



Mechanical interfaces of the DFX to the SC Link, DCM, and the cryogenic equipment

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20 June 2019

Detailed design review of the DFX

Interfaces overview

Tunnel, supports & Beam

SCLink interface

- Leads + Instru
- Jackets flanges

DCM interface

- Leads + Instru
- Jackets flanges

QXL interface

- Vacuum jacket flange
- Cryogenic lines

Instrumentation

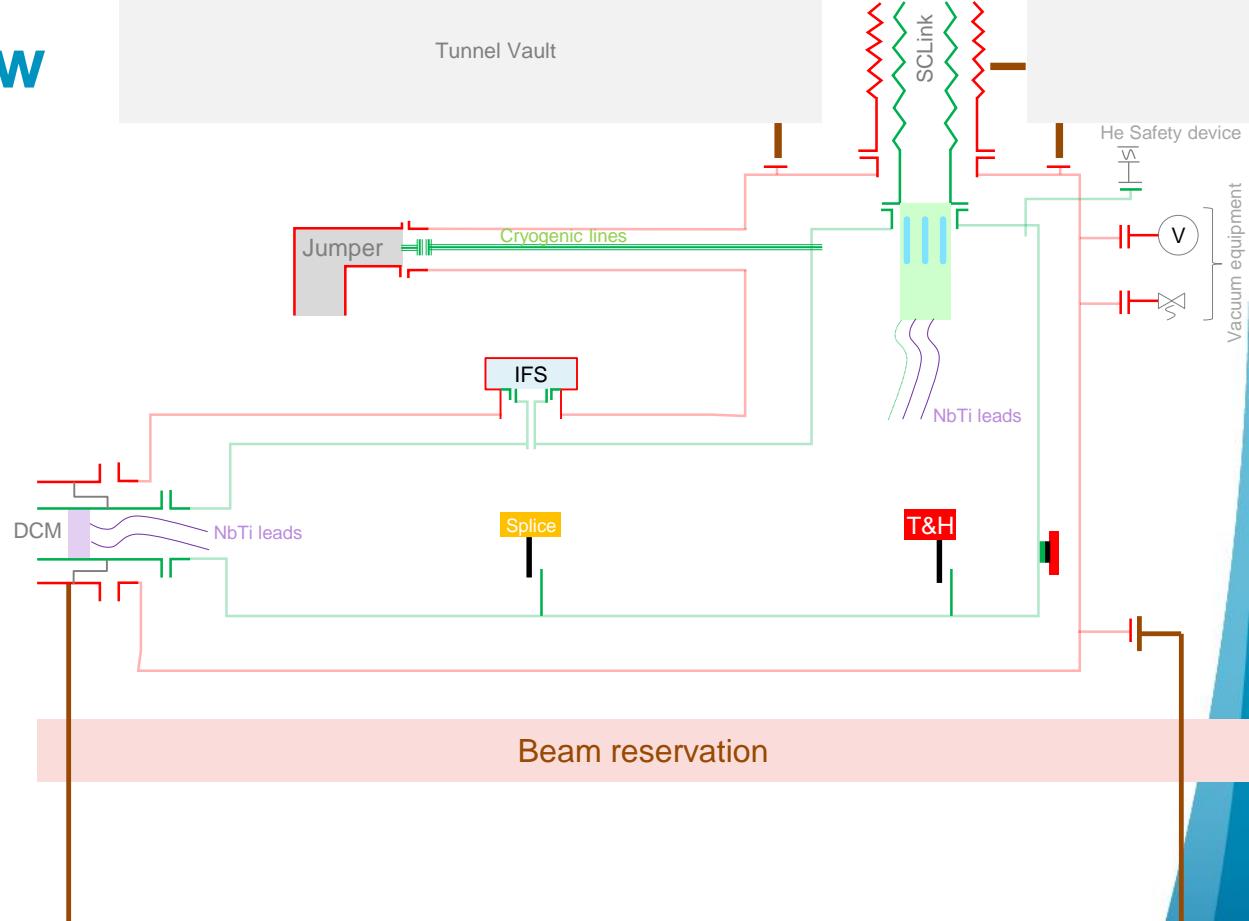
- Sensors supports + IFS
- Splices + bus bars support

