SM18 the CERN MAGNET TEST FACILITY

M. Bajko CERN

2nd International Workshop on Superconducting Magnet Test facilities. May 2018

CONTENT

Status of the infrastructure and test stands for magnets and accelerator subcomponenets at SM18;
Capacity in terms of test accommodation for Magnets, Cavities, Cold Powering equipment;

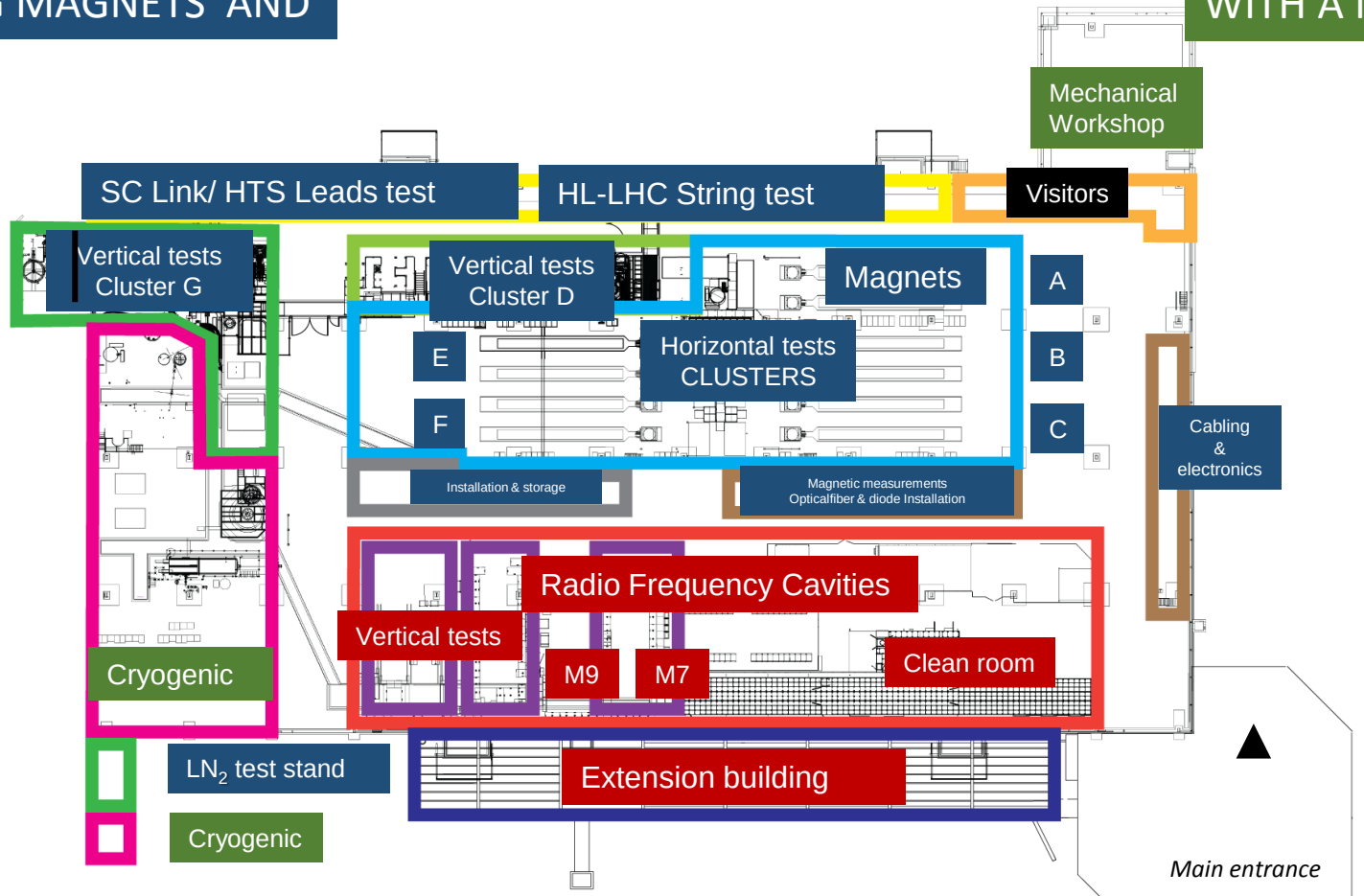
- Why do we need to build new test stands?
- Infrastructure upgrade for test facility
- Test stand readiness for HL-LHC
- Test Facilities Status
- What is next?
- Conclusions

