CERN Activity on SC links and Cold Powering Systems

2nd Joint Hi-Lumi LHC-LARP Annual Meeting
14 November 2012

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The HiLumi LHC Design Study (a sub-system of HL-LHC) is co-funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.

Objective of the meeting

- To present and discuss the activity performed during the year 2012 within the Tasks of the WP 6
- To discuss and organize the future activity
- To agree on future main milestones

The activity of WP6 officially starts in November 2012

Which means that we are ahead of schedule...

PRESENTATIONS

- Introduction (A. Ballarino)
- SC link activity at CERN (A. Ballarino)
- Cryogenics for cold powering system at LHC (U. Wagner)
- Distribution feedbox and proposed cryogenic layout (Y. Yang)
- Energy deposition studies (F. Broggi)
- Conclusion, future activities (All)

Introduction

Progress on SC activity at CERN

Hi-Lumi FP7 WP6

Design study

- Task 1 Coordination CERN/INFN
- Task 2 Cryogenics CERN
- Task 3 Electr. Transf. Cryostat Univ. South
- Task 4 Energy Dep. Material INFN

CERN activity Design study

- Integration
- Civil engineering
- Interfaces (mech, vacuum, electr)
- Vacuum
- SC cables/SC link
- Cryostat of SC link
- Current leads
- Protection

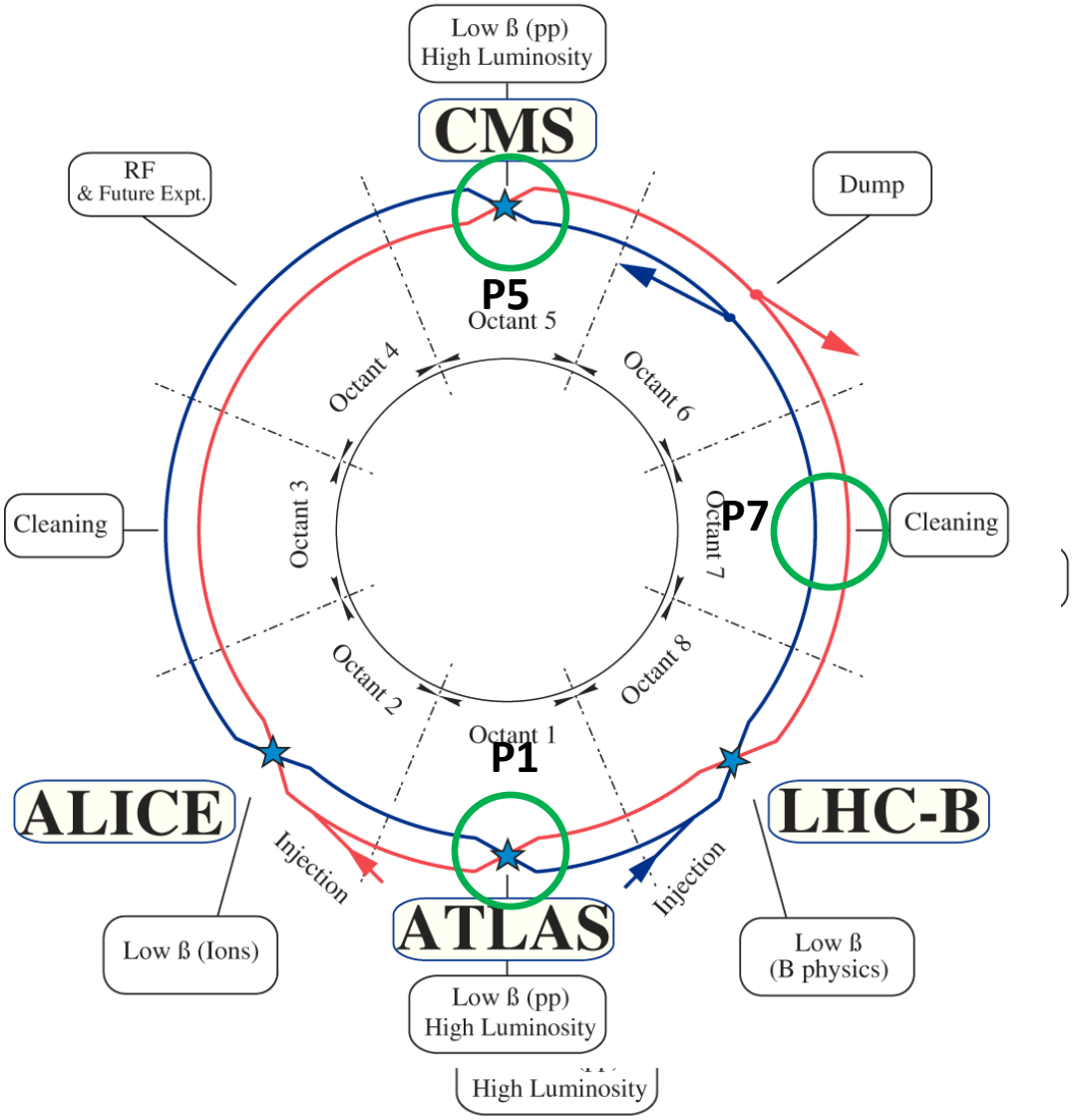
CERN activity

- Prototypes construction
- Cryostat
- Prototypes test

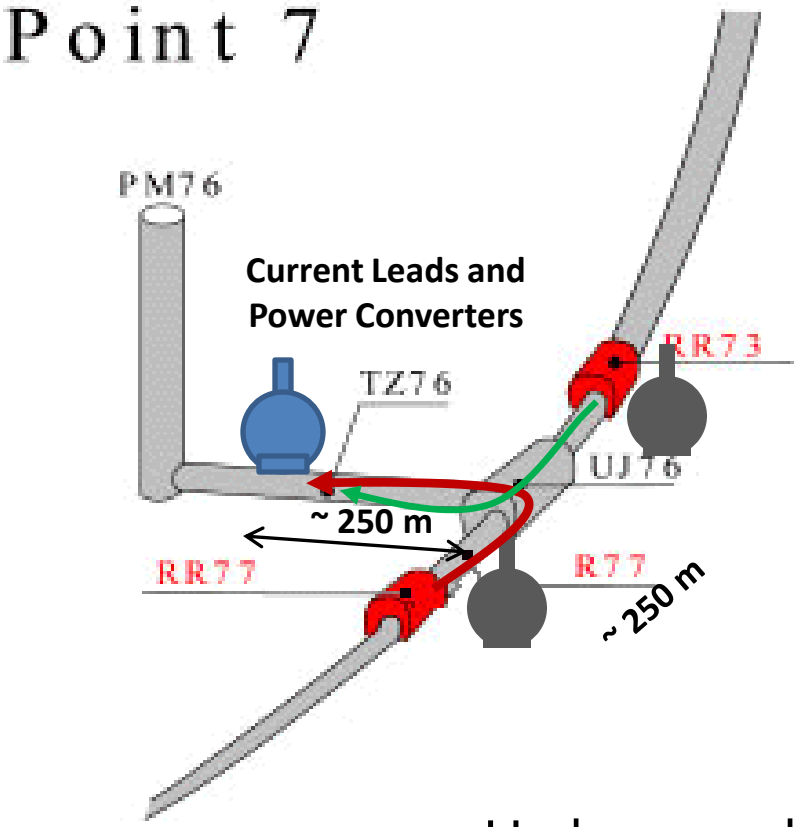
- System design
- Series specification
- Series construction
- Integration
- Operation

Fluka team

Where in the LHC ?



