Cable splices and instrumentation for DFM system

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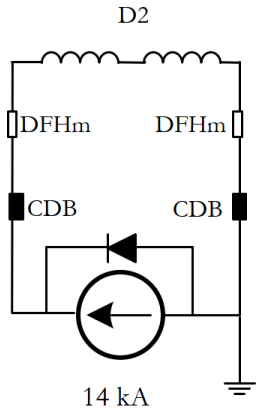
DDR DFM meeting 18th of January 2022

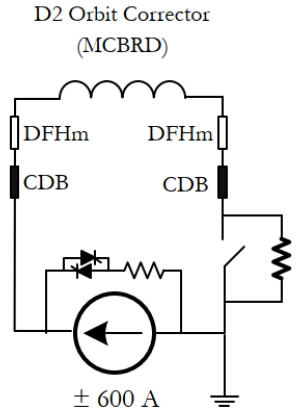
Outline

- **Cable splices of DFM**
- **List of Instrumentation of DFM**
  - Electrical Protection
  - Cryogenic operation
  - Vacuum instrumentation
- **Instrumentation feedthroughs of DFM**

Overview of electrical circuits of MS

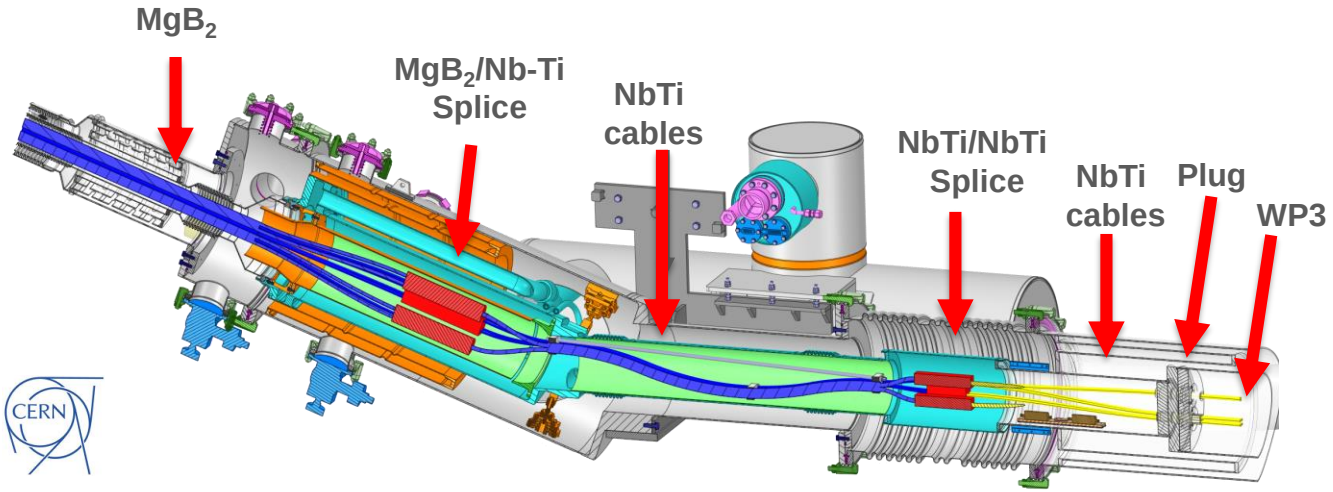
- **5 circuits per MS SC Link**
  - **D2**: 2 cables rated for 18 kA
  - **MCBRD** : 8 cables rated for 0.6 kA
- Current rating, Circuit Time Constants, Protection and electric insulation tests levels defined in EDMS 2659857





