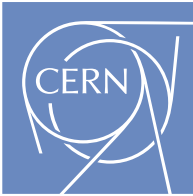




**Organisation Européenne pour la Recherche Nucléaire**  
**European Organisation for Nuclear Research**  
**Laboratoire Européen pour la Physique des Particules**  
**European Laboratory for Particle Physics**

# The Layout Service

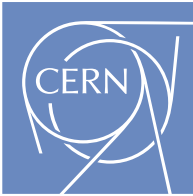
Eve Fortescue-Beck (BE-CO-DA)  
on behalf of the Layout Service



# Agenda

---

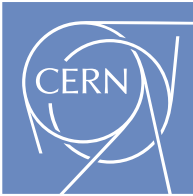
- ▶ What is the Layout Service?
- ▶ Case Study: Cryogenic Instrumentation and Controls
- ▶ 5 ways that the Layout Service helps Maintenance and Asset Management
- ▶ Conclusions



# What is the Layout Service?

---

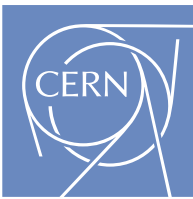
- ▶ A CERN-wide Oracle database
- ▶ A set of tools, including:
  - ▶ A public web-interface with **navigation** and **search** capabilities
  - ▶ Applications for data entry
  - ▶ Views and APIs for external clients
- ▶ Support from a dedicated team of people with expertise and experience
  - ▶ Assist 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

---

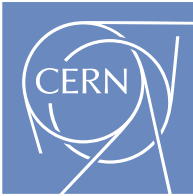
- ▶ **Layout Database and Web Interface developed in 2003**
  - ▶ **Plan** for the installation of components in the LHC
  - ▶ **A model of the beam components architecture (The optics)**
    - ▶ **Magnets**
    - ▶ **Beam instrumentation**
    - ▶ **RF cavities**
    - ▶ ...
  
- ▶ **Gradual Increase 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)

---

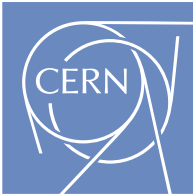
- ▶ **Classifying the components of the infrastructure**
  - ▶ Within a hierarchy of Classes
- ▶ **Defining the components as Functional Positions**
  - ▶ Nature/function of the components
  - ▶ Localisation/position of the components
- ▶ **Defining relationships between these components:**
  - ▶ Optical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



