Organisation Européenne pour la Recherche Nucléaire
European Organisation for Nuclear Research
Laboratoire Européen pour la Physique des Particules
European Laboratory for Particle Physics

The Layout Service

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on behalf of the Layout Service

Agenda

- What is the Layout Service?
- Case Study: Cryogenic Instrumentation and Controls
- 5 ways that the Layout Service helps Maintenance and Asset Management
- Conclusions

What is the Layout Service?

- A CERN-wide Oracle database
- A set of tools, including:
  - A public web-interface with **navigation** and **search** capabilities
  - Applications for data entry
  - Views and APIs for external clients
- Support from a dedicated team of people with expertise and experience
  - Assist the equipment groups to structure their layout data
- Centralises the management of integrated functional position data across CERN
  - Layout data from different domains are **fully inter-related**

History of the Layout Service

- Layout Database and Web Interface developed in 2003
  - **Plan** for the installation of components in the LHC
  - A **model of the beam components architecture (The optics)**
    - **Magnets**
    - **Beam instrumentation**
    - **RF cavities**
    - **…**
- Gradual Increase of scope since 2007
  - **Geographical**: Covers all CERN accelerators and surface buildings
  - **Domain**: All component types (vacuum pipes, control electronics, instrumentation…)

Modeling CERN Infrastructures (Layouts)

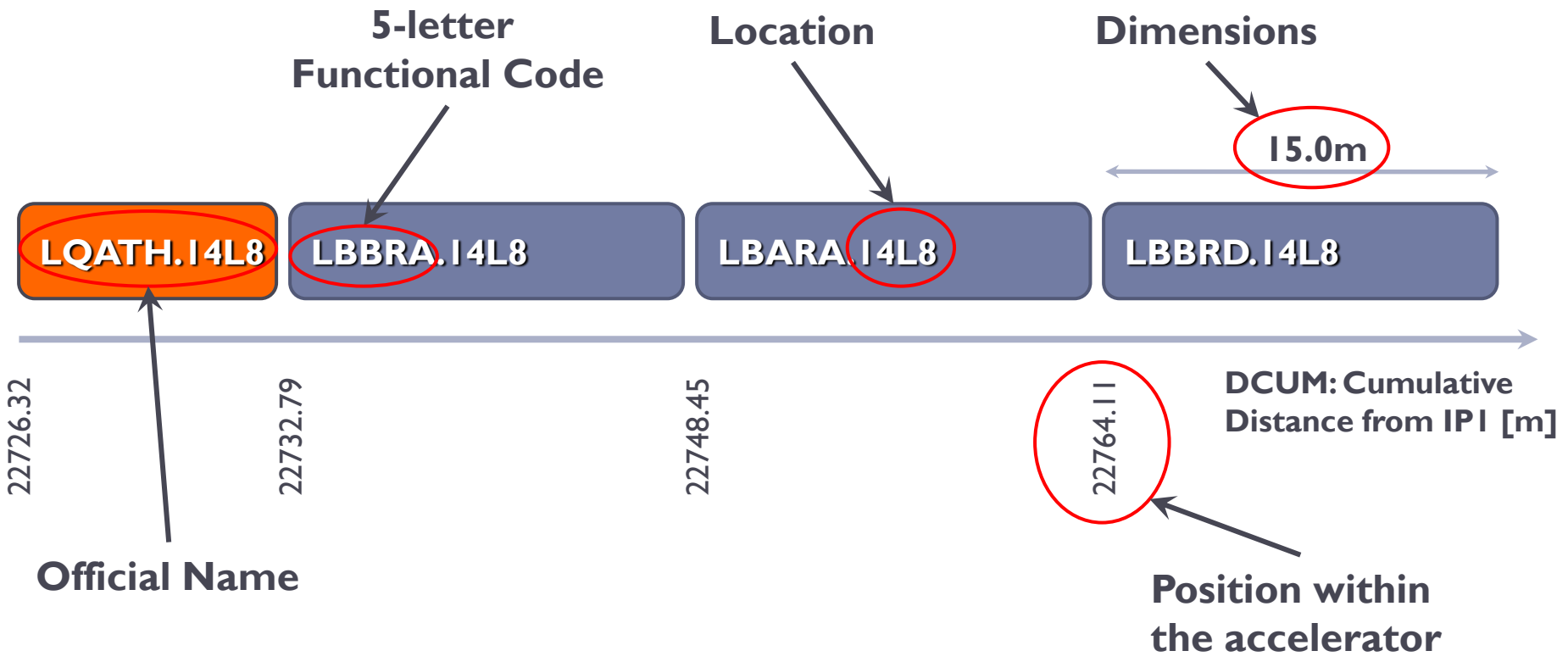
- Classifying the components of the infrastructure
  - Within a hierarchy of Classes
- Defining the components as Functional Positions
  - Nature/function of the components
  - Localisation/position of the components
- Defining relationships between these components:
  - Optical sequences
  - Mechanical assemblies (ABS)
  - Powering and control connections and circuits
  - Logical connections between otherwise unrelated components

