# PROCESS AUTOMATION AT SOLEIL: TWO APPLICATIONS USING ROBOT MANIPULATORS

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# Outline

- Introduction
- SOLEIL Robot Applications
- Conclusions and Future Work

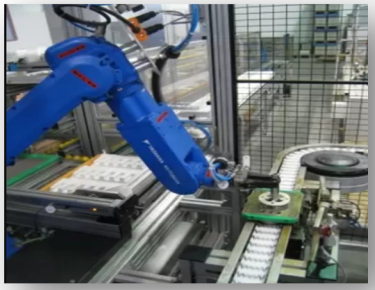
# Introduction

# Industrial Robots and Applications

## Articulated robot:

- A robot whose arm has at least three rotary joints
- It is the most common industrial robot structure

@YASKAWA



@KUKA

@automate org

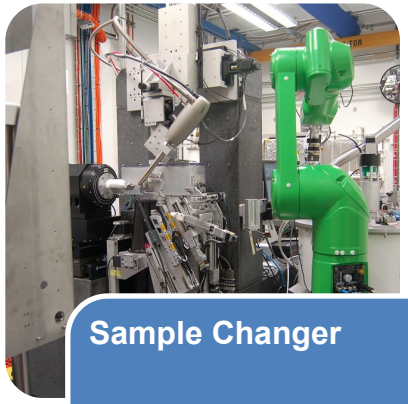
It is used in many process automations:

- Welding
- Painting
- Assembly
- Machine tool tending
- General material handling
- Pick and place

# Robotic Applications in Synchrotrons

## Main uses of articulated robots in a synchrotron:

@NSLS-II



**Sample Changer**

- Macromolecular Crystallography (MX)
- Biological Small-Angle X-ray Scattering (BioSAXS)
- X-Ray Diffraction

@Diamond

**Detector Holder**

- Bragg CDI and Bragg-ptychography
- Structural dynamics with X-ray techniques
- Coherent diffraction and SAXS experiments

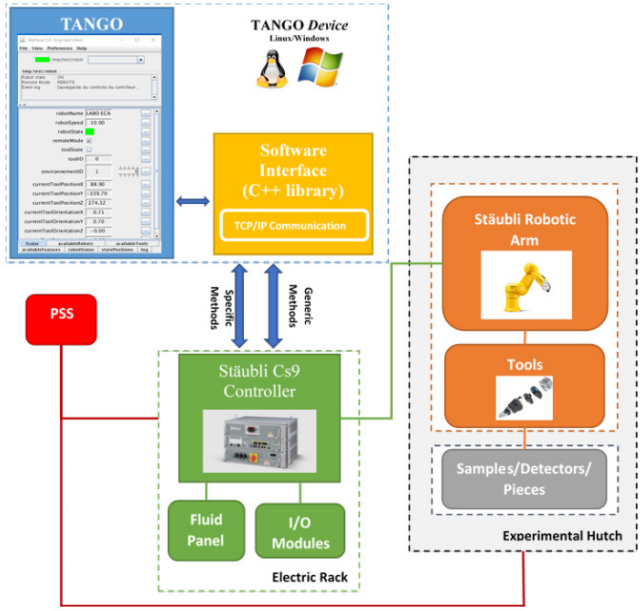
@Australian Synchrotron

**Others**

- Sample Holder
- High precision manufacturing

# SOLEIL Robotic Standard

This standardization defines a robotic standard on both hardware and software.