SM18 TEST HALL

IS ALSO A TRANS-NATIONAL ACCESS ZONE WITHIN ARIES PROJECT

BY SUPERCONDUCTING MAGNETS AND

WITH A MECHNAICAL WORKSHOP

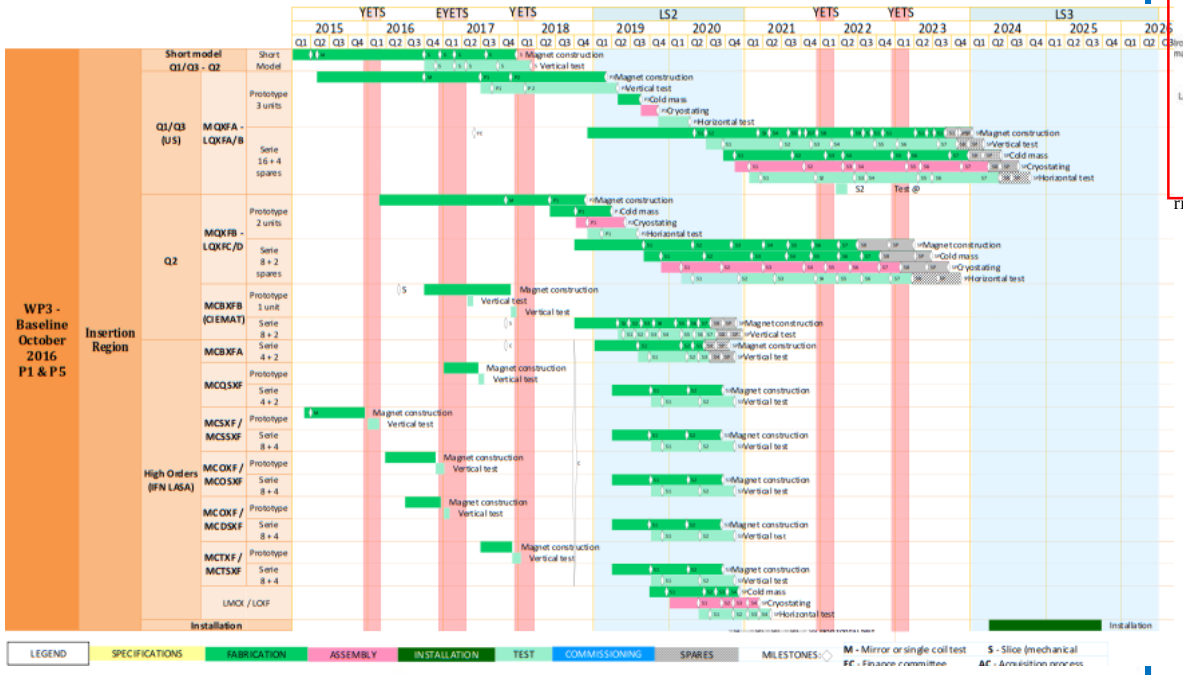


AND CRYOGENIC COOLING

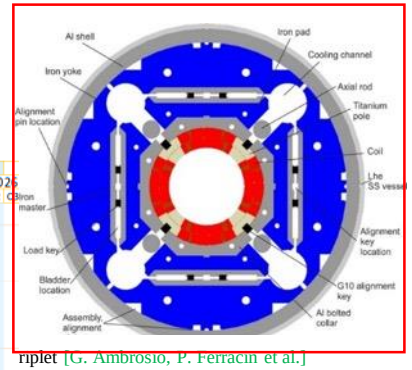
SUPERCONDUCTING RADIO FREQUENCY CAVITIES

UPGRADING FOR HL-LHC

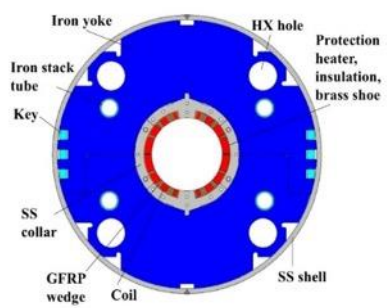
AND HFM PROGRAM



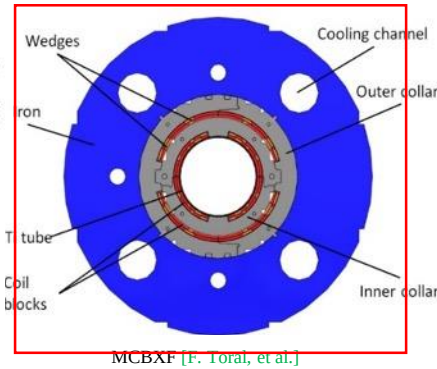
Aprox. 100 magnets to be tested for HL-LHC



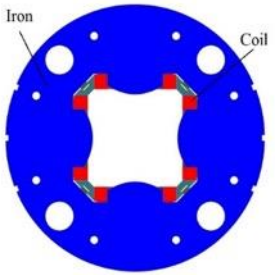
Triplet [G. Ambrosio, P. Ferracin et al.]



D1[T. Nakamoto, et al.]

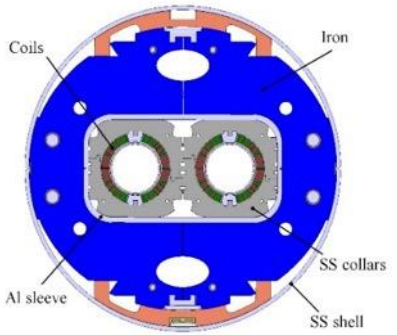


MCBXF [F. Toral, et al.]

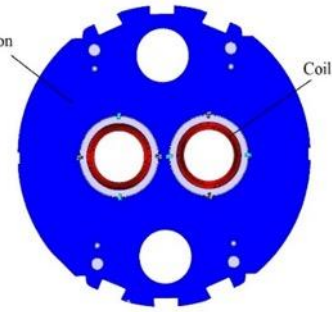


Skew quad

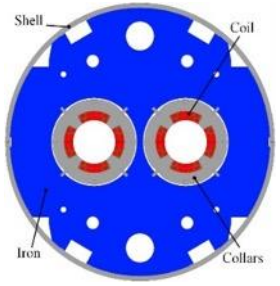
[M. Sorbi, M. Statera, et al.]



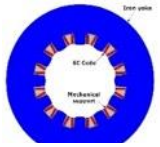
D2 [P. Fabbricatore, S. Farinon, et al.]



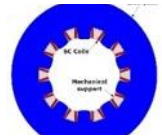
D2 correctors [G. Kirby]



MQYY [H. Felice, et al.]

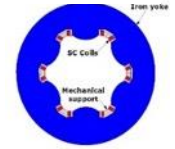


Dodecapole



Decapole

Octupole

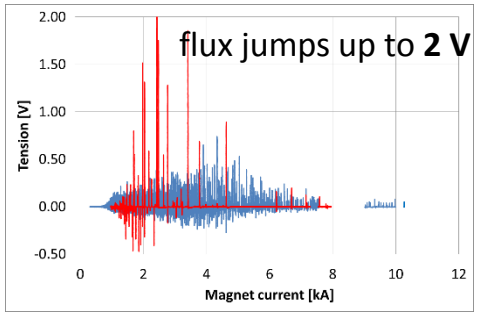


Sextupole

WHY DO WE NEED TO BUILD NEW STANDS?

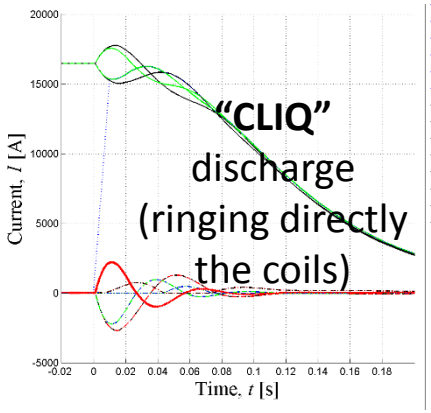
The testing of LHC components was done in SM18 for the series production. The test facility is **fully operational today but**:
The **HL-LHC** magnets will be **completely different from the present LHC magnets**, mainly due to the **new technology** they are based on.

The IT quadrupoles (Q1-Q3) will use **Nb_3Sn** instead of the **Nb-Ti** used by the present ones.



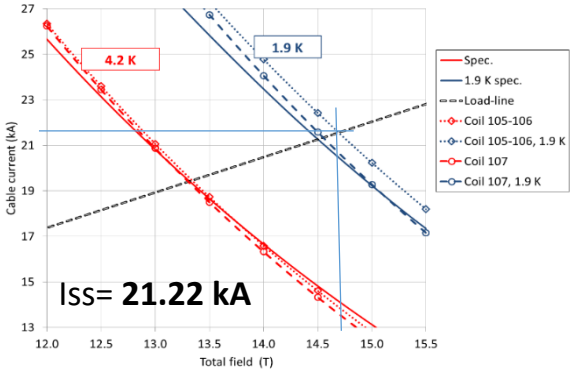
New Quench Detection system (variable threshold for triggering, larger bandwidth)

The **magnetic energy stored (1.2 MJ/m)** in the magnets in operational conditions is 2-4 x higher than LHC.



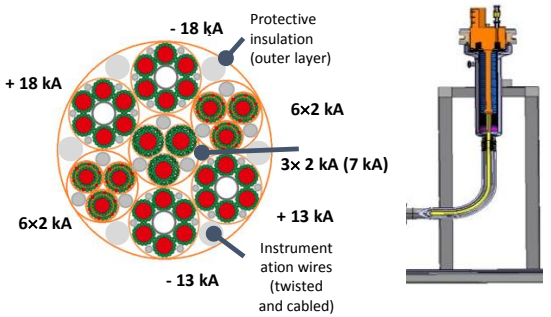
The protection will be done with different system from the present ones (ex. CLIQ and new QH)

The powering of the larger bore magnets will be with **higher current** than the present ones.



