Interconnection boxes : DFH Concept overview and quality assurance

UU-CERN-RFR meeting

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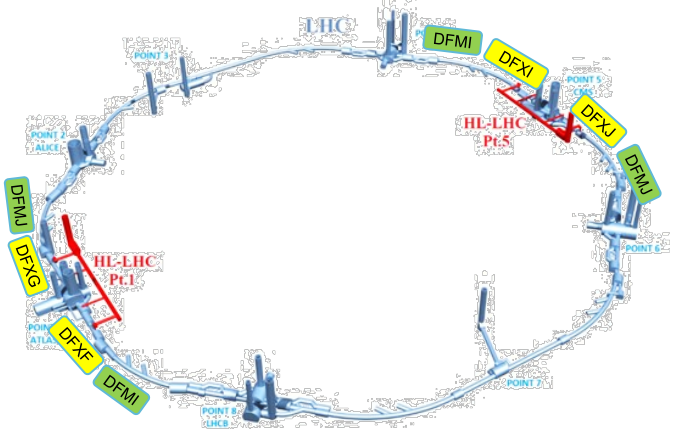
WP6a workpackage leader : A. Ballarino

Context

- Each IP1 and IP5 sides equipped with 2 cold powering chains of cryostats
  - Triplet insertion : **DFH – SC Link (DSH) – DFX**
  - Matching sections : DFH – SC Link - DFM



- DFH basic functions:
  - Electrical interface between SC Link (20K) and power converters (300K)