LHC P7

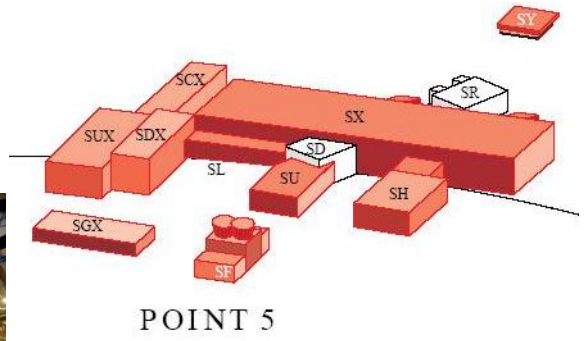


Underground installation

Two links each about 500 m long

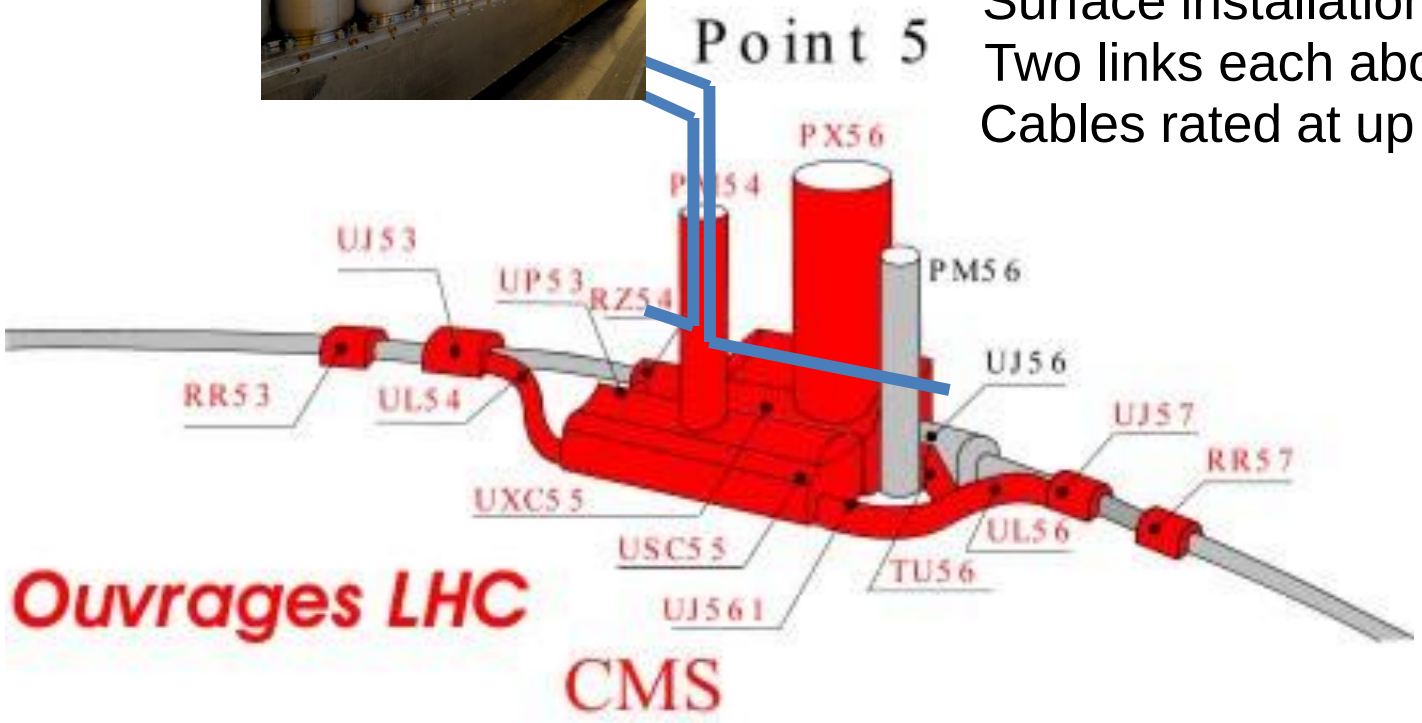
48 cables rated at 600 A per link

LHC P1 and P5



POINT 5

Surface installation
Two links each about 300 m long
Cables rated at up to 200 kA per link



High Luminosity LHC

Introduction

Progress on SC activity at CERN

Activity in the year 2012

- CERN:

1) Development and qualification of **MgB_2 wires** in close collaboration with Columbus Superconductors. Successful test in July 2012 of first PIT round wire with homogeneous superconducting properties.
2) Design and assembly of a novel **test station** for the measurement of 20 m long high-current (up to 20 kA) superconducting links in a variable temperature range.
3) Conceptual study, assembly and test at 4.2 K of novel **MgB_2 and HTS (YBCO and BSCCO) cables**

- CERN:

1) Study of cryogenic options for the cooling of the LHC superconducting links
2) Preliminary integration studies in the LHC machine
3) Study of powering layouts for the LHC Hi-Lumi Triplets

Powering

- Input from optics and magnets:

- **4** quadrupoles (**I=17.3 kA** – Max current for Nb_3Sn)

+

- **1** trim on Q1 (**I= 1 kA**) and **1** separate trim on Q3 (**I=1 kA**)

+

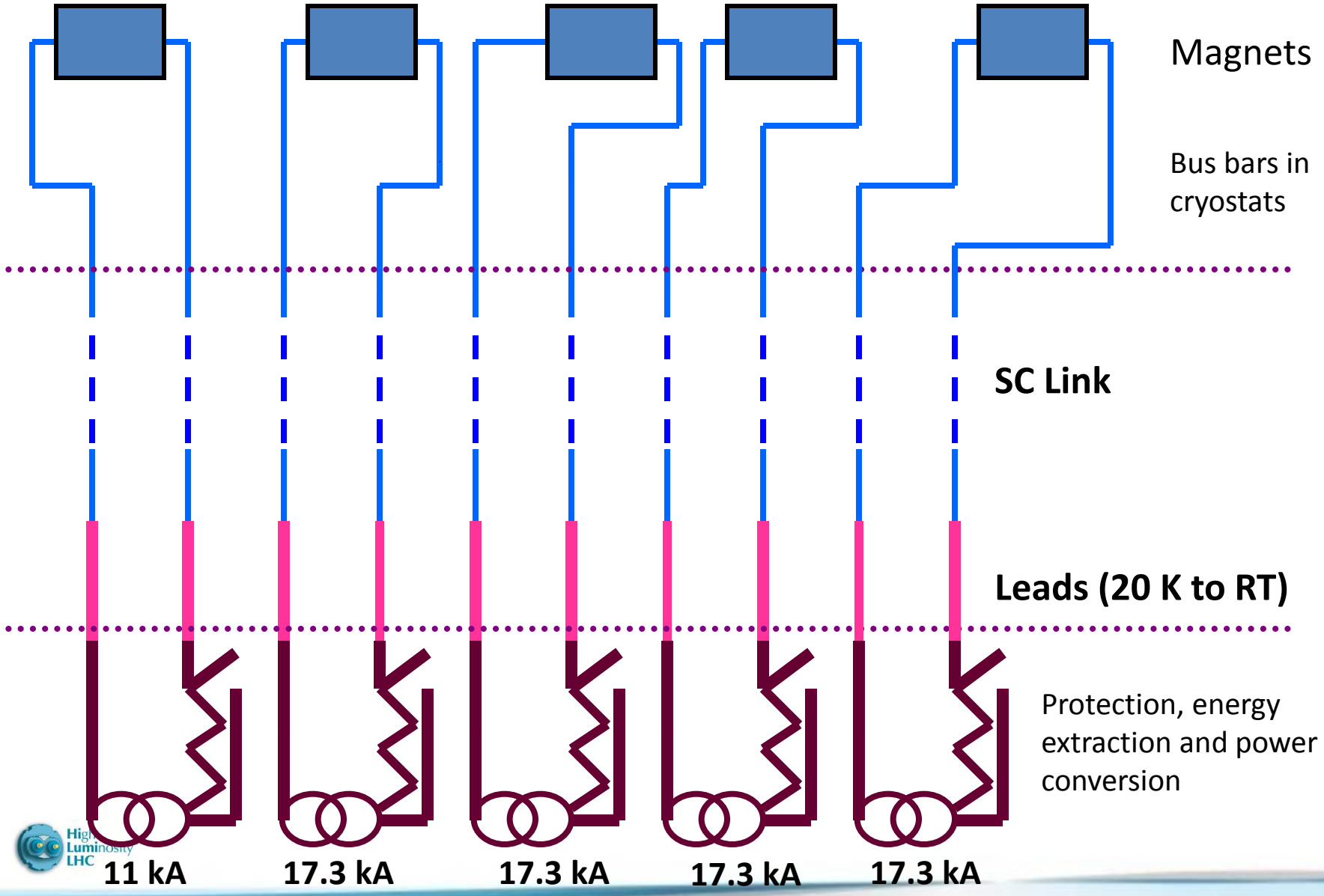
- **1** trim on Q2a (**I=0.2 kA**) and **1** separate trim on Q2b (**I=0.2 kA**)

- **1** separation dipole (**I=11 kA**)