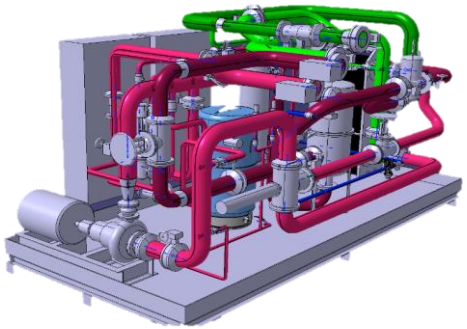
New powering circuits are needed for > 15 kA. Up to 22 kA for models and 20 kA for series magnets and larger diameter cryostats

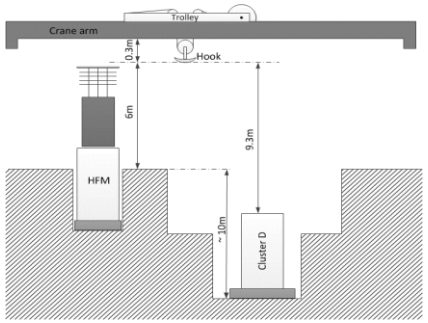
Powering will be made via a **superconducting link** and new generation superconducting **current leads with HTS material**



New powering circuits are needed for > 20 kA and cooling with supercritical He

SM18 INFRASTRUCTURE UPGRADE?





- ❑ DEMINERALISED WATER PRODUCTION: **+ 150 m³/h**

NEEDED FOR DEMINERALISED WATER ENTIRELY COMING FROM MAGNET OPERATION

- ❑ HANDLING: **25 T and longer rope**

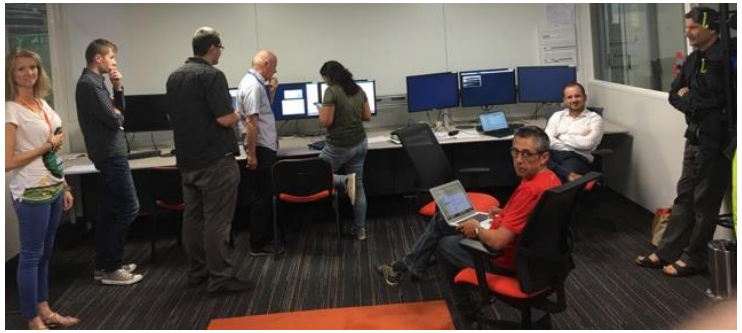
NEEDED FOR OVERHEAD CRANE CHANGE ENTIRELY COMING FROM MAGNET OPERATION

- ❑ nCONTROL ROOM

NEEDED TO EXTEND THE TOO SMALL CONTROL ROOM OF THE VERTICAL TEST FACILITY TO BE USED ALSO FOR HORIZONTAL BENCHES AND SC LINK

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

NEEDED ESSENTIALLY FOR THE RUNNING OF THE HL LHC IR STRING IN PARALLEL WITH MAGNET TESTING



- ❑ PRIMARY WATER COOLING CAPACITY: **+736 m³/h**

NEEDED FOR MAGNETS, CRYO AND RF

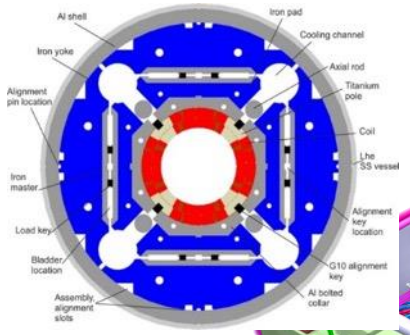
- ❑ CRYOGENIC PUMPING: **+6 g/s LHe**

NEEDED ESSENTIALLY FOR THE RUNNING OF THE HL LHC IR STRING IN PARALLEL WITH MAGNET TESTING

- ❑ POWERING FROM THE NETWORK: **3 MVA**

NEEDED FOR NEW OR MODIFIED PCs FOR MAGNETS AND IR STRING

CLUSTER D (OUR NEW TOY) IS FULLY OPERATIONAL



MQXF models

EE based on IGBT with reaction time < 1ms and adjustable dump resistor

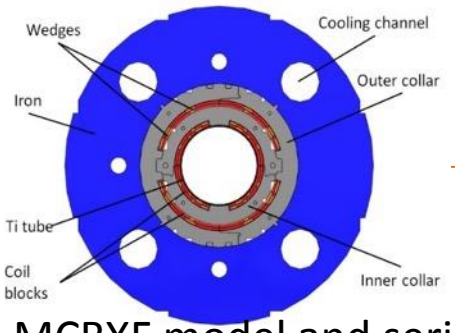
200 channels for differential mode with 200 kHz frequency DAQ

2 x 15 kA power converters in parallel circuit to deliver 30 kA

Variable threshold QDS

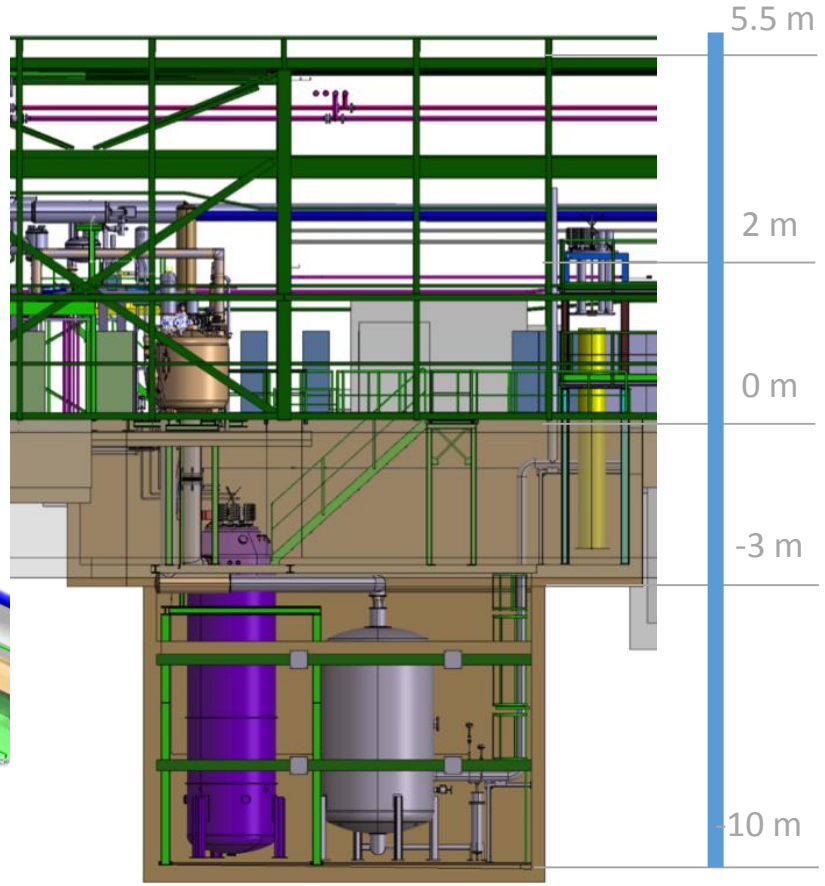
Cryostat for 800 mm dimeter allowing to test a magnets up to 5 m length at 1.9 K

