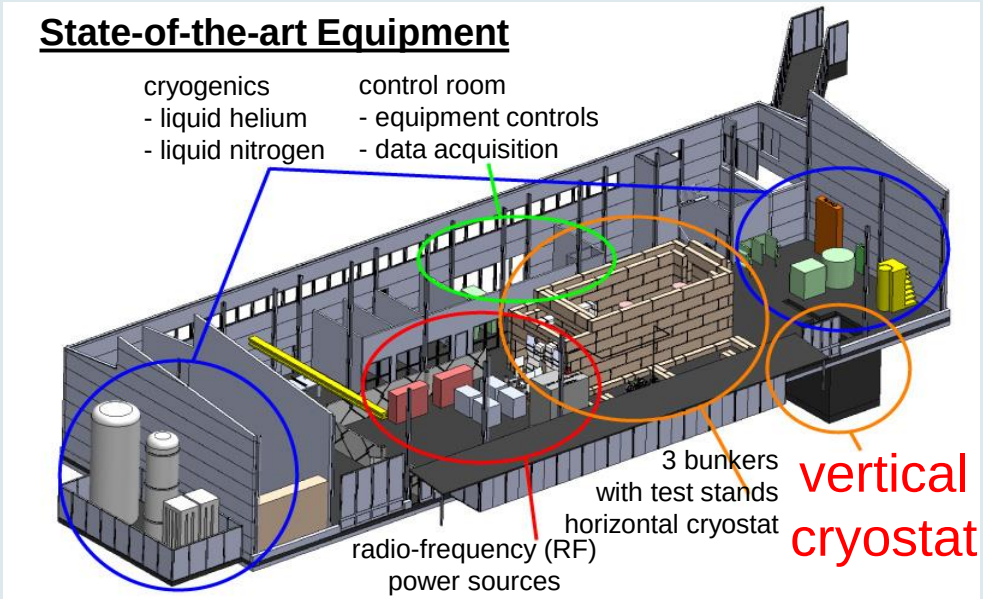
FREIA at Uppsala University

Facility for Research Instrumentation and Accelerator Development

Competent and motivated staff

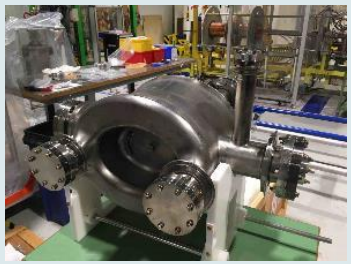
collaboration of physics (Physics Dep.) and engineering (Technology Dep.).

