ISTITUTO NAZIONALE DI FISICA NUCLEARE
SEZIONE DI MILANO
LABORATORIO ACCELERATORI E SUPERCONDUTTIVITA' APPLICATA

Magnet Test Station @ LASA, INFN-Milano

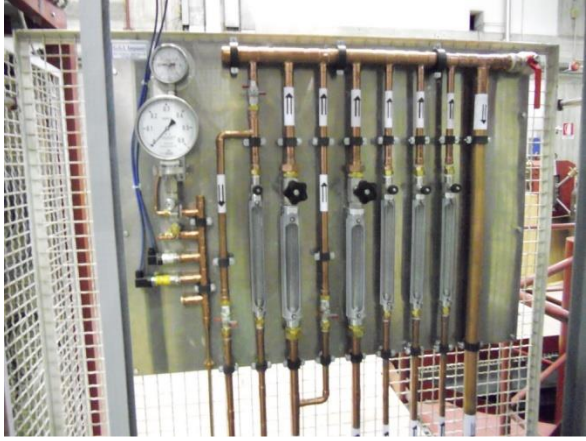
WP10.4 Magnet Test meeting

Giovanni Volpini, CERN 26 November 2014

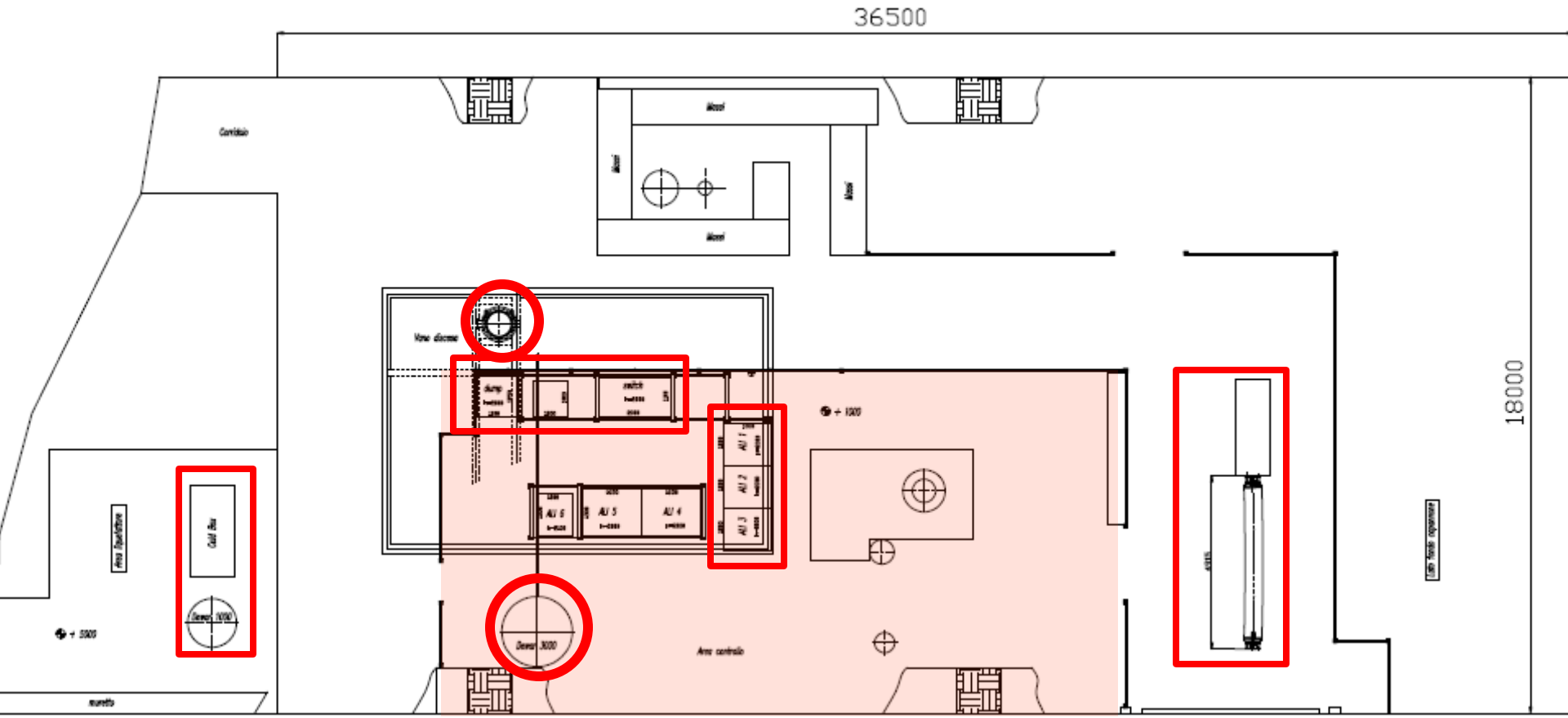
Test Station & Equipment Review

Experimental area

Vertical cryostat



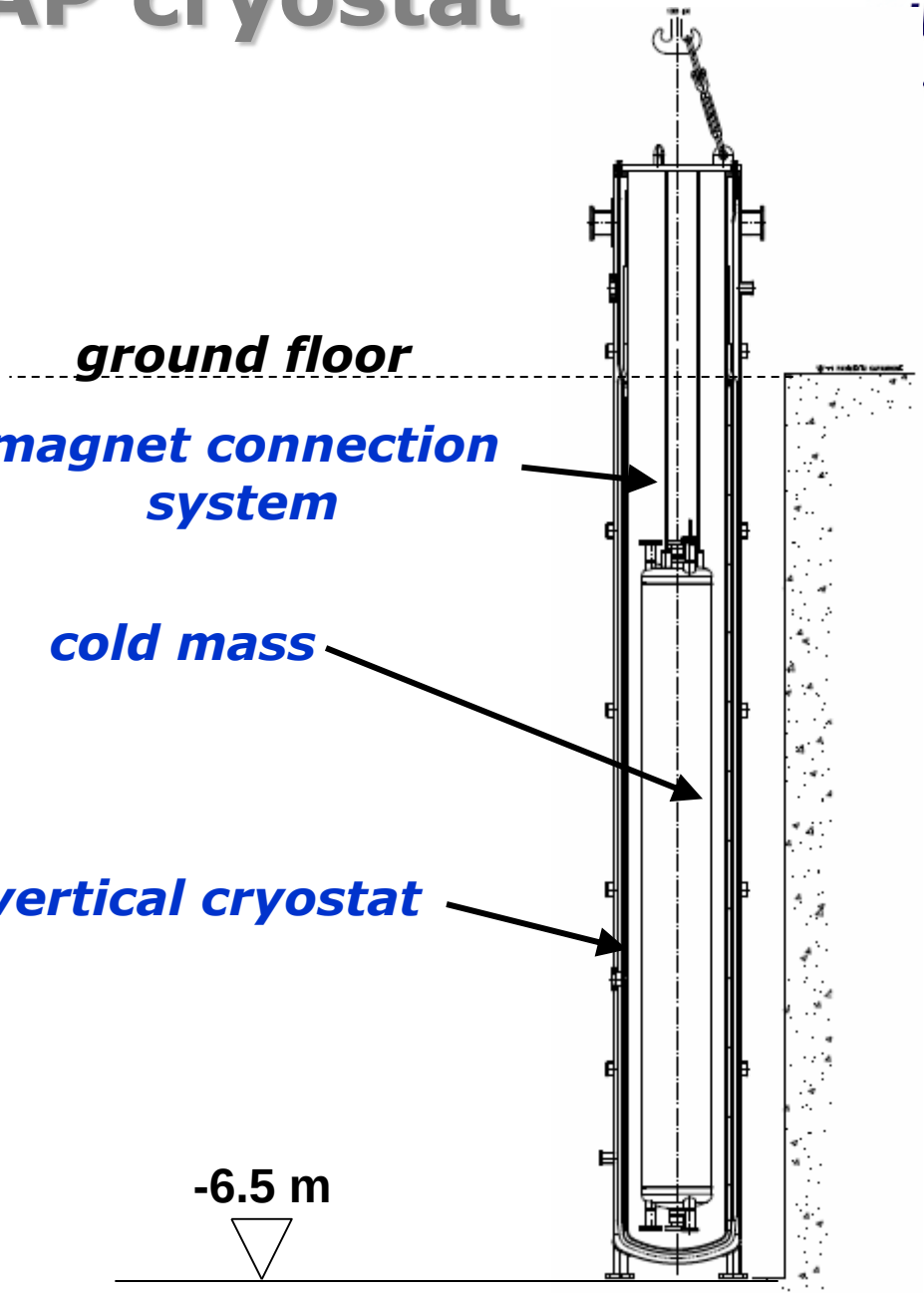
experimental area @ LASA



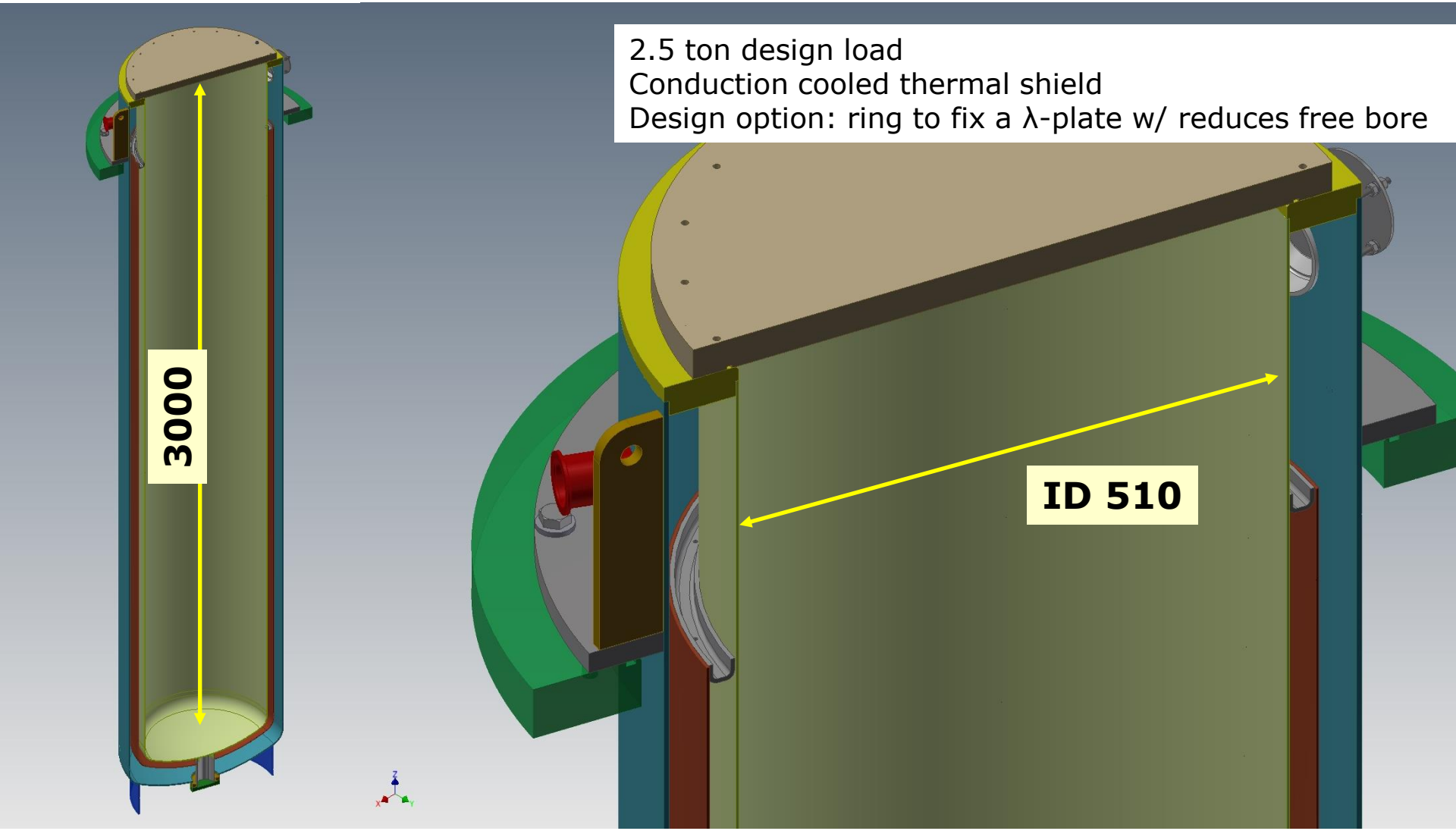
