Test progress INFN

1. Magnet protection
2. Cryostat Manufacture
3. Cooling and Temperature Control
4. Conclusions

Quench Detection System

A system similar to the POTAIM cards.

Engineered and built at LASA, it has successfully tested in field conditions during the MAGIX single coil tests from April until November 2015.

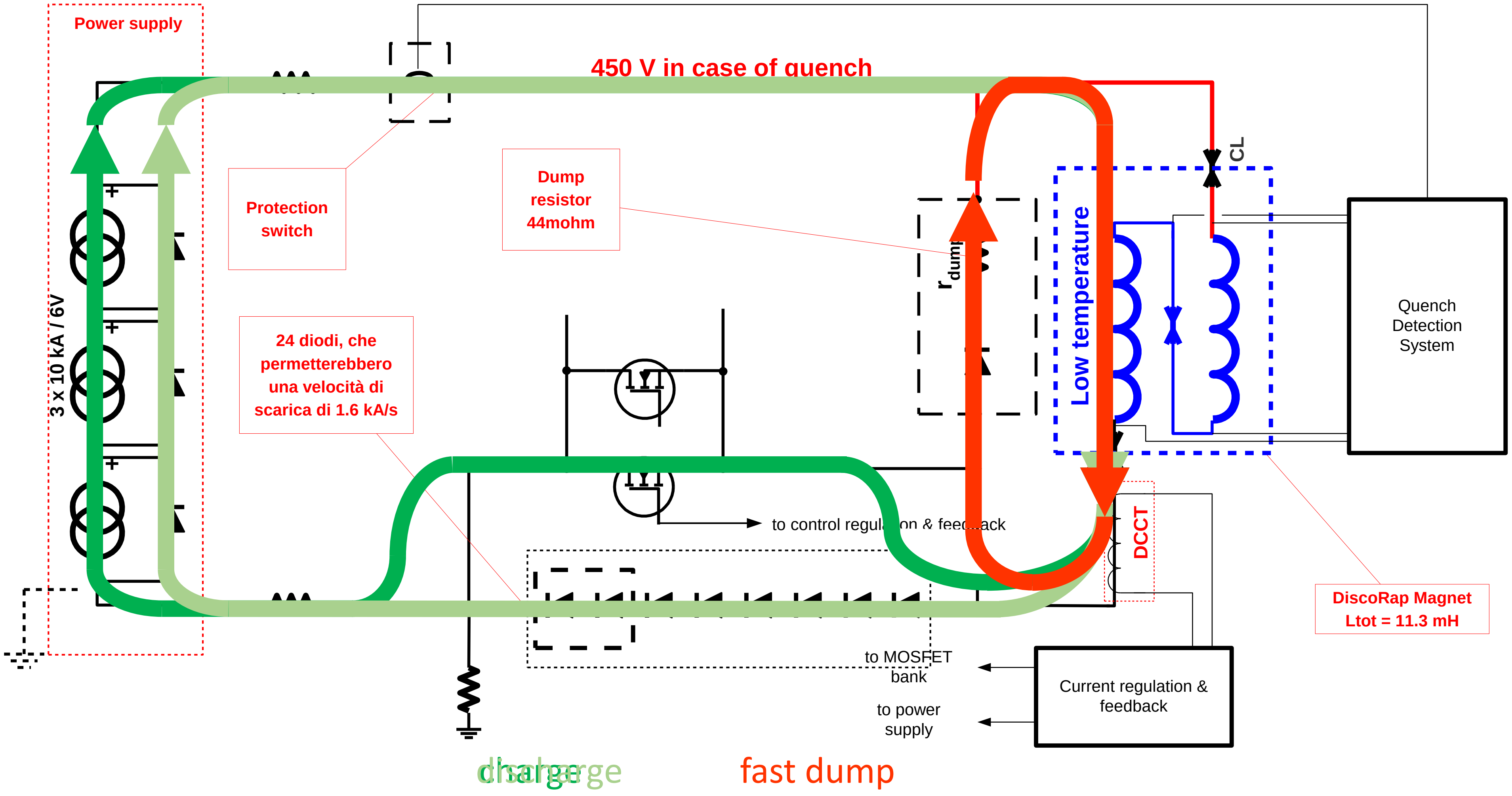
It includes:

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 channels fired

This old-fashioned, voltage-based, Quench Detection System to be integrated by other system(s) to be provided by the collaboration.

