

Safety at HL-LHC IT String during construction, commissioning, and operation

Thu-Po-3.2

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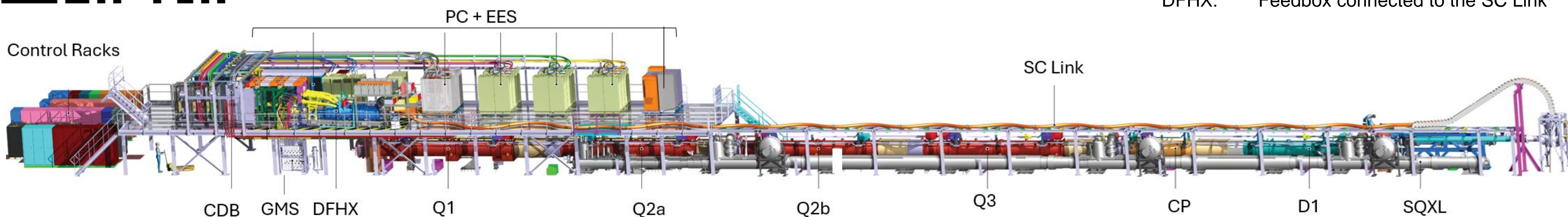
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TAKE A VIRTUAL TOUR

HL-LHC INNER TRIPLET STRING FACILITY

- PC: Power Converter
- EES: Energy Extraction System
- CDB: Circuit Disconnecter Boxes
- SQXL: Cryogenic Distribution Line
- GMS: Gas Management System
- SC Link: Superconducting Link
- DFHX: Feedbox connected to the SC Link