Conventional current leads for 30 kA, 3.5 kV



MCBXF model and series

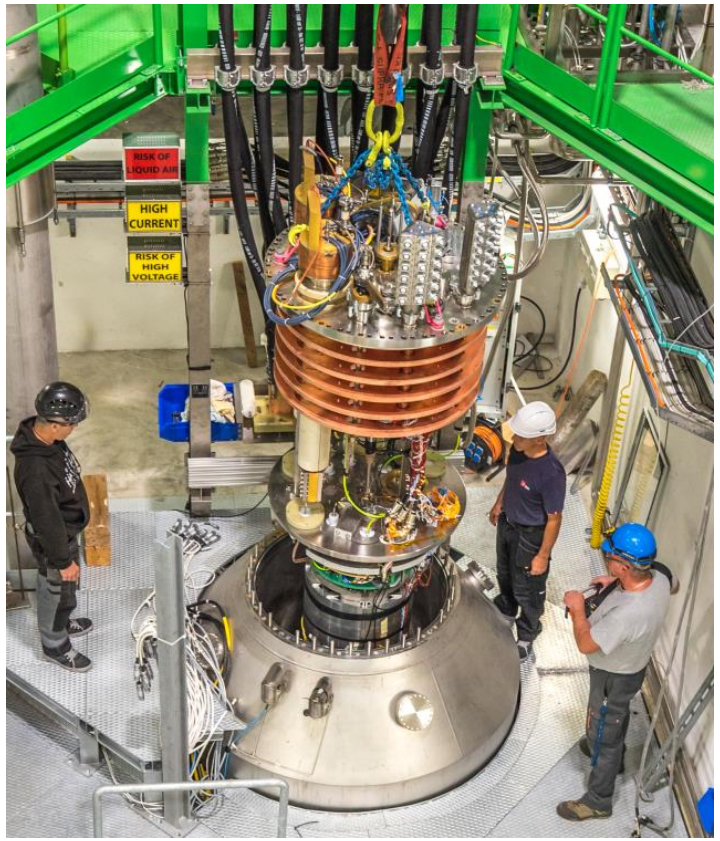
New overhead crane allows handling 25 t and at -3 m level

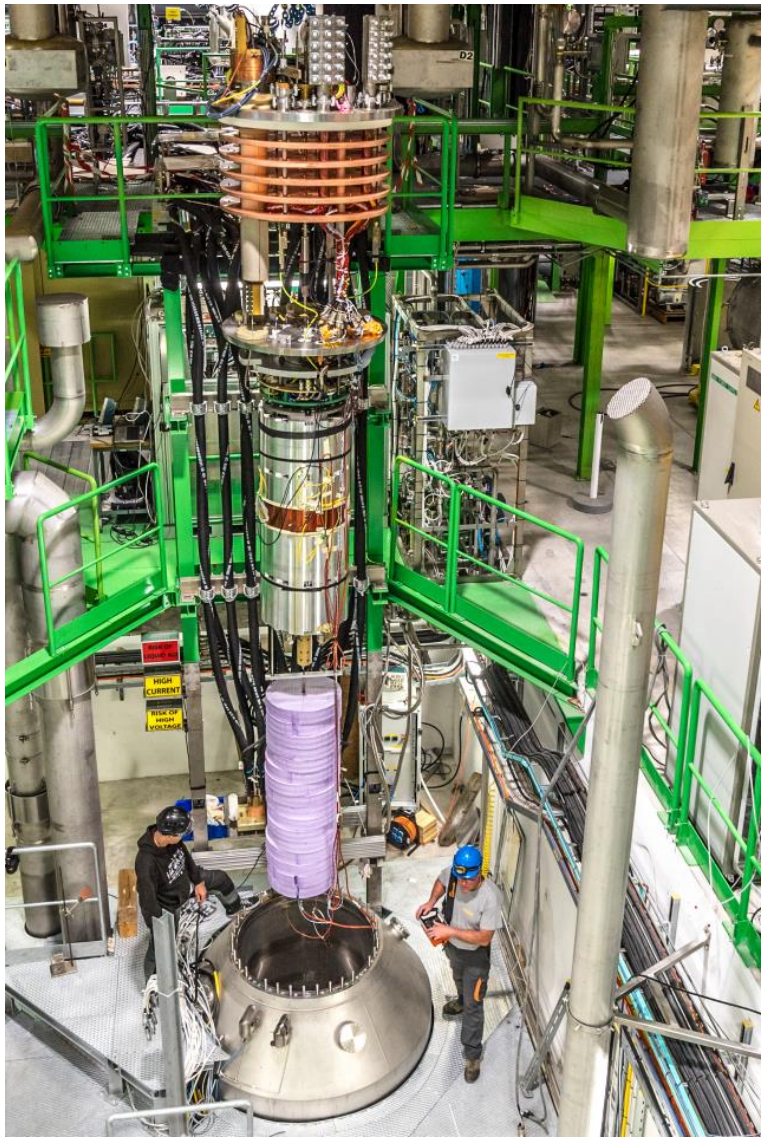


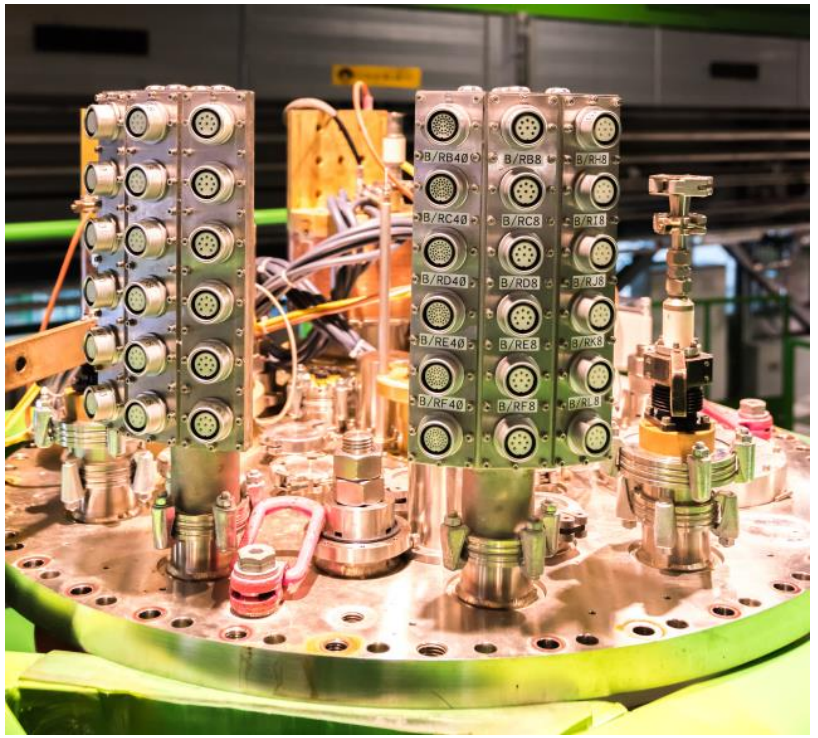
Cold He recovery buffer - 8 m^3 at 5 bar, under the working area in confined space

