1st Accelerators Technology Sector Workshop

Engineering Design Tools and Processes
Project Management Methodologies and Tools

Chair: Mike Lamont

Interconnecting knowledge, experience, methods, people & data to foster learning & collaboration

CERN

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Accelerators and Technology Sector

Managing physical configurations of CERN accelerators with Layout

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Introduction

CERN's infrastructure is constantly evolving over space and time

- Maintenance, renovations, upgrades, new facilities…
- From a simple local change (e.g., moving a crate) to complex long-term projects like HL-LHC or FCC, involving hundreds of experts from many diverse domains at CERN and beyond
- Major activities planned during intense and challenging stop periods (LS, EYETS) interleaved with run periods
- From design to operation phases, documenting the CERN physical configuration is essential
- Resulting cross-domain applications, analysis, understanding and coordination are indispensable to the decision-making process

What is Layout?

- A comprehensive centralised collaborative platform designed to manage the physical configuration of CERN facilities over time
- Aims to provide the unified, coherent and controlled source for functional positions and their layouts
- Answering questions: *"**What** is installed, **Where** and **When** and **Interacting/Interfacing with…**"*
- Initial development started in 2003, in EST/IC group, to facilitate installation and commissioning of LHC
- 21 years later, Layout supports the physical configuration over time, of:
  - Most CERN beam lines
  - Potentially, any infrastructure in underground and surface buildings
    - e.g. SM18 IT STRING

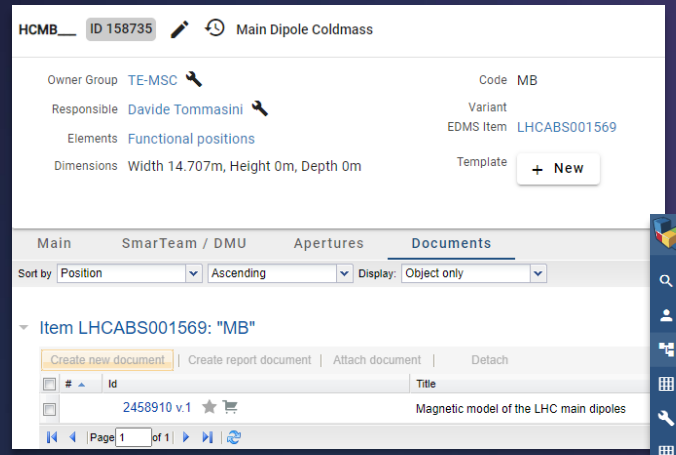
What can you do with Layout ?

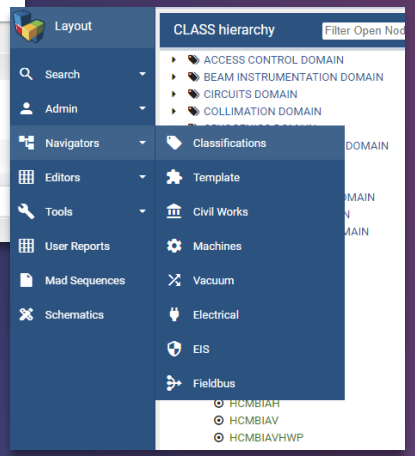
7 main concepts

1. Types & Classes

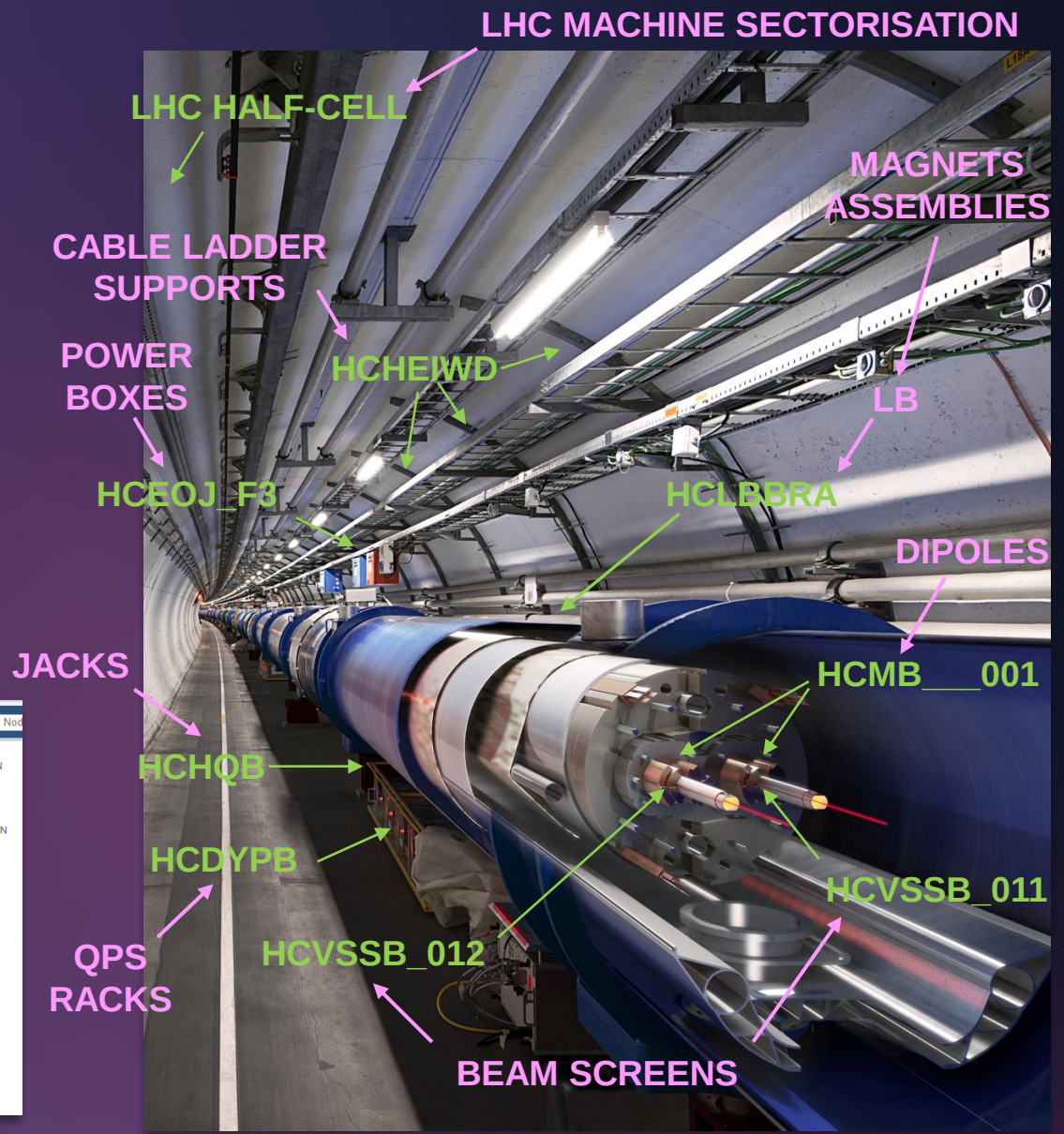
Defining a taxonomy of **functional position types**

- Identifying the **type** of components
  - Naming, description, dimensions, responsible
  - Uniquely mapped to
    - CERN Naming code
    - EDMS item → Access to EDMS document





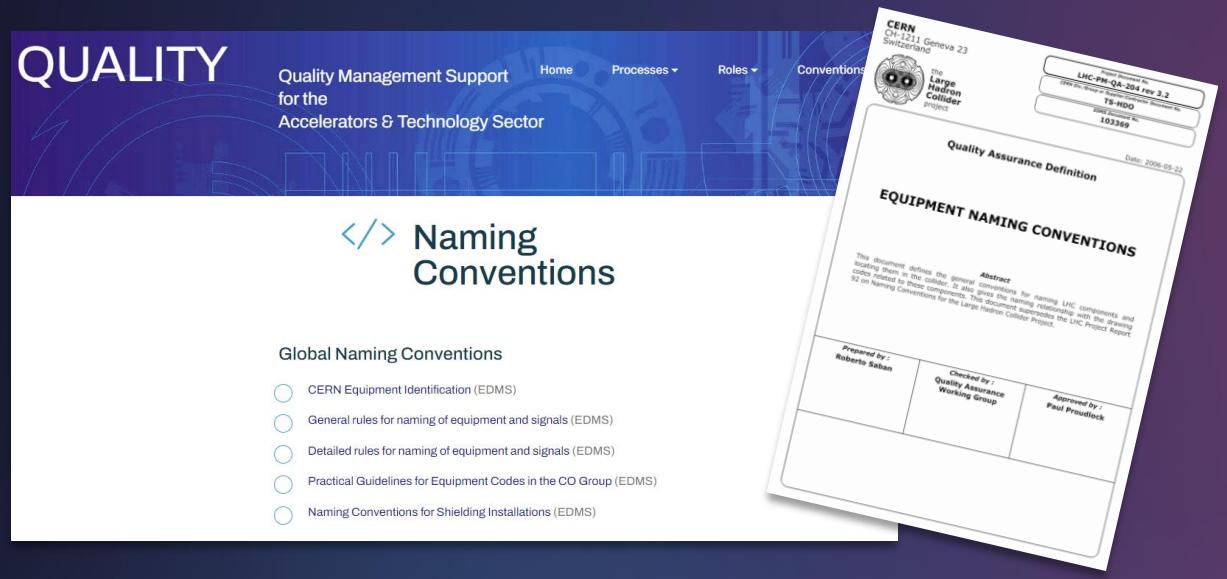
- Categorising the **types** by **classes**
  - organised by shared attributes
    - nature, function, usage