Functional Position Characteristics

- A Type
  - Identified by a 2-5 letter functional code
    - Adhering to CERN naming conventions
- A Location
  - Machine half-cell, period, alcove, building, room, etc
- Metric Positions
  - within the location with respect to given reference points
- Dimensions
  - Very large (several metres)
  - Very small (a few millimetres)
- Unique Name(s)
  - Official name defined by the QA plan of each machine
  - Additional expert names specified by equipment owners

Example: Magnet Functional Positions

All codes, used for functional positions, are defined in the
Accelerators Entities and Signals Naming DB: https://cern.ch/service-acc-naming



Layout Service collaborations with other CERN systems

- Layout Service shares data with ~40 CERN database accounts.
- Layout Service website integrates navigation to other external web interfaces:
  - CERN Phone Book
  - MTF (Assets Maintenance Management)
  - EDMS (Documentation Management)
  - GIS Portals (CERN Geographical Information Systems)
  - IT Network Service
  - Control Configuration Service (Configuration of the Accelerator Controls System)
  - ALIM DB(Power converters database)
  - Norma DB (Normal Conducting magnets database)
- 2.5million .NET page accesses in the last 6 years
  - ~1000 individual users
  - ~500 pages-loads per day in the last year

Case Study: Modeling the LHC Cryogenic Instrumentation and Controls

- Cryogenics Instrumentation and Controls is one of the largest domains to use the Layout Service
  - Most complex system in Layout DB
  - Most demanding domain in term of layout features
- Instrumentation team use the Layout Service to fully document their systems
- Data is used in many aspects of their work:
  - Installation, configuration and maintenance of their components
  - Identify components which make up an instrumentation channel in order to help diagnose faults
  - Generate the control system software

Step 1: Define Instruments

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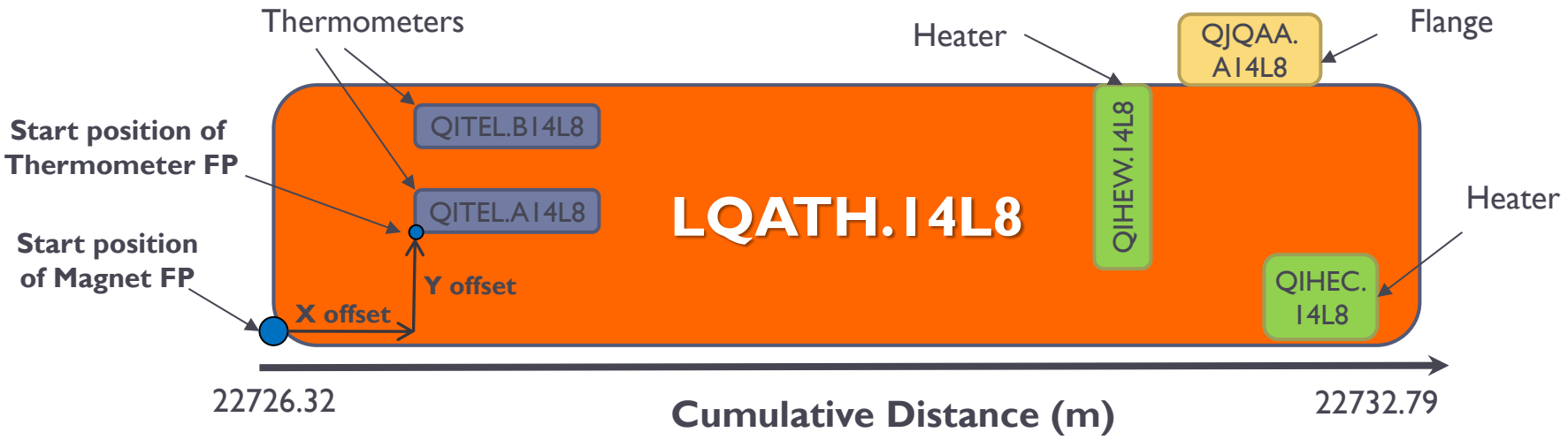
Functional Positions are defined in hierarchies
- An instrument FP is the child of a magnet FP



