Cold Powering of the HL-LHC magnet system WP6

- Motivation
- Work Package description
- Tasks
- Partners & resources

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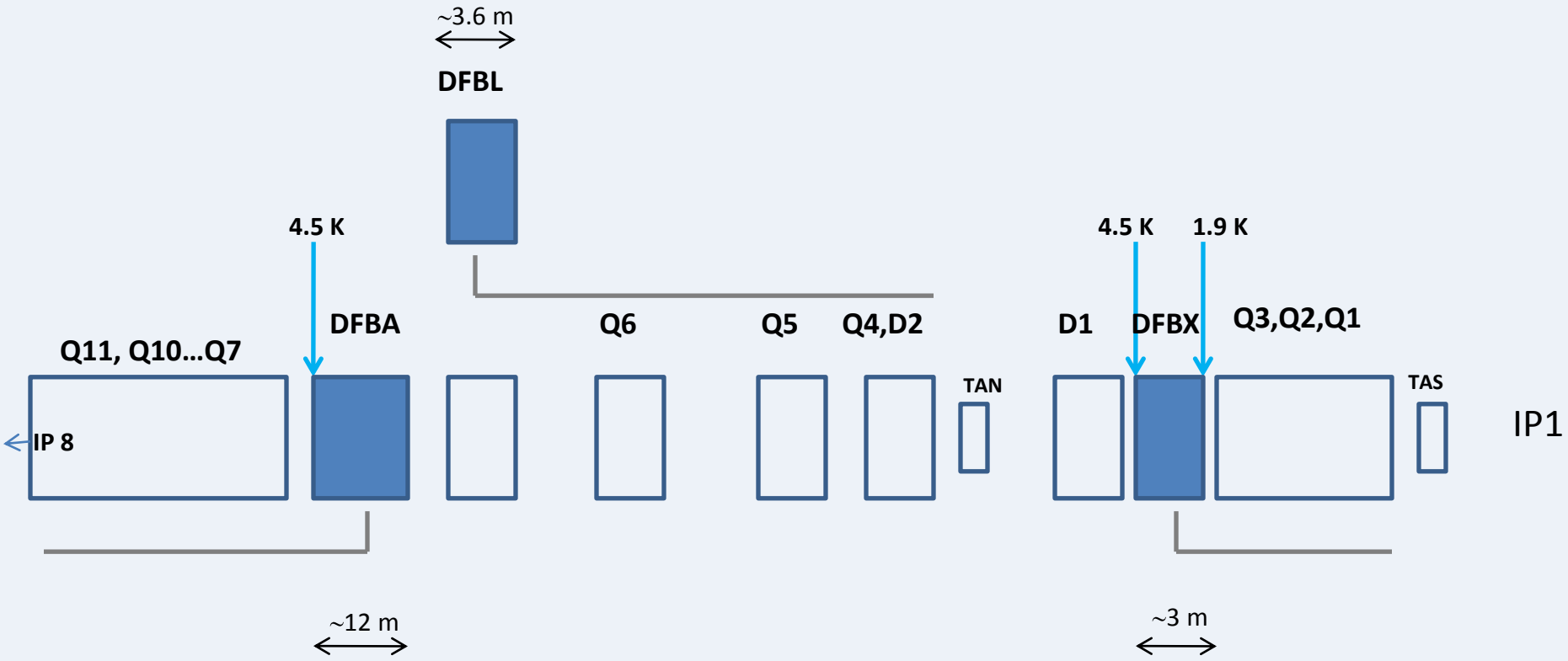
Motivation

- Elaborate a proposal for the cold powering of the superconducting magnet system of the HL-LHC that enables the removal of the power converters and of the cryostats with the current leads from the tunnel to radiation free areas (remote powering)