External services

- Vacuum equipment
- Pressure relief devices

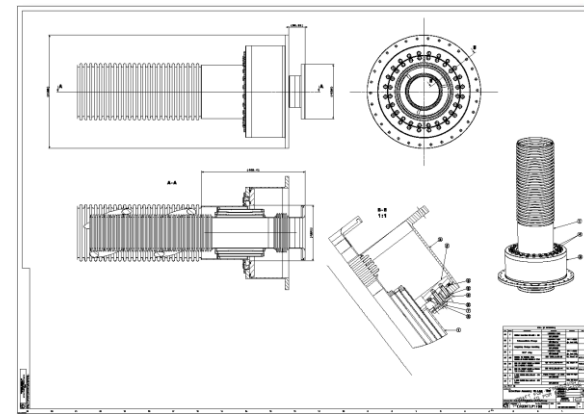
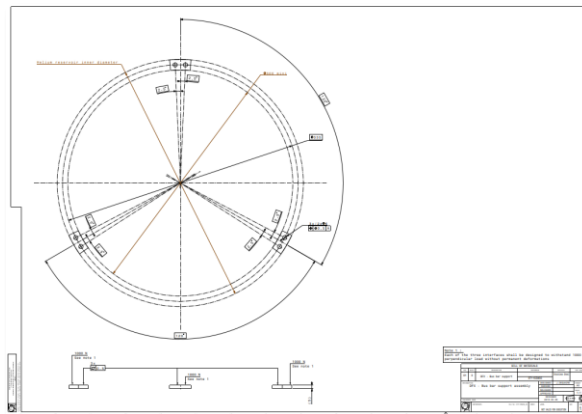
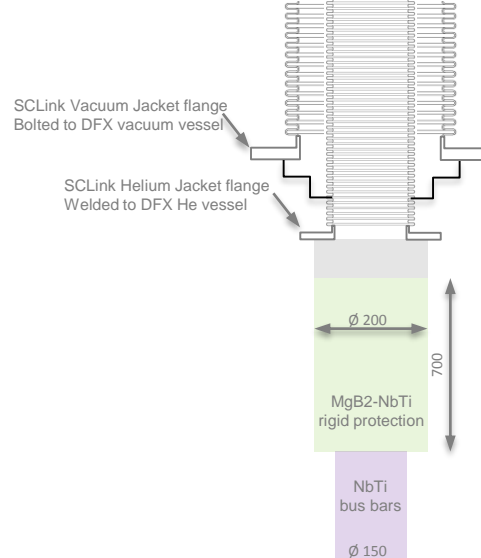
DFX interfaces

- Outer & Inner jackets
- Cryogenics
- Supports
- External services
- Instrumentation & cables/splices



