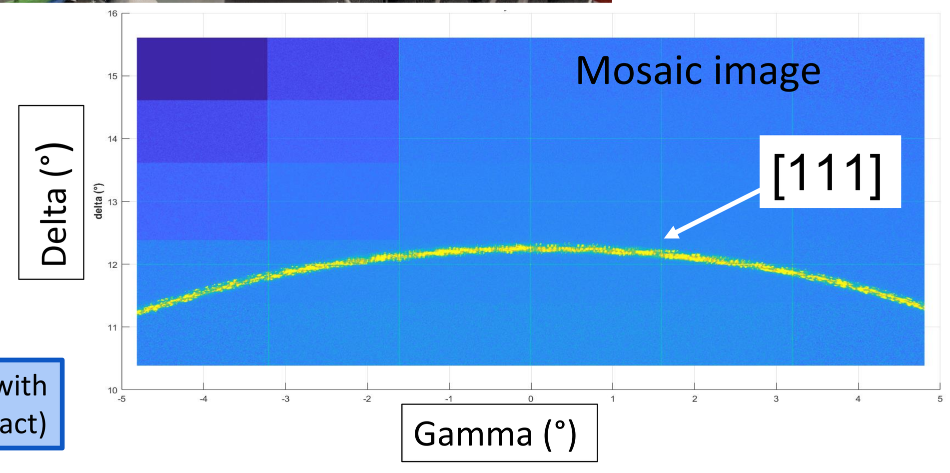
6 axis robot arms deployed at the beamlines



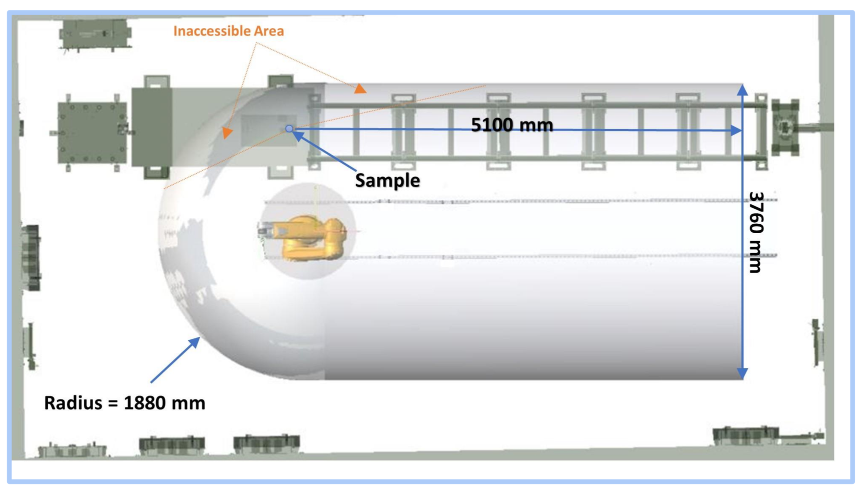
Multi-modal Nano-probe Station at NANOSCOPIUM Beamline







Large robot arm excursion volume

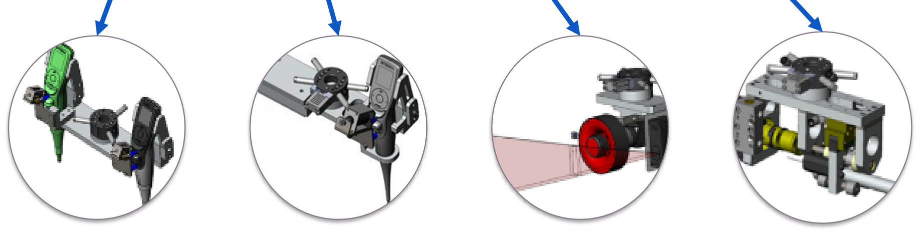


First Results

Powder X-ray diffraction measurement @ 14 keV with unfocused beam of a Si calibration sample.

2D scanning along γ (-3.2° to 3.2°, step 1.6°) and δ (12° to 14, step 1.06°)

Robot for BioSAXS at SWING Beamline



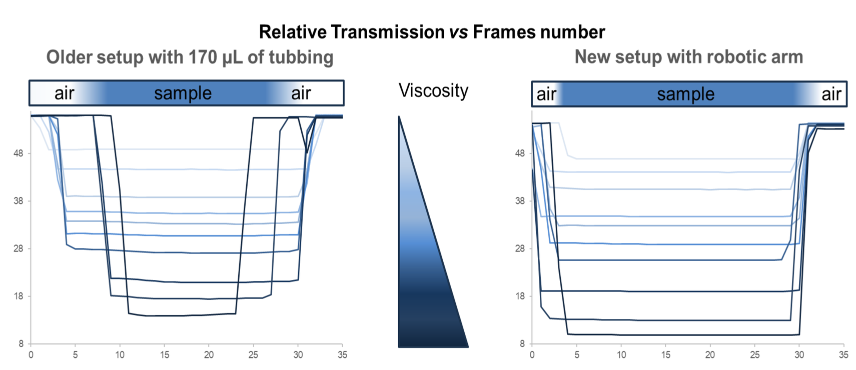
Cleaning Pipette Tool
- 2 x VIAFLO 1250 μl