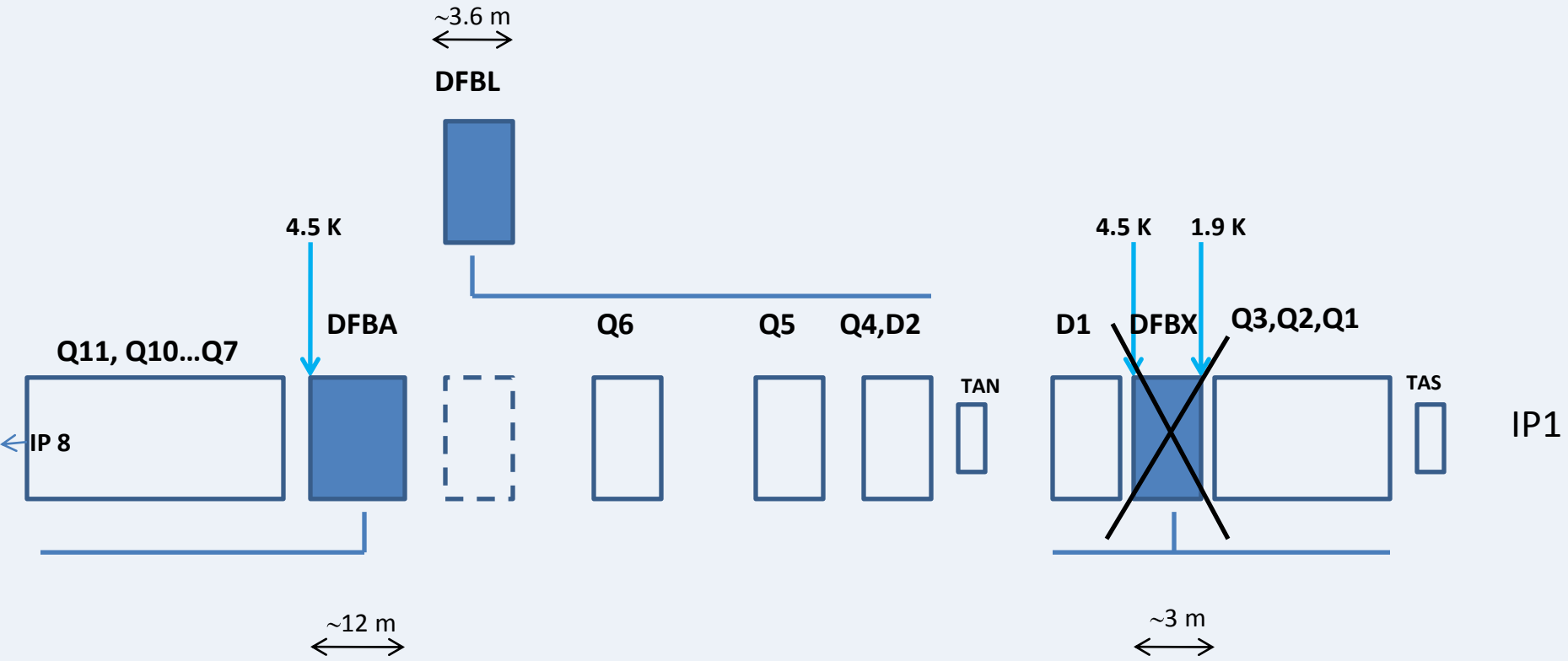
- The study aims at locating power converters, of leads and associated cryostats at the surface→ a superconducting link provides the electrical connection between the current leads, in surface buildings, and the magnets in the tunnel

