ROBOTICS AND AUTOMATION

89. Koordinierungstreffen

10.03.2023 I S. JANASCHKE, F. SUXDORF, H. KLEINES, R. SCHÄFER, A. MÖLLER, M. KLEIN, A. STEFFENS, P. KÄMMERLING, F. BEULE, F.-J. KAYSER, M. GLUM, K. BUSSMANN, F. PALM, D. MARSCHALL, G. BRANDL, CH. FELDER, S. RAINOW, J. VOIGT

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CONTENT

JCNS Projects

- Current ESS- and Robotic projects (SJ)

- Current MLZ-projects (FS)

- Current HBS-projects (HK)

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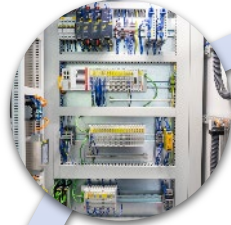Forschungszentrum

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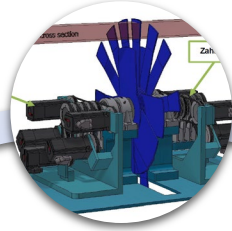- Current MLZ-projects (FS)

- Current HBS-projects (HK)

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ESS PROJECTS

Overview

T-Rex Fanchopper

Shutter Control

T-Rex radial collimator

Diverse Cabinet projects

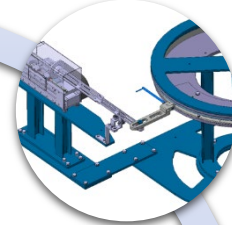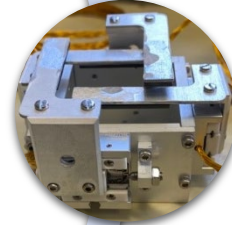|	
MCU 5001a	16 Axes Standard MCU
MCU 5002	2 and 4 Axes Servo MCU
MCU 5003	4 and 18 Axes Piezo MCU
MCU6001a	In-Bunker Motion Control
MCA -400-001	Full Size Cabinet Base 500X
MCA-400-002	Full Size Cabinet Base 600X
MCA-400-101	1 and 2 Ax Pneumatic Box with PSS

DREAM Piezo slits

In-Kind „Linear motion technology"

In-Kind „Robotic (RSCP)"

In-Kind „Rotary motion technology"

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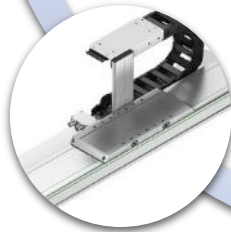
JCNS ROBOTIC PROJECTS

Overview

In-Kind Project

- Mobile and flexible robotics cell with **6 Axis robot**
- Samplechange
- Samplepositioning
- Demonstration purposes (e.g. endless sample flow)

ESS

J-NSE

KWS-2

HBS
Targetchanger?

New sample changer with **6 Axis robot**

New sample changer with **mobile robotic system**

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ESS - ROBOTICS SAMPLE CHANGER PLATFORM (RSCP)

Overview

- Mobile and flexible system

- Specially designed for use on ESS instruments
  → standardized mechanical interface

- Additional conveyor unit to demonstrate an endless sample flow

- Controlled by Beckhoff PLC

Control GUI

Integrated control racks

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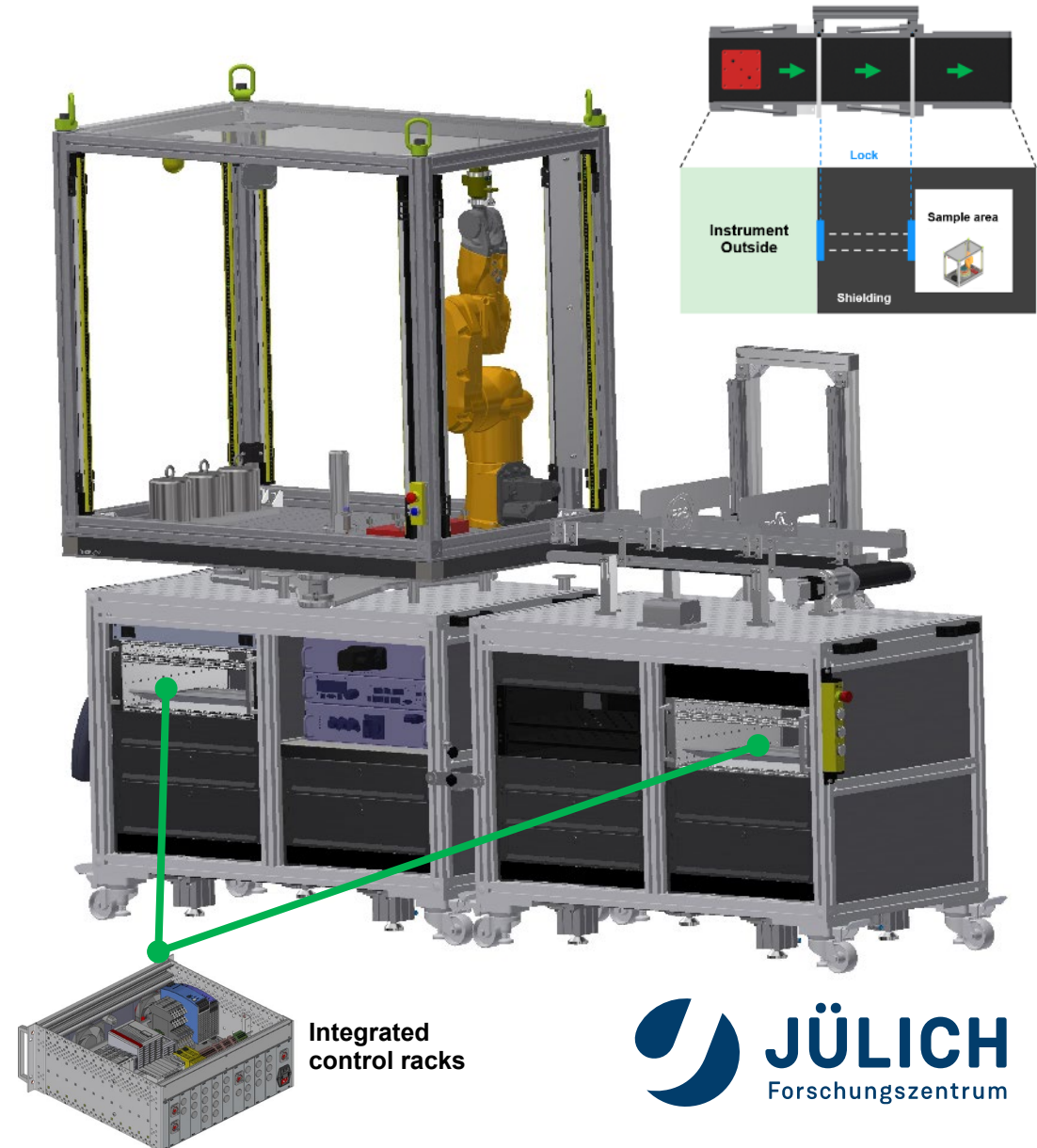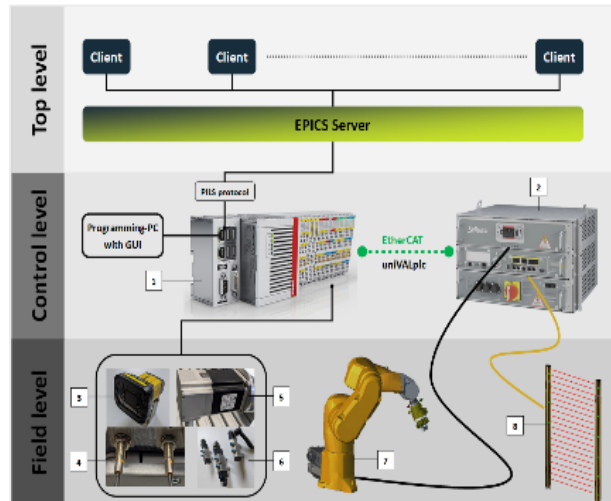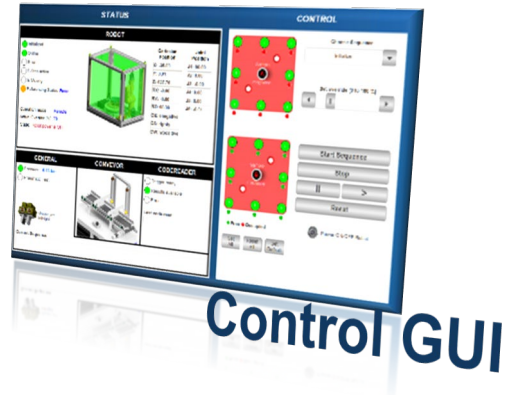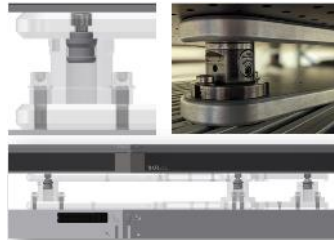
ROBOTICS CELL