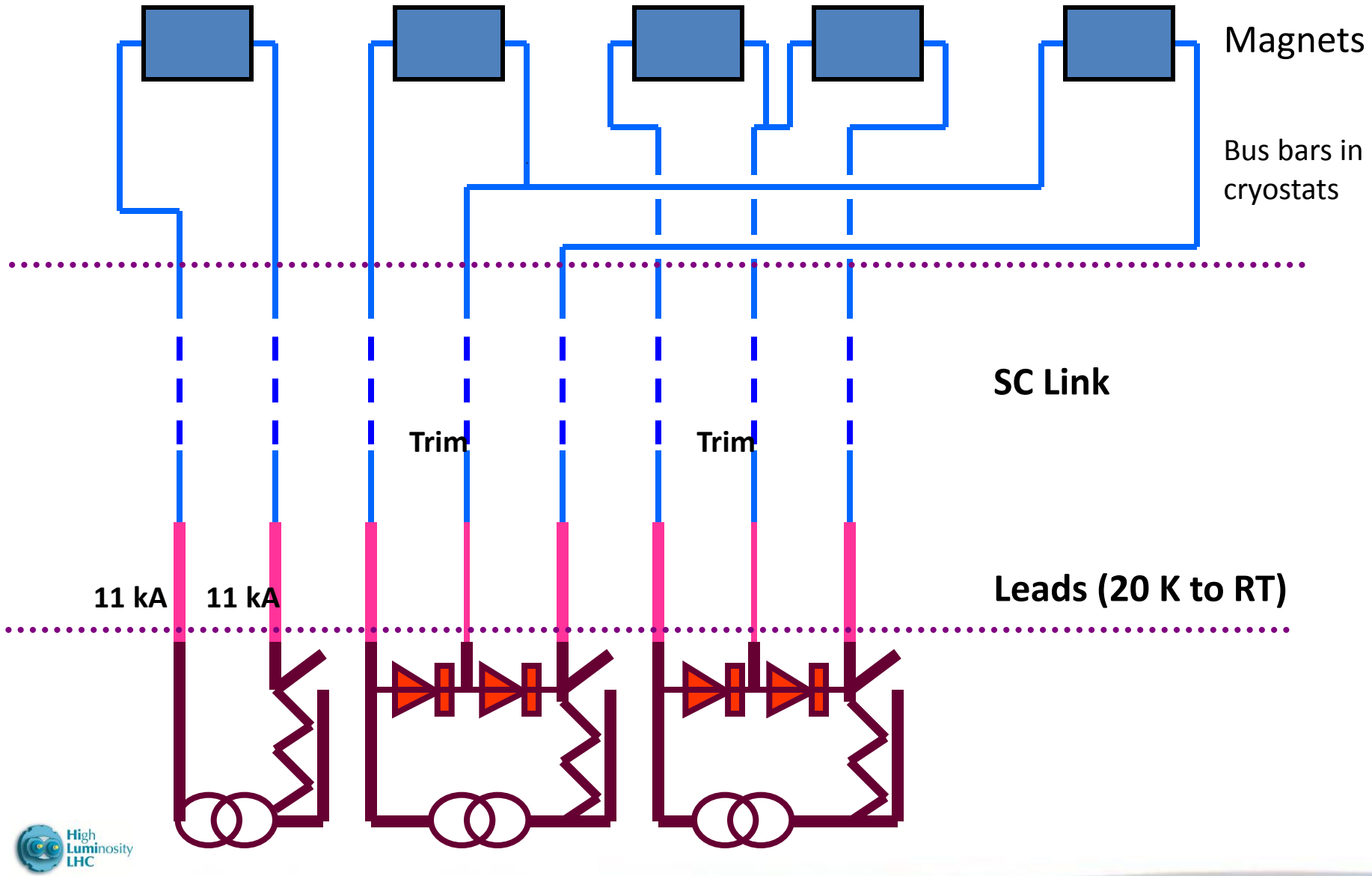
- **Corrector package** – to be defined

June 2012: Iquad = 16.44 kA, Idipole = 9.2 kA

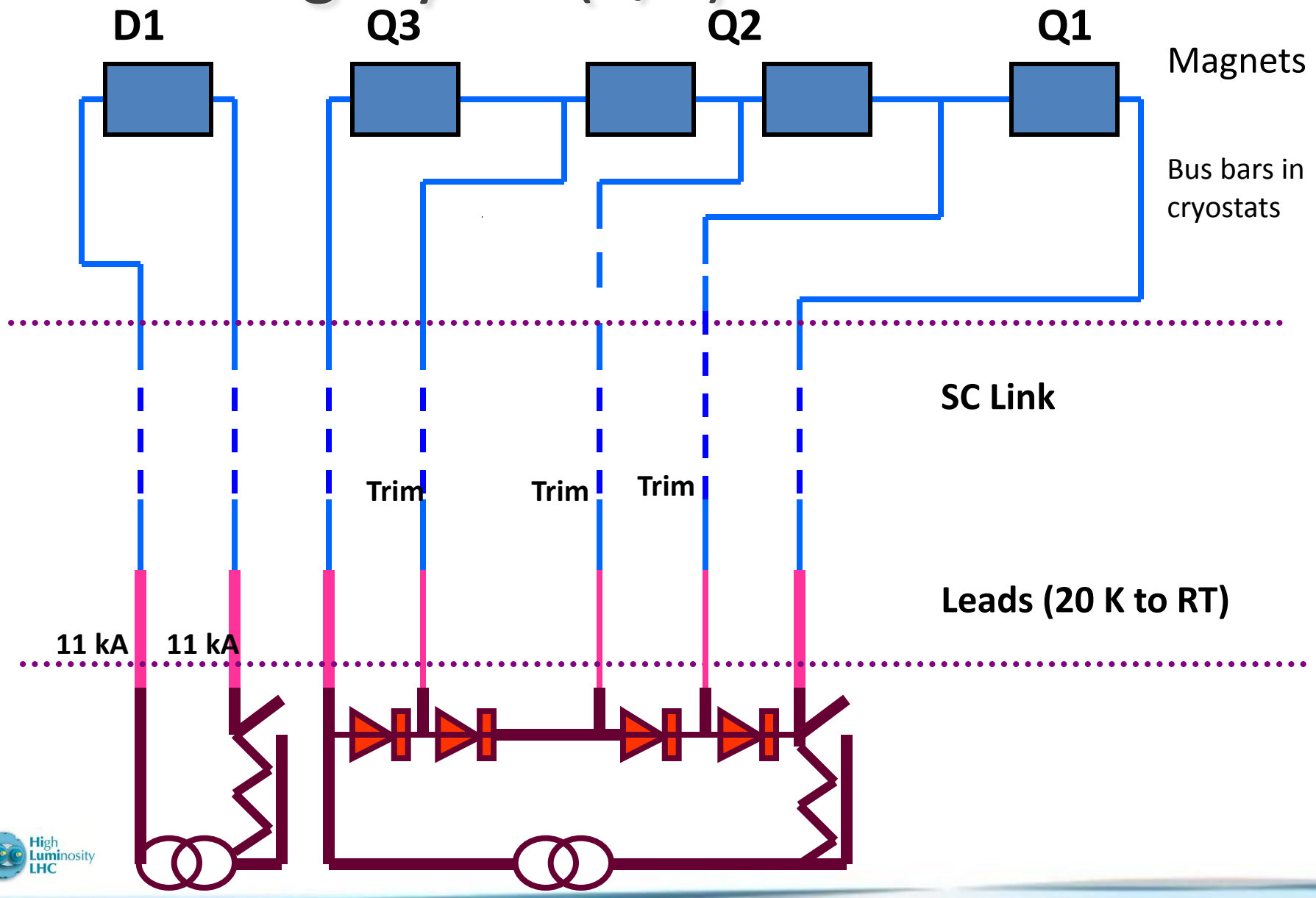
Powering layout (1/3)



Powering layout (2/3)



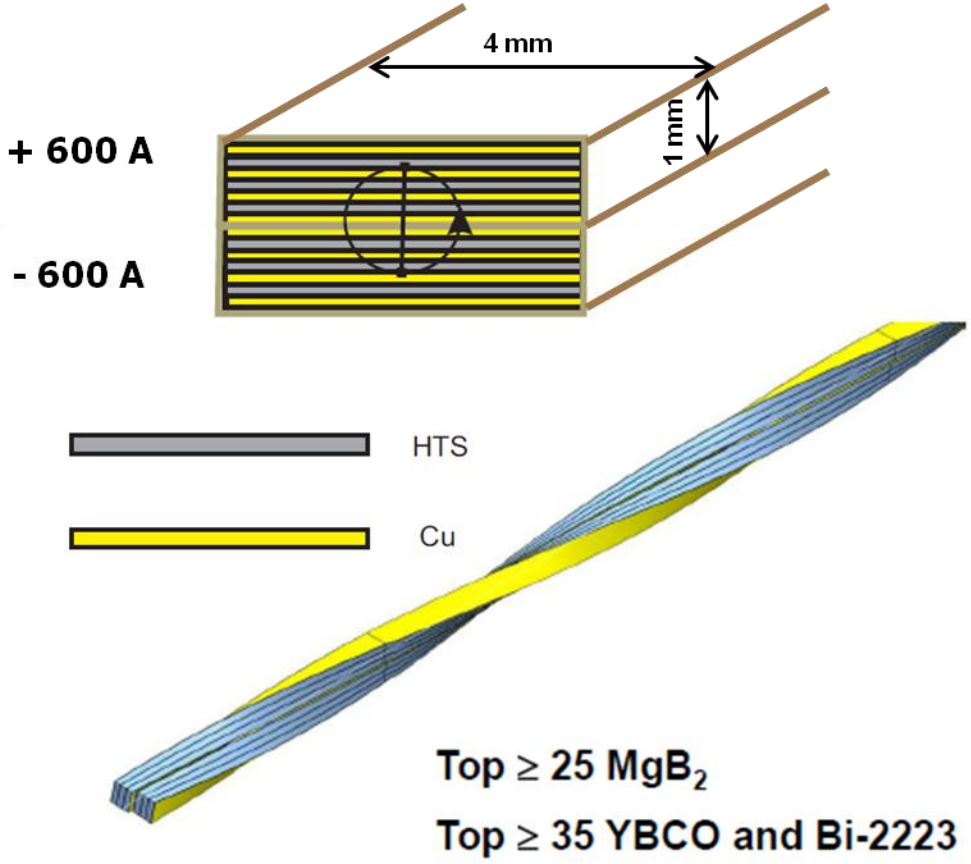
Powering layout (3/3)