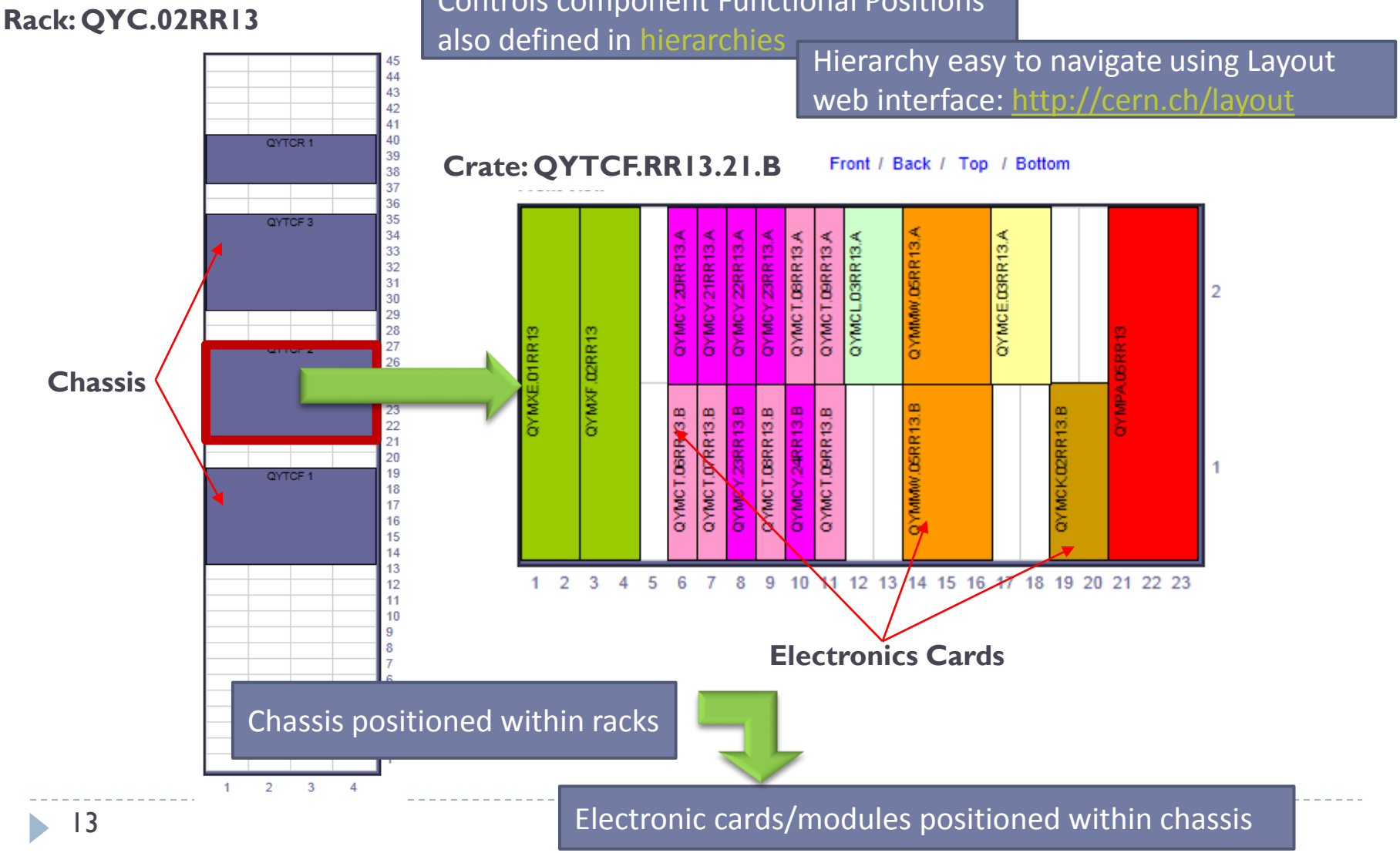
Position of instruments defined as an offset with respect to the start position of the magnet
- Instruments inherit the location
- Their exact positions are calculated

If the position of the magnet changes, the position of the instrument is recalculated automatically

Step 2: Define Electronics

Controls component Functional Positions also defined in hierarchies

Hierarchy easy to navigate using Layout web interface: http://cern.ch/layout



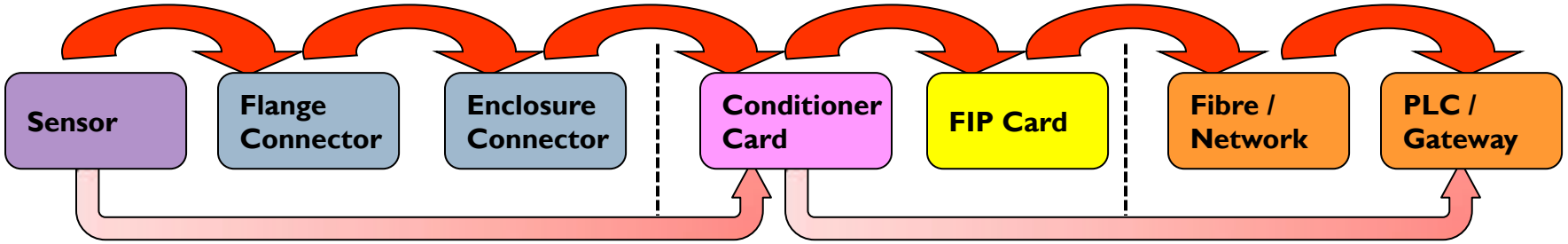
Step 3: Define Connections

Connections are logical relationships between two functional positions

Once all Instrumentation and electronics FPs are declared they are connected together to describe an instrumentation channel

The DB model is able to handle any level of granularity defined by the users

Physical Approach (Cabling): High level of detail, approaching physical installation



Conceptual Approach: Lower level of detail, more conceptual, defining only the minimum connections required to describe the system.