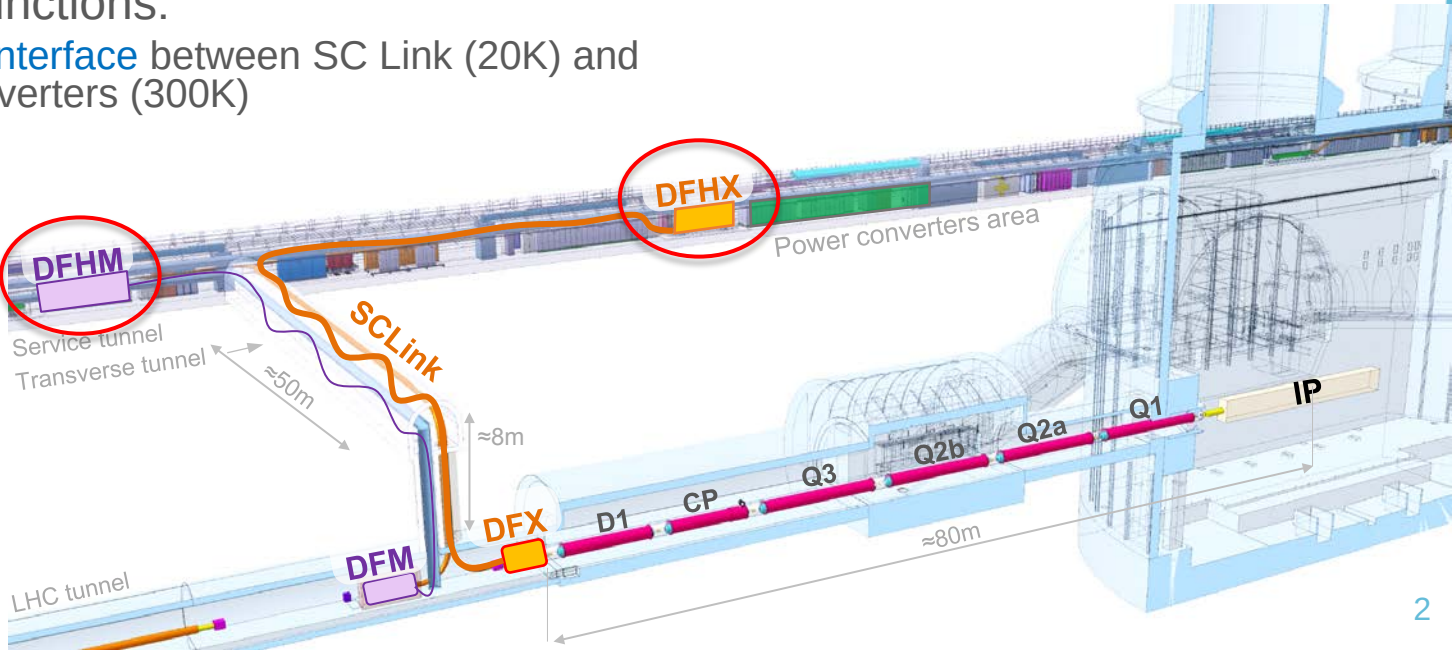
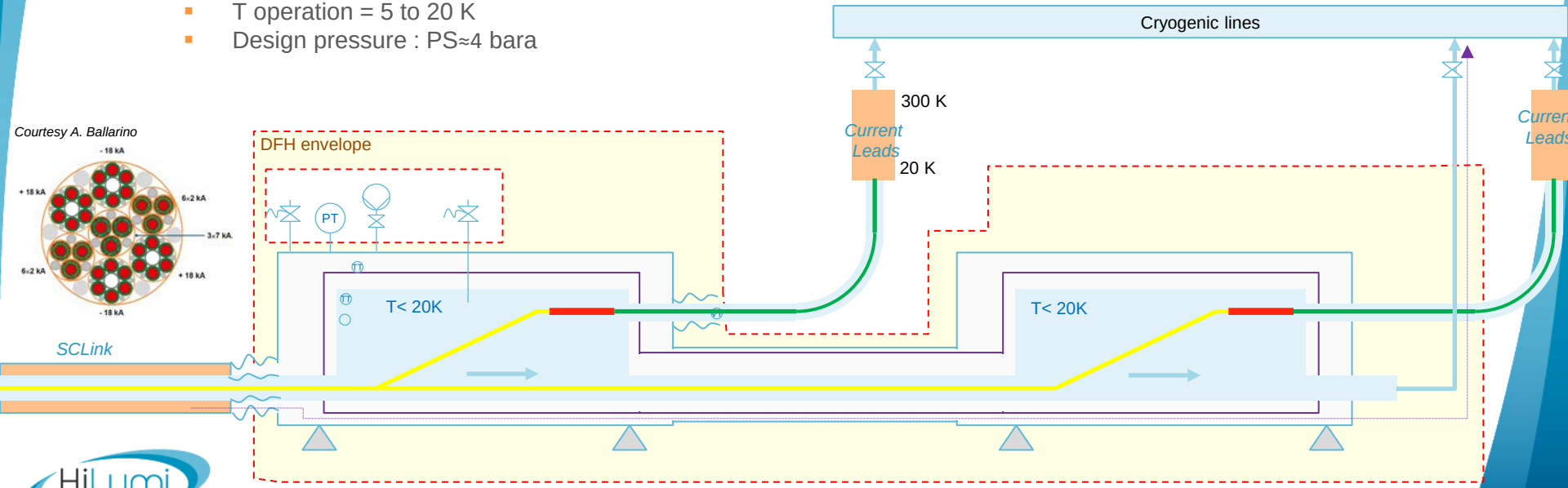


Illustration of the position of the DFH (not latest version for details)

DFH concept

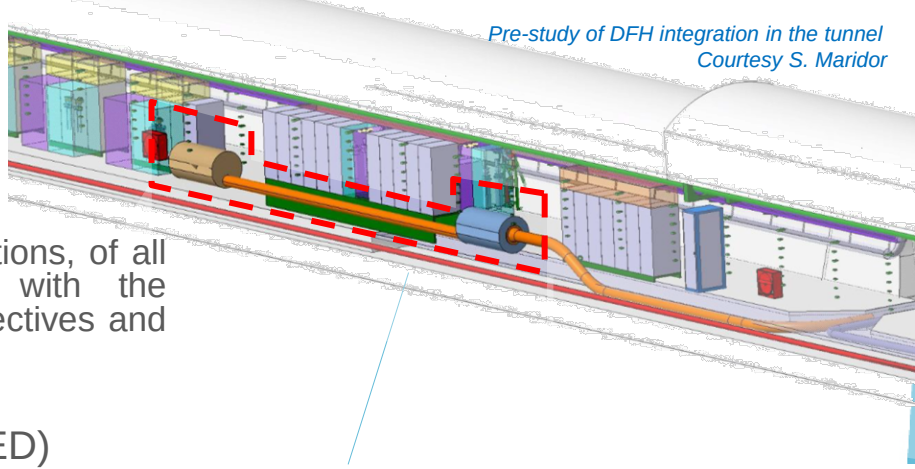
- DFH objectives :
  - Connect the 37 electrical leads from the SCLink side to the current leads interfaces
  - Monitor the electrical connection performance
  - Ensure the cooling of electrical connections and cables
- Overview of the DFH:
  - 37 (19) leads from 0.12 kA to 18 kA in a flow of gaseous helium below 20K.
  - T operation = 5 to 20 K
  - Design pressure : PS≈4 bara