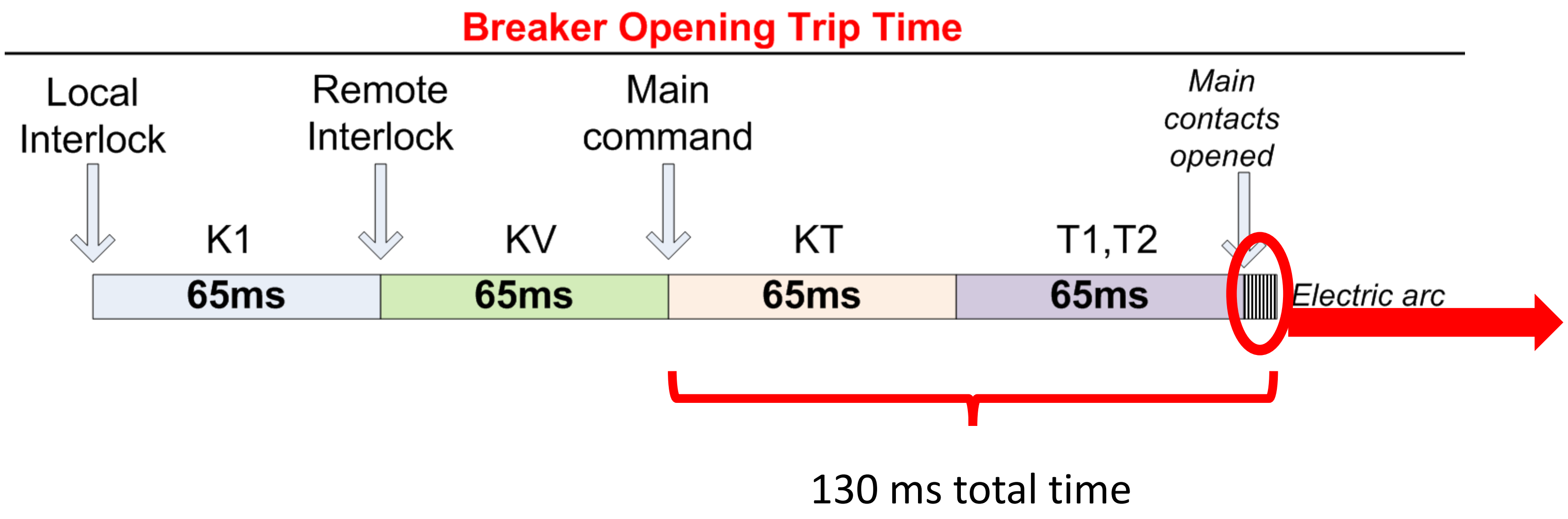
Magnet powering & protection scheme

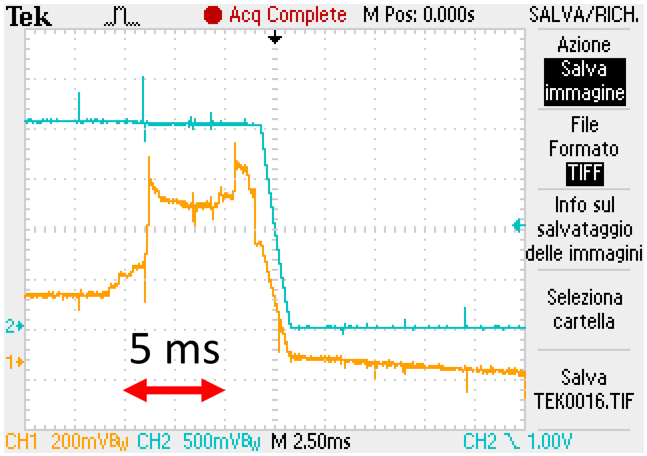


Switch Speed

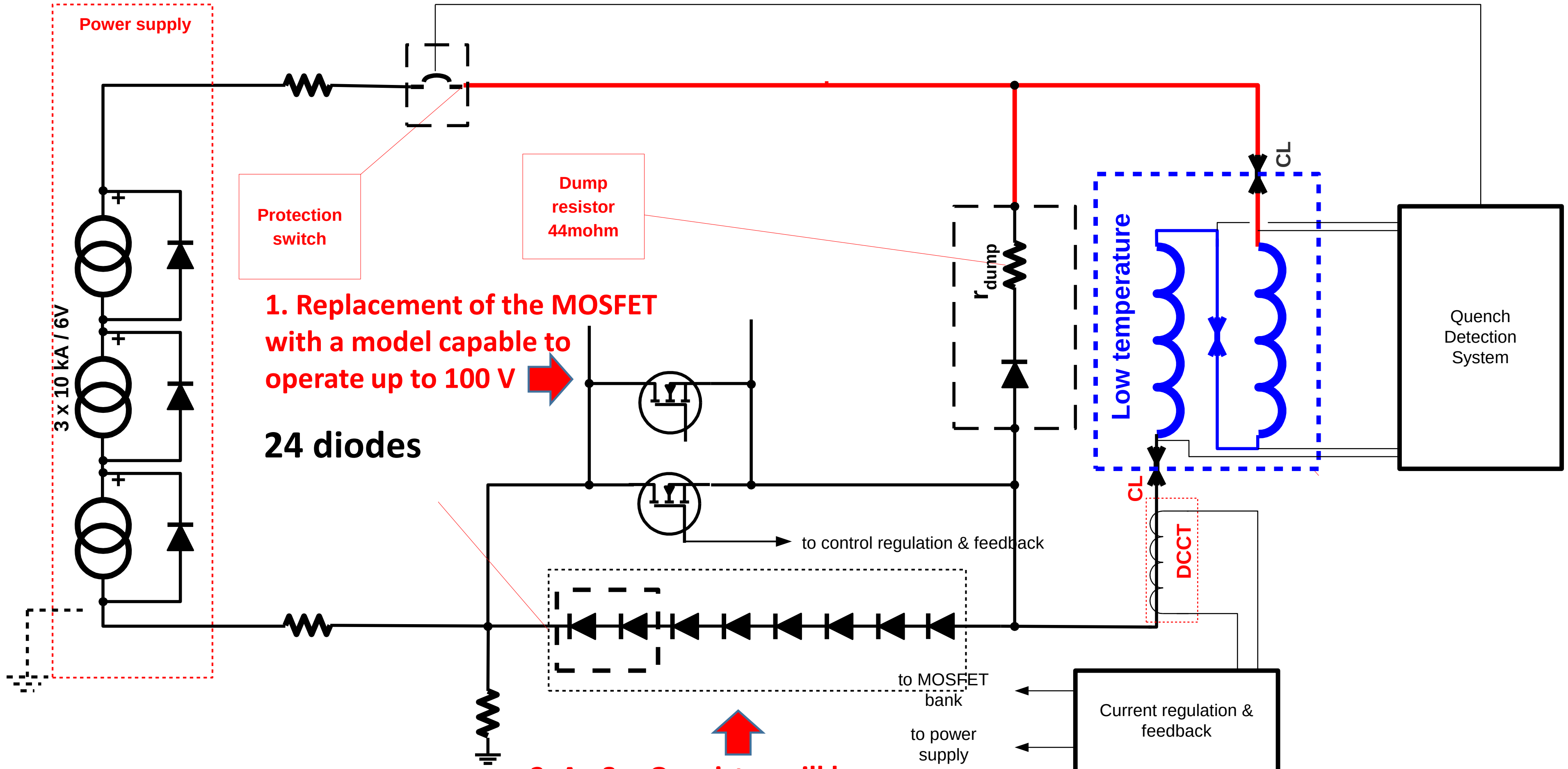
Test with 10 kA has shown that the opening time is globally 130 ms, given by 65 ms operating relay acting on switch electromagnet + 60 ms switch opening + 5 ms arc extinguished.