Central components

Signal lamp

Codereader
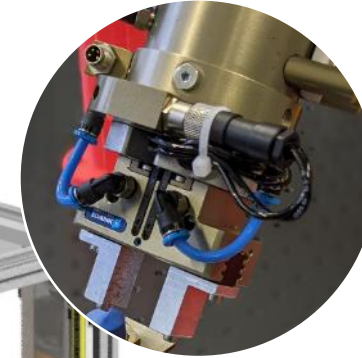
Pneumatic gripper with feedtrough

E-Stop

Safety light curtains

Mechanical interface to ESS Sample area

Sample magazines
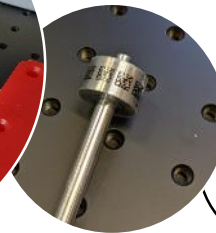
Sample dummy with DataMatrix code

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ESS - ROBOTICS SAMPLE CHANGER PLATFORM (RSCP)

Status

Documentation
90% complete
→ **Completion and Handover to ESS end of May 2023**

Project Status

Project idea
Market research ✓

Component selection
Component procurement ✓

Mechanical construction/fabrication
Electrical installation ✓

First commissioning and tests
Programming ✓

Final commissioning ✓

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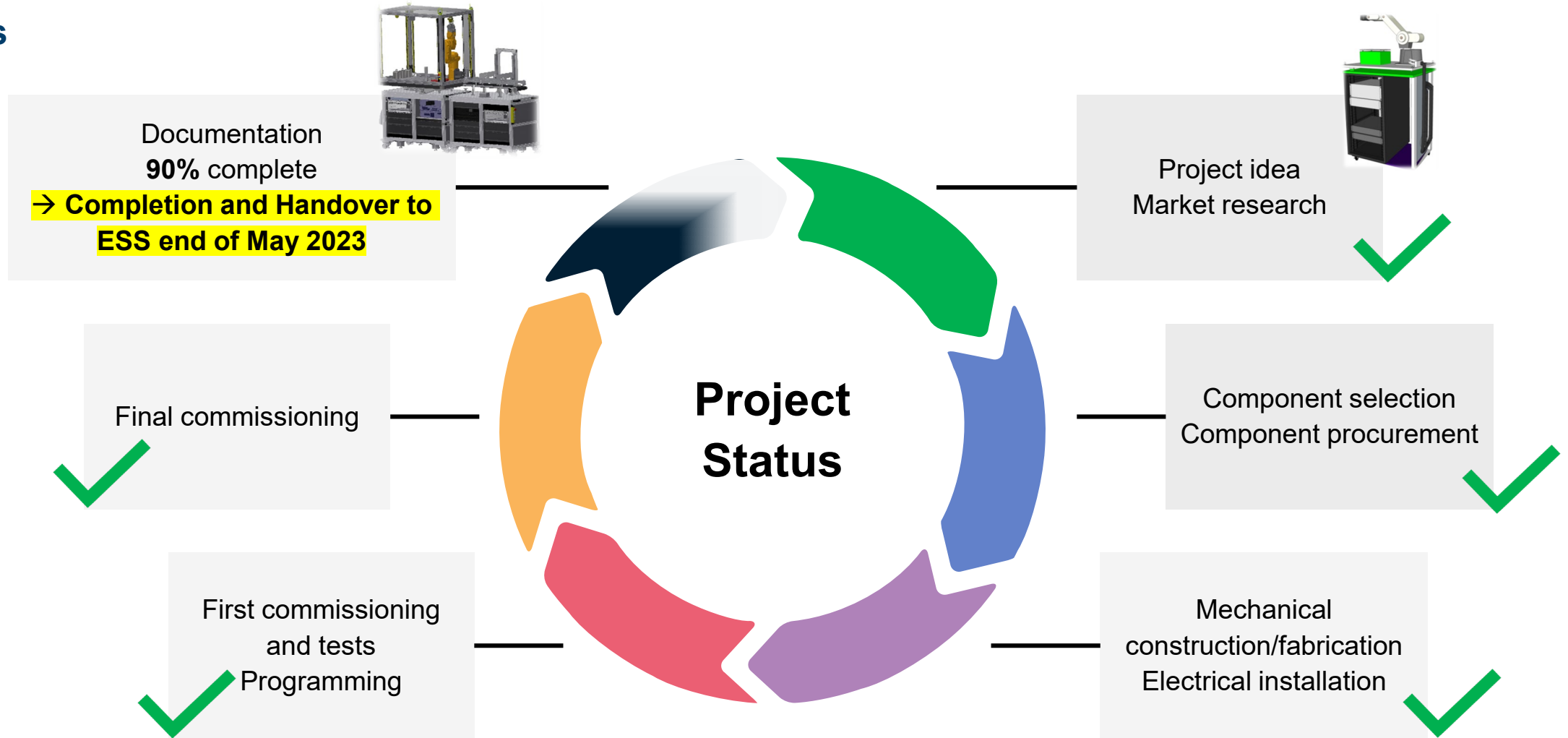
J-NSE „PHOENIX"