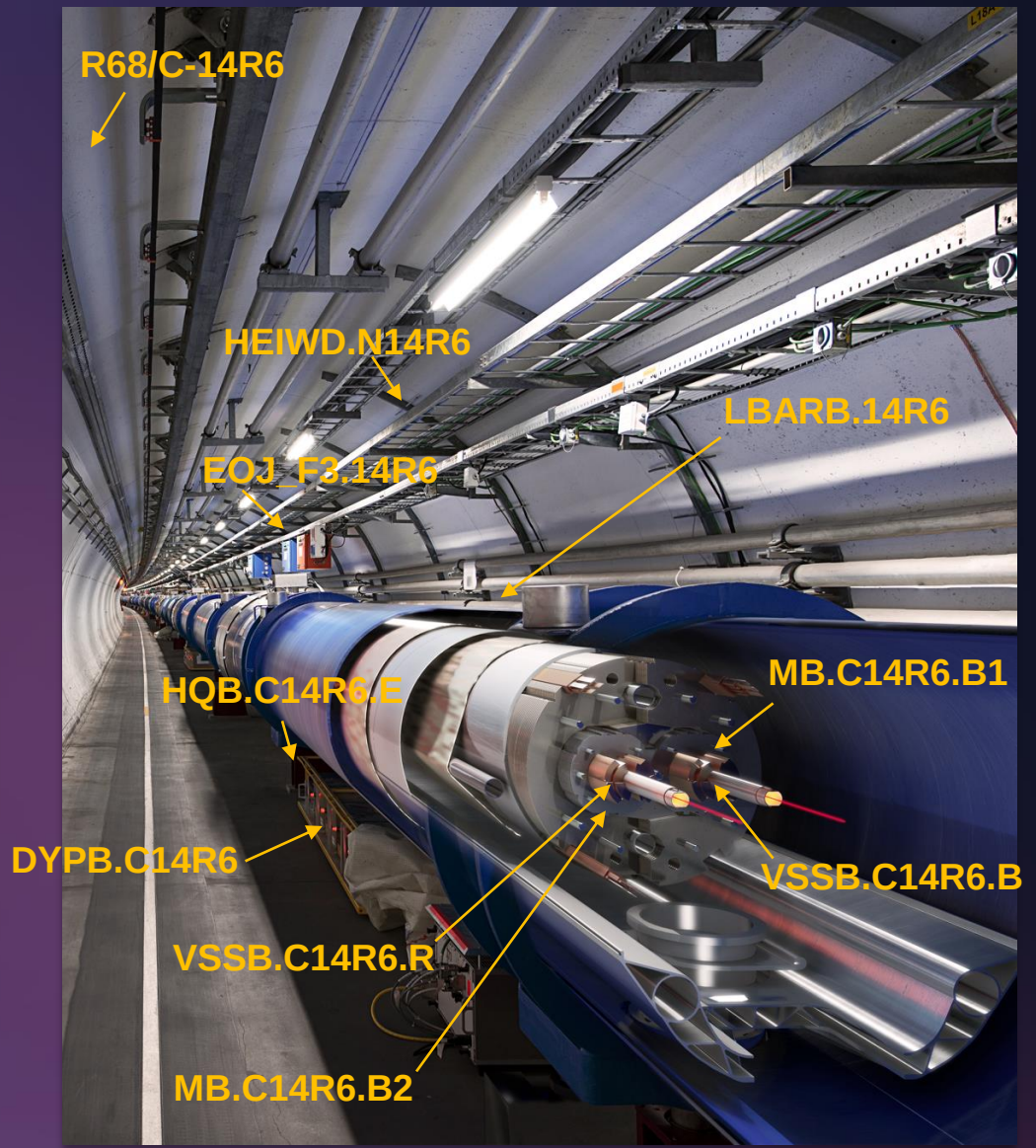


2. Functional positions

- Defining individual components as functional positions
  - Placeholder for a component (not assets)
  - Generally named according to its type and localisation/position

- Generated Layout names, mostly following naming conventions defined in the QA plan of each machine



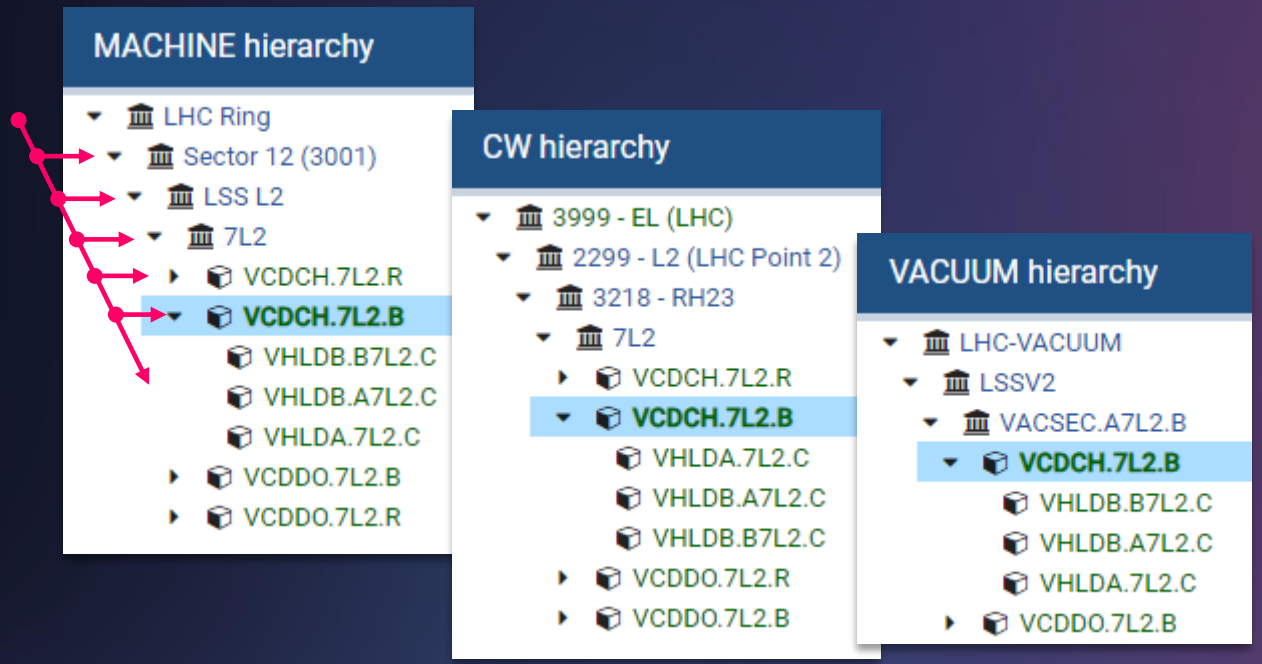


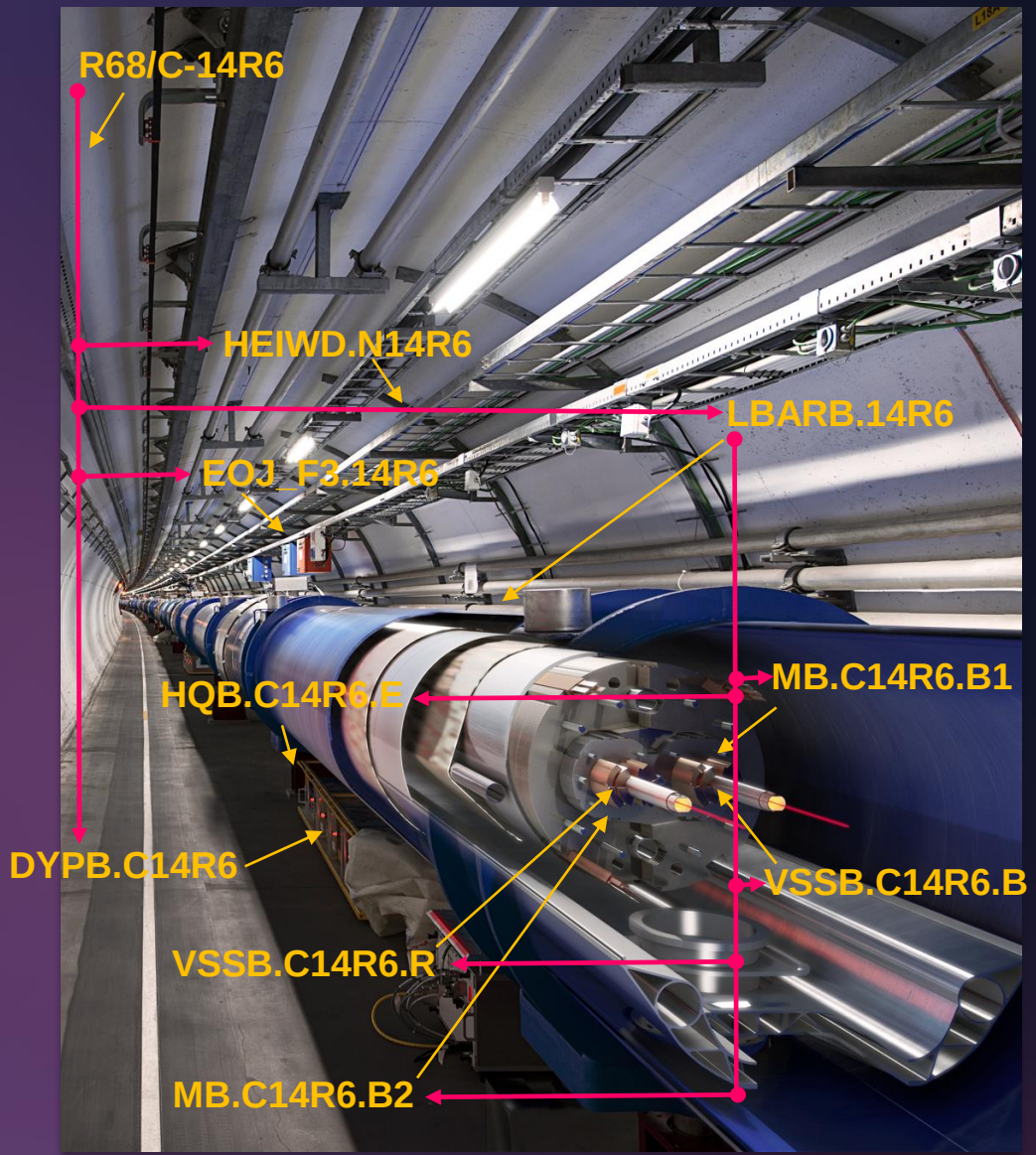
See talk of Giulia Romagnoli, "*Managing Beamline Configurations in the Experimental Areas*"

