Installation IT String in SM18

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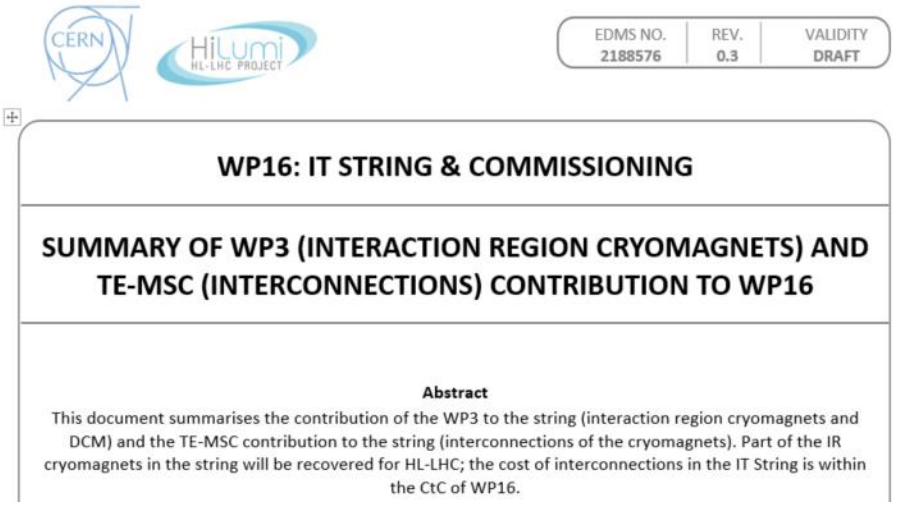
Many thanks to N. Bourcey, F. Crisci, D. Duarte Ramos, Y. Leclercq, H. Prin, R. Principe for their explanations and patience.

Context

EDMS 2188576



In the frame of the IT string installation in SM18 (WP16), a summary of WP3 and TE-MSC contribution is asked.

In addition of the jacks, anchors and cryo-magnets supply from the WP3, TE-MSC is responsible of the installation and the interconnection of the cryo-magnets and DCM for the string.

- Resources payed by WP16

The proposed discussion is to agree on TE-MSC human resources to engage for the string interconnection activities for a given duration.

The material and the personnel will be paid by WP16.

Prior to the installation, tests on simple mock-ups and first version of procedures are prepared and will be under WP3 budget

This discussion does not include the DFX installation nor its connection.

Activities description

A description of the main steps of magnet interconnection for the IT string is given in the following slides.

Many details are still under study!

Main QC steps are also given.

- **QC** : internal MSC-QC (teams to be defined: LMF-QC or from other section ?)
- **QC** : support given by TE/VSC, TE/MPE, TE/CRG, EN/MME…

Assumption : local leak tests are done when all lines (cryomagnets, DCM and jumpers) are welded. Helium gaz is provided from the QXL to qualify the helium volume.

Activities description

The initial conditions considered are:

- Plugs on QXL jumpers are removed
- Ground fixations (holes) are ready for installation of jacks, anchors and DCM frame (EN-ACE action with maps given by MSC)
- Motorized jacks are in place.
- Q1 to D1 magnets are in place and anchors are fixed
- Q1 to D1 magnets are aligned
- ELQA tests on each individual magnet are done
- DCM and possibly its frame are **not** in place.
- DFX can be present (WP6A)

Activity : N lines pulling

N lines pulling

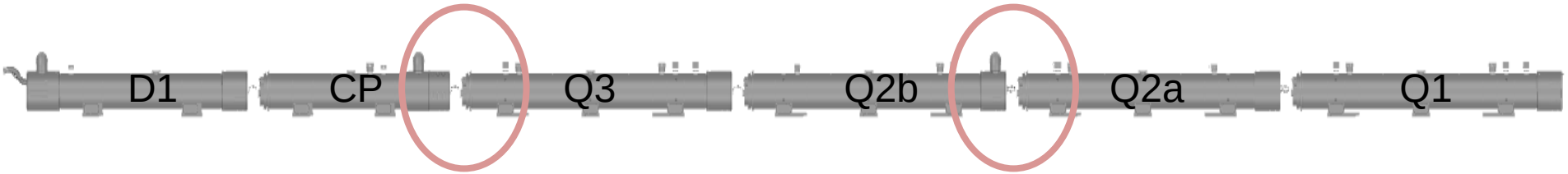
- QC: ElQA test of N lines on the reels
- Cables on reel at DCM position. Installation of winch and pulleys
- Line N1 pulling : 18kA superconducting cables from D1 to Q2a.
- Line N2 pulling : 2kA superconducting cables from D1 to Q2a.
- QC: ElQA test after N lines in position and with/without soldering connection (combined HV and AIV?)

From this step two activities in parallel :

Q1-D1 connection

D1-DCM connection

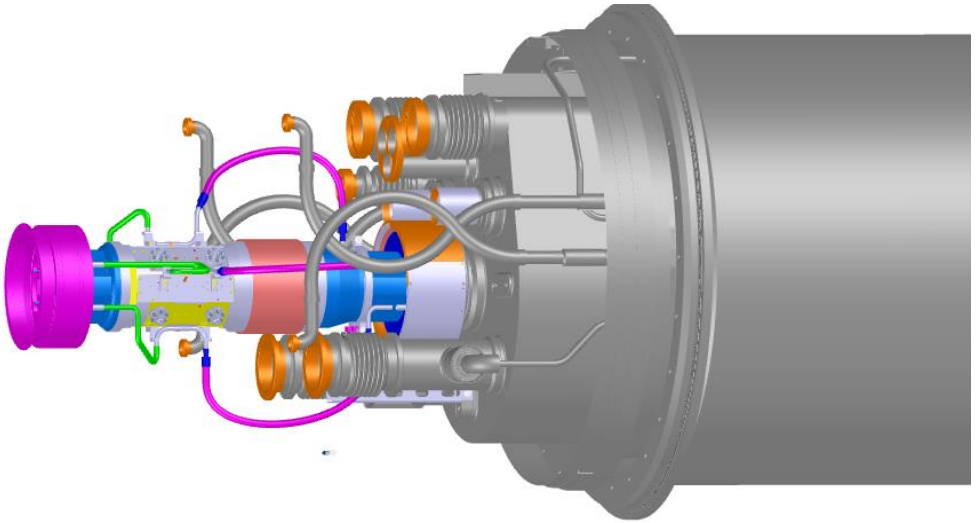
Activity: Q1 to D1connection



Installation of fake BPM/PIM in two interconnections.

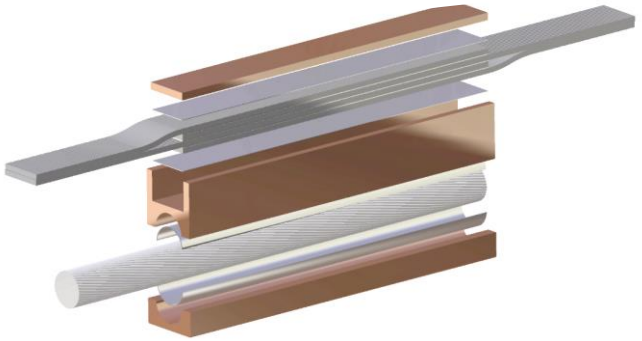
No beam line, BPM or PIM are installed for the string.

