Robotizing SOLEIL beamlines to improve experiments automation

Y.M Abiven*, S.Bouvel, E.Elkaim, K. Medjoubi, A. Somogyi, F. Thiam, S. Pierre-Joseph, L. Chavas, P.Gourhant, V. Pinty, Y. Liatimi, T. Bucaille, B. Pilliaud,

Synchrotron Soleil, Paris, France

* yves-marie.abiven@synchrotron-soleil.fr

Context

Industrial serial-link robotic arms are being introduced into SOLEIL beamlines as a tool to enhance: task-automation, experimental efficiency, and overall security.

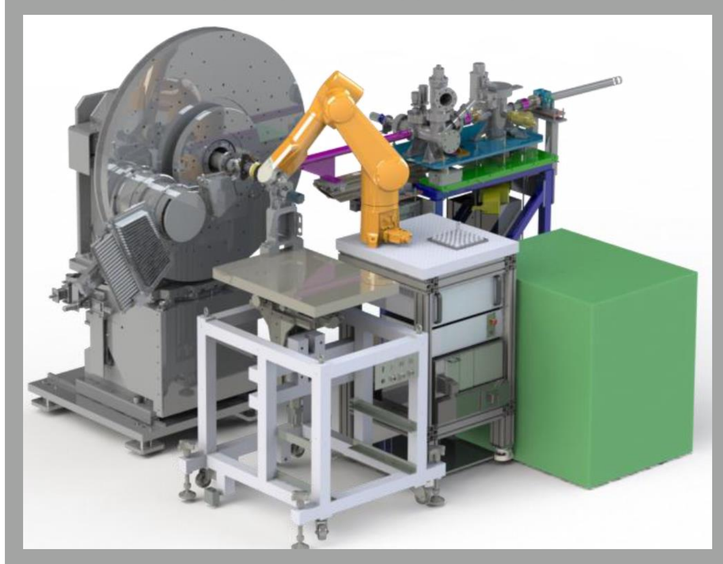
CRISTAL Beamline : Sample pick-and-place operations (with 36-set sample-chambers) using a robot mounted on a movable frame.

NANOSCOPIUM Beamline : High-stability positioning of a detector in large spaces.

General principles for robot implementation: Robot brand standardization, interfacing to the existing control systems, and software integration focused on end-users.

Applications

CRISTAL Beamline

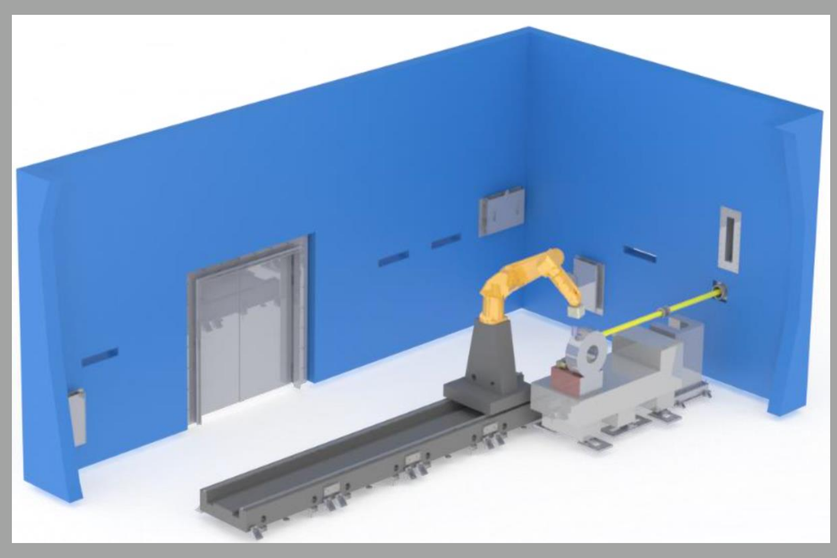


Robotic automation of powder diffraction experiments

System specifications include:

- 3,7 kg payload
- 30 µm positioning repeatability
- 36-set sample chamber
- Automatic magazine mapping

NANOSCOPIUM Beamline



Robot used for X-ray coherent diffraction experiment at NANOSCOPIUM beamline

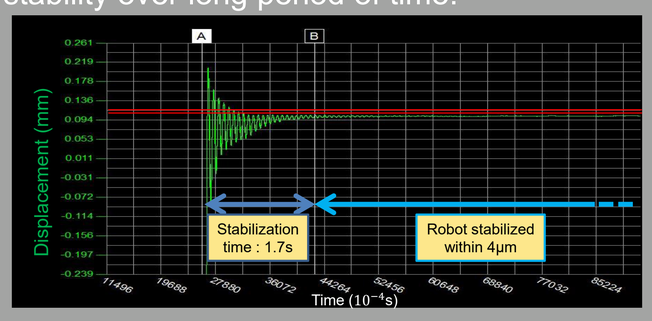
System specifications include:

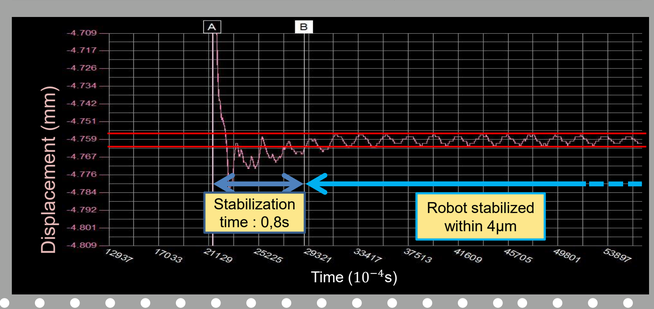
- 6 m range from sample to detector
- 20 kg payload
- 200 µm positioning precision
- 10 µm stability over 48h

Stability Concerns

Stability of the end-joint of the robot is particularly important for the NANOSCOPIUM application (and for overall synchrotron applications).