## Hardware:

- ✓ Brand: Stäubli
- ✓ Controller: Cs9

## Software:

- ✓ C++ Library
- ✓ Generic Methods
- ✓ Specific Methods

**Benefits:**

- ➢ Proficiency in robot integration
- ➢ Better operational management
- ➢ Support and maintenance
- ➢ Possibility of evolving robotic applications

# SOLEIL Robot Applications

# Stäubli TX2-60L Robot

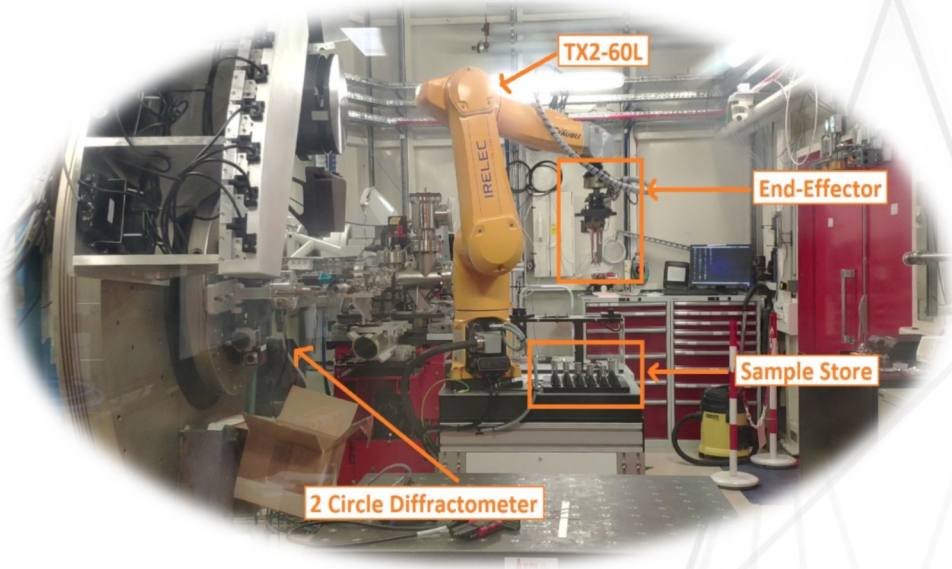

| | |
|---|---|
| Load capacity | 3.7 kg |
| Reach at wrist | 920 mm |
| Repeatability X-Y (ISO 9283) | ± 0.03 mm |
| Max cartesian speed | 10.9 m/s |
| Robot controller | Cs9 (1.7kVA) |

# CRISTAL Robotic Application

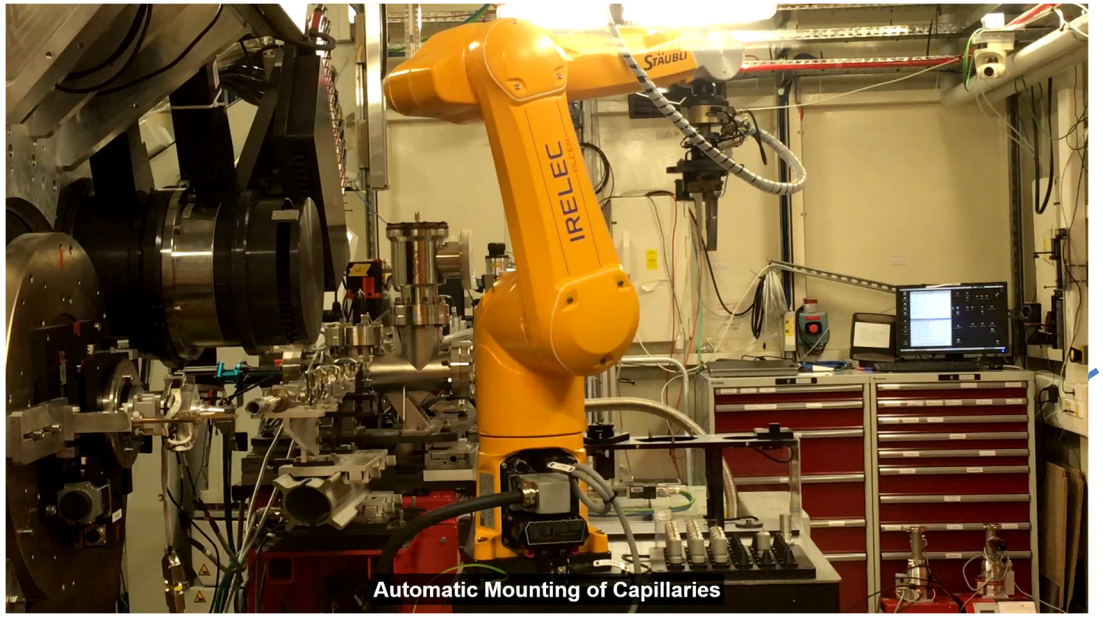
CRISTAL is an Undulator-based X-ray diffraction beamline dedicated to study single crystals and powders.

