Interfaces between Wp3 and Wp6a

Triplets – Superconducting Link

Joint meeting wp3 – wp6a : 23 January 2018

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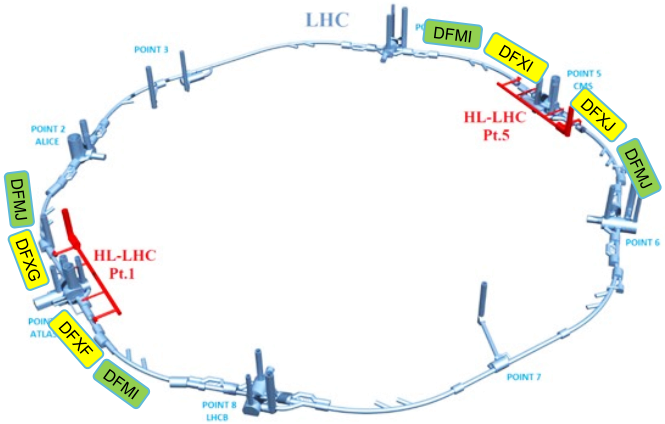
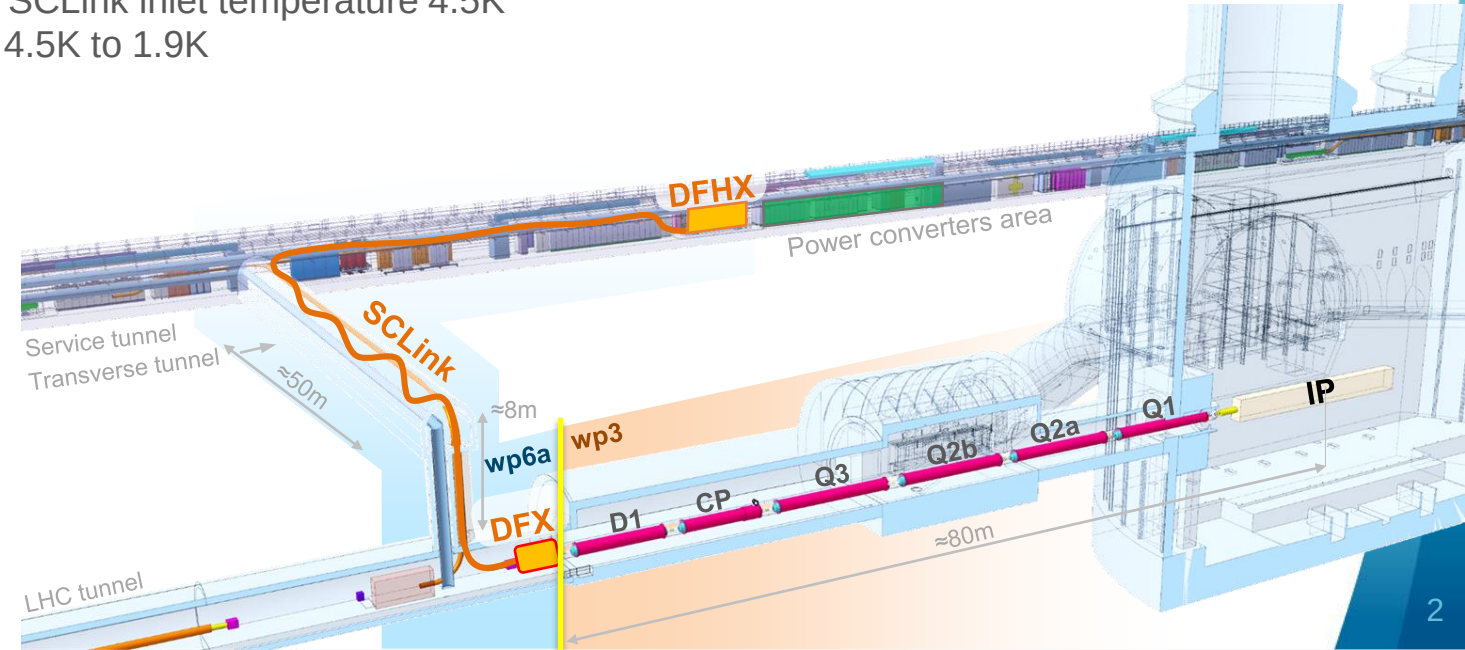
Context