Designed for a slow application, it will be upgraded with a faster relay which will allow some improvement, down to 100 ms or maybe less, in any case **not suitable for a HTS magnet test** at least for temperatures below 30 K.





Magnet protection scheme: updated design

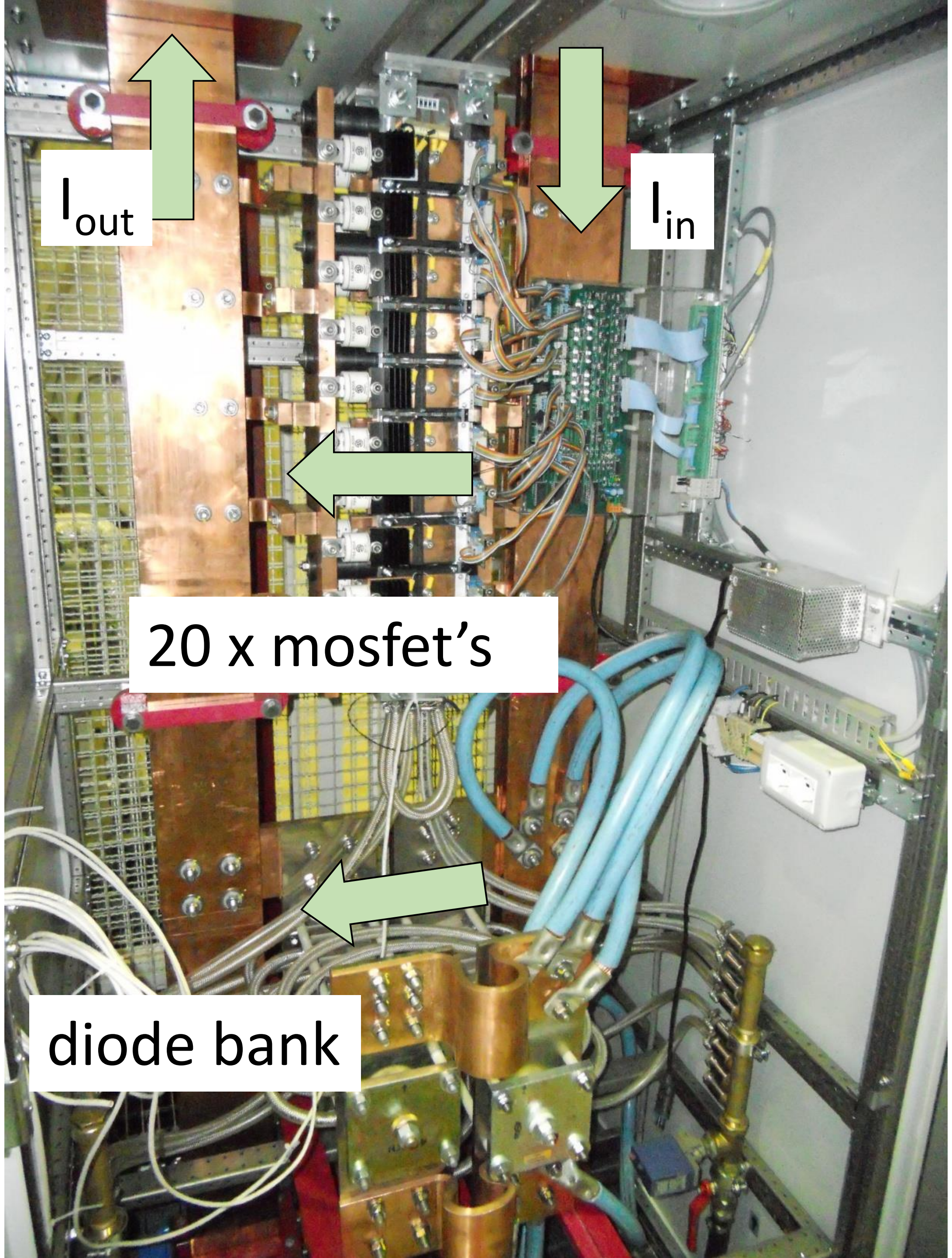


1. Replacement of the MOSFET with a model capable to operate up to 100 V

24 diodes

2. A ~8 mΩ resistor will be added in series to the diodes, providing a maximum total discharge voltage of 100 V

Current control



Alternative solution for the switch

Solution 1
Opening time ≤ 1 ms seems feasible, with replacement of the MOSFET's, introduction of a series resistance, new protections against extra-voltage, re-calibration and test is feasible in a few months.