Overview

- Stäubli Mobile Robotic System
- Autonomous driving within the workspace
- Used for sample change
- **Purpose:** Reduction of magnetic influences of sample environment to the instrument
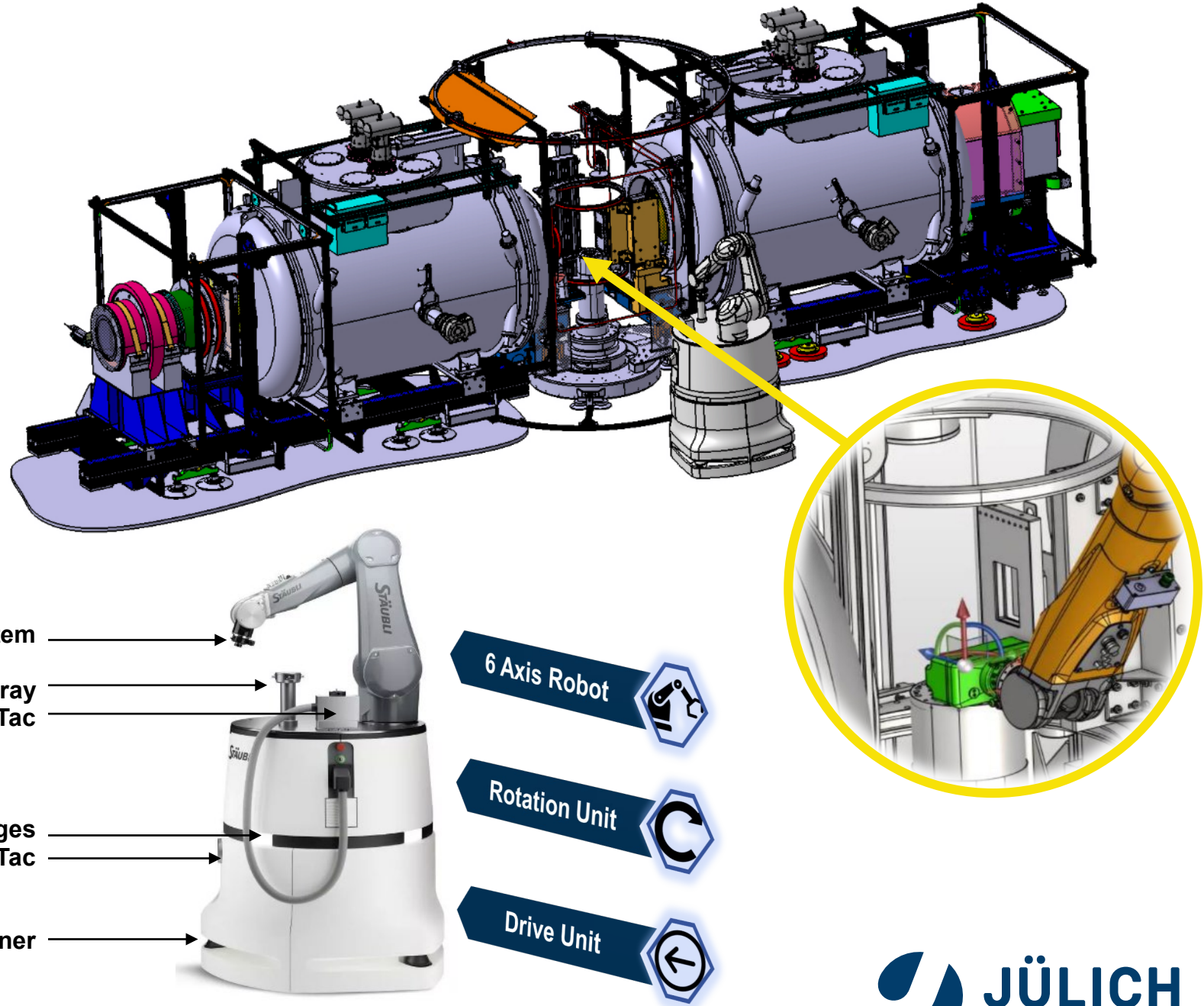

Tool changing system

Tool tray
Flexible CombiTac

Visual and acoustic status messages
Static CombiTac

Laserscanner

6 Axis Robot

Rotation Unit

Drive Unit

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J-NSE „PHOENIX"

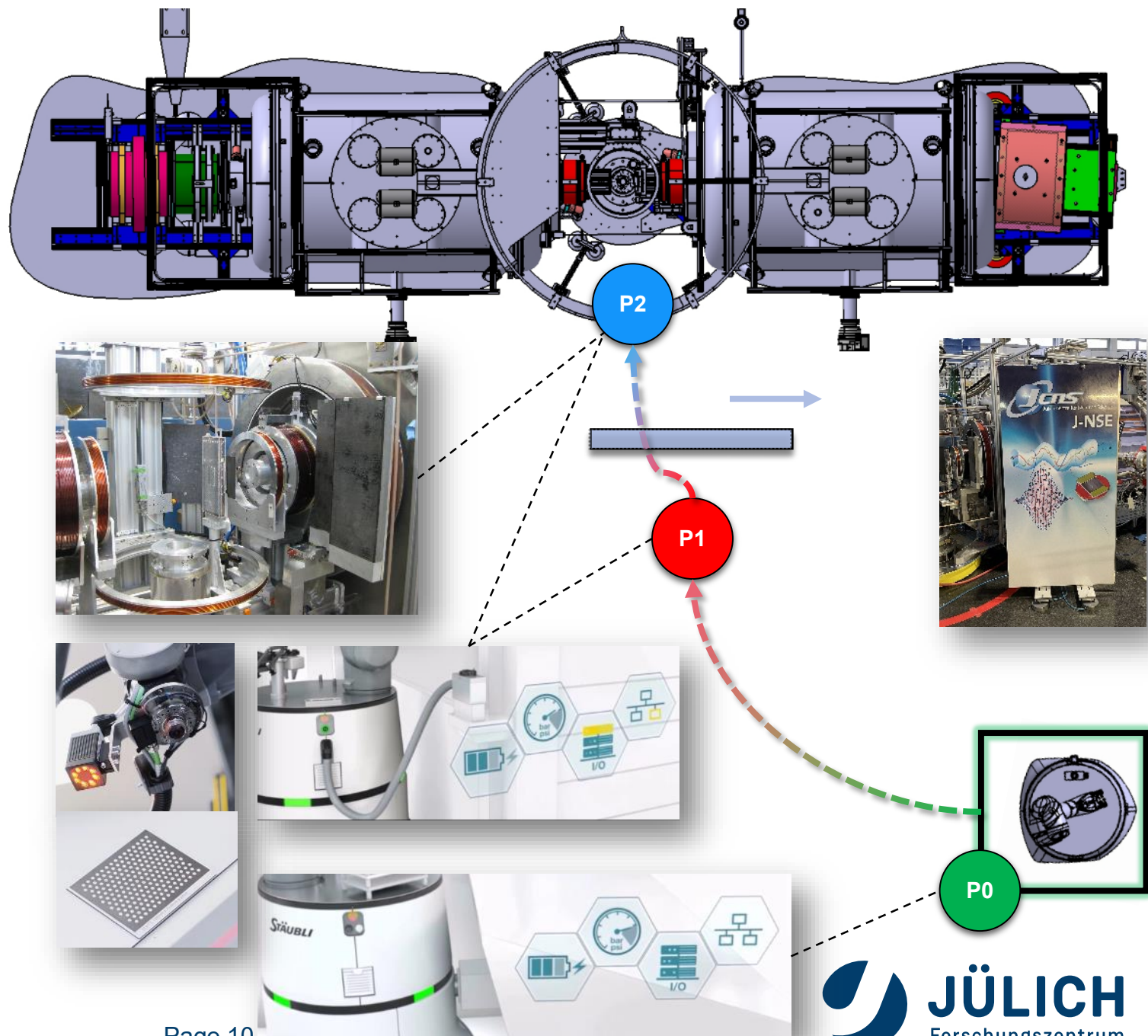## Principle procedure

- **P0: Parking position**
  - Connection to instrument control (**static** CombiTac)
  - Load battery, fill pressure vessel etc.
  - Communication to the control PLC