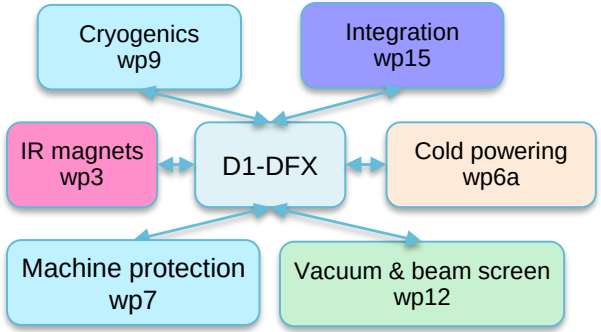
- Each IP1 and IP5 sides:
  - Magnets Q1 to D1
  - Cold powering:
    - Power converters in service galleries
    - DFH : 300K to 20K
    - DSH: SCLink inlet temperature 4.5K
    - DFX: 4.5K to 1.9K

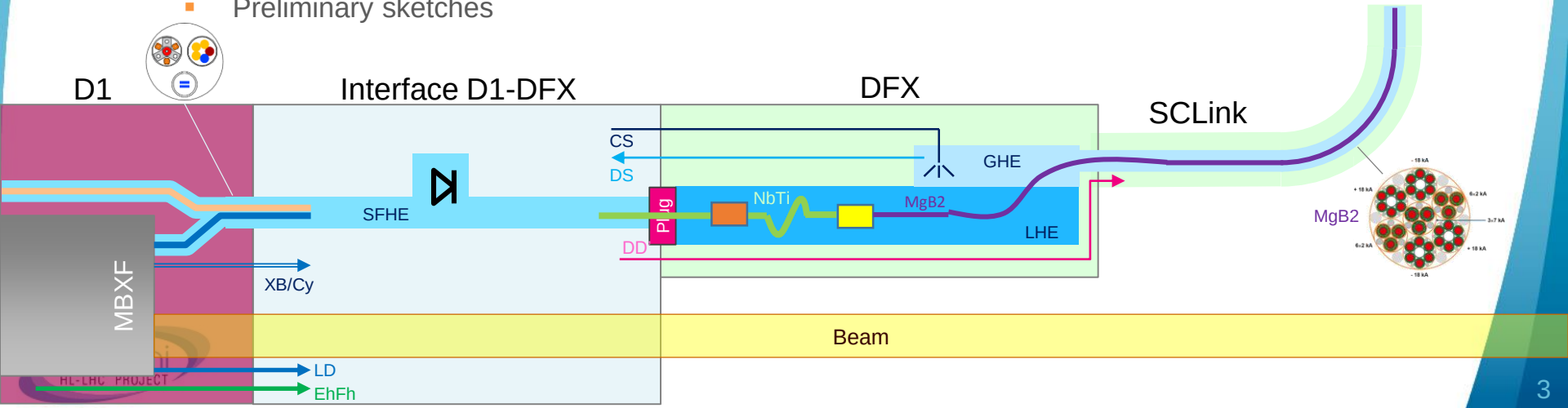




Basic D1-DFX interface Layout

- Cryogenic interfaces
- Electrical layouts
- Key functions:
  - Cryogenic interfaces with QXL
  - Electrical continuity including cold diodes
- WP involved
- Work in progress:
  - Listing requirements
  - Identification of responsibilities
  - Preliminary sketches





Problematics

Cryogenic & Electrical requirements

Beam screen & Vacuum:

- Distance MBXF-End D1 > ≈2m : Beam aperture ➔ VSC equipment redesign (sector valve issue + beam screen aperture)

Beam alignment at D1 end:

- Cantilever distance D1 foot – End D1 >≈3m ➔ beam alignment difficulties (contractions, loads)

Thermal contractions:

- D1 fixed point toward CP end ➔ Triplet cryogenic lines ≈20mm toward CP
- DFX cryogenic lines fixed toward SCLink ➔ few mm toward SCLink
- Locate extra length for bus-bars contractions

Cold diodes & electrical connections:

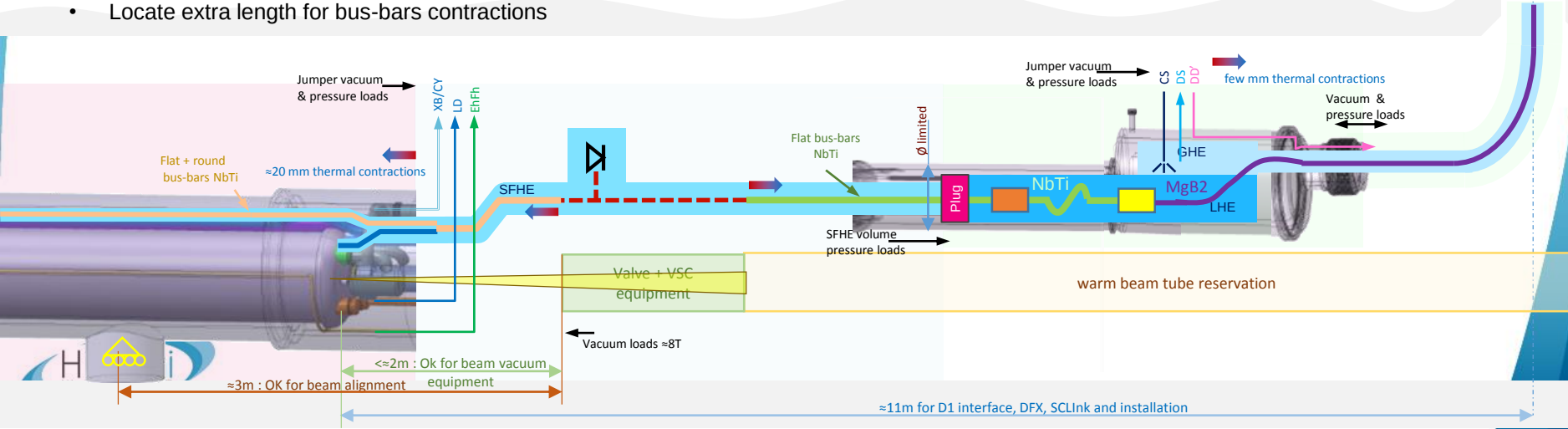
- Flat bus bars for connection to cold diodes

Integration & installation :

- Longitudinal & radial integration : components in //
- Cables routing to be studied
- Access to splices & plugs (D1-DFX-SCLink) ➔ limit radial integration at splices position

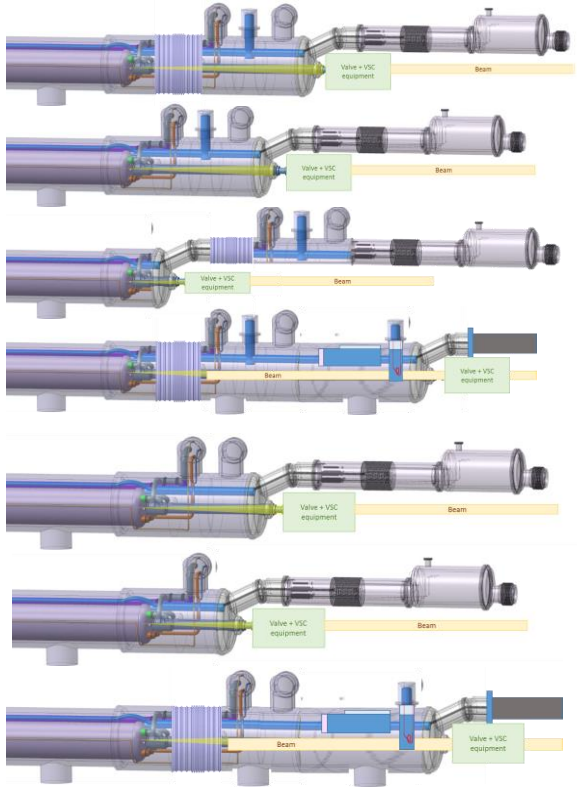
High pressure induced loads :

- Vacuum + helium volumes : ➔ **dedicated designed structures**



Varied studies

- Design sequence:
  - Find a compromise option without showstoppers
  - Discuss with wp feasibility
  - Iterate to optimise the final solution
- Several configurations were studied
- So far, one option presents no showstoppers but technical challenges



Connection cold diodes	Thermal contraction cryo lines	Vacuum loads handling	Aperture Vs VSC equipment	Total length	DFX accesses to splices/plugs	Beam pipe alignment
Beam alignment + Sector valve						
++	+++	+	--	-	++	--
No access for bus bars connection						
--	--	-	--	+	++	--
Cryo pipe integration						
++	++	--	++	-	++	++
Beam alignment + sector valve						
++	++	++	--	+	--	+