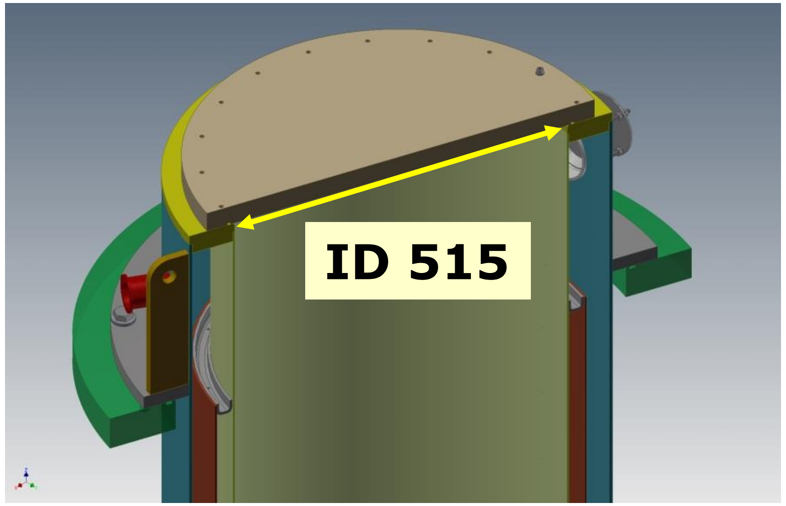
Is the discharge through 24 diodes + 8 mΩ is acceptable for the protection point of view (max 100 V)?

Solution 2
Replacement of the MOSFET's with modules based on IGBT, which can sustain higher voltages. In this case there is a max voltage drop about 400 V (limited by the test station) This requires an extensive redesign of the discharge unit, with new heat exchanger, current connection, control electronics… etc., so unlikely in time for the end of the next year.

Solution 3
Another Fast / Solid State Switch?