Each **equipment group** decides on the level of detail they require, based on the **foreseen use of the information.** The granularity can be refined over time

Step 4: Integration with InforEAM

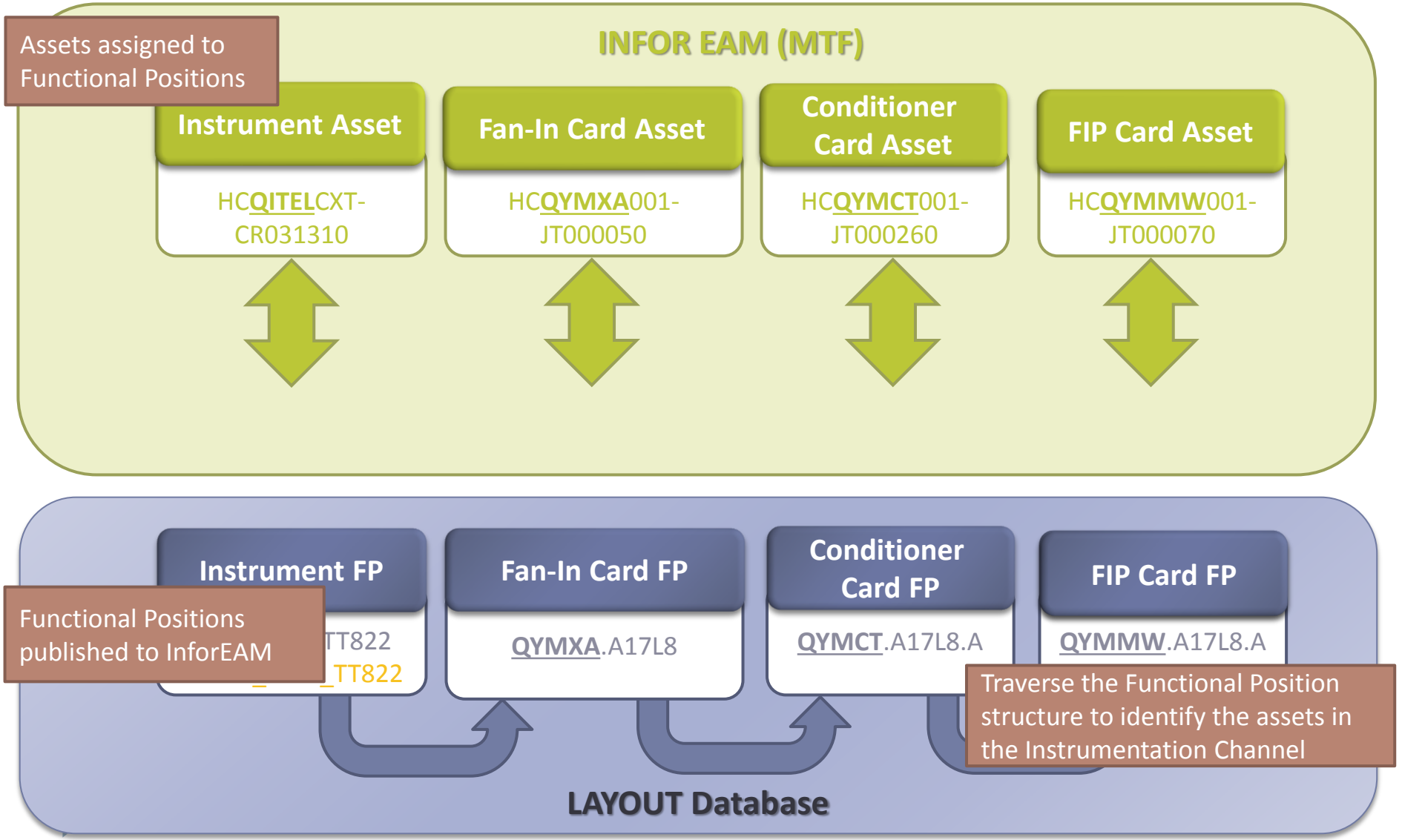
Functional Positions

- **Theoretical position** of a component of a given type
- Stored in **Layout** Database
- Identified by **Functional Position Name**
- A **plan of how components are arranged** and connected in accelerator complex

