Test stand @ CERN

Marta Bajko CERN

1st International Workshop on Superconducting Magnet Test Facilities @ CERN 13th-14th of June 2016
https://indico.cern.ch/event/507584/

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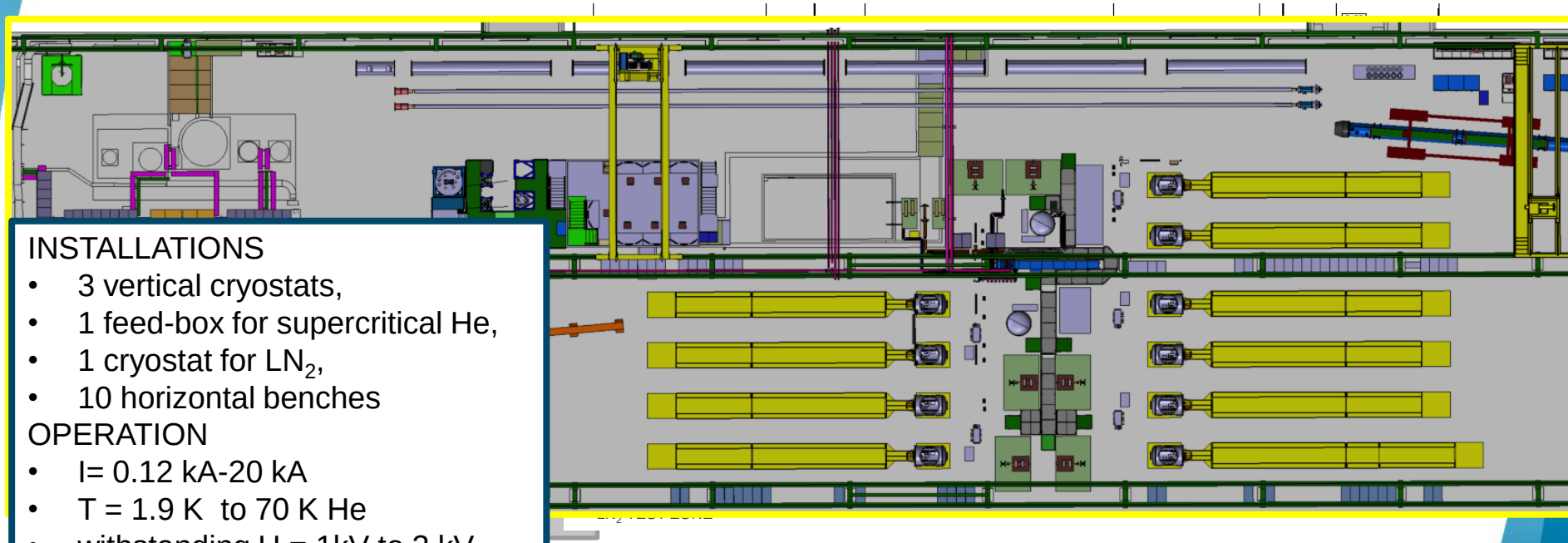
Content

- Magnet test stand layout @ CERN
- Vertical cryostats : on-going upgrades
  - HFM
  - Cluster D
- Horizontal test benches: on-going upgrades
  - Cluster A
  - Cluster E
- Associated facilities upgrades
- Summary and conclusions

Magnet test stands layout @ CERN

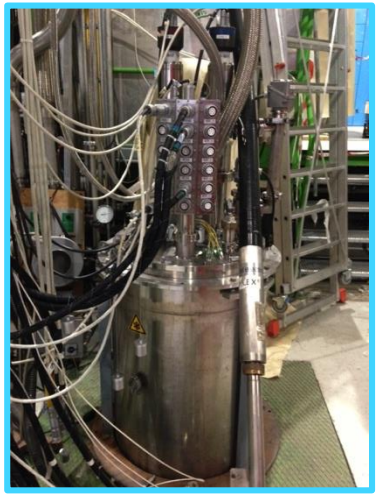
THE SUPERCONDUCTING MAGNET TEST STAND AT CERN in SM18



INSTALLATIONS
- 3 vertical cryostats,
- 1 feed-box for supercritical He,
- 1 cryostat for LN_2,
- 10 horizontal benches

OPERATION
- I= 0.12 kA-20 kA
- T = 1.9 K to 70 K He
- withstanding U = 1kV to 3 kV

Magnet test stands layout @ CERN



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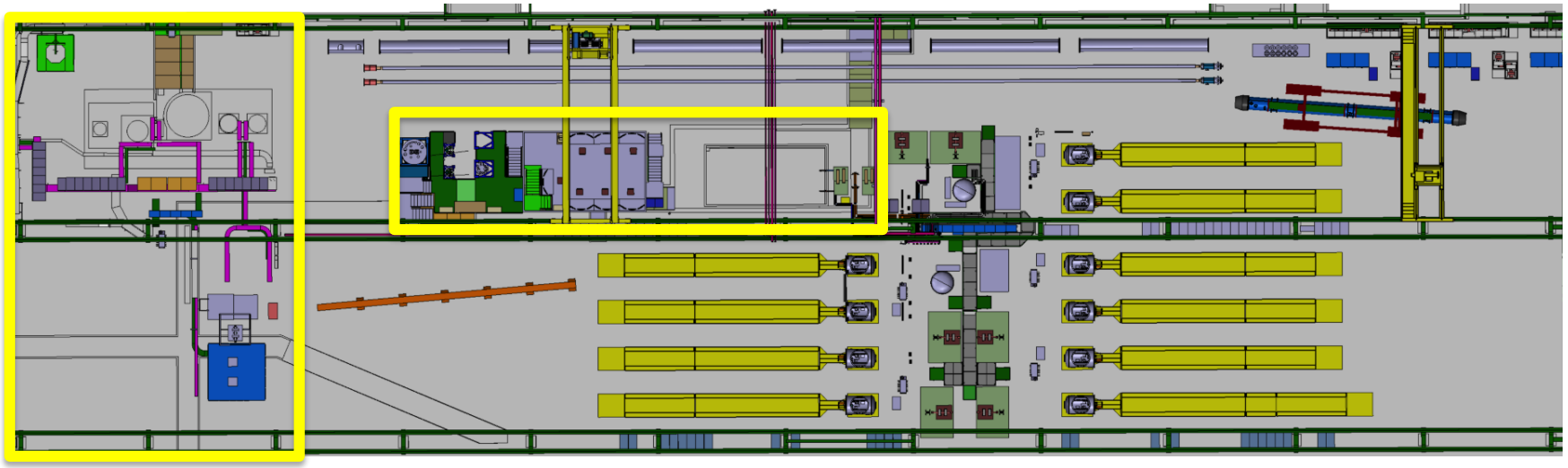
Vertical test stand upgrade

