The Superconducting Undulator Control System for the European XFEL

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Abstract

The European XFEL development program includes the implementation of an afterburner based on superconducting undulator (SCU) technology for the SASE 2 hard X-ray permanent-magnet undulator (PMU) system. The design and production of the first SCU prototype, called PRE -SerieS prOtotype (S-PRESSO) will be manufactured by Bilfinger Noell GmbH, characterized, and installed at the European XFEL facility. The architecture and conceptual design of the S-PRESSO control system, which is currently underway, is based on the Beckhoff automation solution using the TwinCAT Programmable Logic Controller (PLC) development environment. The results are presented in this contribution.

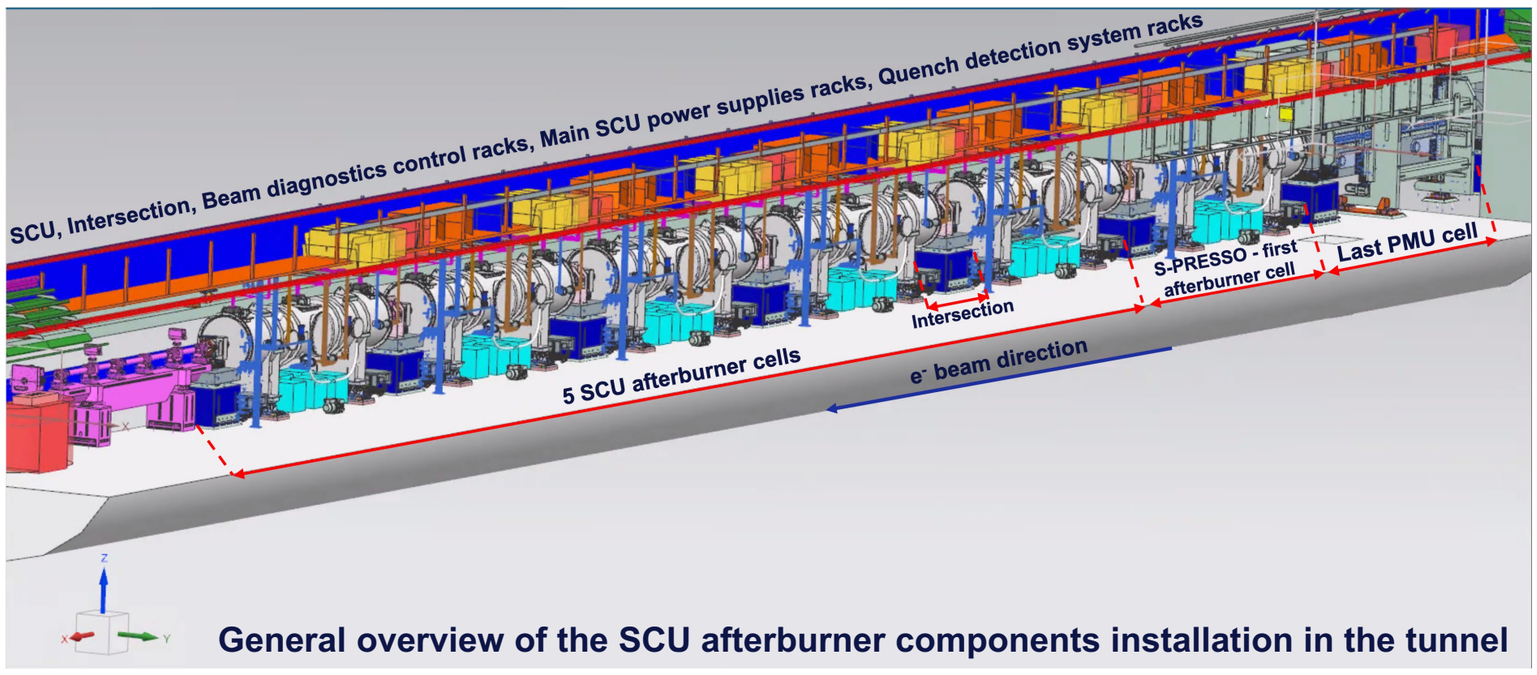
Motivation

Comparison PMUs, CPMUs, and SCUs, S. Casalbuoni et al., Front. Phys. Sec. Interdisciplinary Physics Volume 11 - 2023

- Why superconducting undulators?
  - Higher peak field on axis for the same gap and period length in operation
  - SCUs have 3 times larger K with respect to PMUs for the same period and vacuum gap
  - Further advantage is radiation hardness widely demonstrated for NbTi magnets (i.e. HERA, Tevatron, LHC)

