THE LAYOUT DATABASE SERVICE

Role, evolution, challenges and future plans

BE-CO Technical Committee, 26 February 2015 - Pascal Le Roux (BE-CO-DS) on behalf of the Layout Service

OUTLINE

What is a Layout ?

What is the Layout Database Service?

Role of the service

Collaborations with other CERN systems

Evolution over the last 15 years

Consequences of expansion

New approach and challenges: database consolidation, web user interfaces

Summary

WHAT IS A LAYOUT ?

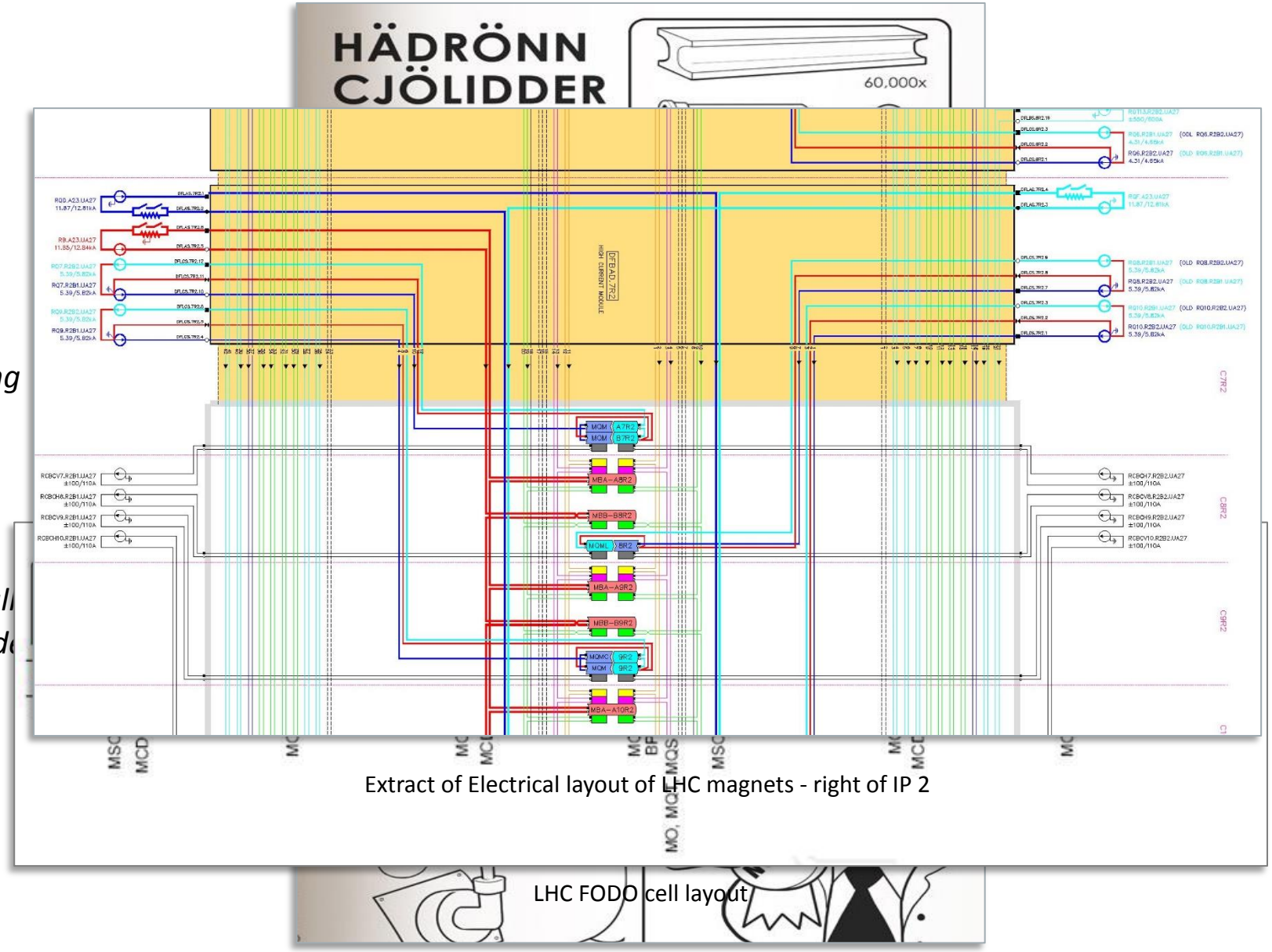
Dictionary definition:

"The way in which the parts of something are arranged or laid out"

Our definition:

"A set of functional positions mechanicall electrically or logically structured to mod system"

Some examples



Extract of Electrical layout of LHC magnets - right of IP 2

LHC FODO cell layout

Large Hadron Collider Layout "IKEA Style"

WHAT IS THE LAYOUT DATABASE SERVICE?

A **CERN-wide Oracle database**

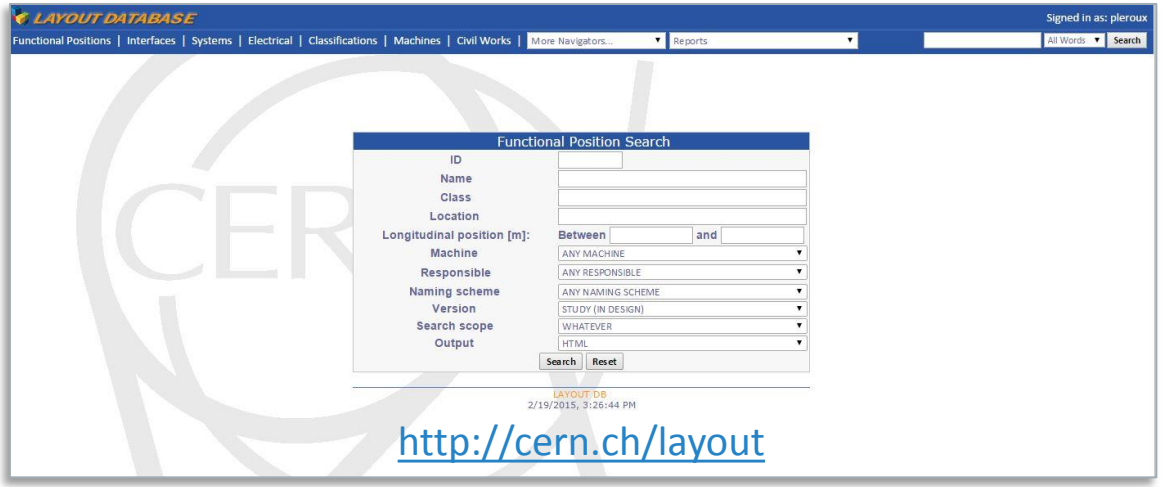
Public DB cluster in building 513 : edmsdb/accdb/cerndb1 where the Layout DB is hosted

WHAT IS THE LAYOUT DATABASE SERVICE?