# Functional Position Characteristics

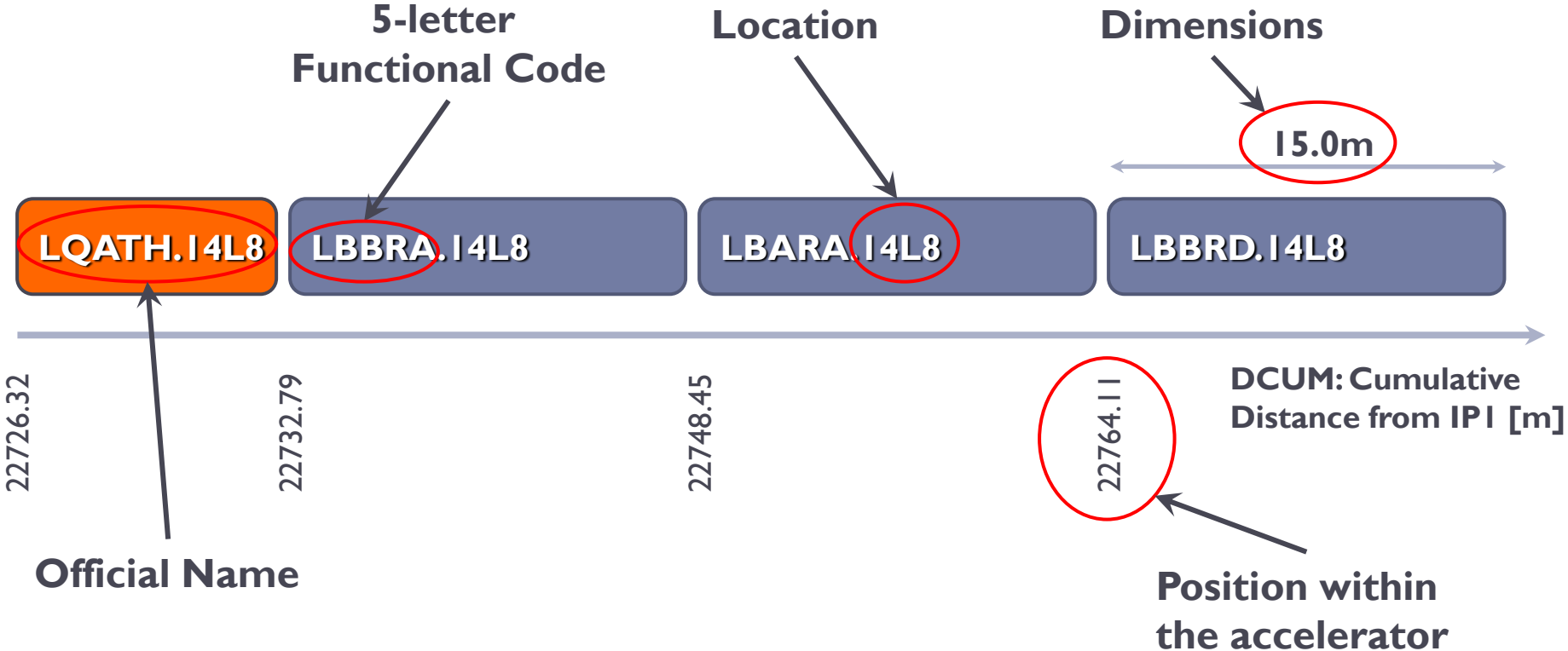
---

- ▶ **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

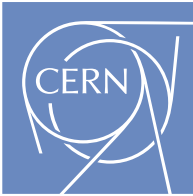


# Case Study: Modeling the LHC Cryogenic Instrumentation and Controls

---



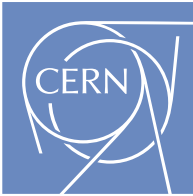
- ▶ **Cryogenics Instrumentation and Controls is one of the largest domains to use the Layout Service**
  - ▶ Most complex system in Layout DB
  - ▶ Most demanding domain in term of layout features
- ▶ **Instrumentation team use the Layout Service to fully document their systems**
- ▶ **Data is used 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