CLUSTER D PICTURES

The test stand is fully operational for the MQXF quadrupole models

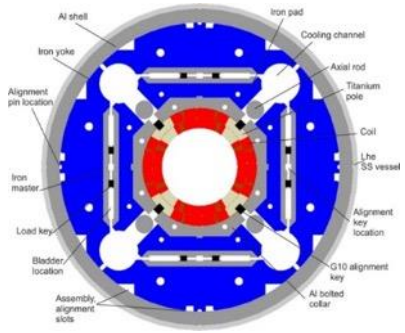




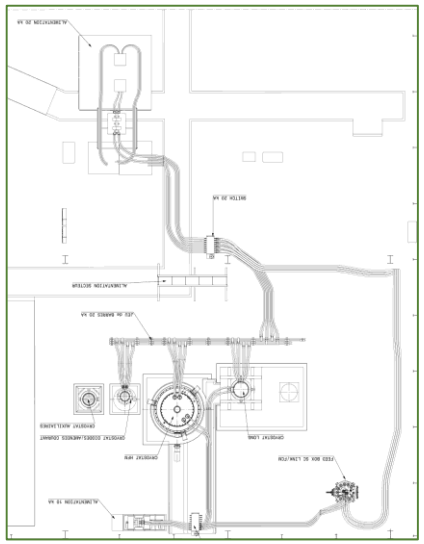


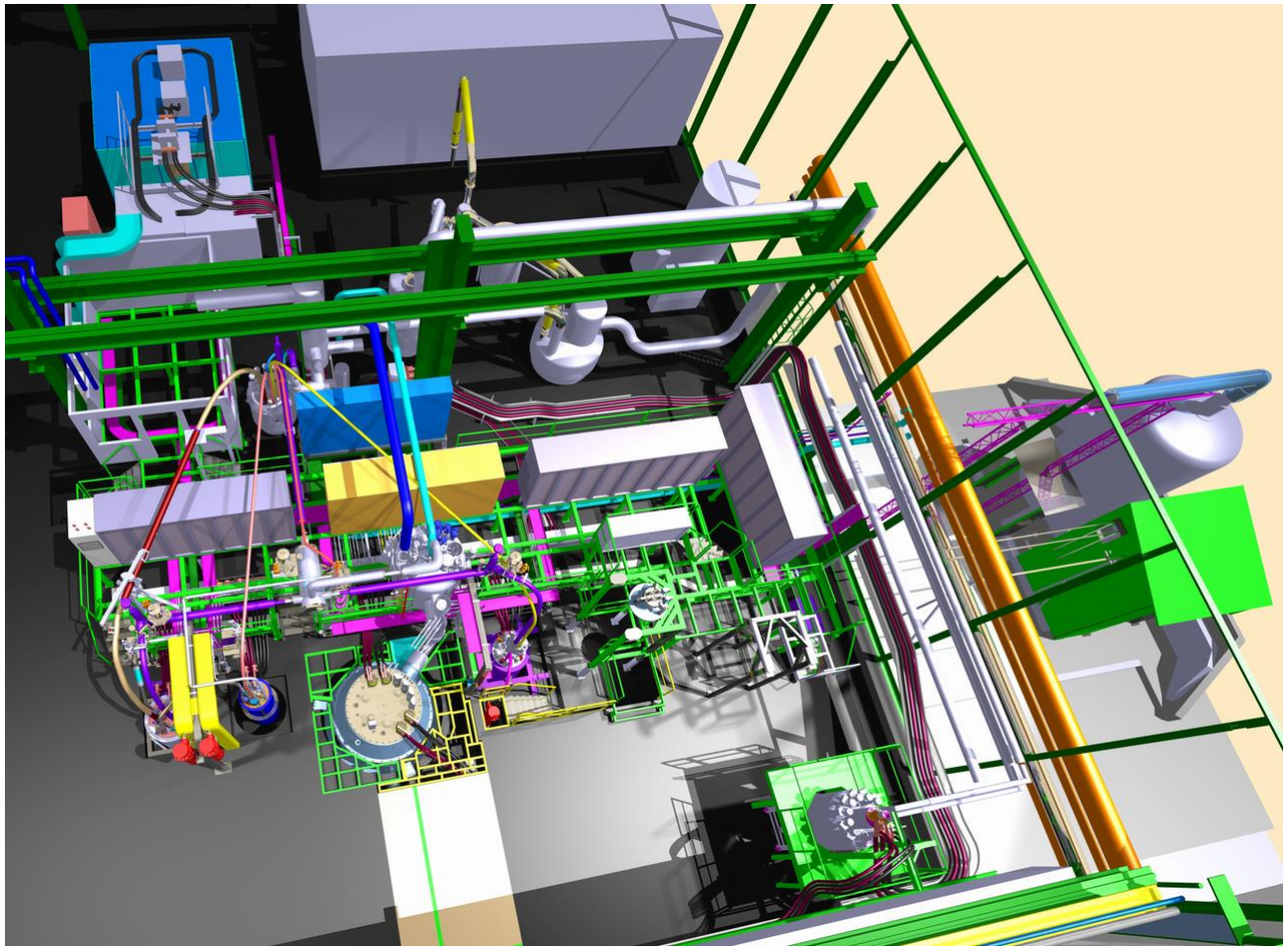
A secondary electrical circuit with 2 x 2 kA and associated EE should be implemented for the combined correctors (MCBXF) in 2019