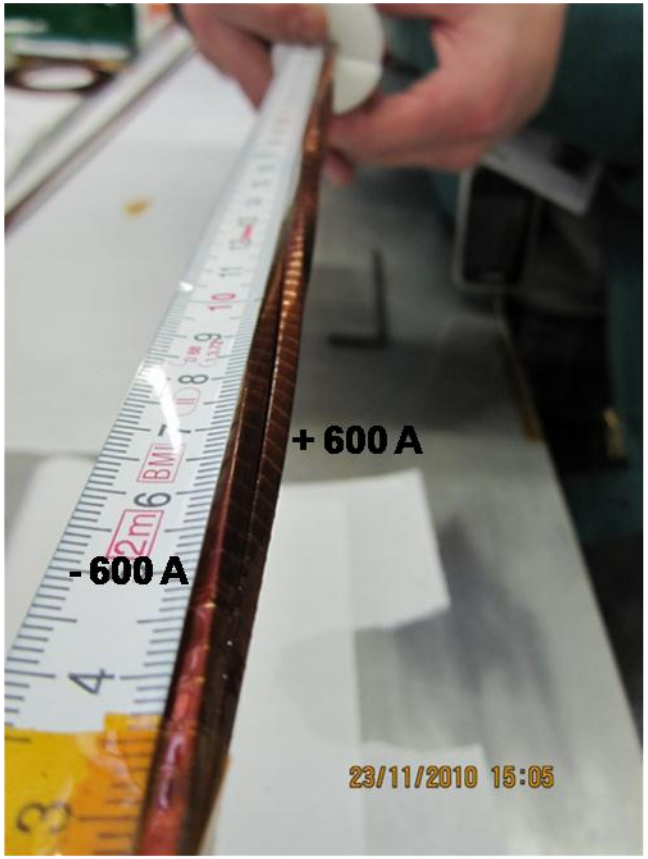


P7 – SC Link (48×600 A)

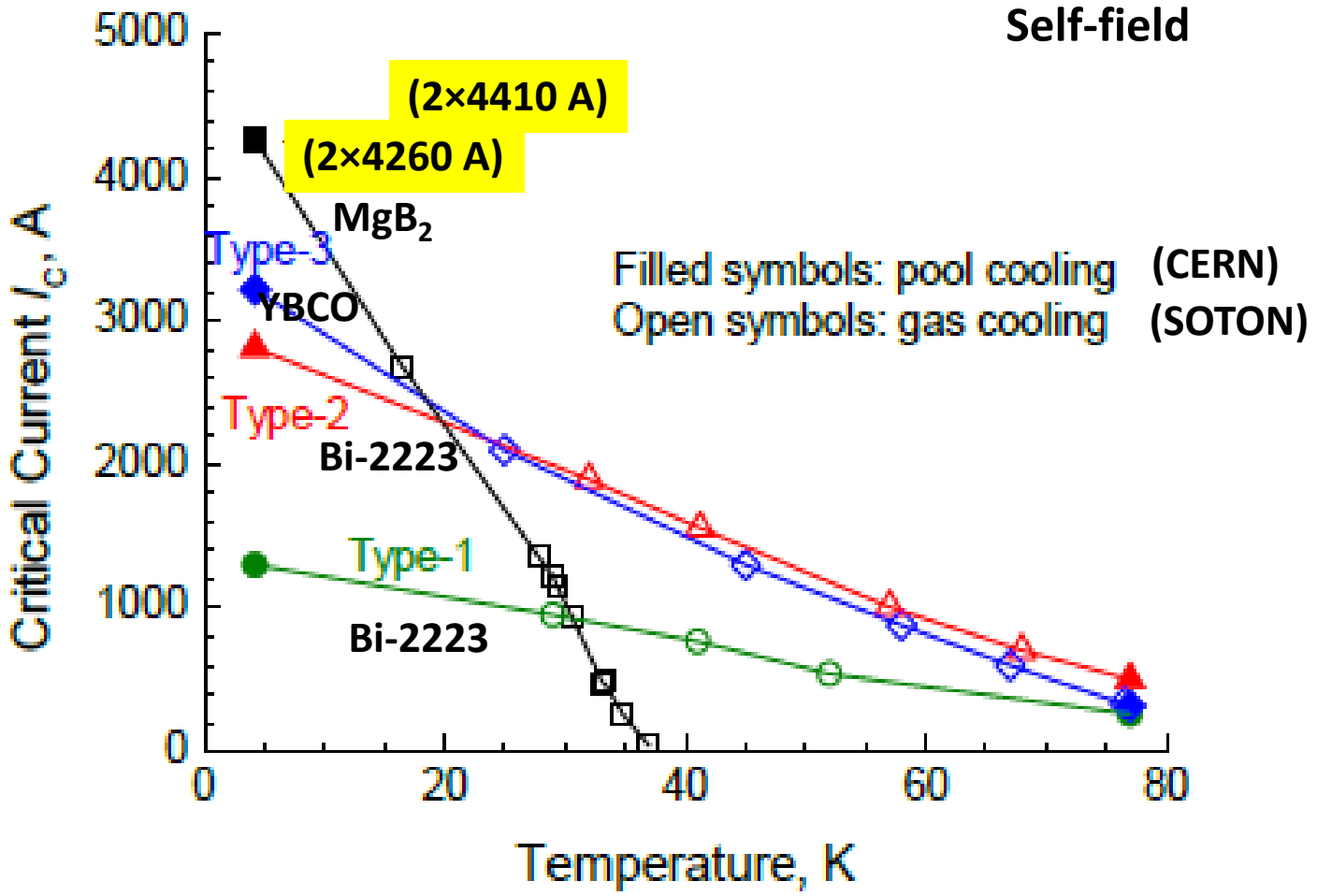
Twisted-pair cables made from tapes

MgB2	: 3.7 × 0.67 mm^2
BSCCO 2223	: 4 × 0.2 mm^2
YBCO	: 4 × 0.1 mm^2



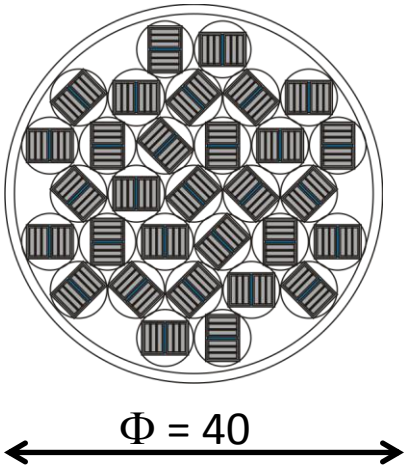


P7 – SC Link (48×600 A)