Sample Pipette Tool
- VIAFLO 125 μl

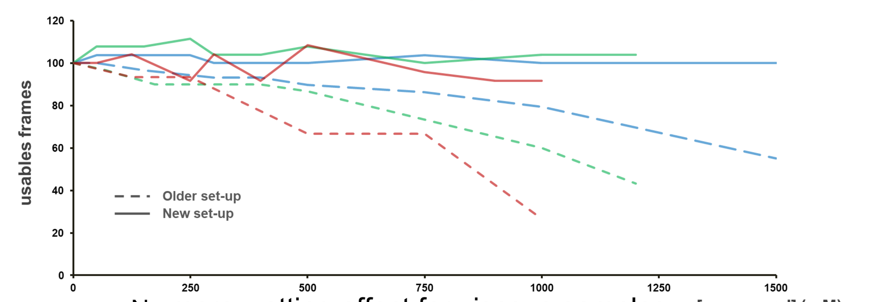
Calibration Tool
- Keyence Vision system
- Laser sensor IL-300 Keyence

HPLC Tool

First Benefits

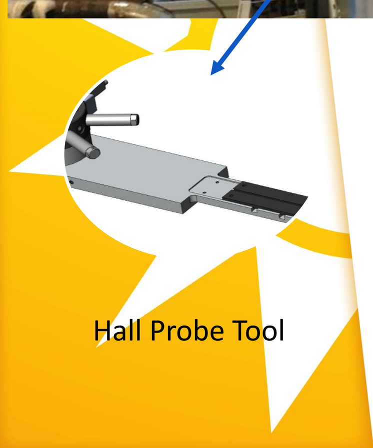


- Viscosity: sucrose << compound X << Nycodenz®

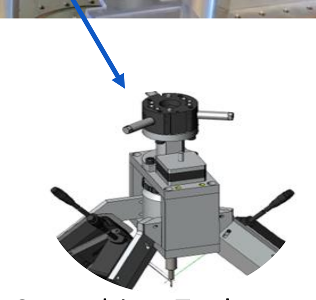


- No more wetting effect for viscous samples
- No more sporadic instabilities
- No more cross contamination
- Better efficiency in cleaning and rinsing procedures
- The entire duty cycle (pipetting/injection/washing/rinsing/drying) is reduced:
  - From 4:00 min to 3:00 for standard samples
  - From 6:00 min to 3:00 for viscous samples

Robotic Magnetic Measuring Bench For Insertion Devices



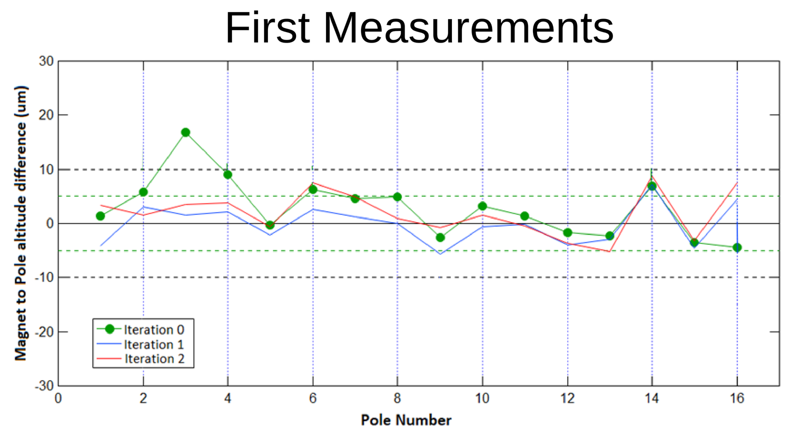
Hall Probe Tool



Screwdriver Tool:
- 3 Laser Sensors IL-S065
- Stepper motor
- Screwdriver tip M1x5

- Automatic sequence which calculate the offset and the correction to be applied to each pole screw, start the acquisition of the hall probe.
- Process to adjust the mechanical and magnetic correction of the magnet modules.

First Measurements



Development made for the CPMU12 prototype developed in the Work Package 6 of the LEAPS-INNOV project

CONCLUSION & PERSPECTIVES

- Robots are fully integrated into TANGO control system.
- Automation is designed as an integrated system including Control, DAQ systems, Data processing Artificial Intelligence.
- Work is in progress to go toward advanced automation to increase the degree of autonomy in our processes/systems.
- Design with a FAIR mindset to easily access Data and Metadata.