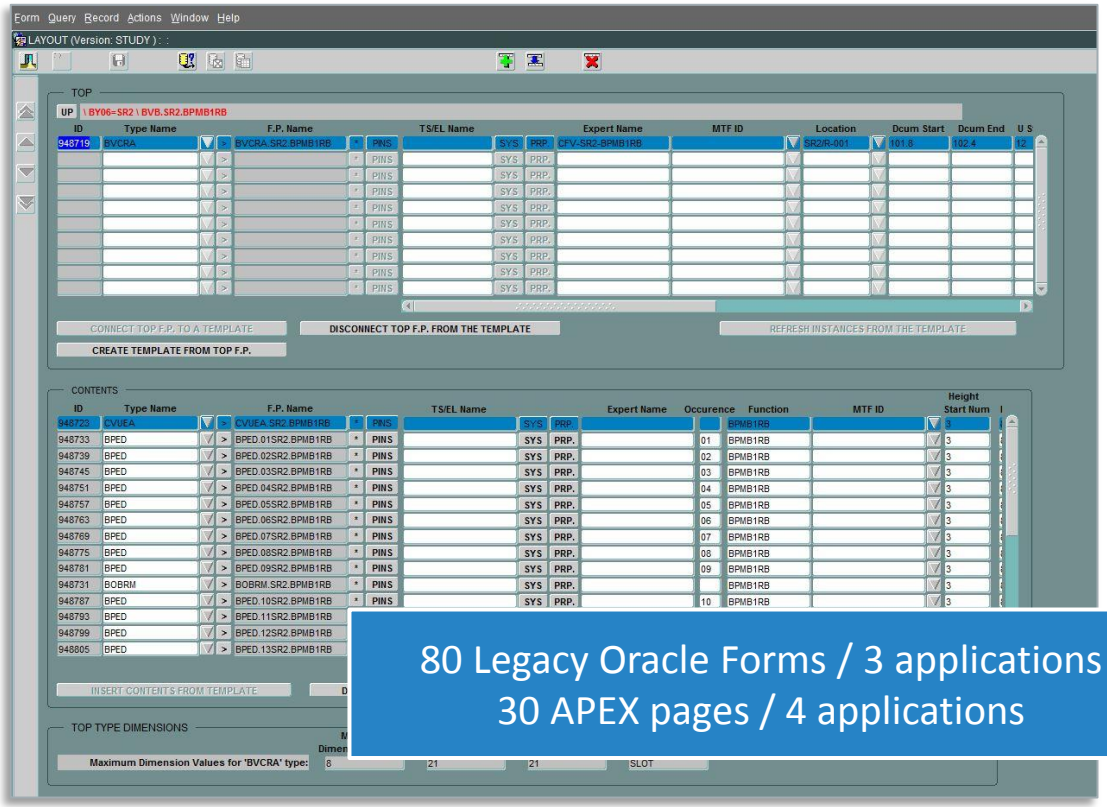
A **CERN-wide Oracle database**

A set of tools, including:

- A public web-interface with navigation and search capabilities
- Limited applications for data entry
- Views and APIs for external clients



http://cern.ch/layout



80 Legacy Oracle Forms / 3 applications
30 APEX pages / 4 applications

WHAT IS THE LAYOUT DATABASE SERVICE?

A **CERN-wide Oracle database**

A set of tools, including:

- A public web-interface with navigation and search capabilities
- Limited applications for data entry
- Views and APIs for external clients

Support from a dedicated team of people with **expertise** and **experience** since 2003

- Provide database support to EN-MEF-DC who manage the beam line layout data
- Assist equipment groups to structure coherently their layout data for electronic components, instrumentation and other non-beam line systems (Racks, WorldFIP, FECs…)

Centralises the management of **integrated, controlled functional position** and **layout** data across CERN

- Layout data from different domains are fully **inter-related**

Pascal

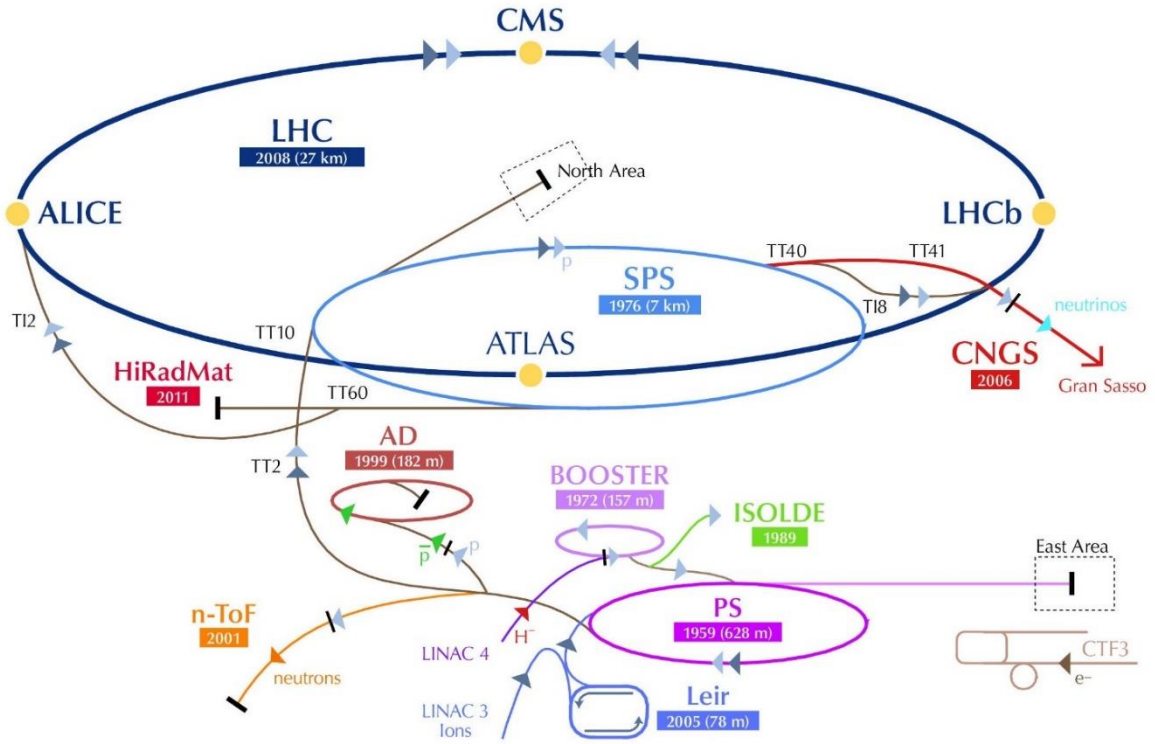
Eve

Vasileios

Chris

ROLE OF THE SERVICE

Document the CERN infrastructures by **modelling** their **architecture** as **layouts**