Assets

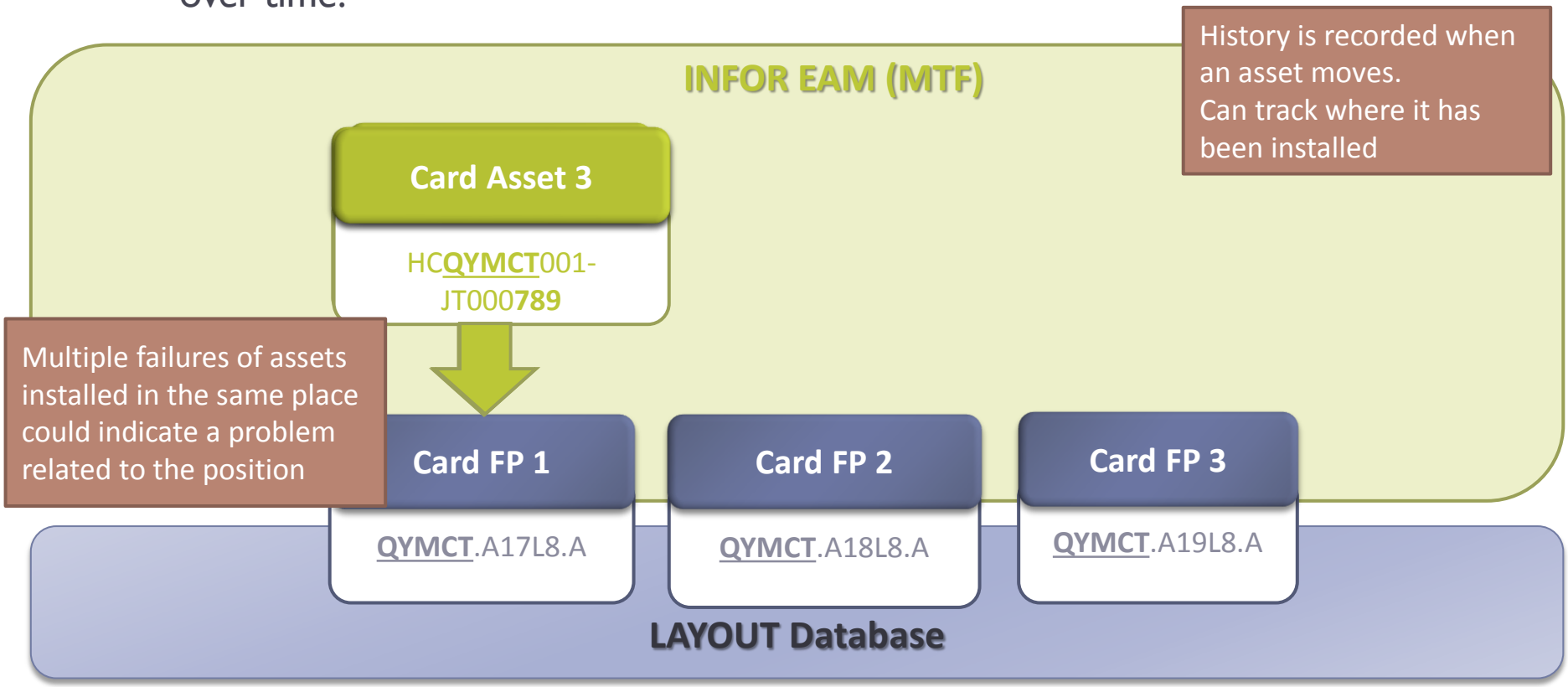
- **Physical piece of equipment** with specific characteristics
- Stored in **InforEAM** (MTF)
- Identified by **CERN Unique Identifier**
- Assets installed in **different positions** over their lifetime.
  ➡ Traceable history

