



# DFH-DFM design status

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HL-LHC - WP6a

***TCC 19 Dec. 2018***

# Context : DF boxes key functions

Each IP1 and IP5 sides equipped with 2 cold powering chains of cryostats

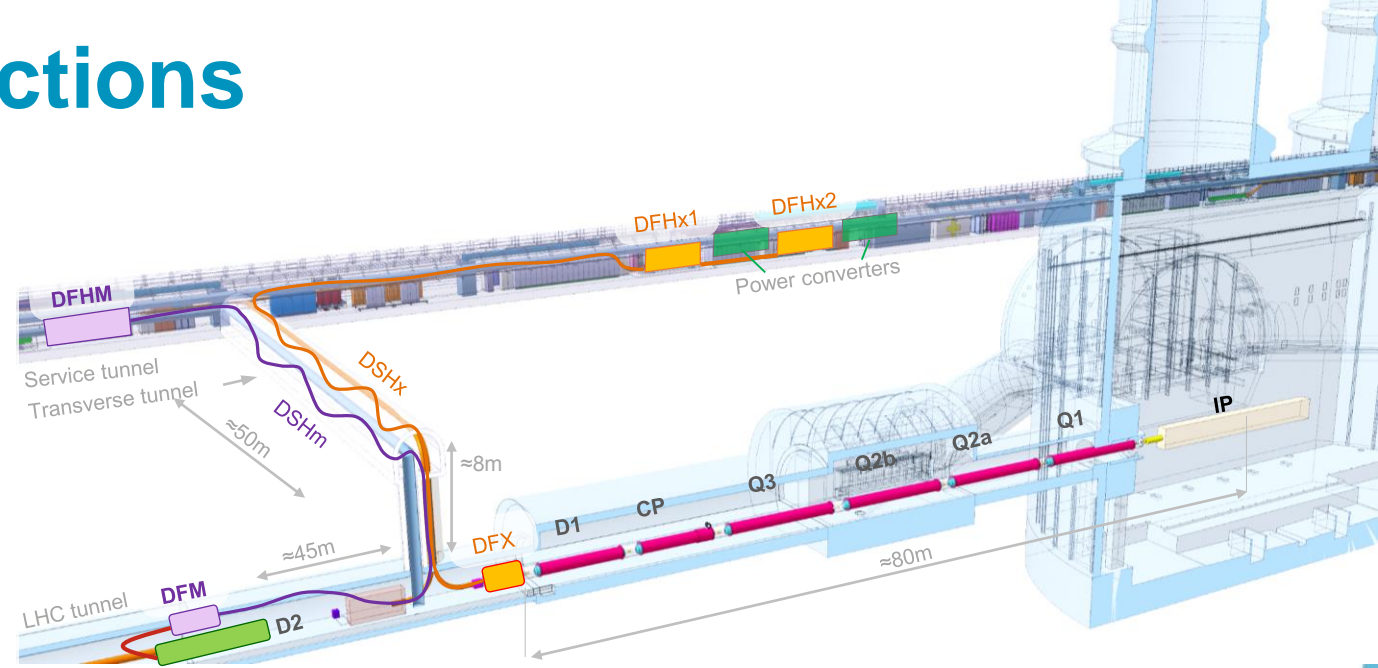
- Triplet insertion : DFHx – SC Link (DSH) – DFX
- Matching sections : DFHm – SC Link - DFM

DFX/DFM basic functions:

- Electrical interface between SC Link and superconducting magnets
- Supply cryogenics to the SCLink