Preliminary results are encouraging, showing a stability better than 10µm. More advanced studies are ongoing to ensure this stability over long period of time.





Hardware integration

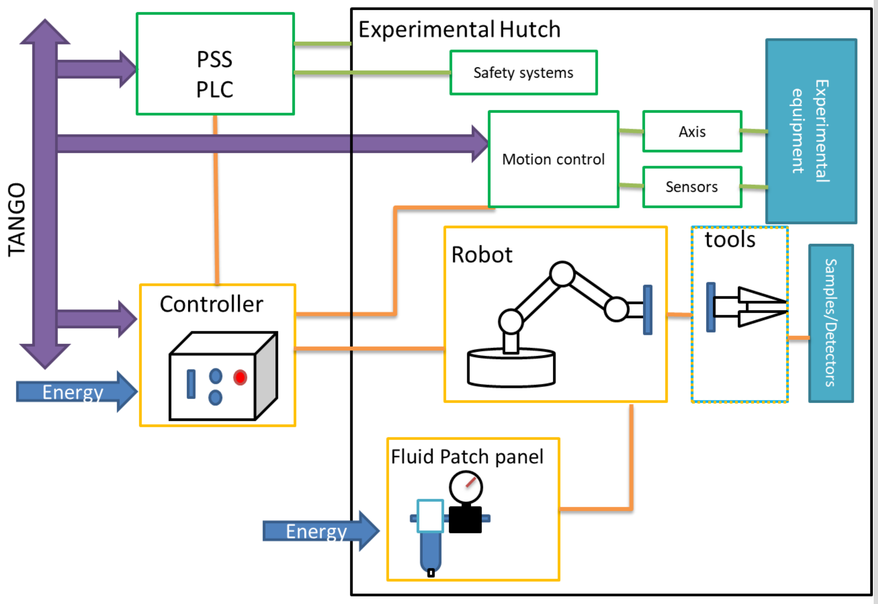
Based on a **standardisation** of all the integrated **equipment** as well as their **interface.**

Standardised equipment :

- Robots
- Controllers
- Tool changers
- Interface I/O
- Fluid patch-panel

Standardised interfaces :

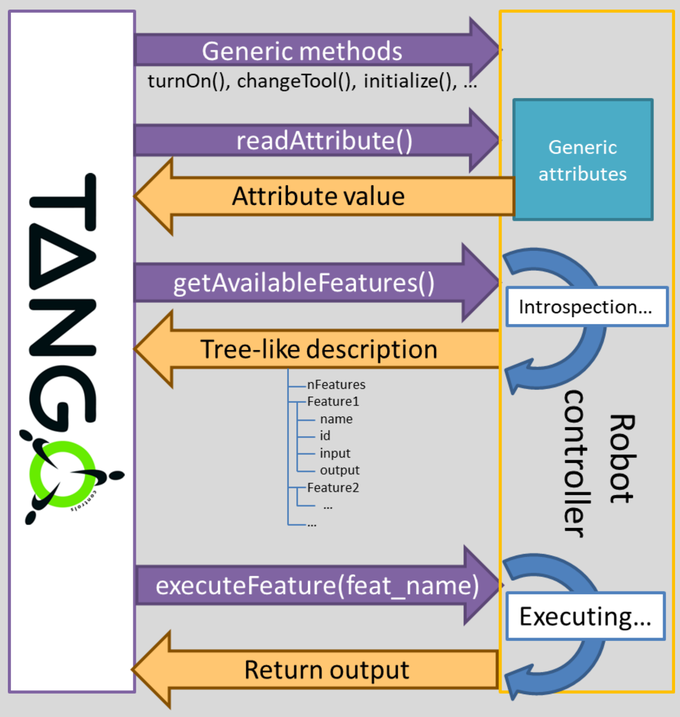
- Robot - Tool
- Robot – Fluid panel
- Robot - Controller
- Robot - Hutch



Software integration

Feature-based approach in the TANGO framework for end-user ease-of-use.

- A list of standard generic methods
- A dynamic low-level list of task-specific features
- Robot introspection of available features and communication of those in a tree-format language.
- Low-level routines not available to the end-user for security purposes.



CONCLUSION

A call-for-tender for robotic integrations has been carried out, of which the IRELEC company was chosen as industrial partner. The Stäubli robot product lineup was also selected, mainly because of the mechanical background of the company. In addition, their new CS9-based controller offers capabilities for collaborative robots in future applications.

The CRISTAL beamline-robot will be implemented in early 2020, and in the NANOSCOPIUM beamline mid-2020.