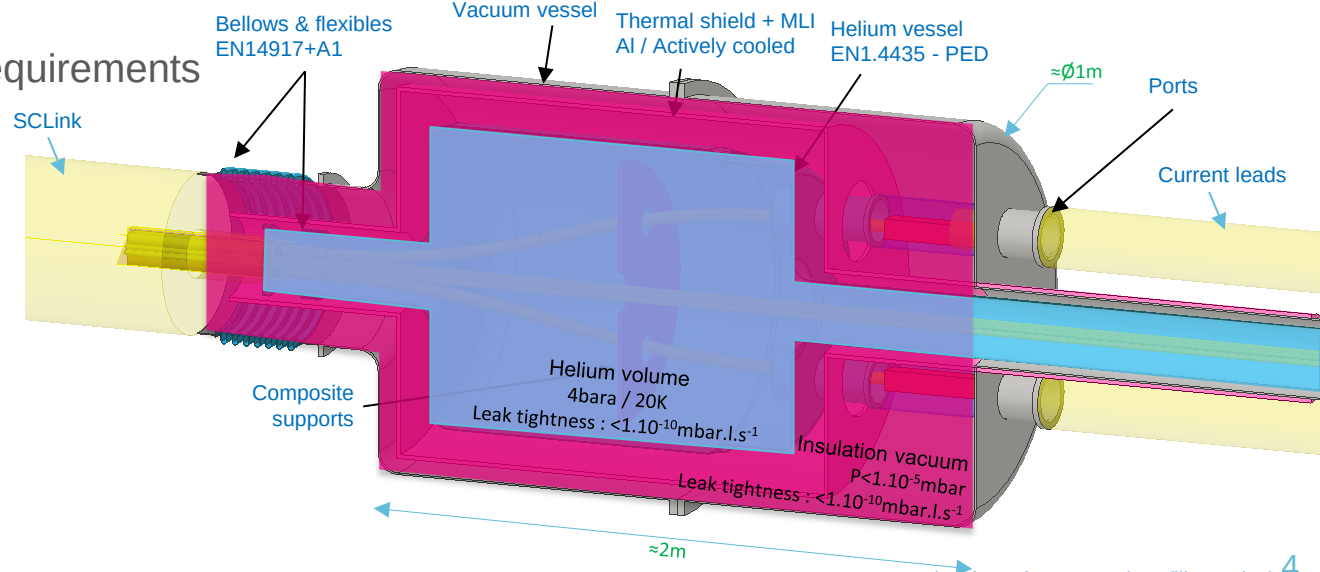
Layout of DFH electrical boxes

Overview of manufacturing and qualification

- CERN safety rules : GSI-M4
  - “The manufacture […] by collaborating institutions, of all new cryogenic equipment shall comply with the applicable CERN Safety Rules, European directives and harmonised standards”
- Pressure European Directive 2014/68/EU (PED)
- HL-LHC QA specific requirements



Pre-study of DFH integration in the tunnel
Courtesy S. Maridor



Artist view of one DFH box (illustrative)

Manufacturing, qualification and QA

Design phase : CERN supply specification drawings acc. ISO-GPS

Procurement

- Design, calculation reports, Technical specifications (PED, HL-LHC QA spec., CE certif.)
- ➔ CERN approval before release

Manufacturing

- MIP, welding book, cleaning, inspection procedures.
- Manufacturing drawings produced from CERN specification dwg
- ➔ CERN approval
- Manufacturing process ➔ Inspection reports (including certifications)
- ➔ CERN reports approval