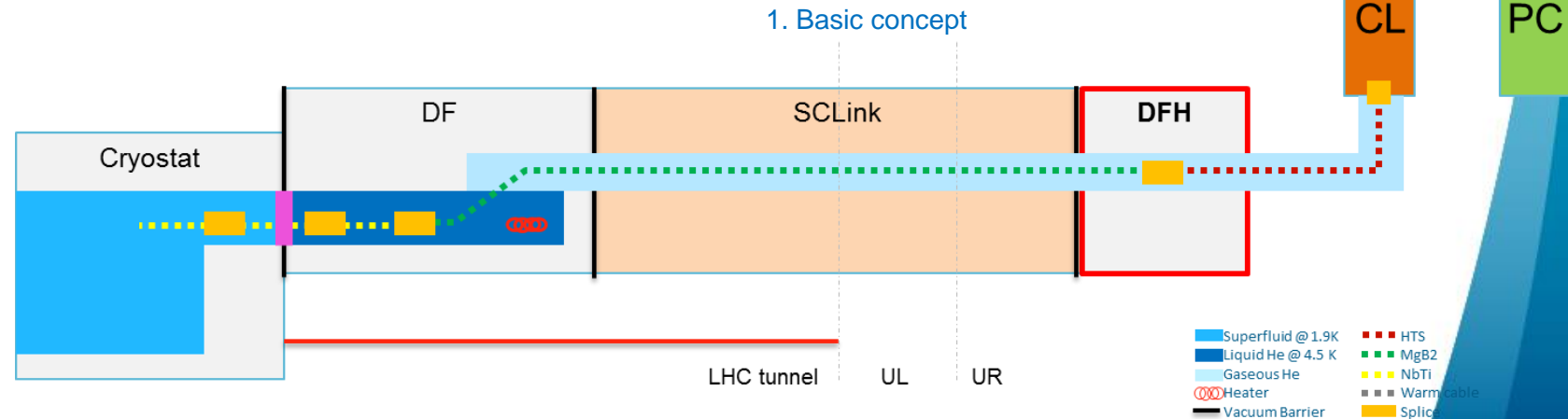
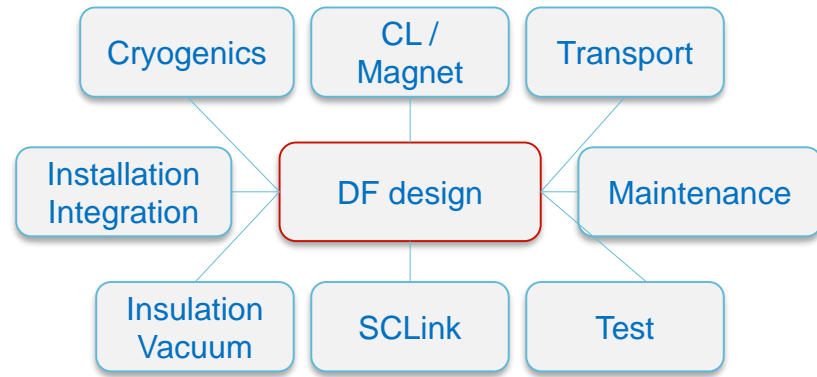
DFH basic functions:

- Electrical interface between SC Link and HTS leads
- Supply cryogenics to the current leads



System Interfaces

## DF system interfaces



# DF Project Sequence

1. Basic concept
2. Iterations with system interfaces
3. Functional & interfaces specifications
4. Design proposal
5. Iterations with system interfaces
6. Conceptual design review
7. Detailed design review
8. Procurement & manufacturing
9. Delivery pre-series unit
10. Series delivery

	DFX	DFHx	DFM	DFHm
	✓	✓	✓	✓
	✓	✓	✓	✓
	Ready for circulation EDMS 1905613	Ready for circulation EDMS 2052656	Ready for circulation EDMS 2052614	Ready for circulation EDMS 2052656
	✓	✓	✓	Pending
	In progress	In progress	In progress	Pending
	Jan.19	Q1 2019	TBD	Q2 2019
	Mar.19	Q2 2019	TBD	TBD
	2019	2019	TBD	TBD
	Q1 2020	Q1 2020	TBD	2021
	2021-2022	2021-2022	2021-2022	2021-2022