The proposal is to install a BPM and a PIM (or an envelop of them) in two interconnections to create more realistic conditions for the cryo-lines welding.



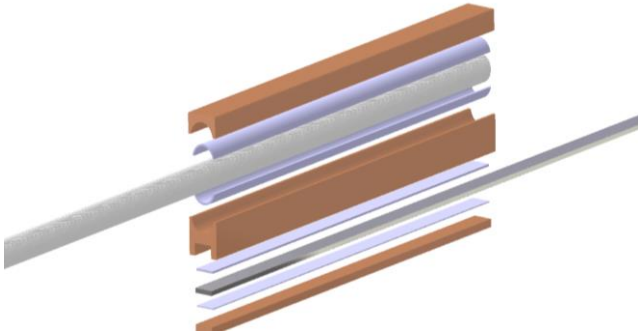
Activity: Q1 to D1connection

- Splice connection work
  - 18kA splice connection
    - ~2 / interconnection
    - QC (to determine: electrical/ visual/ dimension?)



Magnet leads to 18kA cable join

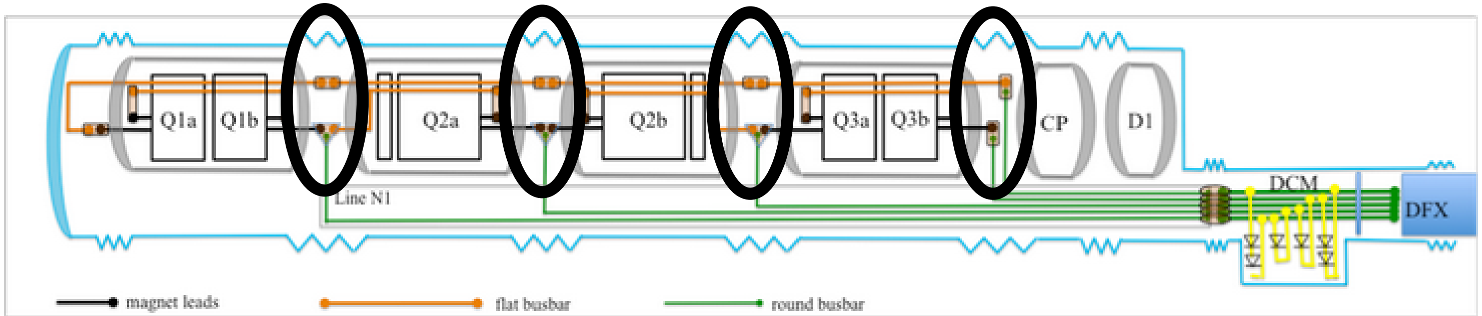
  - 2kA splice connection
    - 4 splices in 3 interconnections
    - QC (to determine: electrical/ visual/ dimension?)



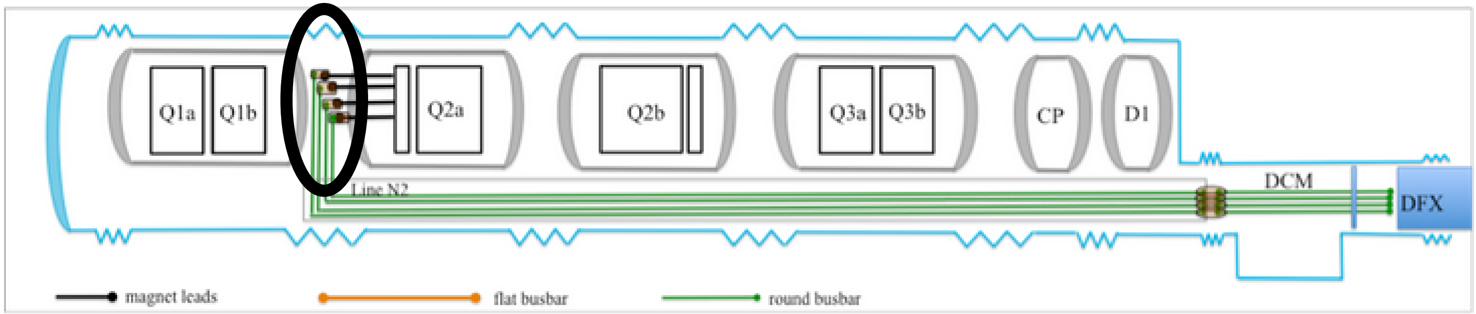
Corrector lead to 2kA cable join

  - EIQA (when and how often?)