The existing system

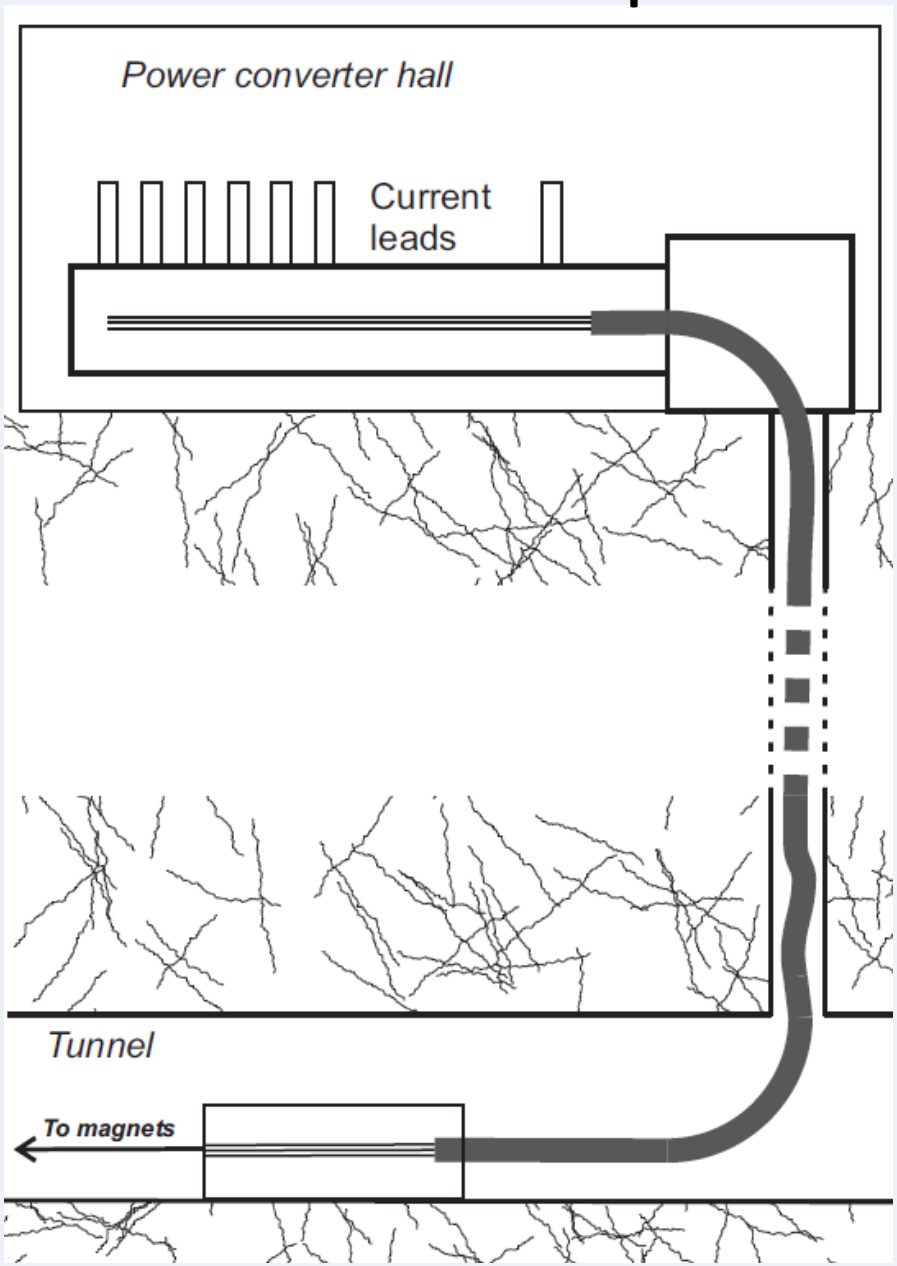


Ex. DFBXA: 4 leads 7500 A, 14 leads 600 A and 10 leads 120 A (Itot ~ 40 kA)

