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

Task 10.4
Test in single mode:
Objectives, plan, subdivision of work

Giovanni Volpini, EuCARD2-WP10 meeting CERN June 14 2013

Objectives

From the DOW

Task 10.3 5 T HTS Dipole Magnet Design and Construction

Design and manufacture **a prototype magnet using Bi2212 cable.** This prototype will be intended to determine the highest stress allowable [...] and manage the wind and react manufacturing operation

Design and manufacture **an accelerator like prototype magnet using YBCO** tape based conductor and having an operating current of at least 5 kA.

Task 10.4. HTS Magnet Stand Alone Test

D10.4) Magnet Cold test: The test will include:

i) warm measurements;
ii) cool down & electrical quality assurance at cold;
iii) power test, training curve;
iv) magnetic measurements
v) re-training

1 o 2 ?

Objectives

From the DOW

Task 10.4. HTS Magnet Stand Alone Test

Subtask 10.4.1 Test station modification

The test station must be adapted to suit the specific features of the magnet.

The adaptation includes:

(i) Cryogenic verification of the cryostat, with respect to the specific level of stored energy;

(ii) Mechanical verification, including magnet weight and forces between stray magnetic field and ferromagnetic structures;

(iii) Assembly station modification;

(iv) Magnet mechanical suspension;

(v) Electrical power.

Subtask 10.4.2 Magnet cool-down and energization.

…

Subtask 10.4.3 Magnetic measurements

Measure the **harmonic content** of the magnet at **different excitation currents** in liquid helium. **Measure AC losses during current cycles.** The tests will be carefully analysed and will give feed back to design.

Schedule

From the DOW

Test station kick-off (MS 65, Report) M26 or 30 June 2015

Magnet Cold test (D10.4) M44 or 31 December 2016

First cable length for magnet winding (MS66) M32 or 31 December 2015

The magnet manufacture completion itself is not a Deliverable…

so we have **1 year**
-to complete the manufacture of all the cable
-to assemble the magnet
-to test it (w/ two cool down's)…

<u>Today: I will present the capabilities of the LASA test station</u>

Introduction

The Magnet Test Station @ LASA has been developed to test the fast-ramped superconducting dipole model for the SIS-300 synchrotron at FAIR (Darmstadt, Germany), built under the scope of a INFN-GSI collaboration. On the Italian side the project was known as DISCORAP, an acronym for Dipoli SuperConduttori Rapidamente Pulsati or Fast Pulsed Superconducting Dipoles.

The magnet was tested between June and September 2012, with excellent results.

Although less challenging from a technical point, also the successful operation of the test station was an important achievement.

Test Station Main Features - I

Vertical cryostat

inner diameter	700 mm
useful length (maximum LHe level)	6,000 mm
DUT maximum load	10,000 kg
suspension system design load	6,000 kg
design pressure	4.5 bar

Power supply

three switching power converters, each 10 kA x 6 V, can be operated in series (present configuration) or in parallel.

may operate in discharge mode for pulsed operation with max $\Delta V \sim -20$ V.

External current bus-bars

air-cooled, 10 kA rated

Current leads

gas-cooled, CuP based, designed by LASA. Maximum operating current probably around 15 kA.

Test Station Main Features - II

Protection

Dump resistor w/ reverse current diode		45 mΩ
Design dissipated energy		500 kJ
Mechanical Switch	double pole, 24 kA (gentleman's loan from *ATLAS)*	
QDS	loan from CERN	

Cryogenics

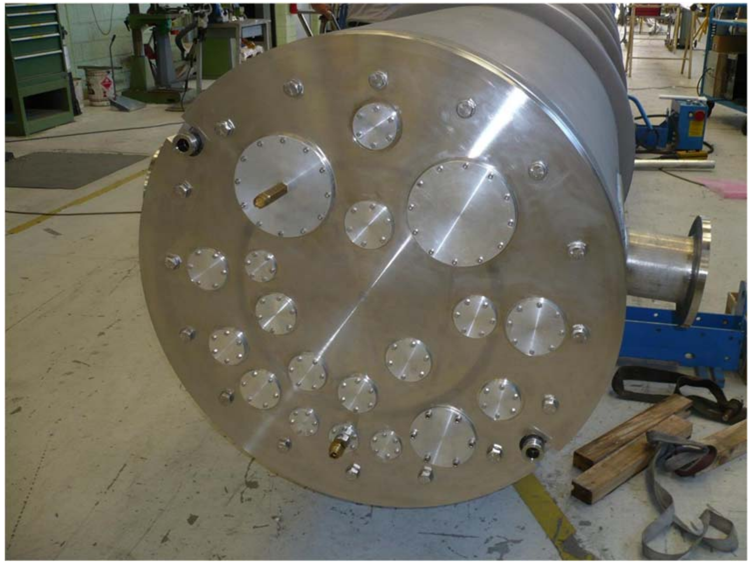
LHe liquifier,	40 liter/hour
LHe storage dewar	3,300 liter