Assembly & qualification phase

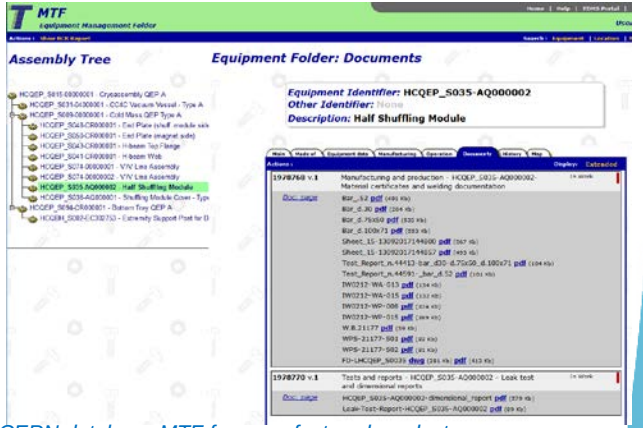
- Assembly procedures / Inspection and qualification plan
- ➔ CERN assembly approval
- Assembly process ➔ Inspection reports

QA follow-up

- Upload documentation to MTF
- Detailed installation and maintenance procedures
- ➔ CERN approval

Delivery to CERN

- Packing and shipping to CERN



CERN database MTF for manufactured products

Non exhaustive list of QA requirements for illustration

	Procurement				Manufacturing & assembly											QA
							Welding		Weld inspection				Leak test		Cleaning	
	Manufacturing drawings	CE certif.	Calculations reports	Pressure test procedure	Material certificate	Dimensional report	Welder	Procedure	NDT personnel	Visual inspection	X-ray proc.	X-ray result	Procedure	Operator	Procedure	MTF archiving
Standard	ISO-GPS	PED	EN13445 EN14917+A1	EN13458-2	EN10028 HL-LHC_QA	NA	ISO 9606-1 ISO14732	EN ISO 15614-1	ISO 9712 NDT level2	ISO 17637	ISO 17636	ISO 5817 Quality B	EN1779A1 EN13185	ISO 9712 Level2	EN12300	
Qualification by notified body		if needed	If needed				X	X	X					X		
Components																
Vacuum vessel	X		X		X	X	X	X	X	X	X	X	X	X		X
Helium vessels	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Thermal shield	X			X	X	X	X	X	X	X	X	X	X	X		X
MLI	X				X	X										X
Structural supports	X				X	X										X