ROLE OF THE SERVICE

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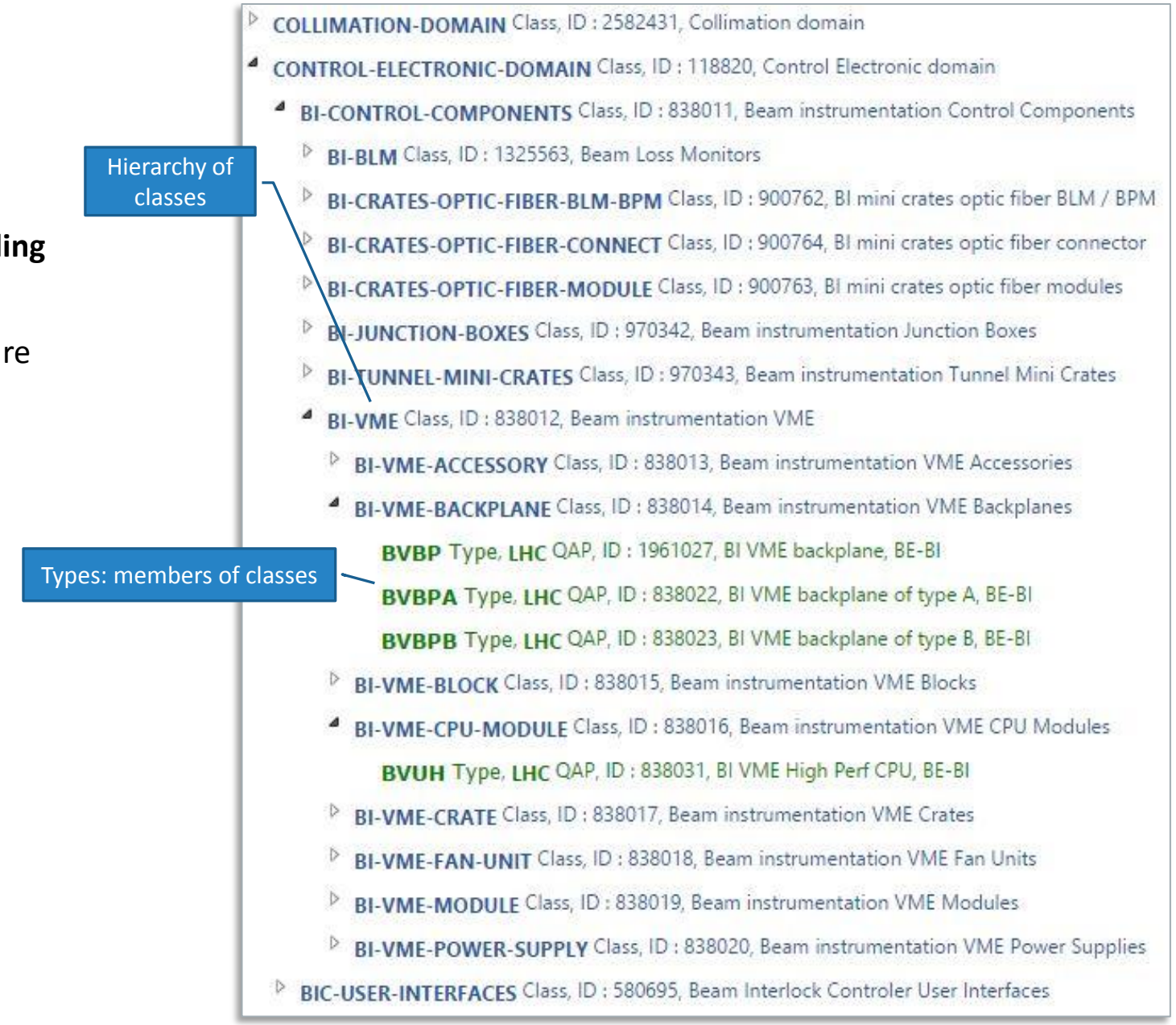
Classifying the components of the infrastructure

- Within a hierarchy of Classes and types



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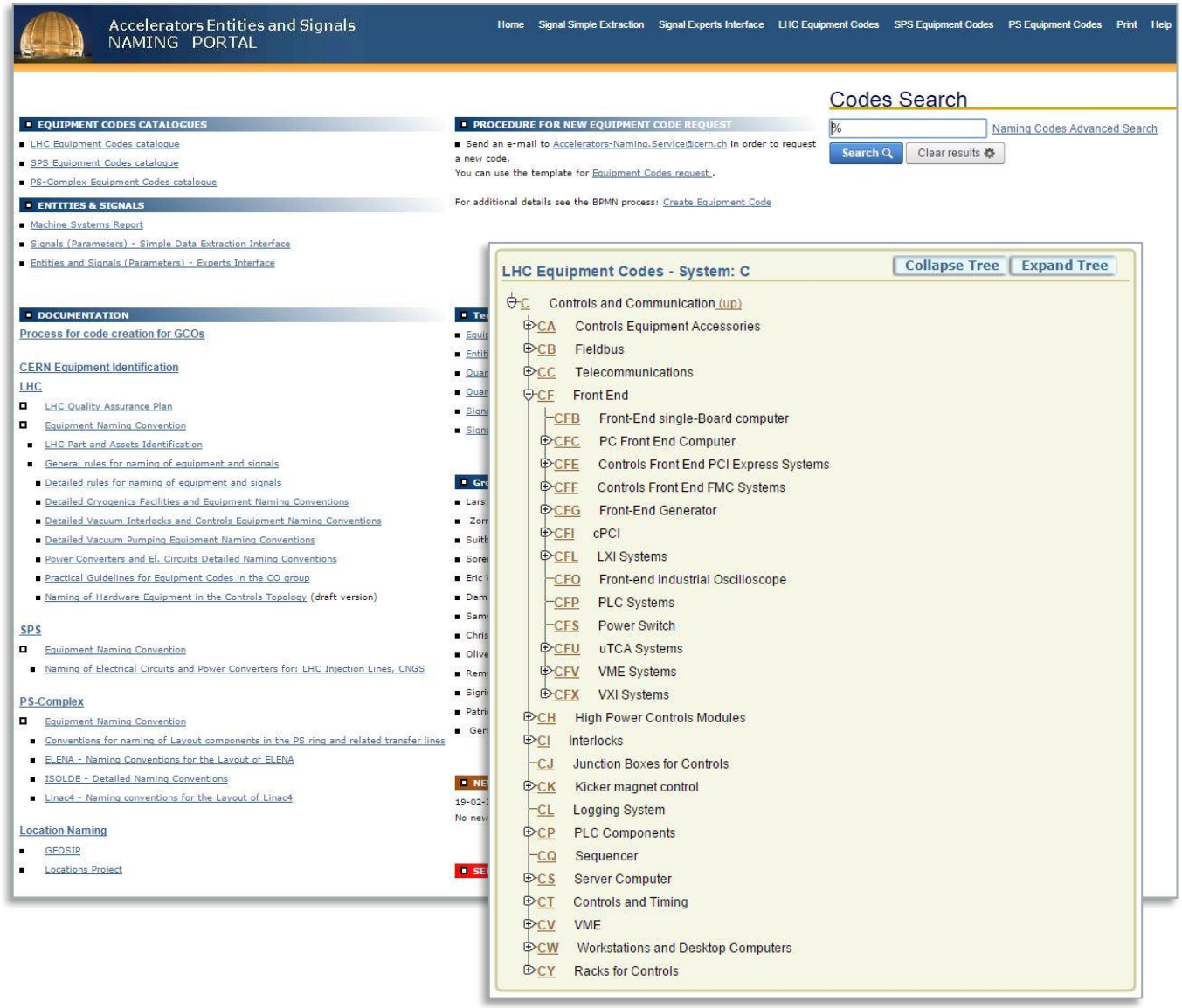
Classifying the components of the infrastructure

- Within a hierarchy of Classes and types
- Types are identified by a 2-5 letters **functional equipment code**
- Adhering to CERN **naming conventions**