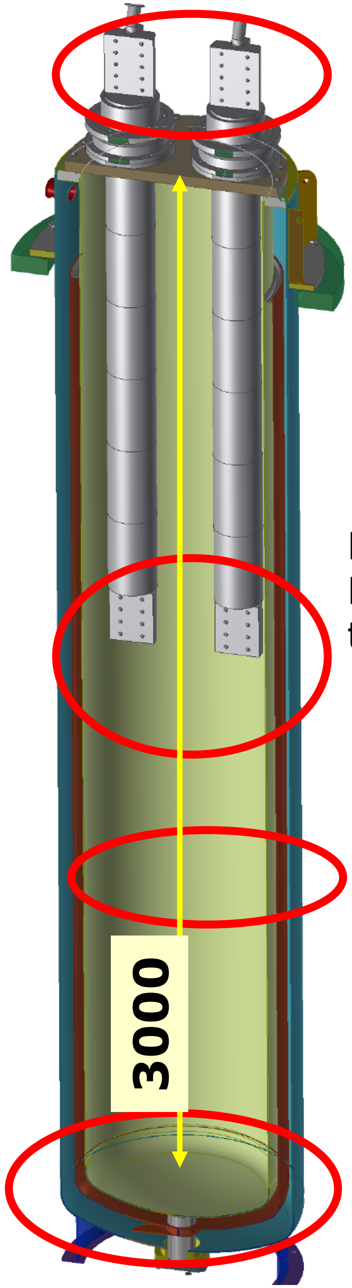
Cryostat

No of sensor, and wiring to be clarified



2.5 ton design load
Conduction cooled thermal shield

Contract awarded
Delivery June 2016

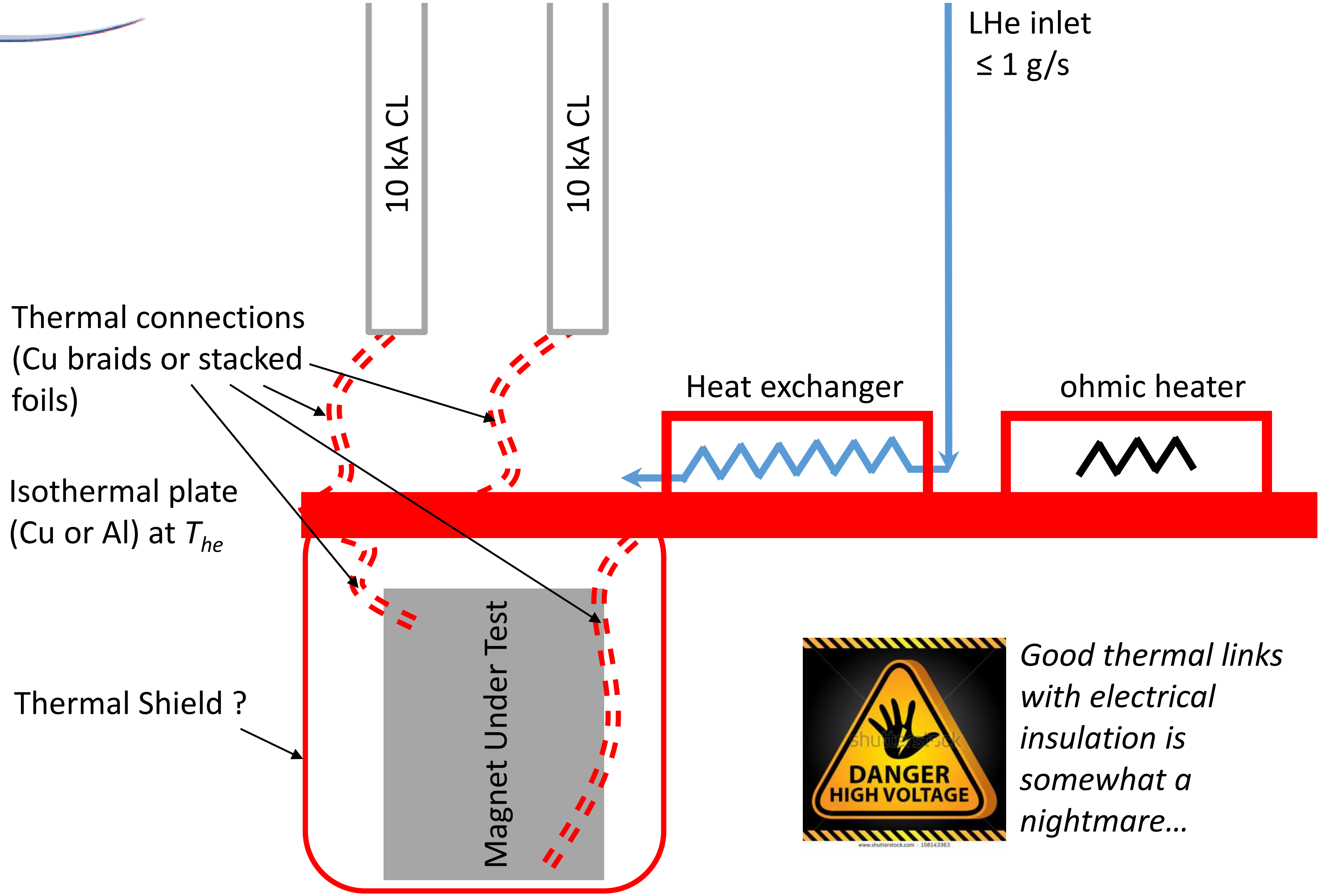


Electrical connections magnet to CLs
Must operate in gas flow up to maximum test temperature

Mechanical connections
Magnet will suspended to three tie rods.

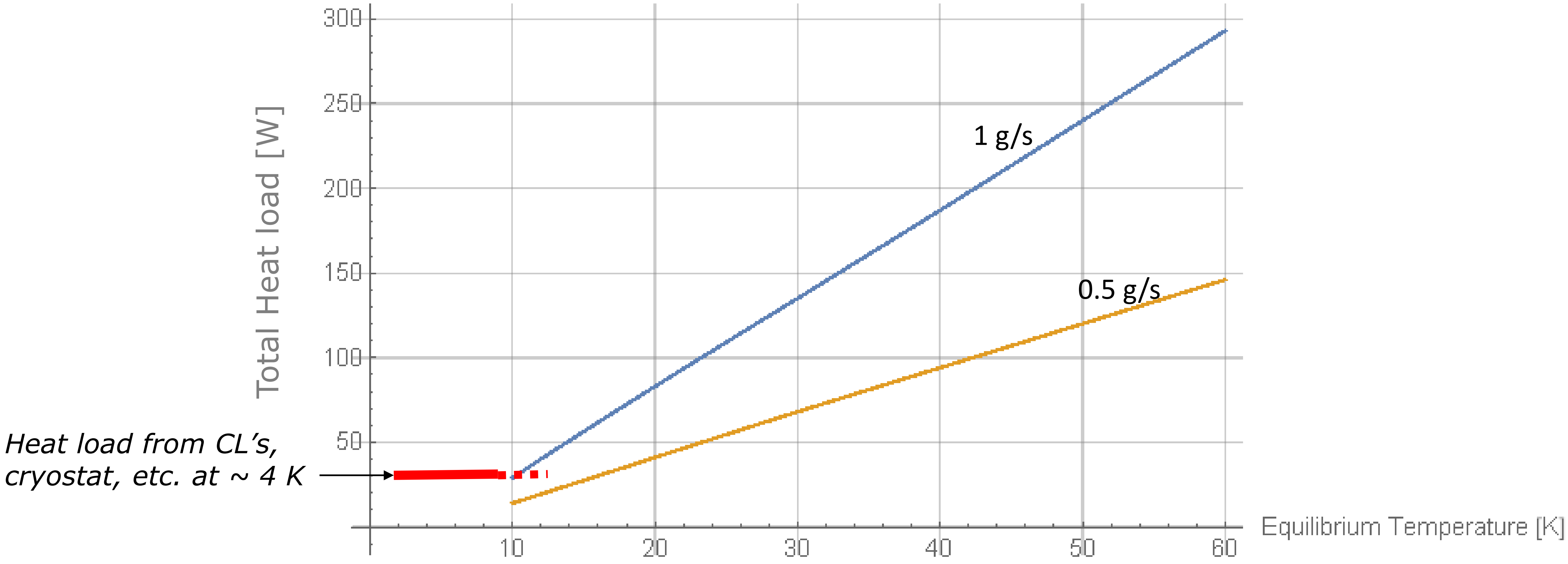
Gas-flow temperature control
A flow of ~1 g/s (30 LHe/h) will be vaporized by heaters to a controlled temperature and then the gas will be fed to the vessel containing the magnet. The exit flow should be enough to keep the CL's cold.
Temperature stability and gradient to be assessed.