Cluster G

Cluster D



The vertical cryostats zone, called Cluster G is about 400 m^2 . It is under upgrade with an extra space called Cluster D of 150 m^2 . It will accommodate the test of **larger diameter** magnets @ **higher operating current** for HL LHC.

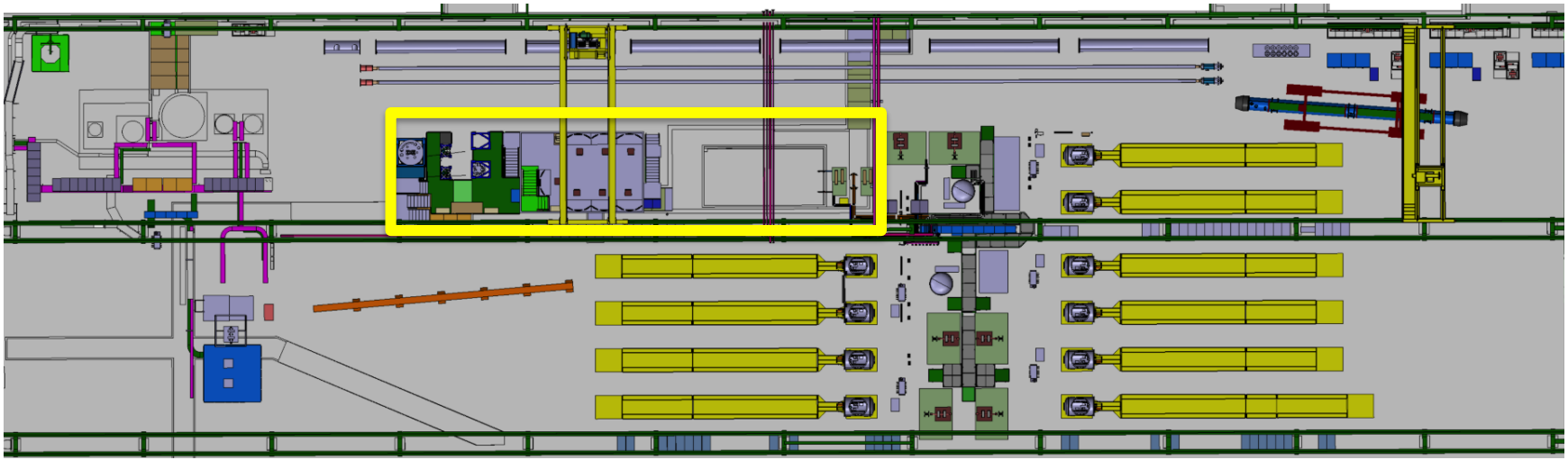
Cluster G upgrade

PRE-COOLING WITH

Ref. HFM cryostat is financed by EUCARD and the WP19 task of HL-LHC

Vertical test stand upgrade

Cluster D



Cluster D test stand

CRYOSTAT : 4.8 m LONG AND Φ 800 mm @ 1. 9 K

POWER CONVERTERS 30 kA AT GROUND LEVEL

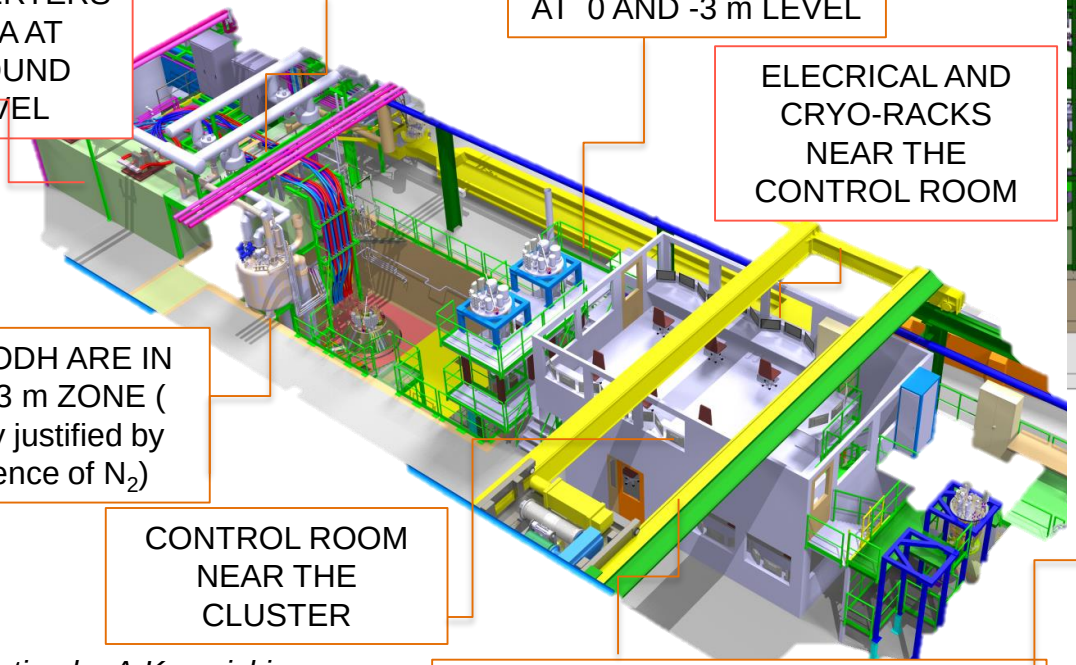
EE and DUMP AT THE 2 m LEVEL

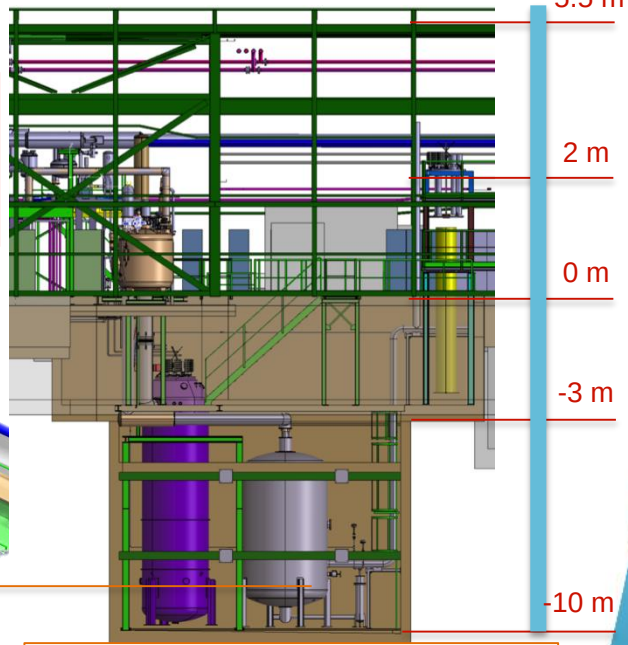
PREPARATION ZONE AT 0 AND -3 m LEVEL

ELECRICAL AND CRYO-RACKS NEAR THE CONTROL ROOM

TWO ODH ARE IN THE -3 m ZONE (mostly justified by presence of N_2)

CONTROL ROOM NEAR THE CLUSTER





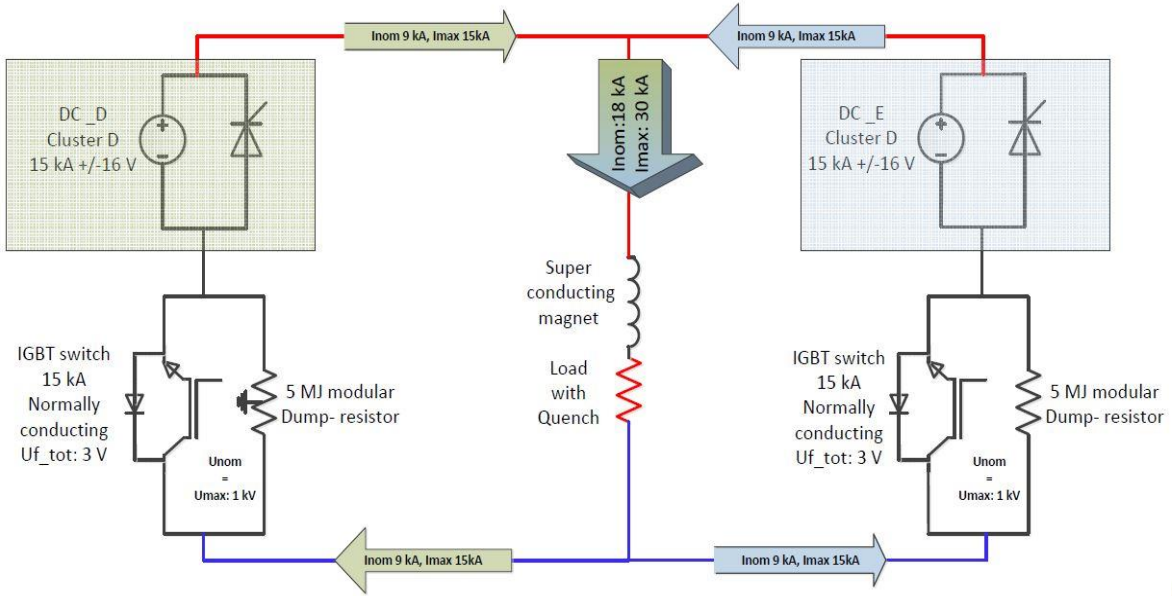
Integration by A.Kosmicki

NEW OVERHEAD CRANE ALLOWS HADLING 25 t AND UP TO -3 m LEVEL

COLD He RECOVERY BUFFER - 10 m^3 at 5 bar, UNDER THE WORKING AREA IN CONFINED SPACE

CLUSTER D: electrical circuit

EL CIRCUIT PARAMETERS	
Max stored energy	10 MJ
Short Sample current	21.5 kA
Magnet inductance	8.27 mH/m
Nominal Ramp Rate	11 – 20 A/s
Max Ramp Rate	200 A/s
Max current	**30 kA**
Max EE voltage	1 kV
Reaction time :	**< 10 ms**