Step 4: Integration with InforEAM



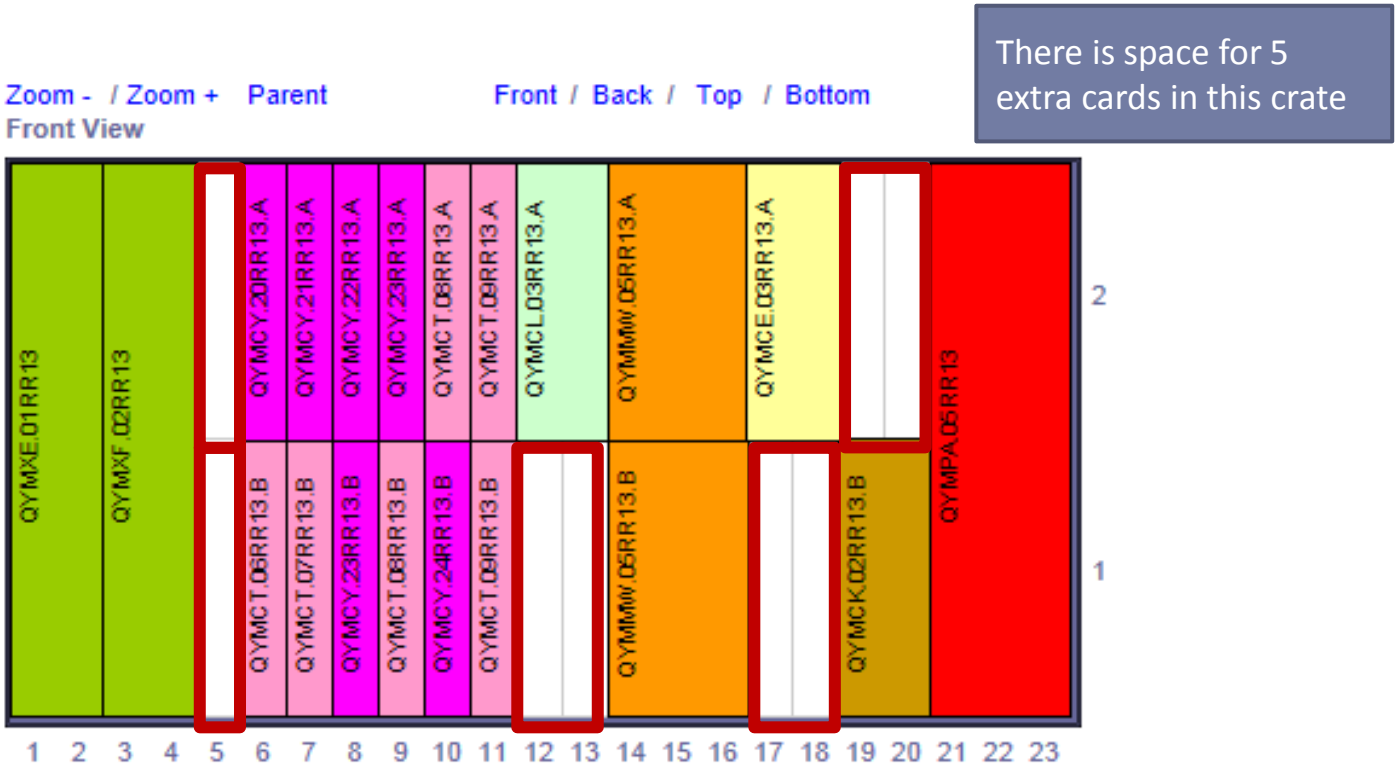
5 ways the Layout Service helps with Maintenance and Asset Management

1. Throughout their lifecycle, assets may be installed in different positions
   - Successive assignments between Funtional Positions and assets are recorded
   - Provides a valuable history and traceability
   - The position of the assets may be correlated with the failure rate of the asset over time.



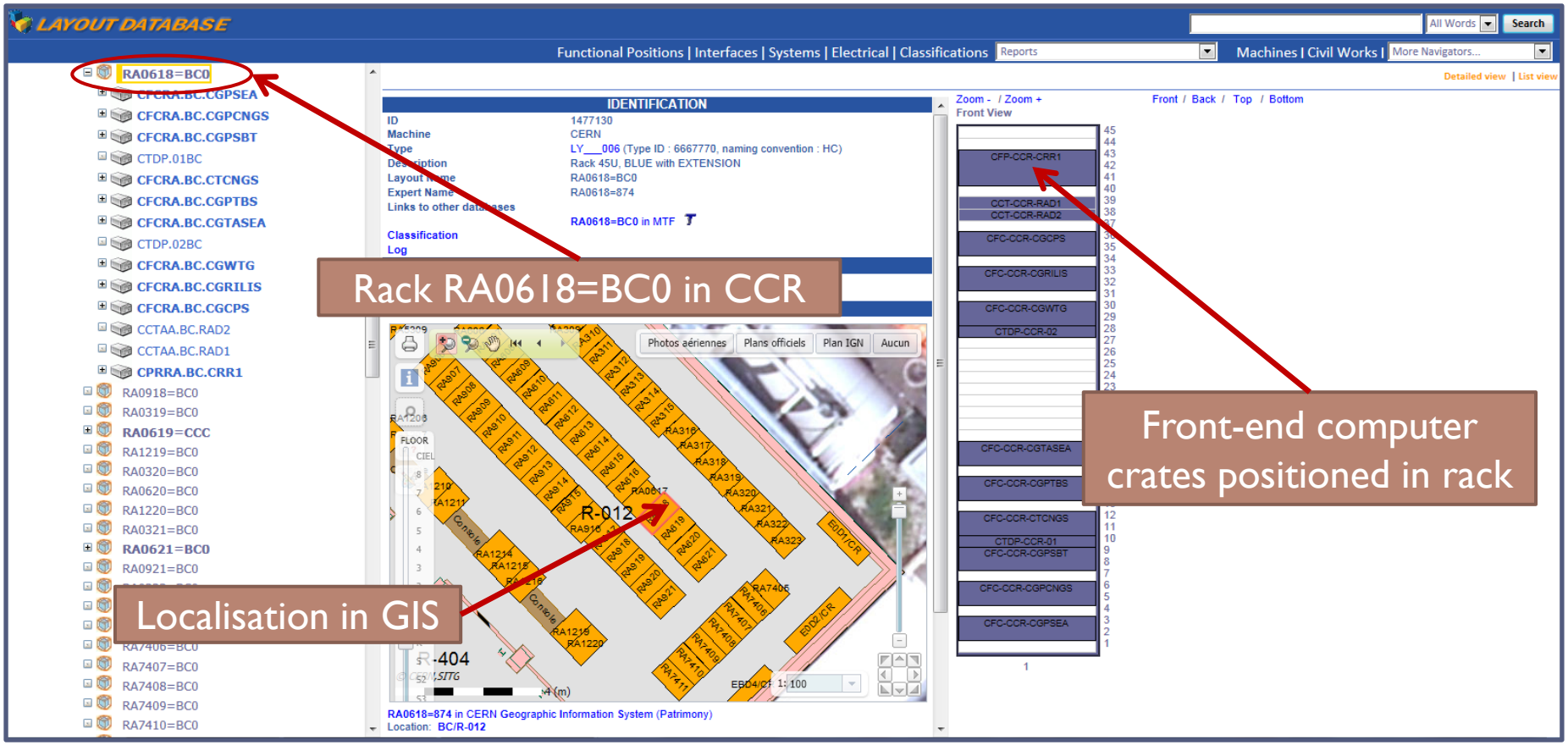
5 ways the Layout Service helps with Maintenance and Asset Management