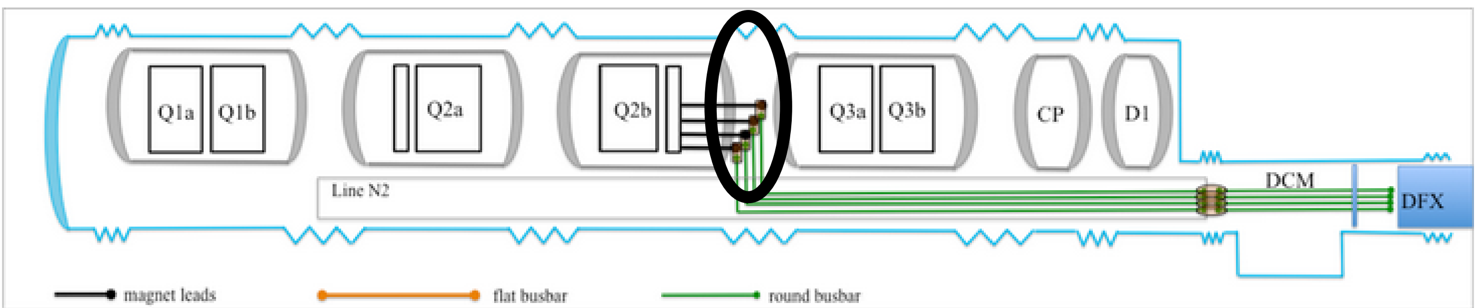
Busbar layout



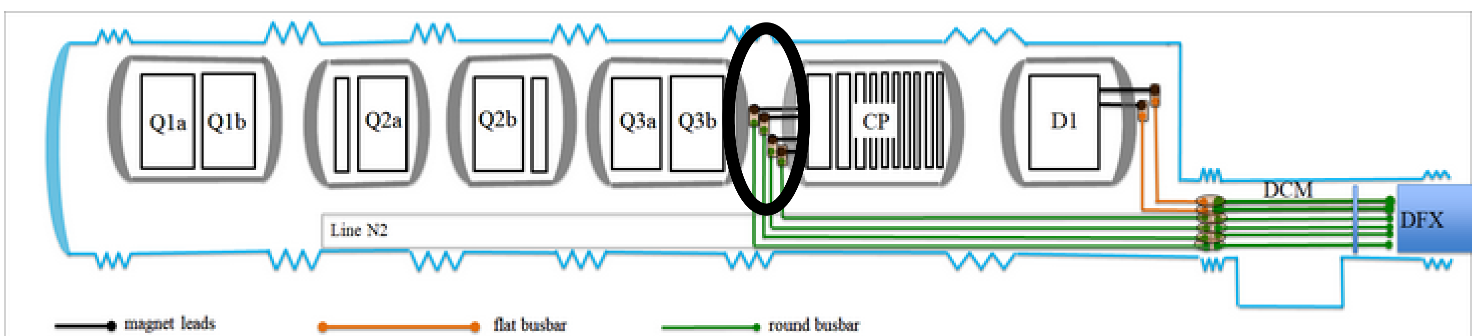
Line N1



Line N2



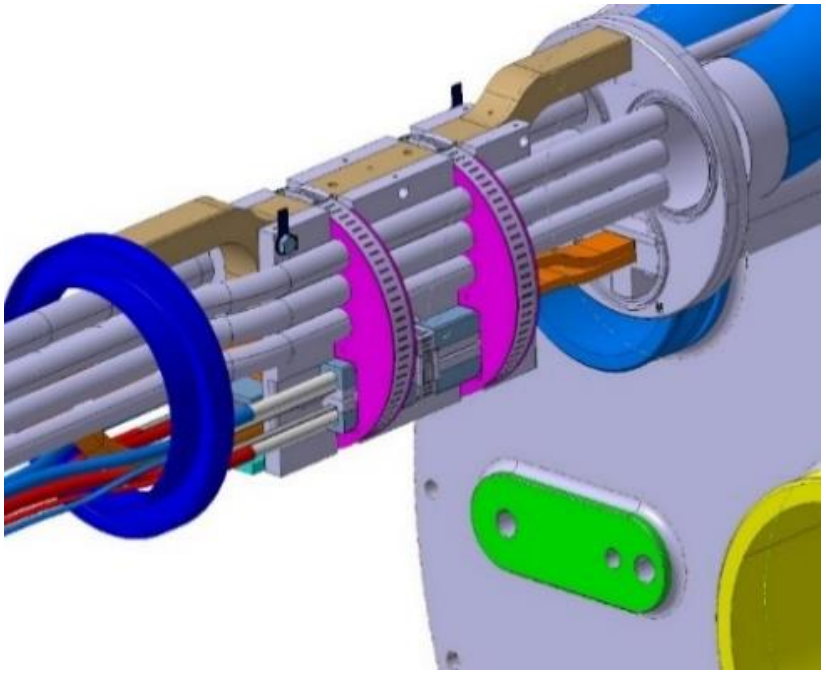
Line N2



Line N2

Activity : Q1 to D1connection

- Installation of fixe points
- Eccobond injection
  - QC (visual inspection)

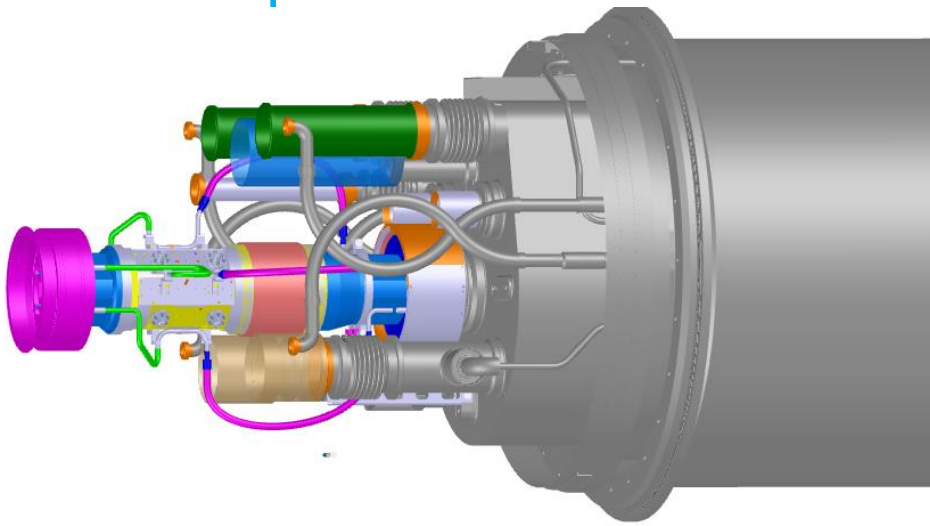


- ElQA test before sleeves welding

Activity : Q1 to D1connection

- Sleeves welding (lip welding)
  - QC: Visual inspection

- Thermal shield lines welding (butt welding)
  - QC: Radiographies and visual inspection



- Ready for local leak tests

Activity : Q1 to D1connection

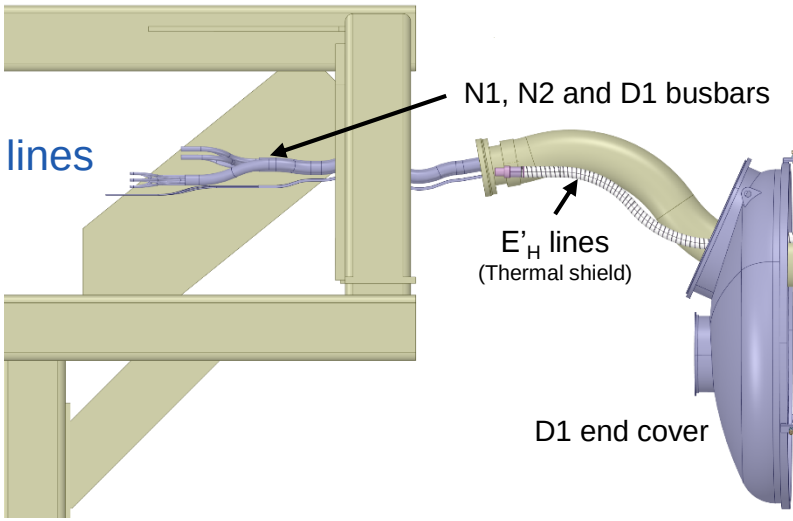
- QC : check before closure
- Thermal shield, MLI
- W closure