# DF boxes conceptual proposal

## Electrical layout ✓

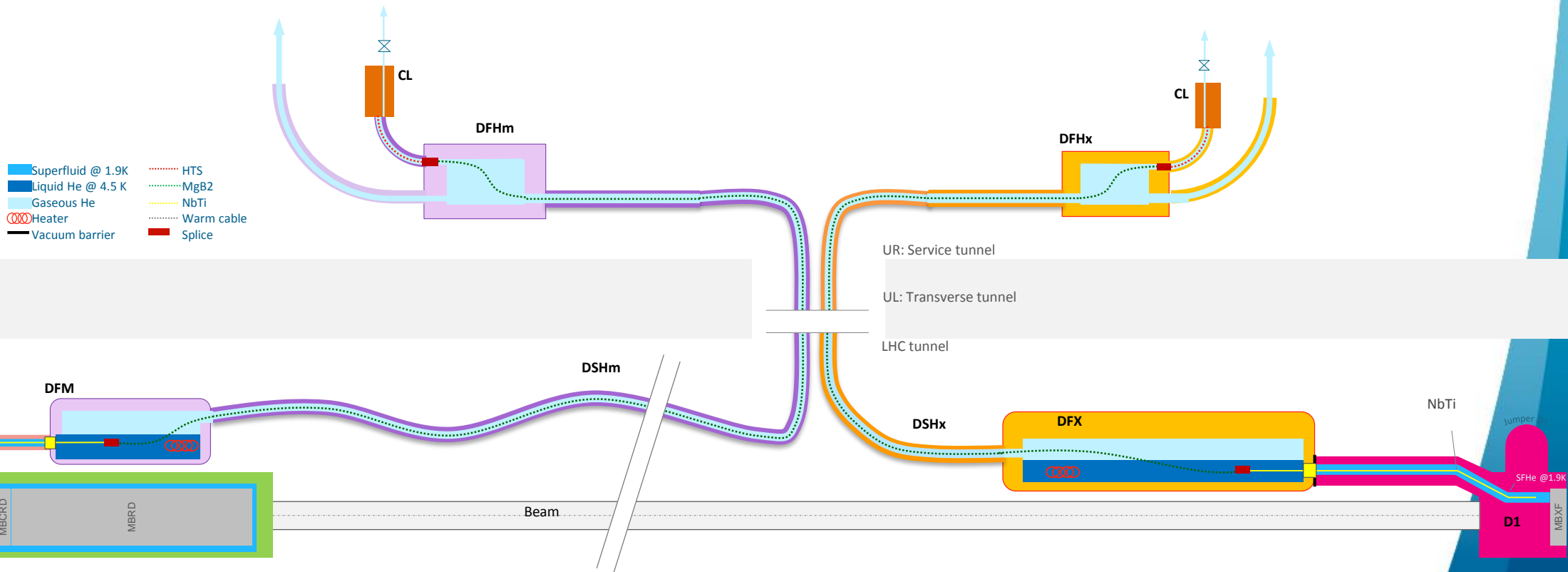
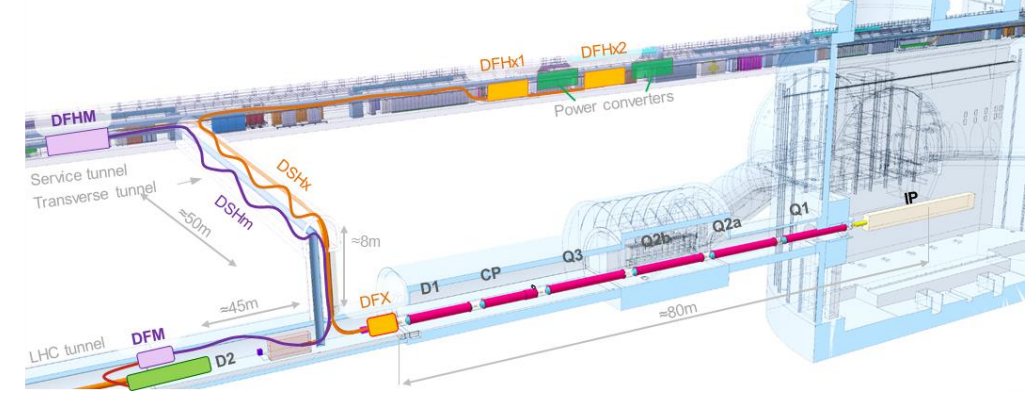
- Superconductors, circuits

## Cryogenic layout ✓

- Helium fluids layout, dynamic

## Integration ✓

- Tunnel allocation, preliminary paths



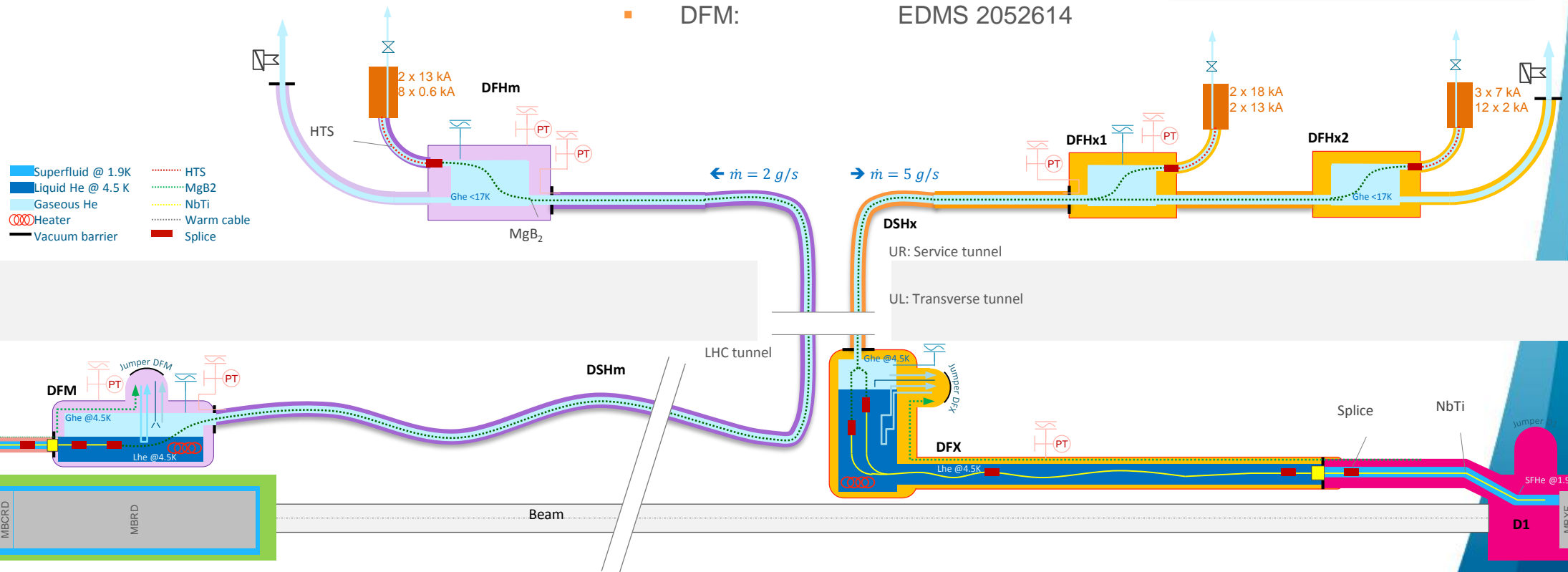
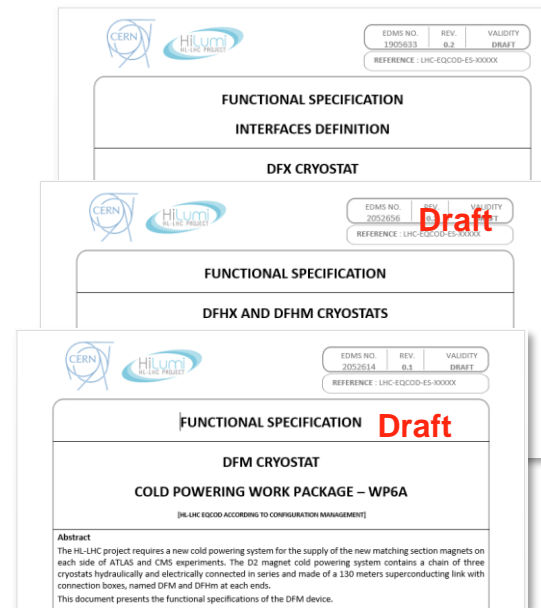
# Functional & Interfaces specifications