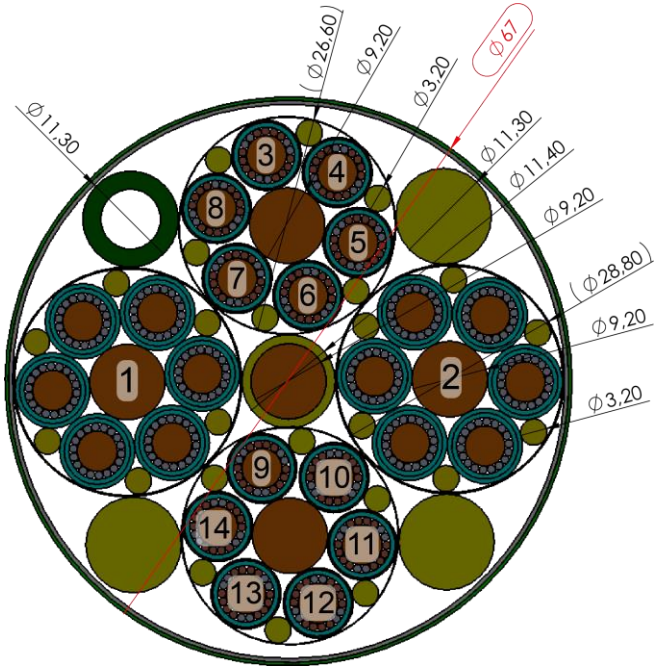
Description of branch of circuit of SC Link

- Each branch of circuit of SC Link in DFM consists of:
  - **Sc cables**
    - **Nb-Ti bus bars**
    - **MgB_2 cable**
  - **Splices**
    - **Nb-Ti/Nb-Ti**
    - **MgB_2/Nb-Ti**



Sc Cables

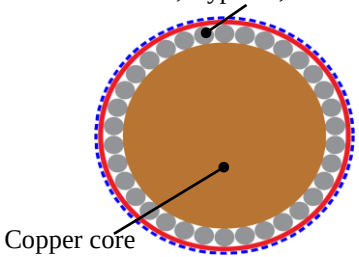
MgB_2 cable



Nb-Ti cable

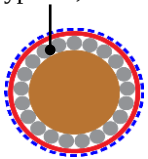
Type of circuit	OD of core (mm)	Type of strands	Trans. Pitch
MQXF, D1, D2	10.9	34 LHC 01	150 mm
MCBXFA/B. MCBRD	4.9	21 LHC 02	75 mm

Nb-Ti wire, Type 01, 1.07 mm OD



18 kA cable

Nb-Ti wire, Type 02, 0.825 mm OD

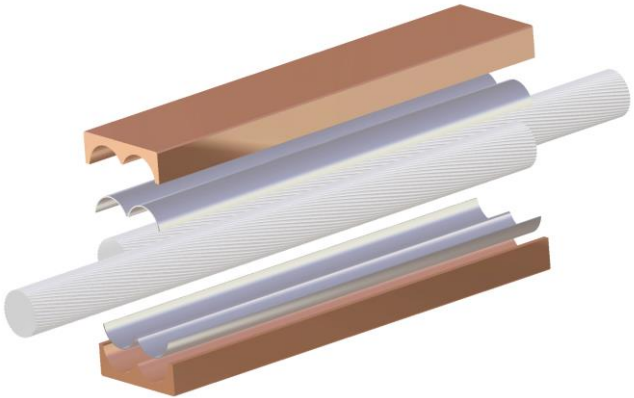


0.6 kA cable

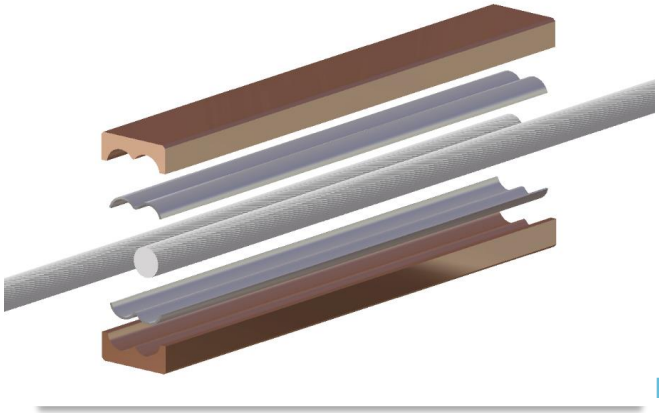
Nb-Ti/Nb-Ti cables splices

Geometry of splices identical to the one defined in Internal review of busbars and splices Apr-14..16, 2021 EDMS@2544721

- **18 kA splice**
  - Sn96Ag4 with Pre-tinning (221°C)
  - Soldering length 150 mm
  - Cu OFE
  - Flux MOB39



