Conventional Safety for HL-LHC

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Outline

- HL-LHC Safety Organisation
- HL-LHC Safety Documentation and Challenges for the Collaborations
- Highlights on 3 deliverables
- Summary

HL-LHC Safety Organisation

Safety actors in a project @CERN
A not exhaustive, but simplified overview

PL is responsible for Safety within their Project

Responsible for Safety of project deliverables under their responsibility

Responsibilities shall in no way replace the Safety responsibilities of the line management of the Departments involved
Safety responsibilities cannot be delegated

Project Correspondents (Conventional and RP)

HSE

Regulator for CERN

HL-LHC Safety Officers

- Since January 2022, the Project Safety Office is composed of two employed staff members who hold the functions of **Project Safety Officer (PSO) and Deputy (DPSO)**.

- For the closed, independent worksites, i.e. HL-LHC Point 1 and 5 worksites, safety is coordinated by an independent **Safety coordinator**.

- The Safety Organisation for HL-LHC is detailed in a specific document (EDMS 1313247).

HL-LHC Safety Documentation and Challenges for the Collaborations

HL-LHC Safety documentation

- **System Safety Assessment** (SSA):
  - **Description** of the system or equipment, its functions, characteristics and final location.
  - **Hazard inventory** and mitigations measure to control the hazards with standard best practises (SBP),
  - **Risk assessments** when mitigation measures are not fully covered by SBP
  - Based on the hazard list, a decision by the HSE unit if the system or equipment has **major safety implications (mSi)**.

- Other documents such as **Master SSA** for complex assemblies of equipment, **Safety Report** for complex risk assessment for assemblies of equipment.

Challenges for Collaboration
Conformity with EU standards

CERN Safety regulations generally request that equipment operated at CERN meets the Essential Health and Safety (ESH) Requirements laid down in **European Directives** on Consumer Products.

Deliverables from countries where other safety standards are legally applied, and where achieving conformity with EU regulations represents a **cost and schedule risk**.

Deliverables manufactured in universities or research institutes, including CERN, where **no internal structure** exists to attest formally the conformity with EU directives.

Deliverables with **advanced technologies** for which there are no provisions in the regulations.

Strategy to meet Essential Health and Safety requirements for equipment with no CE Marking

The HSE Unit will classify the equipment as

“major Safety implication” (mSI)

The HSE and the WP elaborates in collaboration a **list of safety checks** which must be met before the equipment can be used at CERN.