DISCORAP cryostat

Free ID 697 mm
Max operating pressure 4.5 bar abs
Thermal shield cooled by LN or evaporated GHe

DUT
max lenght 5 m
max weight 10 ton



MAGIX Test cryostat



2.5 ton design load
Conduction cooled thermal shield
Design option: ring to fix a λ-plate w/ reduces free bore

Current source

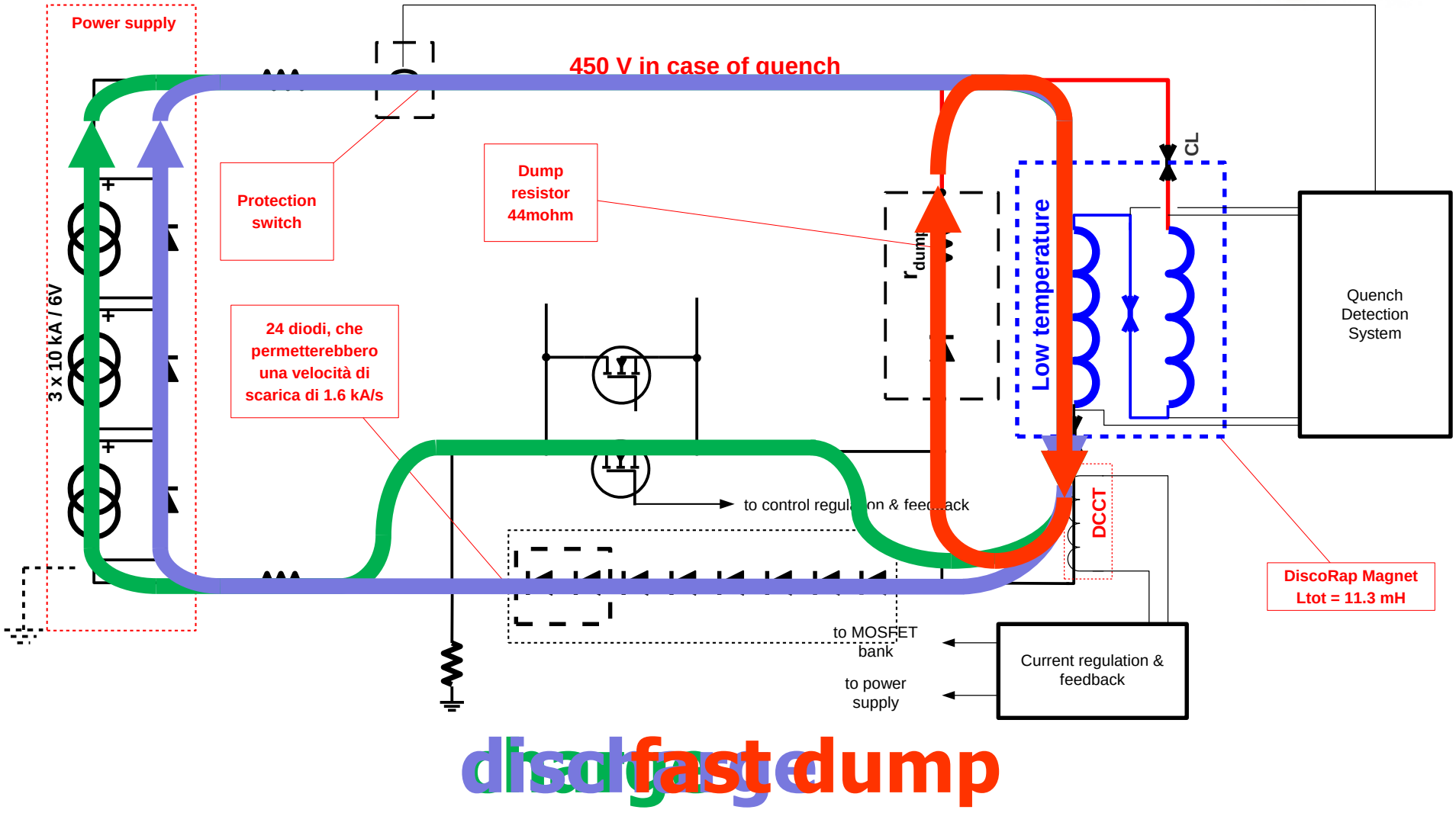
Three 10 kA x 6 V power supplies available at LASA . They can be operated in series or in parallel.