- **P1: Workstation 1**
  - Camera referencing
  - Connection to instrument control (**flexible** CombiTac)
  - **Task:** Move shielding wall to the side
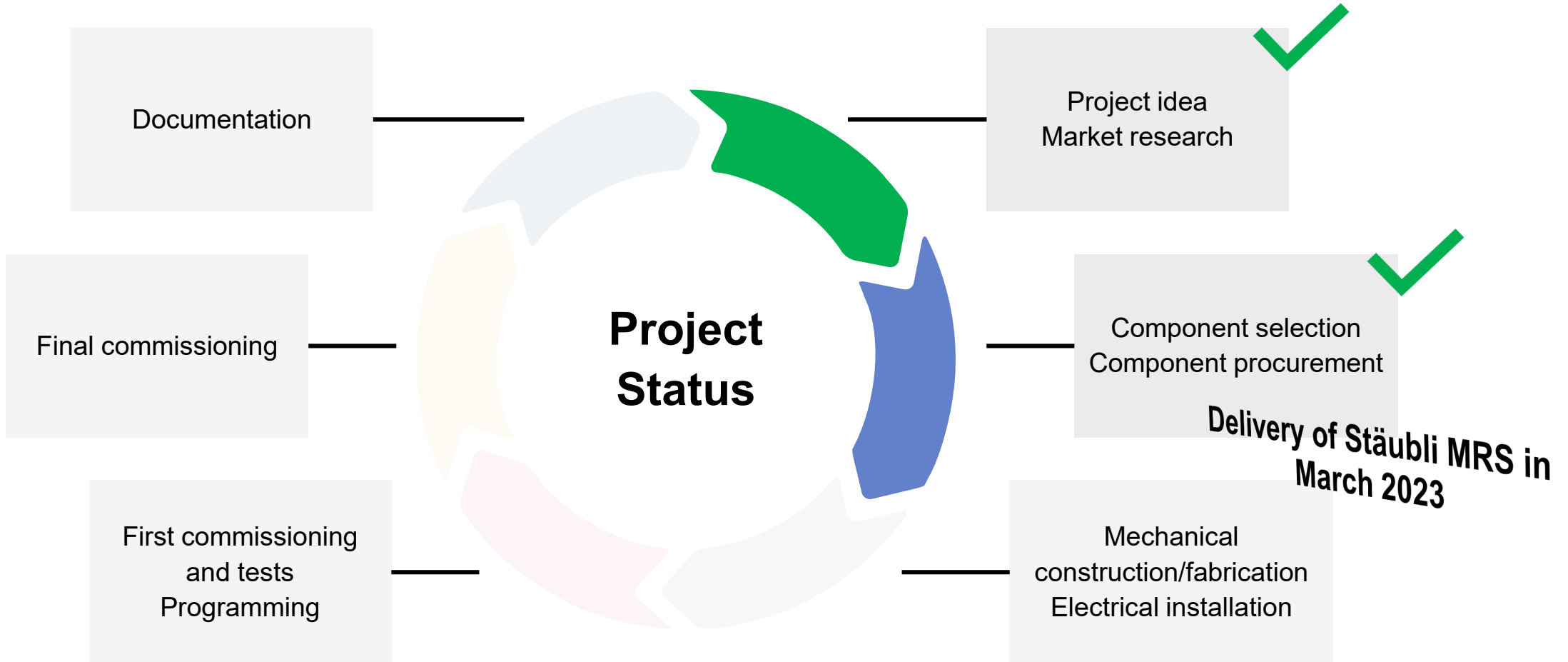
- **P2: Workstation 2**
  - Camera referencing
  - Connection to instrument control (**flexible** CombiTac)
  - **Tasks:**
    - Move shielding
    - Change sample

J-NSE „PHOENIX"

Status

Project Status

- Documentation
- Project idea / Market research ✓
- Final commissioning
- Component selection / Component procurement ✓
  - Delivery of Stäubli MRS in March 2023
- First commissioning and tests / Programming
- Mechanical construction/fabrication / Electrical installation
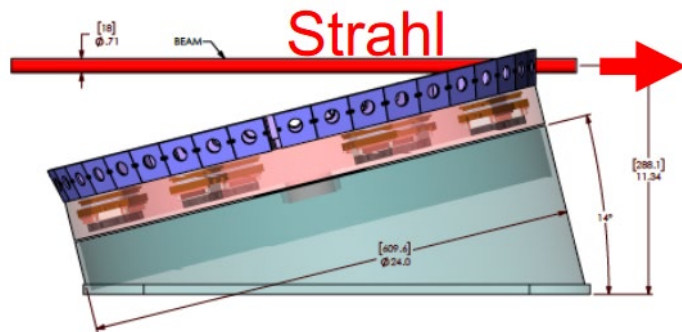
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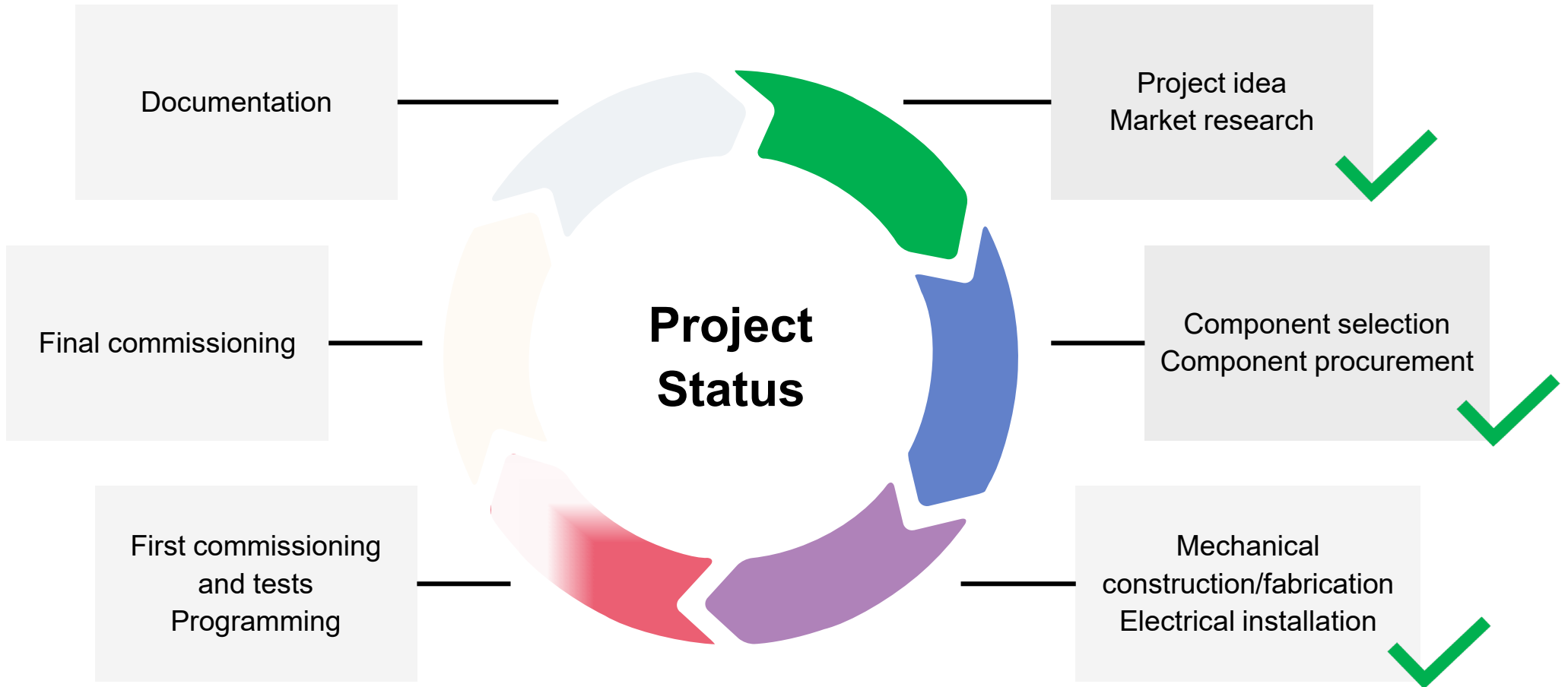
KWS-2 SAMPLE CHANGER

Overview

- Set up as a transportable sample environment

- Robot with samplemagazine (50 cuvettes)

- Samplepositioning system (48 cuvettes)

  - Integrated temperature control

- **Purpose:** Minimize time loss due to complex sample changes (Loosening of screws etc.)