3. Assembly Breakdown Structures

- Organising functional positions as physical Assembly Breakdown Structures

- Several hierarchical structures superposed (like layers)
  - Machine, Civil work (CW), Vacuum, EIS chain

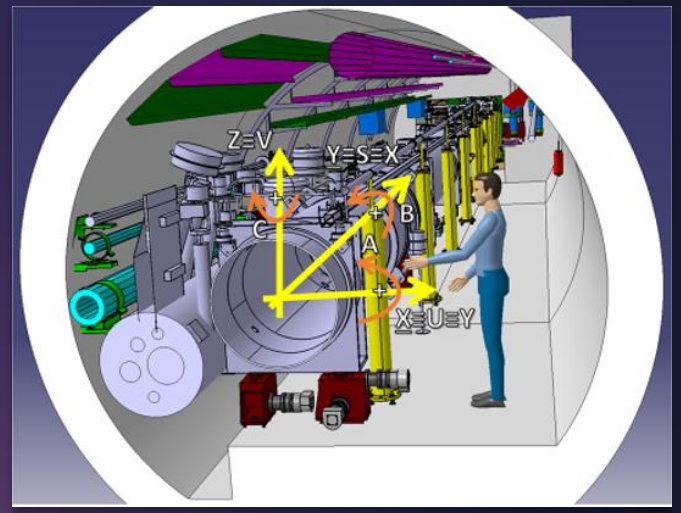


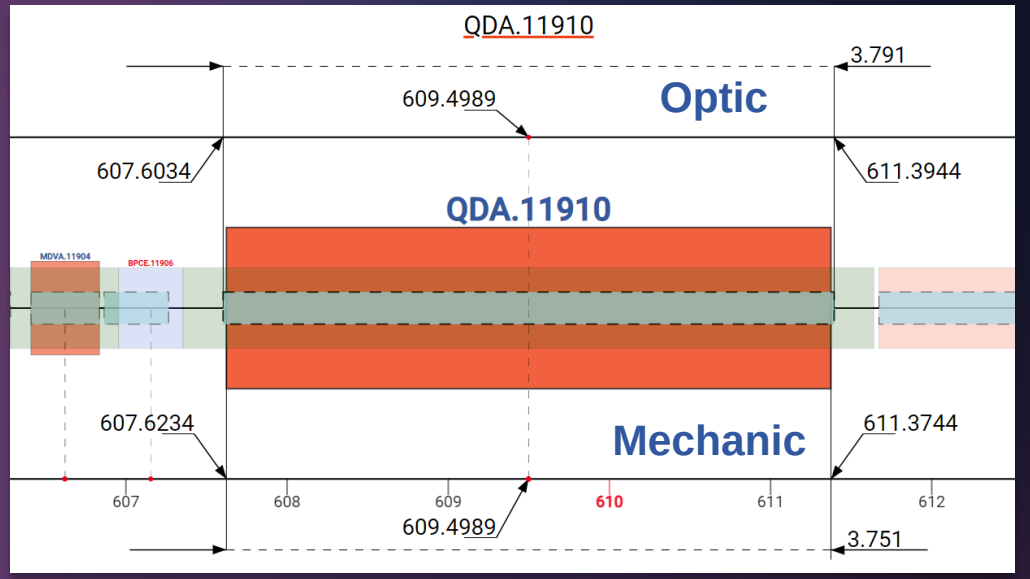


4. Positioning in machines

- A functional position is placed relative to its parent assembly using 3D transformations

- Using relative positions, we compute cumulated distances (DCUMs) and orientations of functional positions in the machine



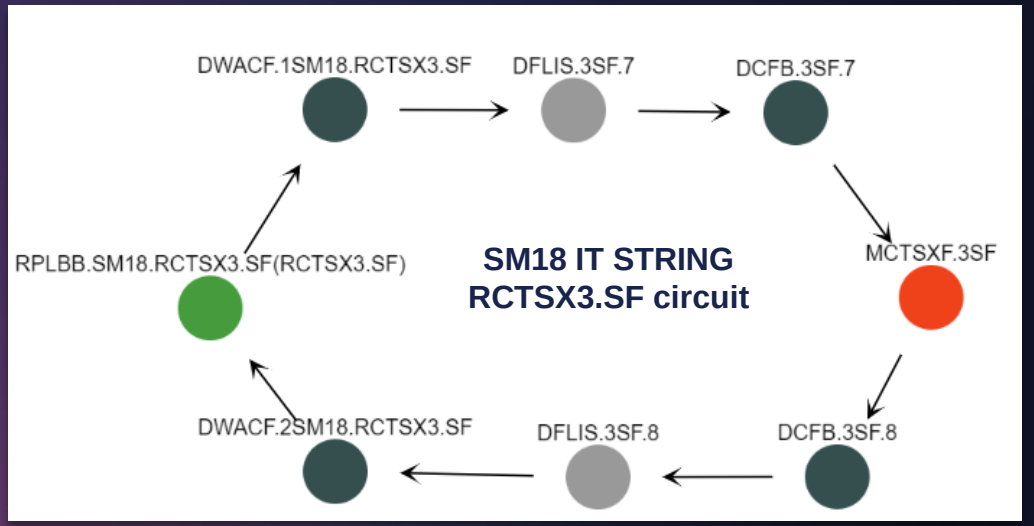


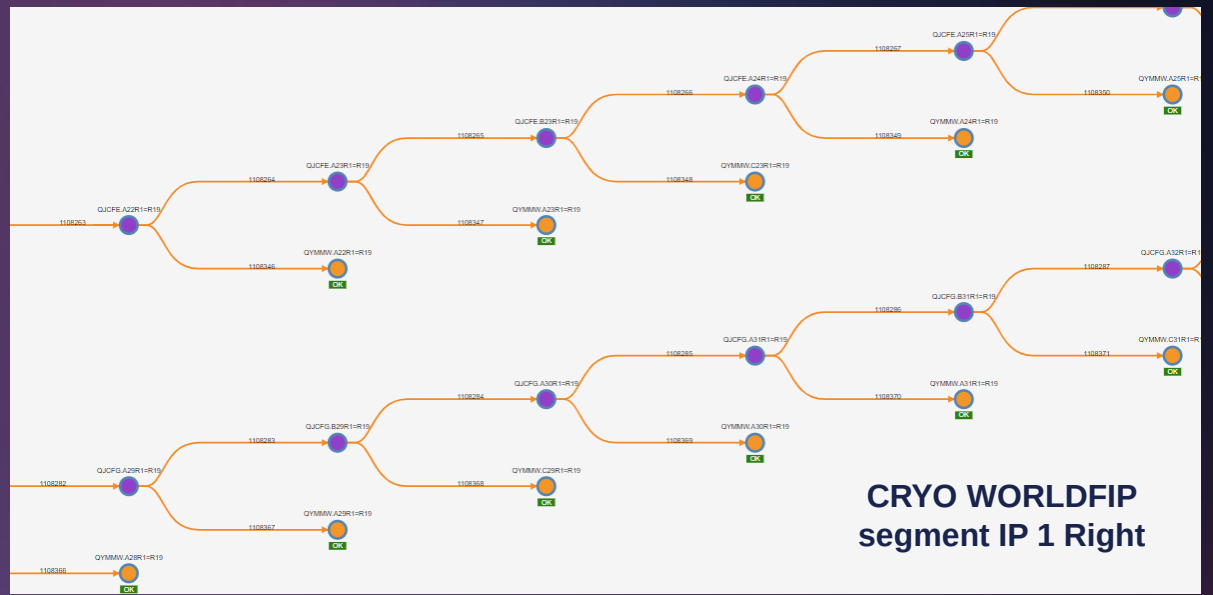
5. Connections & Circuits

- Defining logical or cabled connections from source to target functional positions

- Sets of connections associated to defined circuits
  - Powering circuits connecting power converters, warm & cold cables, current leads, magnets…