Current measured through a 10 kA DCCT.

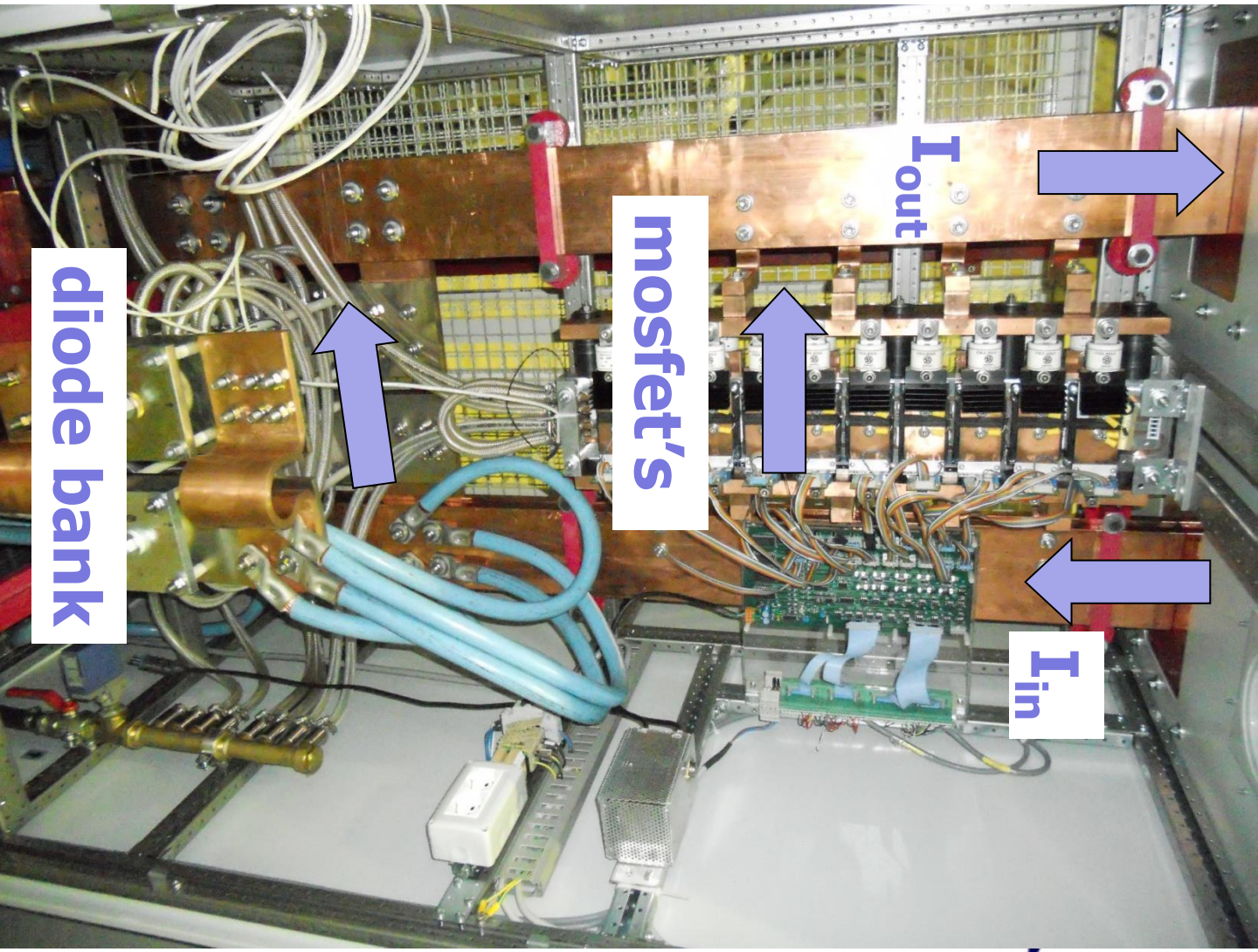
External bus bars designed for 10 kA

A system to operate the power supply in discharge mode is based on a diode bank which sinks the power, in parallel with Mosfet's which short-circuit the diode bank during the current ramp-up. This allows for ~ -15 V during the discharge cycle.