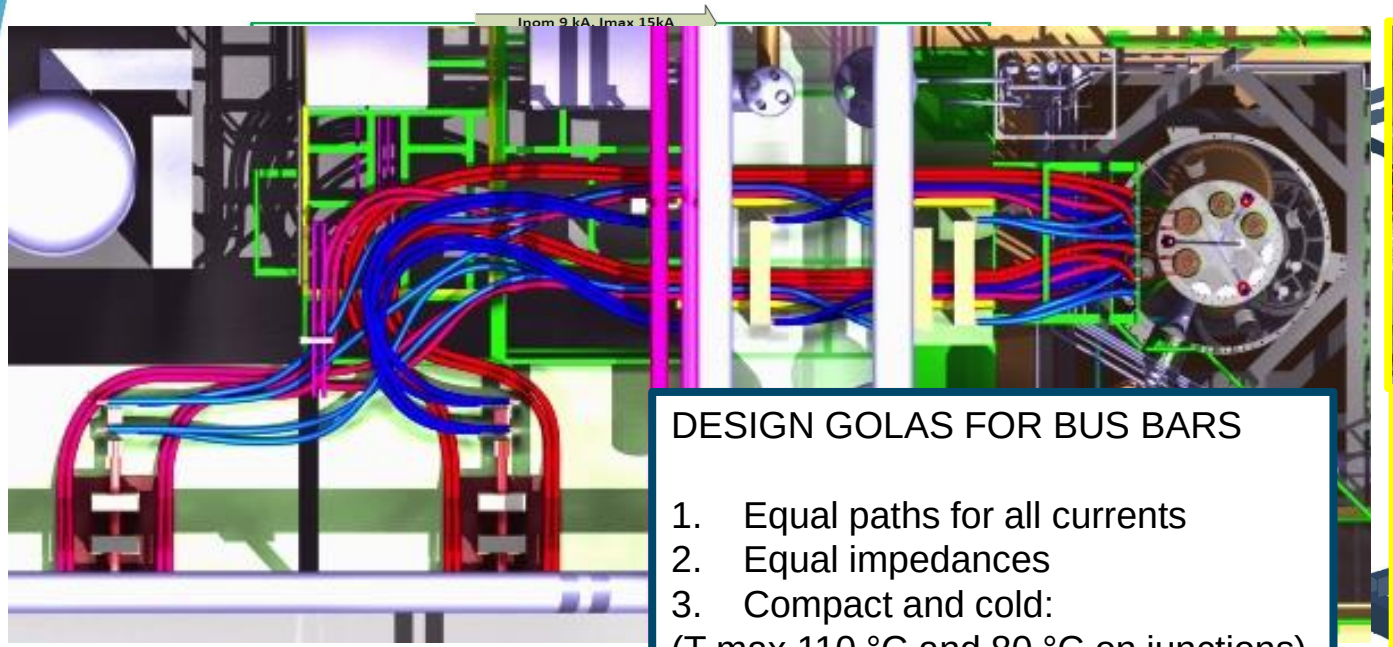


DESIGN DRIVEN BY: cost reduction and operation optimization implying the use of two existing 15 kA power converters for the new circuit

Ref. H. Thiessen, C. Giloux, G.J. Coehling, P. Viret

Cluster D : energy extraction

DESIGN DRIVEN BY : Reaction time **< 10 ms**, which implied the use of **IGBTs**



DESIGN GOLAS FOR BUS BARS

1. Equal paths for all currents
2. Equal impedances
3. Compact and cold:

(T max 110 °C and 80 °C on junctions)

Ref. G.J. Coehling, A. Dinus, K. Petersen

Cluster G and D: cryostat and insert

DESIGN DRIVEN by optimization in operation
- Minimizing time and risk at hydraulic conne
- Minimizing the loss of He after quench

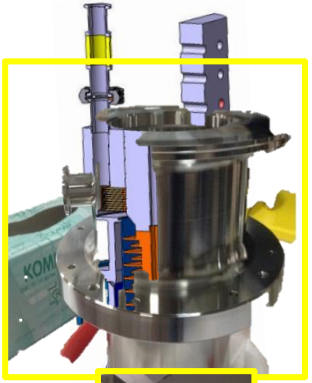
CRYOSTAT PARAMETERS
(Cluster G/D)

Max internal pressure :	5 bara
Magnet temperature :	1.9 K
Useful diameter :	1500 / 800 mm
Useful length in 1.9 K bath :	2.5 / 5.2 m
Max. thermal gradient :	50 K
Magnetic measurements:	yes
Estimated lifetime :	20 years
Number of thermal cycles :	< 1000
Number of Quenches :	< 10000

Ref. Cryostat: A. Van De Craen, M. Struik
Cryogenics: V. Beda, A. J. Lee
Insert: M. Strychalski, P. Viret

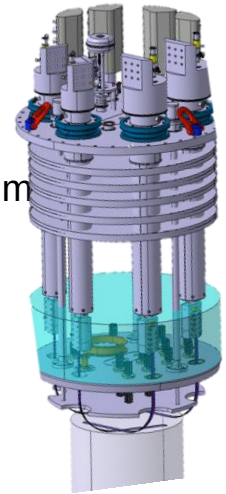
Cluster G and D : WCC and Current Leads

DESIGN DRIVEN BY Optimization in operation :
- Flexible cables
- Current lead operation homogenized with the rest of the test stand and minimizing the flow



CONVENTIONAL GAS COOLED Cu LEADS:
length: 1.7 - 2.1 m
top flange Φ 260 - 280 mm
connection : SC cable

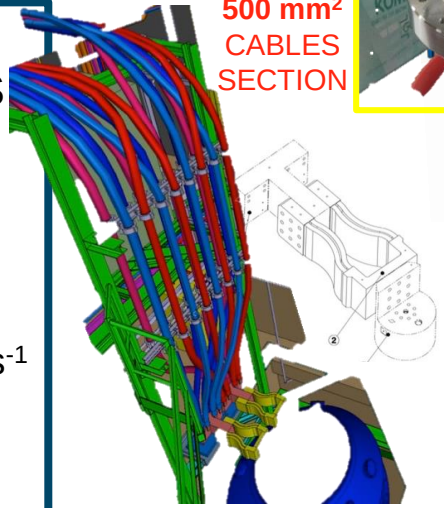
He vapor flow @ 4.2 K:
- 20 kA lead: 0.87 g/s
- 30 kA lead: 1.82 g/s
- 15 kA lead: 0.88 g/s



Water Cooled Cables SPECIFIED PARAMETERS

Current:	5 kA DC
Max in. temperature:	28 °C.
Pressure in operation:	16 bar.
Maximum delta T:	10 °C.
Water speed :	< 2.5 ms^{-1}
Max. temperature :	50 °C.
Operating Voltage: (if fault to ground)	1 kV

500 mm^2 CABLES SECTION



Current Leads SPECIFIED PARAMETERS

Main circuit:	20 kA / 30 kA
Secondary circuit:	15 kA
Design pressure :	5 bara
Max. Voltage to GRD:	3.5 kV