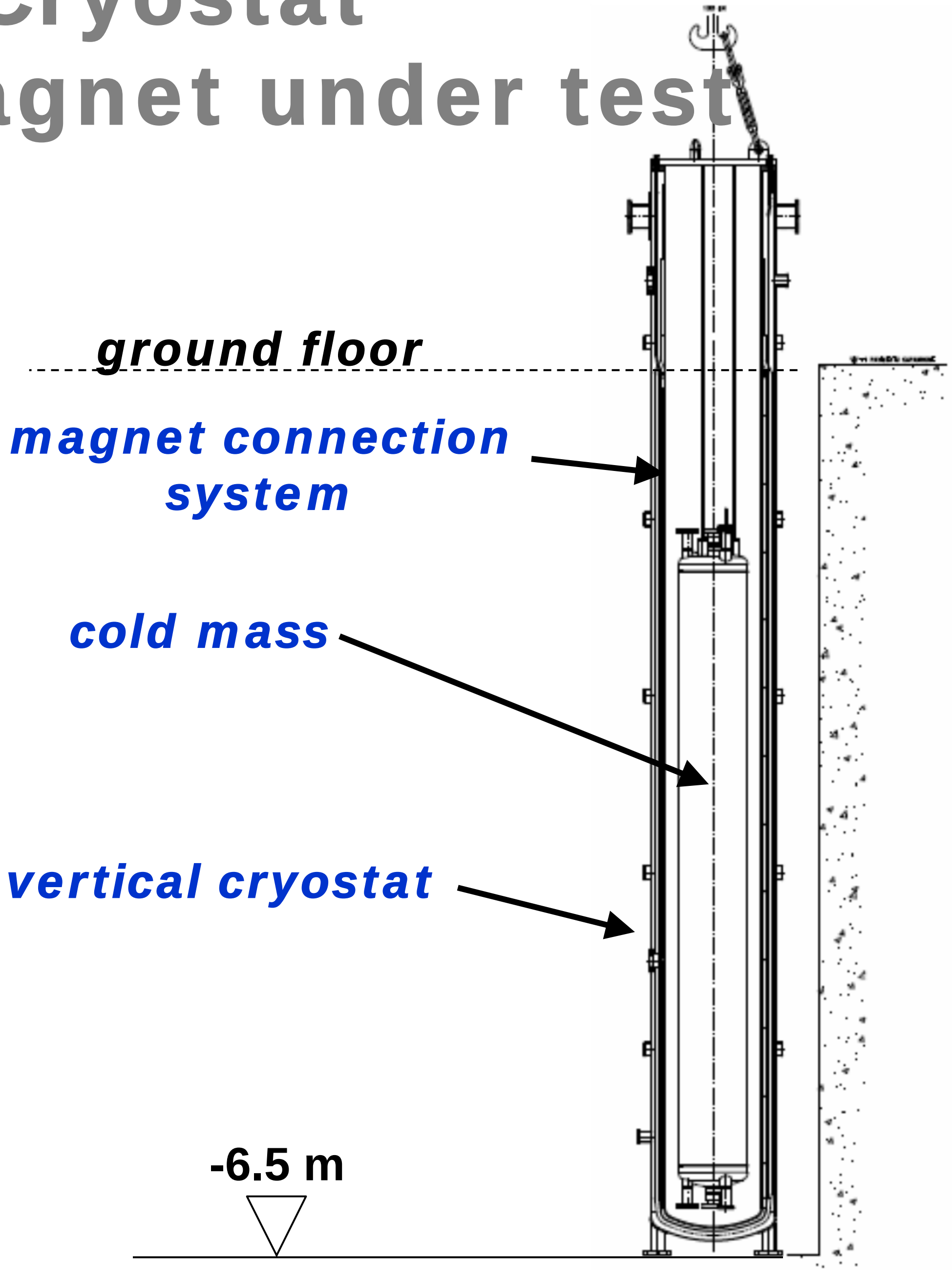
Measurement & Control

Quench study (64 channels, optoinsulated, 1 kHz sampling rate)
Voltamperometric loss measurement
Magnet/station control & monitoring (64 channels, 1 Hz sampling)