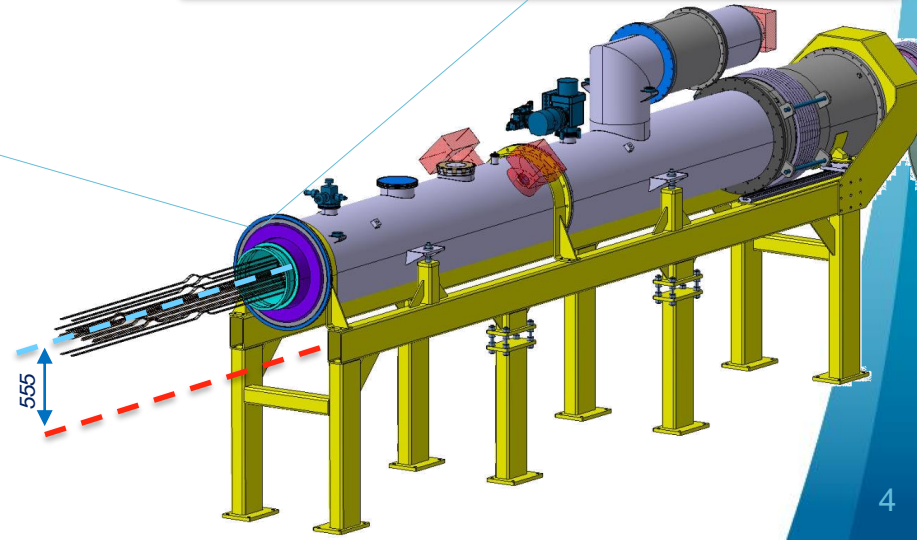
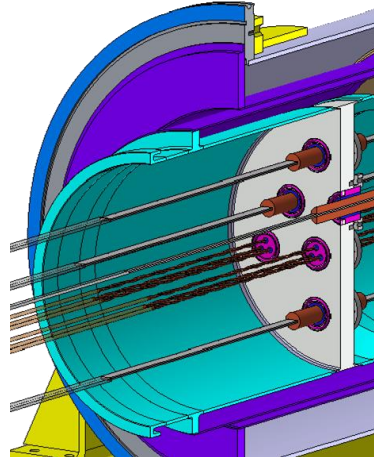
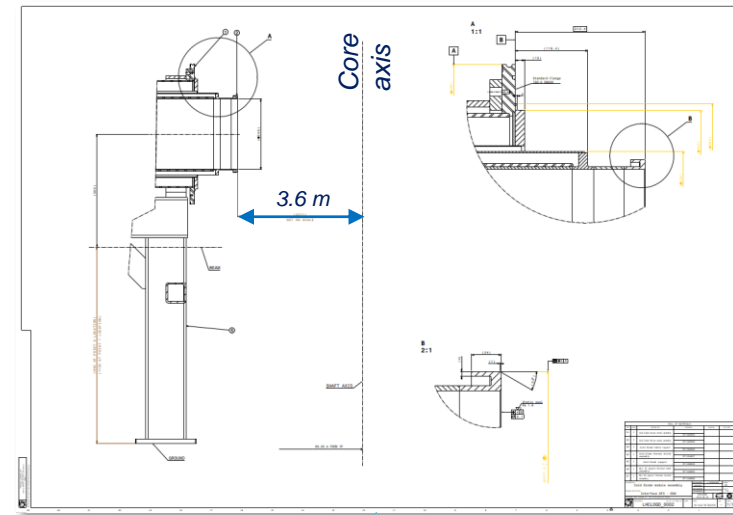
SCLink interfaces

- Vacuum & Helium jackets
 - LHCDHTLP1190
- Helium jacket end
 - $\varnothing 200$ x 700 mm + NbTi bus bars
- Bus bars
 - Design of supports between bus bars de-scoped from prototype deliverables
 - DFX shall present mechanical interfaces in helium vessel
 - LHCLDQD_0003
- NbTi-NbTi splices
 - Fixed to helium vessel
 - LHCLDQD_0003



DCM interface

- D1-DFX Connection Module (DCM)
- Vacuum & Helium Jackets
 - ISOK-DN630 with standard O-ring
 - Lip weld
 - Interface Drawing: LHCLDQD_0002
- Bus bars
 - De-scoped from prototype



DCM interface : Lambda Plate

Bus bars overview (see dedicated talk)

Λ-Plate design based on LHC experience:

- $\Delta P=20$ bar
- Nominal operation 1.9K
- Thermal cycle : 50
- Insulation @ RT : 4.6 kV
- Overall leak rate @ RT : 1.10^{-4} mbar.l.s⁻¹

R&D activities:

- Demonstrator completed
 - 6 kA type plug manufacturing R&D complete
 - 18 kA similar type plug being qualified
- Plug Lab complete
 - Plasma treatment machine
 - Soldering post

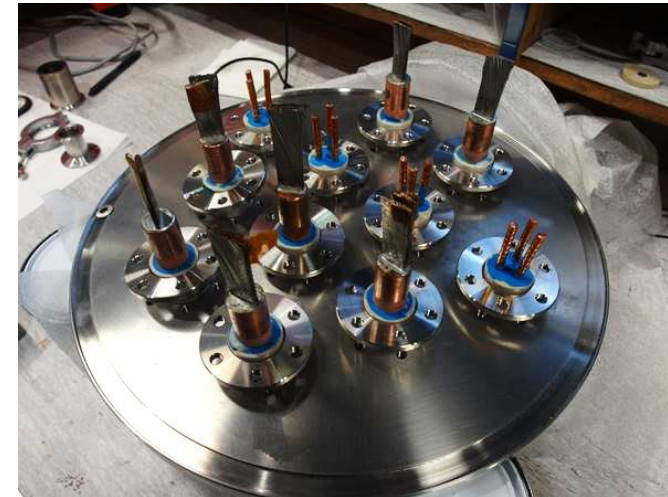
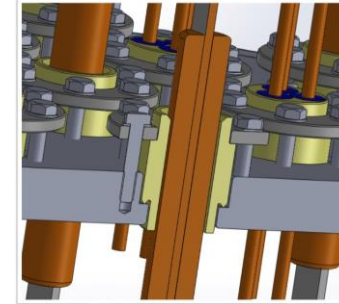
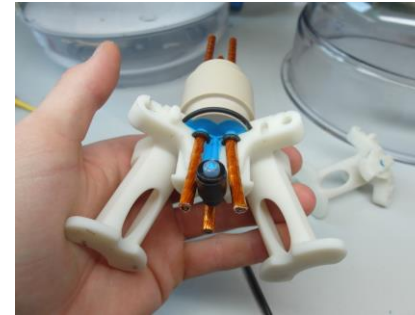
Thermo-mechanical results

- 100% 6 kA plugs @ 1.10^{-10} mbar.l.s⁻¹ after 10 Thermal cycle and Pressure test (electrical qualification pending)
- 80% 18 kA demo plug @ 1.10^{-10} mbar.l.s⁻¹ after 5 Thermal cycles

Final configuration in progress

- 6 kA manufacturing procedure complete
- MQXF cable plug being developed
- Manufacturing & qualification procedures being finalised
- Final qualification with current during System test 2020

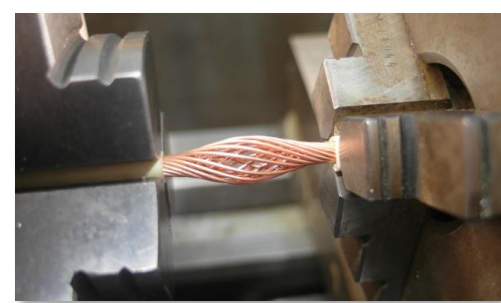
	Cable type				
	I_{cable} [kA]	N_{cables}	Triplet side	Plug	DFX side
MQXF	18	2	18 kA Nb-Ti round	2 x MQXF leads	See J.Fleiter talk Round
MBXF (D1)	18	2	13 kA Nb-Ti flat		
Trims	7	3	18 kA Nb-Ti round	LHC 6 kA	See J.Fleiter talk Round
MCBXF%	2	12	6 kA Nb-Ti round		



Courtesy S.Donche & E.Andrews

DCM interface : Lambda Plate

Cable opening
Cleaning
Plasma treatment



Injection (800 mbar)
under vacuum (<1mbar)
of pre-heated parts (40°C)

Status:

- Plug prototype production is up and running (procedures, tooling & equipment)
- Integration constraints shall now be studied
 - Up to 6m long leads
 - MQXF cable (proto with 13 kA LHC cable)
- Qualification procedures for series to be finalised
 - Individual follow-up & results archiving in place
 - Manufacturing procedures uploaded to EDMS

Production Plan

- Prototype expected by end of 2019
- Injection moulds, Peek & SS parts sub-contracted
- Assembly & qualification (thermo-mechanical + insulation) at CERN



Traceability

Leak test
<1.10⁻⁸mbar.l.s⁻¹

Pressure test
1 h at 30 bara

Thermal cycles
X10 to 77K



Demoulding

Courtesy S.Donche & E.Andrews

Cryogenics interfaces

Jumper interfaces

- Cryogenic lines defined for DFX
- Still discussions on DCM new module TS line
- Jumper location above the QXL
- DN250, longitudinal position TBC

Temperature sensors supports

- Interface long CERNOX

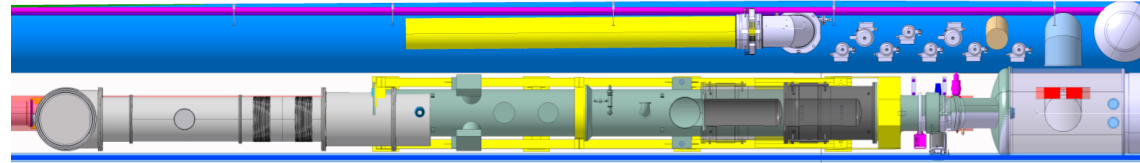
Heaters Vishay® RH100 interfaces

Level gauges interfaces

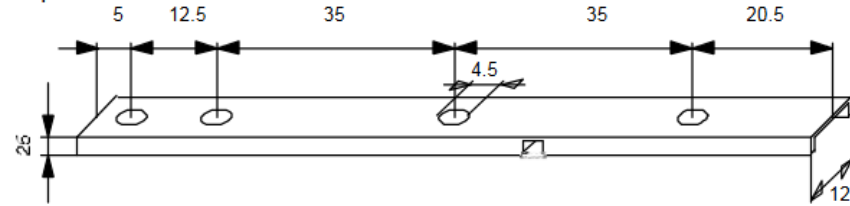
DeltaP gauge pneumatic fittings to be agreed

Pressure relief devices

- See safety dedicated talk

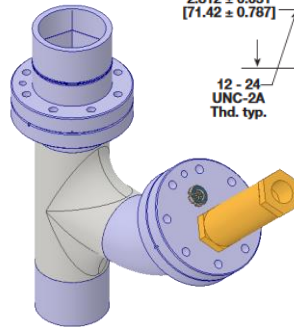
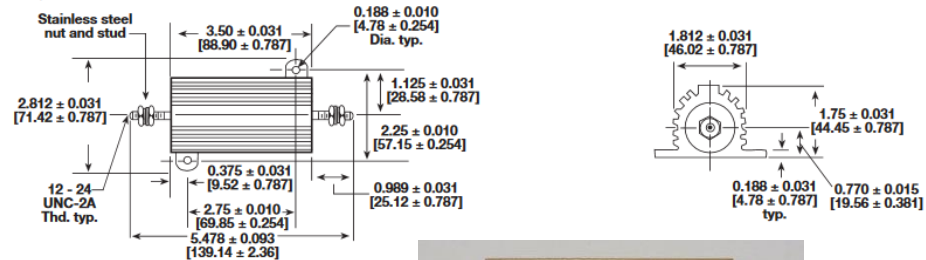


On going work for Jumper location



DIMENSIONS in inches [millimeters]