- Ready for global leak test

Activity : D1 to DCM connection

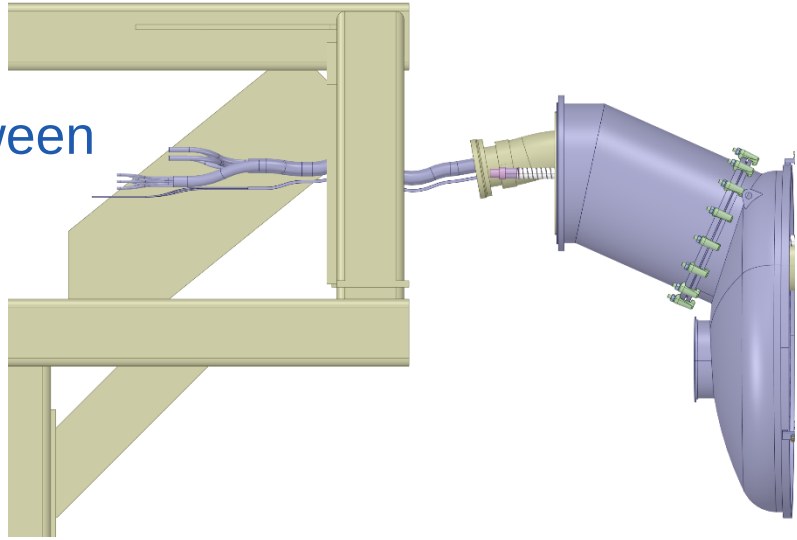
- Installation of the DCM frame

  if not done prior N lines pulling as a support of N lines



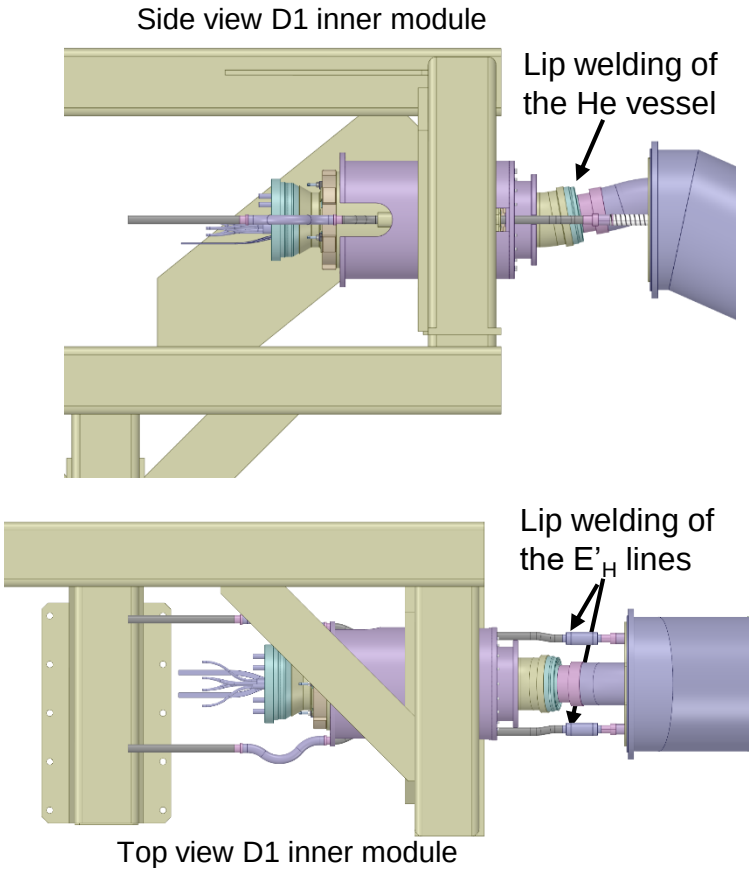
- Installation of the elbowed vessel between DCM and D1

  With thermal shield, MLI, outer shell… (No welding)



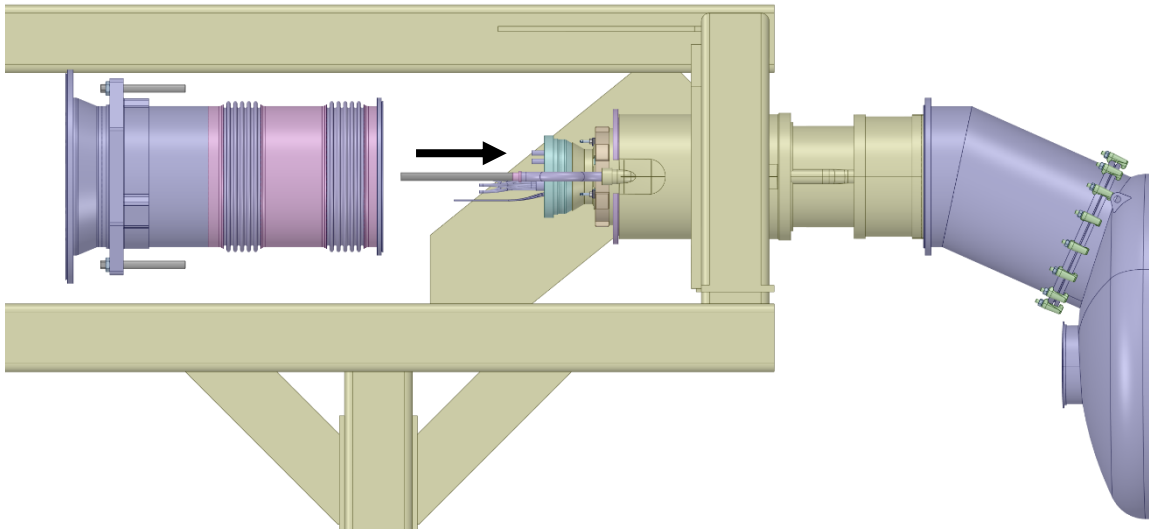
Activity : D1 to DCM connection

- Installation of the inner part of the D1 module
  - Positioning of the module
    - Tooling and procedure to determine
  - Lip welding of the He vessel
    - Installation leak test (He bottle)
  - Lip welding of the E'_H lines
    - Installation leak test (He bottle)
  - QC holding point