no apparatus for magnetic field measurement is present, nor it is foreseen

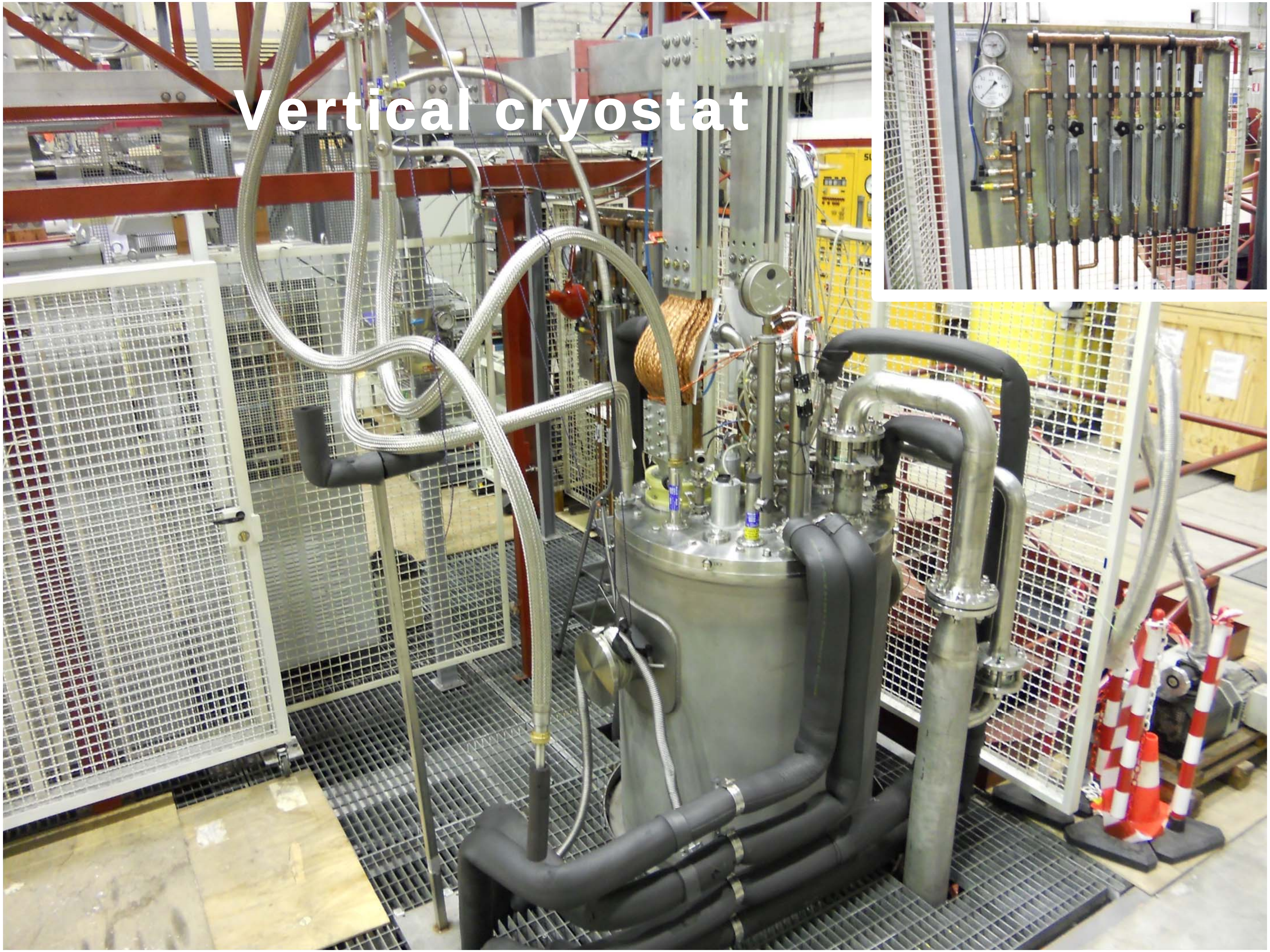
Cryostat with magnet under test





Experimental area

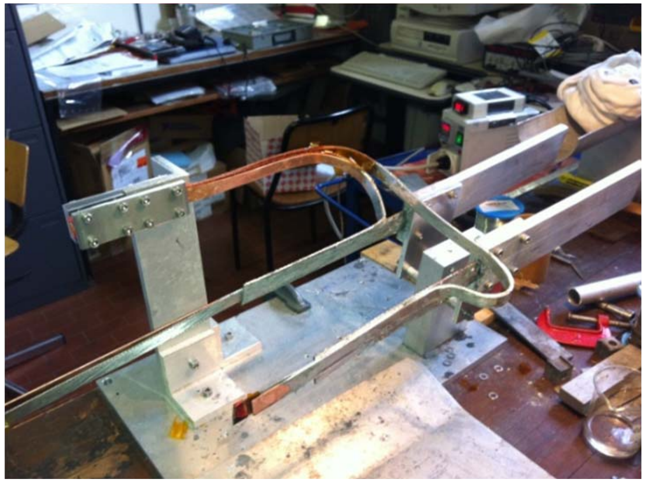
Vertical cryostat