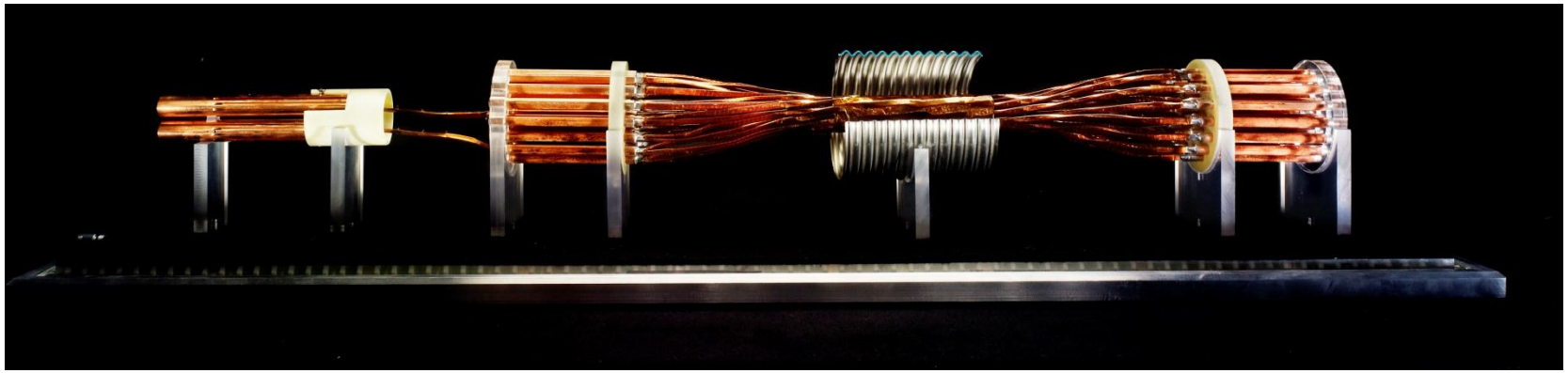


Measurements performed on cable lengths of 2 m

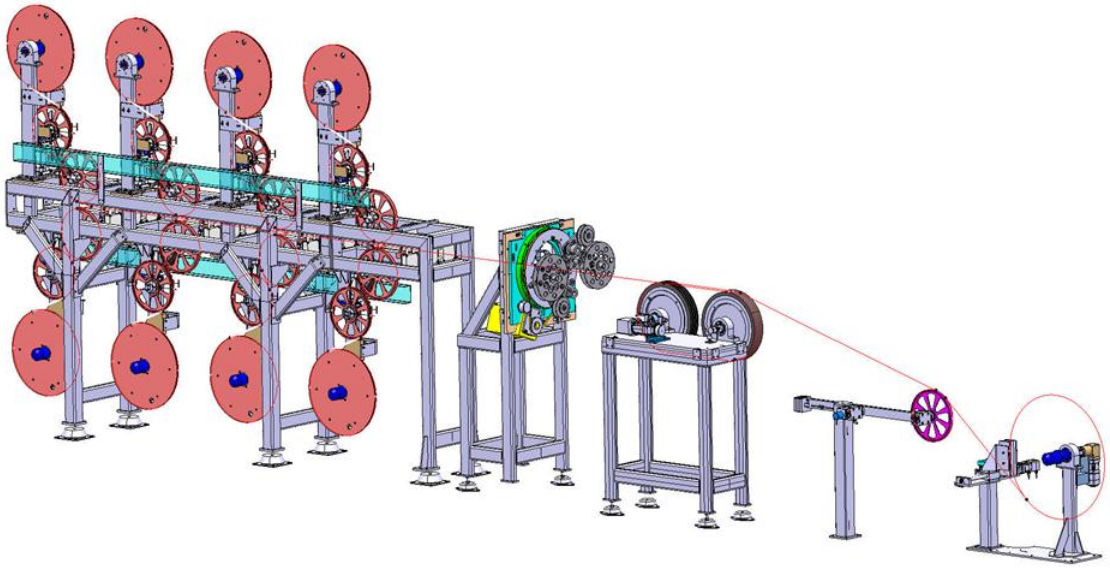
P7 – SC Link (48×600 A)

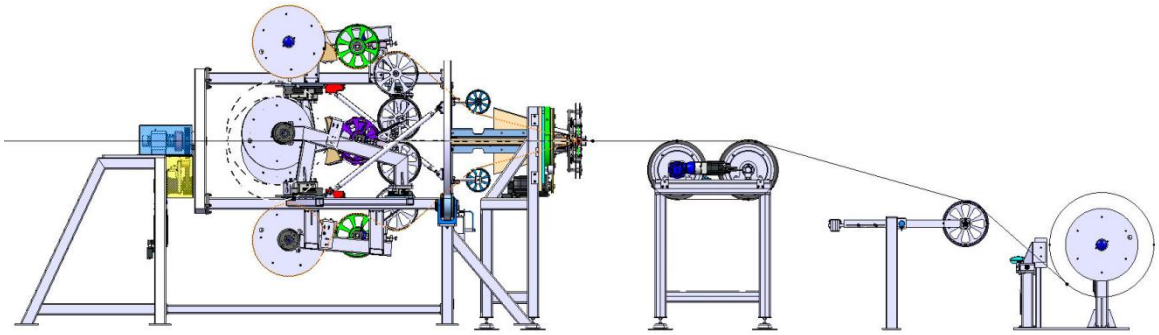


30 kA
~2 kg/m
~ 150 m_{HTS}/m_{cable}

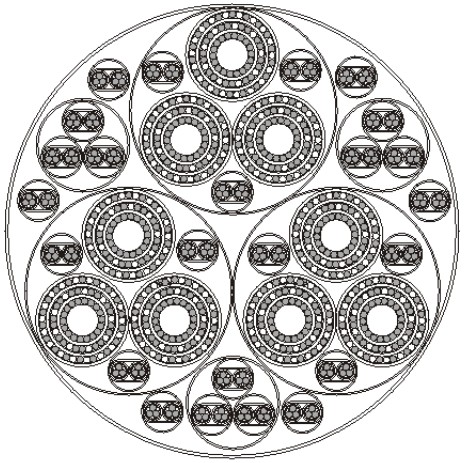


P7 – SC Link (48×600 A)





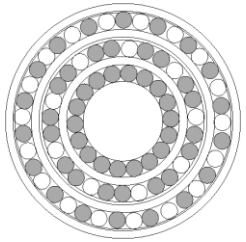
P1 and P5



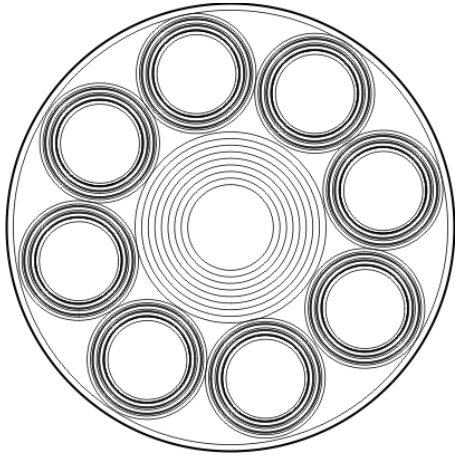
Φ = 75

27 cables 6000 A
48 cables 600 A
Itot = **190 kA @ 20 K**
(~2 × 95 kA)