Strahl

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KWS-2 SAMPLE CHANGER

Status

Documentation

Final commissioning

First commissioning
and tests
Programming

**Project
Status**

Project idea
Market research ✓

Component selection
Component procurement ✓

Mechanical
construction/fabrication
Electrical installation ✓

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CHANGE-OVER TO PROFINET COMMUNICATION

- Change-over of the FRM2 instruments completed
  - Old Profibus card is no longer used

- IN12 and GALAXI still have to be changed

- KWS1, KWS2, MARIA, DNS, TREFF, POLI, ANTARES
  - Instruments are still running with old S7-300 hardware and software

- BioDiff, NSE, SPEHERES, HEIDI, KWS3
  - Instruments run with new S7-1500 CPU
  - partial old hardware

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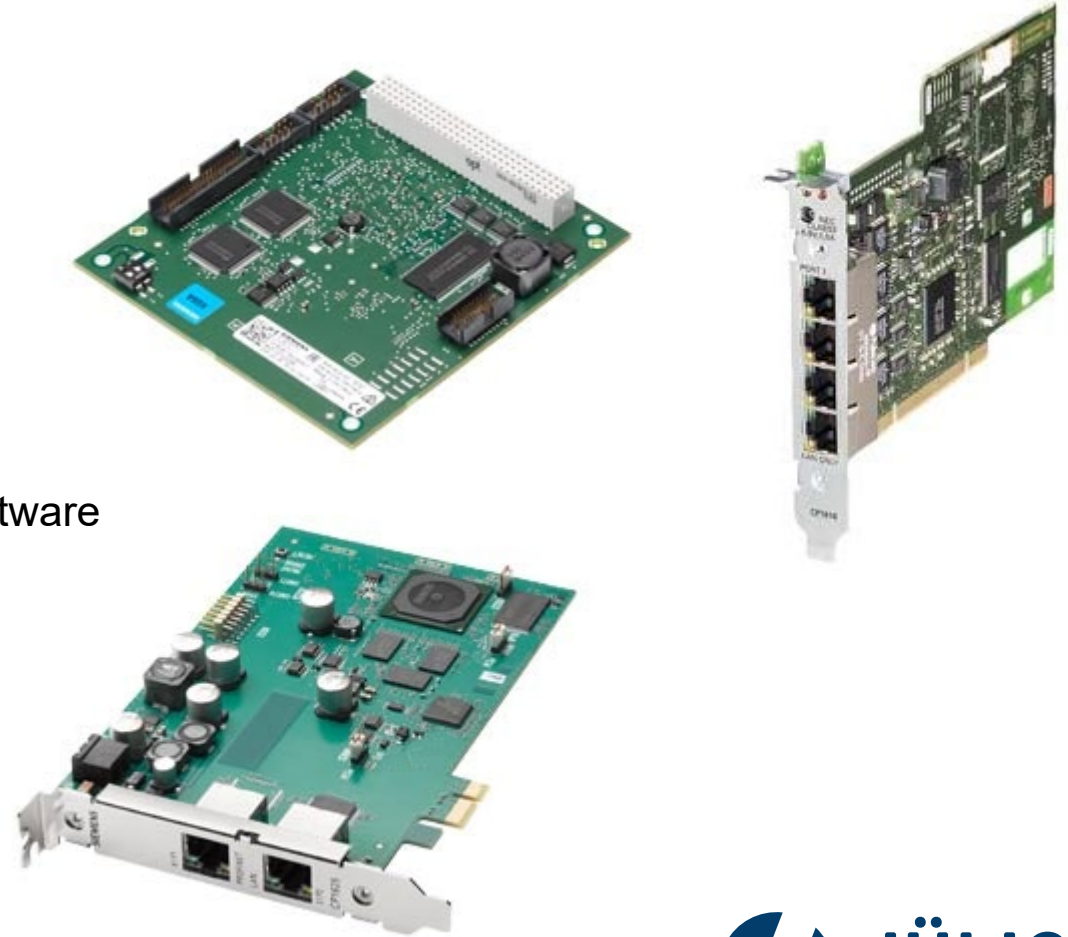
PRODUCT CANCELLATION

S7-300 / ET200S

- For components of the S7-300 and ET200S, the phase-out has been announced

- From 2025 new components can no longer be ordered

- Spare parts available until at least 2033

- There are still many spare parts in JCNS due to electronics upgrade

- New projects are only built up with S7-1500 and ET200SP components

- Electronics upgrade necessary because instruments are constantly being expanded


Announcement of product phase-out (PM400) available as new part until PM410	Product cancellation (PM410) available only as spare part, delivery may be restricted	Product discontinuation (PM490) spare parts not available any more, only in case of warranty
01.10.2023	01.10.2025	not planned, but not before 01.10.2033

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TRANSITION TO S7-1500

KWS3

- Built a new main cabinet

- Decentralized systems partially removed

- Slow-, Vacuum- and F- system in one PLC

- New OP with a new GUI

- Not yet fully put into operation

- Remaining work follows this year

- Base for the electronics and software design for other instruments

  - TMR system at COSY

  - New vacuum systems KWS1/2

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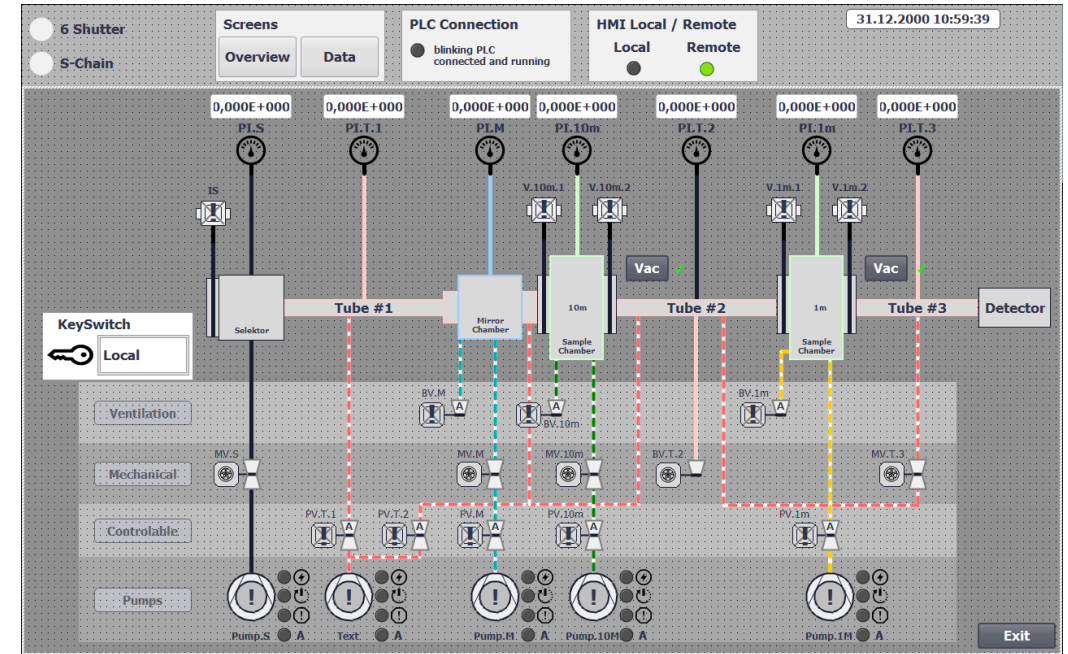
TRANSITION TO S7-1500

electronics upgrade

- Old Siemens TouchPanel (HMI) are no longer supported by new software (TIA portal, WinCC Unified)

- Change to S7-1500 CPU

  - MARIA, DNS, POLI, GALAXI

    - Exchange of the CPU and not supported modules (old S7-300/ET200S modules are used further)