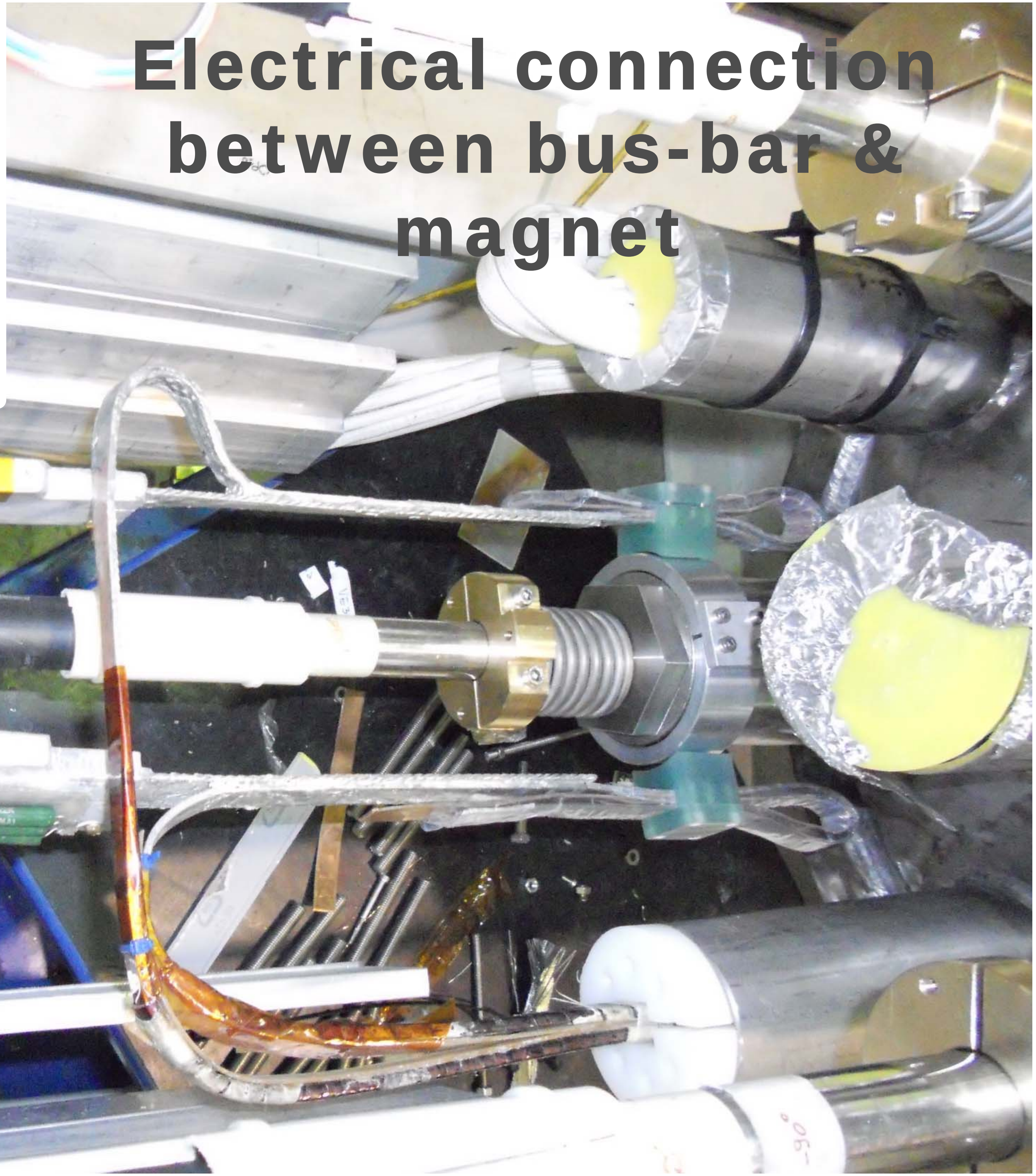


Cold mass on the assembly station

From CL’s to the cold mass

Electrical connection between bus-bar & magnet





cold mass raising

Into the cryostat...

magnet powering scheme - I

