DFX instrumentation requirements

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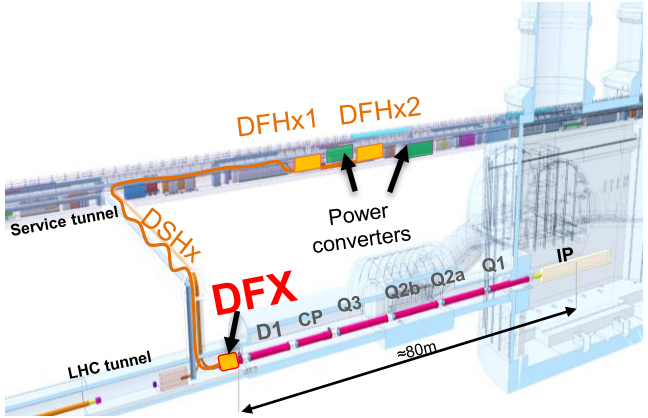
Conceptual design review of the DFX 31 Jan 2019 (Indico/event/783116)

Outline

- DFX instrumentation requirements:
  - Cryogenic
  - Electrical Protection of Circuits
  - Vacuum

Overview of electrical circuits

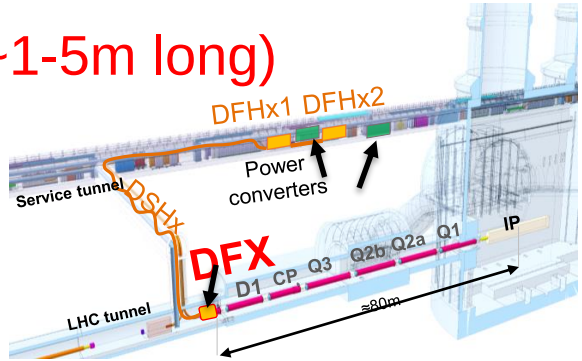
- The cold powering system of Inner triplets consists of:
  - 2 x **18 kA** **MQXF main circuit**
  - 3 x **7 kA** **MQXF trims**
  - 2 x **13 kA** **D1 circuit**
  - 12 X **2 kA** **MCBXF circuit**

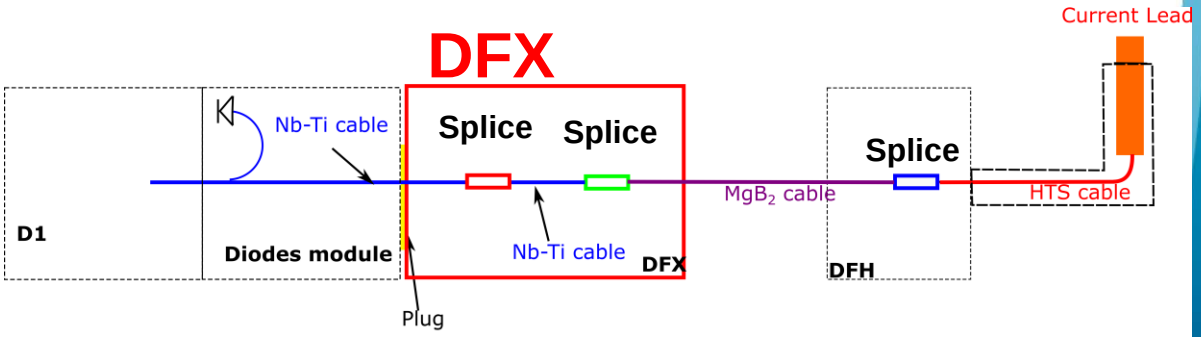


- The DFX located in the LHC tunnel will host the MgB_2/Nb-Ti splices and the Nb-Ti bus bars
- **A total of 19 branches of circuits routed via DFX**

Overview of electrical circuits

- Each branch of circuit (WP6a) consists of:
  - **Sc cables**
    - Nb-Ti bus bar passing trough the plug (~1-5m long)
    - Nb-Ti bus bar extension (~1-5 m long)
    - MgB_2 cable (~100 m long)
    - HTS cable (~4 m long)
  - **Splices**
    - NbTi/NbTi
    - MgB_2/NbTi
    - HTS/MgB_2





