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Adaptable control system for the photon beamlines at the European XFEL: Integrating new devices and technologies for advanced research

European XFEL

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INTRODUCTION

The European XFEL is an X-ray free-electron laser (FEL) [1] that provides seven scientific instruments with highly intense X-ray flashes ranging from the soft to the hard X-ray regime. The dimension of the beam transport and the technologies used to make this X-ray FEL unique have led to the design and buildup of a challenging and adaptable control system based on a programmable logic controller (PLC). Six years of user operation have required constant development of the beam transport to provide new features and improvements for the scientific community to perform their research activities. In 2022, a new distribution mirror [2] was installed in the SASE3 beam transport system to provide photon beams to the seventh and latest scientific instrument, Soft X-ray Port (SXP) [3]. The integration of the distribution mirror in the actual control system is described.
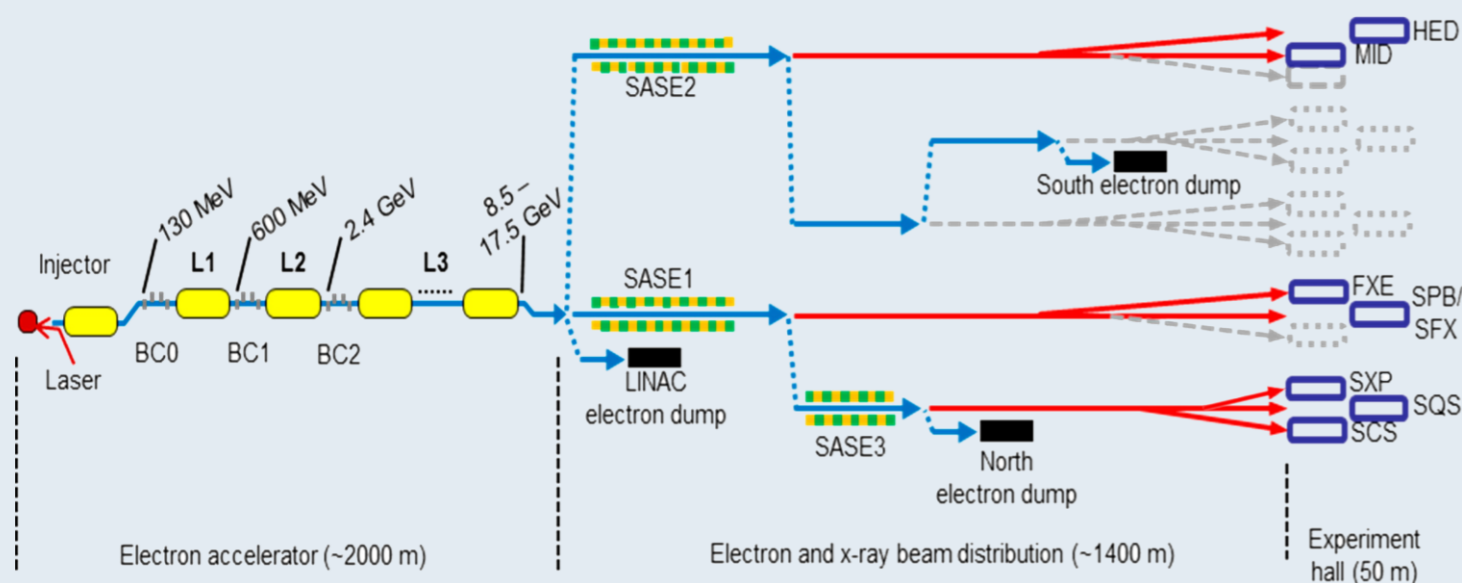

Figure 1: Layout of the European XFEL.