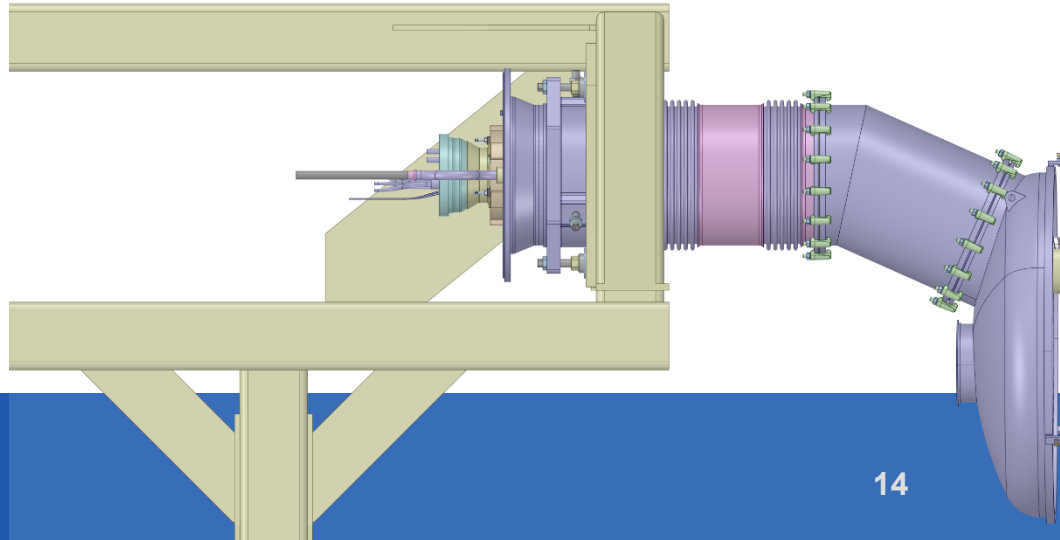


Activity : D1 to DCM connection

- Insertion of the vacuum vessel of D1 module
  - Thermal shield,
  - MLI…

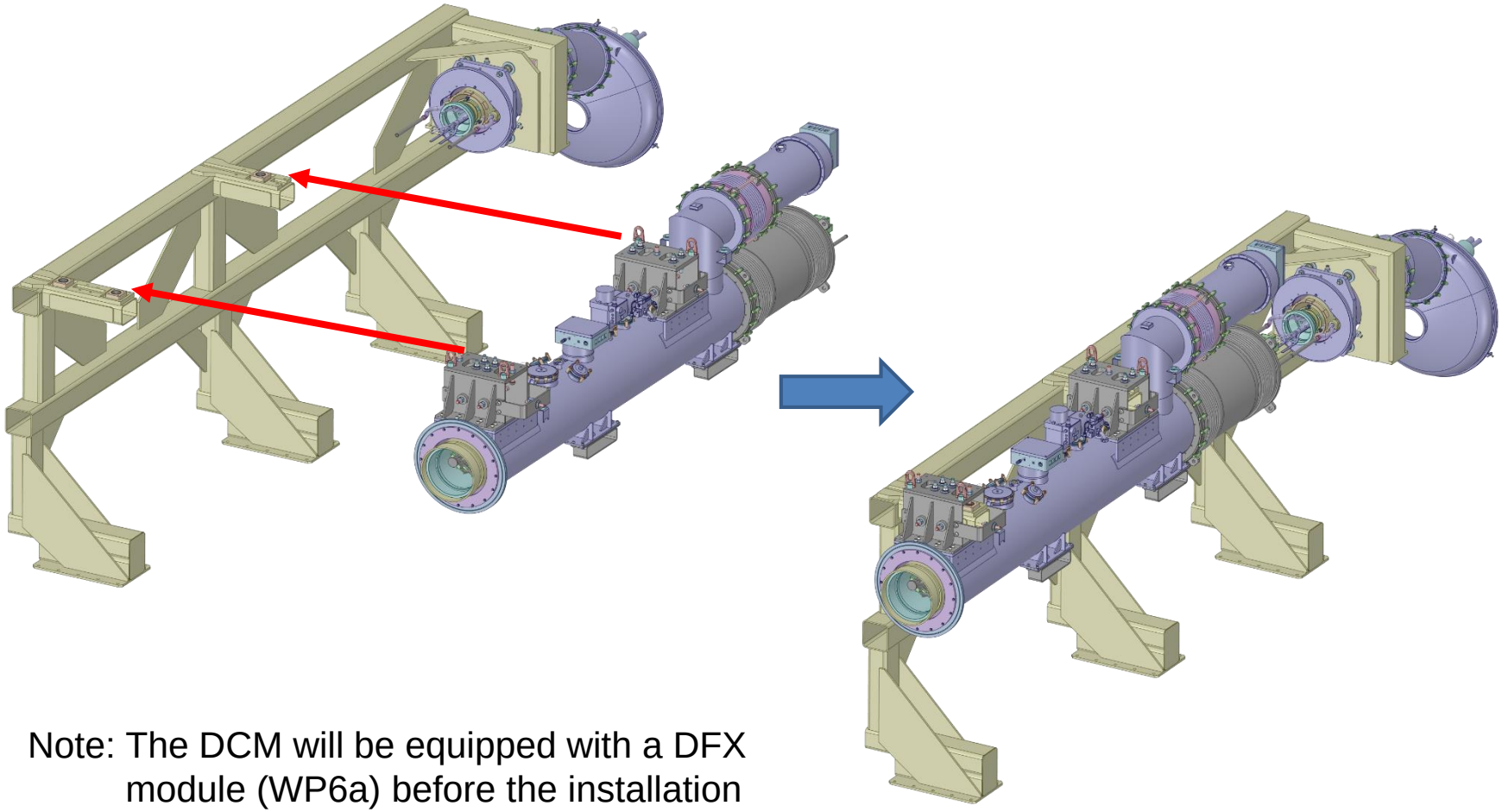


  - Correct positioning thanks to setting screws (criteria to determine)