Additional information

Standards usually specified for HL-LHC cryostats procurement

	Procurement				Manufacturing & assembly											QA
							Welding		Weld inspection				Leak test		Cleaning	
	Manufacturing drawings	CE certif.	Calculations reports	Pressure test procedure	Material certificate	Dimensional report	Welder	Procedure	NDT personnel	Visual inspection	X-ray proc.	X-ray result	Procedure	Operator	Procedure	MTF archiving
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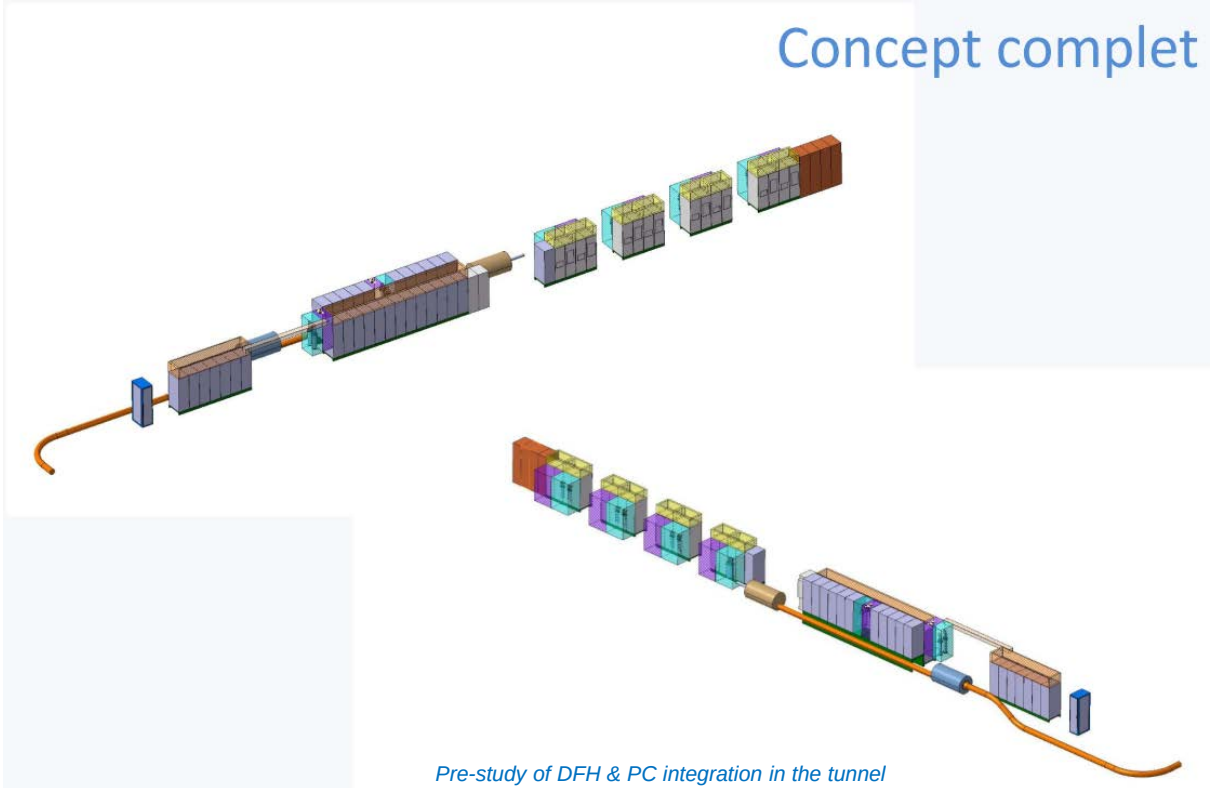
Qualification by notified body		if needed	If needed				X	X	X					X		
Components																
Vacuum vessel	X		X		X	X	X	X	X	X	X	X	X	X		X
Helium vessels	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Thermal shield	X			X	X	X	X	X	X	X	X	X	X	X		X
MLI	X				X	X										X
Structural supports	X				X	X										X

Pressure vessels : general
Pressure Equipment Directive (PED) 2014/68/EU;
EN 13445 Unfired pressure vessels;
EN 13458 Static vacuum insulated vessels;
Materials
EN 10204 Metallic products – Types of inspection documents;
EN 10028-7 Flat products made of stainless steels for pressure purposes;
EN 10216 Seamless steel tubes for pressure purposes;
EN 10217 Welded steel tubes for pressure purposes;
EN 10222 Steel forging for pressure purposes;
EN 10213 Steel casting for pressure purposes;
EN 10253 Butt-welding pipe fitting;
EN 10272 Stainless steel bars for pressure purposes;
EN 12392 Aluminium and aluminium, alloys – Wrought products – special requirements for products intended for the production of pressure equipment;
Brazing
EN 13134 Brazing – Procedure approval
EN 13133 Brazing – Brazer approval
EN 12799 Brazing – Non-destructive examination of brazed joints
Bellows
EN 14917+A1 Metal bellows expansion joints for pressure applications;
EN 13445-3 §14 Expansion bellows
Leak testing
EN 13185 Non-destructive testing – Leak testing – tracer gas method;
EN 1779-A1 Non-destructive testing : leak testing : criteria for method and technique selection;

Cleaning
EN 12300 Cryogenic vessels – Cleanliness for cryogenic services
Welding
ISO 5817 Welding – Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) – Quality levels for imperfections (Requirement: Level B);
ISO 9606-1 Qualification testing of welders – Fusion welding – Steels;
ISO 14732 Welding personnel – Qualification testing of welding operators
EN ISO 15609-1 Specification and qualification of welding procedures for metallic materials - Welding procedure specification - Part 1: Arc welding;
EN ISO 9712 Non-destructive testing – Qualification and certification of NDT personnel. Requirement: Level 2;
EN ISO 17637 Non-destructive testing of welds – Visual testing of fusion-welded joints;
ISO 17636-1 Non-destructive testing of welds – Radiographic testing. X- and gamma-ray techniques with film;
ISO 17636-2 Non-destructive testing of welds – Radiographic testing. X- and gamma-ray techniques with digital detectors;

Preliminary concept of integration



Pre-study of DFH & PC integration in the tunnel
Courtesy S. Maridor