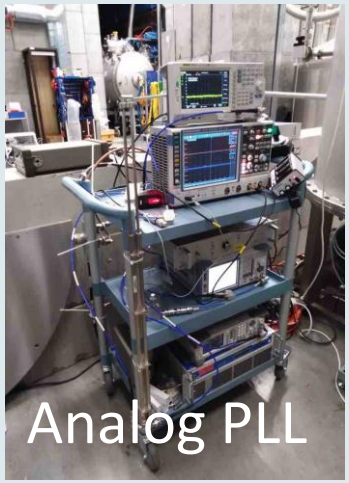
State-of-the-art Equipment



Tests of superconducting crab cavities and and corrector dipoles

Double Quarter-wave (DQW) Crab Cavity



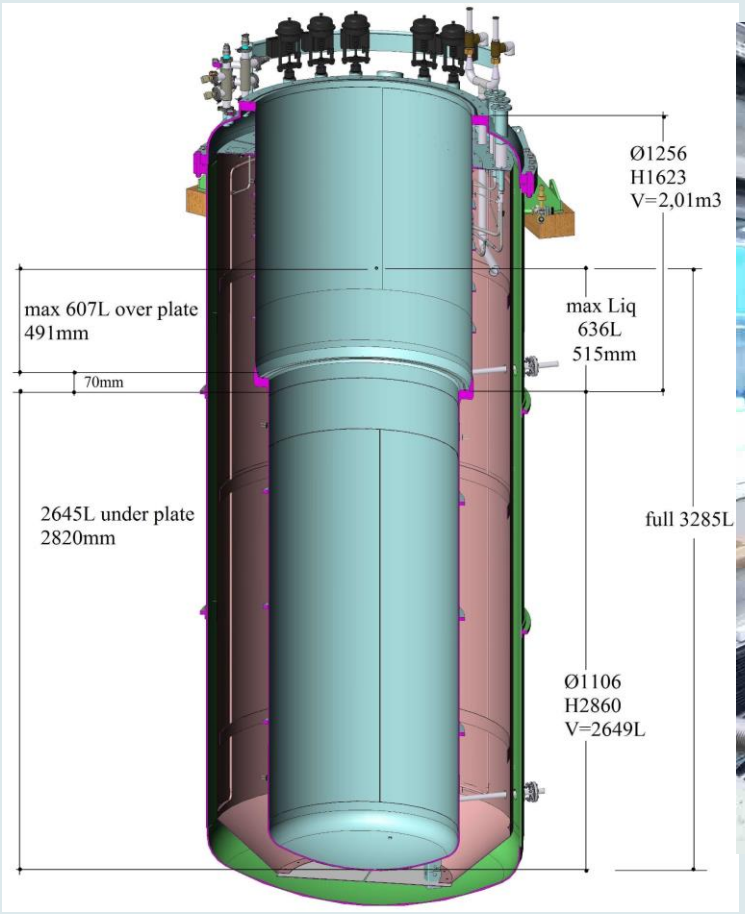


Project Leader Akira Miyazaki

LHC MCBC Corrector Magnet magnet

Project Leader Kevin Pepitone

Vertical cryostat GERSEMI



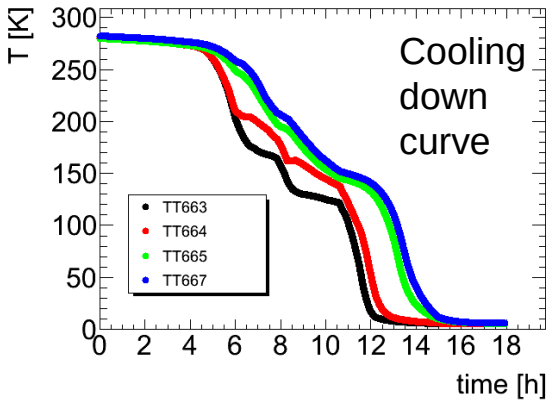
Test of SC cavities & magnets (<350kJ)

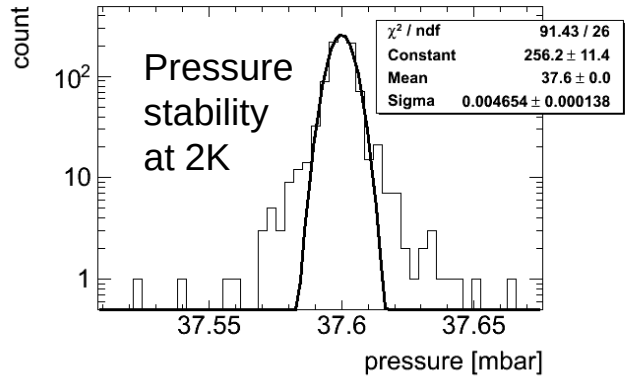
- 3.2m x ø1.1m total volume
- 2.65m x ø1.1m below lambda plate