Activity : D1 to DCM connection

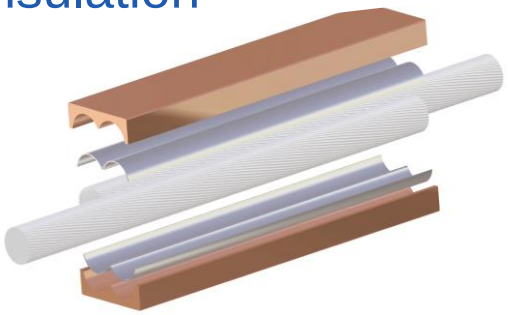
- DCM installation and alignment

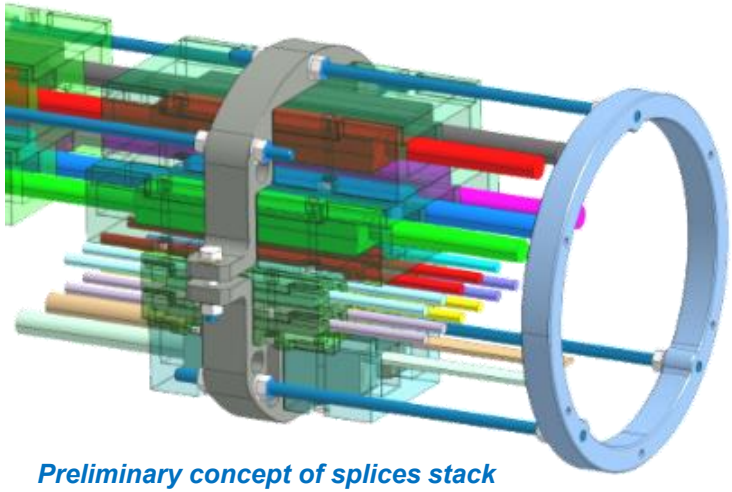


Note: The DCM will be equipped with a DFX module (WP6a) before the installation

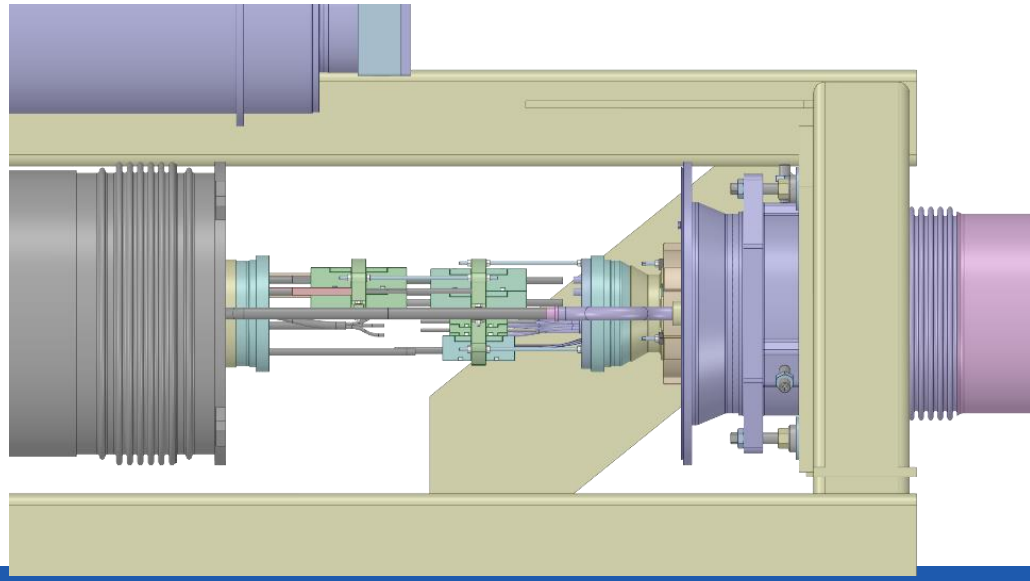
Activity : D1 to DCM connection

- Splices connection (NbTi - NbTi) and splices insulation
  - 12 * 2kA cable splices → QC
  - 5 * 18kA cable splices → QC
  - 2 * 13kA cable splices → QC
- Insulation boxes installation → QC
- Installation of the fixe point → QC

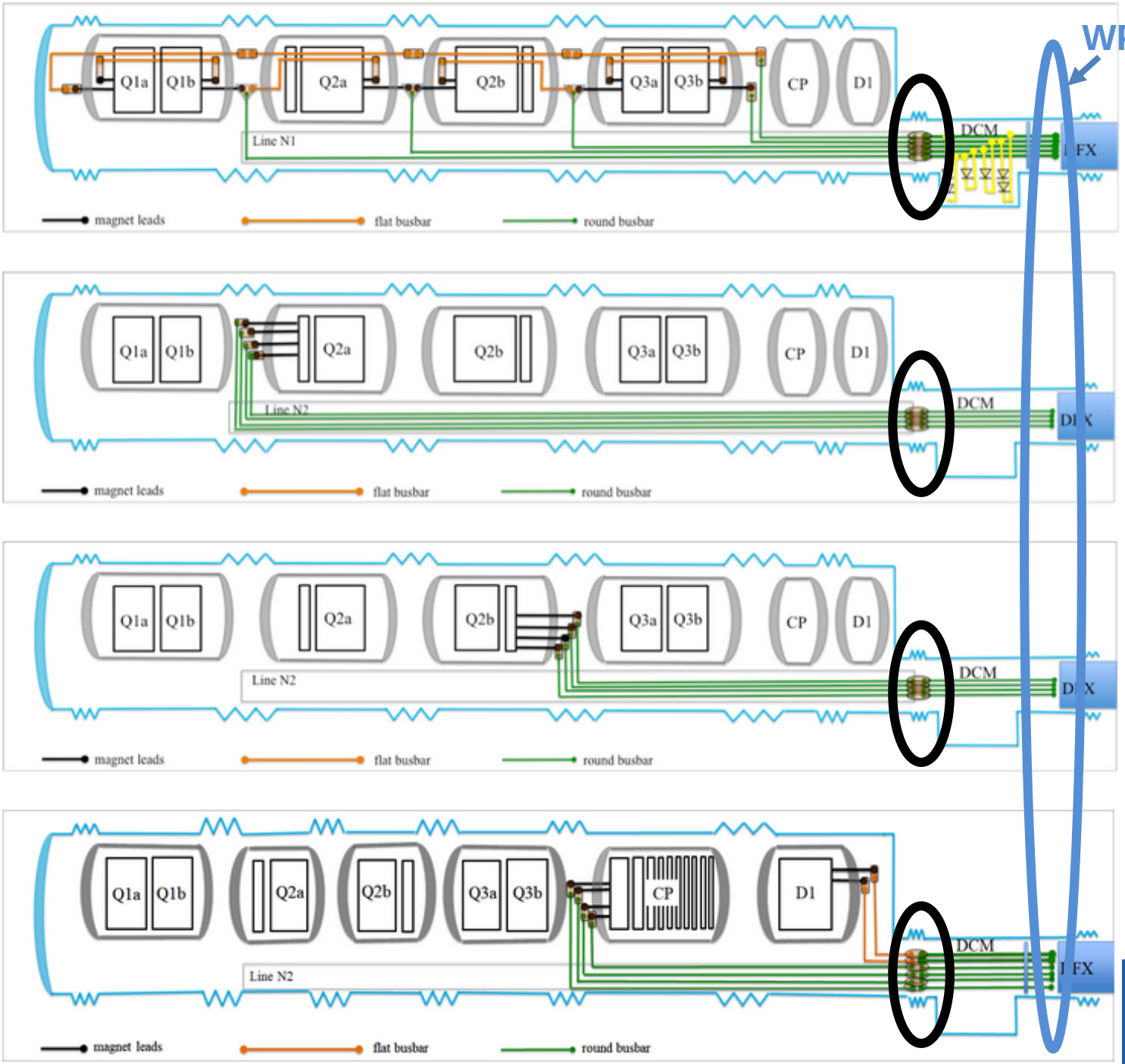




Preliminary concept of splices stack

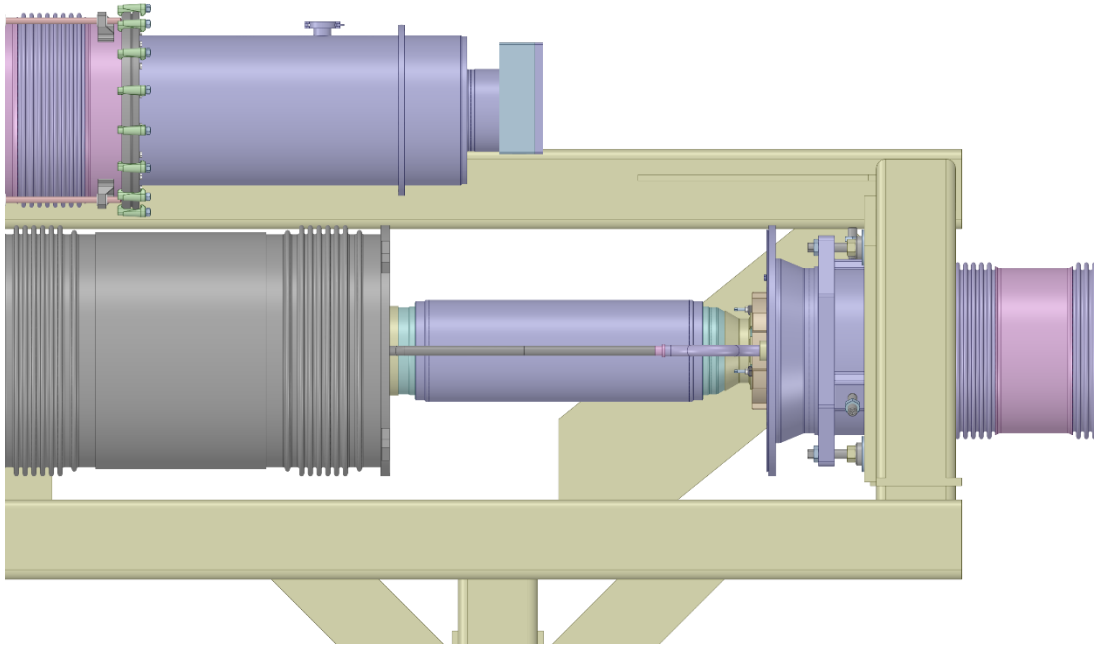


Busbar layout



Activity : D1 to DCM connection

- Sleeve and E'_H lines welding
  - Lip weldings of N lines sleeve
  - Butt weldings of E'_H lines (radiographies)