Conceptual scheme

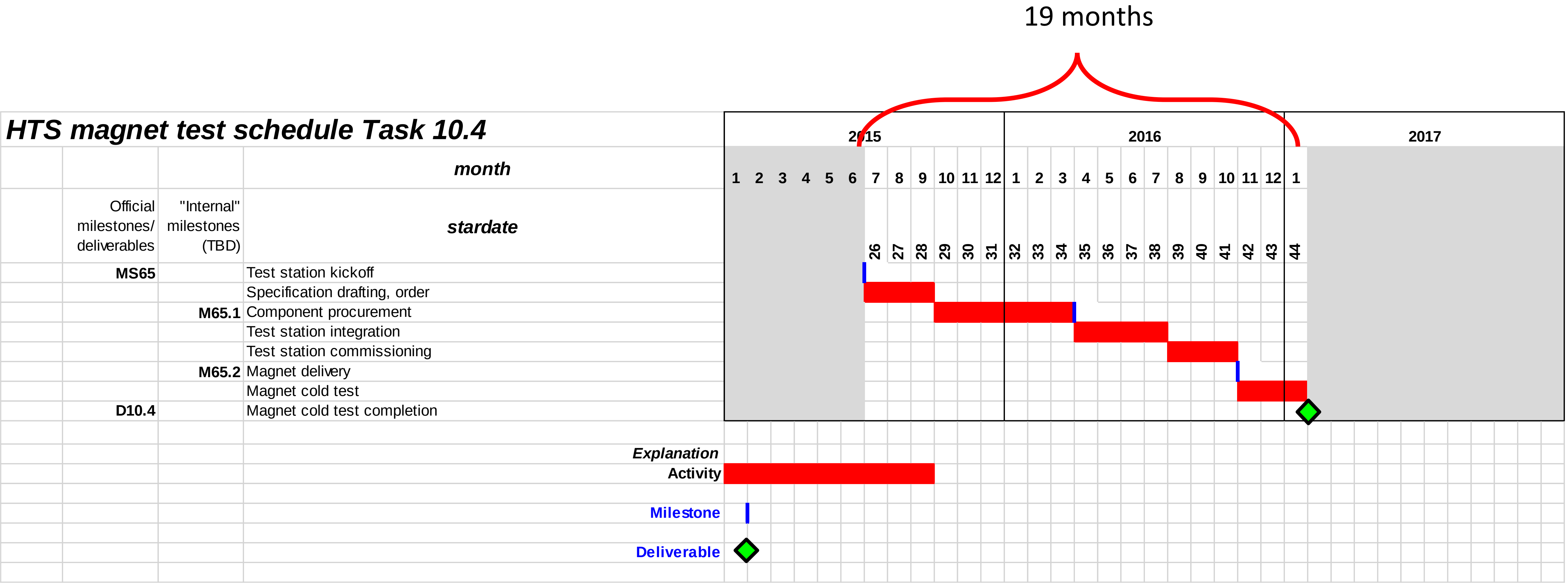


Good thermal links with electrical insulation is somewhat a nightmare…

Heat load vs. equilibrium temperature



Schedule


19 months
HTS magnet test schedule Task 10.4
2015
2016
2017
month
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1
Official milestones/ deliverables
"Internal" milestones (TBD)
stardate
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44
MS65
Test station kickoff
Specification drafting, order
M65.1
Component procurement
Test station integration
Test station commissioning
M65.2
Magnet delivery
Magnet cold test
D10.4
Magnet cold test completion
Explanation
Activity
Milestone
Deliverable

Conclusions

Old fashioned, Voltage-based, Quench Detection System commissioned and field-tested; to be integrated by other system(s)

A concept for the magnet fast discharge being proposed; if OK we go ahead with implementation