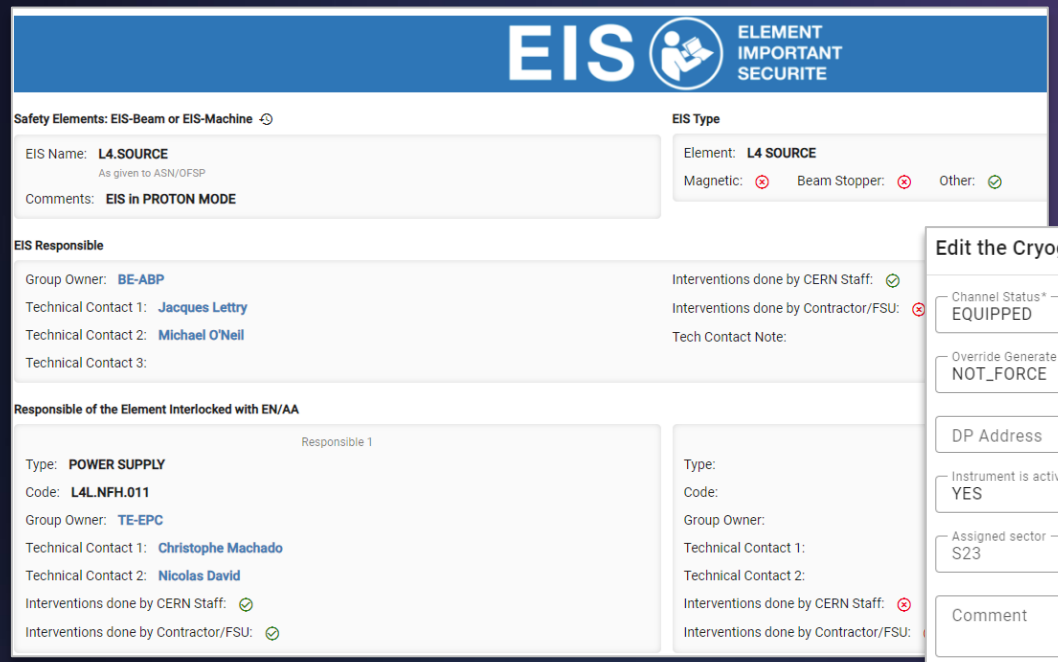
  - Control circuits: WorldFIP, Timing, White Rabbit, Cryogenic instrumentation…

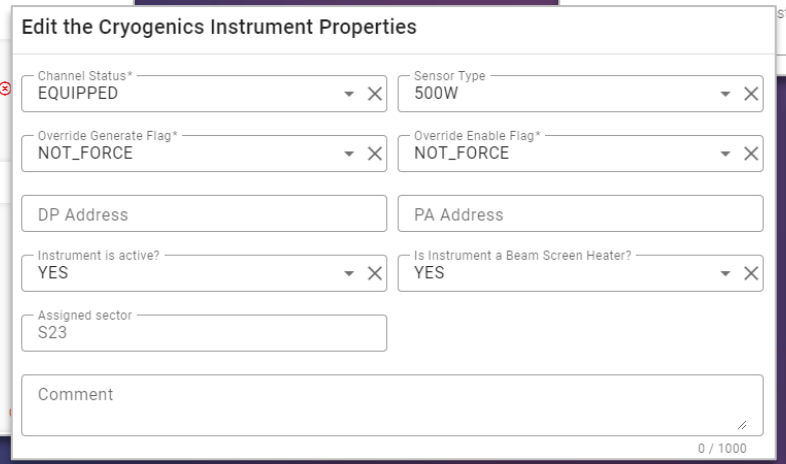


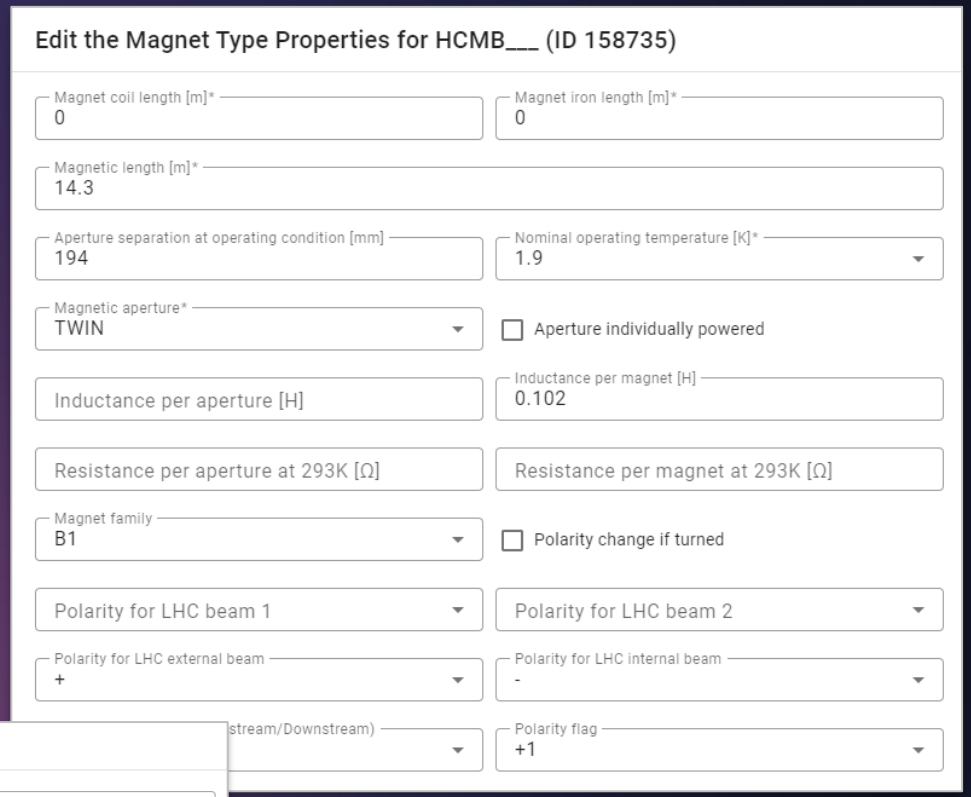


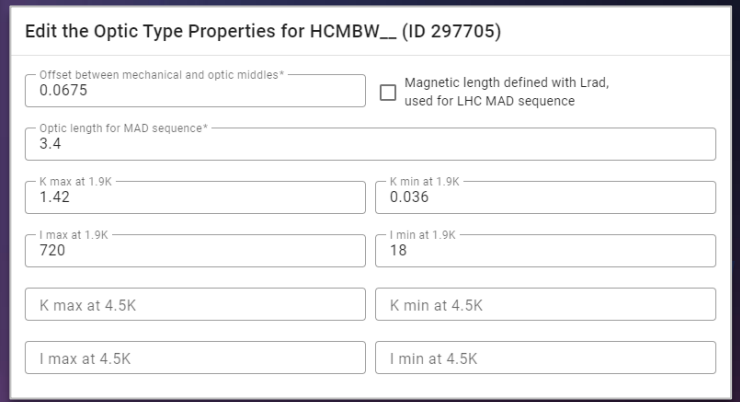
6. Domain specific data

- Defining domain specific data associated to types and functional positions
  - e.g. for Optic, Magnet, Vacuum, Aperture, Circuit, Power converter, BLM, Cryogenic instrumentation and EIS domains









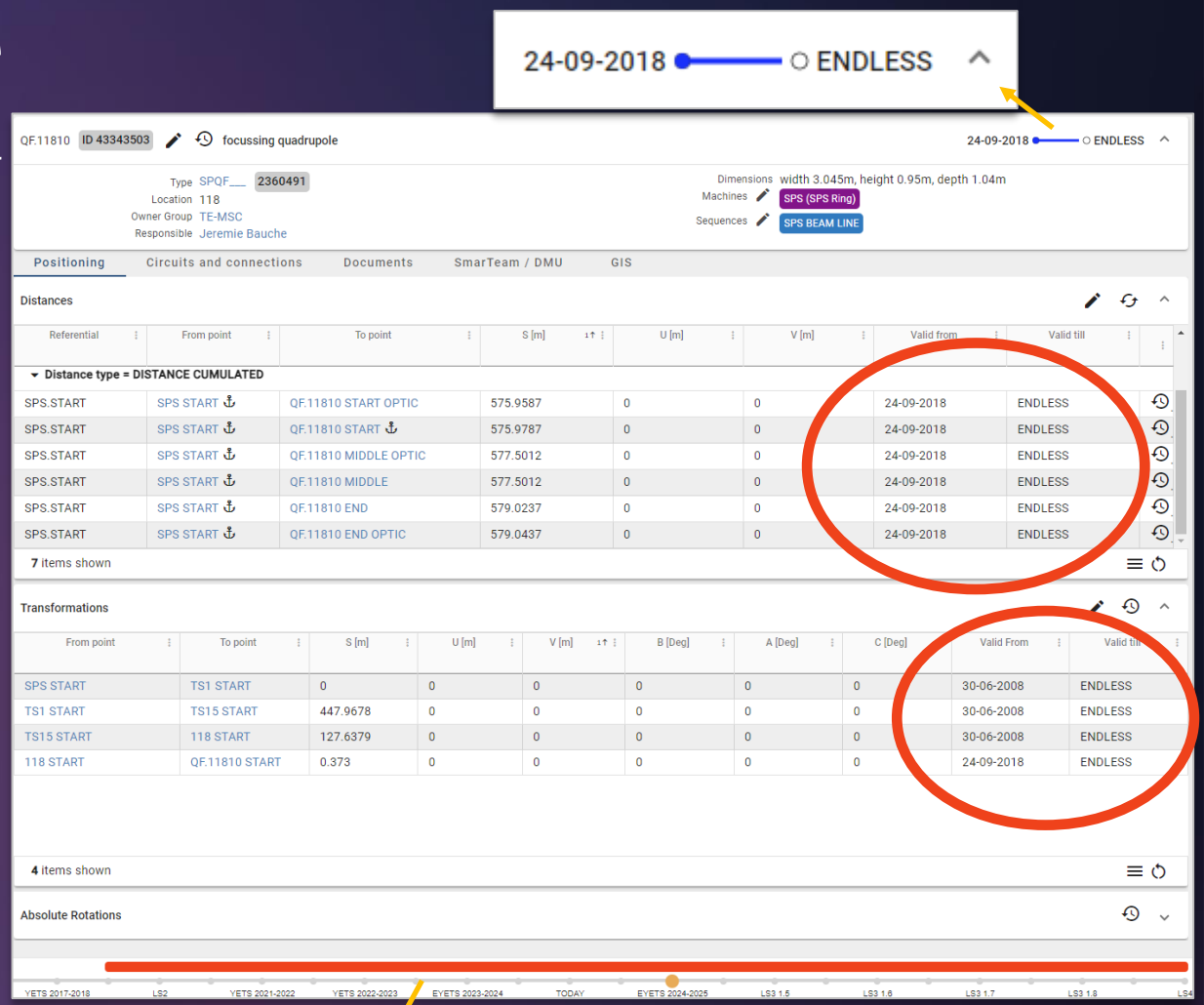
7. Managing data over time

- Functional positions and their relationships all have a Validity Period (lifetime)
  - physical breakdown structures, relative positions, distances, connections, etc.