Connection cold diodes	Thermal contraction cryo lines	Vacuum loads handling	Aperture Vs VSC equipment	Total length	DFX accesses to splices/plugs	Beam pipe alignment
Beam alignment + sector valve						
NA	--	-	+	+	++	-
Splice access + radial integration						
NA	--	-	+	+	++	++
Beam alignment + sector valve						
NA	++	++	--	++	--	+

Option as support for discussion

✓ : requirement fulfilled
✎ : need additional work

Cryogenic & Electrical requirements

Beam screen & Vacuum:

- Ok for sector valve & beam vacuum equipment ✓
- Maybe not enough for aperture/beam screen overlap ✎

Beam alignment at D1 end:

- Cantilever distance D1 foot – End D1 ✎

Thermal contractions:

- D1 Jumper shall handle 20mm longitudinal displacement ✎
- DFX QXL interface “Jumper” to be studied (low pressure lines) ✎
- Room for extra length for bus-bars contractions ✓

Cold diodes & electrical connections:

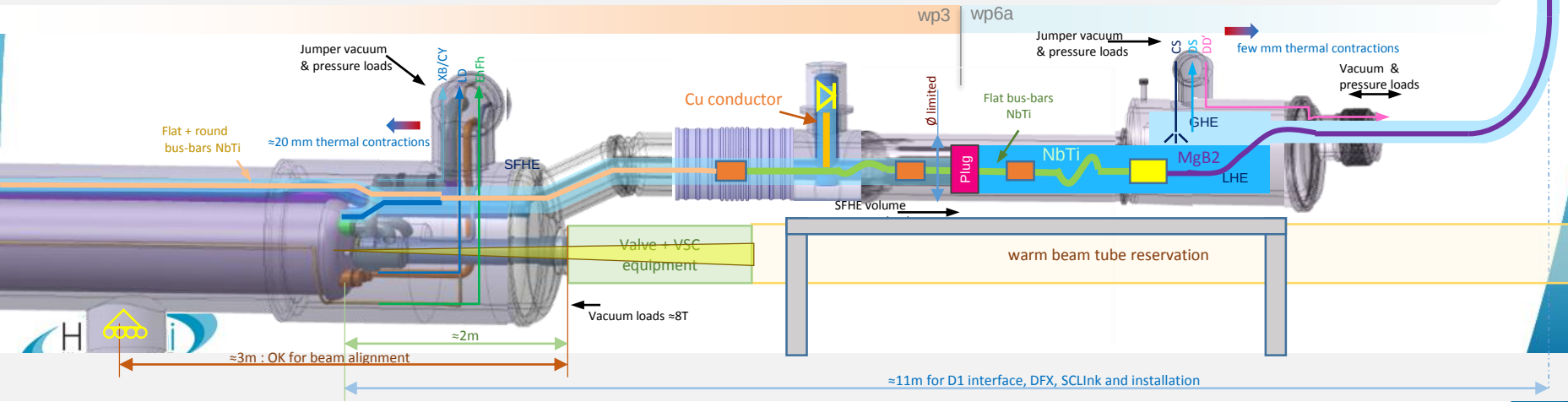
- Flat bus bars for connection to cold diodes ✓

Integration & installation :

- No cryolines along the interface
  - ➔ Radial integration feasible ✎ + access to splices & plugs ✓
- Minimised interface Triplet-DFX

Not yet verified:

- Feasibility of pressure profiles handling (“jumper 2”, plug) ? ⚠
- Compatibility with assembly sequence ?
- Validation with integration study in the tunnel environment ?



Observations

- Interfaces between triplets and DFX are identified
- No easy design option exists but a possible compromise may be found