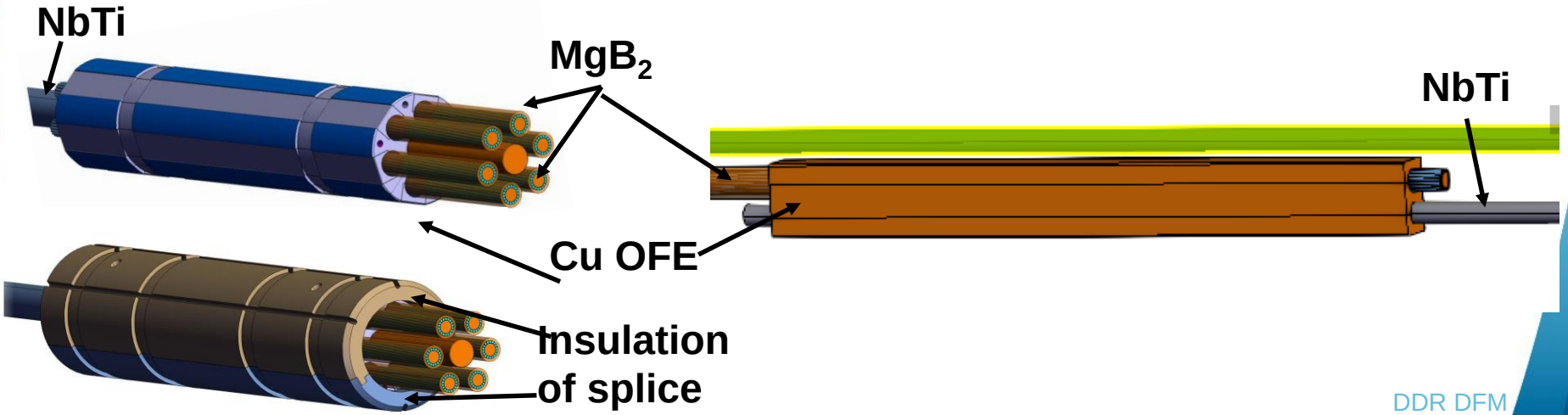
- **0.6 kA splice**
  - Sn96Ag4 with Pre-tinning (221°C)
  - Soldering length 100 mm
  - Cu OFE
  - Flux MOB39



MgB_2/Nb-Ti cables splices

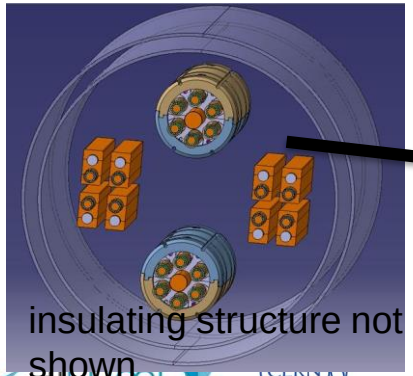
MgB_2/Nb-Ti splices of DFM with same geometry as the one of DFX

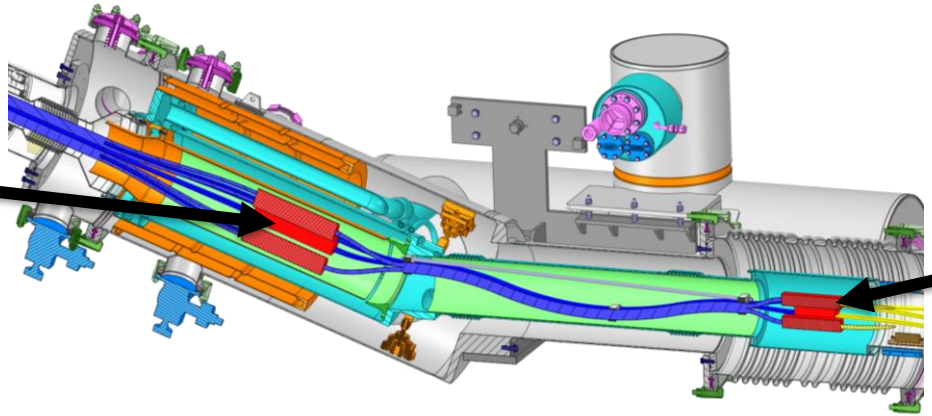
- **18 kA splice**
  - Sn-Pb (183°C)
  - Soldering length 200 mm
  - Cu OFE
  - Flux MOB39
- **0.6 kA splice**
  - Sn-Pb (183°C)
  - Soldering length 200 mm
  - Cu OFE
  - Flux MOB39