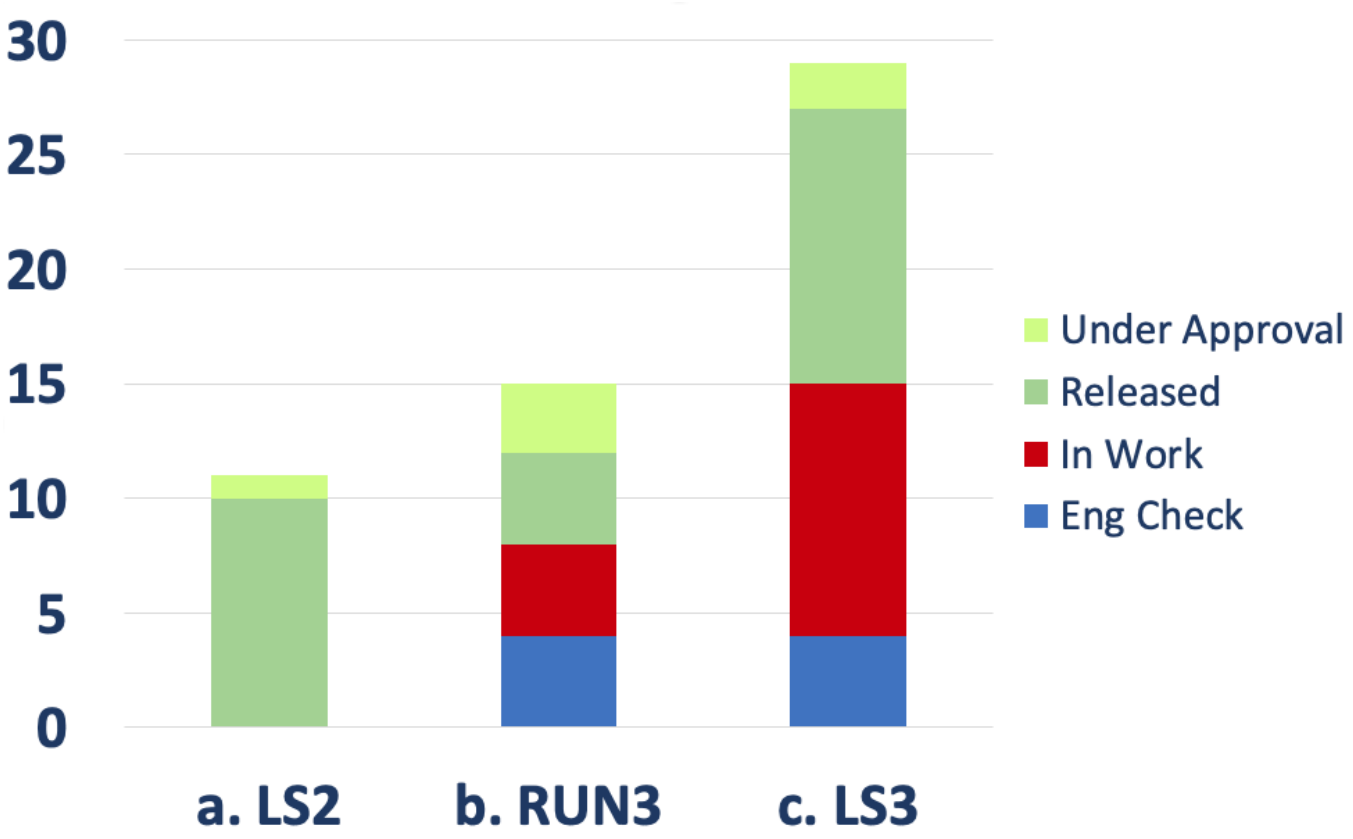
- In-situ verifications
- Documentation checks

Safety Authorisation Form

Gives authorisation to operate the equipment/system

Achievements

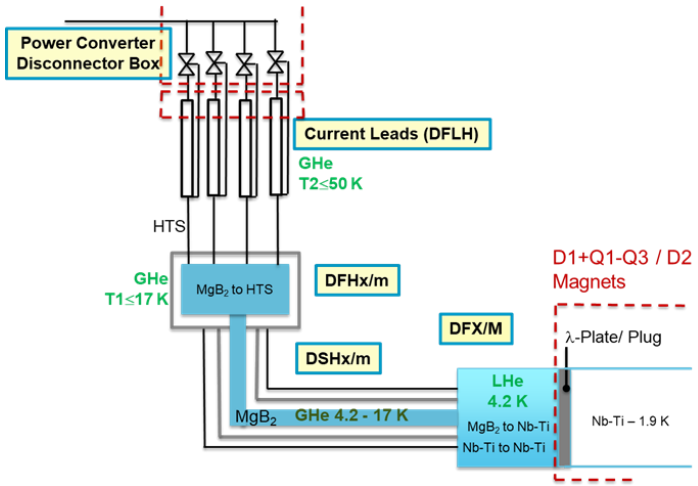
- All System Safety Assessments and Safety Reports for deliverables installed up to LS2 completed.