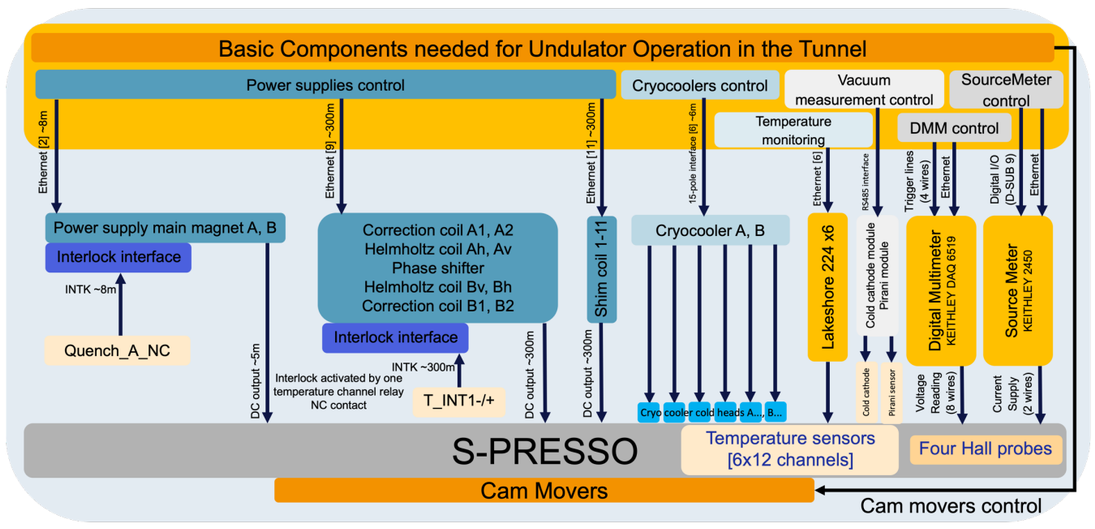
S-PRESSO design key parameters

Parameter	Value	Unit
Period length λ_U	18	mm
Max. magnetic field	1.82	T
K value	3.1	
Vacuum gap	5	mm