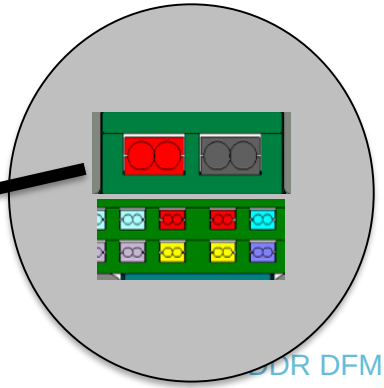
Splices assemblies

- **MgB_2/Nb-Ti splices**
  - splices maintained together via insulating structure
  - Splice assembly is a sliding point vs cryostat (free to rotate and to slide with amplitude of +/-20 mm)
- **Nb-Ti/Nb-Ti splices**
  - splices maintained together via insulating structure
  - Splice assembly is a fix point vs cryostat



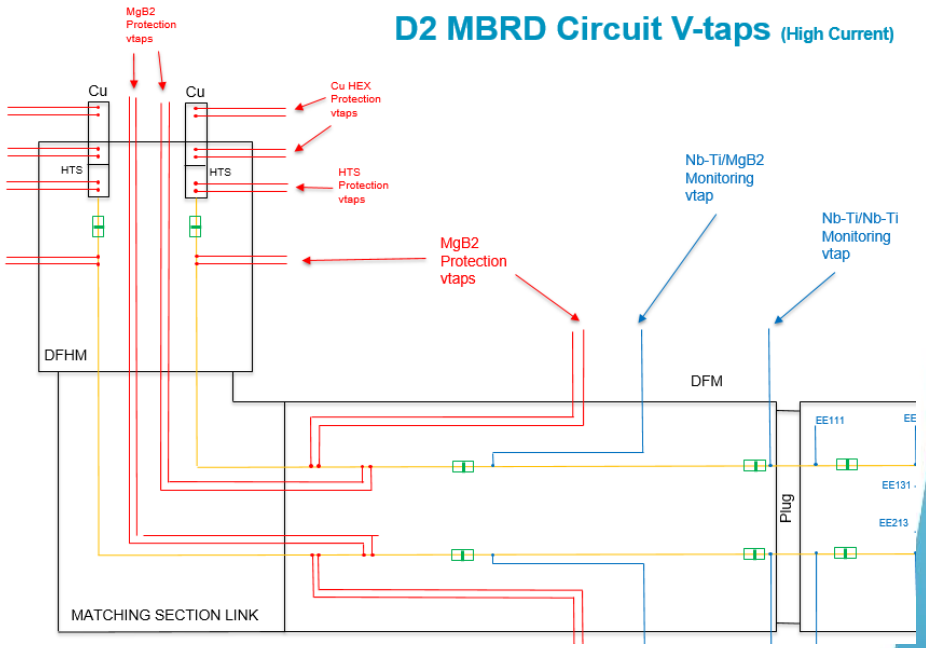


Assembly of splice inspired from the DFX, exact arrangement under finalization



SC Link electrical instrumentation

- **Each branch of circuits** equipped with **14 Vtaps** for the **protection** of:
  - **Current lead** heat exchanger
  - **SC cables** (HTS, MgB_2, NbTi)
  - **Splices** (HTS/MgB_2, MgB_2/NbTi and NbTi/NbTi)
- Same layout for all branches of circuits (0.6-18 kA) IT and MS
- **Requirements for the protection** of the SC-Links components presented by A. Ballarino in cold powering review July 2017 (Indico/643197)
- **4 Vtaps placed in the DFM will be routed out at the level of DFM**



HL-LHC Circuit Voltage Taps Layout of SC Link (EDMS 2411822)