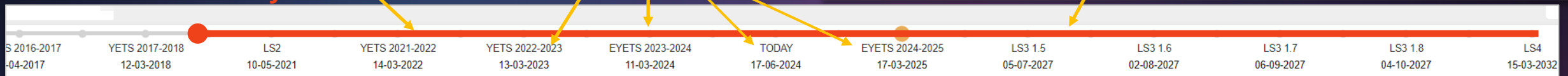
- A Layout **version** is a snapshot of the configuration at a specific date
  - Using end dates of shutdown periods (approx.) (YETS, EYETS, LS) + intermediate weekly dates

- Enabling continuous and consistent change management over time
  - Editing all versions included in the lifetime simultaneously

QF.11810's Validity Period
Start date/version <= lifetime < End date/version



Layout timeline

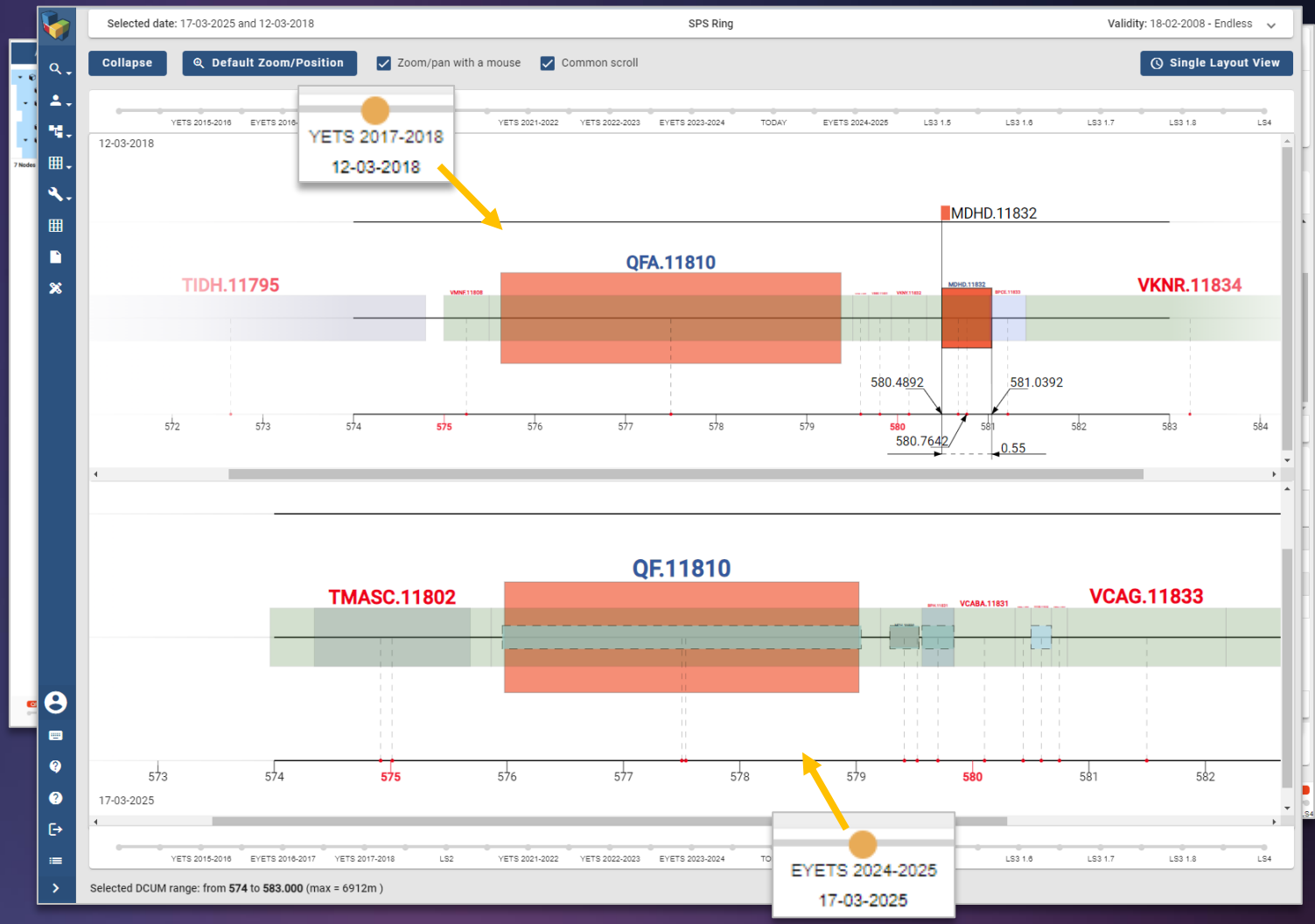


7. Managing data over time

From the Layout UI, users can seamlessly

- Navigate through the past, present, and futures layouts of the facilities
- Edit and clone certain layout data over time
- Compare two versions of a beam line configuration

SPS Chronological Layout Comparison

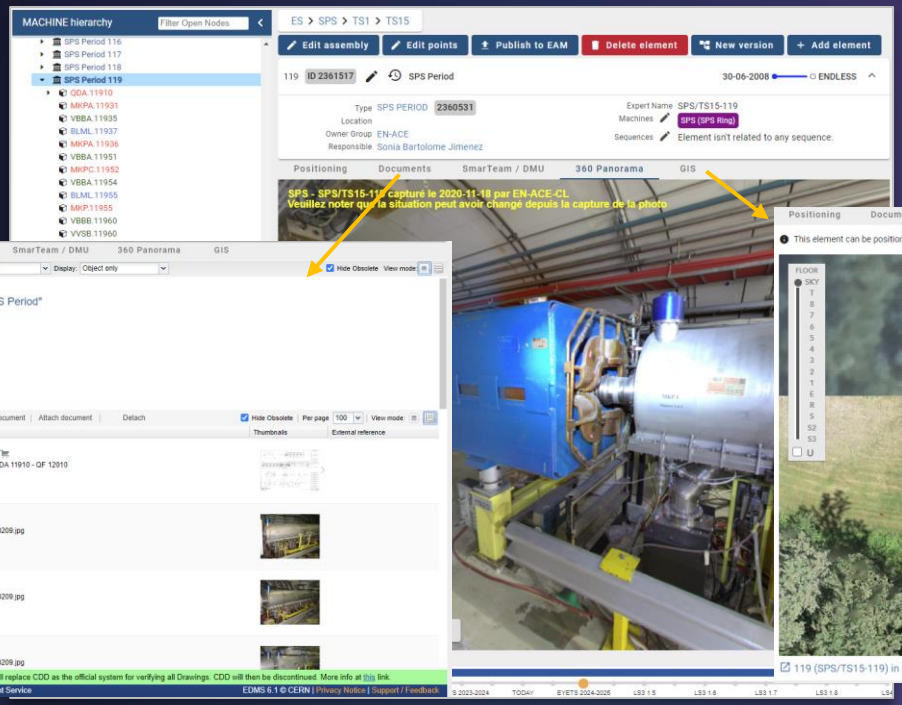


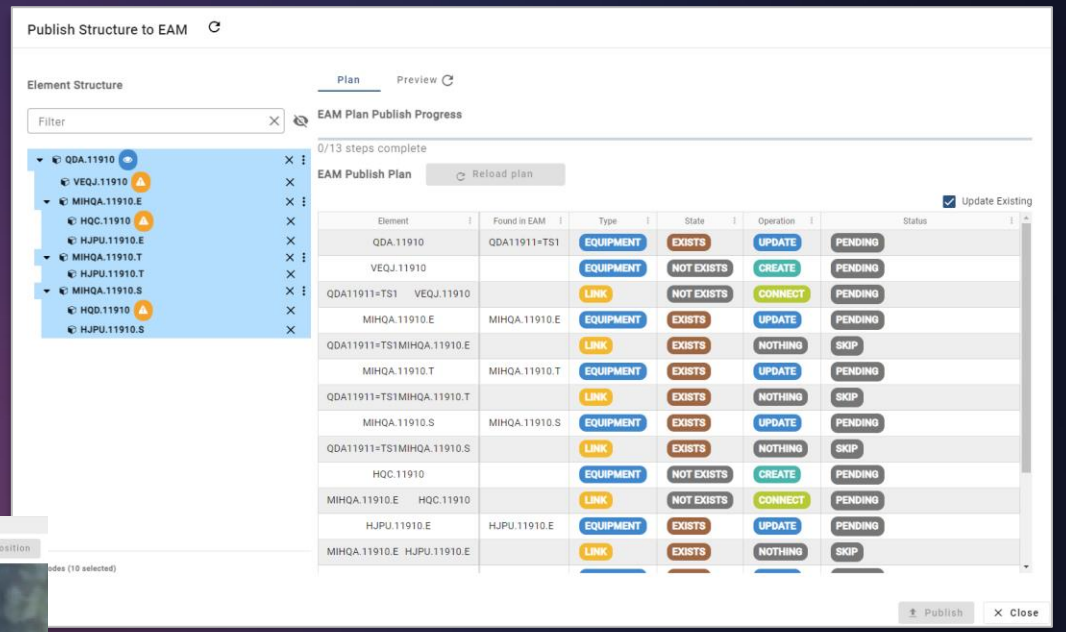
Layout Ecosystem

EAM, EDMS, Panorama, GIS integrated into Layout UI

- Publication from Layout to EAM
  - Functional positions, physical breakdown structures
  - Using EAM API (EN-IM)