3 × 6 kA

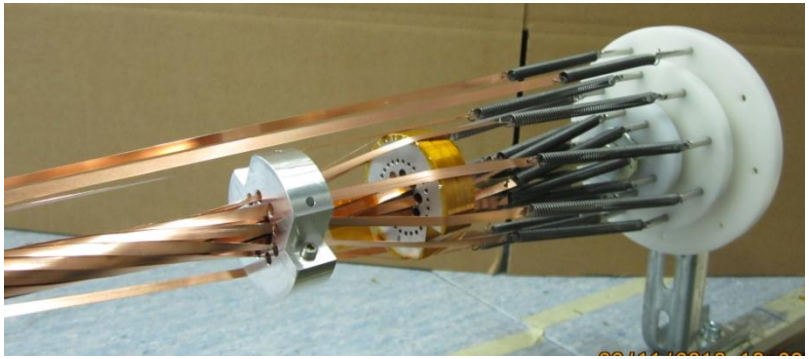


Φ = 15.5

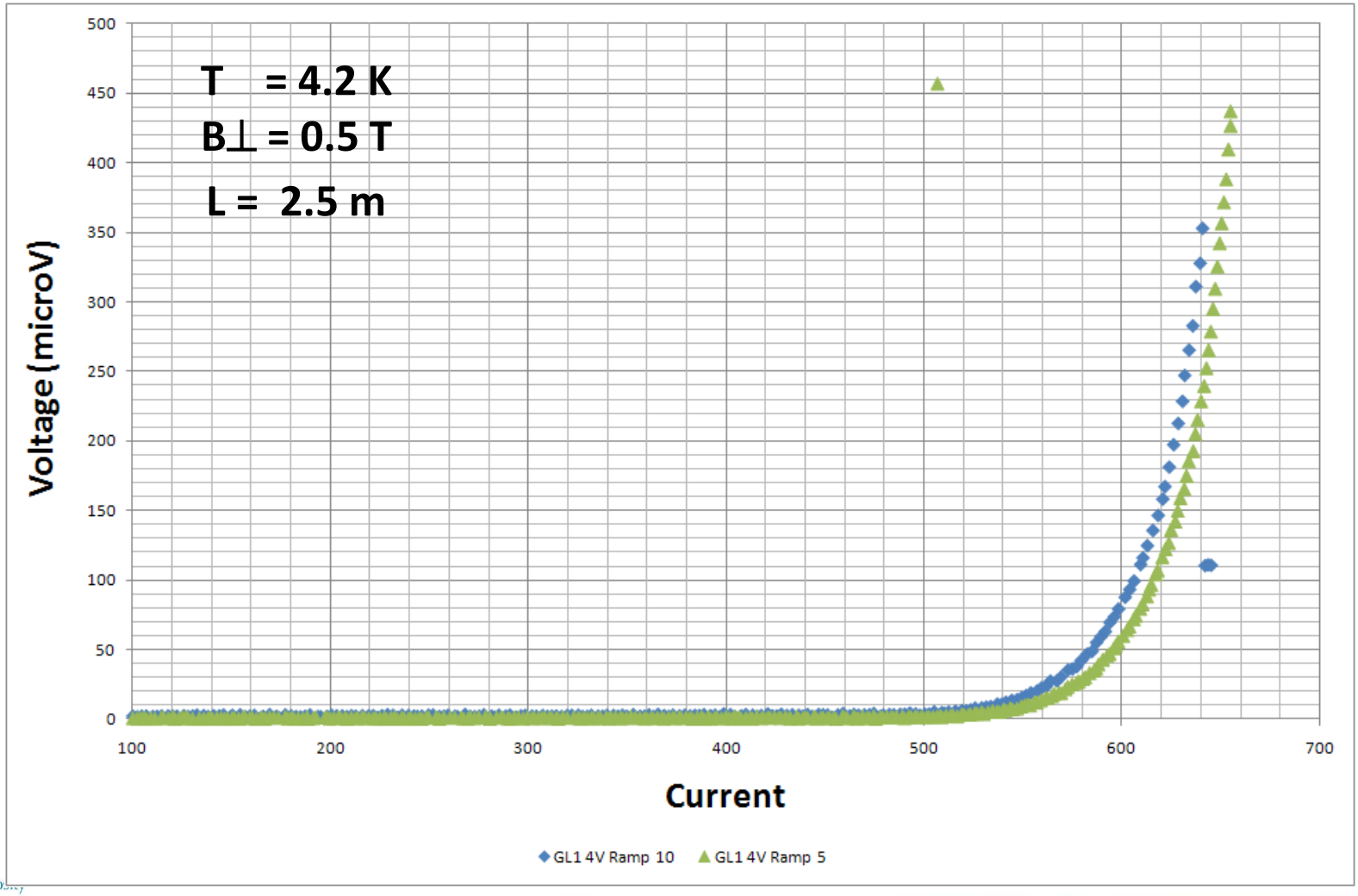


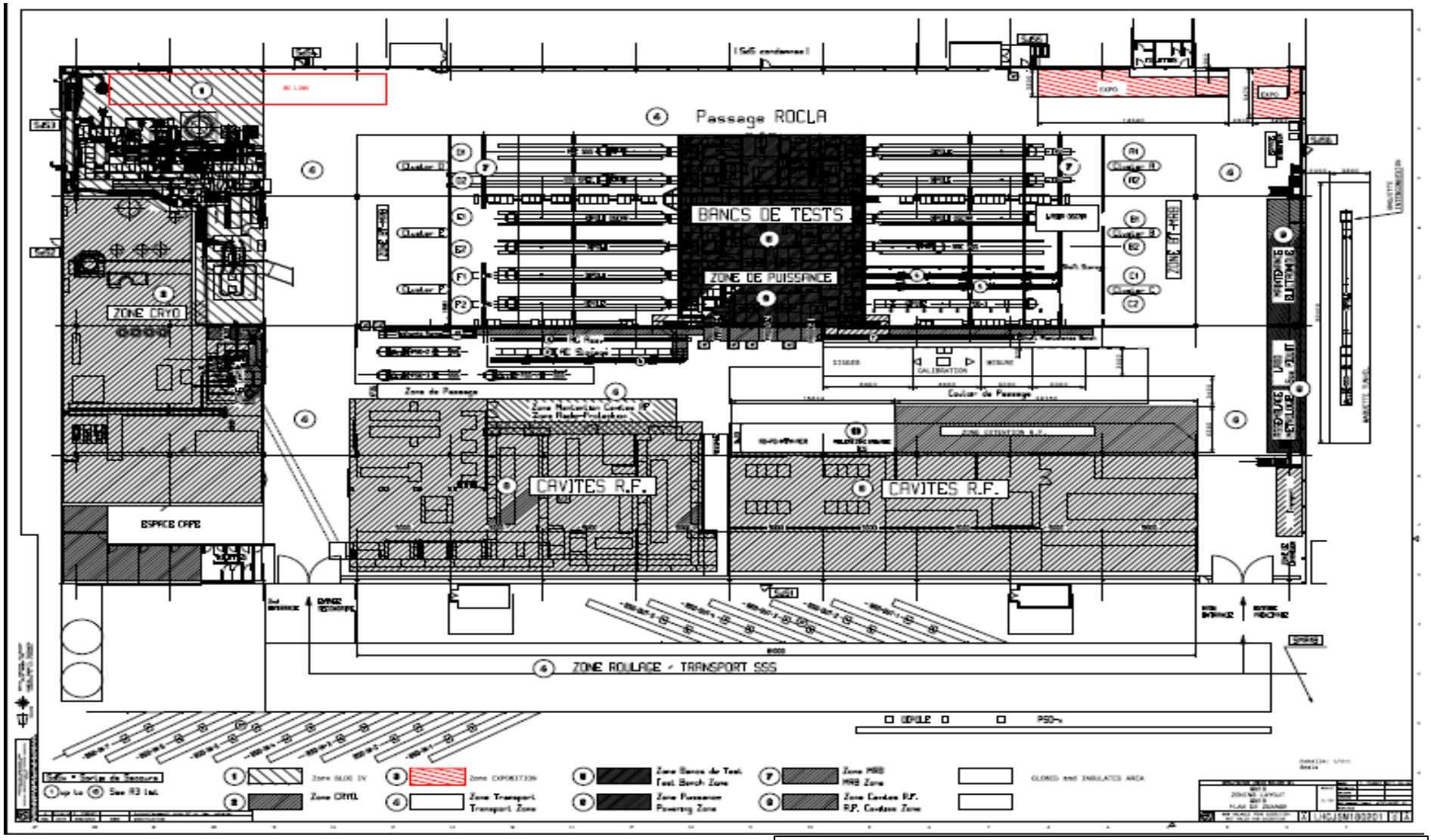
Φ =70

24 × 6000 A
42 × 600 A
Itot = **169 kA & 20 K**
(~ 2 × 84.5 kA)