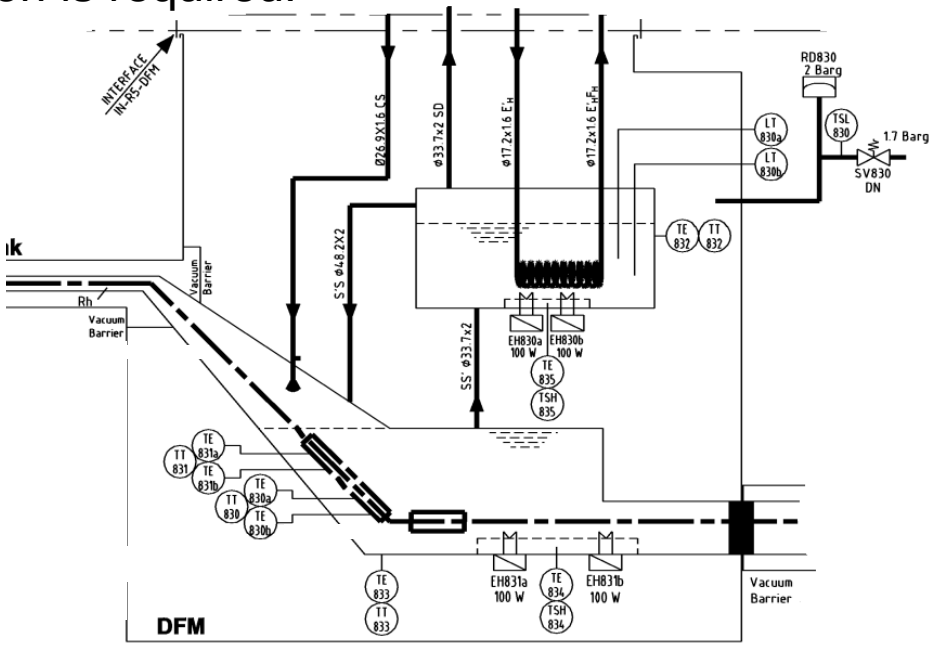
Engineering Specification: Instrumentation of the Cold Powering System EDMS 2512704 and 2591698

Cryogenic instrumentation of DFM

For a safe operation of SC Link system, during nominal operation but also during transients, dedicated cryo instrumentation is required.

Cryogenic instrumentation of DFM :

- **8 Thermal transducers (TT)**
  - Two in vacuum attached to He vessel (Cernox)
  - 4 in the splice box (He vessel) (Cernox)
  - 2 temperature sensors attached to the resistive heaters (PT100)
- **5 Heaters**
  - 1 GHe/LHe Heat exchanger
  - 2x100 W resistive Heaters in external bath (includes 1 spare)
  - 2x100W resistive heater in the lower bath (includes 1 spare)
- **1 He pressure gage**
- **Two LHe level** transducers
- **Cryo control valves** are part of cryo jumper



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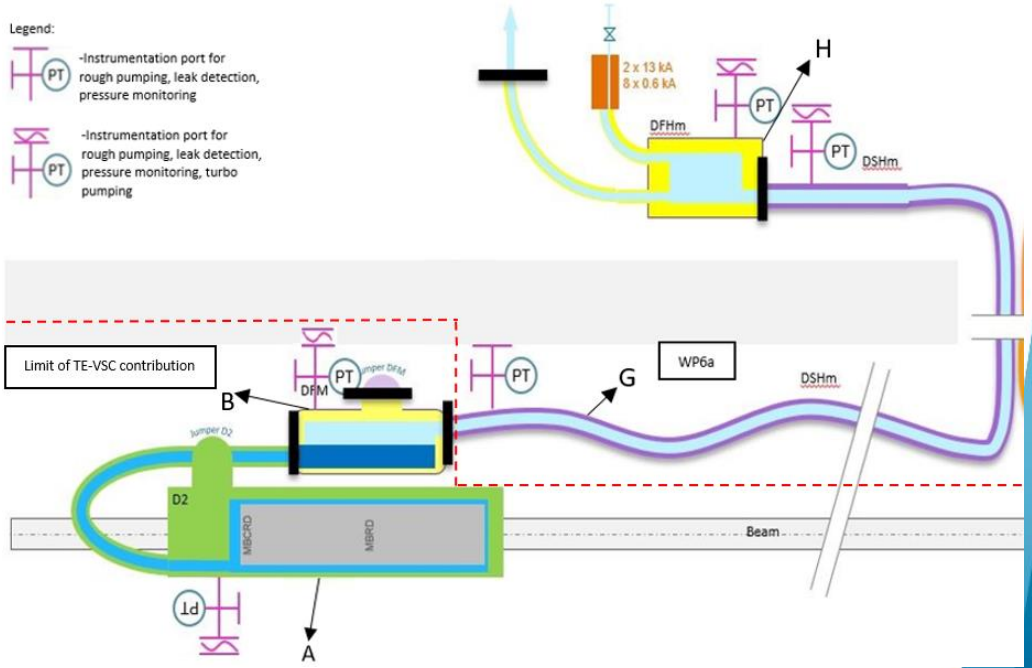
Engineering Specification: Instrumentation of the Cold Powering System EDMS 2512704 and 2591698