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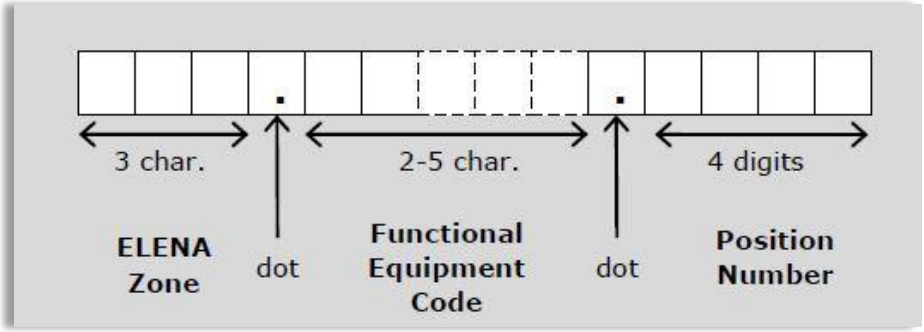
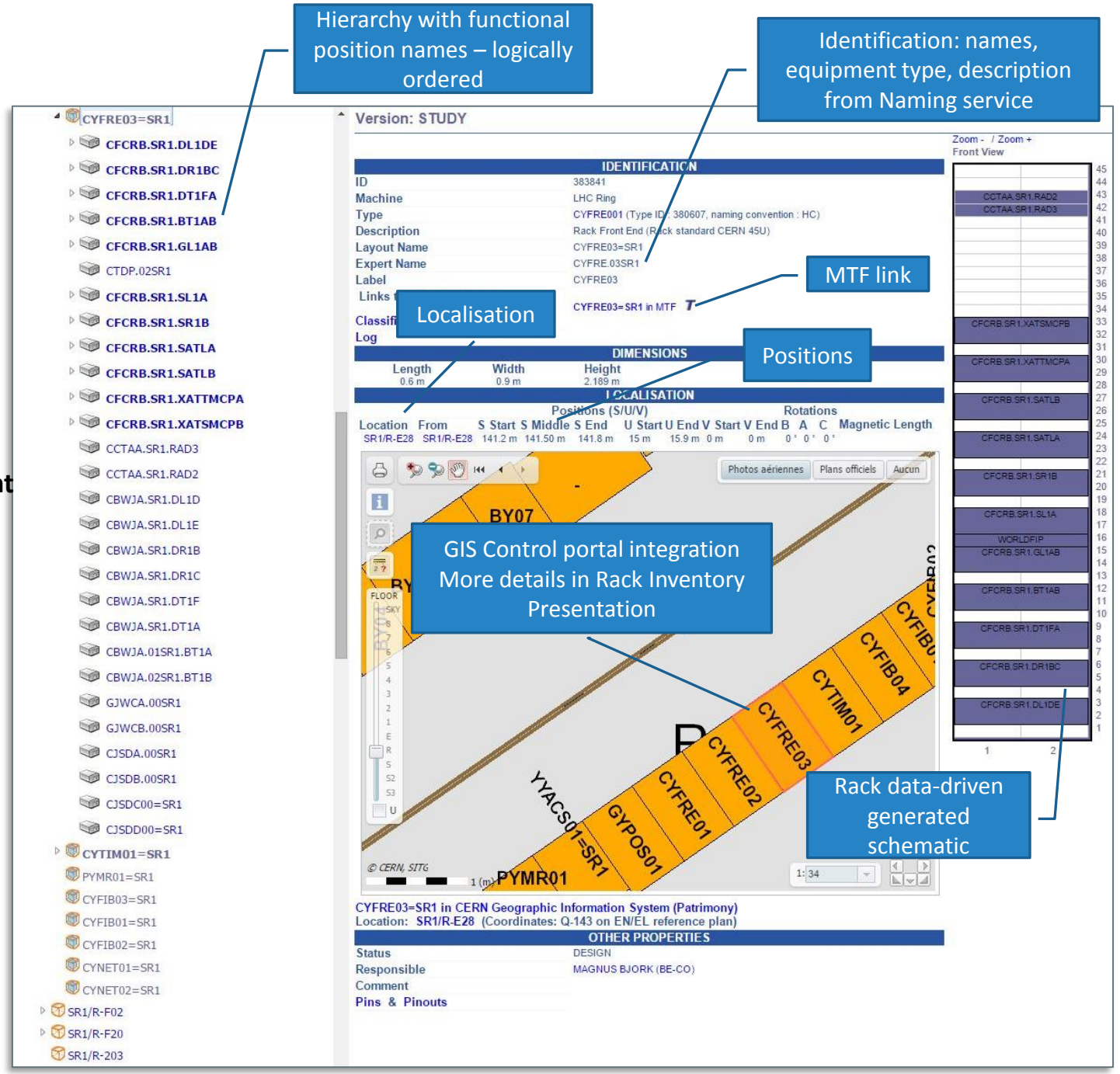
Defining, identifying the components as **Functional Positions**

- Nature/function of the components
- Localisation/position of the components
- Official name defined by the QA plan of each machine



Example: ELENA naming convention



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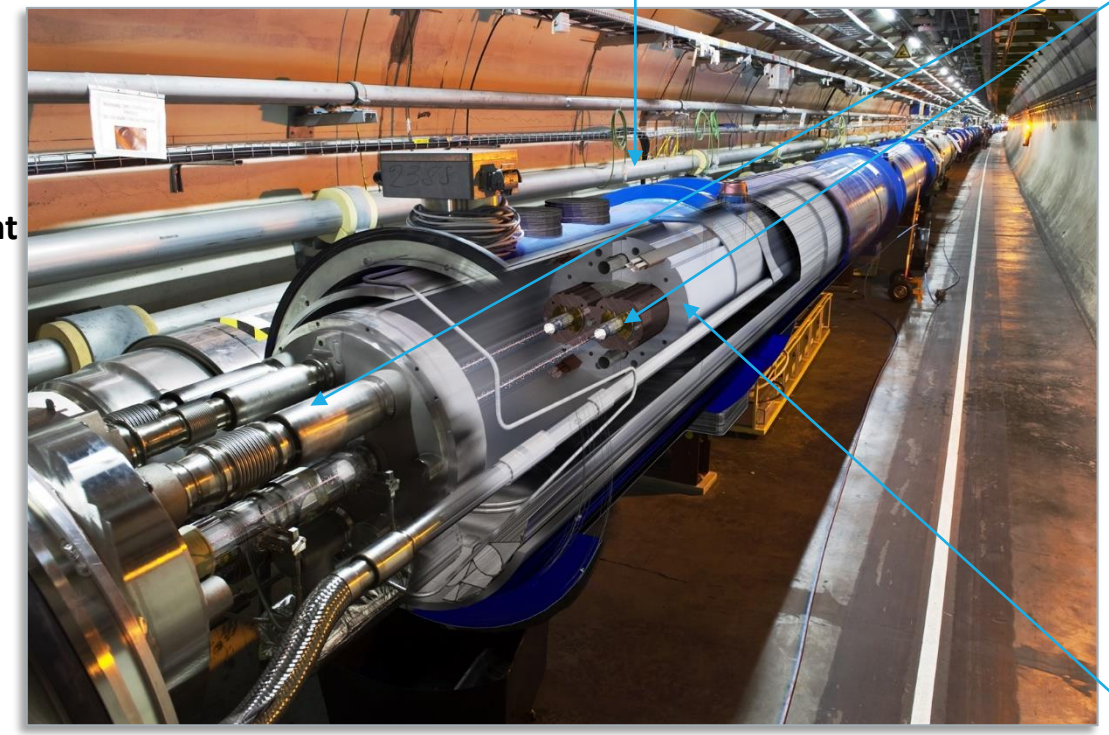
- **Mechanical** assemblies (Physical structures)