Ref. *WCC: C. Gonzalves Perez*
Current Leads: S. Gianelli, P. Moyret

Cluster DAQ system

High Luminosity LHC

LHC Project D
CERN Div./Group or Supplier
TE/MS
EDMS Docu
1518

NI PXIe-6358

Simultaneous X Series Data Acquisition

Example of HF system

Zoom/Alternate Images

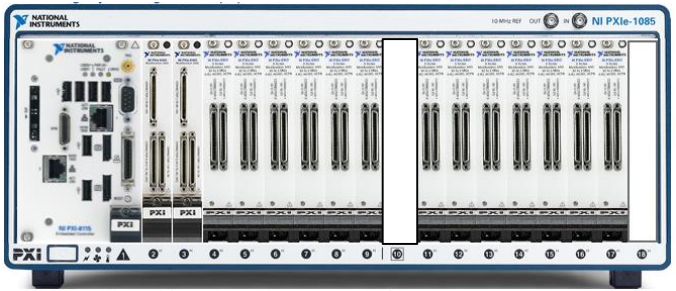
Starting at ~~$ 6,086~~ $ 5,355.68 (view pricing options)

View Data Sheet

- 16 simultaneous analog inputs at 1.25 MS/s/ch with 16-bit resolution; 20 MS/s total AI throughput
- Four analog outputs, 3.33 MS/s, 16-bit resolution, ±10 V
- 48 digital I/O lines (32 hardware-timed up to 10 MHz)
- Four 32-bit counter/timers for PWM, encoder, frequency, event counting, and more
- Analog and digital triggering and advanced timing with NI-STC3 technology
- Support for Windows 7/Vista/XP/2000

DAQ
SPECIFIED PARAMETERS

Input channels:	+/- 10 V ar
Nr of HF channels:	200 differential
HF frequency:	200 kHz
HF,MF,LF resolution:	16 bit resolution
HF,MF,LF accuracy:	1 mV
MF frequency:	50 kHz
Nr of LF channels:	144
LF frequency:	1 kHz
Timing:	GMT synchronization



Data Analysis with DIADEM

Ref. DAQ: H. Reymond, M. Charrondiere, M. I. Tapani
Analysis: H. Bajas, F. Gomez de la Cruz