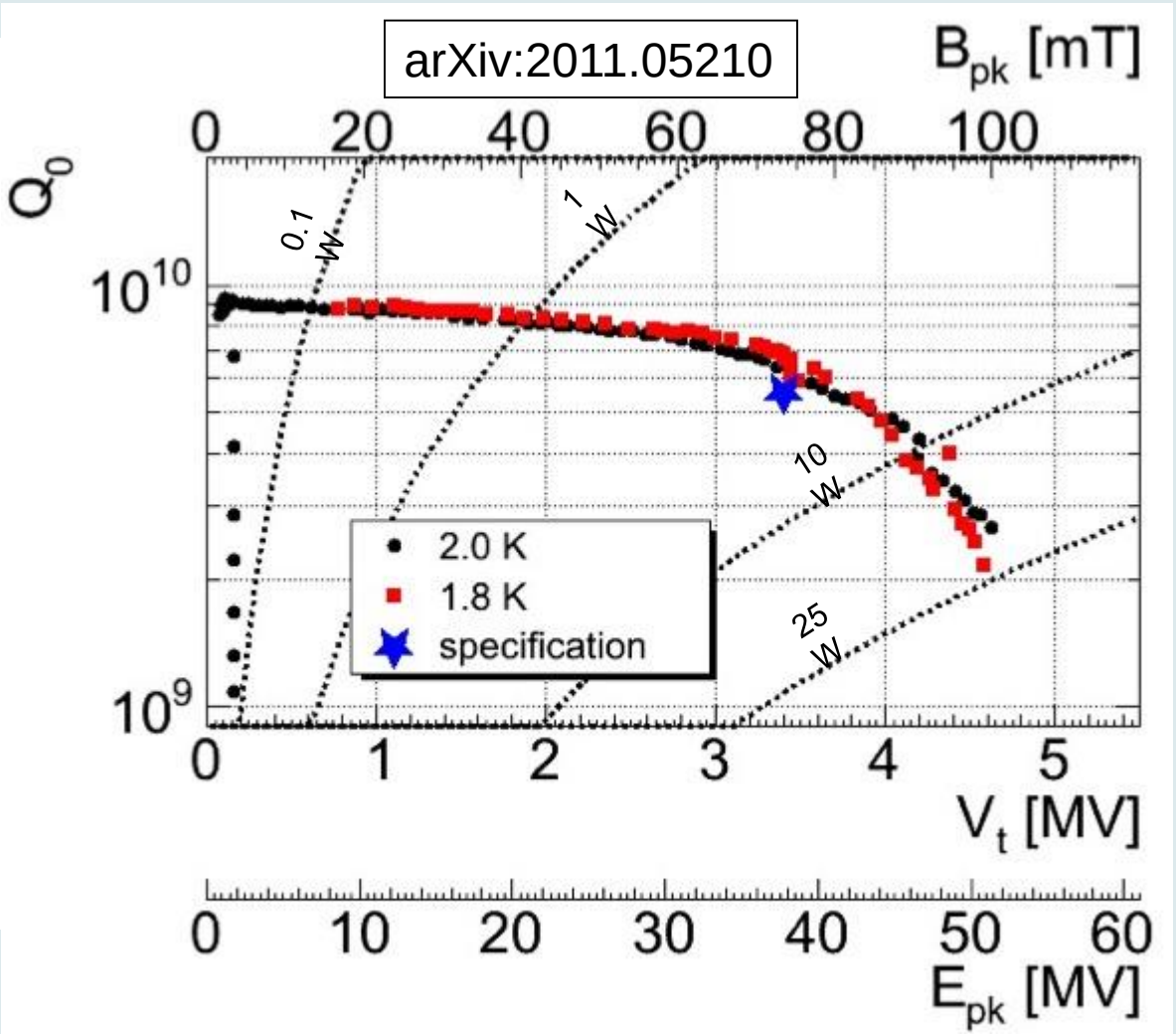
Flexibly reduce the helium volume by cryogenic foams

Operation on liquid bath or pressurized (with a 2K heat exchanger)

First result of DQW crab cavity testing

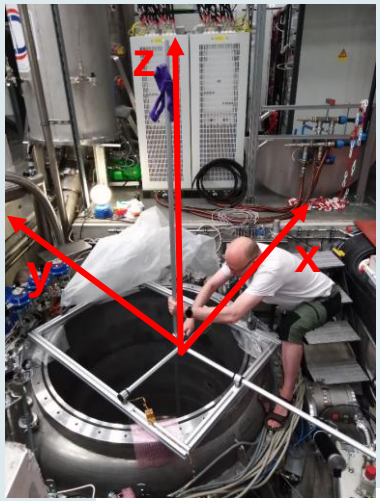


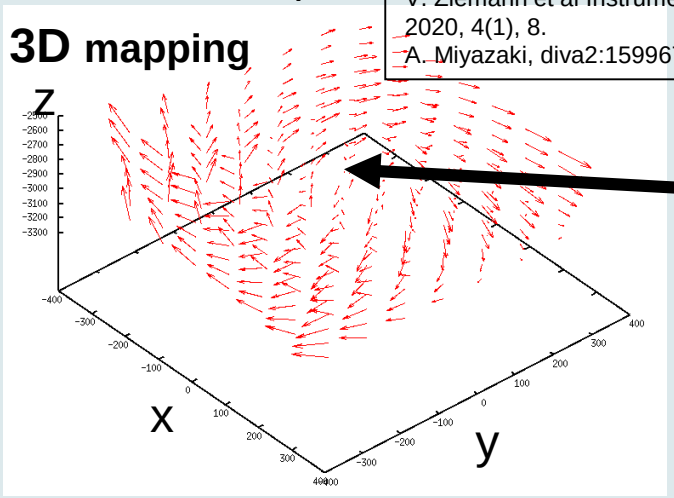




- ✓ Cryogenics worked nicely
- ✓ for the cavity
- ✓ **The result met the project specification**