- Ready for local leak tests

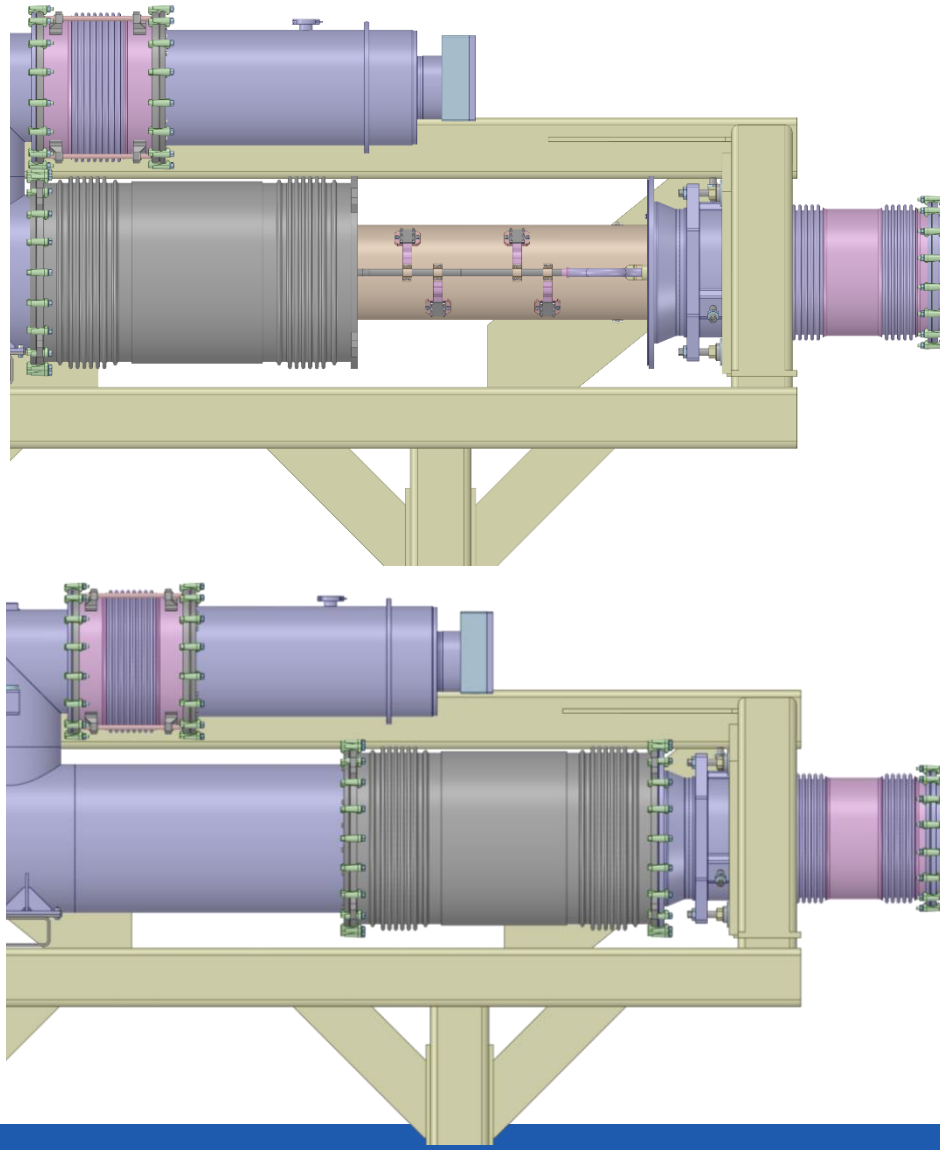
Activity : D1 to DCM connection

- QC : check before closure

- Thermal shield
- Thermal shield connection
  MLI

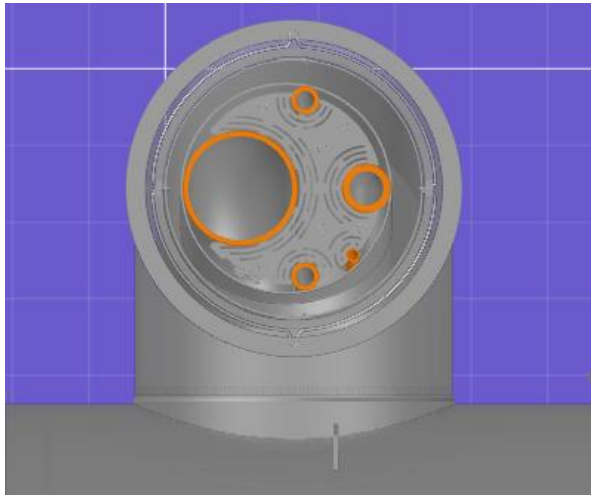
- W closure

- Ready for global leak test



Activity : Jumpers connection

- 3 Jumpers to weld
- Cryo-lines welding (lip & butt welding)
  - QC: Radiographies and visual inspection



- Ready for local leak tests

Activity : Jumpers connection

- Thermal shield welding
- W closure
- Ready for global leak tests

Planning and Resources

The SM18 IT string will be the first cryo-magnets connection closed to real conditions and will require lots of preparation and documentation prior the installation. Today, we have only a general picture of how to proceed.

Before the IT string installation, teams will practise on simple mock-ups few parts of the assembly and in collaboration with QA/QC team, will prepare first versions of the interconnection procedures.

A significant follow-up is necessary to maintain the know-how and take benefit of the lessons learnt during the IT string installation, to apply them for the HL-LHC project, as the planning for the connection must be optimised (IT string is «only» a fourth of a part of HL-LHC project).

I suggest that strengthened teams for the field coordination and QA/QC are involved, ideally the same people that will be involved for the HL-LHC project in LS3 (three-four years after the string installation).

IT string needs also experimented technicians to improve and optimise the tooling for LS3.

Planning and Resources

IT string is an opportunity to learn and to update the procedures. An effort on the resources and the preparation, will may be slow down magnet production for one or two months but will be a real gain during LS3.