    - New software -> new commissioning of the entire instruments

    - Control and expansion of the existing documentation

  - KWS1, KWS2, TREFF

    - New construction of the control cabinets

    - Revision of the documentation and security considerations

    - Complete new commissioning of the instrument

- Vacuum/Argon system MARIA, SPHERES

  - No change at the moment planned

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OTHER PROJECTS

## Completed Projects

- DNS

  - New chopper put into operation

- Heidi

  - 11 axes of external controllers integrated into the PLC + additional axis added

- KWS2

  - „Dehnapparatur" finally put into operation and transported to Garching

  - Colossus Samplepositioning system integrated in existing PLC control

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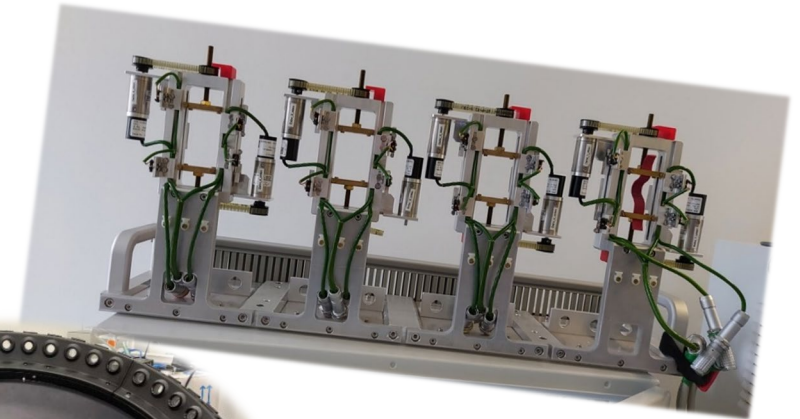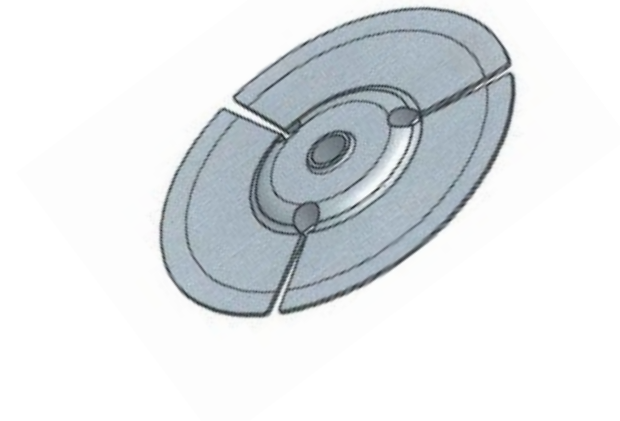
OTHER PROJECTS

Open projects

- Construction of new control cabinet for TOPAS and POWTEX
  - Circuit diagram,planning and programming of the cabinets by ZEA-1
  - Use of the JCNS software for axis control and communication

- New „Cryoeinsatz" for BIODIFF
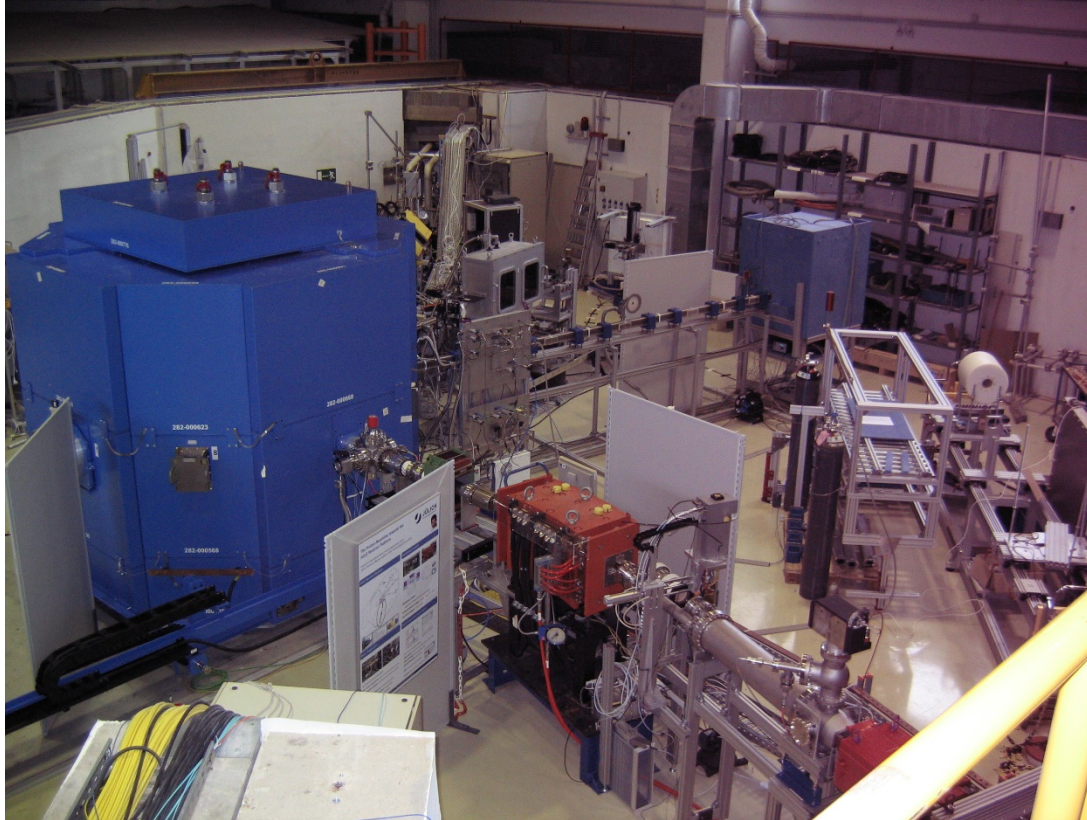 - Stepper drive is replaced by PI drive
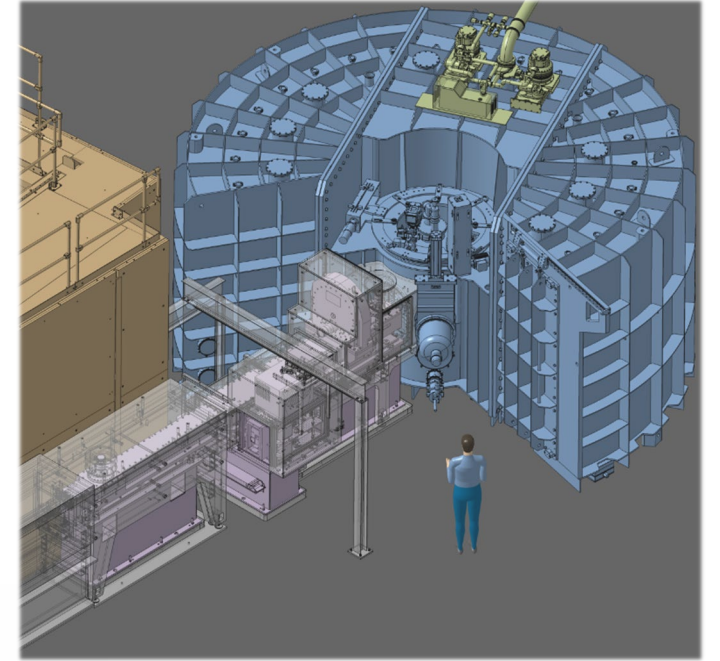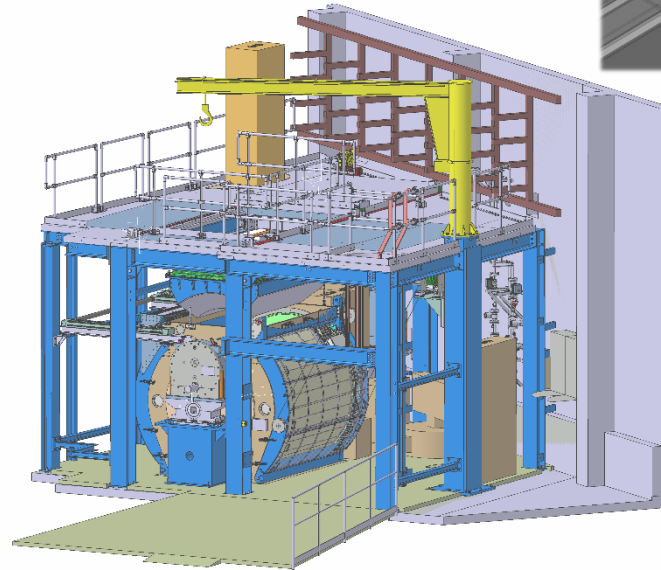
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HBS ACTIVITIES: JULIC NEUTRON PLATFORM @ COSY