---





# Step 1: Define Instruments

---

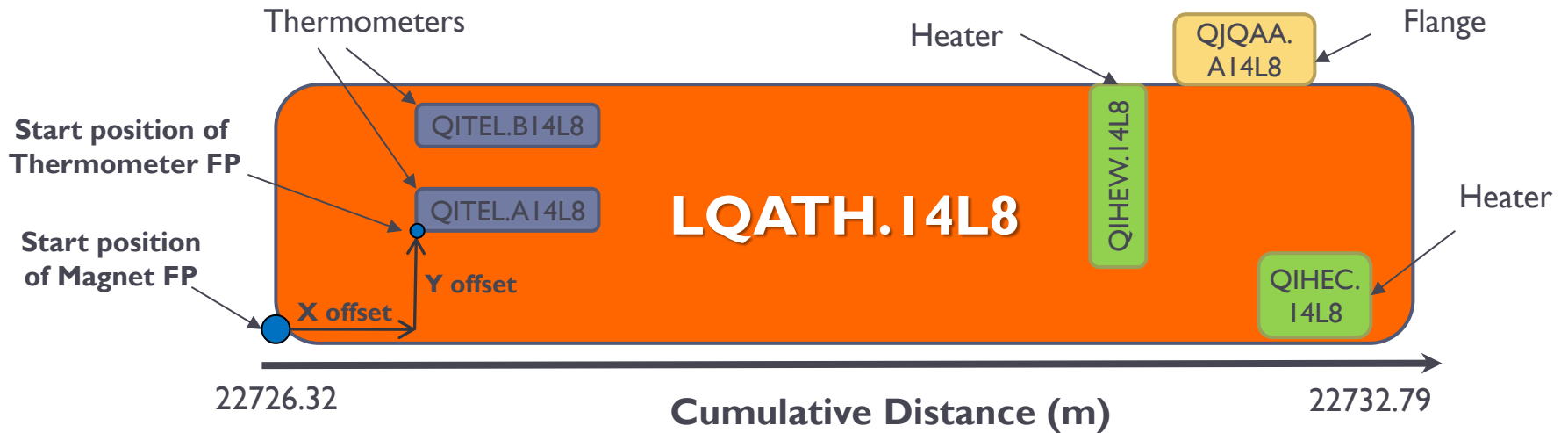
LQATH.14L8



# Step 1: Define Instruments

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**

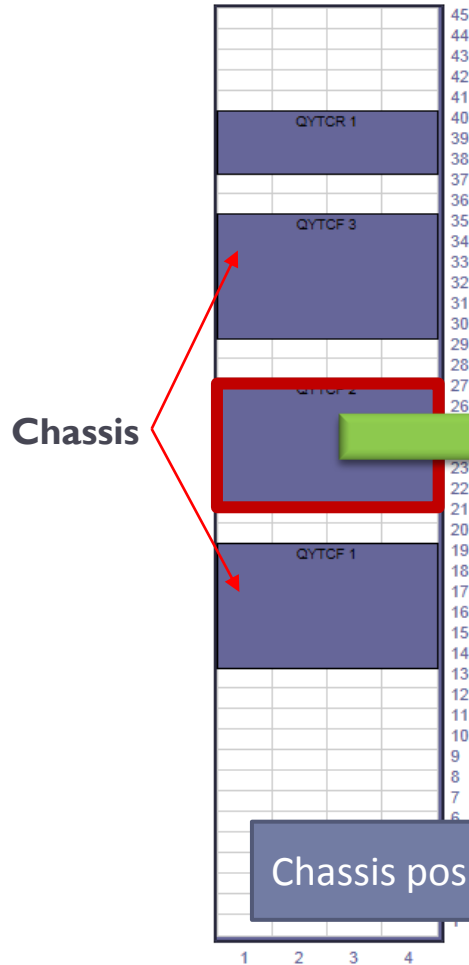
If the position of the magnet changes, the position of the instrument is recalculated **automatically**

# Step 2: Define Electronics

Rack: QYC.02RR13

Controls component Functional Positions  
also defined in **hierarchies**

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



Crate: QYTCF.RR13.21.B

Front / Back / Top / Bottom



Electronics Cards

Chassis positioned within racks



Electronic cards/modules positioned within chassis

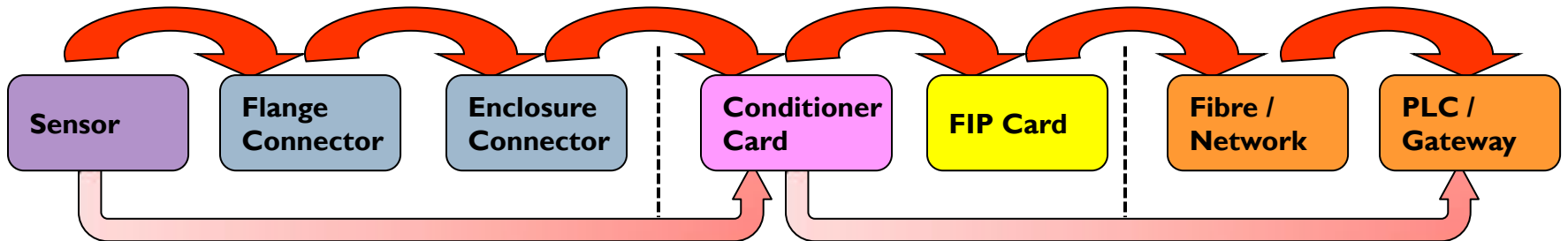
# Step 3: Define Connections

**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

Assets assigned to Functional Positions

## INFOR EAM (MTF)

Instrument Asset

HCQITELCXT-  
CR031310

Fan-In Card Asset

HCQYMXA001-  
JT000050

Conditioner  
Card Asset

HCQYMCT001-  
JT000260

FIP Card Asset

HCQYMMW001-  
JT000070



Instrument FP

Functional Positions  
published to InforEAM

TT822  
\_TT822

Fan-In Card FP

QYMXA.A17L8

Conditioner  
Card FP

QYMCT.A17L8.A

FIP Card FP

QYMMW.A17L8.A

Traverse the Functional Position  
structure to identify the assets in  
the Instrumentation Channel