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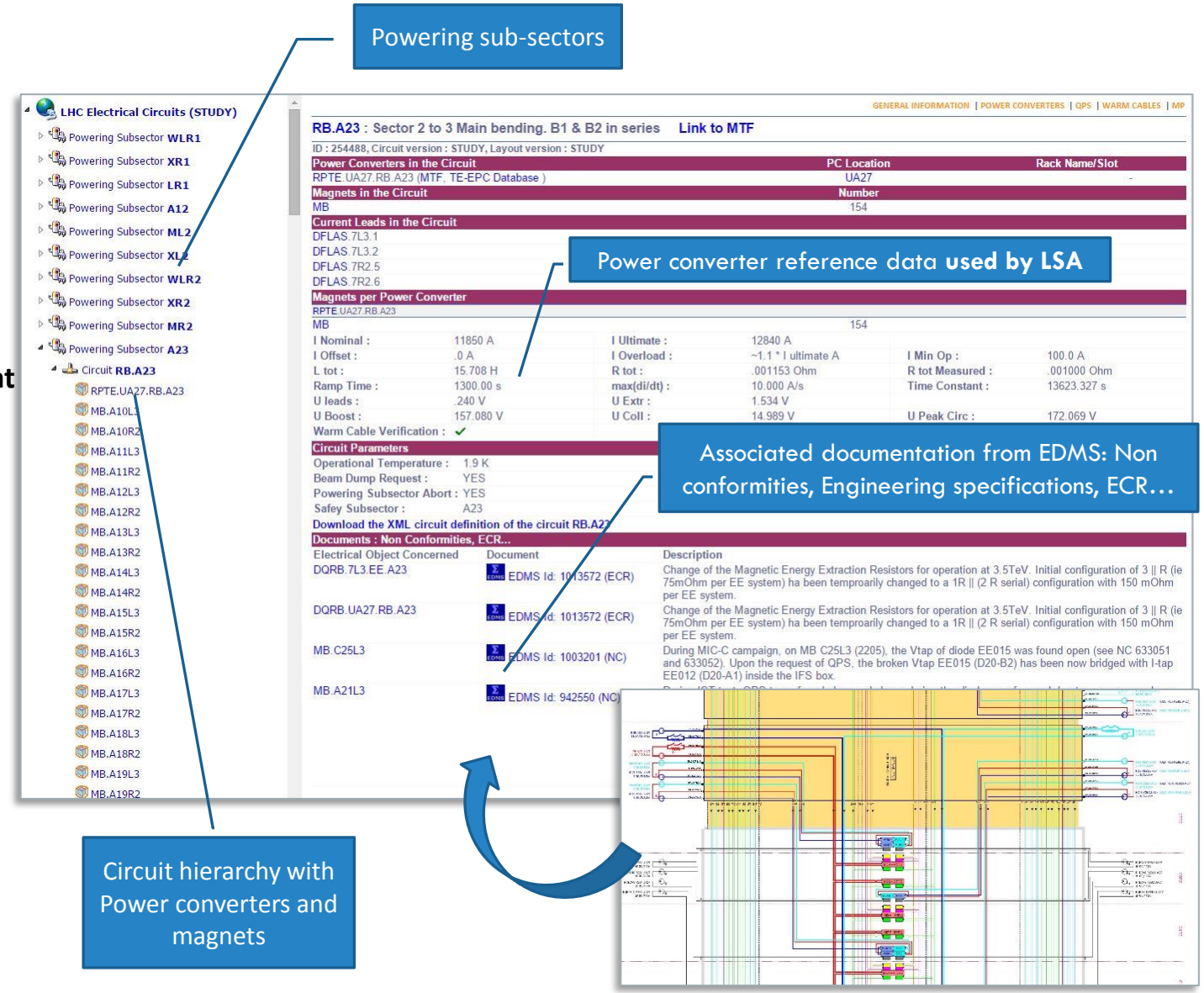
- **Powering** connections & circuits



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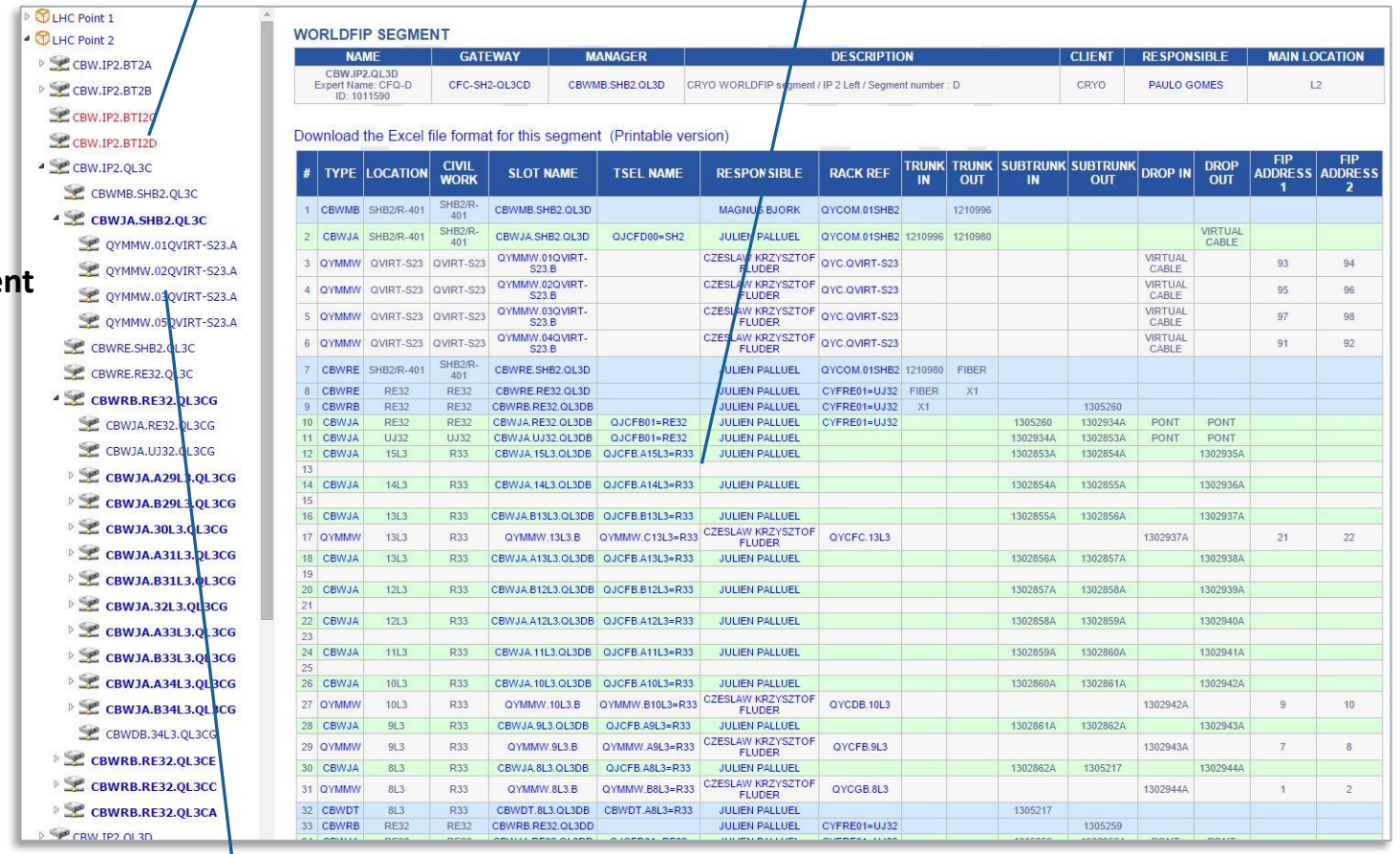
- **Control** connections & circuits

WorldFIP segments

Complete segment report with FIP adresses, cable numbers… downloadable as Excel file



NAME	GATEWAY	MANAGER	DESCRIPTION	CLIENT	RESPONSIBLE	MAIN LOCATION
CBW.IP2.QL3D Expert Name: CFQ-D ID: 1011590	CFC-SH2-QL3CD	CBWMB.SHB2.QL3D	CRYO WORLDFIP segment / IP 2 Left / Segment number : D	CRYO	PAULO GOMES	L2