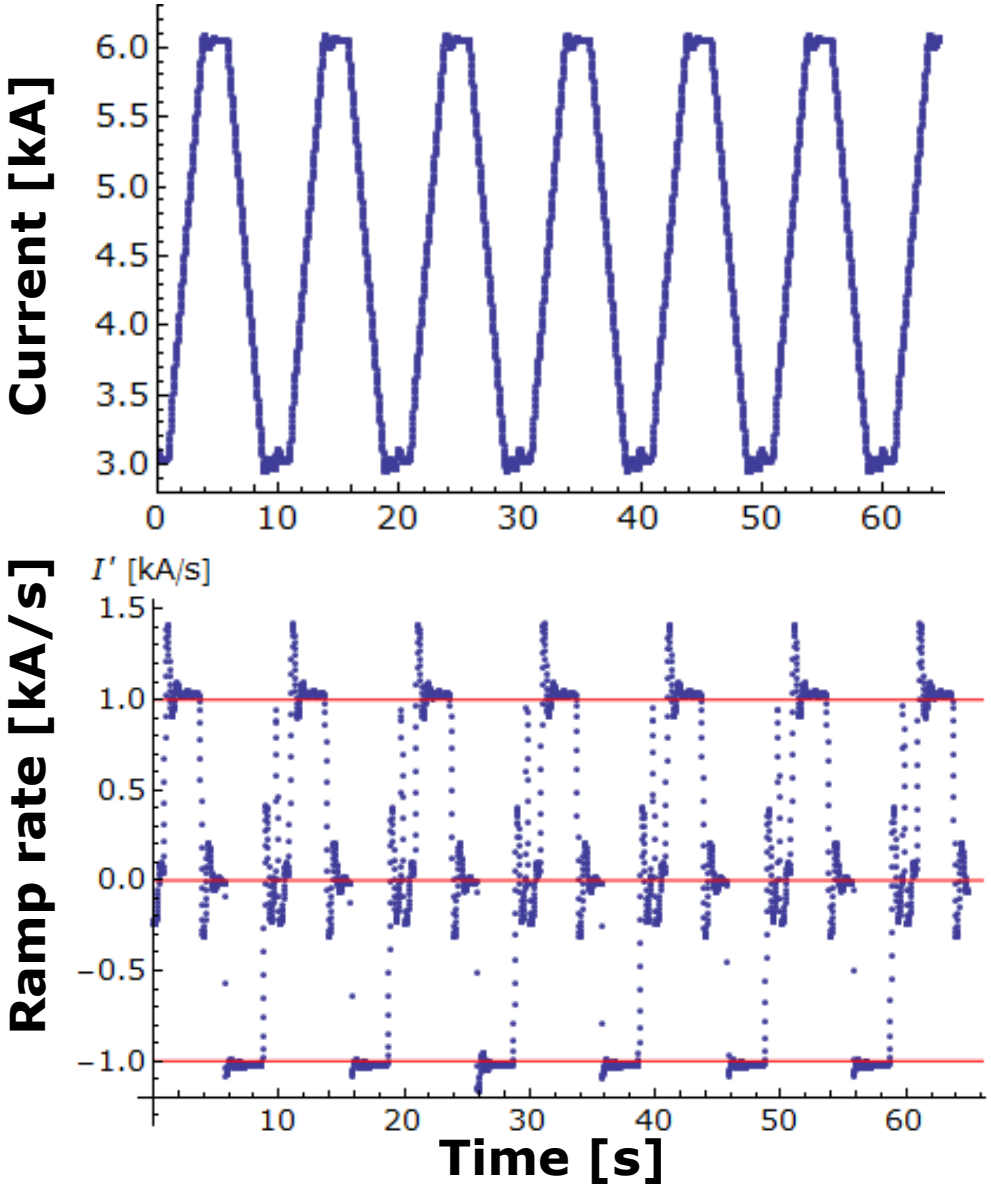
Sourcing and sinking current



Current control

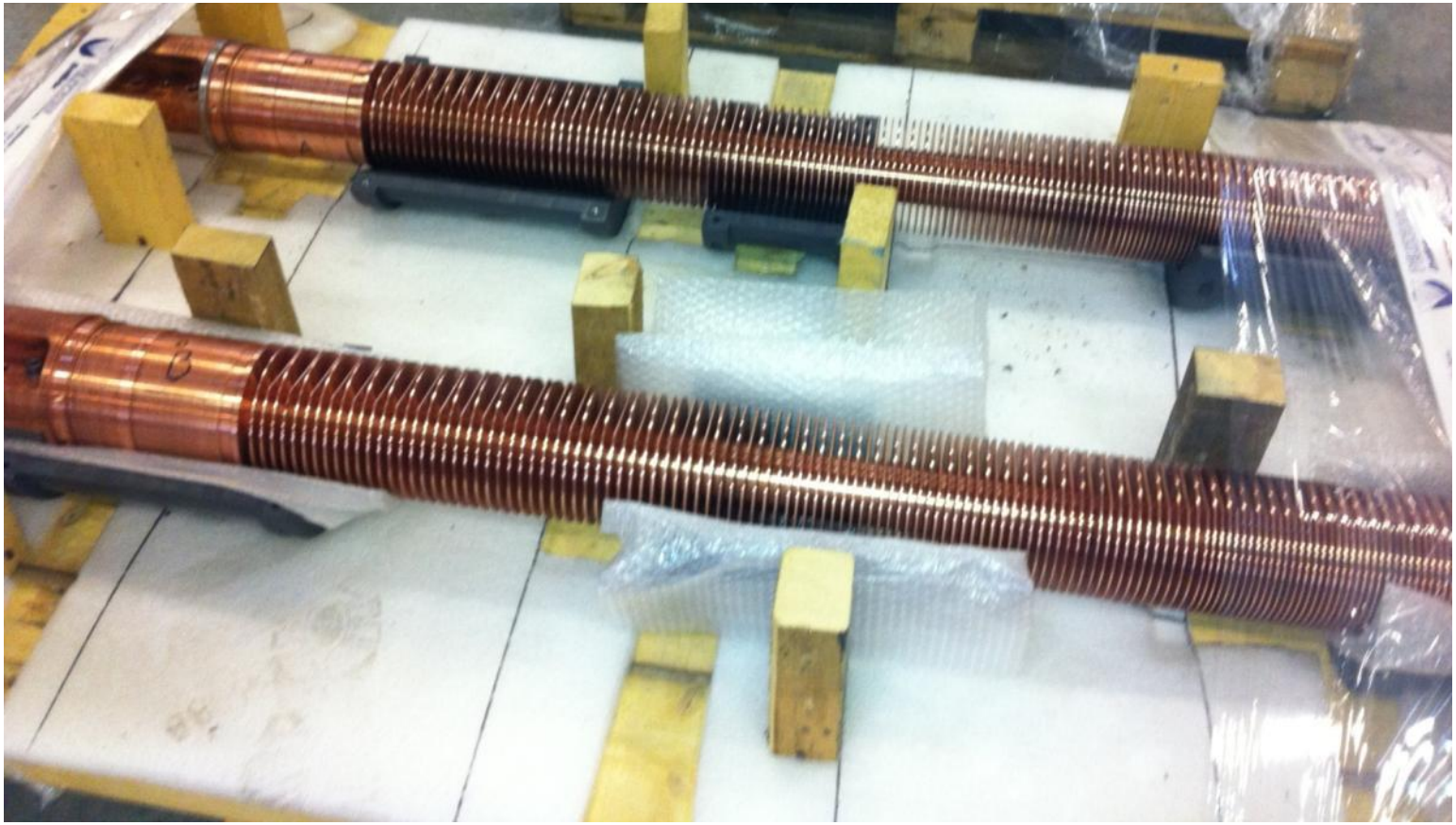


an example : test run 1.5 T to 3 T @ 0.5 T/s



Current leads

Bare heat exchanger of the 10 kA-class CL designed at LASA and manufactured by RIAL Vacuum.
The use of CuP allows for optimized heat load performance at I=0



Control & Data Acquisition Architecture

1. QDS (MSS Magnet Safety System)
Initiates a fast discharge or switches off the power supply incase some voltage thresholds on the magnet or on its electrical connection are exceeded. Includes a capacitor bank for firing quench heaters.

2. Current Control & Slow Acquisition
Two different functions, implemented in the same hardware & software system.
Slow acquisition monitors and records most important data (temperatures, current, voltage along critical items) from the cooldown to the operation. Data are avalilable to the operator and recorded at about 1 Hz.

3. Fast Acquisition
Records voltages across the magnet under test with 1 kHz sampling frequence, in coincidence with a fast discharge

4. V*I AC losses measurement system
A dedicated system which measures the AC losses by numerical integration of V*I product, measured by a couple of synchronized VMM.