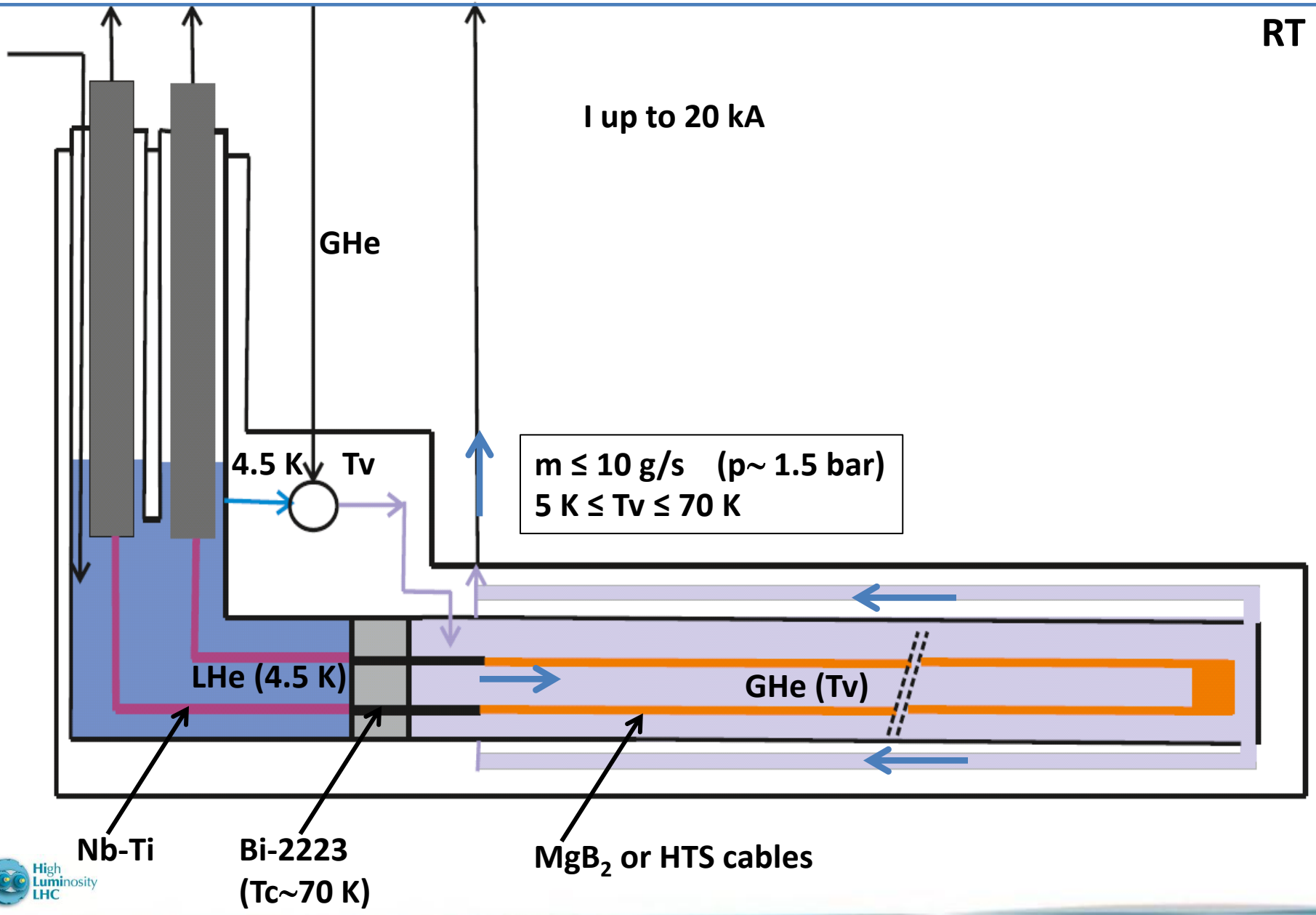
Characterization of MgB_2 wire





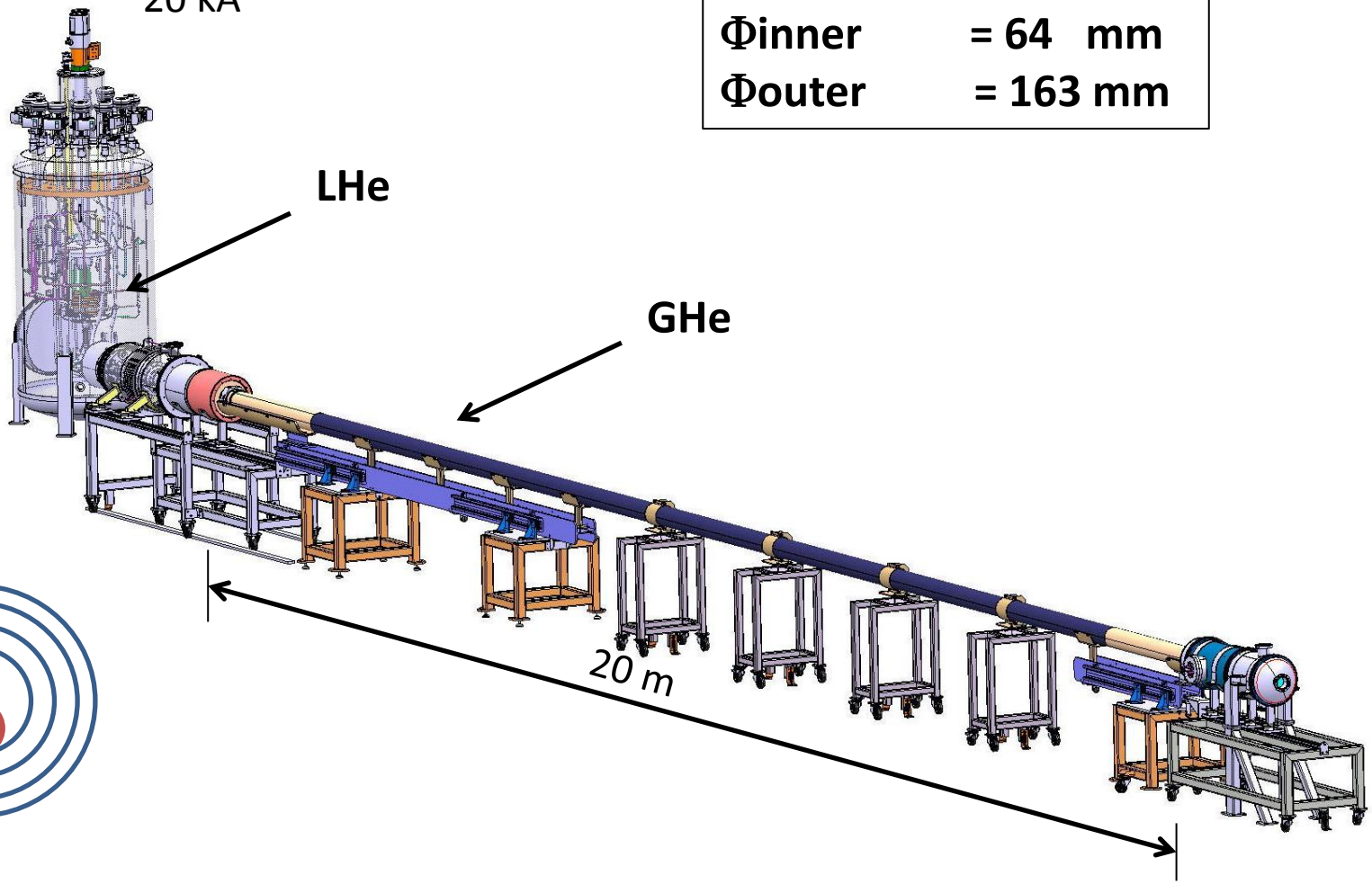
Refrigerator: 6 kW @ 4.5 K
(18 kW for test of LHC magnets)
25 000 LHe Dewar