- Panorama (EN-ACE), EDMS (EN-IM), GIS (SCE-SAM)



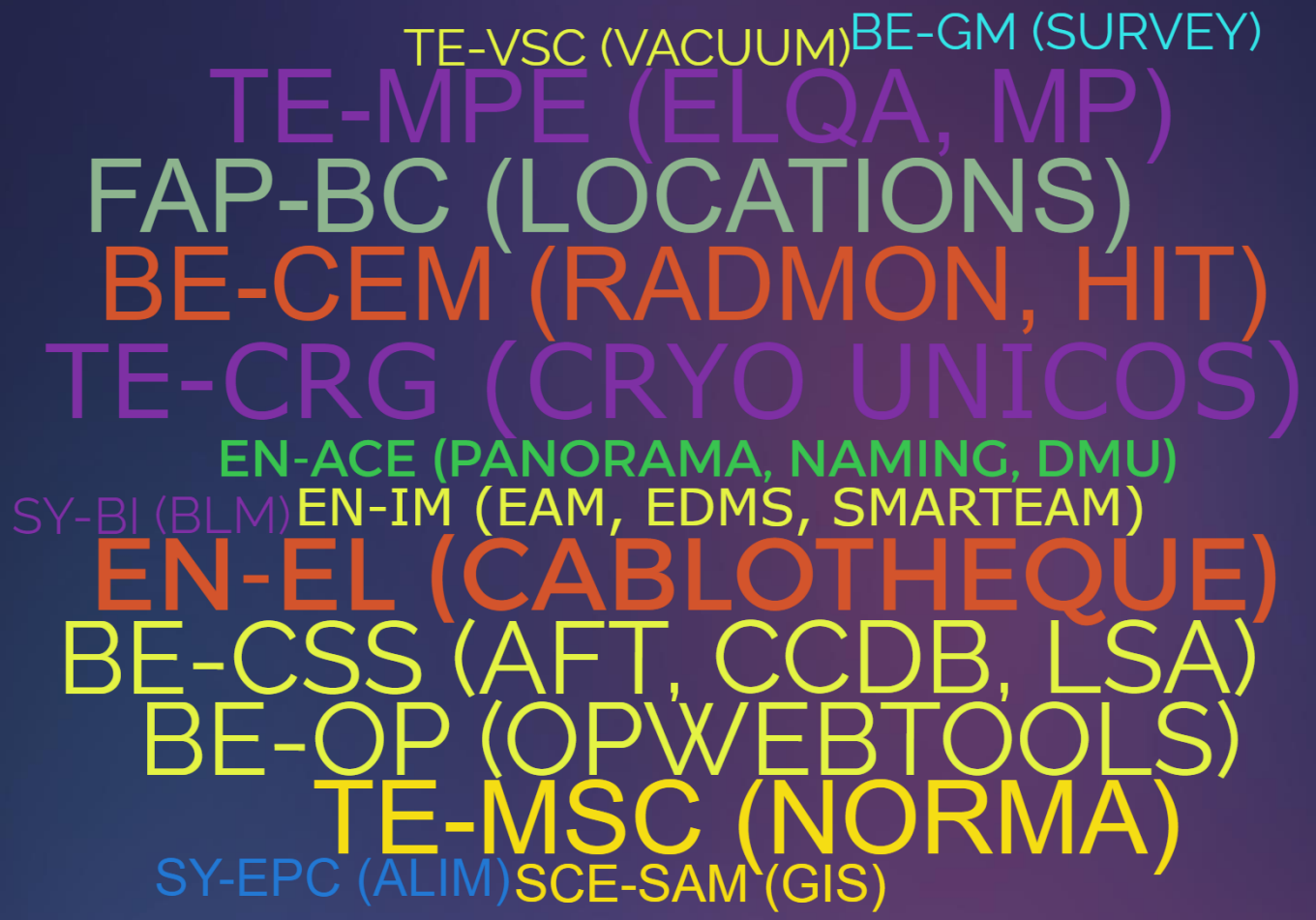


Linked to applications

- Controls Configuration (BE-CSS)
- Network.cern.ch (IT-PW)
- Normal Conducting Magnets (TE-MSC)
- Power converters DB (SY-EPC)

Interconnecting services, data

- Exchanging data with multiple groups, databases (40+ databases)



Collaborative layouts

From beam line to control electronics

(Simplified examples)

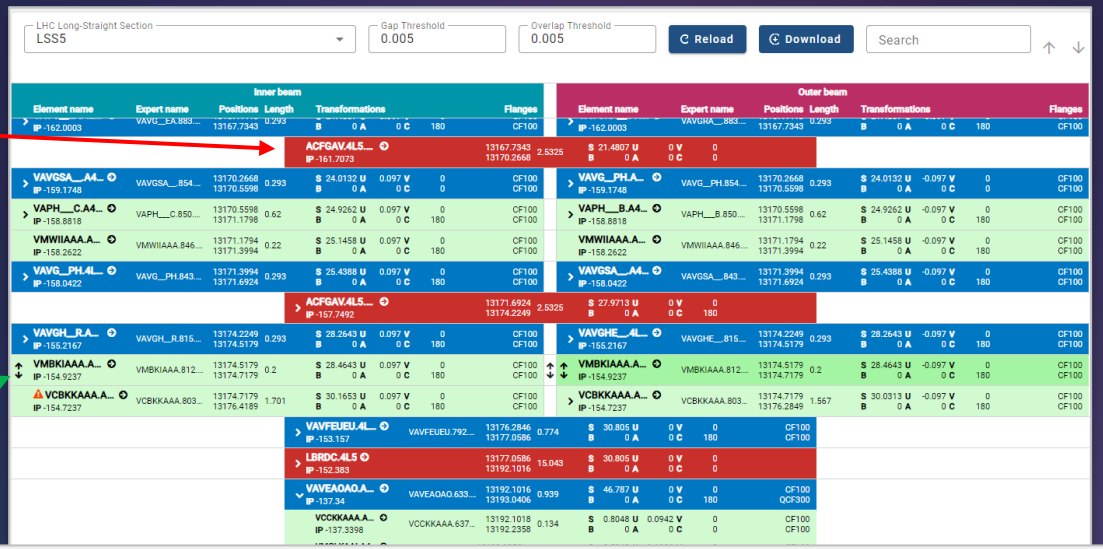
Building up LHC base layouts

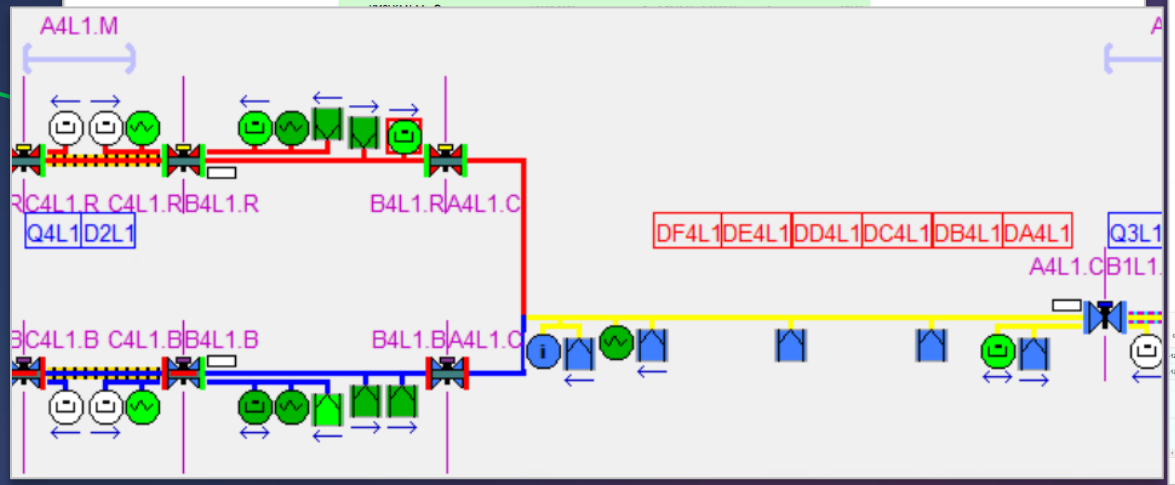
1. **EN-ACE-CL Configuration managers** define FPs acting on the beams,
collecting information from ECR, specifications, drawings…
authored by **equipment groups**

2. **TE-VSC-BVO Vacuum managers** build up the base vacuum layouts
(chambers, modules..) to complete the gaps using
LHC Beam Vacuum Editor