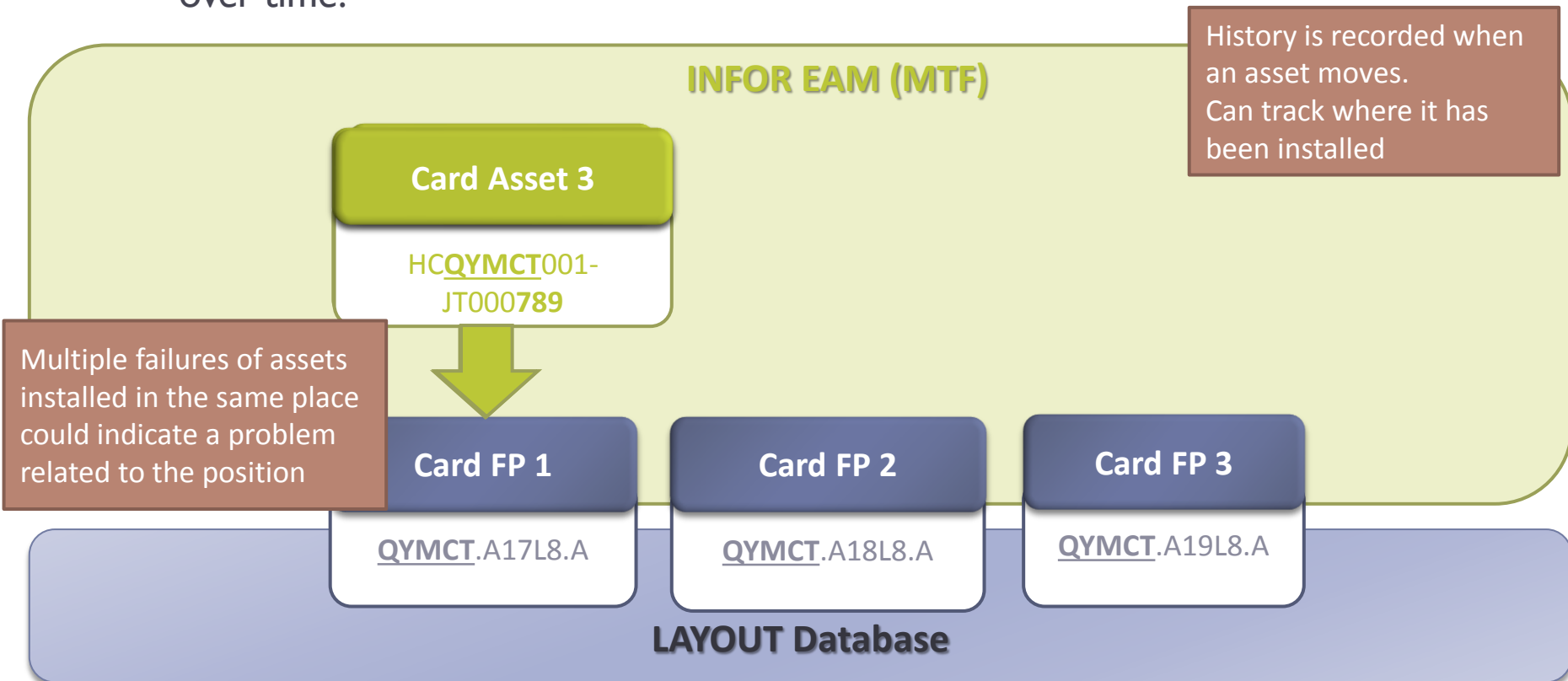
LAYOUT Database



# 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 Functional 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

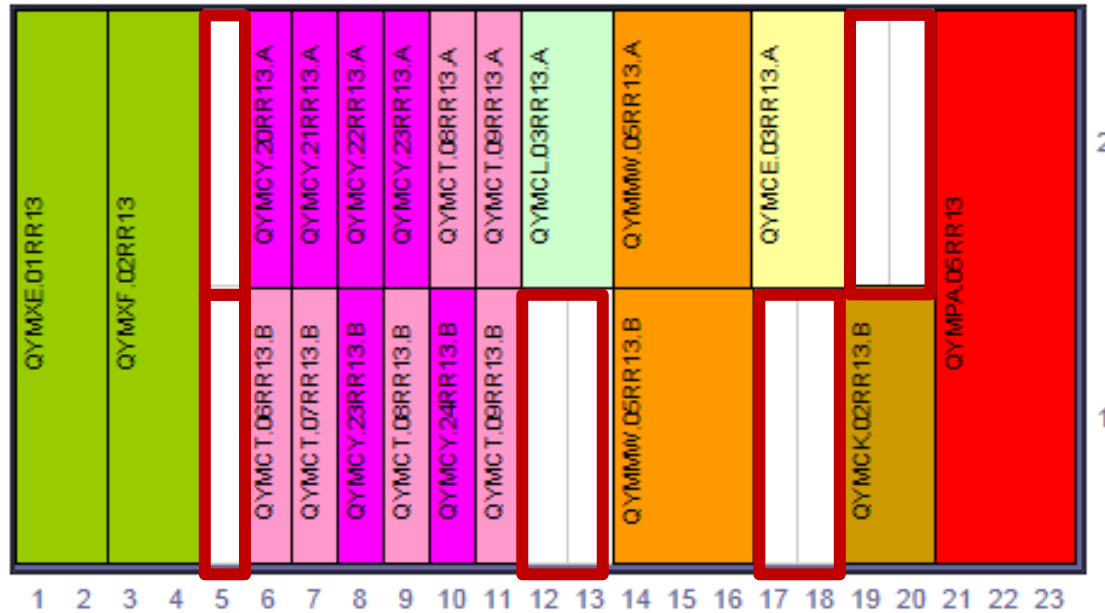
## 2. Possibility to identify unused functional positions and empty space

- ▶ Find Functional Positions that do not have assets installed
- ▶ Visualise free space in a crate, rack etc...

Zoom - / Zoom + Parent  
Front View

Front / Back / Top / Bottom

There is space for 5 extra cards in this crate



# 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.

**LAYOUT DATABASE**

Functional Positions | Interfaces | Systems | Electrical | Classifications | Reports | Machines | Civil Works | More Navigators...

RA0618=BC0

**IDENTIFICATION**

ID	1477130
Machine	CERN
Type	LY__006 (Type ID : 6667770, naming convention : HC)
Description	Rack 45U, BLUE with EXTENSION
Layout Name	RA0618=BC0
Expert Name	RA0618=874
Links to other databases	
Classification	RA0618=BC0 in MTF
Log	

**Rack RA0618=BC0 in CCR**

**Localisation in GIS**

**Front-end computer crates positioned in rack**

45	CFC-CCR-CRR1
44	
43	