HiLumi HL-LHC PROJECT

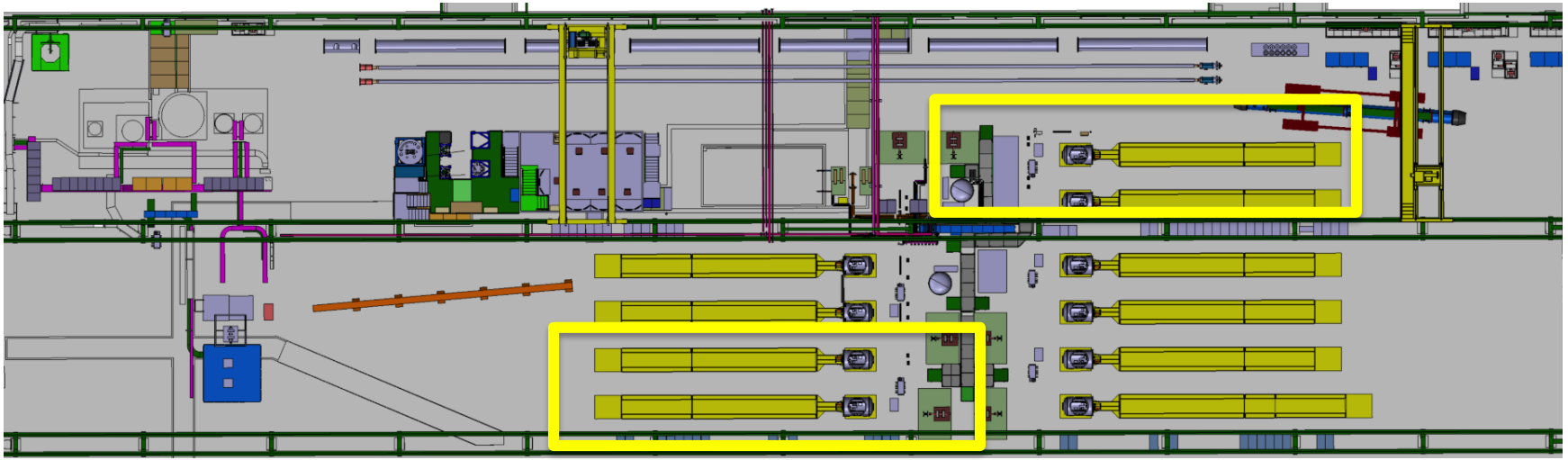
EuCARD²

Cluster D in pictures

Ref.
Construction:
H. Botella, R. Morton, E. Perez Duenas,
Safety: E. Paulat

Horizontal test bench upgrade

Cluster A

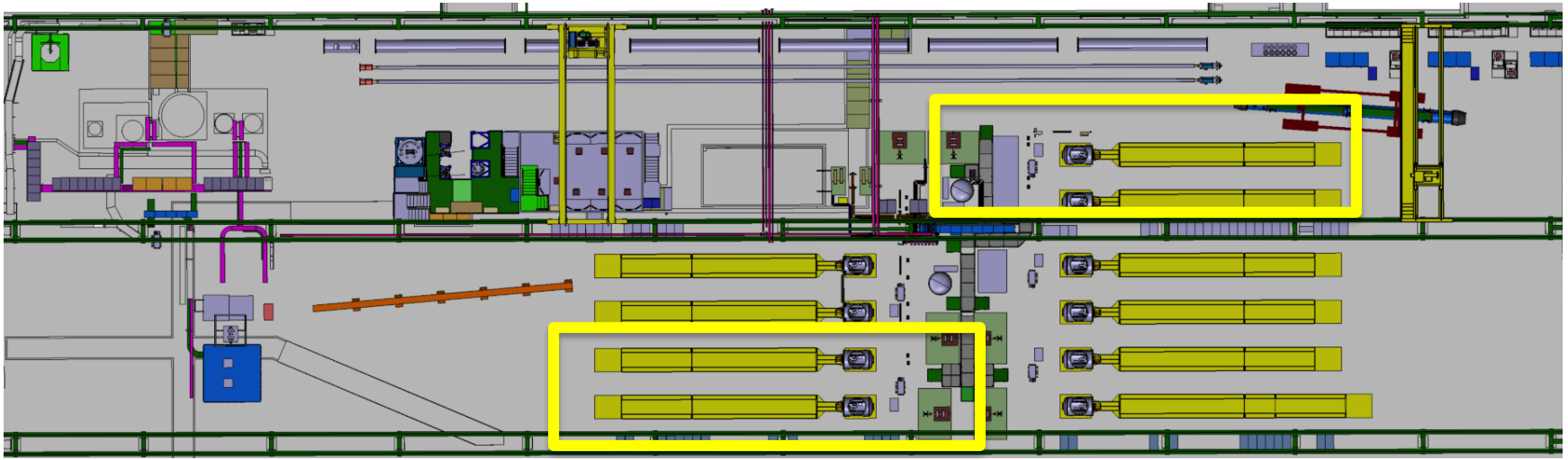


Cluster E

The horizontal test zone Cluster A to F excluding D is composed by 10 benches. They are equipped with 5 independent electrical circuits allowing to test magnets up to 15 kA @ 1.9 K. Two clusters are planned to be upgraded to 20 kA capacity.

Horizontal test bench upgrade

Cluster A



Cluster E

The UPGRADE is DRIVEN by HL-LHC needs:

Target for prototype test: 90% I_{SS} ≤ 20 kA
Target for series test : 108% I_{nom} = 17.8 kA

Cluster E will have the same characteristics. Foreseen later.

Magnet weight: 25 tonnes