2. Possibility to identify unused functional positions and empty space
   - Find Functional Positions that do not have assets installed
   - Visualise free space in a crate, rack etc…



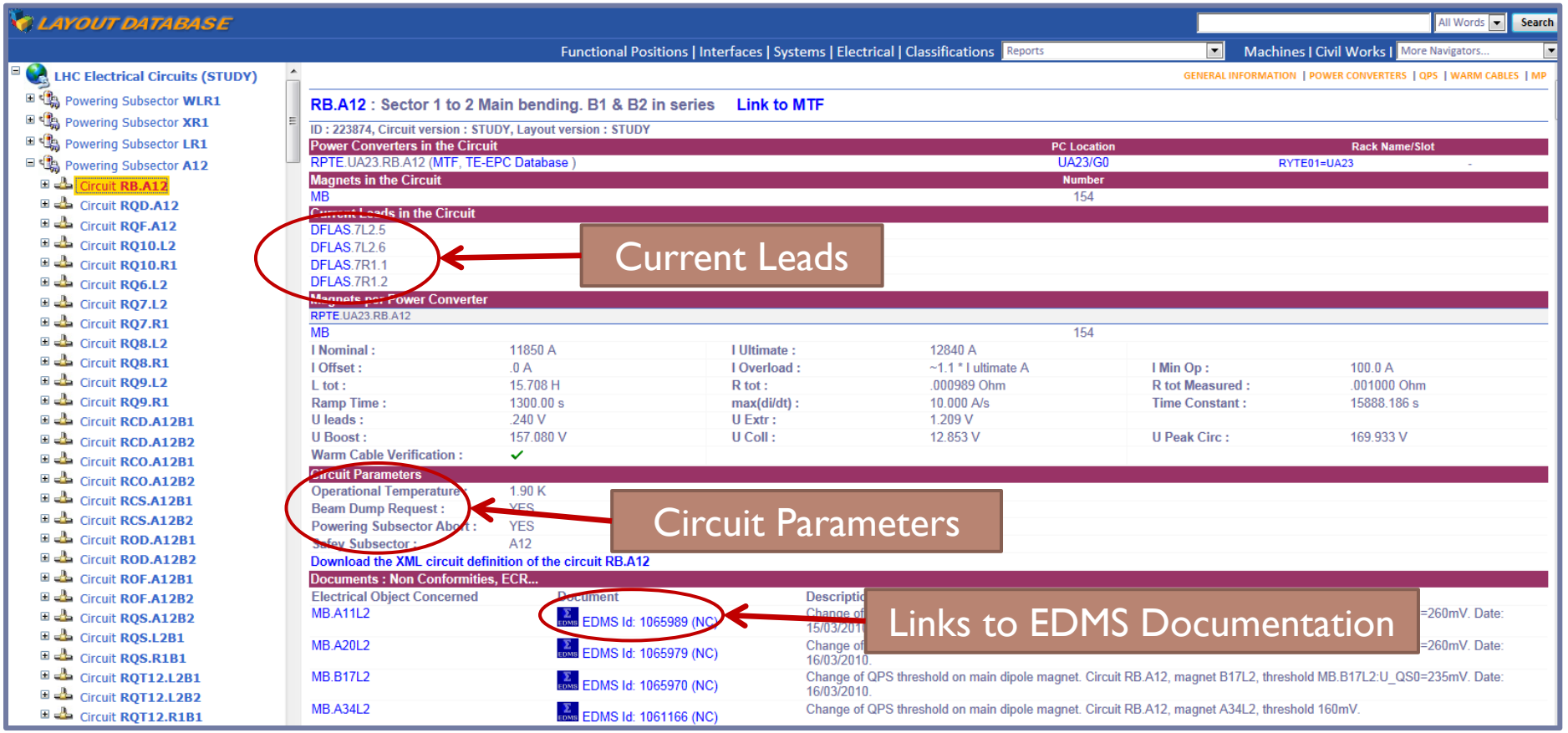
5 ways the Layout Service helps with Maintenance and Asset Management

3. Once an asset is assigned to a Functional Position, one can build combined complex reports
   - Integration between layout and GIS helps to quickly localise components on site when intervening for urgent maintenance.