CLUSTER G (A STAND FOR HFM) FULLY OPERATIONAL



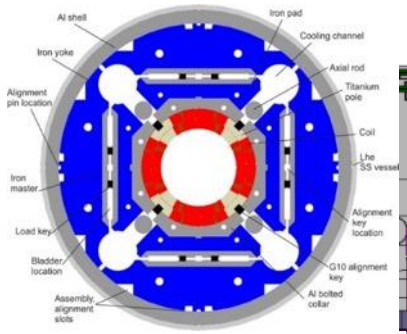
MQXF models



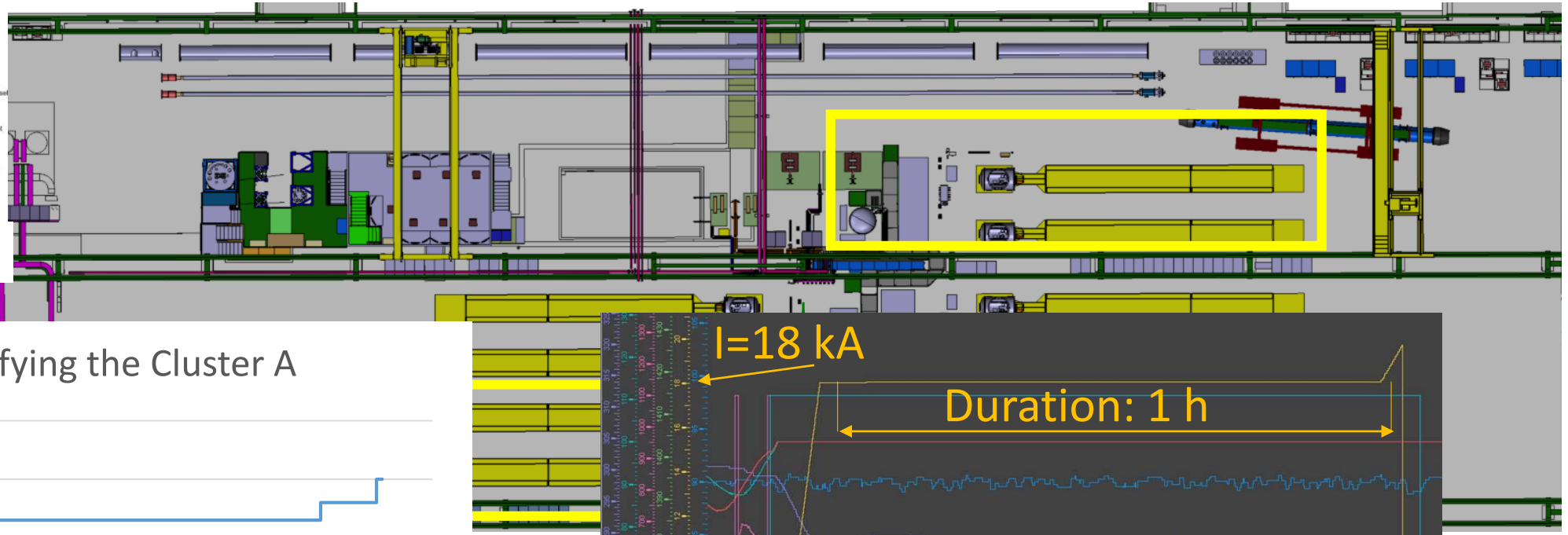


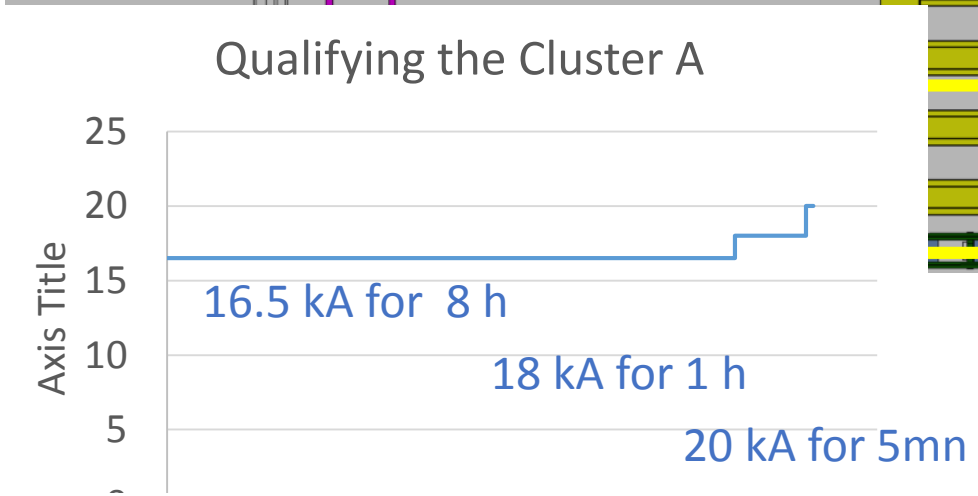
"HFM" CRYOSTAT ALLOWS TESTING MAGNETS WITH
1500 mm diameter and 2. 5 m length

CLUSTER A READY FOR POWERING UP TO 20 KA



Q1-Q3 cryo magnets

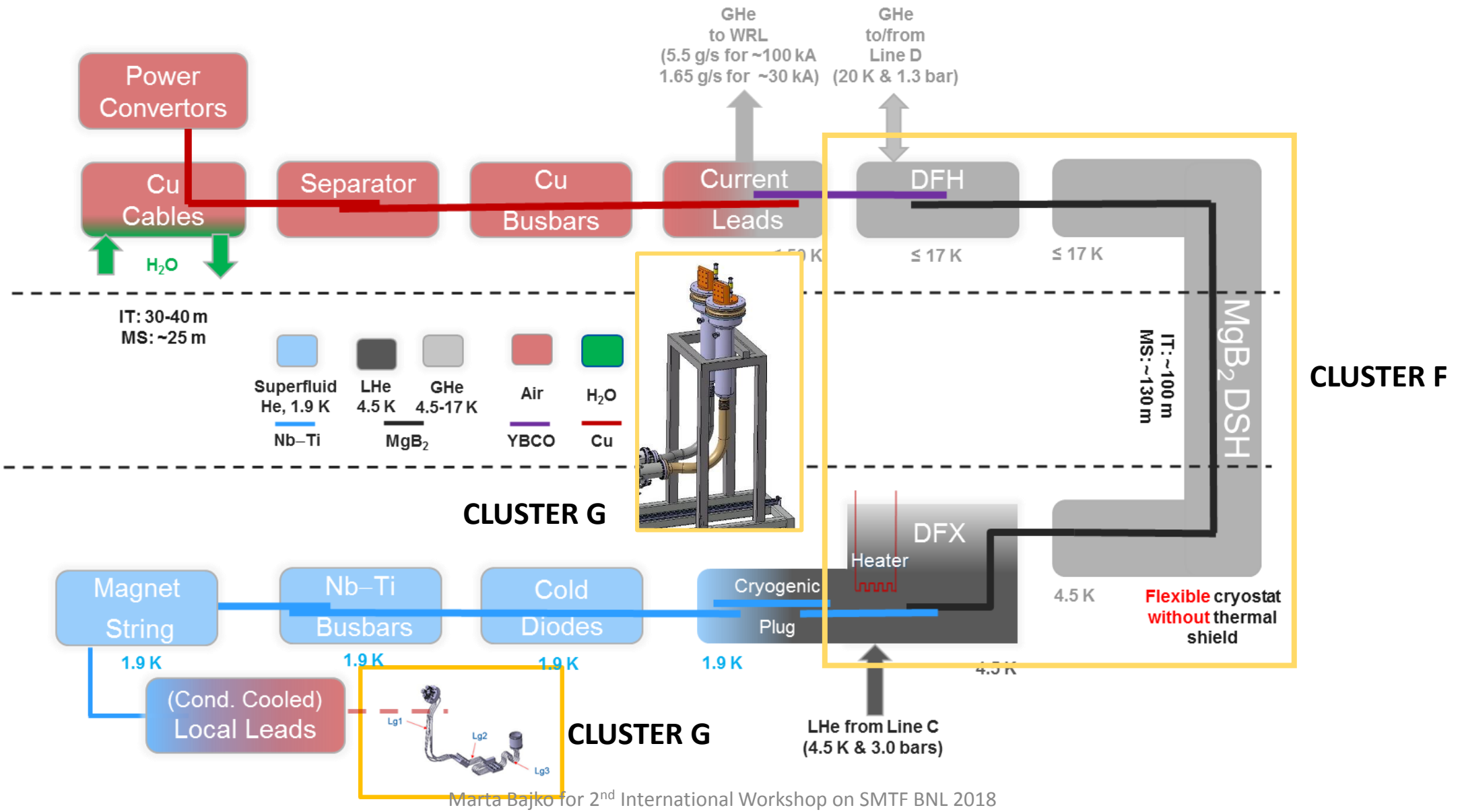




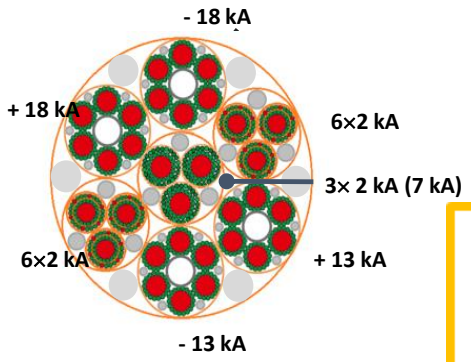
CLUSTER F will be equipped with a new 20 kA PC, 2 x 2kA PC and EE, CLIQ and new QH units, series DAQ. The CFU will be modified with 2 x 2 kA CL.