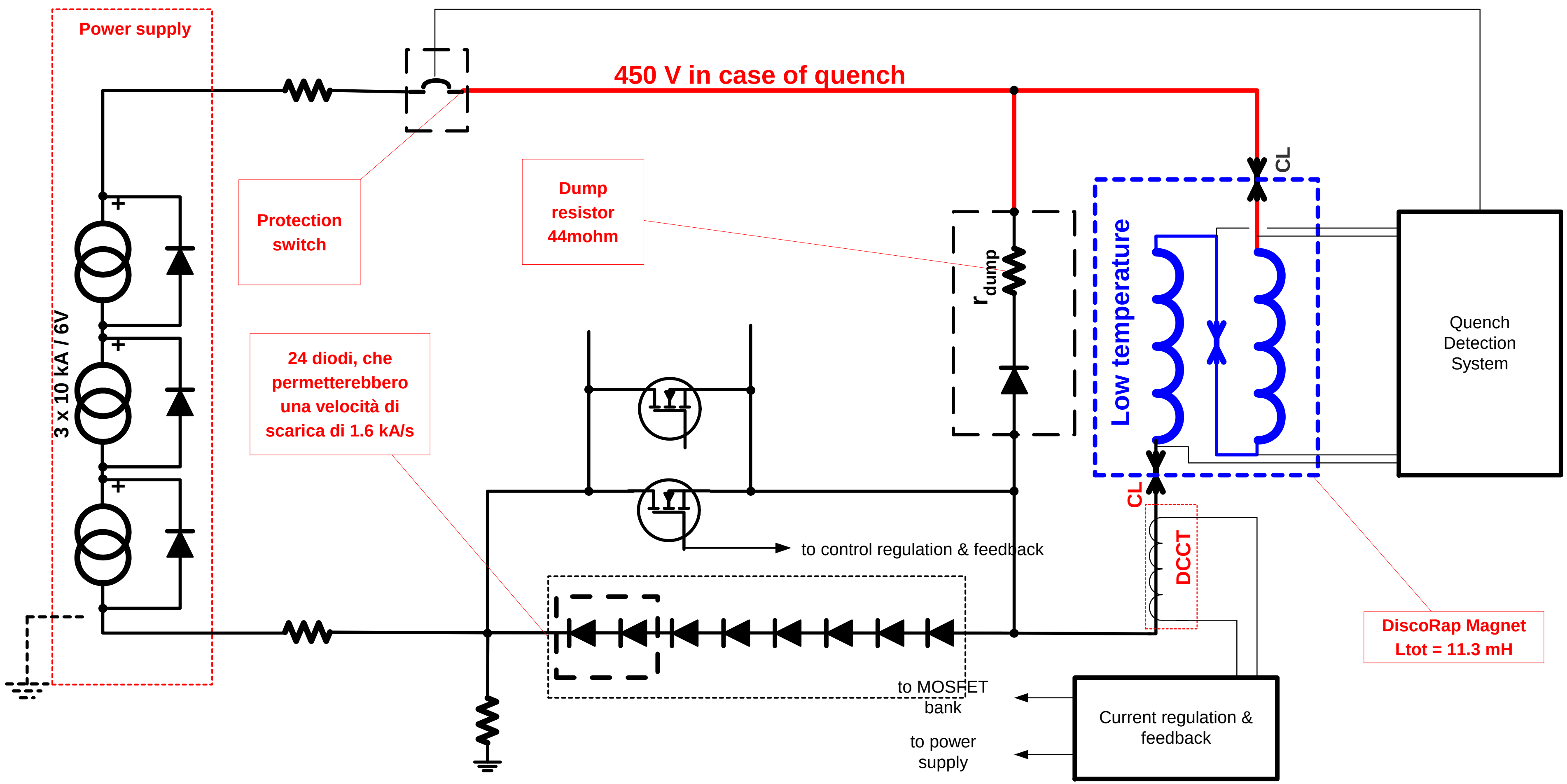
The discharge of an inductance requires a power supply which can provide a negative tension while feeding a positive current: i.e. it must be able to both source and sink energy.