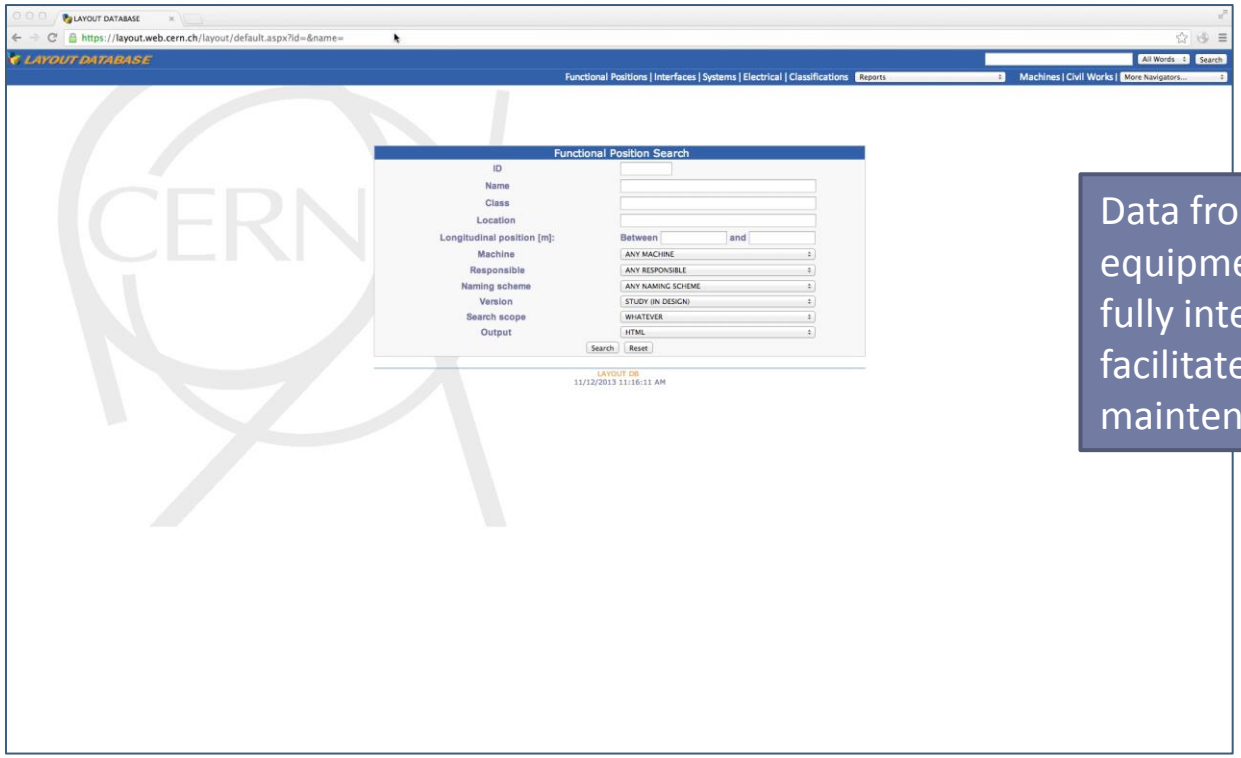
5 ways the Layout Service helps with Maintenance and Asset Management

4. Identification of power sources of components
   - The descriptions of the connections and circuits (from magnets, to cold cables , current leads, warm cables, power converters) can help ensure the electrical lockout.



5 ways the Layout Service helps with Maintenance and Asset Management

5. Ability to navigate through the connections (circuits) between functional positions
   - Quickly diagnose failures in acquisition chains
     - Identify faulty asset in the chain and create a work order on that Asset



Data from different equipment groups is fully integrated, which facilitates cross-domain maintenance

7 2. The thermometer is attached to the dipole magnet LBBRA.29R7 › the WorldFip network

Conclusion

- The Layout Database provides the infrastructure models, required by Asset management
  - Integrated Data, permits navigation across domains and web interfaces
  - Available to everyone at CERN
  - Flexible enough to handle the needs of many diverse user groups
  - It will also evolve to cope with future Asset Management requirements, if needed

- Several equipment groups at CERN have included the management of their Functional Positions as a standard part of their QA plan
  - Layout-type data is already managed internally within equipment groups
    - Why not centralise this information using common tools?
    - Profit from cross-domain integration
    - Effort to structure this data in Layout DB is different, but not necessarily increased