- List requirements and detail concepts
  - Insulation vacuum layout
  - Splices locations
  - Plugs and jumpers location
  - Safety approach
- Transverse iterations for optimisation

- Define key parameters (nominal and design)
  - Temperatures, mass flows
  - Number and type of leads
  - Splices resistances
  - Components main dimensions

→ Functional specifications:  
(Ready for circulation)

- DFX: EDMS 1905633
- DFH (x & m): EDMS 2052656
- DFM: EDMS 2052614





# DFHx design proposal

## Integration & interfaces layout

- DFH in series between SCLink and current leads
- Envelope:  $\approx \varnothing 1.5\text{m} \times 4\text{m}$  on rails

## Electrical layout

- MgB2 – HTS – Current leads

## Cryogenic layout

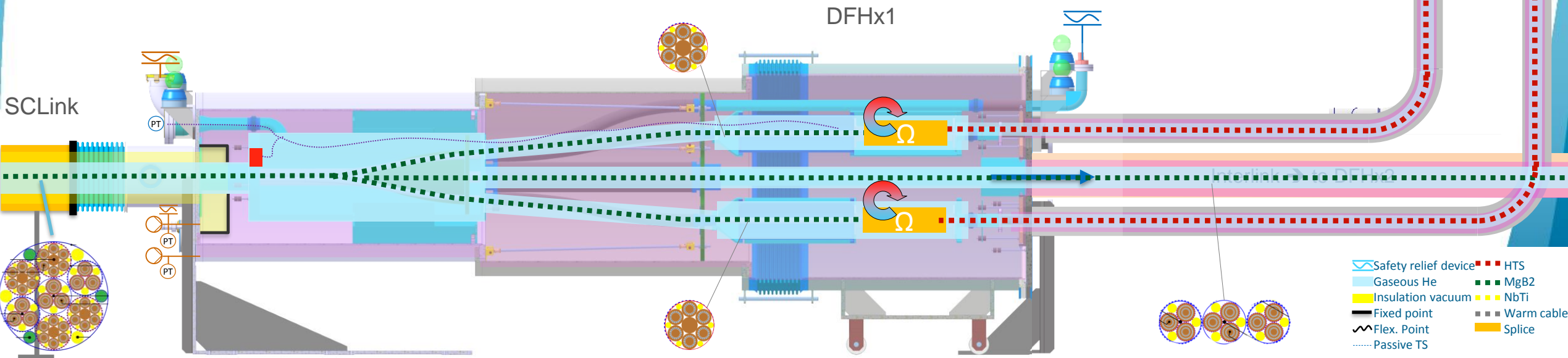
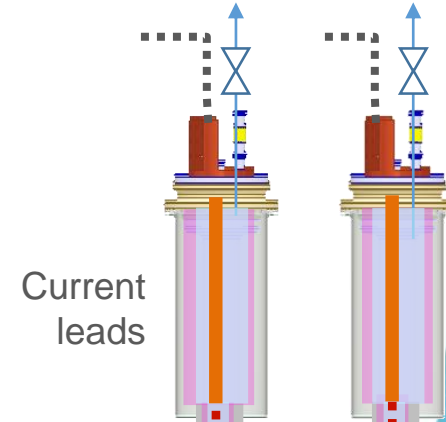
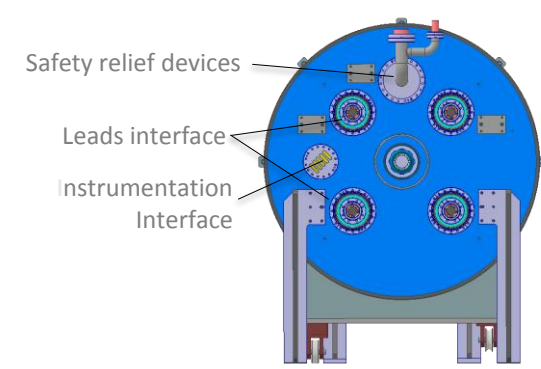
- 1 common helium volume
- Heat extracted through convective heat transfer