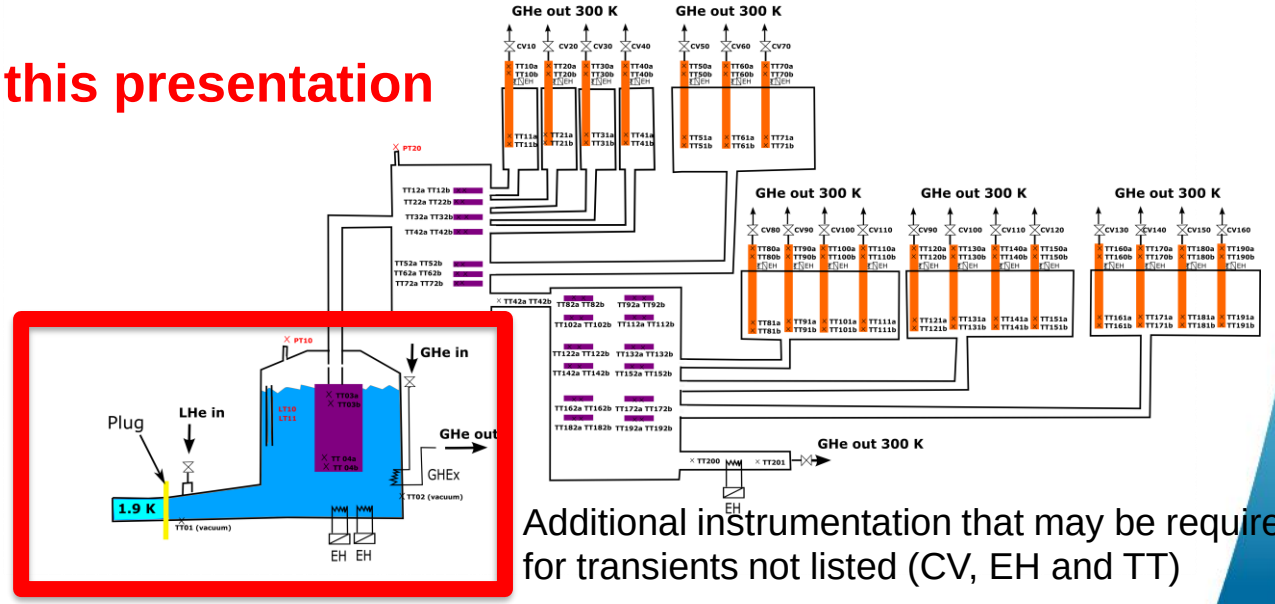
Cryogenic requirements

- **Immersion** of Nb-Ti/MgB_2 splices and Nb-Ti bus bars in saturated **LHe bath at 1.3 bar**=> regulation of level required
- Generate from the LHe bath, a GHe mass flow to:
  - Maintain the **MgB_2 cable** of the Sc Link **below 17 K**
  - Maintain all the **MgB_2/HTS splices** (DFH box) **below 17 K**
  - Thermalize to **50 K** the cold terminal of the **HeX** of each **current lead**

General cryogenic layout of Sc Link for triplets

- Feedthroughs for cryo Instrumentation of DFX located in DFX
- No routing of cryo instrumentation of DFH and current leads via the DFX
- General cryogenic instrumentation layout of Sc Link elaborated with S. Claudet