CERN Novel Test Station



High Luminosity LHC

CERN Novel Test Station

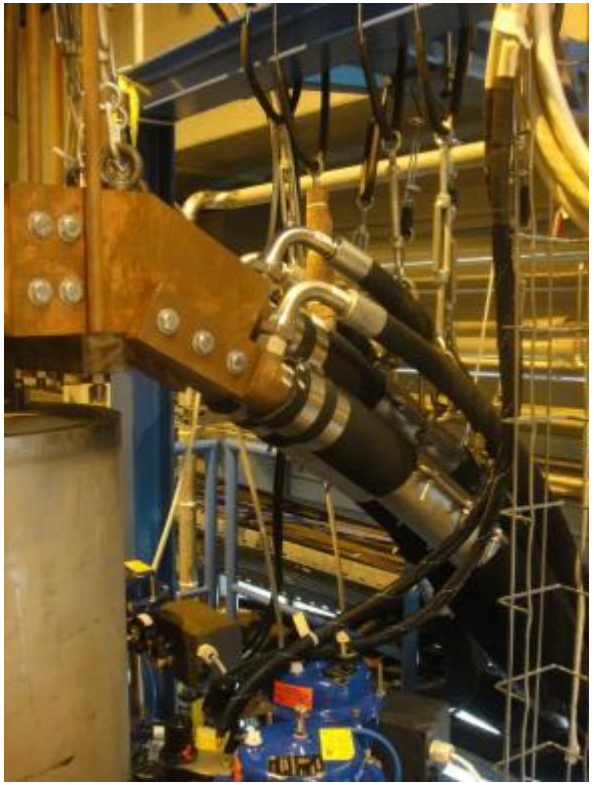


L	**= 20 m**
Φinner	**= 64 mm**
Φouter	**= 163 mm**

High Luminosity LHC

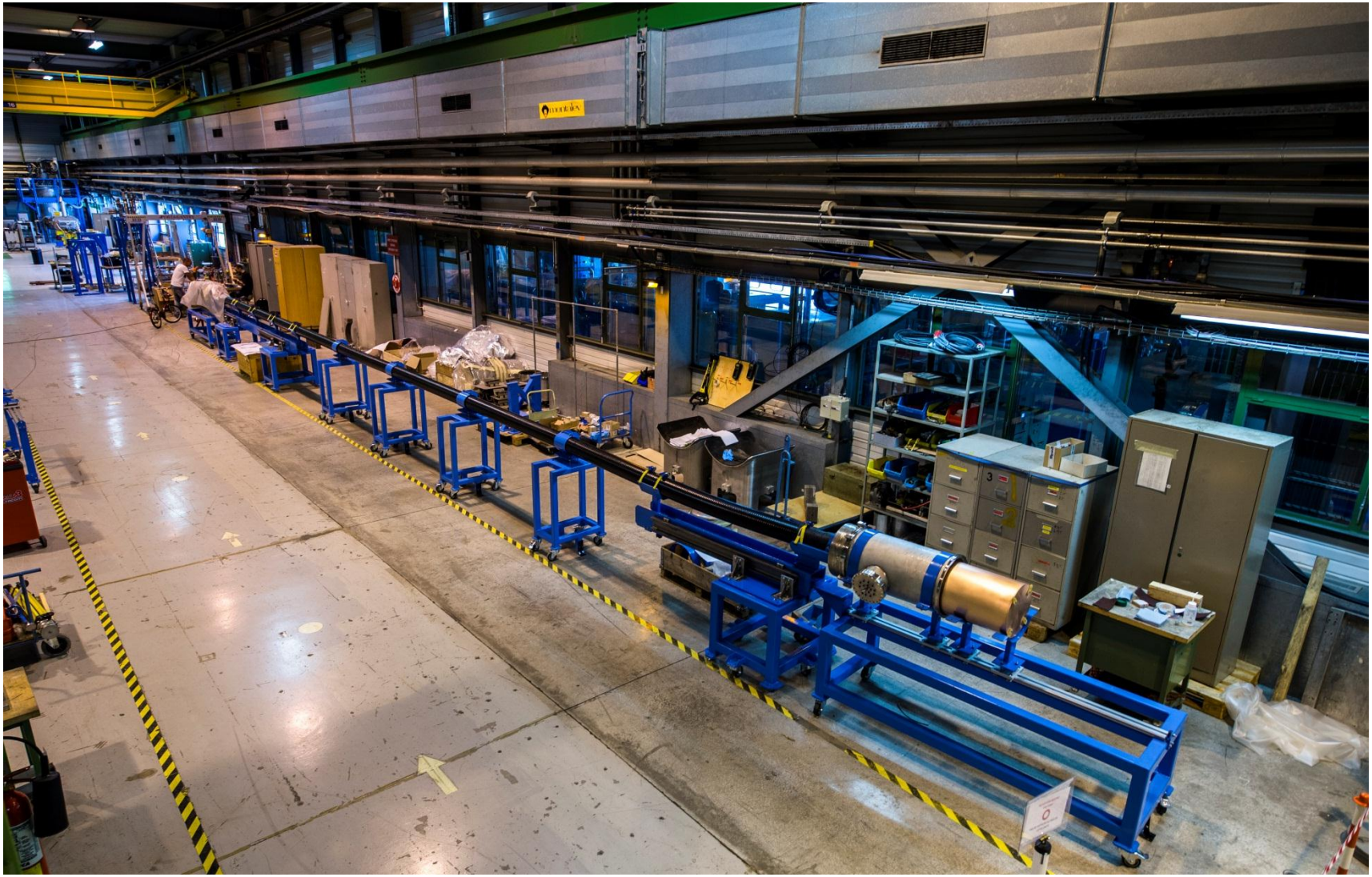
Nexans cryostat


H ~ 4 m




VELAN
VELAN

CERN Novel Test Station

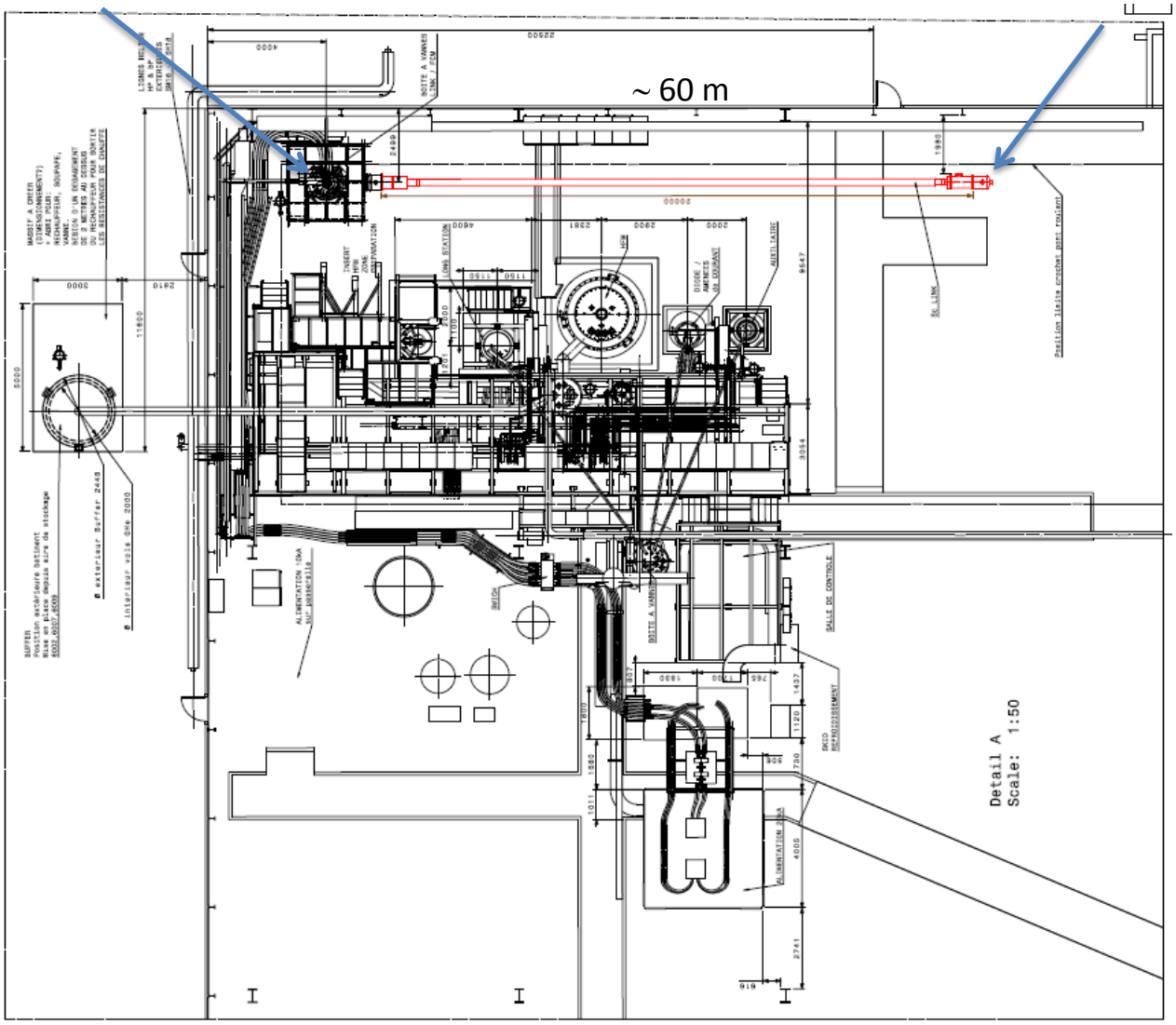


Completely assembled, ready for cool-down

Upgrade of test station

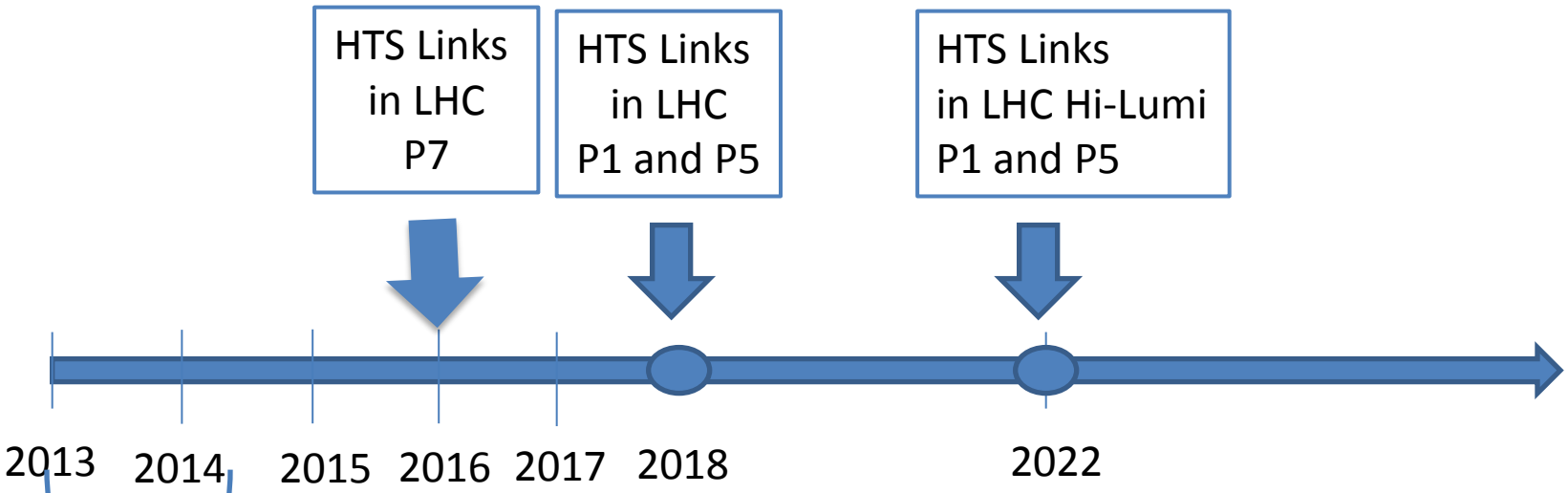
He supply from present test station

LHC-type cryostat with leads
GHe cooling as in final system
Use of several power converters



SM-18

Timeline



2011 - 2012: Qualification of MgB_2 conductor 1 kA range cables

2013-mid 2014: Test of 20 m horizontal lines

2014-mid 2015: Test of 60 m horizontal lines

2016 - 2017: Test of vertical lines (LHC shaft)

Conductor for prototypes

Series P7

Series P1 and P5

High Luminosity LHC

Deliverable and Milestones (2013)

- D6.1 Preliminary report on cooling options for the cold powering system (Task 6.2) **M18**
- D6.2 Preliminary report on results of thermo-electrical studies (Task 6.3) **M24**

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