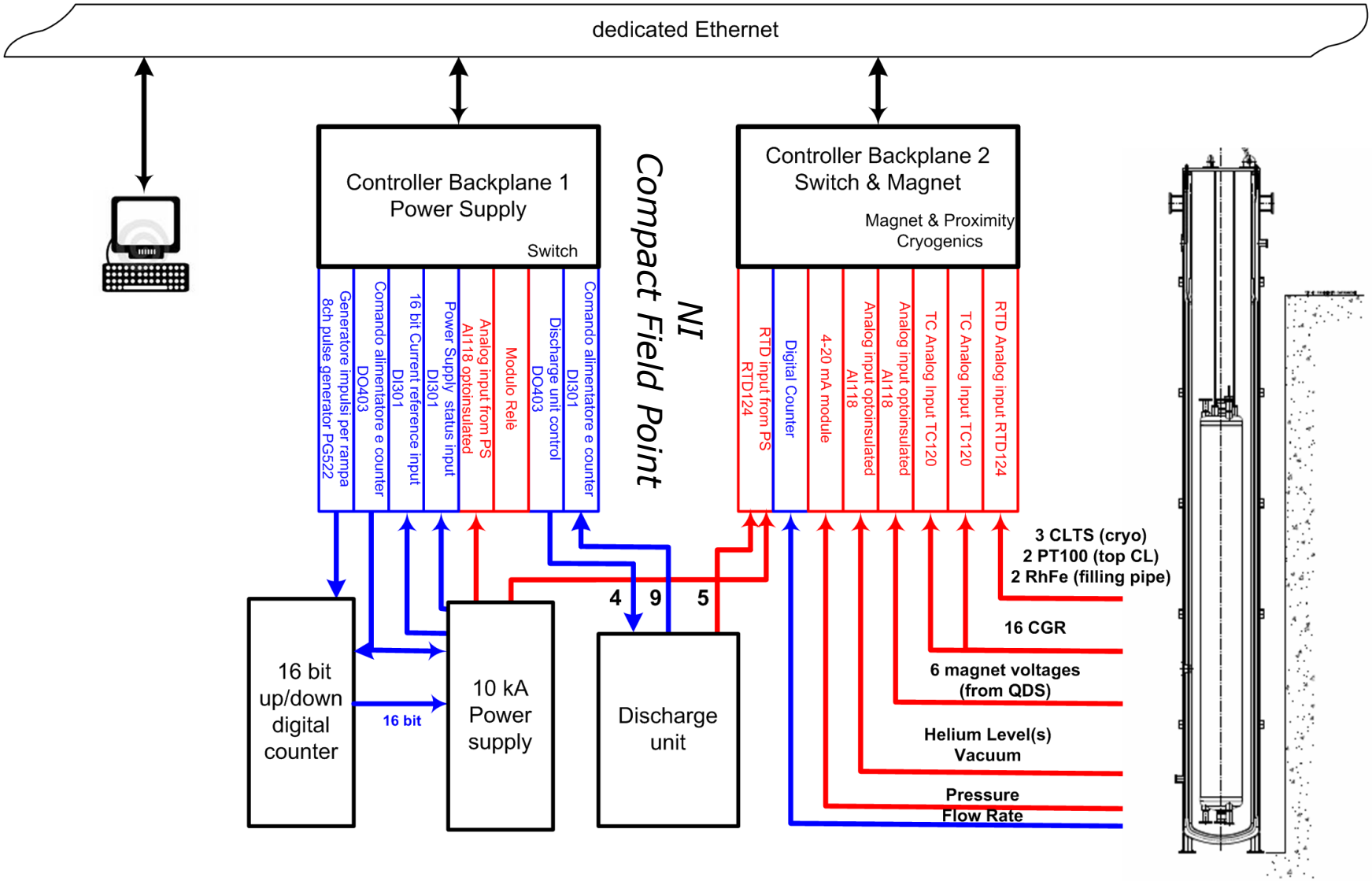
It is completely independent from other systems, from the voltage taps on.
This allows to perform checks, modification on the ground, etc. without affecting other safety-critical systems.

1. Magnet Safety System

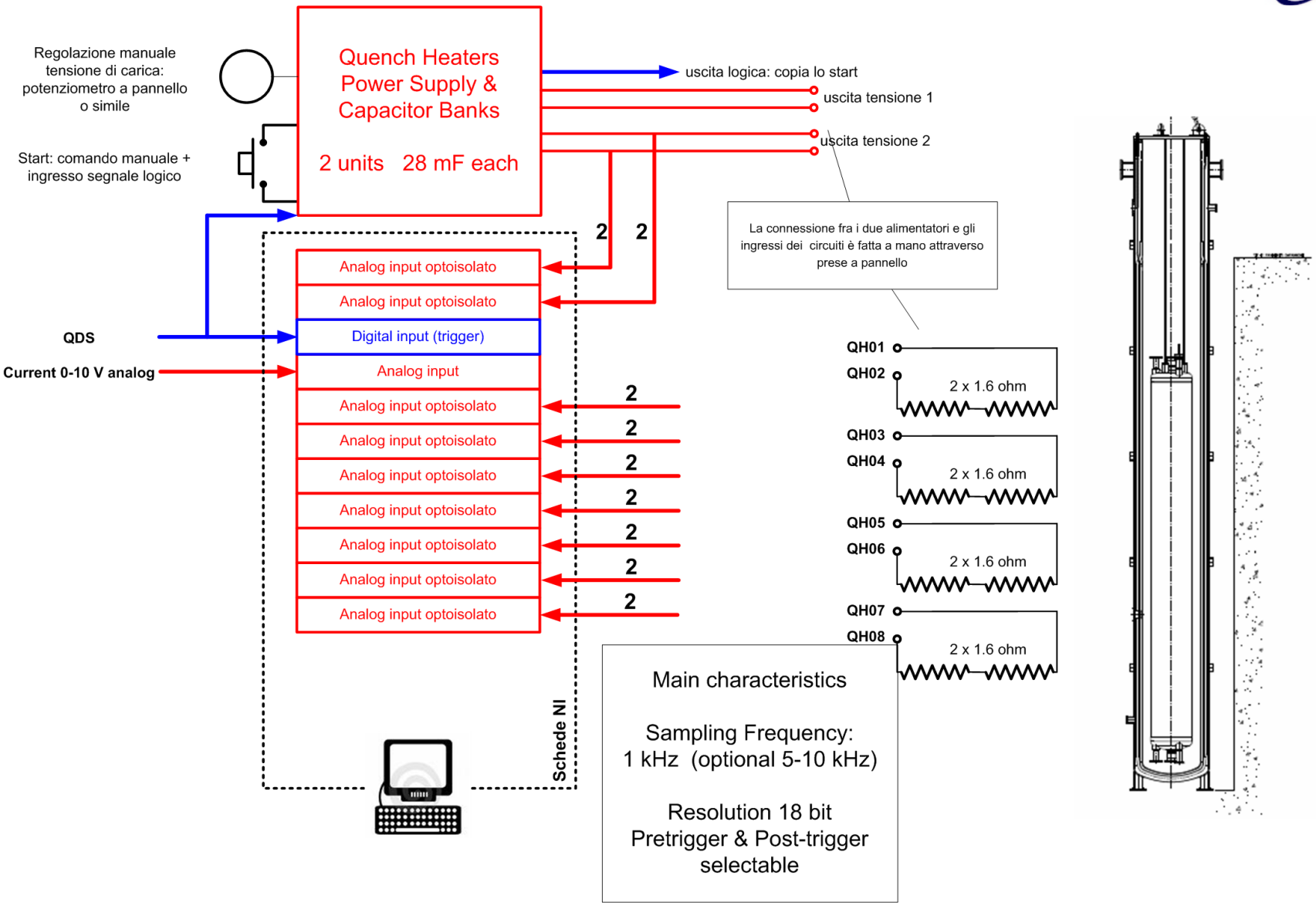
16 channels (may be expanded), each:

- optoinsulated input,
- bridge/single end
- independently configurable
- Voltage thresholds ±4V, ±1.25V, ±500mV, ±100mV
- Time validation ranges: 0-10 ms, 0-100 ms, 0-1 s
- Input signal made available in copy
- Memory of fired channels