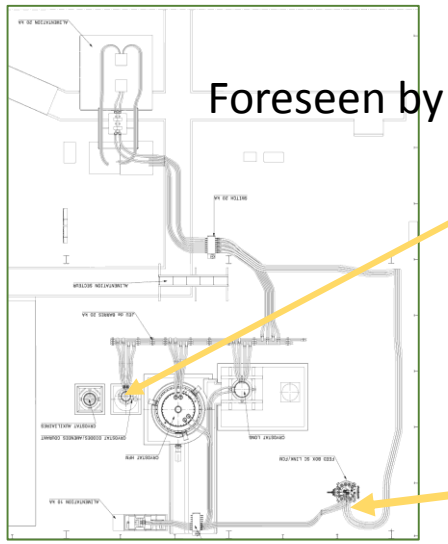
This is a major intervention, starting in 2018. The bench should be operational for 2020.

NEXT COMING PROJECT # STAND FOR SC LINK SYSTEM

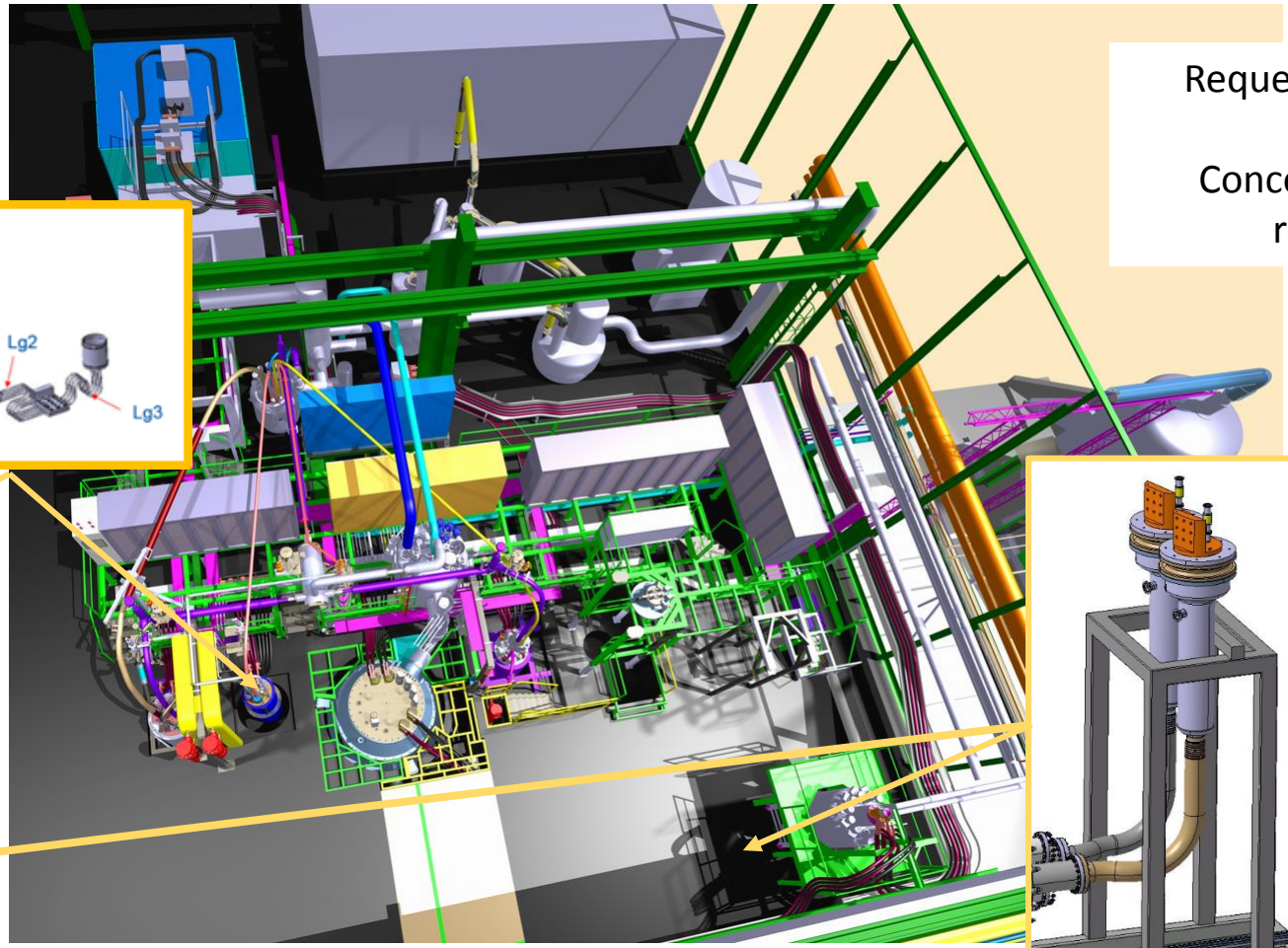


NEXT COMING PROJECT STAND FOR NEW TYPE of HTS CL





Foreseen by mid 2018



Request just arrived.

Conceptual spec in redaction.

"The Feed Box" would be used for the high current lead test in supercritical He, while "the diode" cryostat will be working in vacuum for the Cu leads

Foreseen by mid-2019. Work just started.

TEST CAPACITY IN SM18

11th test done

SM18 in test from January to August 2017
Horizontal benches: D2L103 , MB1011, MB1109, SSS523, MB1555, MB2507, MB1375, OSQAR, D4, 4001

19th test finished

Long: MQY28 + thermal cycle done and finished
next 11T DP102

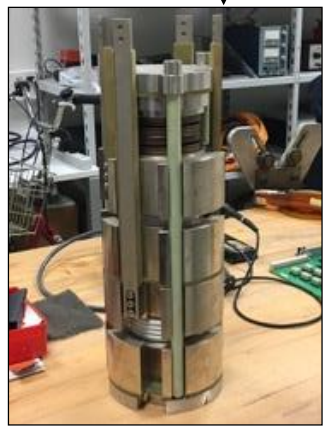
Diode: Splice test, Splice test2, Shunt test with "eco-bond", Feather2 done, 1st run LHC diodes

Siegtal: SMC11T4b, Sushi MgB2 with MCBY (4.2 K) , RMC QXF PIT 2
Sushi with HTS tapes, CCT for HL-LHC done