#	TYPE	LOCATION	CIVIL WORK	SLOT NAME	TSEL NAME	RESPONSIBLE	RACK REF	TRUNK IN	TRUNK OUT	SUBTRUNK IN	SUBTRUNK OUT	DROP IN	DROP OUT	FIP ADDRESS 1	FIP ADDRESS 2
1	CBWMB	SHB2/R-401	SHB2/R-401	CBWMB.SHB2.QL3D		MAGNUS BJORK	QYCOM.01SHB2		1210996						
2	CBWJA	SHB2/R-401	SHB2/R-401	CBWJA.SHB2.QL3D	QJCFD00=SH2	JULIEN PALLUEL	QYCOM.01SHB2	1210996	1210980				VIRTUAL CABLE		
3	QYMMW	QVIRT-S23	QVIRT-S23	QYMMW.01QVIRT-S23.B		CZESLAW KRZYSZTOF FLUDER	QYC.QVIRT-S23					VIRTUAL CABLE		93	94
4	QYMMW	QVIRT-S23	QVIRT-S23	QYMMW.02QVIRT-S23.B		CZESLAW KRZYSZTOF FLUDER	QYC.QVIRT-S23					VIRTUAL CABLE		95	96
5	QYMMW	QVIRT-S23	QVIRT-S23	QYMMW.03QVIRT-S23.B		CZESLAW KRZYSZTOF FLUDER	QYC.QVIRT-S23					VIRTUAL CABLE		97	98
6	QYMMW	QVIRT-S23	QVIRT-S23	QYMMW.04QVIRT-S23.B		CZESLAW KRZYSZTOF FLUDER	QYC.QVIRT-S23					VIRTUAL CABLE		91	92
7	CBWRE	SHB2/R-401	SHB2/R-401	CBWRE.SHB2.QL3D		JULIEN PALLUEL	QYCOM.01SHB2	1210980	FIBER						
8	CBWRE	RE32	RE32	CBWRE.RE32.QL3D		JULIEN PALLUEL	CYFRE01=UJ32	FIBER	X1						
9	CBWRB	RE32	RE32	CBWRB.RE32.QL3DB		JULIEN PALLUEL	CYFRE01=UJ32	X1			1305260				
10	CBWJA	RE32	RE32	CBWJA.RE32.QL3DB	QJCFB01=RE32	JULIEN PALLUEL	CYFRE01=UJ32			1305260	1302934A	PONT	PONT		
11	CBWJA	UJ32	UJ32	CBWJA.UJ32.QL3DB	QJCFB01=RE32	JULIEN PALLUEL				1302934A	1302853A	PONT	PONT		
12	CBWJA	15L3	R33	CBWJA.15L3.QL3DB	QJCFB.A15L3=R33	JULIEN PALLUEL				1302853A	1302854A		1302935A		
13															
14	CBWJA	14L3	R33	CBWJA.14L3.QL3DB	QJCFB.A14L3=R33	JULIEN PALLUEL				1302854A	1302855A		1302936A		
15															
16	CBWJA	13L3	R33	CBWJA.B13L3.QL3DB	QJCFB.B13L3=R33	JULIEN PALLUEL				1302855A	1302856A		1302937A		
17	QYMMW	13L3	R33	QYMMW.13L3.B	QYMMW.C13L3=R33	CZESLAW KRZYSZTOF FLUDER	QYCFC.13L3					1302937A		21	22
18	CBWJA	13L3	R33	CBWJA.A13L3.QL3DB	QJCFB.A13L3=R33	JULIEN PALLUEL				1302856A	1302857A		1302938A		
19															
20	CBWJA	12L3	R33	CBWJA.B12L3.QL3DB	QJCFB.B12L3=R33	JULIEN PALLUEL				1302857A	1302858A		1302939A		
21															
22	CBWJA	12L3	R33	CBWJA.A12L3.QL3DB	QJCFB.A12L3=R33	JULIEN PALLUEL				1302858A	1302859A		1302940A		
23															
24	CBWJA	11L3	R33	CBWJA.11L3.QL3DB	QJCFB.A11L3=R33	JULIEN PALLUEL				1302859A	1302860A		1302941A		
25															
26	CBWJA	10L3	R33	CBWJA.10L3.QL3DB	QJCFB.A10L3=R33	JULIEN PALLUEL				1302860A	1302861A		1302942A		
27	QYMMW	10L3	R33	QYMMW.10L3.B	QYMMW.B10L3=R33	CZESLAW KRZYSZTOF FLUDER	QYCDB.10L3					1302942A		9	10
28	CBWJA	9L3	R33	CBWJA.9L3.QL3DB	QJCFB.A9L3=R33	JULIEN PALLUEL				1302861A	1302862A		1302943A		
29	QYMMW	9L3	R33	QYMMW.9L3.B	QYMMW.A9L3=R33	CZESLAW KRZYSZTOF FLUDER	QYCFB.9L3					1302943A		7	8
30	CBWJA	8L3	R33	CBWJA.8L3.QL3DB	QJCFB.A8L3=R33	JULIEN PALLUEL				1302862A	1305217		1302944A		
31	QYMMW	8L3	R33	QYMMW.8L3.B	QYMMW.B8L3=R33	CZESLAW KRZYSZTOF FLUDER	QYCGB.8L3					1302944A		1	2
32	CBWDT	8L3	R33	CBWDT.8L3.QL3DB	CBWDT.A8L3=R33	JULIEN PALLUEL				1305217					
33	CBWRB	RE32	RE32	CBWRB.RE32.QL3DD		JULIEN PALLUEL	CYFRE01=UJ32				1305259				

Hierarchy of a segment with managers, repeaters, tap box, agents, fip diags

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- **Mechanical** assemblies (Physical structures)
- **Powering** connections & circuits
- **Control** connections & circuits
- MAD **optic** sequences
- **Logical** connections between otherwise unrelated components : EIS Safety Chains

Data provided to LSA since 2006

```
/*********************************************************************
/*                        LHC SEQUENCE
/*********************************************************************

LHCB1 : SEQUENCE, refer = CENTRE, L = LHCLENGTH;
IP1:OMK,                          at= pIP1+IP1OFS.B1*DS;
  MBAS2.1R1:MBAS2,                at= 1.5+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 2209454,                                  from= IP1;
  TAS.1R1:TAS,                    at= 20.015+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 102103,                                from= IP1;
  BPMSW.1R1.B1:BPMSW002,          at= 21.564+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 6080259, assembly_id= 6080224,         from= IP1;
  BPMSW.1R1.B1_DOROS:BPMSW002,    at= 21.564+(-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 10429420, assembly_id= 6080224,         from= IP1;
  BPMWK.1R1:BPMWK,                at= 21.62+(0-IP1OFS.B1)*DS, slot_id= 6080224,                                             from= IP1;
  BPMWF.A1R1.B1:BPMWF,            at= 21.724+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 6080267, assembly_id= 6080224,         from= IP1;
  MQXA.1R1:MQXA,                  at= 26.15+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 282126, assembly_id= 102104,            from= IP1;
  MCBXH.1R1:MCBXH,                at= 29.842+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 282213, assembly_id= 102104,           from= IP1;
  MCBXV.1R1:MCBXV,                at= 29.842+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 282212, assembly_id= 102104,           from= IP1;
  BPMS.2R1.B1:BPMS,               at= 31.529+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 241889, assembly_id= 102105,           from= IP1;
  MQXB.A2R1:MQXB,                 at= 34.8+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 241890, assembly_id= 102105,             from= IP1;
  MCBXH.2R1:MCBXH,                at= 38.019+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 249450, assembly_id= 102105,           from= IP1;
  MCBXV.2R1:MCBXV,                at= 38.019+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 249451, assembly_id= 102105,           from= IP1;
  MQXB.B2R1:MQXB,                 at= 41.3+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 241892, assembly_id= 102105,             from= IP1;
  TASB.3R1:TASB,                  at= 45.342+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 241893, assembly_id= 102106,           from= IP1;
  MQSX.3R1:MQSX,                  at= 46.608+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 282127, assembly_id= 102106,           from= IP1;
  MQXA.3R1:MQXA,                  at= 50.15+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 241895, assembly_id= 102106,            from= IP1;
  MCBXH.3R1:MCBXH,                at= 53.814+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 249456, assembly_id= 102106,           from= IP1;
  MCBXV.3R1:MCBXV,                at= 53.814+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 249457, assembly_id= 102106,           from= IP1;
  MCSX.3R1:MCSX,                  at= 53.814+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 249458, assembly_id= 102106,           from= IP1;
  MCTX.3R1:MCTX,                  at= 53.814+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 249459, assembly_id= 102106,           from= IP1;
  MCOSX.3R1:MCOSX,                at= 54.297+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 282237, assembly_id= 102106,           from= IP1;
  MCOX.3R1:MCOX,                  at= 54.297+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 282236, assembly_id= 102106,           from= IP1;
  MCSSX.3R1:MCSSX,                at= 54.297+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 282235, assembly_id= 102106,           from= IP1;
  DFBXB.3R1:DFBXB,                at= 56.427+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 104672,                                from= IP1;
  BPMSY.4R1.B1:BPMSY,             at= 58.3145+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 104595,                               from= IP1;
  MBXW.A4R1:MBXW,                 at= 61.322+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 134500,                                from= IP1;
  MBXW.B4R1:MBXW,                 at= 65.588+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 134501,                                from= IP1;
  MBXW.C4R1:MBXW,                 at= 69.854+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 134502,                                from= IP1;
  MBXW.D4R1:MBXW,                 at= 74.12+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 134503,                                 from= IP1;
  MBXW.E4R1:MBXW,                 at= 78.386+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 134504,                                from= IP1;
  MBXW.F4R1:MBXW,                 at= 82.652+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 134505,                                from= IP1;
  X1FCR.4R1:X1FCR,                at= 141.16+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 378054, assembly_id= 102108,           from= IP1;
  BRANA.4R1:BRANA,                at= 141.376+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 883446, assembly_id= 102108,          from= IP1;
  X1ZDC.A4R1:X1ZDC001,            at= 141.71+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 2019586, assembly_id= 102108,          from= IP1;
  TANAR.4R1:TANAR,                at= 142.75+(0-IP1OFS.B1)*DS, mech_sep= 0, slot_id= 102108,                                from= IP1;
  TCL.4R1.B1:TCL,                 at= 149.73+(0-IP1OFS.B1)*DS, mech_sep= 0.1755, slot_id= 6755437,                          from= IP1;
  BPMWB.4R1.B1:BPMWB,             at= 151.0945+(0-IP1OFS.B1)*DS, mech_sep= 0.1780, slot_id= 181634,                         from= IP1;
  MBRC.4R1.B1:MBRC,               at= 157.9+(0-IP1OFS.B1)*DS, mech_sep= 0.1880, slot_id= 241903, assembly_id= 102110,       from= IP1;
  MCBYV.A4R1.B1:MCBYV,            at= 164.439+(0-IP1OFS.B1)*DS, mech_sep= 0.1940, slot_id= 249460, assembly_id= 102111,     from= IP1;
  MCBYH.4R1.B1:MCBYH,             at= 165.735+(0-IP1OFS.B1)*DS, mech_sep= 0.1940, slot_id= 249462, assembly_id= 102111,     from= IP1;
  MCBYV.B4R1.B1:MCBYV,            at= 167.031+(0-IP1OFS.B1)*DS, mech_sep= 0.1940, slot_id= 249464, assembly_id= 102111,     from= IP1;
  MQY.4R1.B1:MQY,                 at= 169.553+(0-IP1OFS.B1)*DS, mech_sep= 0.1940, slot_id= 241907, assembly_id= 102111,     from= IP1;
```