Operating temperature: 4.2 K and 1. 9 K
Max. Operating current: **20 kA, 2 x 2 kA**
Max. Pressure in the magnet in case of quench: 20 bars
Max. Test voltage: 3 kV

Facilities Upgrade

UPGRADE DRIVEN BY The recommendation enabling to carry out the full test programme with no contraints

CRYOGENIC COOLING PRODUCTION: **+ 35 g/s LHe**

Needs essentially for HL-LHC IT STRING run in parallel with magnet testing

DEMINERALISED WATER PRODUCTION: **+ 150 m^3/h**

Needs for demineralised water entirely coming from magnet operation

HANDLING: **25 t and longer rope**

Needs for overhead crane entirely coming from magnet operation

nCONTROL ROOM

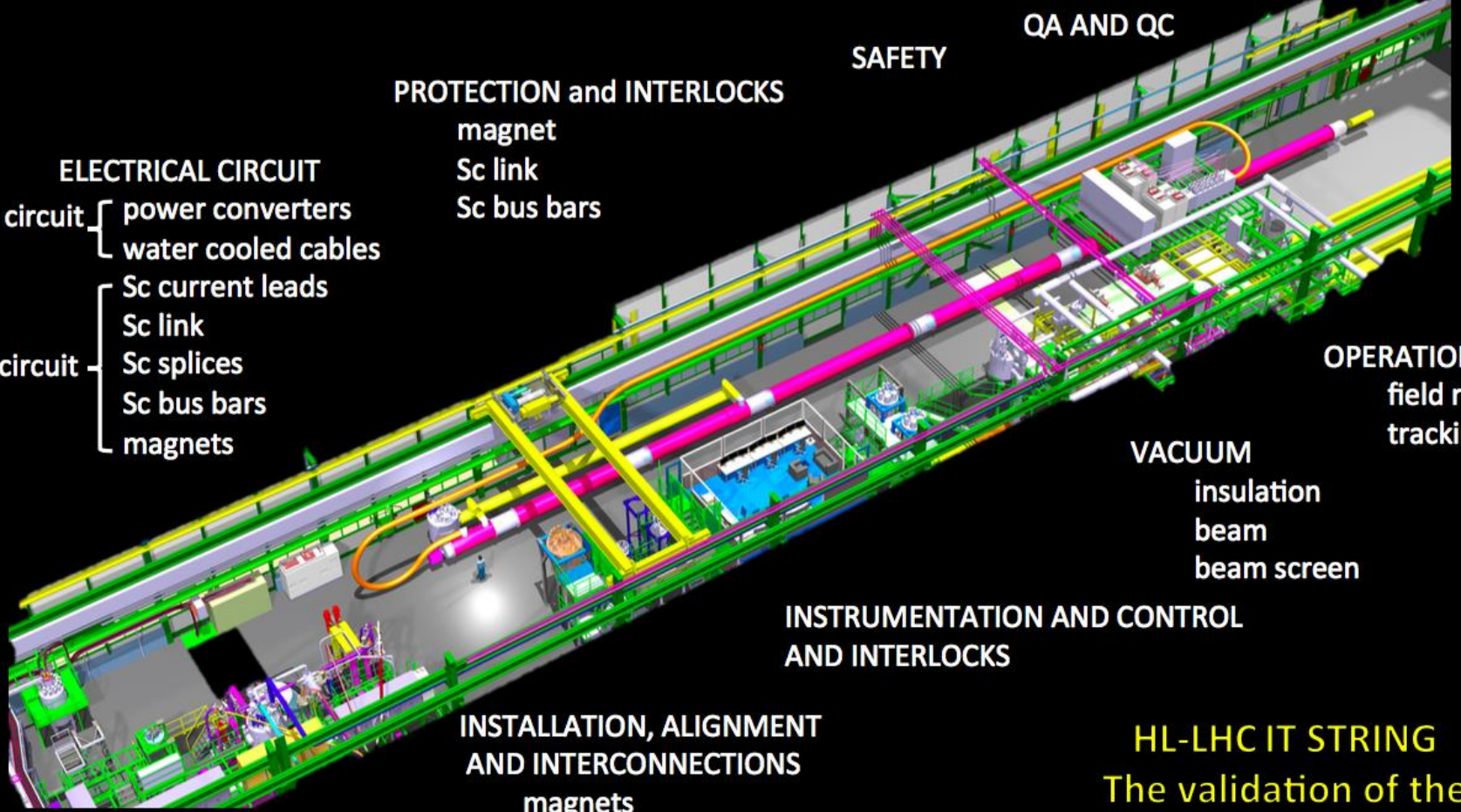
Needs to extend the small control room of the vertical . Test facility to be used also for horizontal benches and Sc link