Highlights on 3 deliverables

WP6a: Cold Powering

Courtesy: T. Otto

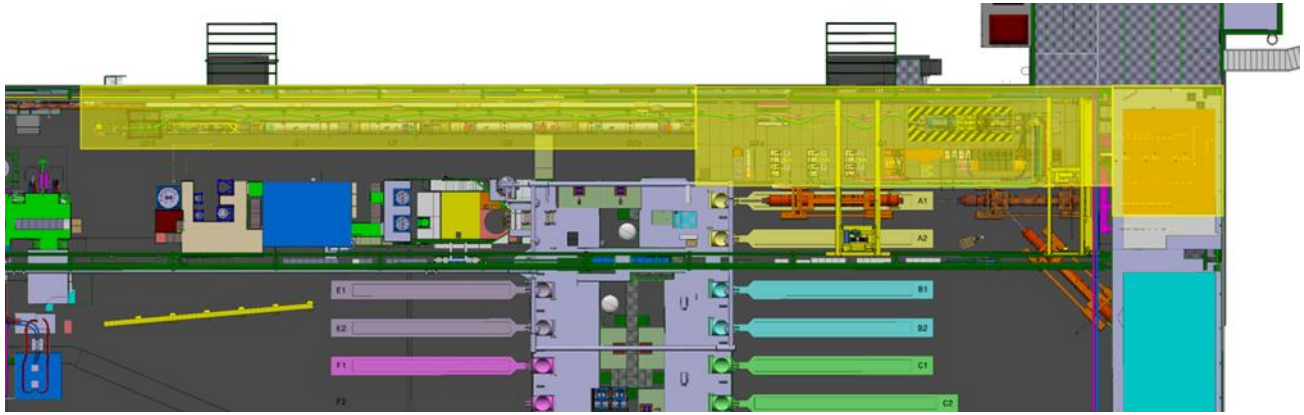


- HTS cables in SC Link transport current from HL-LHC to tunnel
- Cooled by 15 K gaseous He

- **Failure modes in the electrical circuits** focussing on QDS / QPS - Working group chaired by P. Cruikshank
  - **Most credible incident** (Probability ≈ $3 \cdot 10^{-6}$/year): electrical arc after a single QDS/QPS failure leading to helium release by the flap valves. Only local hazard, not enough He for ODH.
  - **Worst critical incident**: total failure of QDS+QPS. The electrical arc is powerful enough to pierce the outer cryostat and expose persons.
    - In SC Link, probability < $3 \cdot 10^{-7}$/year: protect SC link mechanically
    - In other components, only after total failure of QDS/QPS, prob. < 10^{-11}/year. « Broadly acceptable risk »

WP16: IT String

Courtesy: T. Otto



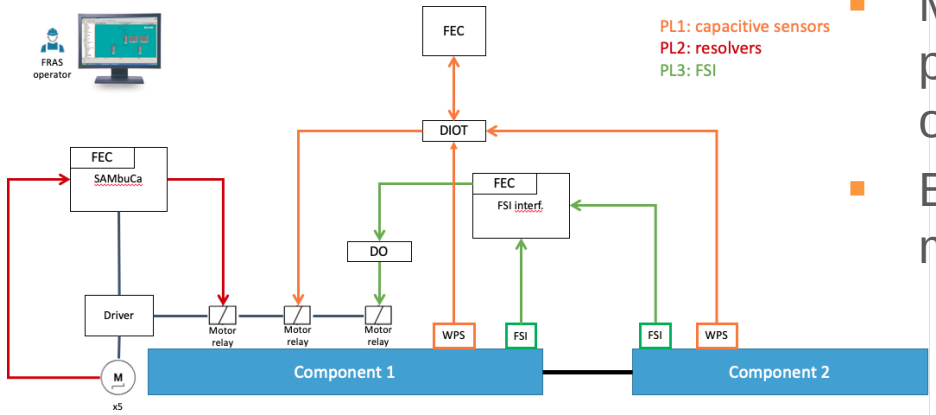
In Test hall SM18
(surface building)

- Probabilistic Safety assessment building upon WP6a
- MCI helium release flow estimated as $q \approx 2.3$ kg/s :
  - In the large SM18 hall this rate is considered safe:
    - Safety distance given by fence around IT String.
    - He inventory too low to cause ODH.
  - Protect SC link by a safety distance (50 cm) for electrical arcs.
  - Commission all circuits, including QDS/QPS, at low energy.

WP15.4: FRAS

Courtesy: M. Sosin, B. Adiego

- The **FRAS** will:
  - align simultaneously and remotely from the CERN Control Centre all the components from Q1 to Q5 on both sides of the Interaction Point within ± 2.5 mm,
  - move independently the components within the stroke of the corresponding bellows.
- **Risk analysis performed using FMEA**:
  - For personnel, Calibrated Risk graph from IEC 61511
  - For machine protection, risk matrix provided by TE-MPE
  - Risk reduction achieved by multiple protection layers according to IEC 61511



- Mechanical bellow protection: 3 layers of protection (position sensors and interlock on motor)
- Beam injection interlock in case of misalignment

Summary

End notes

- Safety assessments are on good track.

- Conformity / Standards
  - May be additional work to prove compliance.
  - We do our best to accommodate the requirements.
  - In case collaborations have questions or concerns, please let the WPL and Project Safety Officers know.

Thanks for you attention