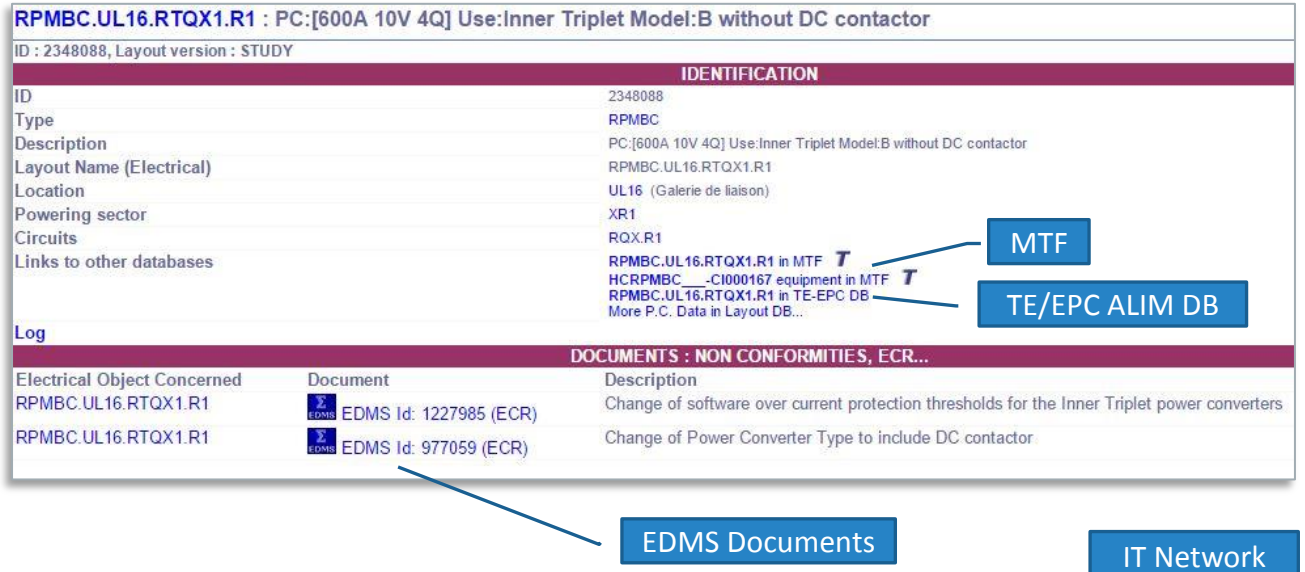
LHC sequence file generated from the database. Used by BE-ABP as one input file for MAD program (Methodical Accelerator Design simulation program)

COLLABORATIONS WITH OTHER CERN SYSTEMS

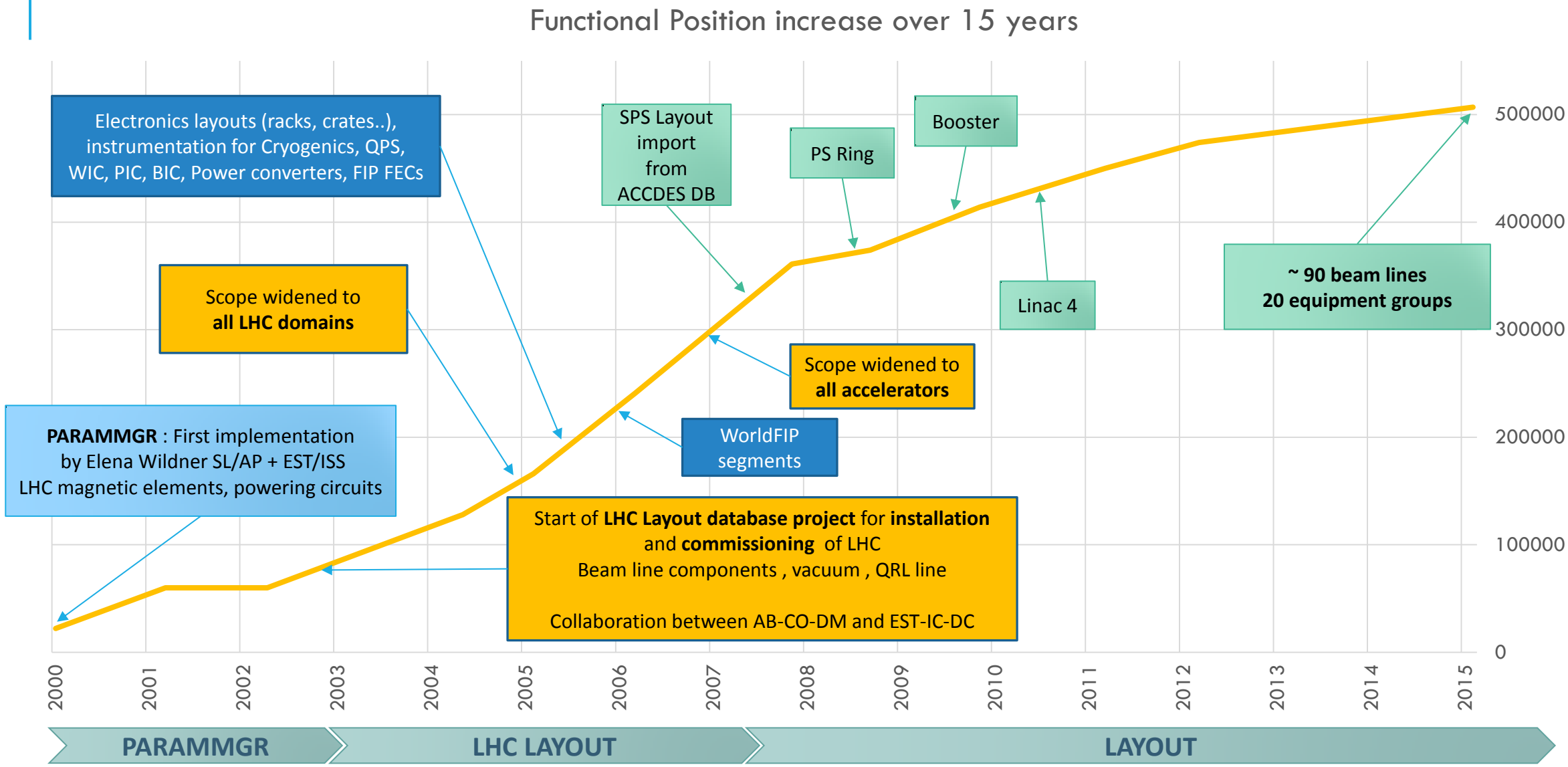
Layout database shares data with ~40 CERN database accounts (LSA, CCDB, SURVEY…)