For 2019

Operational

Operational

For mid 2016



HL-LHC IT STRING

The validation of the

collective behavior

of the system components

SM18 2020-2022

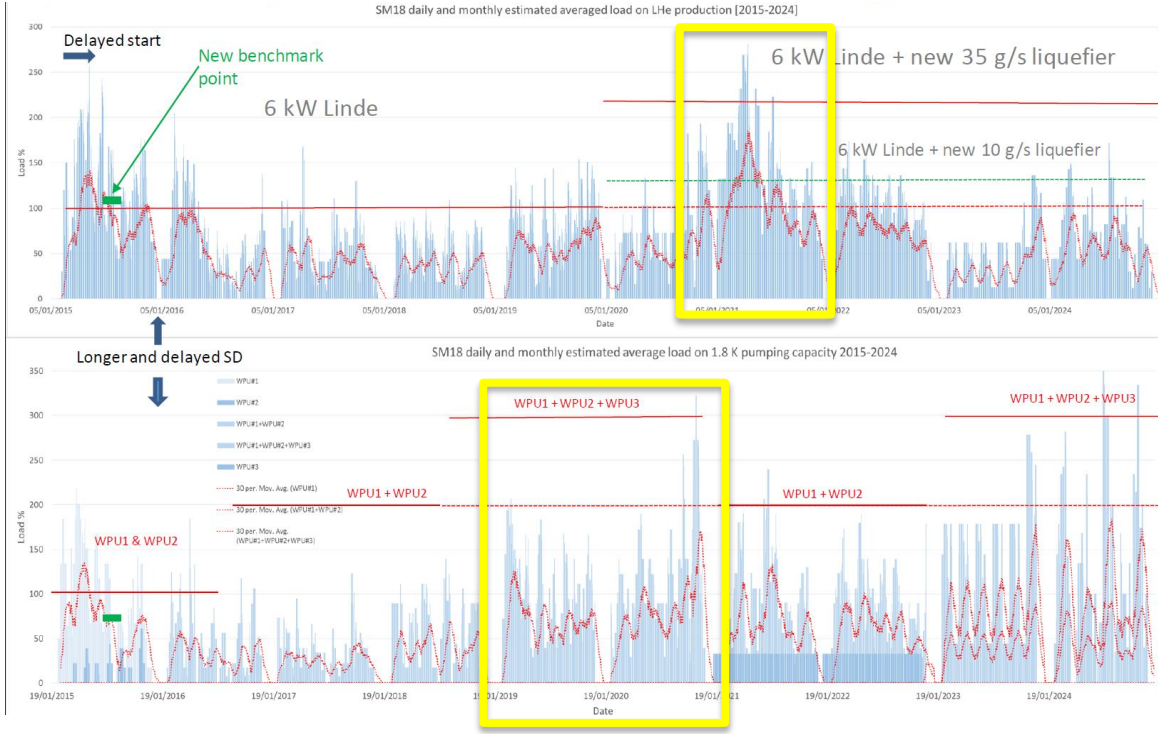
HiLumi HL-LHC PROJECT

Thank you for your attention

EuCARD²

Spare slides on Facilities upgarde

Test stands : cryogenics upgrade



An additional **35 g/s liquefier** (thus bringing the **total production capacity for LHe at 4.2 K to 60 g/s)**

The existing total pumping capacity in SM18 at **1.8 K is 12 g/s**, **combining** the capacity of **WPU1 and 2**.
If need for IR STRING a dedicated 3rd WPU shall be installed.

Ref. L. Serio

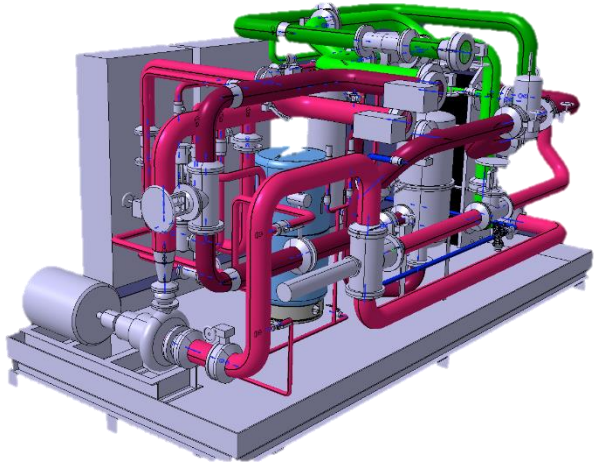
Foreseen for 2019

Test stands : demineralized water production

The demands for the magnet test stations, including the IT String, will rise to a peak of 1.7 MW (142 m^3/h).

Ref. A. J. Broche

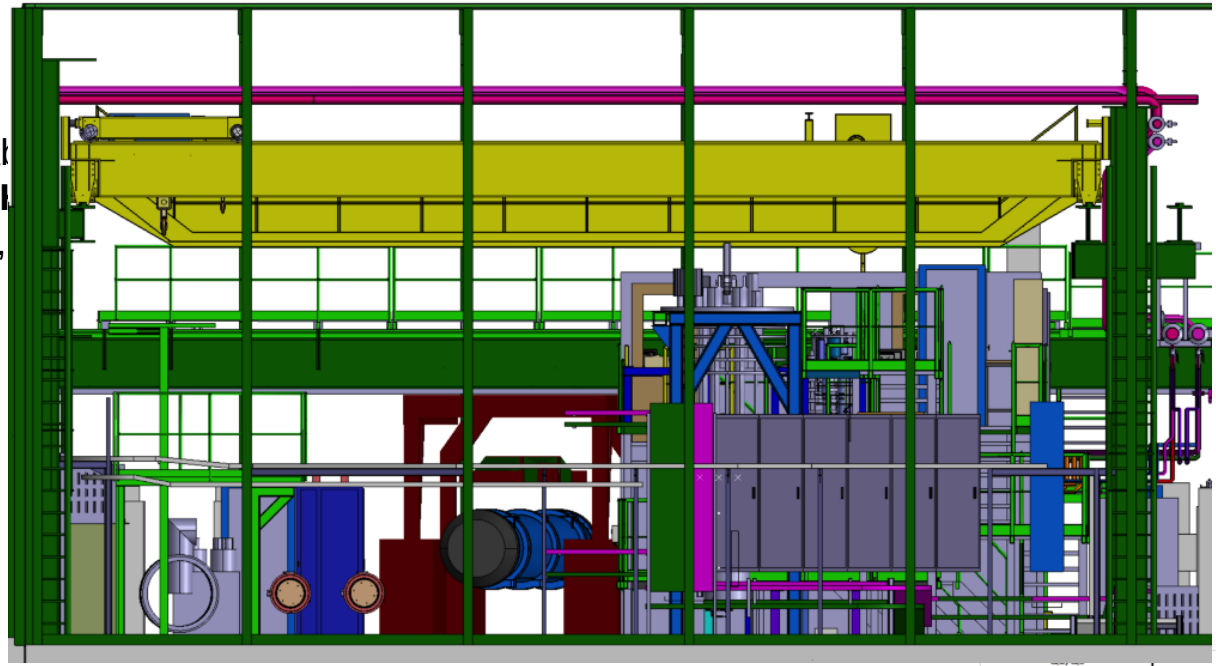
At present SW18 houses a demineralised water station with a thermal capacity of 800 kW limiting the operation to two test stands