42	
41	
40	
39	
38	
37	
36	
35	
34	
33	
32	
31	
30	
29	
28	
27	
26	
25	
24	
23	
12	
11	
10	
9	
8	
7	
6	
5	
4	
3	
2	
1	

RA0618=874 in CERN Geographic Information System (Patrimony)  
Location: BC/R-012

# 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.

**LAYOUT DATABASE**

Functional Positions | Interfaces | Systems | Electrical | Classifications | Reports | Machines | Civil Works | More Navigators...

LHC Electrical Circuits (STUDY)

- Powering Subsector WLR1
- Powering Subsector XR1
- Powering Subsector LR1
- Powering Subsector A12
  - Circuit RB.A12**
  - Circuit RQD.A12
  - Circuit RQF.A12
  - Circuit RQ10.L2
  - Circuit RQ10.R1
  - Circuit RQ6.L2
  - Circuit RQ7.L2
  - Circuit RQ7.R1
  - Circuit RQ8.L2
  - Circuit RQ8.R1
  - Circuit RQ9.L2
  - Circuit RQ9.R1
  - Circuit RCD.A12B1
  - Circuit RCD.A12B2
  - Circuit RCO.A12B1
  - Circuit RCO.A12B2
  - Circuit RCS.A12B1
  - Circuit RCS.A12B2
  - Circuit ROD.A12B1
  - Circuit ROD.A12B2
  - Circuit ROF.A12B1
  - Circuit ROF.A12B2
  - Circuit RQS.A12B2
  - Circuit RQS.L2B1
  - Circuit RQS.R1B1
  - Circuit RQT12.L2B1
  - Circuit RQT12.L2B2
  - Circuit RQT12.R1B1