HFM: MQXFS5 , FRESCA2 , *FRESCA2 done*

Cluster D: MQXFS5 2nd run done

Cryo Cooler: humidity sensitivity study + hy test

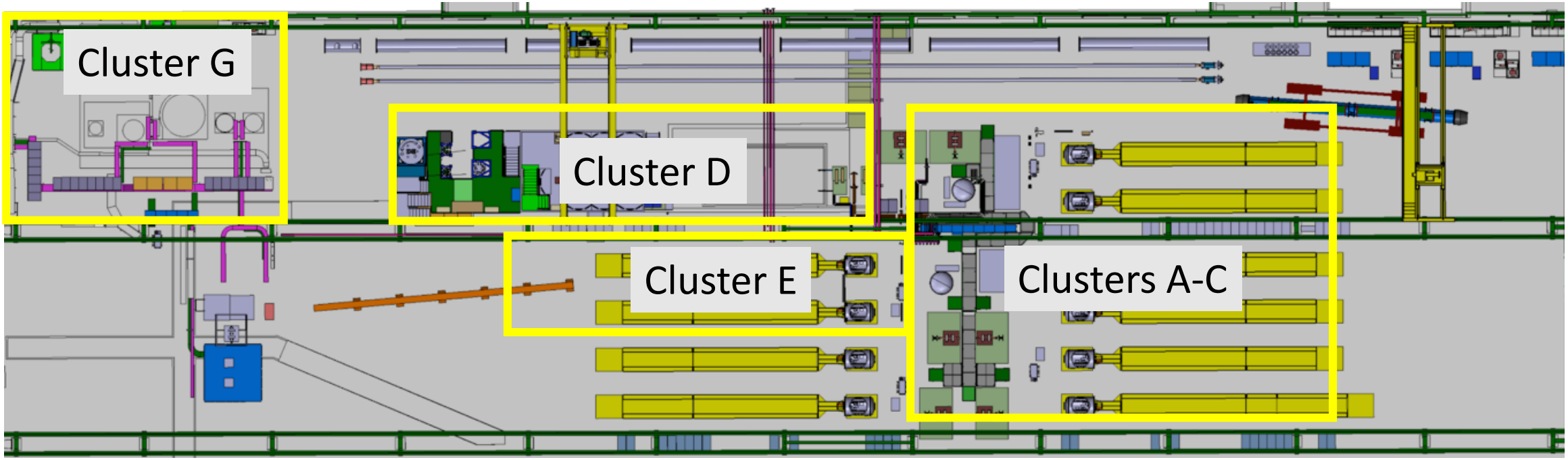


SUMMARY INSTALLATIONS, R&D AND TOOLS

4 cryostats 1 Feed box: 20 kA, EE, Cliq, 1. 9 K-50 K

1 cryostats : 30 kA, EE, Cliq, 1. 9 K-4.2 K

8 test benches 13- 20 kA, Cliq, 1. 9 K-4.2 K



R&D: Optical fibers, strain gauges, quench antennas, accelerometers, magnetic measurements shafts

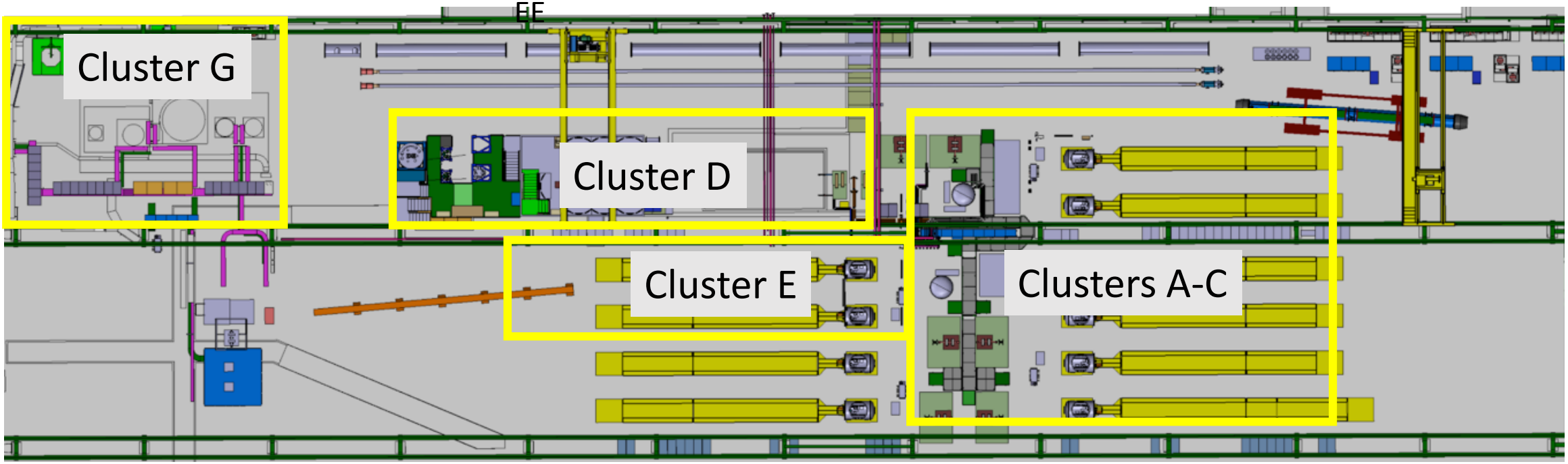
Tools for operation: Diadem for online analysis, Carpenter for QA/QC, DB

What is next? SECONDARY CIRCUITS AND DIAGNOSTICS TOOLS

HFM with 2 circuits : 15 kA and 20 kA with both equipped with EE!!

Cluster D : with 2x 2kA (but possible to upgrade to 15 kA) and 30 kA with EE

At least 2 benches with 2 x 2 kA and 1 x 20 kA



R&D: Optical fibers, strain gauges, quench antennas, accelerometers, magnetic measurements shafts

Tools for operation: Diadem for online analysis, Carpenter for QA/QC, DB

CONCLUSIONS

- In 2014 it was evaluated the needs for HL-LHC and set up a project to upgrade the test facility.
- We are today in line with that strategy with some delays (coming from civil engineering, cryostat commissioning), but still in line with the needs of the project.
- The evaluation of the needs for major services has been done.
  - The upgraded installations are operational for demineralised water, handling and control room. Electrical distribution, primary water production and cryogenic cooling capacity upgrade is ongoing . Expected to be operational 2019.
  - *The cryogenic pumping needs are again under evaluation which maybe different from our initial estimate (we may need higher pumping capacity).*
- Test benches for model magnet testing are new (Cluster D and HFM) with up-to-date technology and flexibility to test also correctors (on non- HL-LHC magnets). *(in few numbers: 1.9 K, 30 kA, IGBT, 200 kHz, 2ms, EE, Cliq, Sc link, FBG)*.
- Test benches (Cluster A and C) of cryo magnets (both for WP3 and WP11) are operational and need little modifications to allow testing the prototypes A new test bench (Cluster F) with 20/(2x 2) kA powering capacity is now in the design phase (but we have the converters already in fabrications). This test bench will allow reducing a risk in case the existing old reworked bench fails.
- Test bench for model and demonstrator of cold powering with SC link is operational (FeedBox). Modifications are on-going to complete for powering the cryo test bench. The test bench for series test(Cluster F, Feed Box and Diode cryostat) of Sc link components (HTS leads, SC link) is in the design phase.
- The infrastructure upgrade has been started (and partially finished) and is estimated to be in time for 2019 including the primary water , electrical distribution and cryogenic cooling capacity upgrades.
- We gave access to the facilities in the first year of ARIES alredy to 2 projects.

An important part of the preparation has been done with success, but it remains 2 years of hard work in front of us.