The existing system

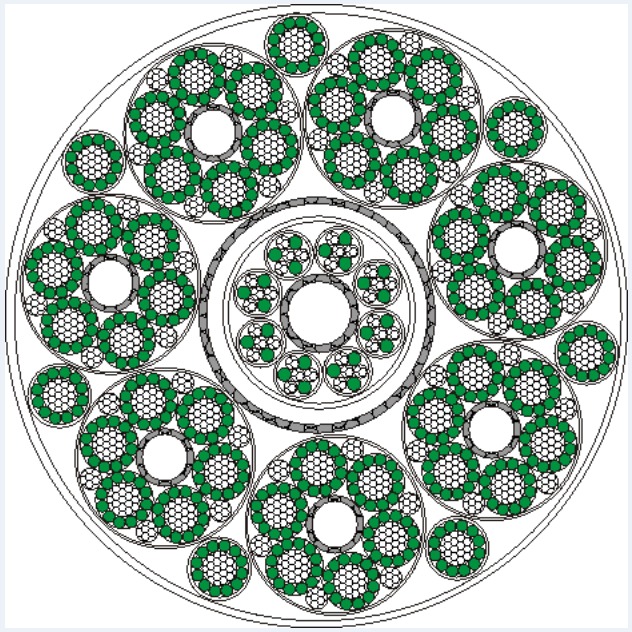

~3.6 m
DFBL
4.5 K
4.5 K
1.9 K
DFBA
Q6
Q5
Q4,D2
D1
DFBX
Q3,Q2,Q1
Q11, Q10…Q7
TAN
TAS
IP 8
IP1
~12 m
~3 m

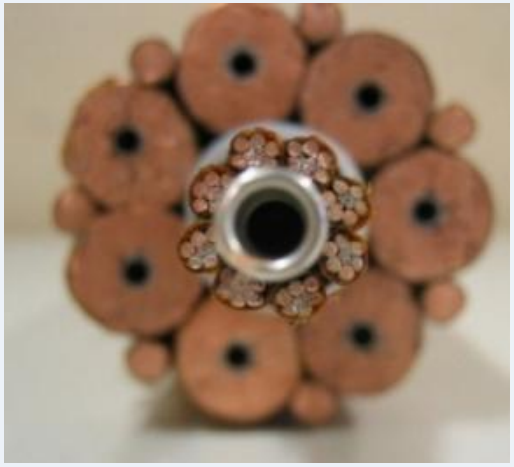
Cold powering system



- Cryostat with current leads
- Superconducting link
  Vertical & Horizontal parts
- Cold box for electrical interconnection to magnet bus-bar

MgB_2 multi-cable developed for the New Inner Triplet project





Φ = 62 mm

7 × 14 kA, 7 × 3 kA and 8 × 0.6 kA cables – Itot~120 kA @ 30 K

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Synergy with other on-going projects

- Task 5 (High-Tc Superconducting Link) of EUCARD WP 7 (High Field Magnets) Development of an horizontal link, about 30 m long, containing an assembly of 48 High Temperature Superconducting (HTS) cables rated at 600 A. Participants: CERN, University of Southampton, BHTS and Columbus Superconductors

- Activity being performed at CERN in the context of the consolidation program (R2E) of the LHC. Development of horizontal and vertical links containing multi-cable assemblies transferring a total current > 100 kA . The maximum current of each individual cable is 6000 A, and the cryogenic cooling uses what today available in the LHC

The HL-LHC magnet system will require circuits transferring currents > 12 kA. Also, the cryogenic system may offer different cooling options, which may have an impact on the type of superconductors used in the link

Tasks and Participants

Task 6.1: Coordination and Communication

Task 6.2. LHC Cryogenics: Cooling and Operation

Task 6.3. Thermo-electrical and mechanical models

Task 6.4. Energy deposition and material studies

Participants: CERN, University of Southampton, University of Florida and LASA-INFN Milano

Work-package coordinators: CERN and LASA-INFN Milano

Task 6.2, Task 6.3 and Task 6.4 are proposed to start 12 months after the other WPs

Task 6.1: Coordination and Communication

Coordination by CERN

"The activities of this task are for the WP leader to oversee and co-ordinate the work of all the other tasks in the WP7, to ensure the consistency of the work according to the project plan and to coordinate the WP technical and scientific tasks with other tasks carried out within other work packages when relevant…."