Cryostat contarct awarded

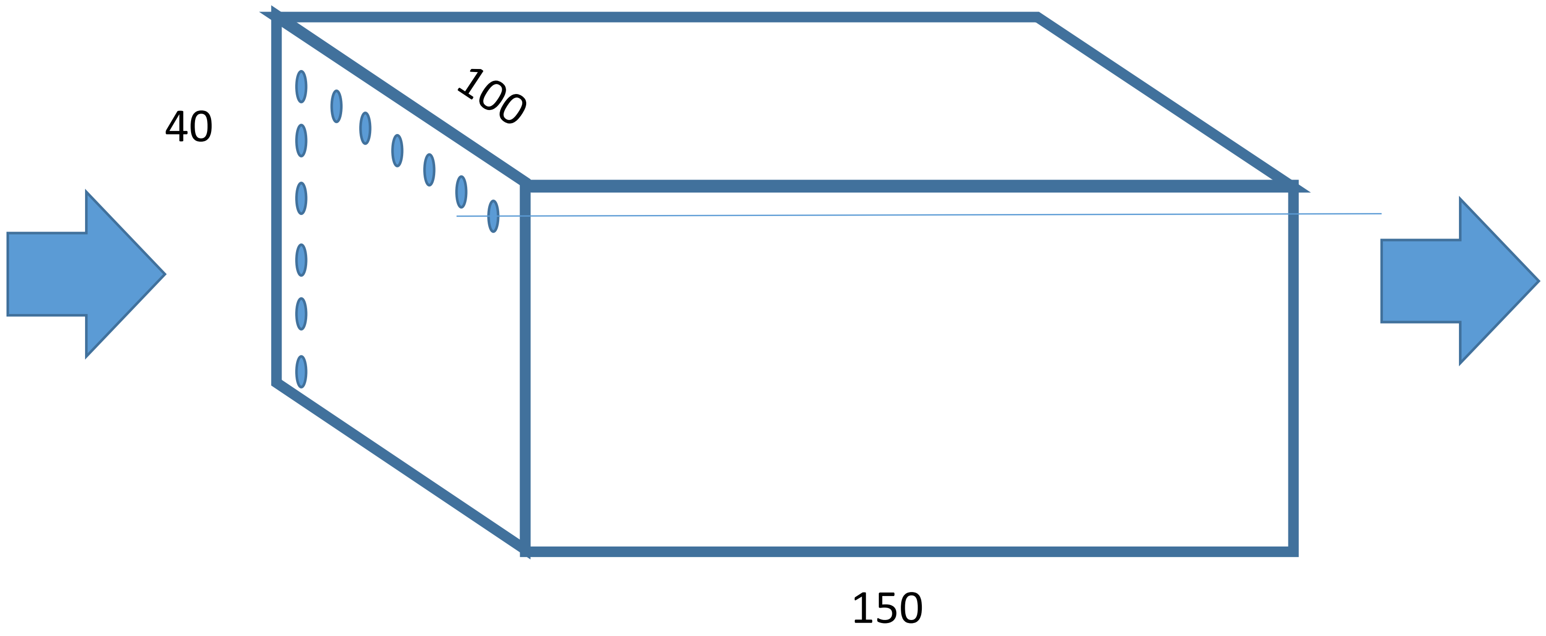
Temperature control to be studied

Thank you for your attention

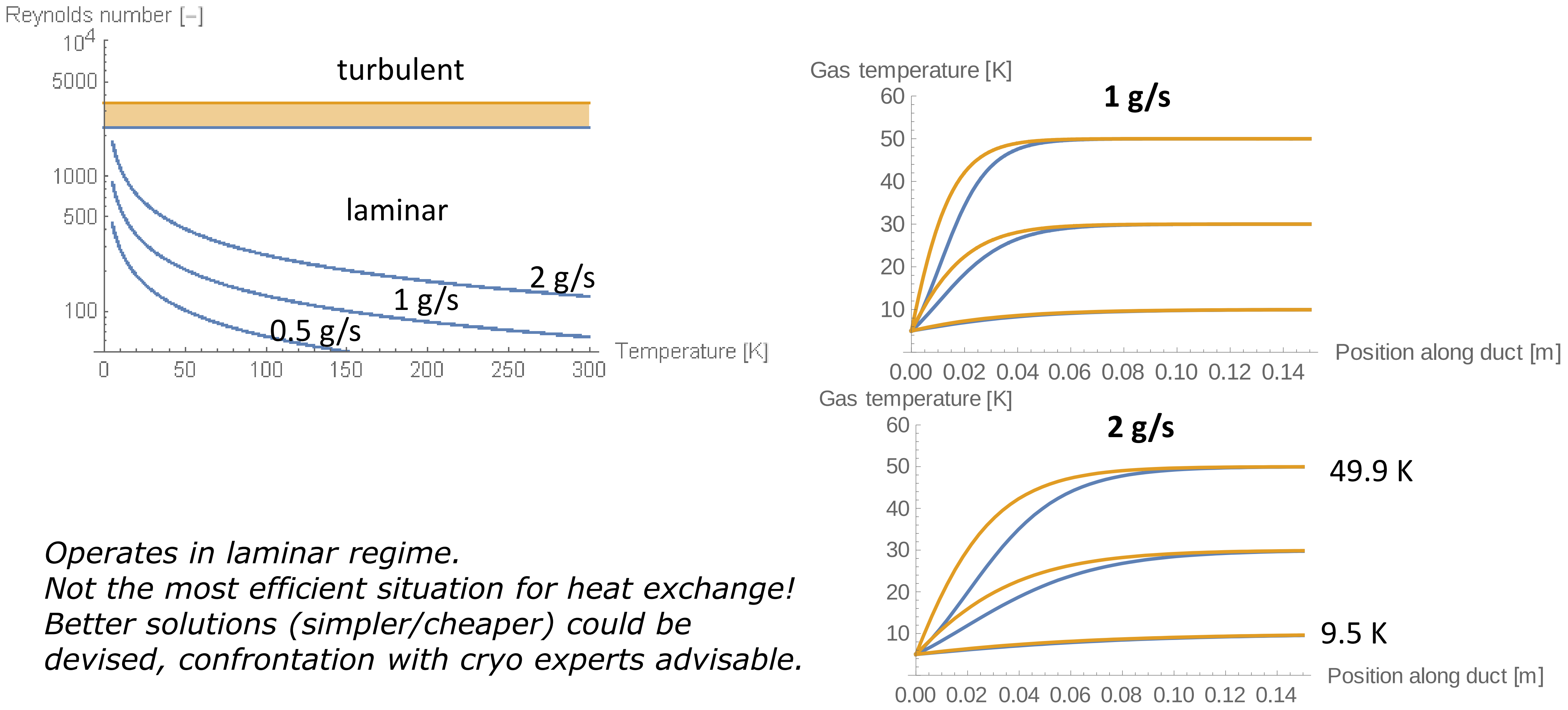
Experimental area

Heat Exchanger

The exchanging element is a copper block, cross section 100 x 40 mm^2 ,length 150 mm,
with 1000 round holes 1 mm in diameter along its length.
This should be feasible by 3D printing. End chambers could be (e-beam) welded at its extremities.