## Insulation Vacuum layout

- Vacuum barrier at SCLink-DFHx interface

## Mechanical layout

- Splices fixed to helium vessel
- Flexible structures for thermal contractions and installation



- Safety relief device
- Gaseous He
- Insulation vacuum
- Fixed point
- Flex. Point
- Passive TS
- HTS
- MgB2
- NbTi
- Warm cable
- Splice

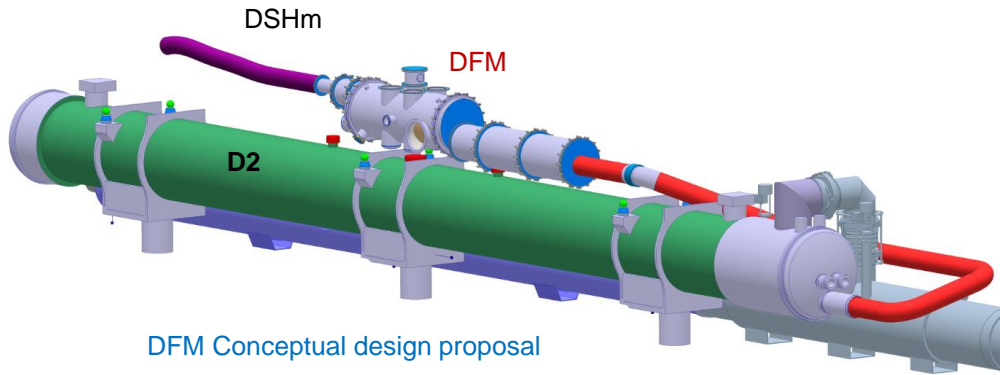
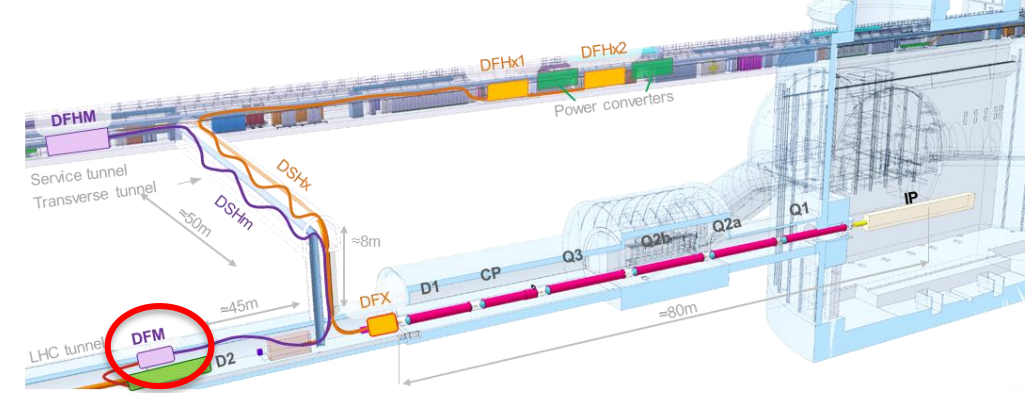
# DFM : detailed design proposal

## Baseline design proposal:

- General layout :
  - DSHm-DFM above and parallel to D2
  - D2-DFM connection path
- NbTi splices and leads immersed in LHe

→ Conceptual design proposal has been developed (inspired from DEMO1 DDFX)

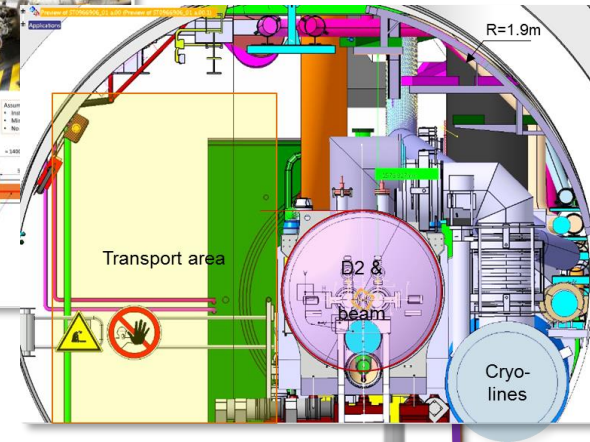
→ iterations with system interfaces **in progress**