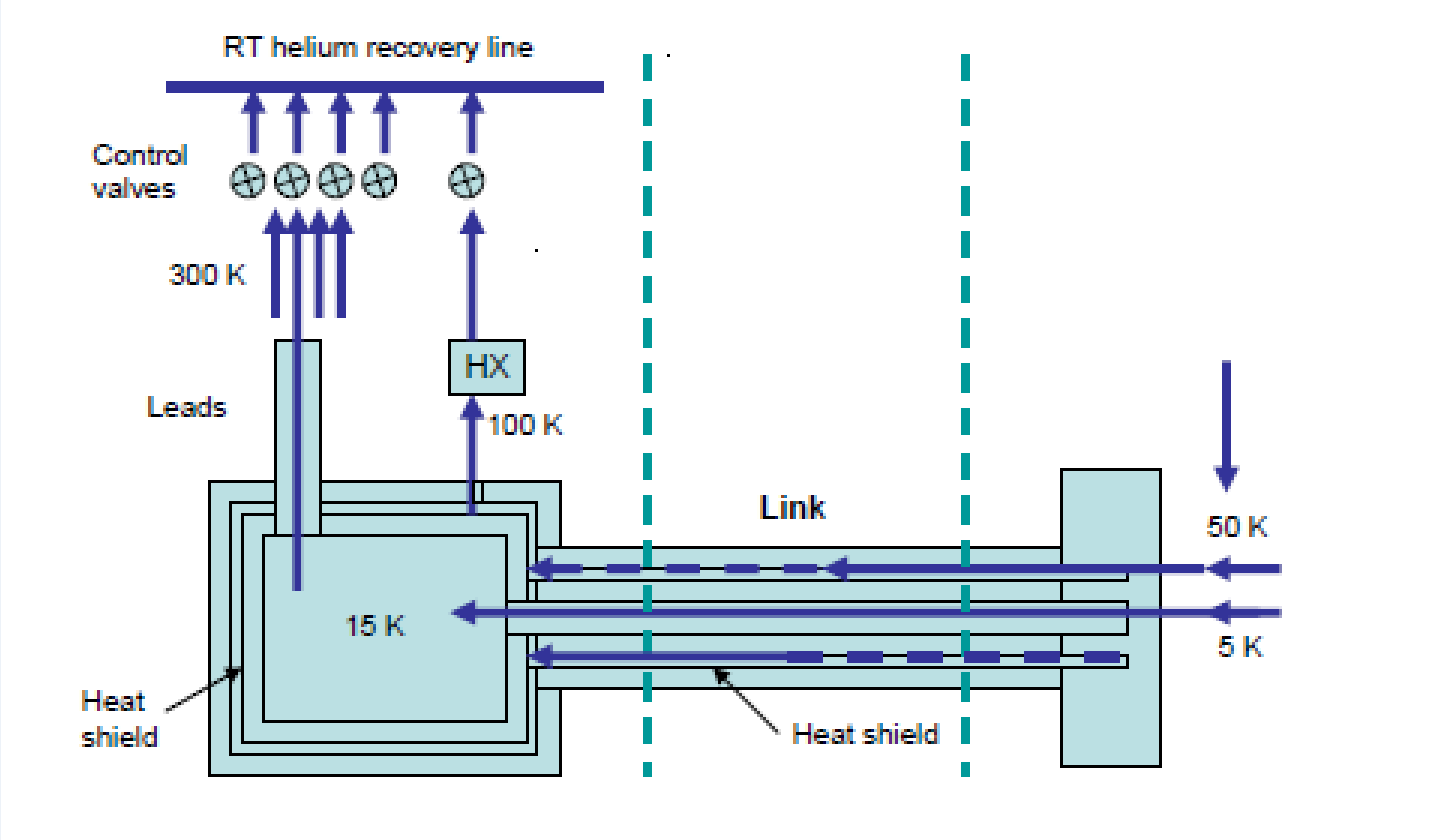
The task includes the coordination of the global cold powering system taking into account inputs from the different work packages and from parallel activities strictly related to LHC machine and carried over at CERN, e.g. global system integration, superconducting cables design,…

Task 6.2. LHC Cryogenics: Cooling and Operation

Coordination by CERN, participation of University of Southampton (Task 6.3)

- Study of cryogenic cooling, i.e. availability of cryogen at appropriate temperature and pressure levels
- Elaboration of a flow-scheme
- Definition of requirements for control and operation
- Study of modifications required for the integration of the new cold powering system in the LHC machine

Deliverables: intermediate and final reports


RT helium recovery line
Control valves
300 K
HX
Leads
100 K
Link
50 K
15 K
5 K
Heat shield
Heat shield

Task 6.3. Thermo-electrical and mechanical models

Coordination by University of Southampton, participation of CERN

- Study of thermal and electrical performance of multi-circuit long transfer line both in steady-state and in transient conditions. Cooling with supercritical helium (T~5 K) is the baseline, but also liquid helium and liquid nitrogen cooling will be analyzed

- Study of potential thermal or electrical interference (cross-talk) between cables in the link belonging to different electrical circuits

- Design of a cryostat optimized for incorporating the leads feeding the magnet system via the superconducting link

Some experimental work be of support for this task

Deliverables: intermediate and final reports, codes and drawing folders

Task 6.4. Energy deposition and material studies

Coordination by LASA-INFN Milano, participation of University of Florida and of CERN

- Study of energy deposition on cryogenic components
- Study of induced radiation – to be taken into account for repair and maintenance operations on components of the cold powering system
- Study of radiation hardness of advanced superconductors of potential use in the link (in parallel with an on-going program, which includes measurements, being performed by CERN)

Deliverables: intermediate and final reports

Resources

Person-months per participant:

Task 6.1: 18 (CERN), 18 (INFN-LASA)
Task 6.2: 18 (CERN), 6 (Univ. of Southampton)
Task 6.3: 144 (Un. of Southampton), 35 (CERN)
Task 6.4: 35 (INFN), 35 (Univ. Florida), 35 (CERN)

Thanks for your attention