CONTEXT

Integration of a new distribution mirror chamber, Chambers for HOrizontal Mirror (CHOM), into the control system.
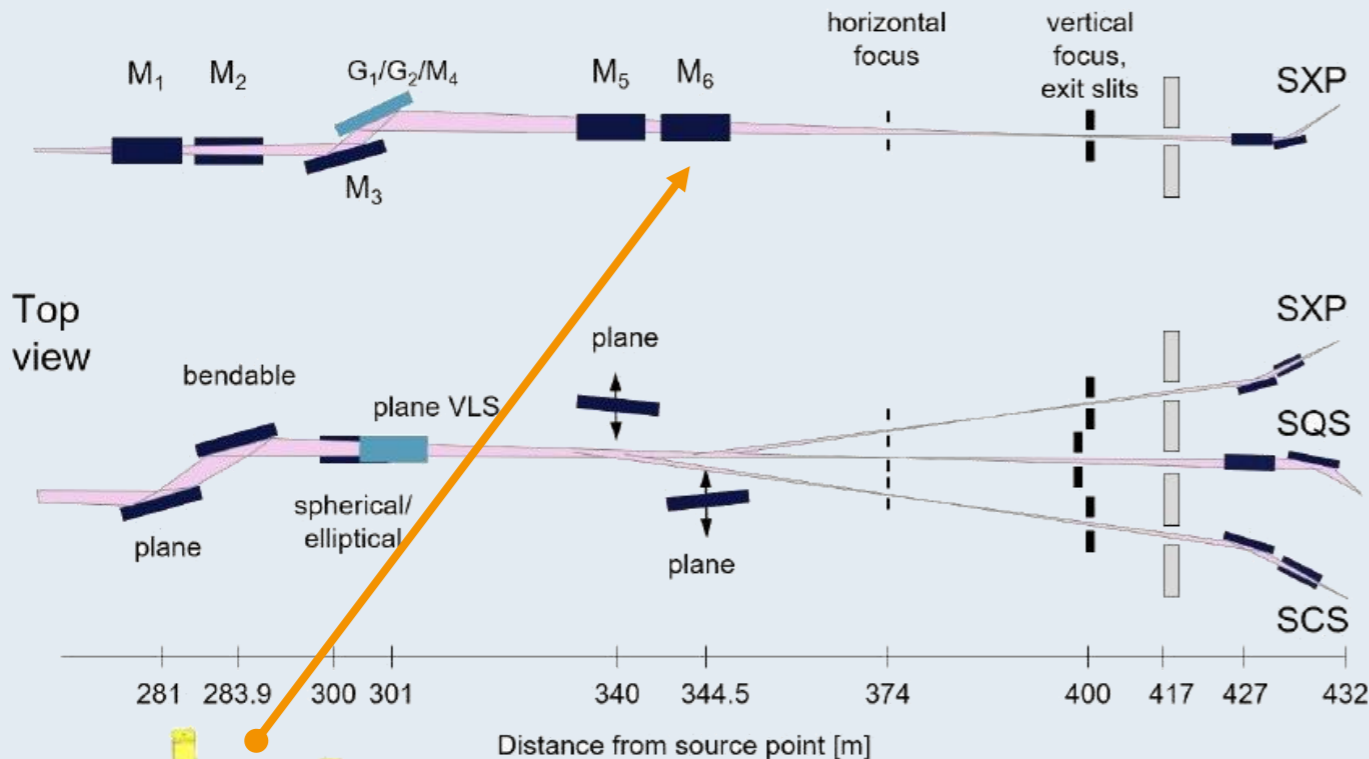

Figure 2: Side and top view sketch of the SASE3 X-Ray transport system.

Figure 3: 3D representation of the mirror chamber (CHOM)

Technical specifications

- Vacuum
  - Ion pump 300 l/s
  - Pirani gauge
  - Cold cathode gauge
- Motion
  - Five 2-phase stepper motors with 200 steps per 360°
  - Absolute encoder with synchronous serial interface (12-bit)
  - two Piezo actuators
- Others
  - Camera
  - Viewport light
  - Two magnetic safety switches

M6 CHOM INTEGRATION IN SA3 CONTROL SYSTEM

- **Design and documentation**
  - Electrical Diagram
  - Export file (XML) with PLC configuration
  - Project data setting
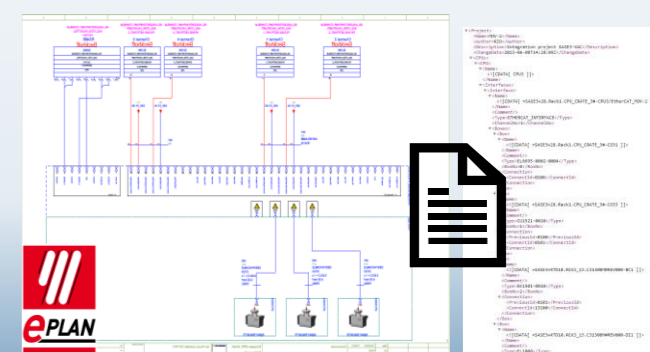 - Interlock definition

Figure 4: M6 CHOM documentation.