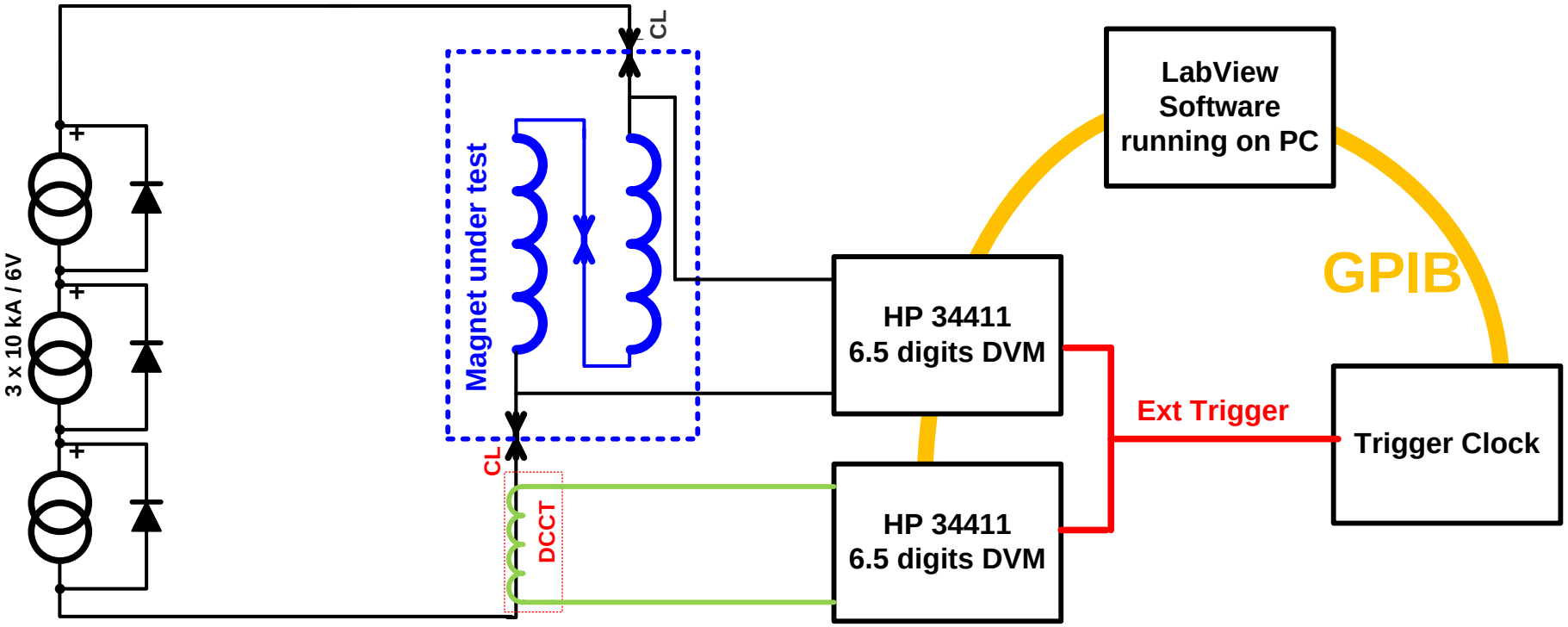
2. Slow Acquisition



3. Fast Acquisition



4. AC-loss measuring apparatus



Net work *Q* performed by the power supply on the magnet between t_0 and t_1.

$$Q(t_1,t_0)=\int_{t_0}^{t_1} V\cdot I\,dt \approx \Delta t\sum_{j=1}^{n} V_j\cdot I_j$$

cooldown

Large magnet cool down may be be performed:

- *with temperature controlled GN, keeping a ΔT of less than 40 K between any of the eight temperature probes located within the cold mass; the ΔT is increased to 50 K, when the hot spot temperatures drops below 200 K;*

- *with LN, when the cold mass hot spot drops below 127 K;*

- *with LHe, after thermalizing the cold mass in LN.*

Time Table, DISCORAP dipole, 6 tons

15/6	*cool down start*	*flow rate 400 nL/min GN ΔT =40K*
25/6	*Tmax = 238 K*	*ΔT =50 K*
2/7	*Tmax = 126 K*	*LN is fed directly into the cold mass*
4/7	*cold mass at 77 K*	
6/7	*LN removal starts*	
7/7	*LN removal completed, LHe cooling starts*	
9/7	*cold mass at 4 K*	
10/7	*cryostat filled, the test starts.*	

cooldown

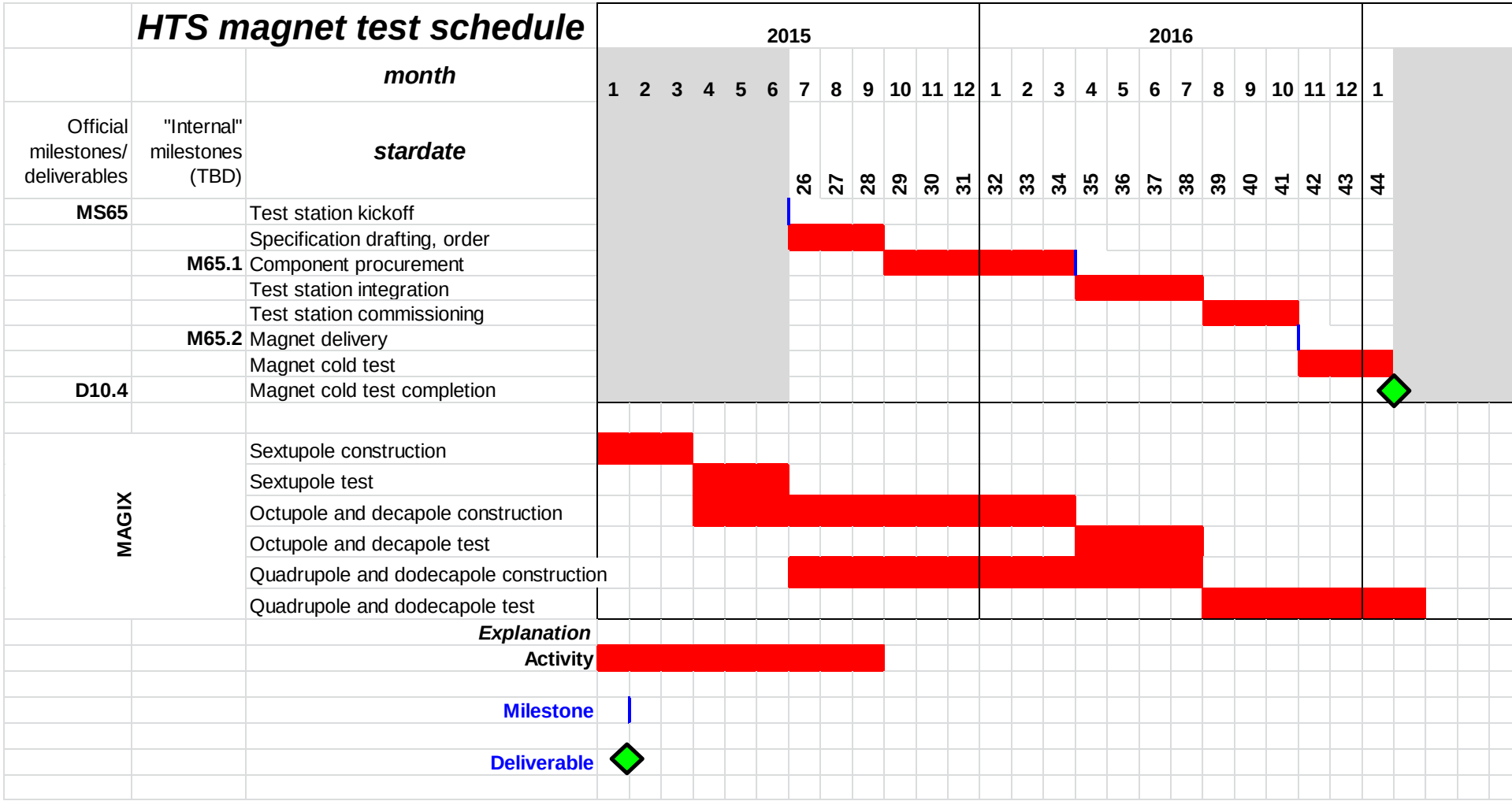
Three pipes carry the cryogen inside the cryostat and the magnet:

- *The lower pipe brings the fluid directly inside the magnet. The circumferential gap is sealed with Al tape, so that the fluid is forced to flow within the magnet*

- *The upper pipe (not seen in the picture) ends near the top of the magnet. Its purpose is mainly to allow a quiter LHe refill during the test.*

- *A third pipe is used as syphon for LN removal; the residual LN is then evaporated by means of heaters*