DFM Conceptual design proposal

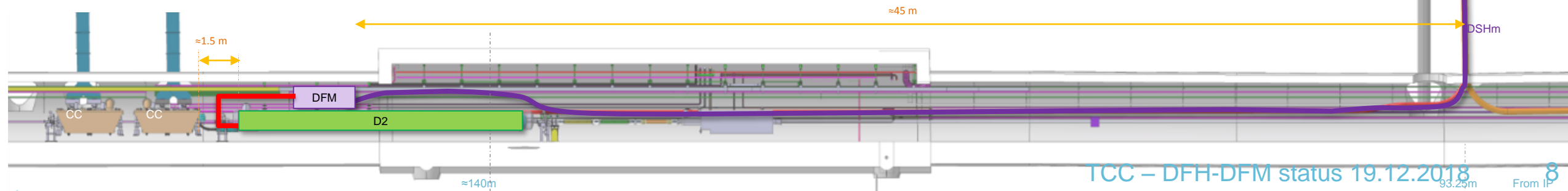
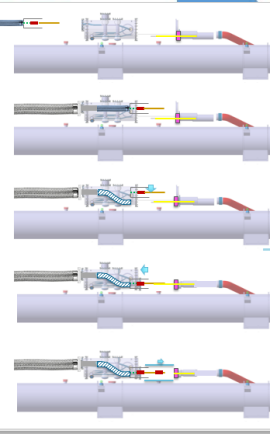
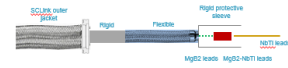
## Integration : DFM-D2 routing

- LHC design
- Results from integration study
  - (E.Chaudet & A.Vande Craen)
  - Positive slope feasible
  - Several feasible options
  - Further studies needed to estimate option 2 space requirements D2-CC



## Proposal Assembly sequence

- Initial configuration:
  - D2 installed
  - D2-DFM link installed
  - Plug toward D2-DFM link connected
- SCLink installation
  - Same configuration as DFX:
    - MgB2-NbTi splices are located in a rigid protective sleeve
    - Only NbTi leads are apparent
  - Insertion straight
  - Lower protective sleeve
  - Close vacuum vessel
  - Splice NbTi-NbTi
  - Slide sleeve back & weld





# DFM design proposal

## Integration & interfaces layout

- DFM in series between SCLink & D2-DFM connexion
- Envelope:  $\approx \varnothing 1\text{m} \times 4\text{m}$
- Fixed to the wall/ground (to be studied)