Operational from April 2016

Test stand : HADLING upgarde

To enab… r than
into the L… nserts
height, … he top



CHARACHTERISTICS

Max. 10 m long 27 t in angle?
2 times installation and 2 times dismounting the STRING

Max. 25 t 5 m long + turn from horizontal to vertical with dedicated tool

10-15 m long with specified handling points to be studied and adapted in addition to the LHC magnets. Weigth aprix. 26-27 t.

Ref. R. Rinaldesi

Estimate of the heaviest HL LHC magnets weight:

			Q2		
cold mass	cryostat	cold mass	MCBXFA	cryostat	
8.6 m	9 m	7 m	1.2 m	9 m	
22500 kg	3780 kg	18313.95 kg	3139.535 kg	3780 kg	
Total:	26280 kg		Total	25233.49 kg	

25 T HANDELING CAPACITY WAS KEPT

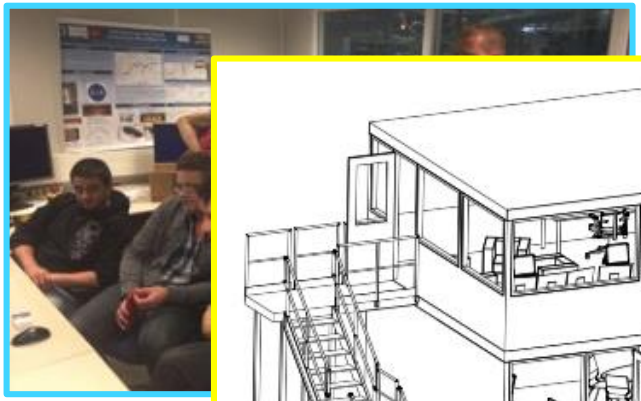
Operational from February 2016

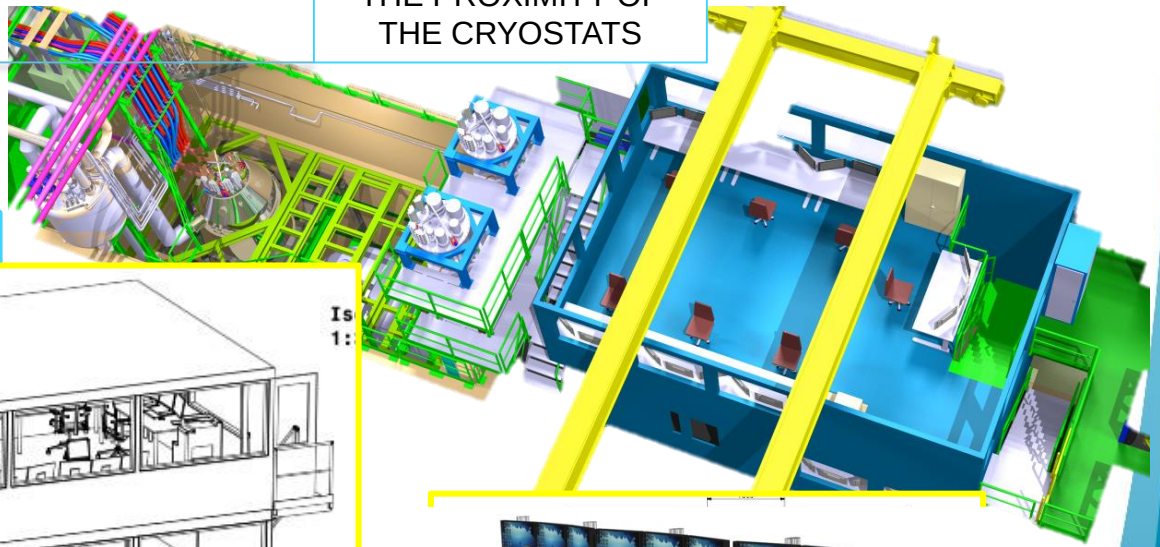
New Control room

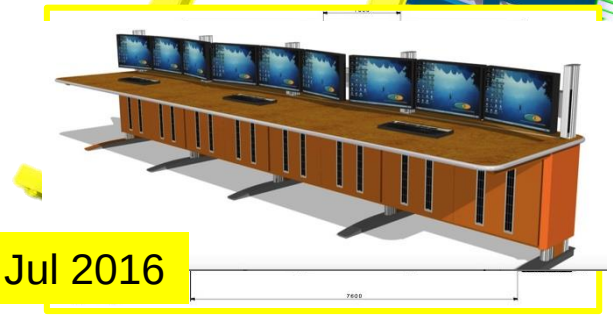
The motivation to build a new control room is driven by:
Safety and
Working conditions

CONTROL ROOM WITH LARGER SPACE

CONTROL ROOM AT THE PROXIMITY OF THE CRYOSTATS







Ref. M. Charrondier

Foreesen for Jul 2016