RH100, NH100



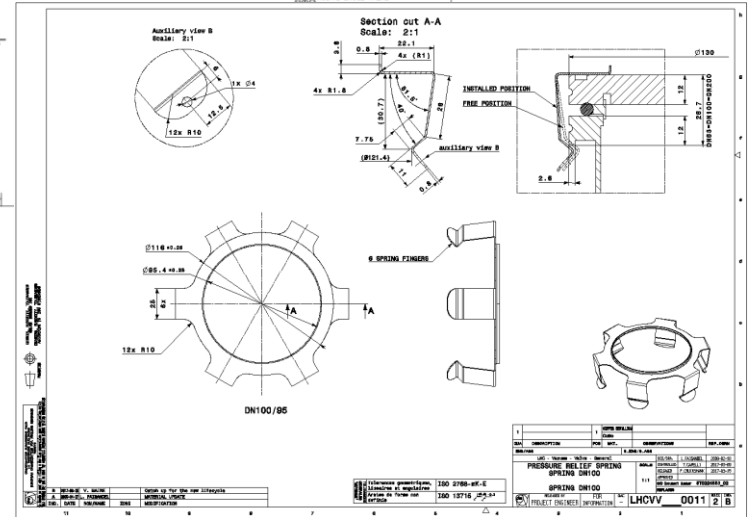
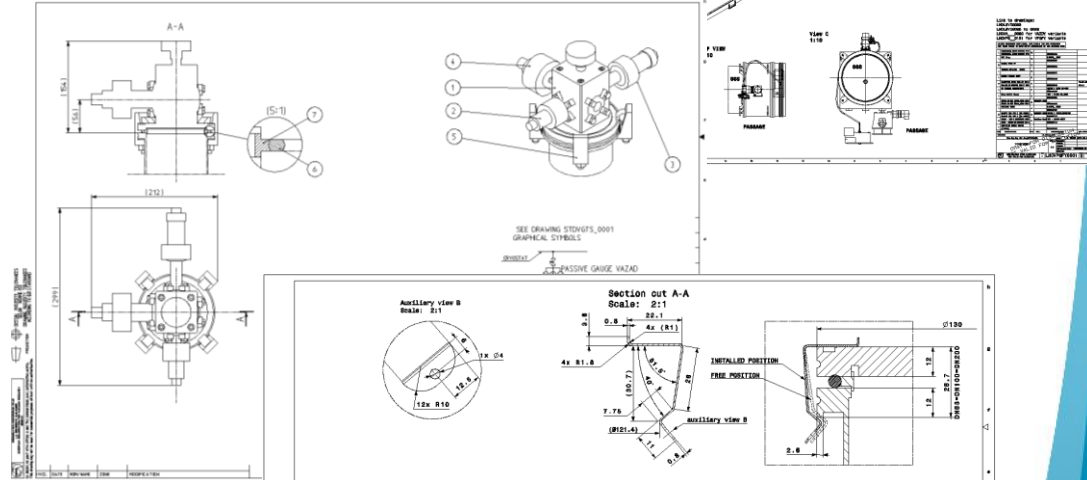
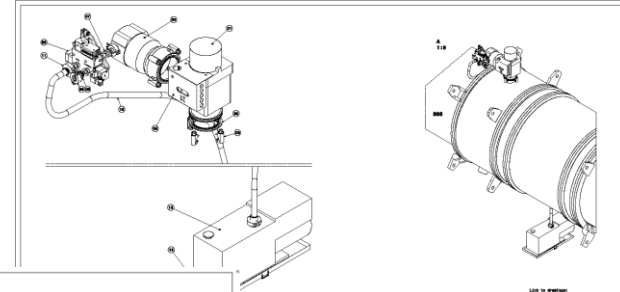
Insulation vacuum interface

SCLink insulation vacuum volume

- Pumping equipment :
 - valve + turbopump + primary pump
 - LHCVPGFY0001
- Gauges interface
 - 3 gauges on one ISO DN100
 - LHCVA___0076
- Relief plate interface
 - ISO-K DN100
 - LHCVV___0011