During the IT string connection, the resources estimation is

- Main coordinator : 1FTE
- Project engineer : 1 FTE (part time of each project engineer)
- Field coordination : 2 FTE (two field coordinators for D1-Q1 section: 0.8 FTE each, 1 field coordinator for D1-DCM section: 0.4 FTE)
- QA : 1 FTE (following of procedures)
- QC : 0.5 FTE (to determine)
- Logistics : 0.5 FTE (transport, machining, …)
- Technicians and welders (next slide)

Planning and resources

Technical resources and duration for each activity.

Few activites will be done in parallel if the resources are sufficient.

If external **QC** takes more than ½ day in the week, extra time must be added.

Learning time is reasonably considered in the given duration, but time for non-conformity repair must be added !

- N lines pulling
  - 2 field coordinators, 3 technicians (2 staff, 1FSU)
  - Duration : 1 week

- D1 module and DCM installation (without splices connection)
  - 2 technicians (1staff, 1 FSU)
  - Duration : 2 weeks

Planning and resources

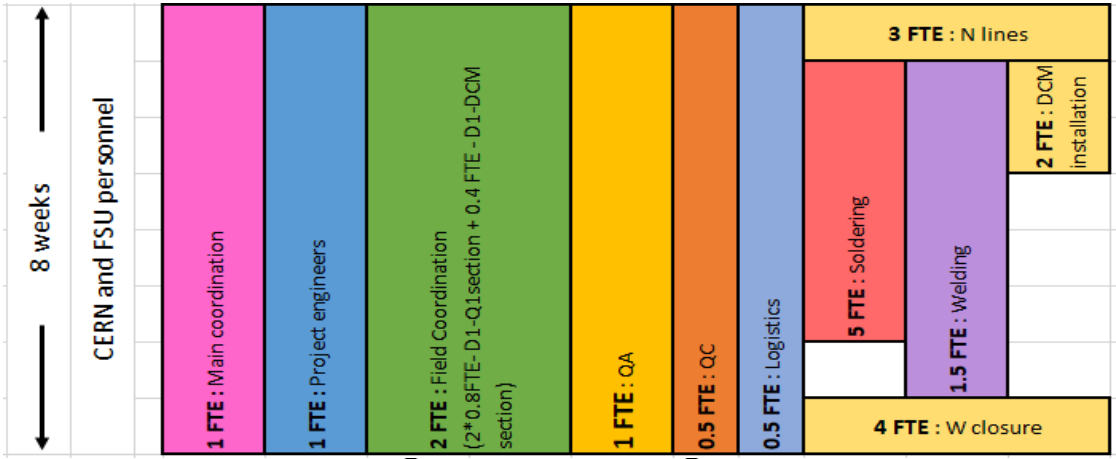
- Splices connection and fixe points installation
  - 2 teams of 2 for splices soldering (2 staff, 2 FSU)
  - 1 person for fixe point and eccobond injection (1 FSU)
  - Duration : 3 weeks for D1-Q1 section
  - Duration : 2 weeks for DCM-D1 section (and DCM-DFX)

- Welding : Jumpers and cryo-lines
  - 2 experienced welders from MSC
  - Duration : 6 weeks (75% time)

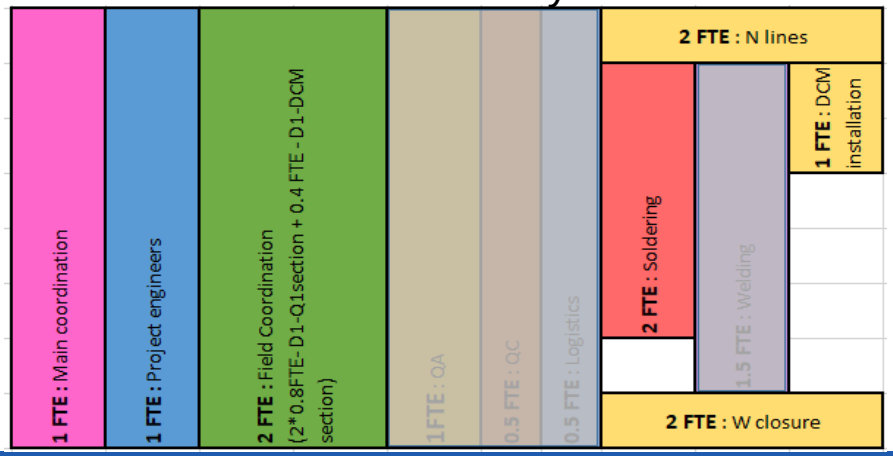
- Thermal shields and W closure
  - 4 technicians (2 staff, 2 FSU)
  - Duration : 1 week

Summary on resources

MSC activities for WP3 only = 8 weeks, but the interconnection work will take longer (Local leak test, FRAS, ….)

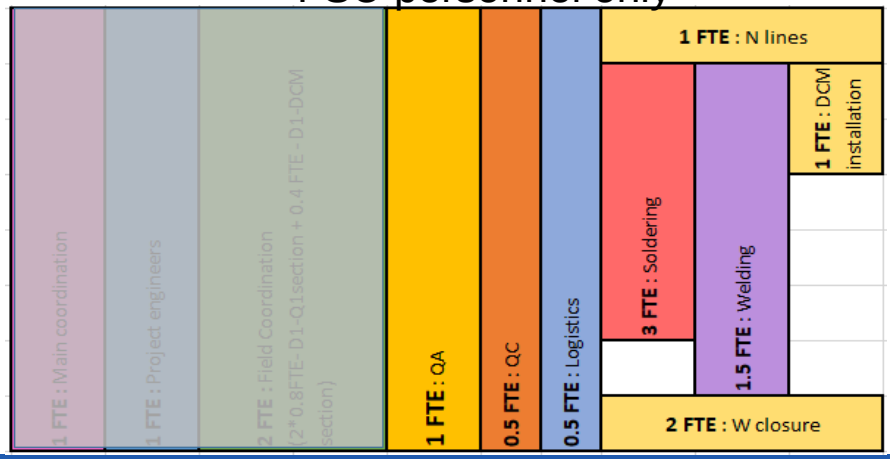


CERN staff only



6 FTE

FSU personnel only



5.6 FTE

Top of the iceberg

The interconnection work is only the top of the iceberg. A lot of work, drawings and documentation need to be prepared.

- Test on simple mock ups (line N pulling, Splice soldering, …)
  - Define the tooling
  - Prepare the procedures
  - …
- Validate the drawings
  - Global and detail views
  - Kit for interconnection
  - …
- Define the interface of WP3 with the other WPs
  - Interface to the superconducting link (WP6a), defined in EDMS 2429304 ☑
  - Interface to the cryogenics (WP9), defined in EDMS 2728042
  - Interface to protection (WP7), defined in EDMS 2369405
  - Interface to FRAS (WP15), defined in EDMS XXXX
  - Local/global leak test?
- Define the **QC** procedures
  - For LS1 and LS2, the team was independent from LMF section. Still the case?
  - Criterias to define and procedures

The progress of the tests on mock up/drawings/procedures are under the sections responsibility and budgeted by WP3