The price tag of a 10 kA ± 40 V is probably around 180 k€. For budget reasons we have opted for a system based on:

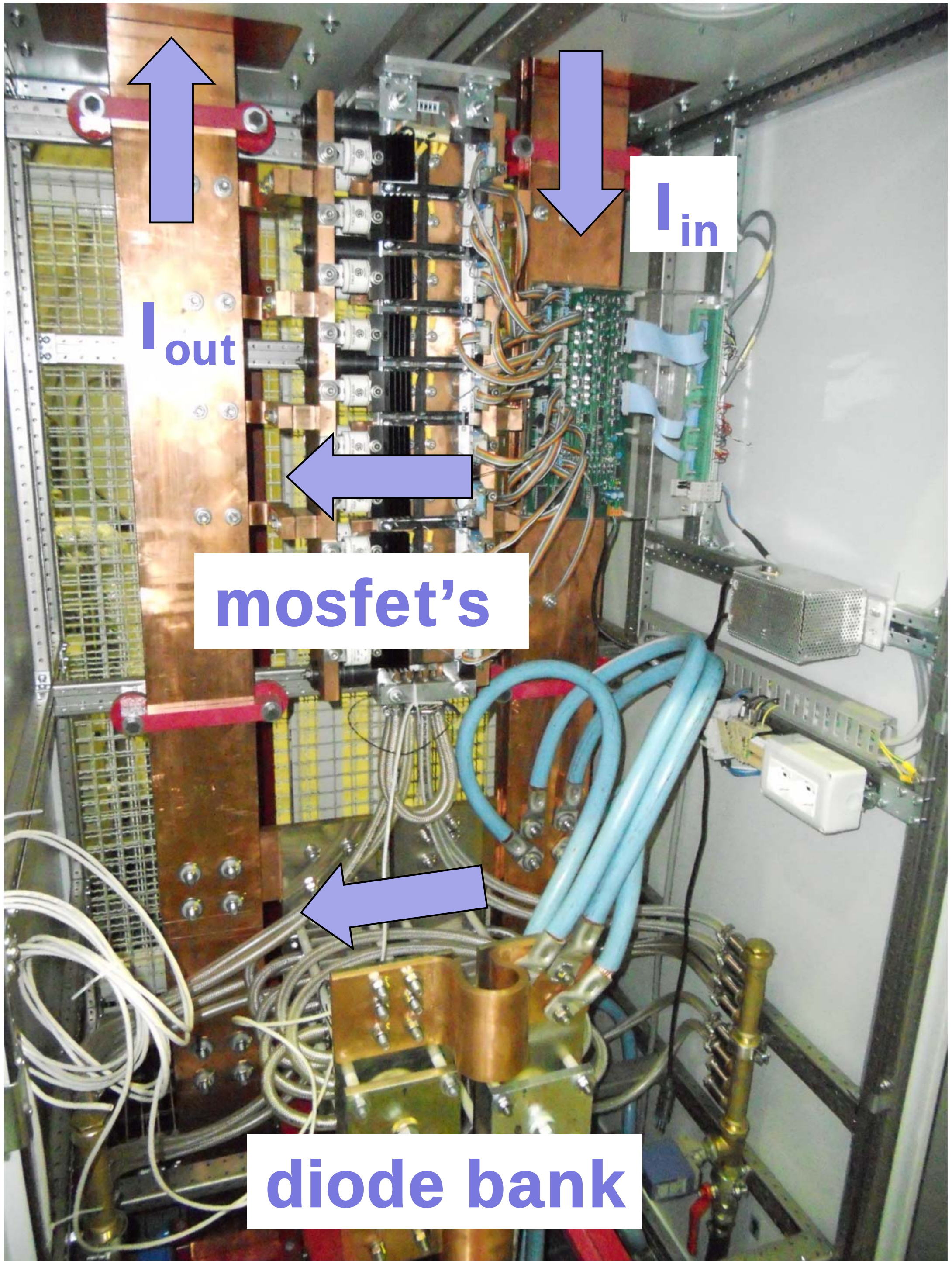
1) the three 10 kA x 6 V power supplies available at LASA;
2) a discharge system based on a diode bank which sinks the power, in parallel with Mosfet's which short-circuit the diode bank during the current ramp-up.