- Component delivery problems + unexpected beam time in 12/2023

   => intermediate solutions + concentration on essentials

- Electronics design partly developed by ZEA-1 (D. Marshall + F. Palm)

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CONTROL SYSTEM CONCEPT

| Central Target Control System	Moderator Control Systems	Instrument Control Systems
Vacuum System Cooling System Target Handling System Movable Shielding Door / PPS System	• Methan Moderator • LH2-Moderator	• Diffractometer TOAD • Reflektometer HERMES (LLB)

Technology decisions:

- NICOS + TANGO (and not CSS + EPICS)
- Siemens PLC technology
- Control/User-Room, dedicated network, local servers
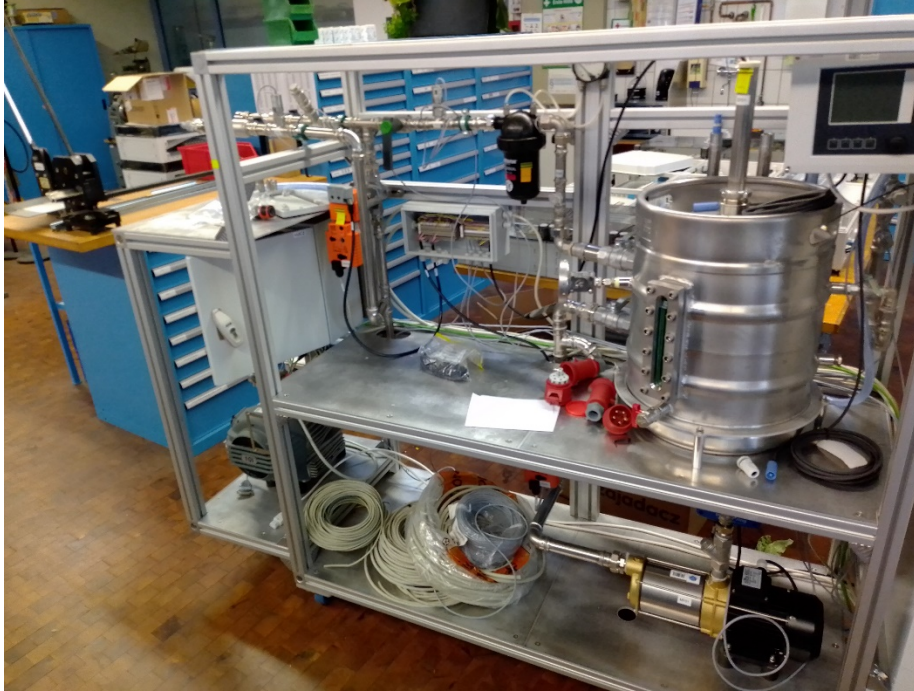
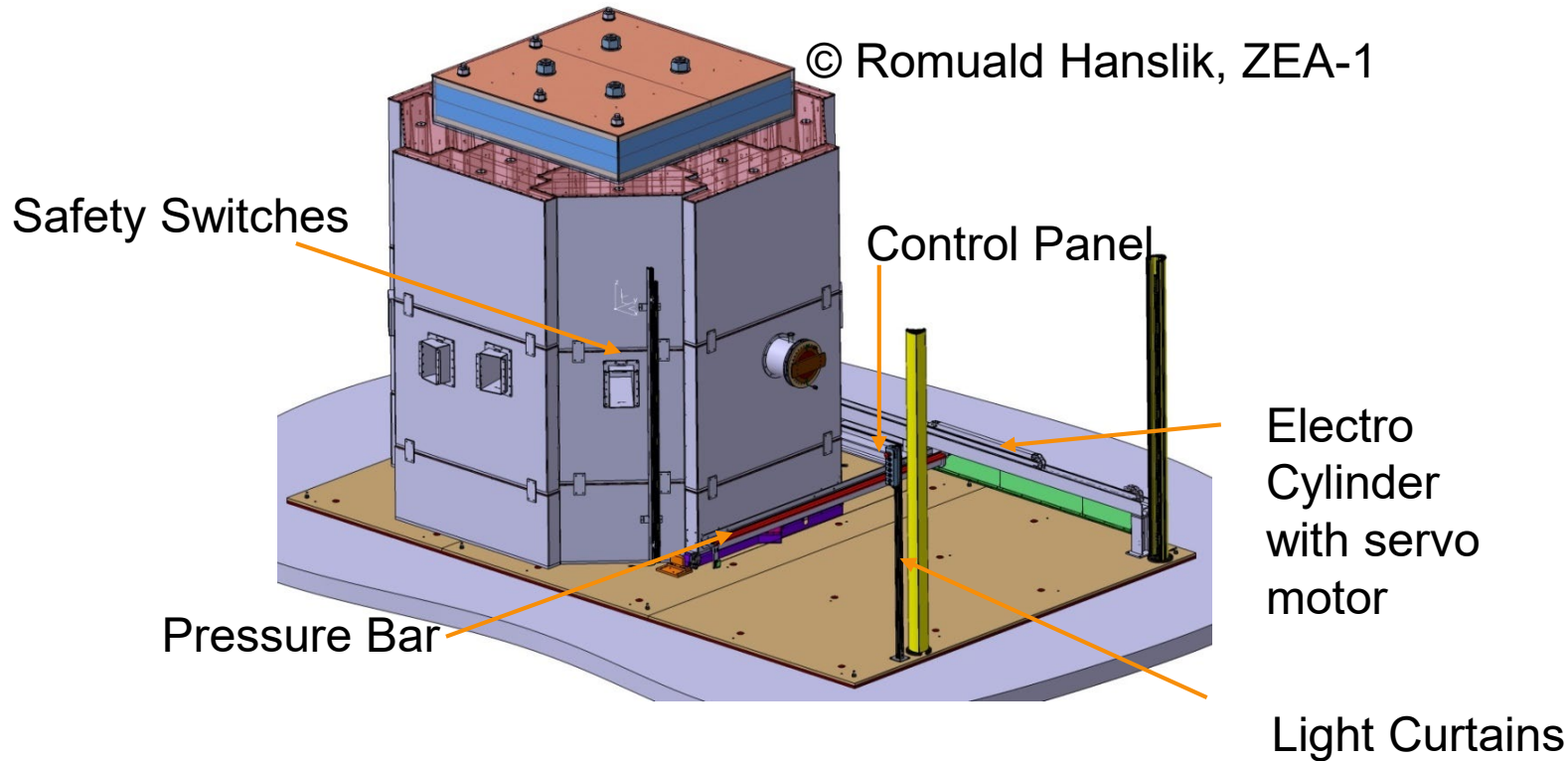S7-1500
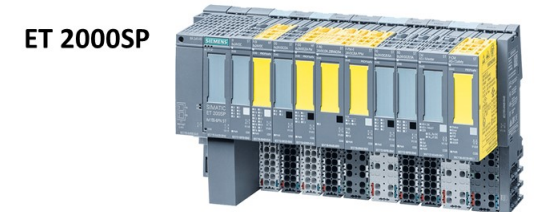
ET 2000SP