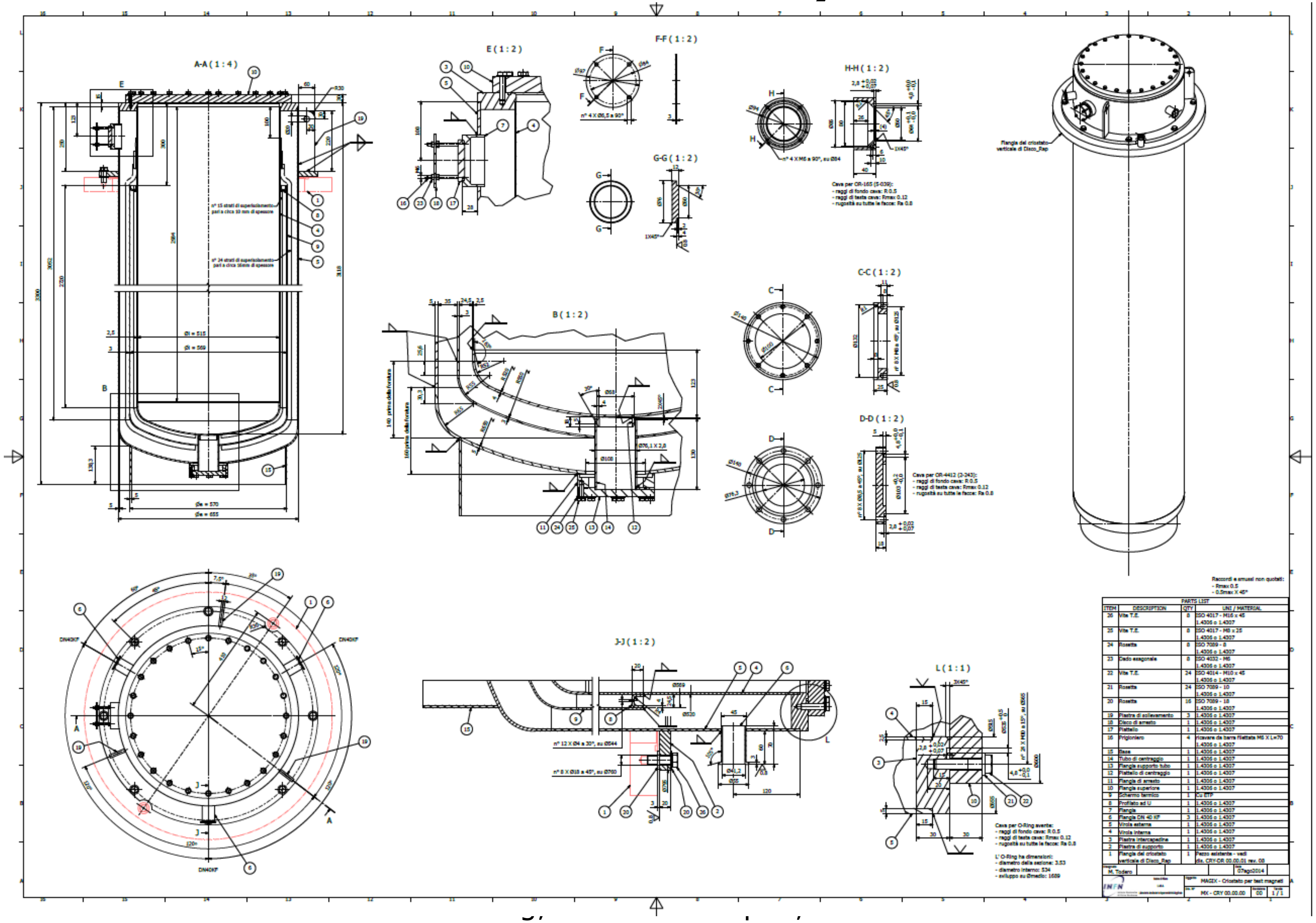


Heat Exchanger Design



Operates in laminar regime.
Not the most efficient situation for heat exchange!
Better solutions (simpler/cheaper) could be devised, confrontation with cryo experts advisable.

MAGIX Cryostat



PARTS LIST			
ITEM	DESCRIPTION	QTY	UNI / MATERIAL
26	Vite T.E.	8	ISO 4017 - M16 x 45 1.4306 o 1.4307
25	Vite T.E.	8	ISO 4017 - M8 x 25 1.4306 o 1.4307
24	Rosetta	8	ISO 7089 - 8 1.4306 o 1.4307
23	Dado esagonale	8	ISO 4032 - M6 1.4306 o 1.4307
22	Vite T.E.	24	ISO 4014 - M10 x 45 1.4306 o 1.4307
21	Rosetta	24	ISO 7089 - 10 1.4306 o 1.4307
20	Rosetta	16	ISO 7089 - 18 1.4306 o 1.4307
19	Piastra di sollevamento	3	1.4306 o 1.4307
18	Disco di arresto	1	1.4306 o 1.4307
17	Piattello	1	1.4306 o 1.4307
16	Prigioniero	4	ricavare da barra filettata M6 X L=70 1.4306 o 1.4307
15	Base	1	1.4306 o 1.4307
14	Tubo di centraggio	1	1.4306 o 1.4307
13	Flangia supporto tubo	1	1.4306 o 1.4307
12	Piattello di centraggio	1	1.4306 o 1.4307
11	Flangia di arresto	1	1.4306 o 1.4307
10	Flangia superiore	1	1.4306 o 1.4307
9	Schermo termico	1	Cu ETP
8	Profilato ad U	1	1.4306 o 1.4307
7	Flangia	1	1.4306 o 1.4307
6	Flangia DN 40 KF	3	1.4306 o 1.4307
5	Virola esterna	1	1.4306 o 1.4307
4	Virola interna	1	1.4306 o 1.4307
3	Piastra intercapedine	1	1.4306 o 1.4307
2	Piastra di supporto	1	1.4306 o 1.4307
1	Flangia del criostato verticale di Disco_Rap	1	Pezzo esistente - vedi dis. CRY-DR 00.00.01 rev. 00

M. Todero — 07ago2014
MAGIX - Criostato per test magneti
MX - CRY 00.00.00 — 00 — 1 / 1

Meetings

Task 4 HTS Magnet Test
event/355138
26 Nov 2014

Status of WP10
Indico/354955
8 Jan 2015

WP10 meeting
5 June 2015
indico.cern.ch/event/395379/

Test Station Kickoff meeting
Milestone 65
Indico/
11 June 2015

Today
event/462150