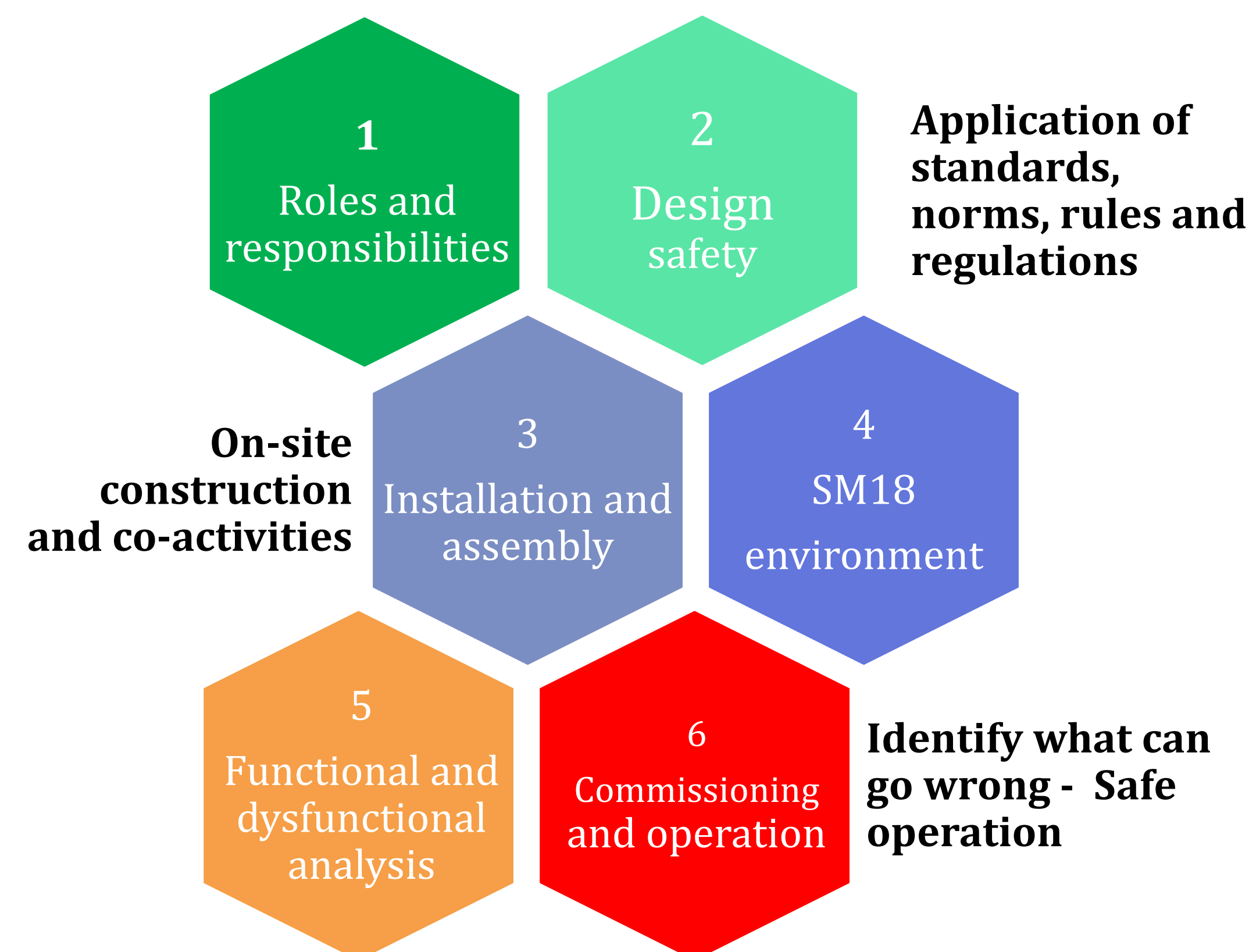


In May 2024, the cryogenic and the warm powering systems' installation have been completed and the individual tests successfully and safely executed.

SAFETY COORDINATION DURING HL-LHC IT STRING LIFE CYCLE

Six main areas of coordination have been identified to coordinate the safety aspects during the HL-LHC IT String life cycle.

- Areas 1 and 2 are defining the roles and responsibilities in terms of safety and the aspects related to the design phase.
- Areas 3 and 4 address the safety aspects related to the construction phase by considering the SM18 environment.
- Areas 5 and 6 are dedicated to the safety aspects related to the commissioning and operation includes the system and equipment functional and dysfunctional analysis.



DESIGN SAFETY

Table 1. List of SSA, Master SSA and Safety report documents.

System/Equipment/complex assembly	Document type
• Electrical Failure Modes of the Inner Triplet String Test Assembly in SM18	Safety report
• Test String in SM18	Master SSA
• Inner triplet and cold powering	Master SSA
• Inner Triplet Master	Master SSA
• Cold Powering	Master SSA
• Safety of Power Converters (PC)	SSA
• Q1-Q3 MQXFA	SSA
• Q2a-Q2b MQXFB	SSA
• D1 (MBXF)	SSA
• Corrector Package CP	SSA
• D1-DFX Connection Module (DCM)	SSA
• IT Cryogenics for Test String	SSA
• Full remote alignment system (FRAS)	SSA

- Individual system or equipment not fully conform with EU directives undergoes the so-called System Safety Assessment (SSA).
- For complex systems Master SSAs are conducted.
- A safety report identifies and assesses the combined electrical and cryogenic hazards related to the failure modes.

SAFETY DURING CONSTRUCTION



- The complexity of the HL-LHC IT String construction phase requires careful consideration of all safety aspects.
- safety of the personnel, as well as the safety protocols integrated in the applied procedures.
- The cryogenic distribution system has been successfully and safely installed and tested*
- Three successful cooldown tests to 1.9 K.

* Details on A. Onufrena oral presentation, *Commissioning of the cryogenic system of the HL-LHC Inner Triplet String test bench*, this conference.

SAFETY DURING COMMISSIONING AND OPERATION

- Aims at ensuring the safest commissioning and operation phases of the HL-LHC IT String in SM18.
- Three specific safety zones are defined by considering the risks of electrical failures and helium release.
- The **Forbidden** zone is an envelope of at least 50 cm distance from any cold powering.
- The **Controlled** zone is at least 1.5 m distance from any cold powering or warm powering equipment, implemented via an access-controlled and fenced spaces.
- The **Extended** zone is at least 5 m distance from any cold and warm powering equipment not accessible during the commissioning phases above a given quench energy level.