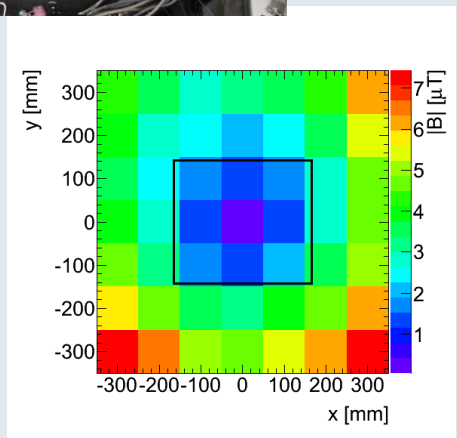
The vertical cryostat will be used also to test LHC superconducting dipole corrector magnets which will lead to some magnetization of the structures surruounding the vertical cryostat which may be detrimental for the crab cavity tests. In order to compensate for this magnetization Helmholtz coils have been installed around the vertical cryostats and tested. With these the residual field is measured to be 3-4 µT.

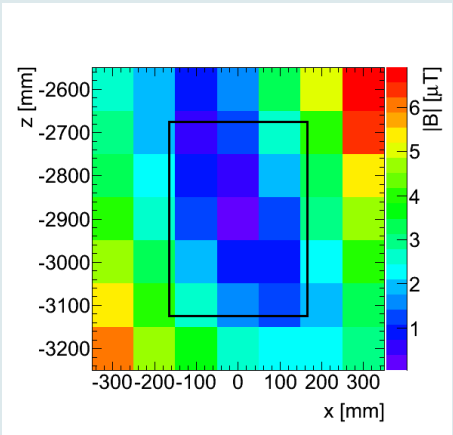


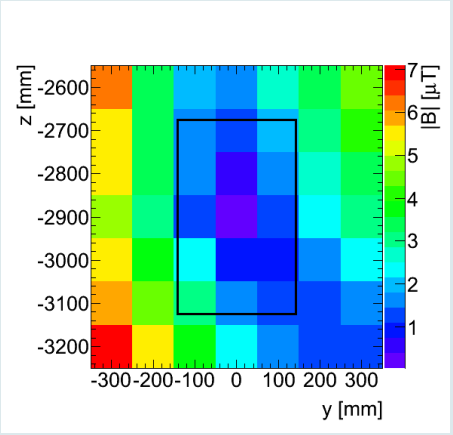


V. Ziemann et al Instruments 2020, 4(1), 8.
A. Miyazaki, diva2:1599675

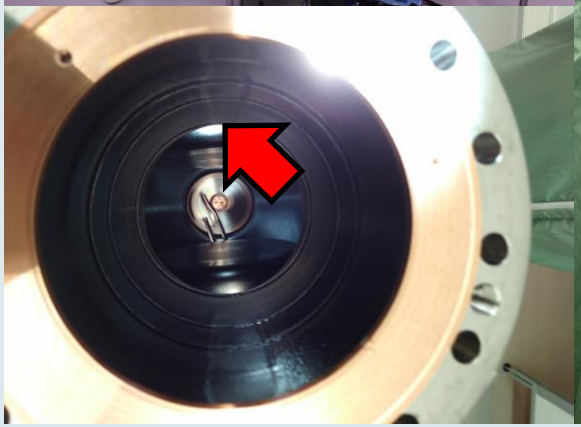
Center of the cavity can be perfectly at 0 field







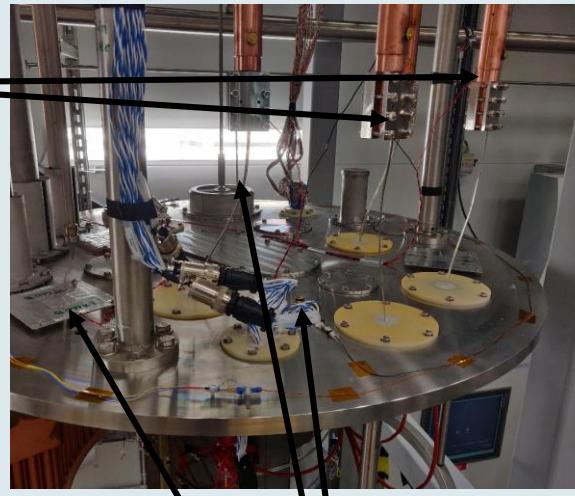
Renewed tests of the same crab cavity with Helmholtz coils are planned – the crab cavity was returned to FREIA but the pick-up antenna fell off in transport. The pick-up antenna was successfully remounted in the FREIA cleanroom. The cavity however had to be returned to CERN again to check for scratches on the inside of the cavity.