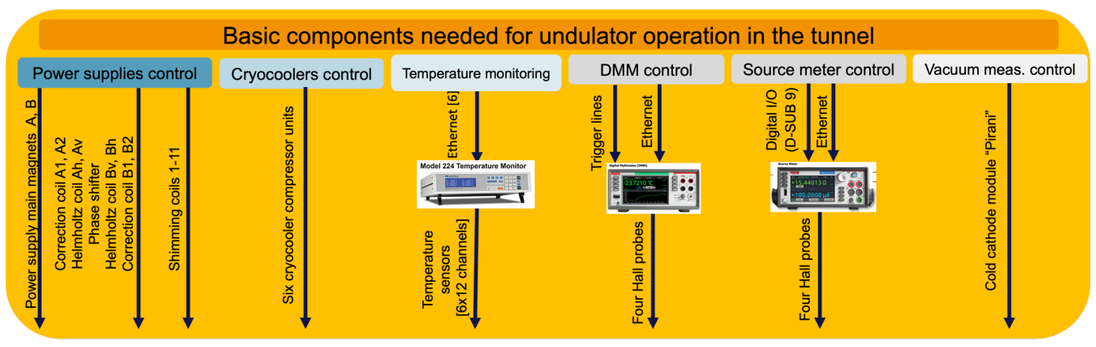


General overview of the SCU afterburner components installation in the tunnel

Simplified diagram of the S-PRESSO local control system

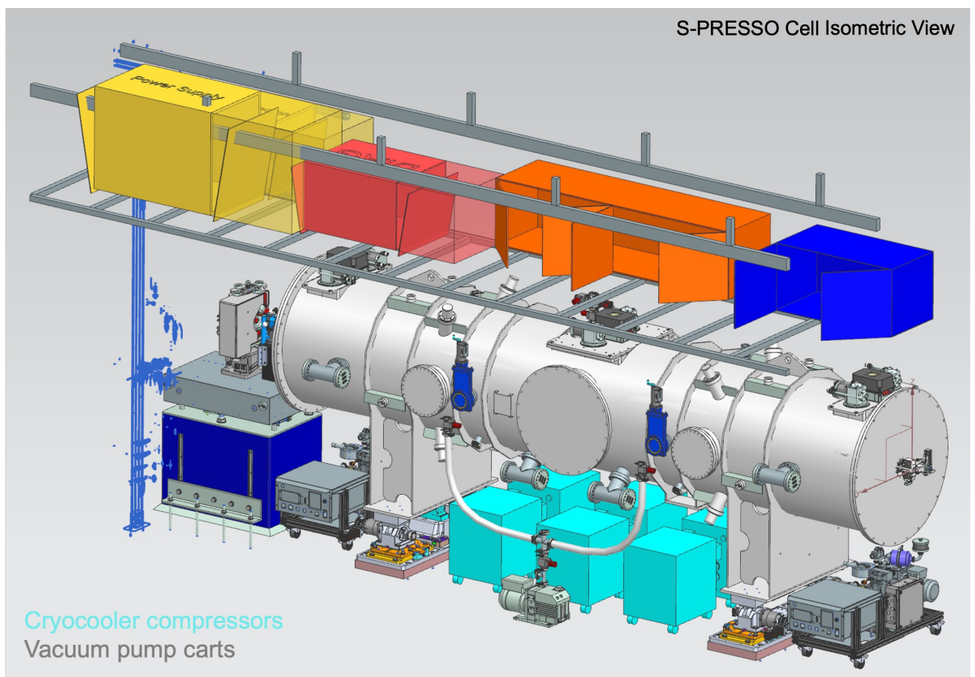


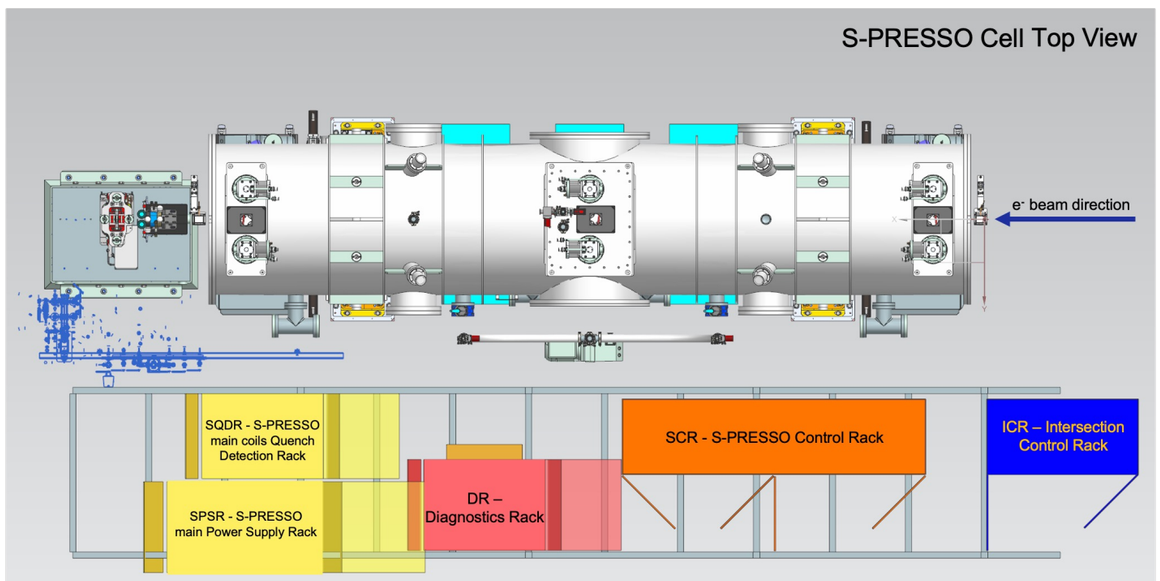
Schematic view of the S-PRESSO control rack (SCR)



The following control racks will be involved in the operation of the S-PRESSO cell:

- S-PRESSO main coils Quench Detection Rack (SQDR)
- S-PRESSO main Power Supply Rack (SPSR)
- Diagnostic rack (DR)
- S-PRESSO Control Rack (SCR)
- Diagnostics Control Rack (DCR)





Overview of the S-PRESSO installation in the tunnel

Summary/Outlook

- The conceptual design as well as the software and hardware architecture layout of the local and global control systems of the SCU afterburner project are currently being finalised.
- As an outcome, the S-PRESSO control rack (SCR) is designed by Beckhoff Automation GmbH in collaboration with Bilfinger Noell GmbH and the European XFEL GmbH.
- The same type of Intersection components as for the existing undulator system will be used for the SCU afterburner project including their control system, which will be integrated into the SCU local control system.
- The control system is designed based on more than six years of experience operating the existing undulator systems, planning the smooth integration of the first SCU module, S-PRESSO, during the regular maintenance period without interruption of the facility operation.
- During the approximately six-month shutdown period, which is scheduled for 2025, the necessary infrastructure for the SCU afterburner project is planned to be installed in the tunnel.

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