**RB.A12 : Sector 1 to 2 Main bending. B1 & B2 in series** [Link to MTF](#)

ID : 223874, Circuit version : STUDY, Layout version : STUDY

**Power Converters in the Circuit**

PC Location	Rack Name/Slot
UA23/G0	RYTE01=UA23

**Magnets in the Circuit**

Number
154

**Current Leads in the Circuit**

- DFLAS.7L2.5
- DFLAS.7L2.6
- DFLAS.7R1.1
- DFLAS.7R1.2

**Warm Cable Verification** : ✓

**Circuit Parameters**

Operational Temperature :	1.90 K
Beam Dump Request :	YES
Powering Subsector Abort :	YES
Safety Subsector :	A12

[Download the XML circuit definition of the circuit RB.A12](#)

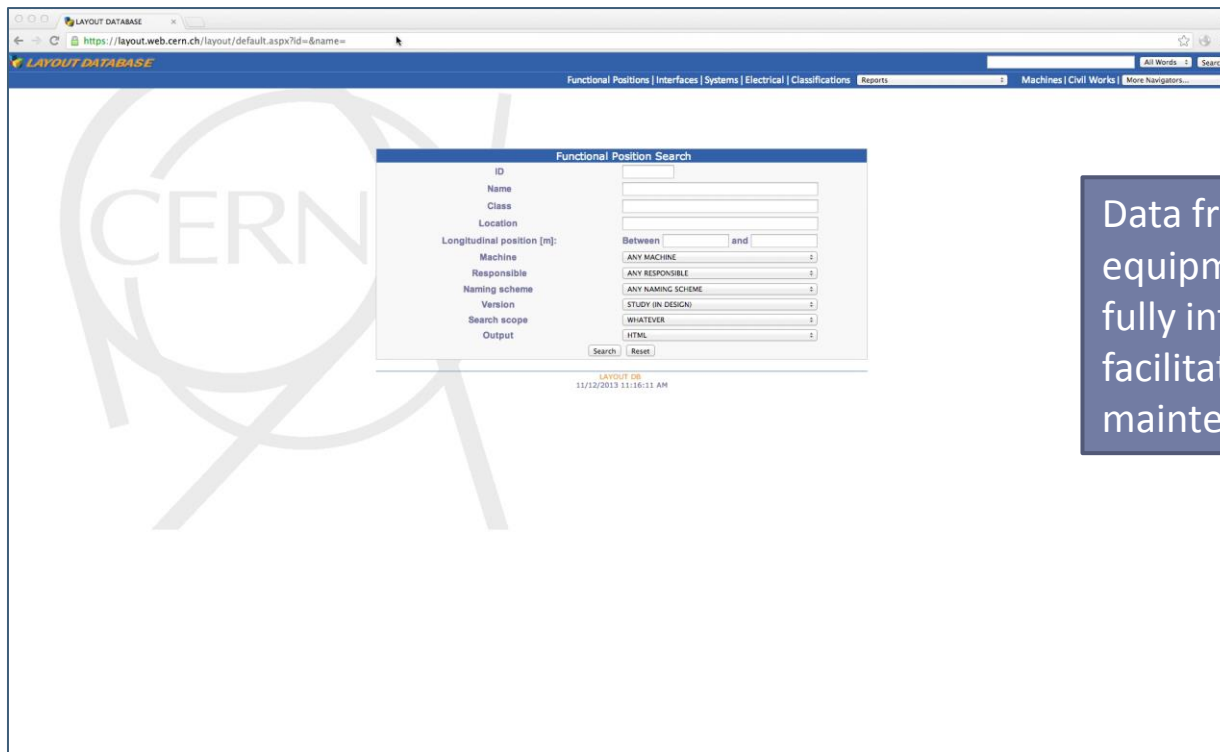
**Documents : Non Conformities, ECR...**

Electrical Object Concerned	Document	Description
MB.A11L2	EDMS Id: 1065989 (NC)	Change of ... =260mV. Date:
MB.A20L2	EDMS Id: 1065979 (NC)	Change of ... =260mV. Date:
MB.B17L2	EDMS Id: 1065970 (NC)	Change of QPS threshold on main dipole magnet. Circuit RB.A12, magnet B17L2, threshold MB.B17L2:U_QS0=235mV. Date: 16/03/2010.
MB.A34L2	EDMS Id: 1061166 (NC)	Change of QPS threshold on main dipole magnet. Circuit RB.A12, magnet A34L2, threshold 160mV.

# 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

# 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