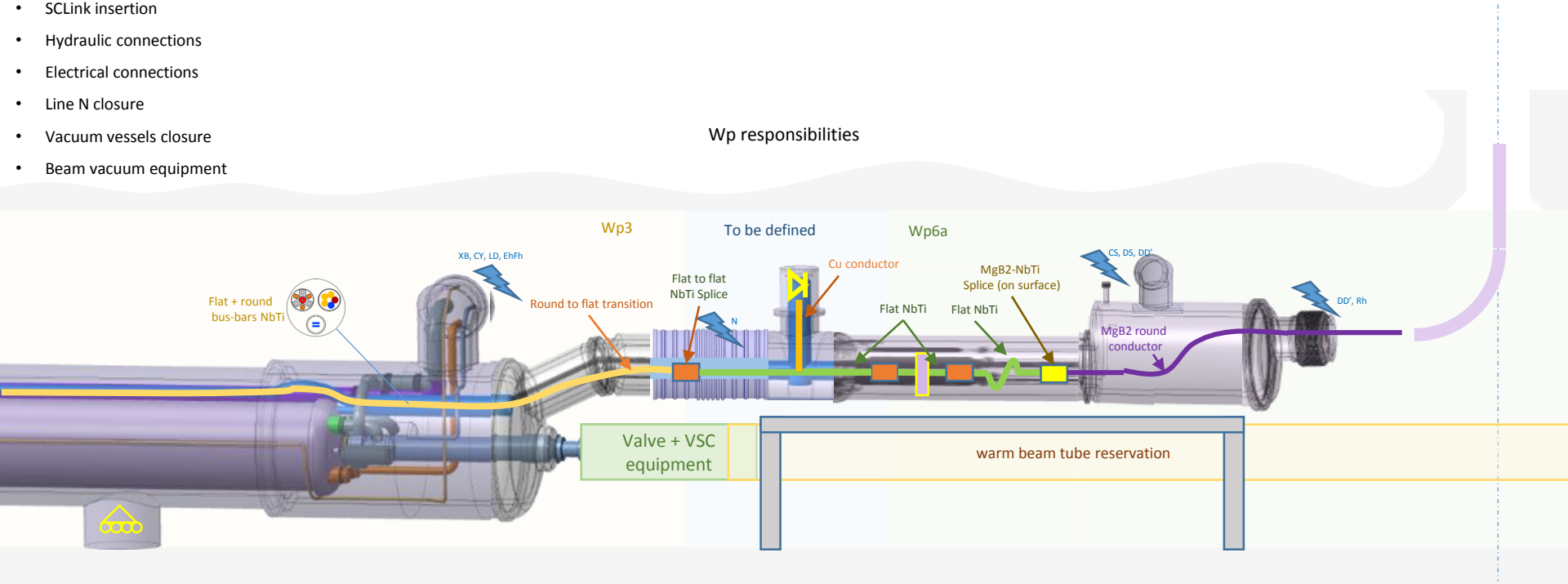
- Next steps:
  - Iterate with workpackages
  - In depth studies to understand pressure induced loads and integration are needed

Spare slides

Installation sequence: support for discussion

- Empty tunnel
- Tooling installation
- D1 installation
- Cryolines connection
- Bus bars routing
- DFX + Cold diodes installation
- SCLink insertion
- Hydraulic connections
- Electrical connections
- Line N closure
- Vacuum vessels closure
- Beam vacuum equipment

Wp responsibilities



Possible compromise found so far:

No showstoppers but comes with technical consequences

	Beam aperture Vs VSC equipment	Beam alignment	Loads distribution	D1 cryolin. contraction	DFX cryolin. contraction	Installation & connections	Integration Maintenance	Consequences
Jumpers & cryolines - J1 for wp3 on D1 - J2 onto DFX for wp6a local supply	- Minimise distance - J2 in shadow	- Compromise - Less pressure loads to cantilever	Compromise with: - J1 big Ø, high P in rigid D1 envelope - J2 with smaller Ø, lower P.	Allow movement in jumper1	Very limited	- All lines pre-assembled at the surface - More space @ interco. - Interco Ø ↘ by 150mm	- No lines routed nor connected @ D1 end - No lines // to interconnect nor splices ➔ maximise access & integration - J2 in shadow: longi space saved	- 20mm displacement in J1 **taken by QSL design** - Handle pressure loads from J2 locally - Design interface with QXL
Cold diodes : - Fixed to DFX in limited vacuum vessel volume	- Parallel to warm beam line	- Optimised	Challenge to handle pressure induced loads	Fixed to plug, bellows at interconnection.	J2 in DFX ➔ full access	Pre-connected to plug @ surface Round 2 flat located at the end: optimise installation	Full access to connections & diodes replacement R2F connection in the tunnel	- Design supporting structure - Heat losses by conduction for supports
	+	+		+	++	++	++	

Status: compromises are proposed for discussion, not ideal for anyone. Assumptions need to be confirmed. Interfaces between cryostats & cold powering limited to one cryogenic volume (SFHE) and NbTi-NbTi splices.

Main consequences: Additional cryogenic services are needed, complex and rigid structural studies are required to prove feasibility

Still to be defined:

- Overlap beam aperture / beam screen
- Extra length bus bars policy
- Direction for triplet bus bars installation
- SCLink installation & splices structural access