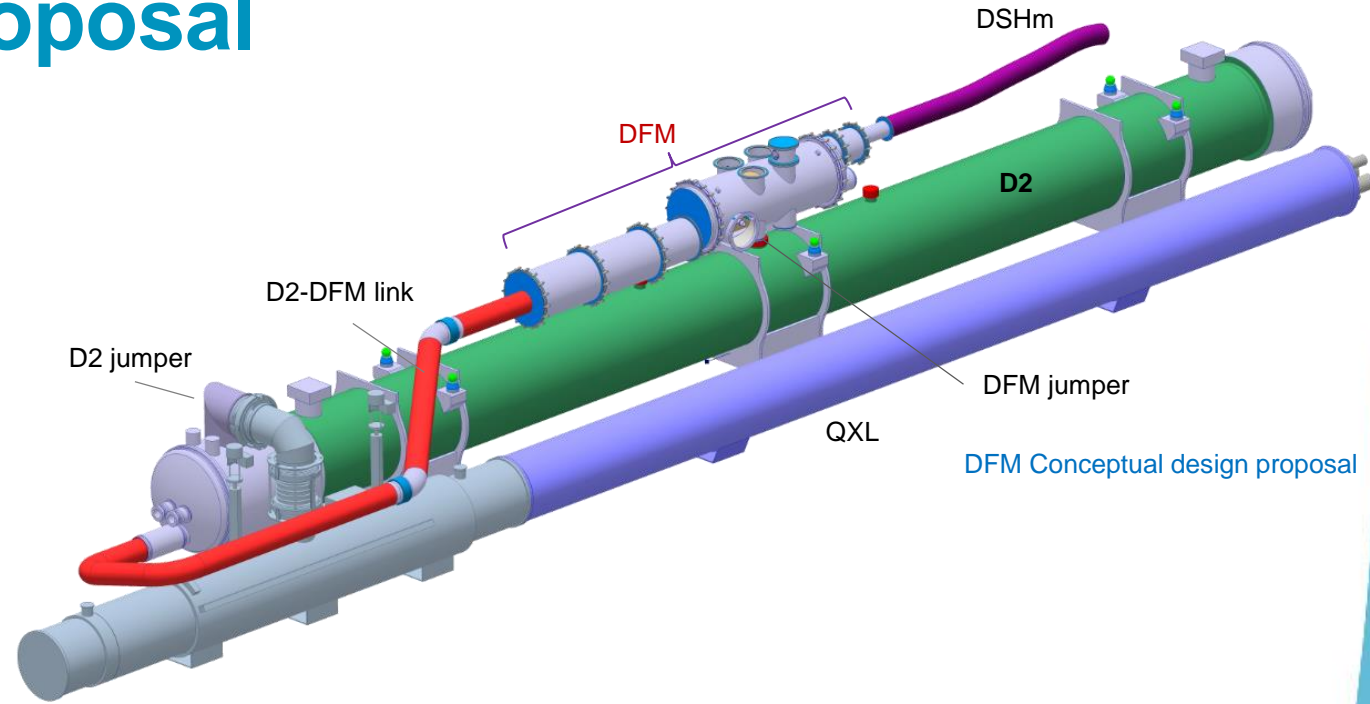
## Electrical layout

- MgB2 – NbTi – Current leads

## Cryogenic layout

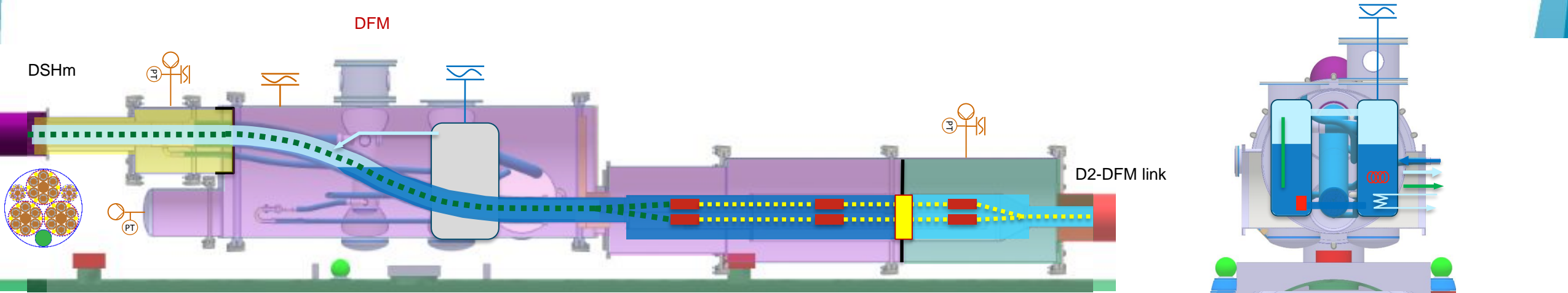
- 1 common helium volume
- Splices immersed in liquid
- Gaseous mass flow from liquid vaporisation
  - (Demo1 principle)

## Vacuum barriers at SCLink-DFM & DFM-D2link interfaces



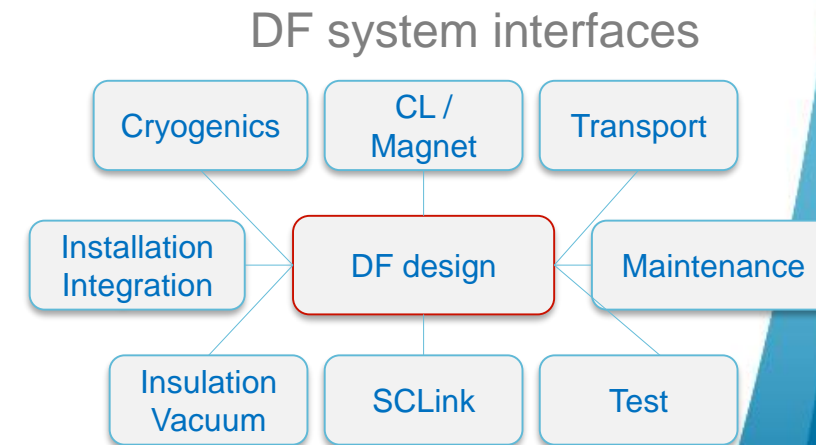
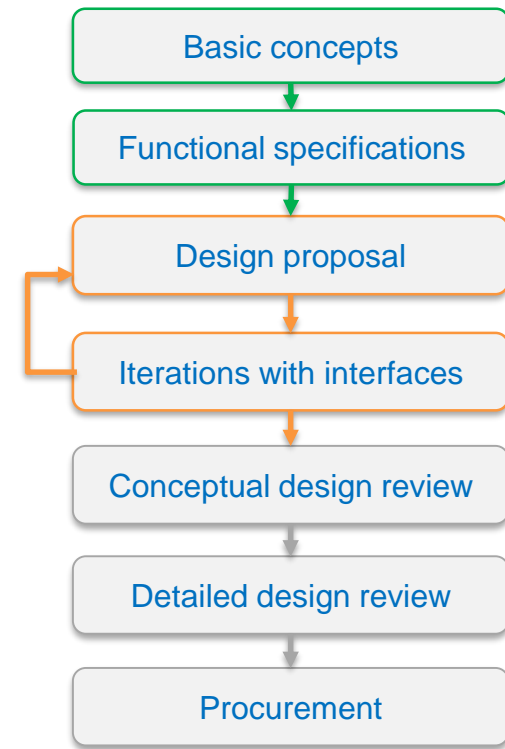
DFM Conceptual design proposal

Superfluid @ 1.9K	HTS
Liquid He @ 4.5 K	MgB2
Gaseous He	NbTi
Heater	Warm cable
Vacuum barrier	Splice