Layout Service website integrates navigation to other external web interfaces at CERN:

- MTF (Assets Maintenance Management)
- EDMS (Documentation Management)
- Power converters Database (Alim DB)
- GIS Portals (CERN Geographical Information Systems)
- Normal Conducting magnets database (Norma DB)
- Control Configuration Service (CCDB)
- IT Network Service, etc…



EVOLUTION


Functional Position increase over 15 years
Electronics layouts (racks, crates..), instrumentation for Cryogenics, QPS, WIC, PIC, BIC, Power converters, FIP FECs
SPS Layout import from ACCDES DB
PS Ring
Booster
Linac 4
~ 90 beam lines
20 equipment groups
Scope widened to all LHC domains
Scope widened to all accelerators
WorldFIP segments
PARAMMGR : First implementation by Elena Wildner SL/AP + EST/ISS
LHC magnetic elements, powering circuits
Start of LHC Layout database project for installation and commissioning of LHC
Beam line components , vacuum , QRL line
Collaboration between AB-CO-DM and EST-IC-DC
500000
400000
300000
200000
100000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
PARAMMGR
LHC LAYOUT
LAYOUT

UNDERESTIMATED IMPACT OF EXPANSION

As you have seen, over the last 10 years, the Layout service has expanded enormously

- Increase in **geographical scope**: From LHC main tunnel to any accelerator related locations
- Increase in **domain scope**: From LHC beam-line components to potentially any domain covered at CERN (Magnets, QPS, Shielding's…)
- Consequently, increase in **responsibility and technical expertise** provided

Scope extension not initially foreseen in 2003

Evolution not well controlled:

- Fulfilling missing functionality **extending far beyond the Layout primary scope** in response to critical user requests
- Prioritising short-term satisfaction of user, **neglecting maintainability**, underestimating long-term support
- **Over-compensating for equipment group's** lack of time, resources, commitment and understanding of their own data/business

Resulting in :

- Sub-optimal evolution of the database (wrong choices, duplicate implementations …)
- Technical debts
- Increased supports

"PHILOSOPHY" DID NOT CHANGE

Layout service's philosophy of providing support for **centralised**, **integrated** functional position data has not changed over the last decade

Equipment groups are responsible for the accuracy of their data, but not necessarily its maintenance

In order to maintain a **global coherency**, **data management**, **integration** and **control** of layout data is currently performed by "layout data managers"

- ~4 FTEs across BE-CO-DS and EN-MEF-DC

EXPANSION WILL NOT STOP

The expansion will definitely continue, demands are there:

- Support for HL-LHC
- Maintenance Management Project expressed the need to extend the scope to any surface buildings
- Requests for experiment layouts
- Not even talking about FCC layout studies…

NOT SCALABLE, NOR SUSTAINABLE…

The service is becoming increasingly unsustainable with the current limited resources, due to:

- The number of **domains** covered
- The range of **functionalities** provided
- The complex, **labour-intensive nature** of the highly-relational data
- Reliance on **domain expertise** within the Layout team
- **LHC centric** data model not originally designed to support all infrastructures
- A growing user community implies a **proliferation of user-support** and **data maintenance**

The current philosophy, procedures and tools are no longer appropriate, as they cannot be scaled to meet the ever-increasing demand for the service

NEW APPROACH

Review the responsibility model, **redistribute the roles** and **delegate responsibility** for data management

As far as possible, equipment groups should be able to maintain their data

- Requires new accredited functions in the groups
- Knowledgeable person with appropriate competences to manage and be responsible for the data

Representatives from EN-MEF-DC to become responsible for **validating changes** made by users to **ensure the continuity of the global coherency**

Transform Layout Database Service in BE-CO-DS

- From data support oriented team to **Agile development team**
- Focus on **providing database and tools**, **minimise direct data management**
- **Additional resources** allocated for development phase

Hernan Diaz Rodriguez


Margarita Chrysogelou

CHALLENGES: DATABASE CONSOLIDATION

A complete new database is required

- To eliminate **technical debt** incurred by incremental evolution
- To **rationalise**, consolidate similar core concepts
- To model **more accurately** the business logic of the specific domains
- To **reinforce integrity constraints** of the specialised domain data
- To implement a **fine-grained access scheme** to protect data
- Improve **interoperability** and **automated synchronisation** with other systems (CCDB, LSA, MTF/InforEAM, GIS, Survey DB, Norma DB)
- To develop a detailed **time-oriented database mechanism** in order to manage past, current and **future** layouts
- Use standardised BE-CO-DS **Oracle Commons** database modules (for auditing, history, notification, error management…)

Without this new model, it is **not possible to delegate responsibility** for the data management back to the equipment groups

Re-establish clear boundaries for the scope of the Layout Database

- e.g. Separate pure Layout Data (Hardware topologies) from UNICOS configuration data (software objects and parameters) (concerned cryogenics, vacuum, QPS)

CHALLENGES: WEB USER INTERFACES

A new database implies complete new Graphical User Interfaces

- Combine read/write capabilities into **one modern, web-based tool**
- **Modular** GUI for power users such as EN-MEF-DC
- **Tailored tools**; customised to the different data sets, procedures and workflows of each domain

Excellent **opportunity to streamline** the approach between Layout and other BE-CO systems in terms of implementation technology and architecture

- No more .NET or APEX but latest BE-CO technology stack : Java spring MVC + REST + ExtJS or JSF

SUMMARY

The Layout Service is a 12 years old **critical information system** (used by many people to do lots of different things)

It's scope has **evolved significantly**, but the database and tools have not

Layout service **must evolve** in order to preserve both the quality of data and the overall level of service

- Current situation/ philosophy is not scalable
- Need to give responsibility for data management back to the equipment groups
- Break vicious cycle : too much data support meaning less development

2015 will be a crucial year for the service; the **resources are now available** to do the work and it is essential to **make significant progress** in the coming months

We need to have at least the **main core features** of the new system in place **before LS2**

- For **key Layout users** i.e. MEF + CRG
- This is already a **very ambitious goal**, but it would significantly reduce the amount of data support for LS2
- **Less critical domains can follow incrementally** in function of necessity, time and resources available