First results of MCBC magnet testing

Cable thermalized Heaters, temperature sensors

Many Vtaps



Heaters, temperature sensors on the magnet

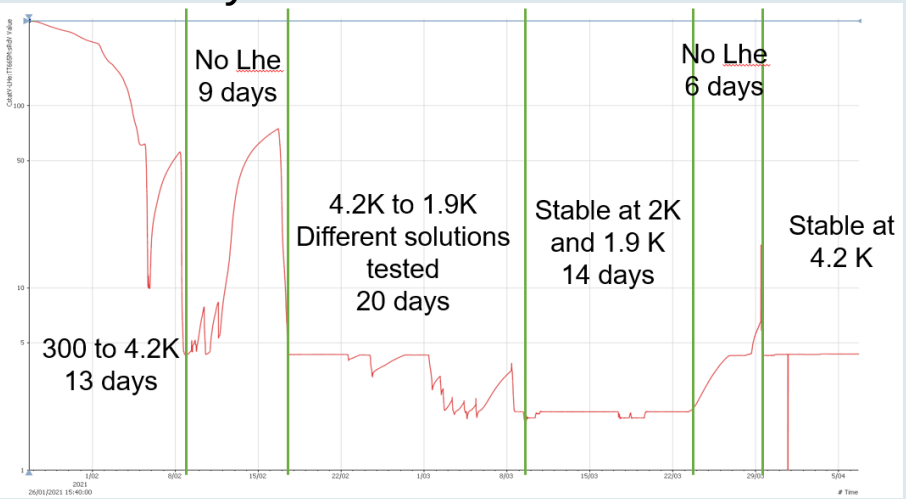
Heaters, level prob and temperature sensors on the lambda plate