## Experimental Platform for powder diffraction measurements

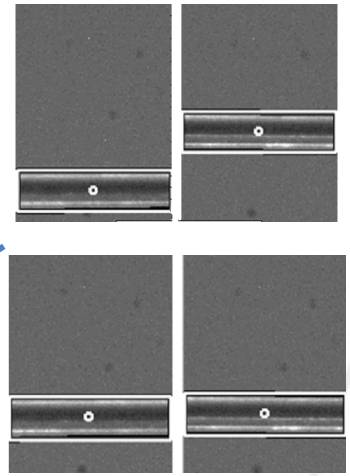
- 2-Circle Diffractometer → 2 detectors
  - Multi-crystal analyzer detector
  - Curved pixel detector
- TX2-60L Robot
- Mobile Chassis
- Sample Store (36 samples)
- End-Effector:
  - 3-finger centric gripper
  - Collision and overload protection system
  - Laser sensor
  - Pneumatic tool changing system



# CRISTAL Robot Application



Automatic Mounting of Capillaries



Automatic Mounting of Capillaries → Sample self-Centering Task → Diffraction Measurements → Automatic Dismounting of Capillaries

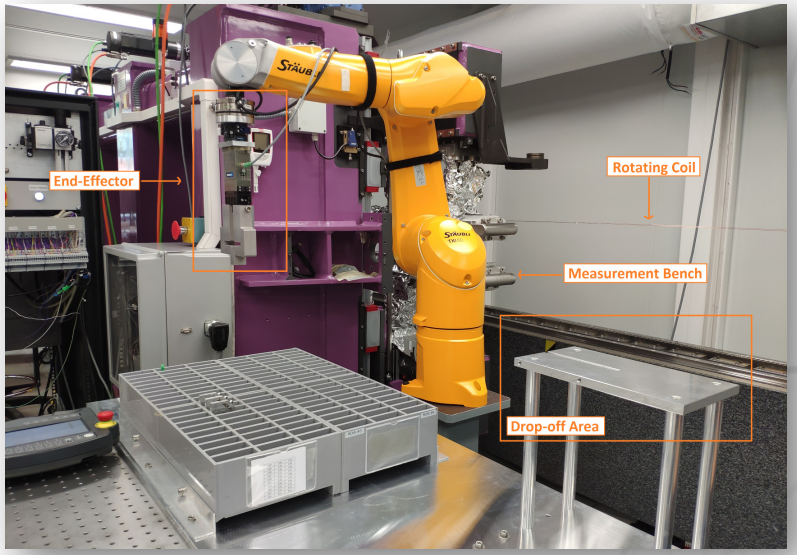
It takes about 1 minute 30 seconds

# Robotic Bench for Magnetic Characterization

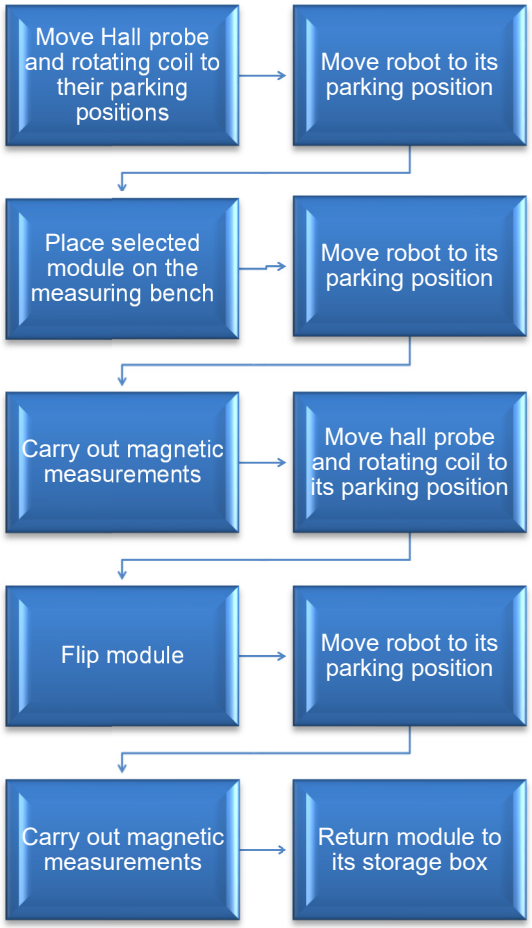
Magnetic characterization of insertion devices (undulators) magnets.

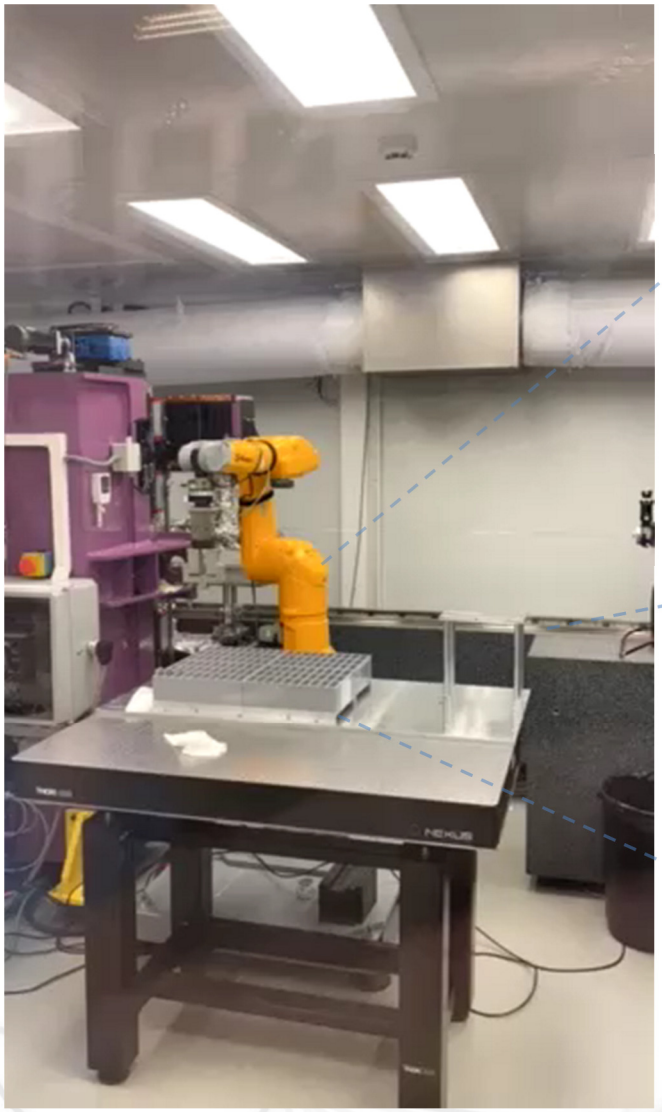
## Experimental Platform

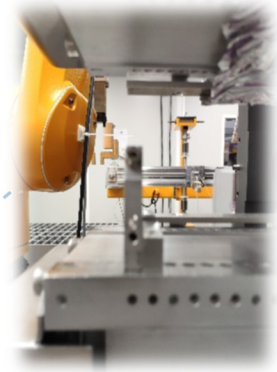
- Hall effect probe
- Rotating coil
- Storage Boxes (120 magnets)
- TX2-60L Robot
- End-Effector:
  - Electric 2-finger parallel gripper
  - Force/Torque sensor system
  - Manual changing system