=>Focus on DFX in this presentation

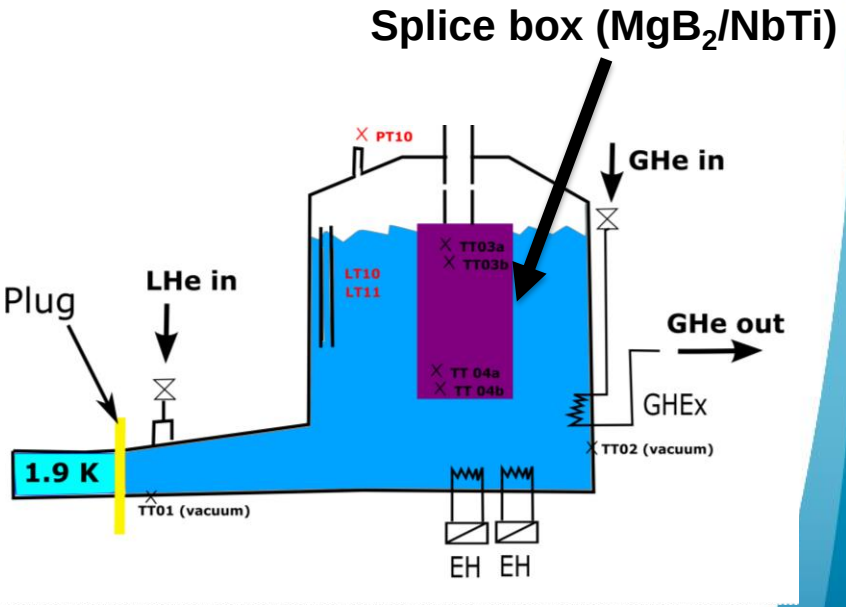


Additional instrumentation that may be required for transients not listed (CV, EH and TT)

Cryogenic instrumentation of DFX

For the cryo-operation of DFX we will need

- 6 Thermal transducers (TT) Cernox
  - Two in vacuum attached to He tank
  - 4 in the splice box (He tank)
- Three heaters
  - 1 Ghe/LHe Heat exchanger
  - 2 resistive Heaters (includes 1 spare)
- 1 He pressure gage
- Two LHe level transducers
- Cryo valves part of cryo jumper



Elaborated in collaboration with S. Claudet

Additional instrumentation that may be required for transients not listed (CV, EH and TT)

Cryogenic instrumentation of DFX

- **Temperature transducers wiring:**
  - **4 wires per probe**
  - **2 probes in vacuum**=> 8 wires at feedthrough
    - One probe being the spare of the other, located on different place
    - >1 m long wires, no thermalization required
    - Wires manganin AWG 36 (EDMS 320597)
  - **4 probes in LHe** => 16 wires at feedthrough:
    - Wires Cu AWG 32 (EDMS 320597)
- **LHe level transducers wiring**
  - **The two probes** shall be (by design of DFX) easily replaceable for unscheduled repair work interventions
  - Wires of the probe not yet defined
- **Electrical heater wiring** not defined yet (Nb. of spare wires and section)

Electrical Protection requirements

- Each of the circuit of the Sc-Link shall be protected by a dedicated Quench Detection System that:
  - Detect any quench or detached VTaps
  - Triggers the removal of energy from the circuit (strategy depends on the circuit): fast abort, EE system, quench heater

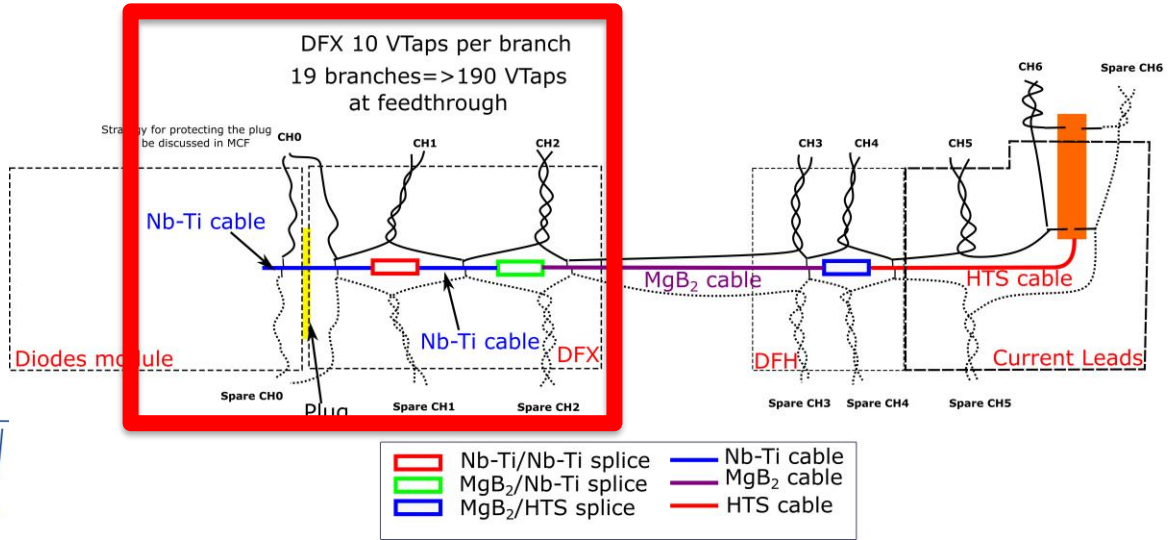
- **Requirements for the protection** of the Sc-Links components presented by Amalia in July 2017 (Indico/20170703)
  - **Active protection** of superconducting components and current leads
  - **Protection thresholds**: 100 mV for the leads, 1-5 mV for HTS cable, 50-100 mV for each MgB_2 cable.
  - **Monitoring of individual splices** (MgB_2 to HTS, MgB_2 to Nb-Ti and Nb-Ti to Nb-Ti)