- **Automatic PLC project generation**
  - Four inputs
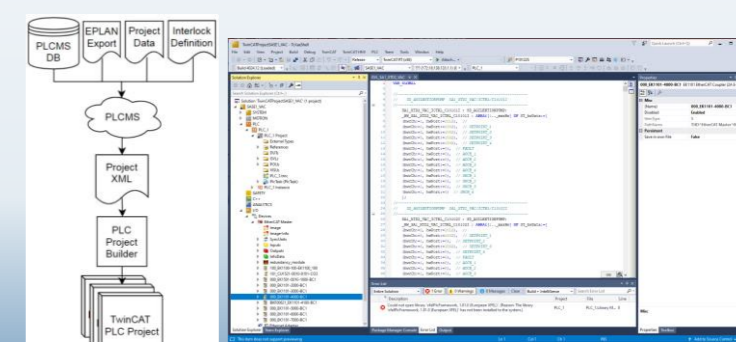 - PLCMS [4]
  - Project builder

Figure 5: PLCMS architecture / TwinCAT project

- **Hardware integration**
  - Adaptable local PLC crate
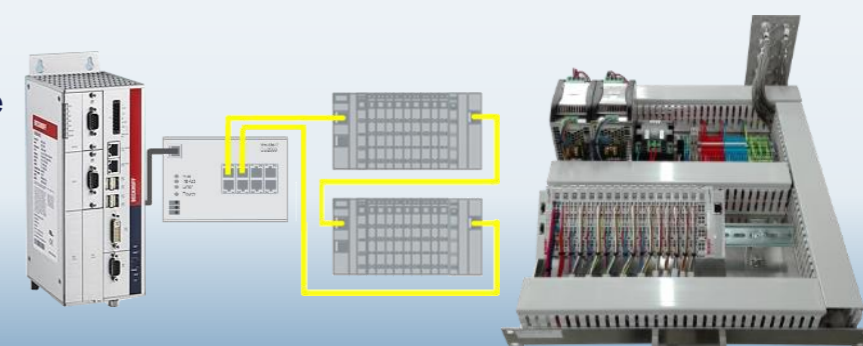 - Ring topology
  - EtherCAT protocol
  - Redundancy

Figure 6: Master PLC and local PLC crate

- **SCADA (Karabo)[5]**
  - Central message broker
  - In-house system
  - Distributed control system
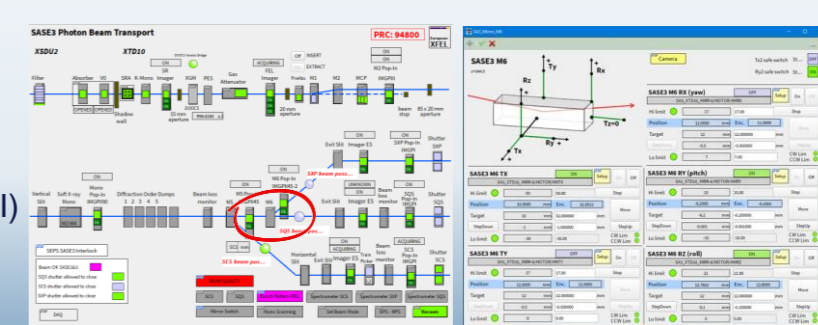 - Graphical User Interface (GUI)

Figure 7: M6 CHOM integration in Karabo

Conclusion

- **Standardisation** in many aspects plays a crucial role in large control systems.
- **Collaboration** is essential for adapting the control system, as it involves many competencies.
- **Coordination** is central to integrating new devices into the control system.

Summary

European XFEL has an adaptable control system through various innovative tools and concepts, including the PCLMS and the PLC framework. **The standardisation** of software, hardware and procedures, enabling the management of an expanding and dynamic control system for the photon beam transport. The current control system demonstrates its capacity to integrate new devices and cutting-edge technologies to meet the demand for advanced research.

References

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[5] Steffen Hauf, "The Karabo distributed control system", Journal of synchrotron radiation,

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