ET 200pro

ET 200eco

COOLING AND VACUUM SYSTEM

- Cooling system: pump, valves, water quality, pressure, flow and temperature monitoring

- Vacuum devices + cooling system devices: common setup including electronics

- Successfully tested with test recipients

- Cooling system not allowed to operate during beam time due to target vacuum leak

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MOVABLE SHIELDING I

© Romuald Hanslik, ZEA-1

Safety Switches

Control Panel

Electro Cylinder with servo motor

Pressure Bar

Light Curtains

- Safety actuators and sensors connected via Siemens ET200eco decentral periphery
  - Missing components => not yet mounted
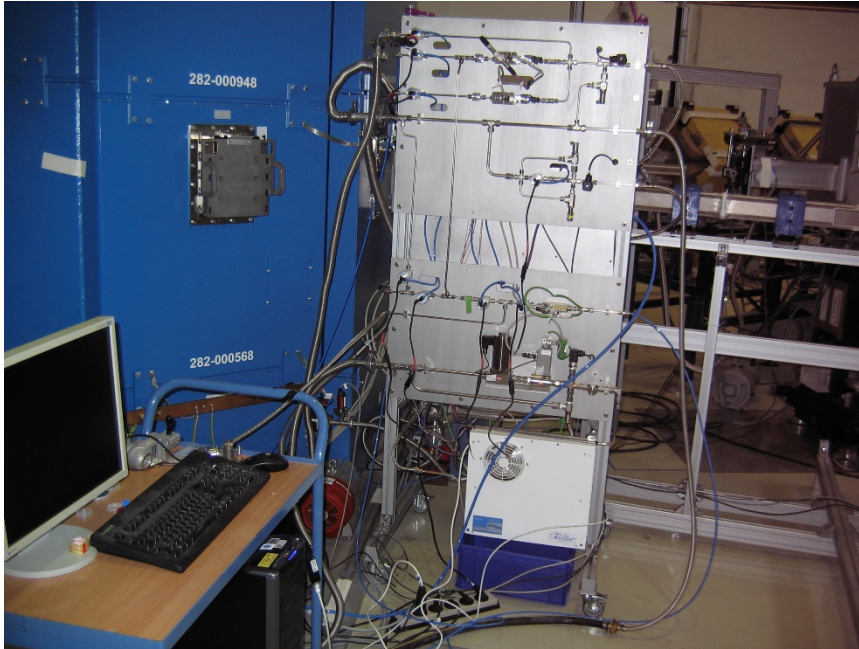- Main Cabinet: Central Safety PLC + power distribution

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MOVABLE SHIELDING II
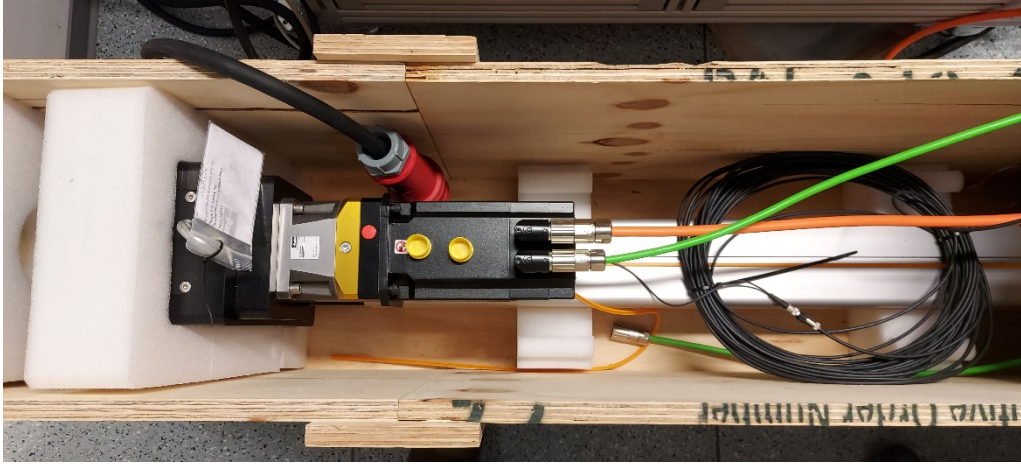
- Parker Electrocylinder: 56 kN, 2m range

- Incomplete PROFIdrive implementation by Parker

  $\Rightarrow$ Additional SW layer has to be implemented for the integration into the JCNS SW framework

- Movable in Lab via PLC + Profidrive

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METHANE MODERATOR



- Cold solid neutron moderator (methane, mesytilene,…): 10 K cryostat

- Devices: Flow controllers, vacuum devices, pressure controllers, valves, sensors,….

- Intermediate hardware solution (missing components)

- Intermediate SW solution: Windows/Labview (phd thesis)

- Schematics for final cabinet ready, most components arrived

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REFLECTOMETER HERMES
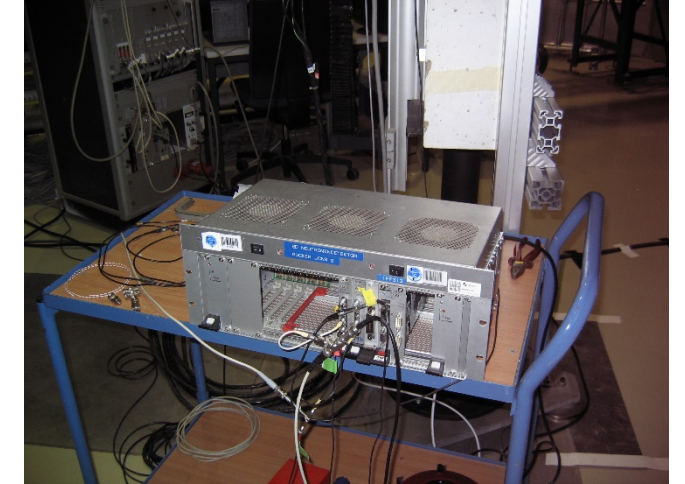
- Detector readout with JCNS electronics works (NICOS/TANGO)

- Successful NICOS tests of LLB motion electronics in lab

- Did not work at HERMES due to problems with GPIB devices

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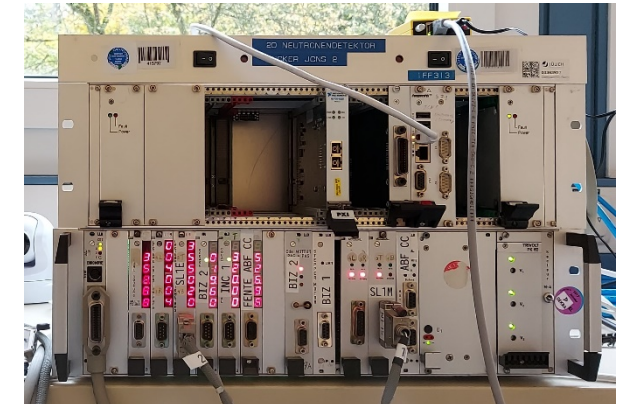
FUTURE ACTIVITIES

- **Cooling system:** Test with real target after leak repair

- **Movable shielding door:** Installation and commissioning in March 2023

- **PPS-System:** Installation in March + April 2023, commissioning until July 2023

- **Target Exchanger:** Parker servo controllers in June? Installation in July. Commissioning in August

- **Target Diagnostics:** Not yet existing

- **Methane Moderator:** Replace intermediate components, replace Labview/Windows by NICOS/TANGO/Linux

- **LH2 Moderator:** Components for intermediate system available?

- **TOAD:** Conversion to NICOS + TANGO

- **HERMES:** Solve GPIB problems + tests with NICOS

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