Instrumentation for circuit protection (DFX)

- Each branch of circuit (19 branches) equipped with VTaps
- Pairs of VTaps formed within the DFX
- Spare for all VTaps
- Feedthrough for VTaps on DFX
- Design of feedthrough(s) shall consider the different electric potential of the circuits
- Wire use for VTaps Cu AWG 26 (EDMS 2030599)

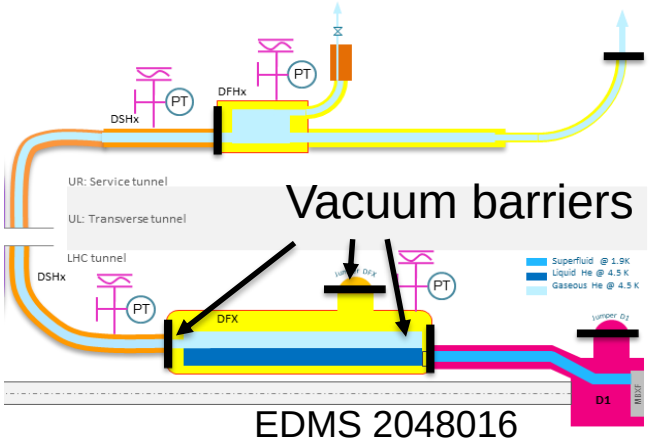
Instrumentation for circuit protection

- NbTi bus bars, NbTi/NbTi splices and MgB_2/NbTi splices protected at the level of DFX
- A total of 10 VTaps per branch of circuit =>190 VTaps
- Each NbTi bus bar of plug protected via a specific VTap paired to another located in diode module

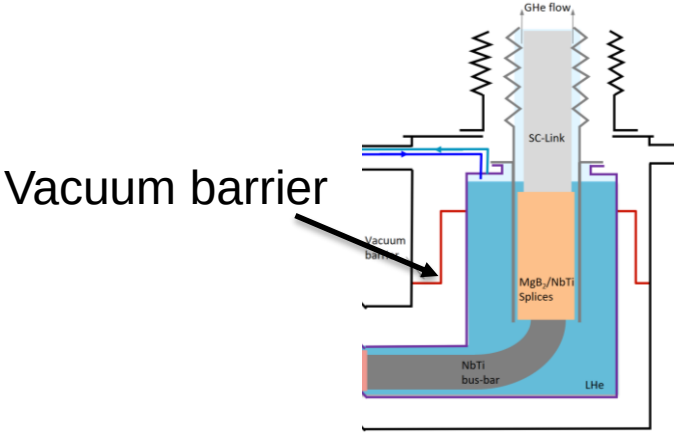


Vacuum instrumentation of DFX

- The cold powering chain of IT made of three vacuum volumes (EDMS 2048016)
- Vacuum barrier DFX/DSH embedded in the DFX



EDMS 2048016



Sketch from Y. Yang

- Each of the **two vacuum volume** of **DFX** equipped with **two pressure transducers** (type to be defined)

Summary

- Instrumentation in DFX:
  - **Cryo**:6 Temp probes, 2 Level gages, one pressure transducer, one GHe/LHe heat exchanger, two resistive heaters
  - **Protection**:190 Vtaps over the 19 branches of circuit
  - **Vacuum:** two times two transducers (type to be defined)
- Design of feedthrough and piping should account for possible reserve spare instrumentation if required
- Design of feedthrough should consider the different electric potential of the circuits (VTaps)