Vacuum instrumentation

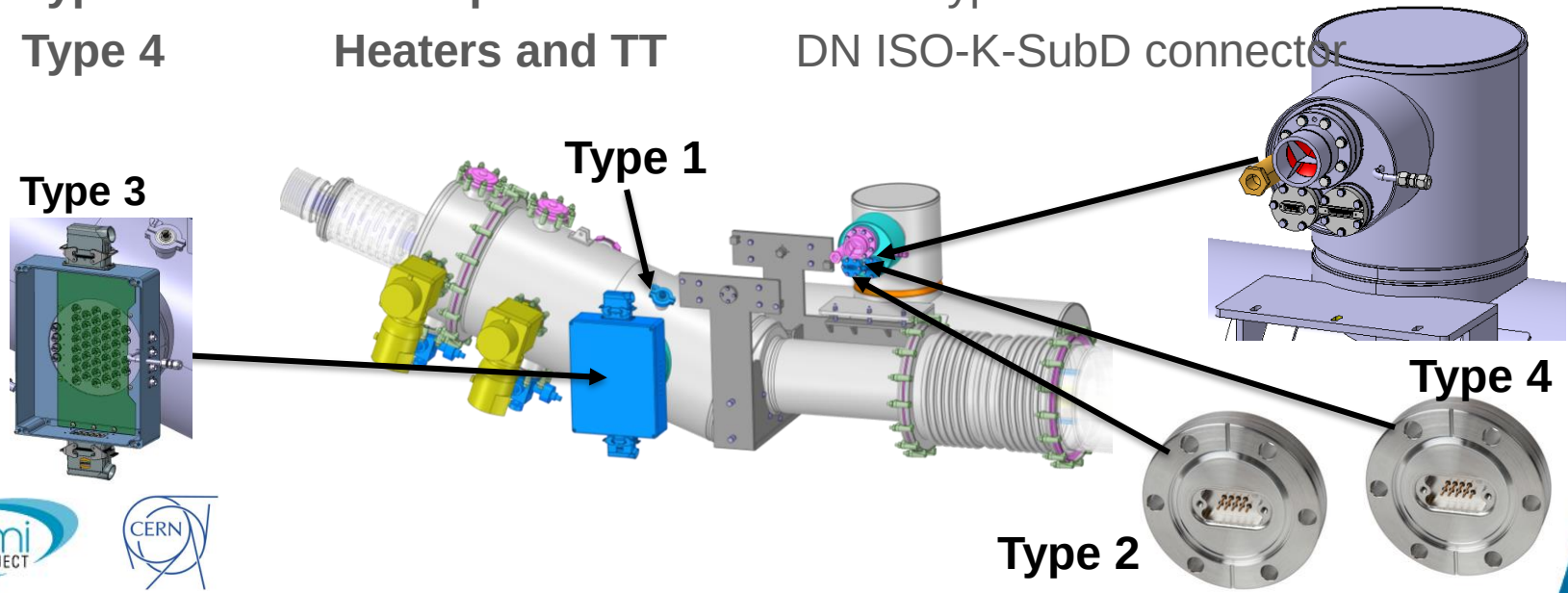
- Each SC Link system made of three vacuum volumes **DFM**, **DSHM** and **DFHM** (EDMS1824906)
- DFM equipped with vacuum ports to plug pumping units and/or vacuum instrumentation
- => **no wiring in the vacuum vessel**



EDMS 1824906

Feedthrough for instrumentation of SC-Link

- DFM equipped with four feedthroughs:
  - **Type 1** **vac. temp probes** DN ISO-K-SubD connector
  - **Type 2** **LHe level gage** DN ISO-K-SubD connector
  - **Type 3** **40 Vtaps** IFS L-Type
  - **Type 4** **Heaters and TT** DN ISO-K-SubD connector



Conclusions

- Geometry of splices (including insulation) finalized
- Splices arranged in assemblies per type (NbTi/NbTi and NbTi/MgB_2)
- List of instrumentation for cryo and electric protection defined
- Feedthroughs of instrumentation defined, type of connector to be confirmed together with CRG and MPE