Schedule



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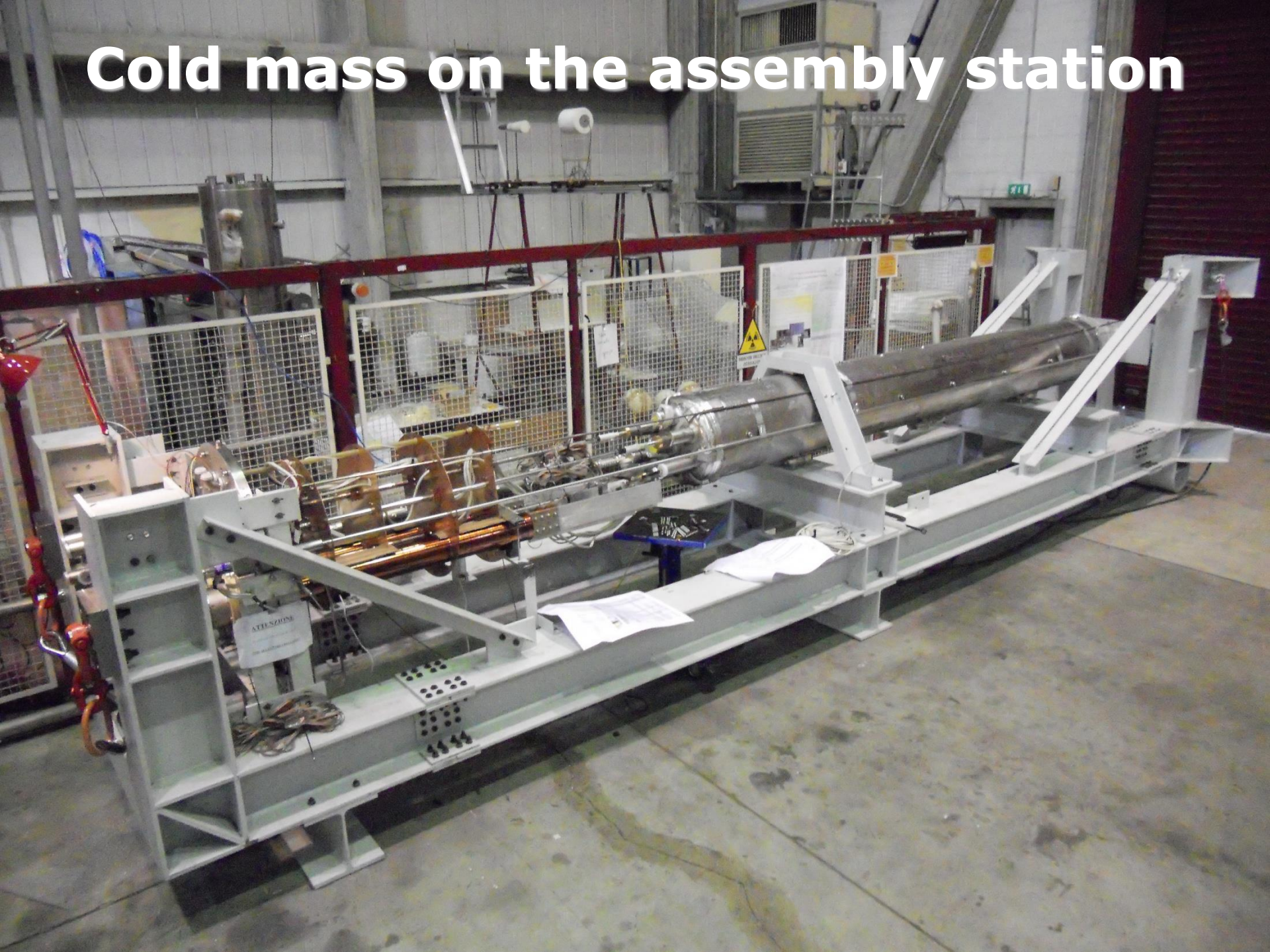
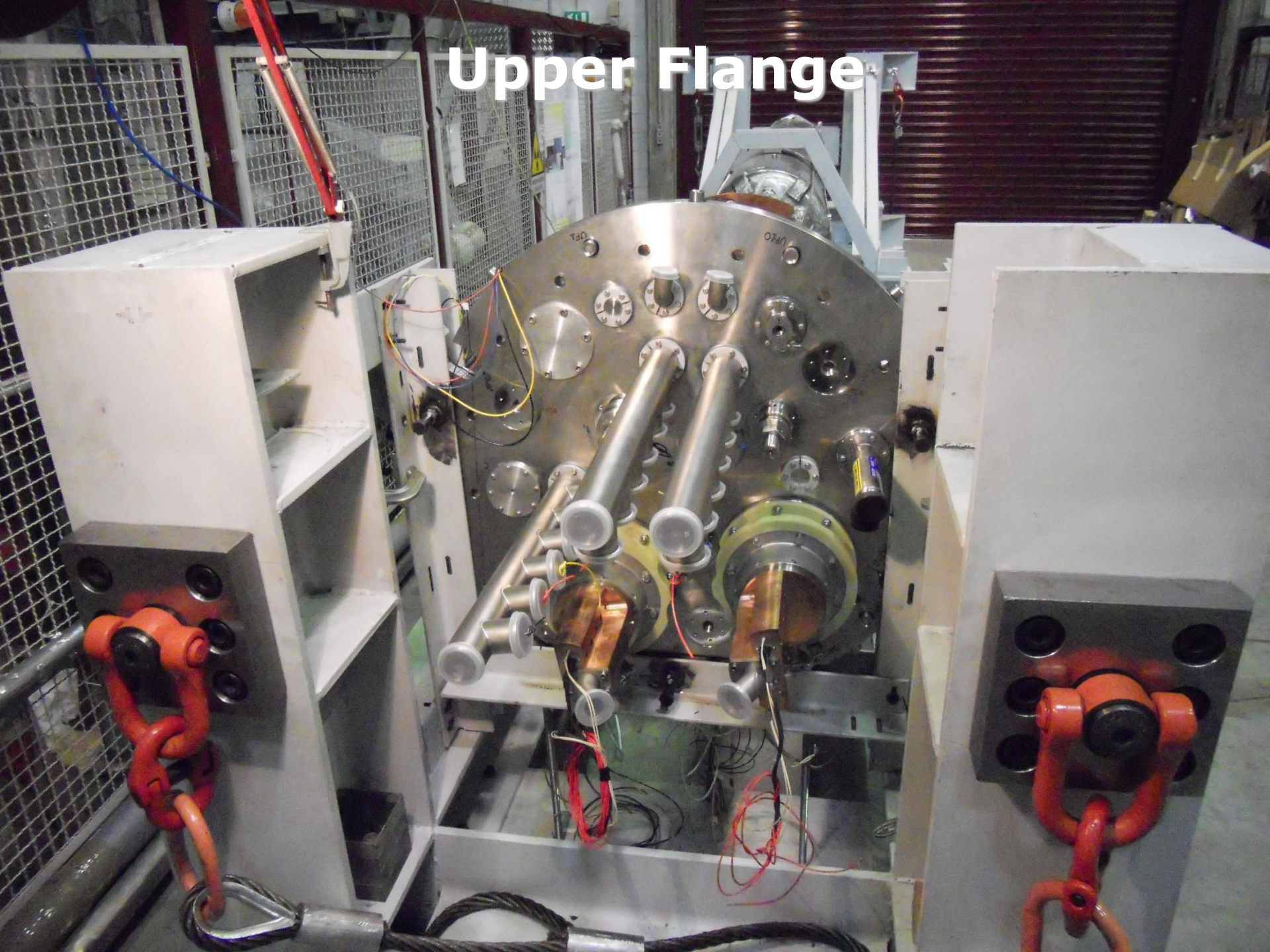
Assembly & Cryostat Insertion