# Summary

- Functional specifications ready for circulation for all DF boxes
- Conceptual design proposals of DFH and DFM made
- Next steps: progress on design towards functional, maintainable and affordable industrially-compatible solutions

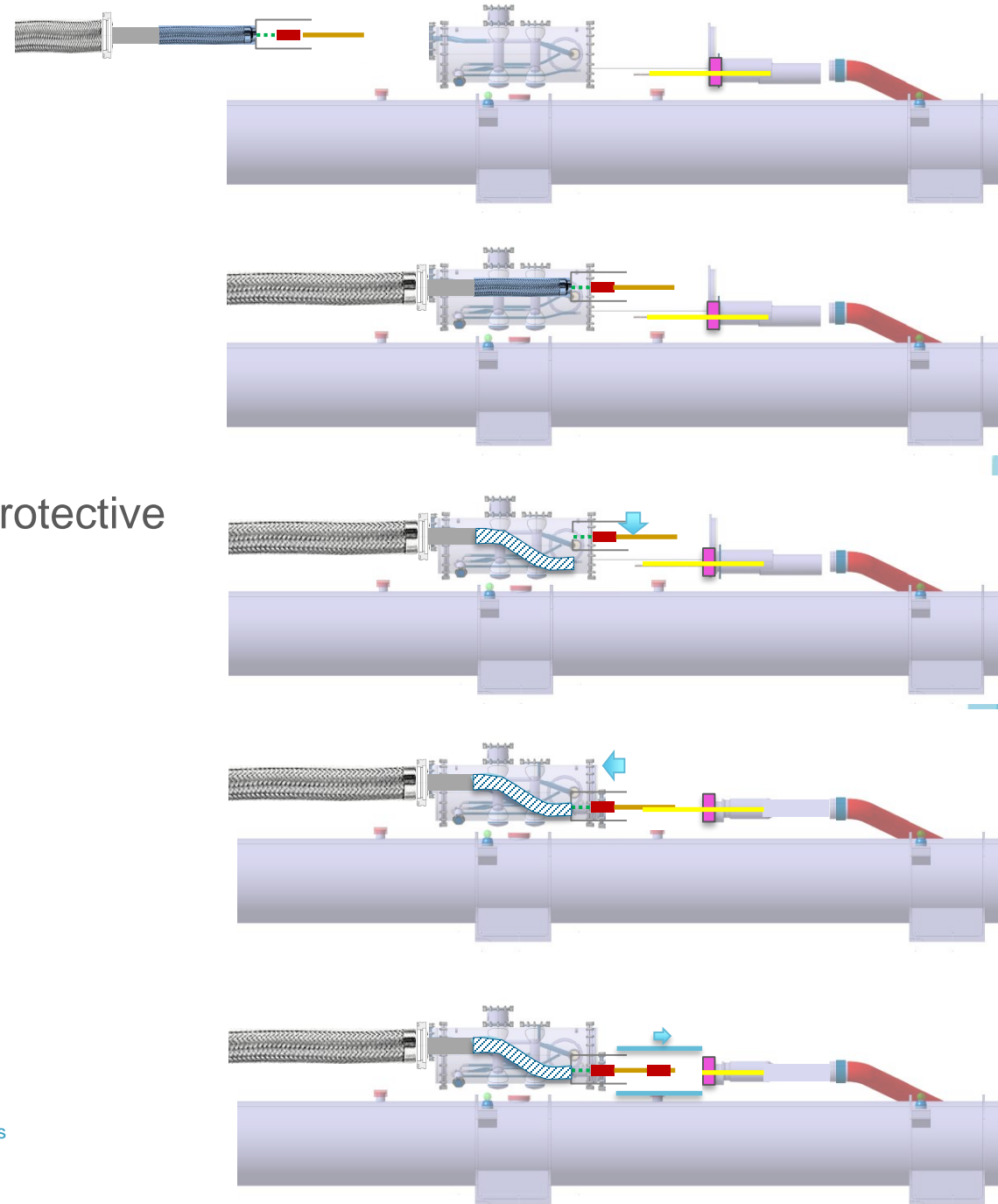
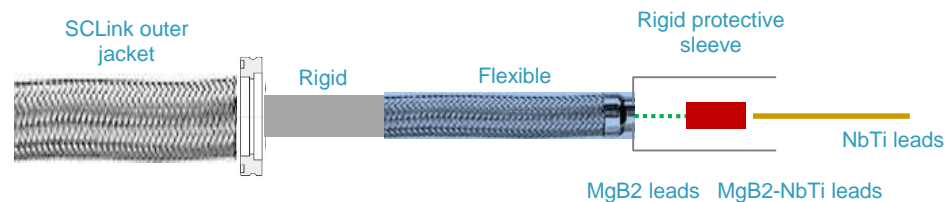




# Spare slides

# Proposal Assembly sequence

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  - Slide sleeve back & weld



# DFM integration – preliminary illustrative views