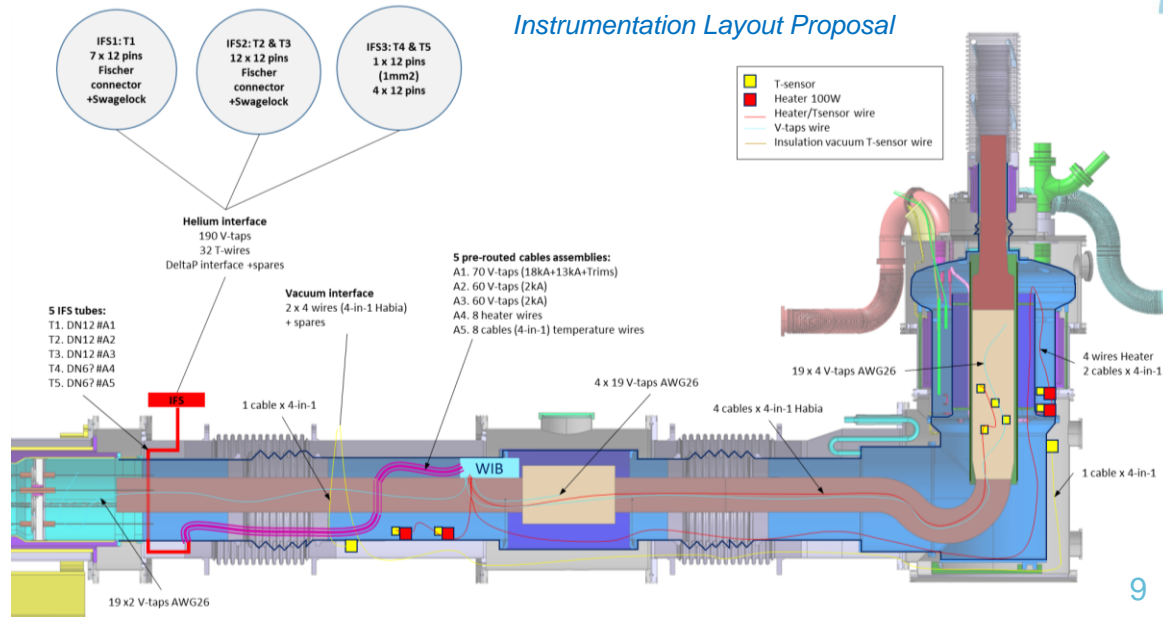
DFX insulation vacuum volume

- Pumping equipment
 - Valve + Turbopump + Primary Pump
 - LHCVPGFY0001
- Gauges interface
 - 3 gauges pn pne DN100
 - LHCVA___0076
- Relief plate interface
 - ISO-K DN200
 - ST0705009_01



Instrumentation interface

- Mechanical supports
- Wire Instrumentation Box (WIB)
- IFS
 - (CERN design & supply)
 - 3 Flanges
 - 5 tubes sorted by functions
 - 190 V-taps
 - 32 T-wires
 - 8 power wires
- Vacuum instrumentation feedthrough ISO DN100



Civil Engineering & Transport Interfaces

CERN responsible for supports design to ground/ceiling in the tunnel

Conceptual proposal to ceiling and ground being discussed at CERN

DFX interfaces

- Civil engineering : threaded blocks
- Transport : adequate lifting points compliant with design
- Tooling not defined today

Forces distribution DFX to tunnel

- Configuration:
 - Rigid outer DFX + supports + ring fixed to tunnel vault
 - Bi-lateral lower support transferring longitudinal loads to ground
- Constraints transferred to tunnel walls through red surfaces