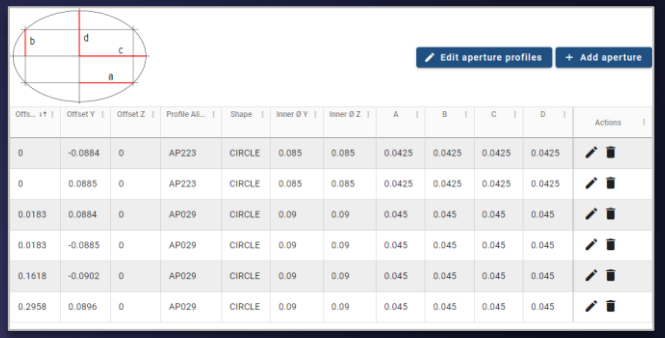
3. Add child components
Vacuum instrumentation, supports…

6. Vacuum data delivered to **TE-VSC-ICM** Vacuum DBs to configure their controls, generate their SCADA synoptics



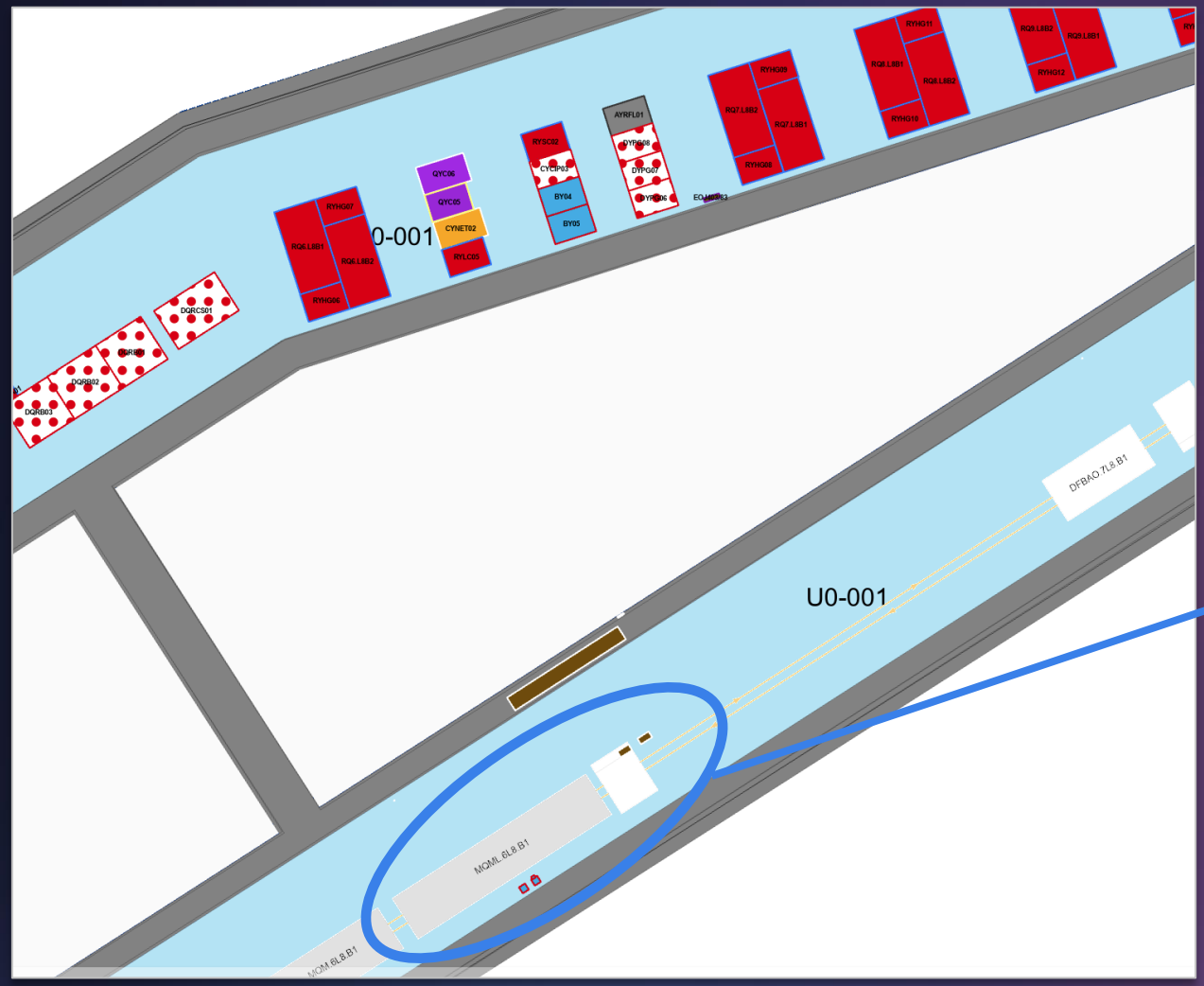


4. Define the apertures



5. Perform elementary aperture checks with the LHC aperture graph

Cryogenic instruments, Control electronics…

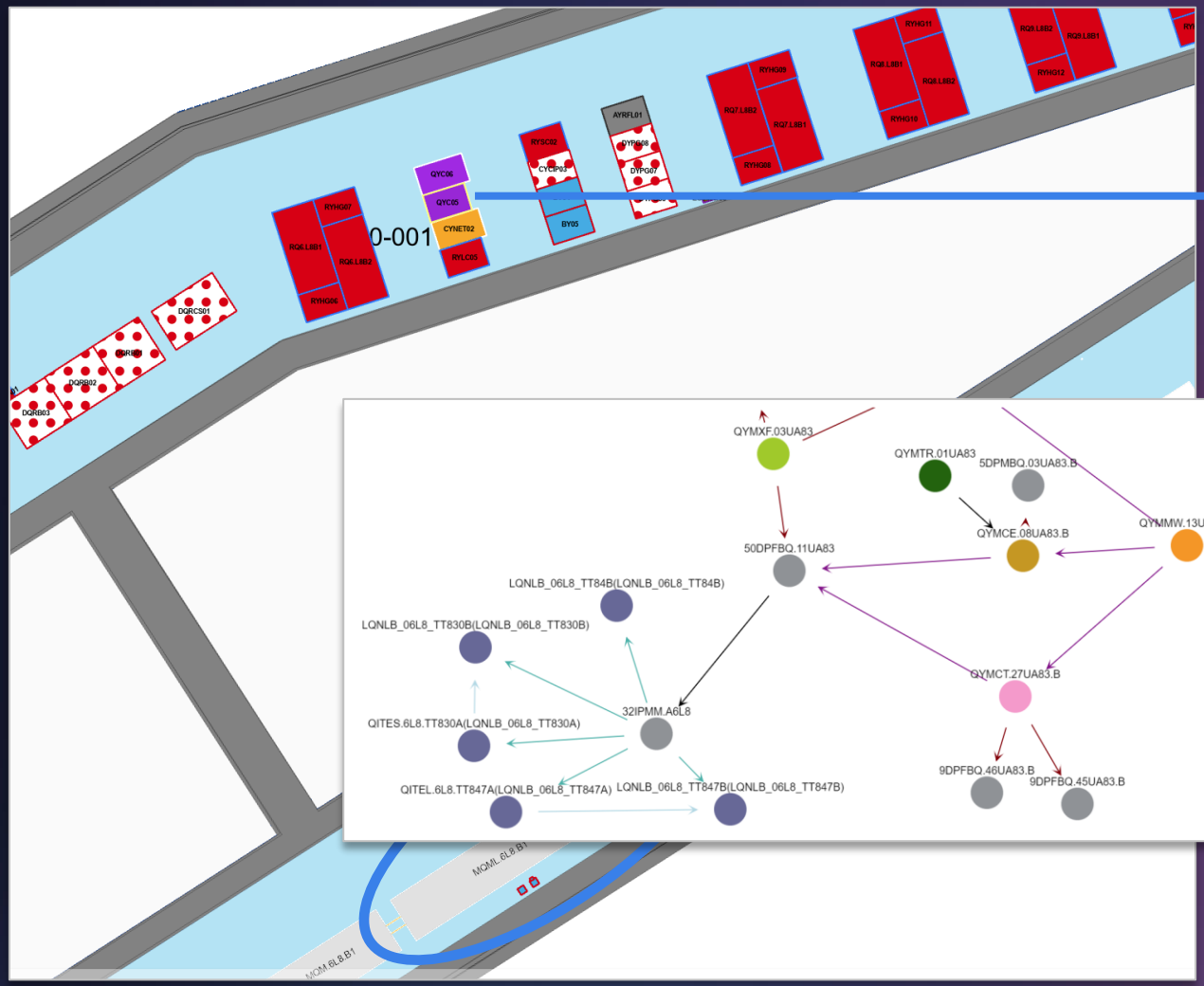


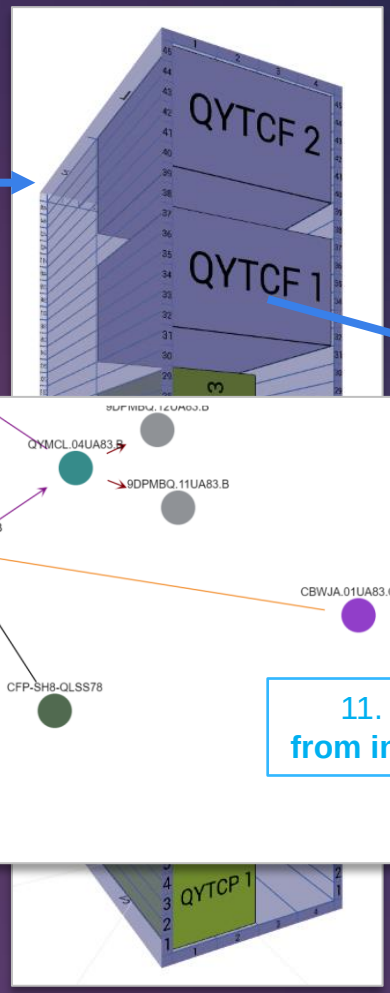
8. **EN-ACE-CL Configuration managers** maintain the **QRL line** (**TE-CRG** inputs) and **cryo-assembly layouts**