Cold mass on the assembly station



Upper Flange

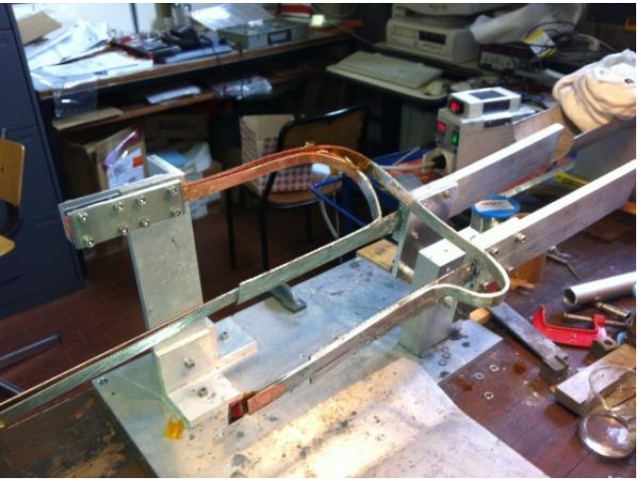


From CL's to the cold mass

cold mass raising

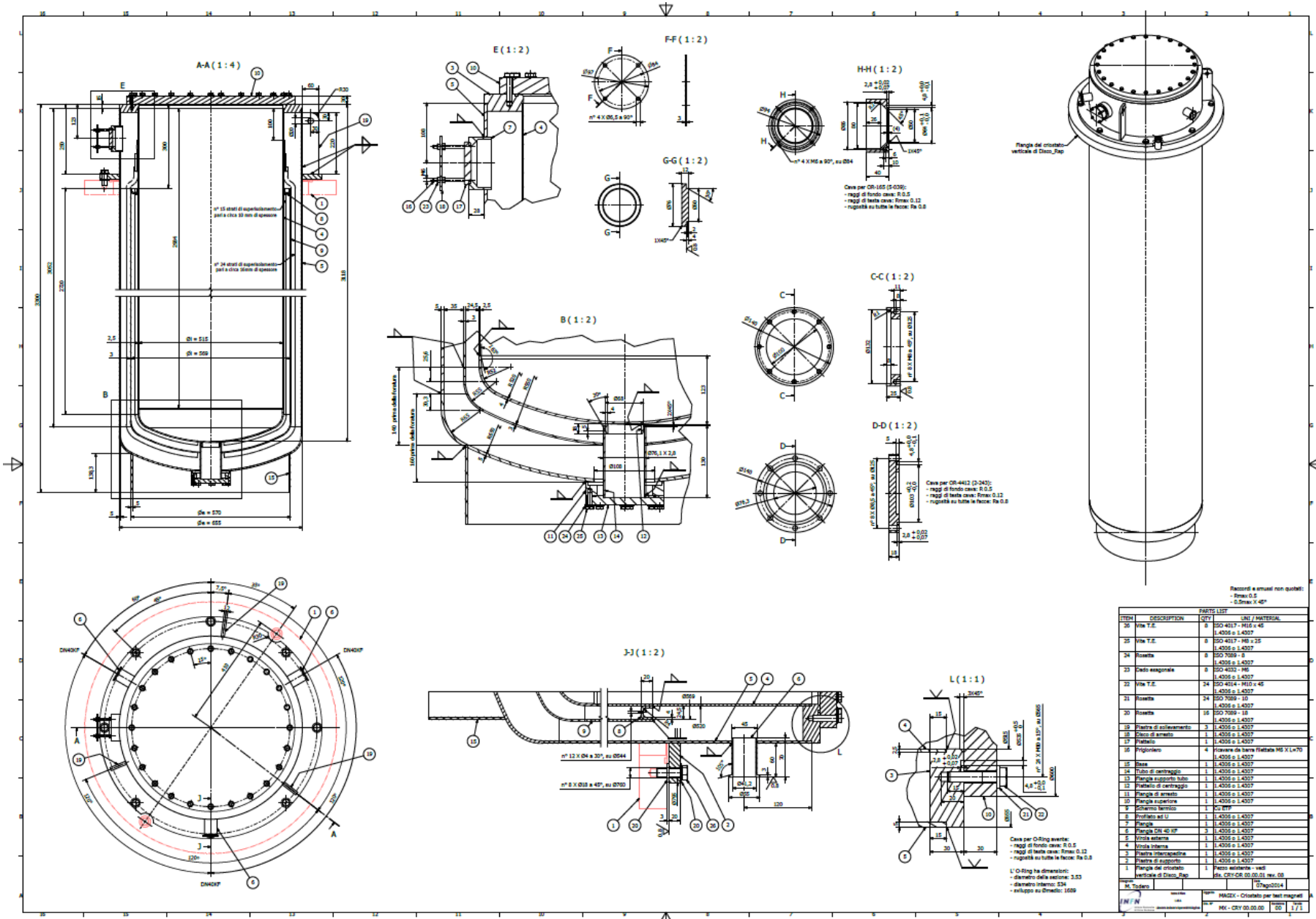
into the cryostat

Electrical connection between bus-bar & magnet

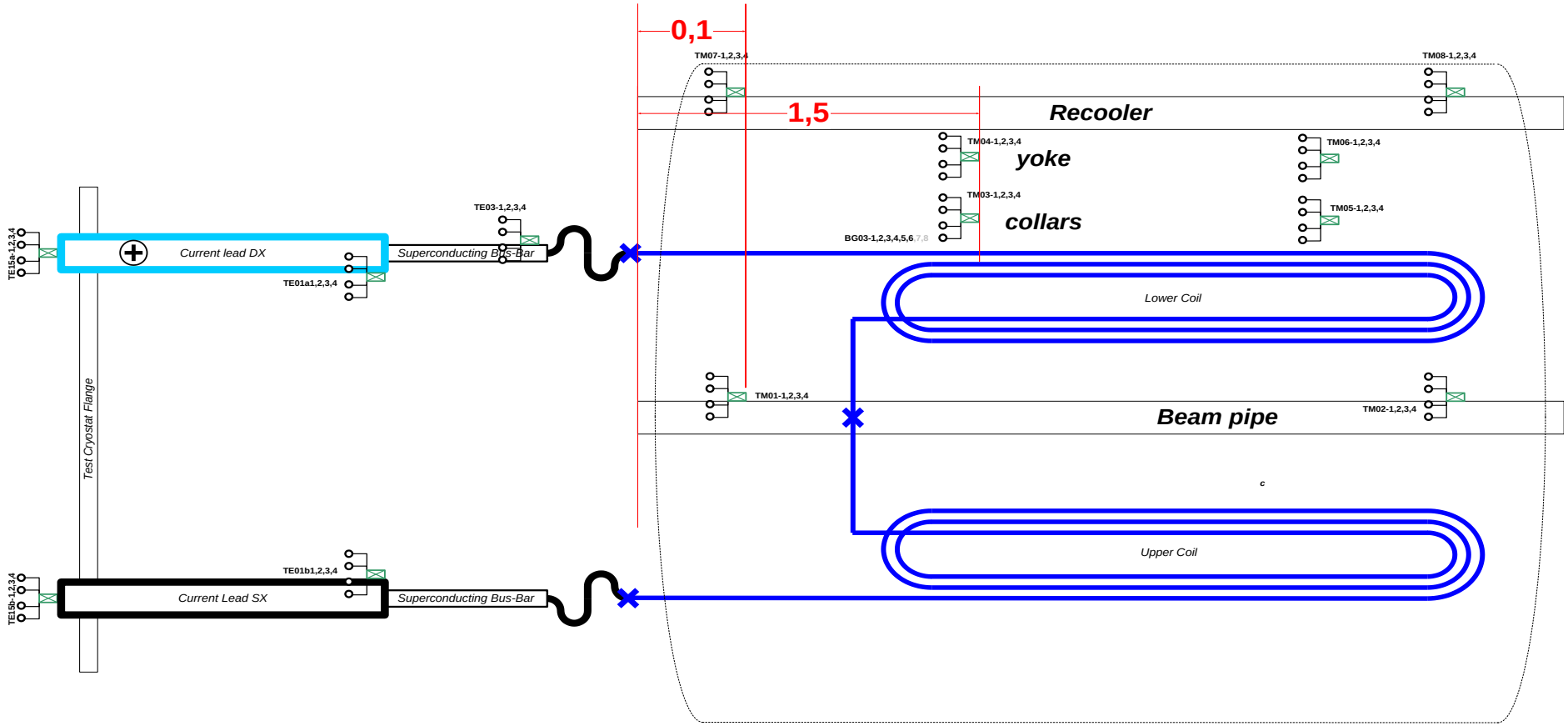


The END

MAGIX Cryostat



Temperature probes on the CM



T-probe and voltage taps