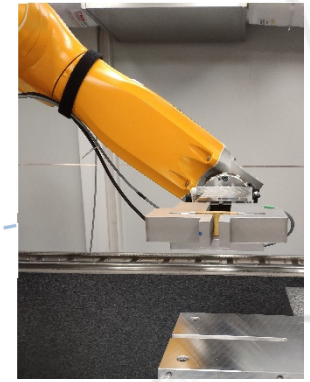


# Robotic Bench for Magnetic Characterization

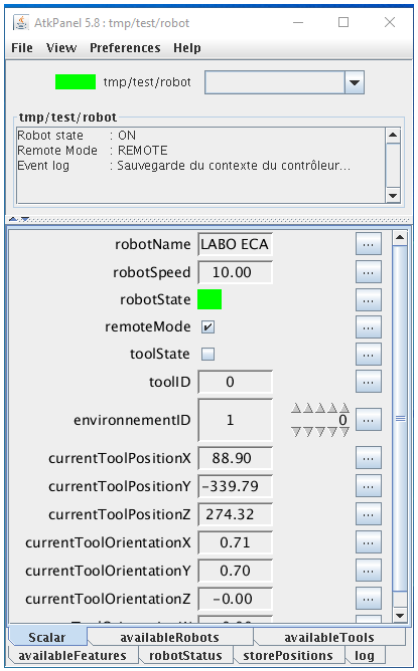


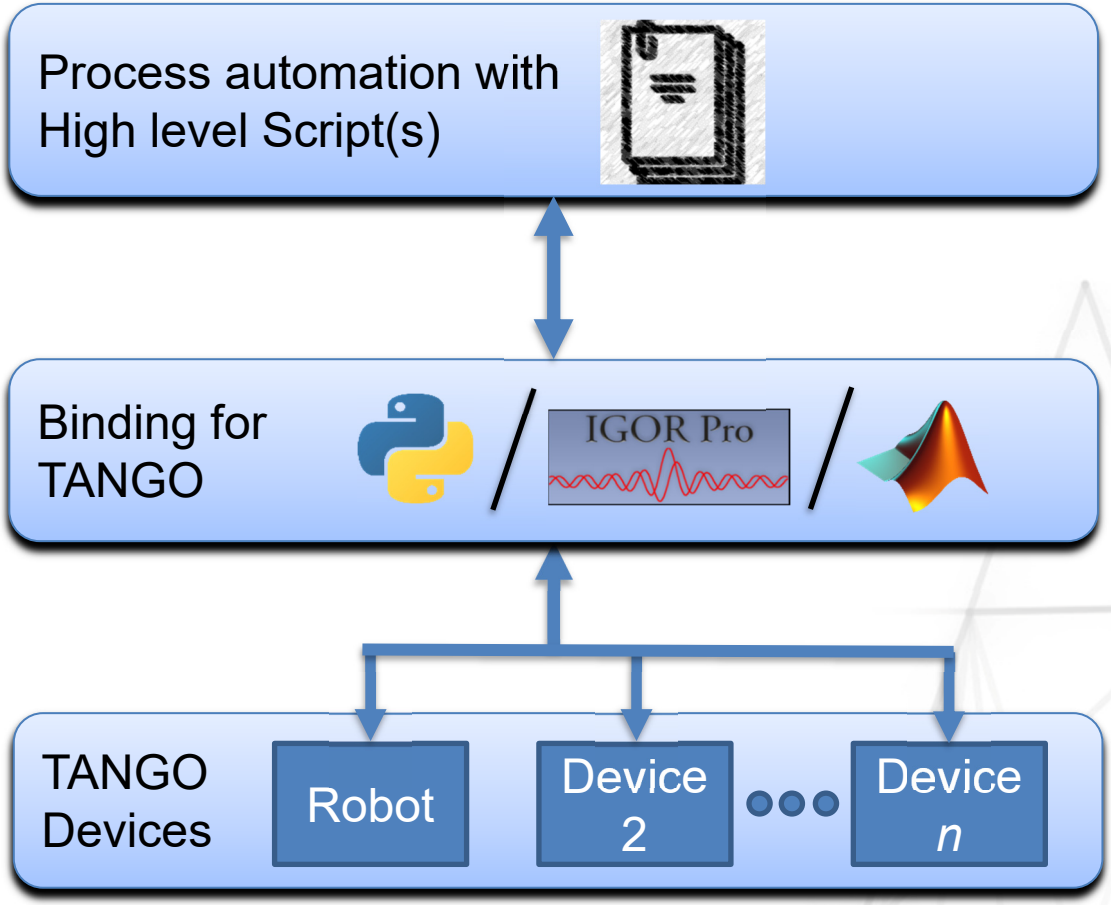







# Software Integration




It allows to easily integrate the robot to the beamlines/teams processes

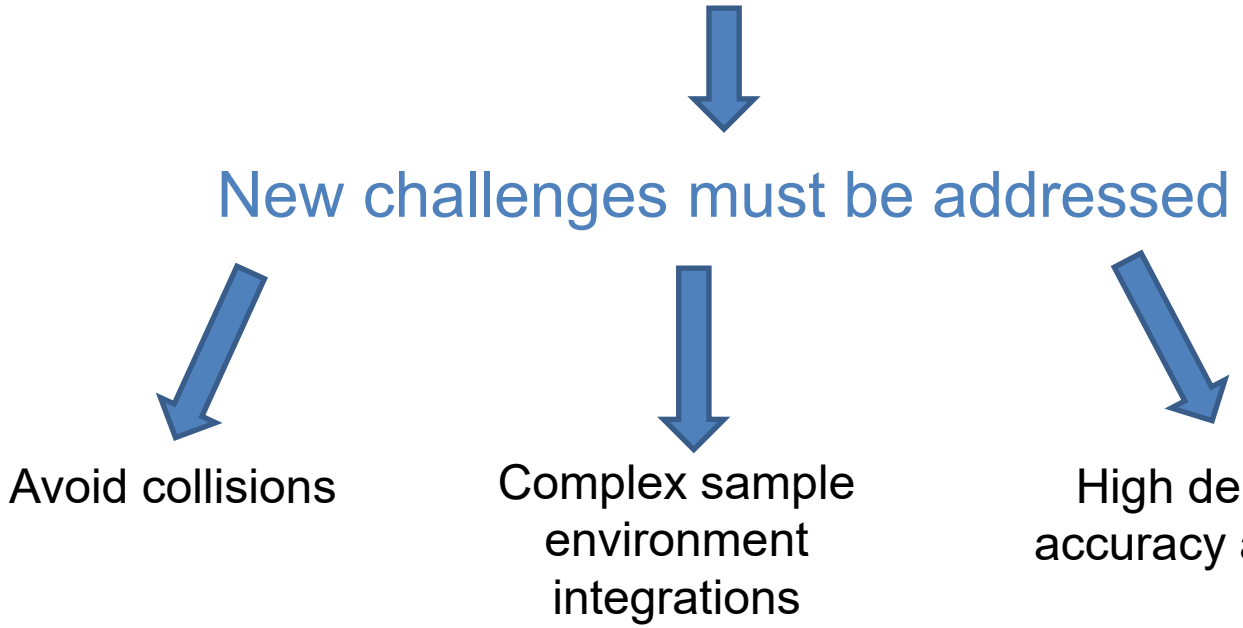
# Conclusions and Future Work

# Conclusions and Future Work

- The standardization permits the robot to be a “brick", easy to integrate into process automation.
- Opportunity to carry out experiments/measurements 24 hours a day.
- Since 2019, two applications have been deployed. One application was designed and developed *in-house* and the other one was developed by a subcontractor.

# Conclusions and Future Work

Ten other applications have already been identified to include industrial robots in experiment automations.



# Thank you!