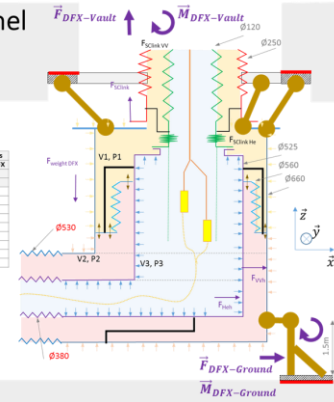
Configurations

Phases	Pressures				Weight	Vacuum induced loads		He V induced loads	
	Atm	P1	P2	P3		z=0	z=10	z=0	z=10
Neutral	1	1	1	1	20	0	0	0	0
Purging	1	1	0	0	20	0	0	0	12
Dist vacuum	1	0	1	20	10	5	0	-2	0
Dist vacuum / purge	1	0	1	0	20	10	5	0	12
DFX vacuum	1	1	0	1	20	10	15	-22	12
DFX vacuum / purge	1	1	0	0	20	10	15	-22	0
Nominal	1	0	0	1.5	20	10	5	-22	-2
Unspooled magnet	1	0	0	2.5	20	10	5	-22	-3
Design pressure	1	1	1	2.5	20	10	0	0	-2

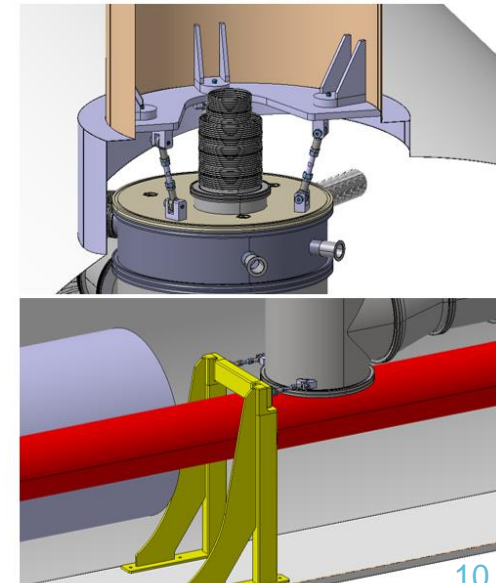
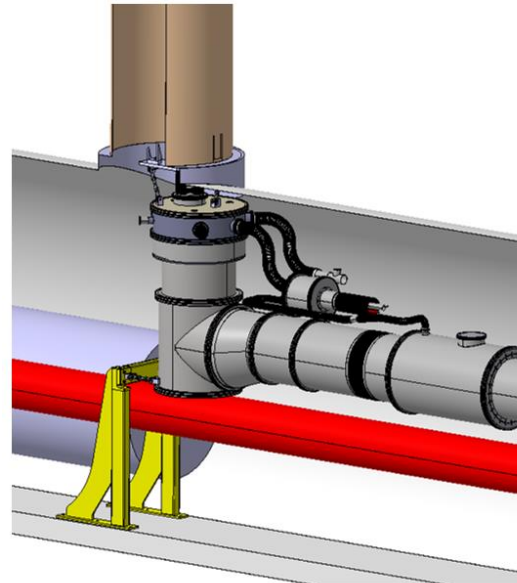
Maximum transferred loads

$$\begin{aligned} \bar{x} &< 1 \text{ kN} & \bar{z} &< 1 \text{ kN.m} \\ \bar{F}_{DFX-vault-y} &< 1 \text{ kN} & \bar{M}_{DFX-vault-z} &= \pm 10 \text{ kN.m} \\ \bar{z} &[-20; +5] \text{ kN} & \bar{z} &< 1 \text{ kN.m} \end{aligned}$$

$$\begin{aligned} \bar{x} &\pm 25 \text{ kN} & \bar{z} &< 1 \text{ kN.m} \\ \bar{F}_{DFX-ground-y} &< 1 \text{ kN} & \bar{M}_{DFX-ground-z} &= \pm 25 \text{ kN.m} \\ \bar{z} &< 1 \text{ kN} & \bar{z} &\pm 10 \text{ kN.m} \end{aligned}$$



On going studies for load transfer to civil engineering



Summary

- Mechanical interfaces are mostly defined
- Some interfaces require more work (jumper, IFS)
- Bus-bars supports de-scoped from prototype, DFX shall present mechanical interfaces