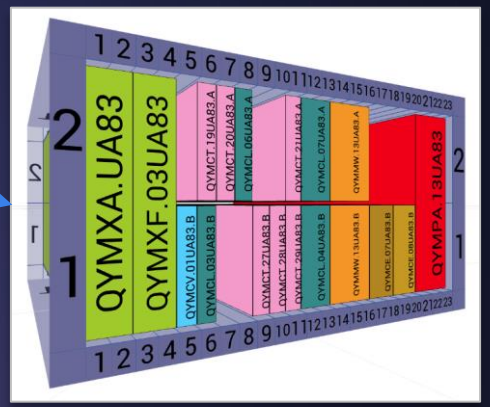
9. **TE-CRG-IC** define the **cryogenic instrumentation** (Thermometers, valves…)

- Sector 78 (3007)
  - LSS L8
    - 7L8
      - QRLDF.7L8 (QRLDF.7L8.Q)
        - QITEL.7L8.TT950 (QRLDF_07L8_TT950)
        - QITEL.7L8.TT951 (QRLDF_07L8_TT951)
        - QITEL.7L8.TT901 (QRLDF_07L8_TT901)
        - QITEL.7L8.TT961 (QRLDF_07L8_TT961)
        - QITEL.7L8.TT991 (QRLDF_07L8_TT991)
    - 6L8
      - LQNLB.6L8 (Q6L8)
        - QITES.6L8.TT830A (LQNLB_06L8_TT830A)
        - QITES.6L8.TT830B (LQNLB_06L8_TT830B)
        - QITEH.6L8.TT84B (LQNLB_06L8_TT84B)
        - QITEL.6L8.TT847B (LQNLB_06L8_TT847B)
        - QITEL.6L8.TT847A (LQNLB_06L8_TT847A)

Cryogenic instruments, Control electronics…





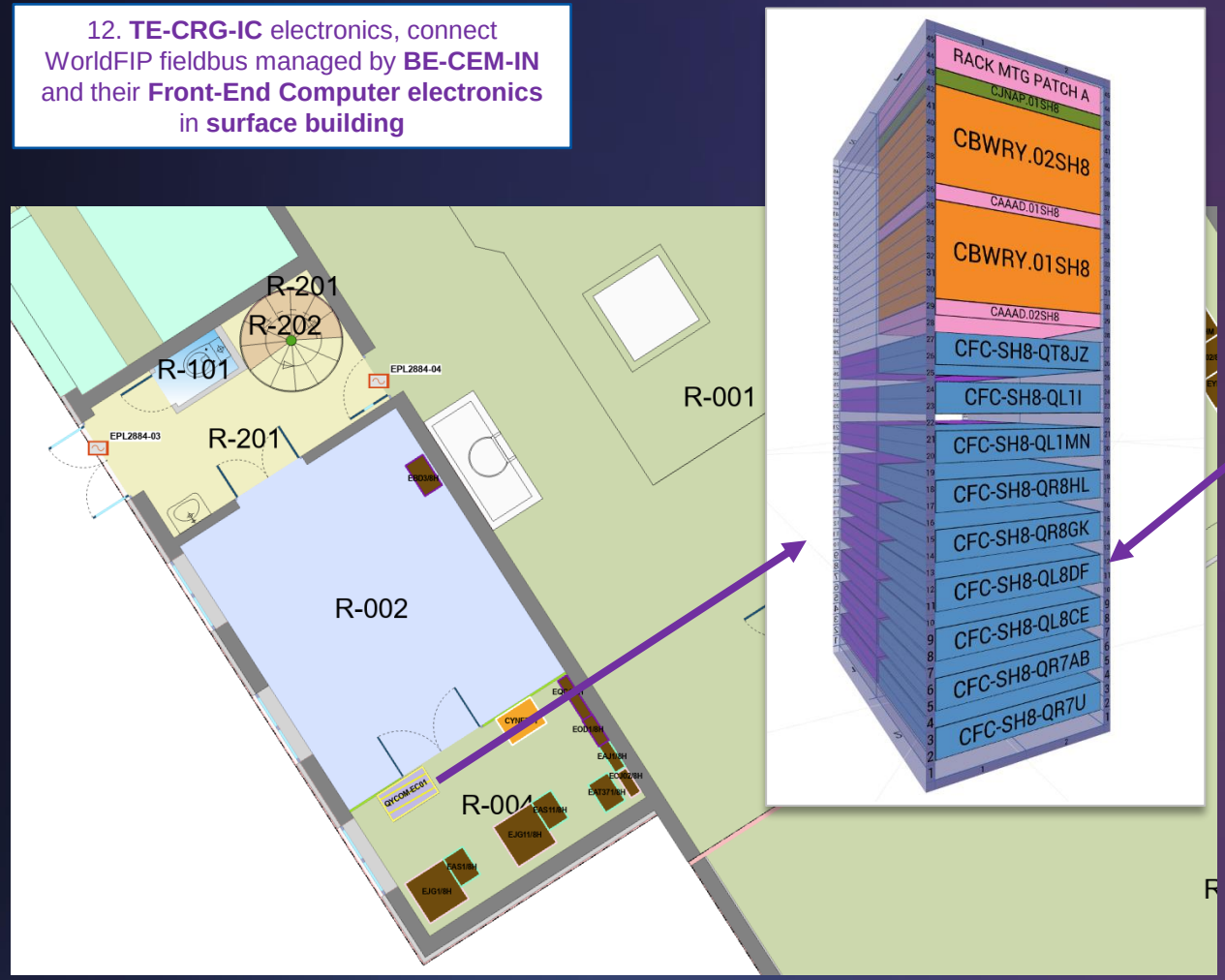


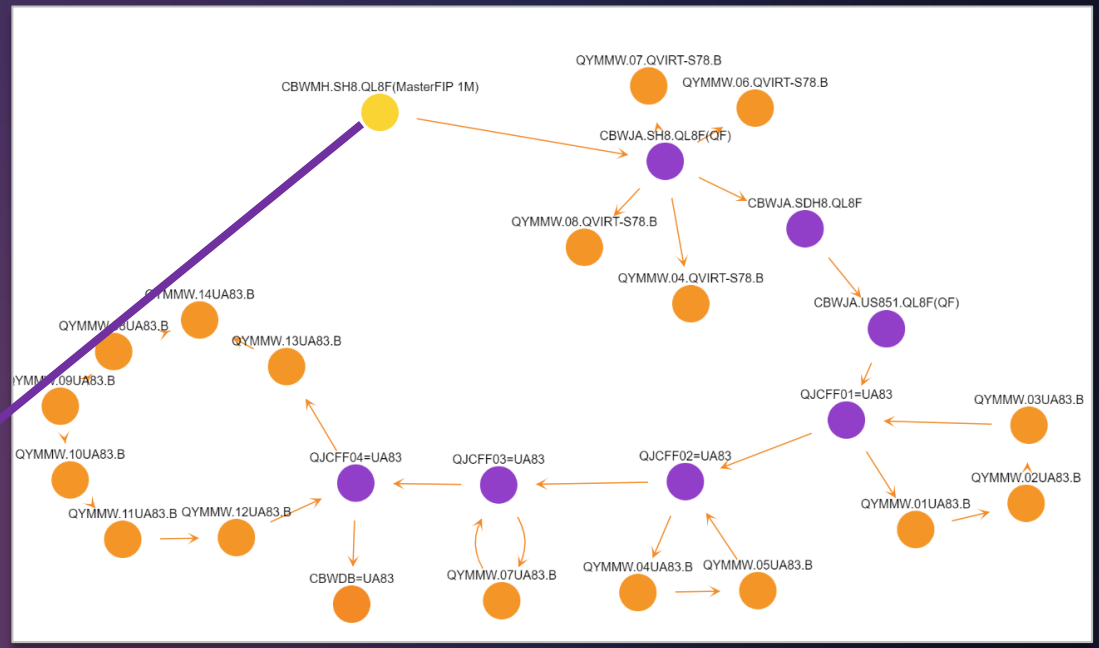
10. **TE-CRG-IC,** helped by **BE-CEM-IN,** defined all their **electronics** (racks, crates, modules, connectors, pins…)

11. Define all **connections from instruments to electronics**

Cryogenic instruments, Control electronics…

12. **TE-CRG-IC** electronics, connect WorldFIP fieldbus managed by **BE-CEM-IN** and their **Front-End Computer electronics** in **surface building**





13. This **Front-End Computer** layout data is connected to **Control Configuration Database** provided by **BE-CSS-CSA** for the **Logical Configuration (Software)**

14. Layout data delivered to **UNICOS database** managed by **TE-CRG-IC** for the **Industrial Control Configuration** (SCADA, PLC)

Summary

- Centrally documenting and maintaining the physical configuration of CERN infrastructures is essential to cope with its complex evolution over space and time

- Layout provides necessary features to model this global physical configuration over time and interoperate with its ecosystem

- Teams can share and assemble their specific expert data in Layout to enable various cross-domain applications across ATS

Thank you for your attention

Questions ?

Credit: CERN