The maximum power at the magnet's extremities probably does not exceed 15 V, so that the highest ramp rate is around 0.6 T/s, instead of 1 T/s.

magnet powering scheme II



Current control



cooldown

The DISCORAP model magnet (6 tons) cool down was performed:

With temperature controlled GN, keeping a DT of less than 40 K across the cold mass; the DT is increased to 50 K, when the hot spot temperature drops below 200 K;

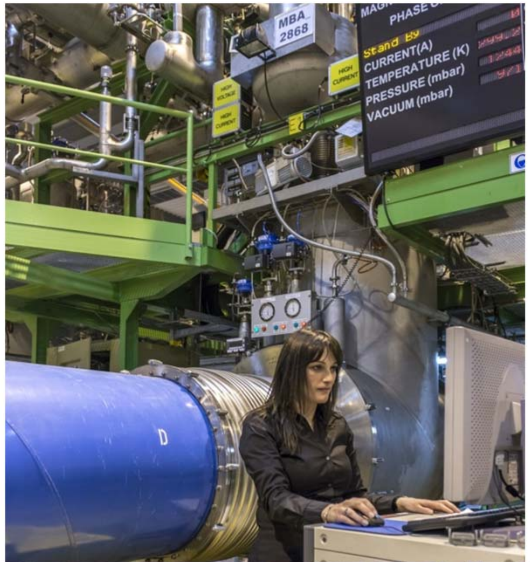
with LN, when the cold mass hot spot drops below 127 K;

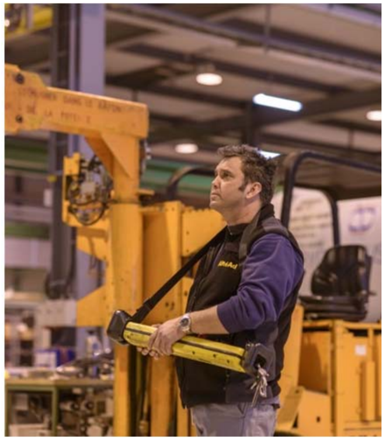
with LHe, after thermalizing the cold mass in LN.

Time Table

14 days from room temperature to 127 K approx
2 days from 127 K to 77 K
2 days thermalization in LN bath
1 day LN removal
2 days cool down to 4 K
1 day LHe fill up and start

SM18 test station @ CERN





Adapted from Marta Bajko’s presentation on Task 9.2 - MagNet@CERN (TA)
EuCARD2 meeting, Thursday June 13, 2013

Test organization

From the DOW

Task 10.4 (standalone test) will be led by INFN, with the participation of CERN, CEA, TUT, DTI and Grenoble INP

CERN will play a fundamental role in the test with its expertise and equipment, including

Magnetic field mapping equipment
Quench antennas
Optical fibers for stress/temperature measurement
…

A number of other partners, including CEA, TUT, DTI, have expressed their interest to participate to the test. Others are welcomed: there is a plenty of work to do for everybody!

thank you for your attention!