GERSEMI: Satellite equipment

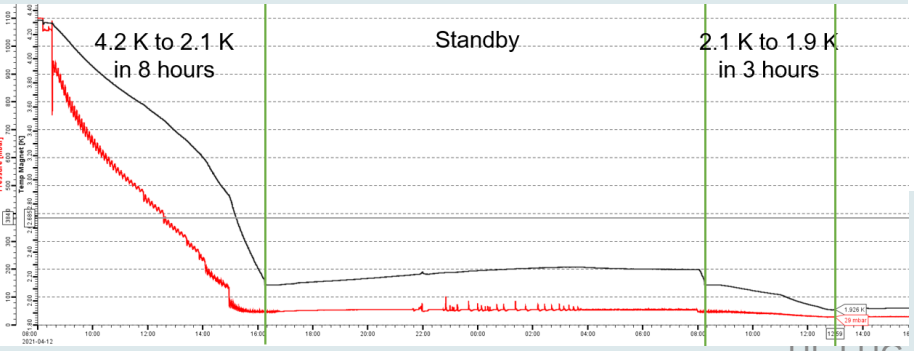
Results of MCBC testing

Cooling from 300 K to 4.2 K

Issues due to simultaneous cooling with an ESS cryomodule

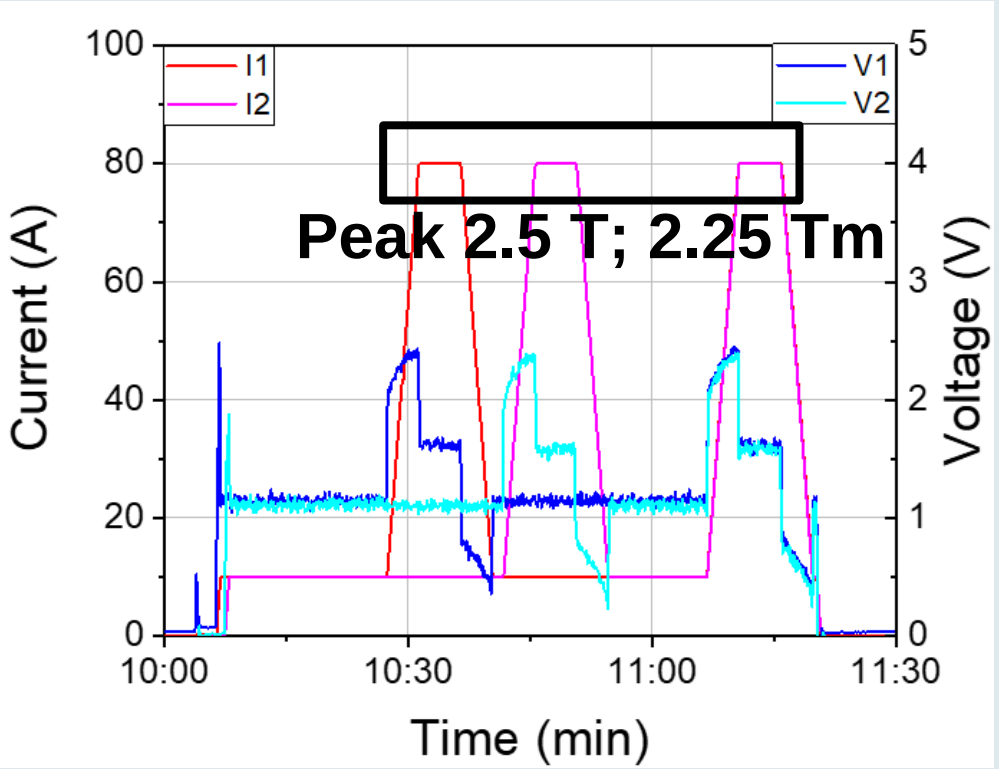


Cooling from 4.2 K to 1.9 K



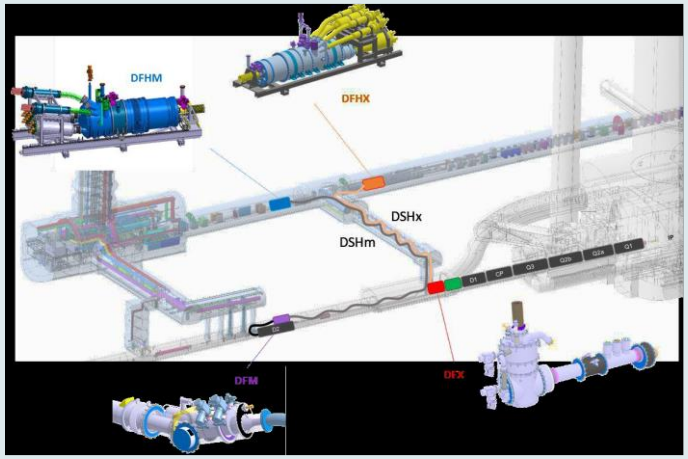
arXiv:2108.10648

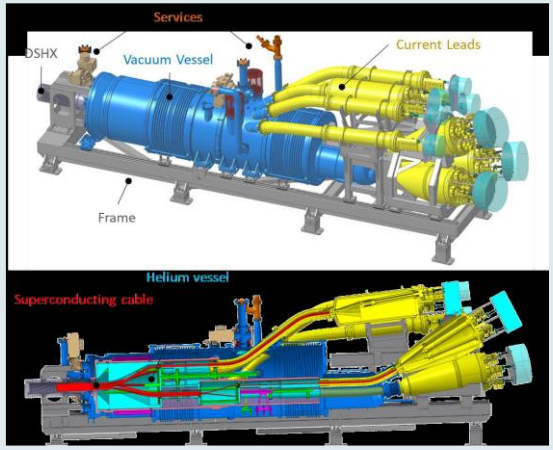
Powering at 1.9 K



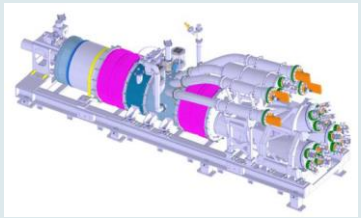
Manufacture of the components of DFHX and DFHM cryostats

These are the cryostats that will house the connection the HTS Current Leads to the MgB_2 Superconducting Link powering the HL-LHC Triplets and D2 magnets.

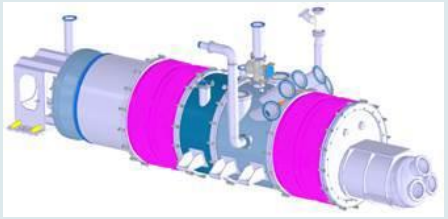




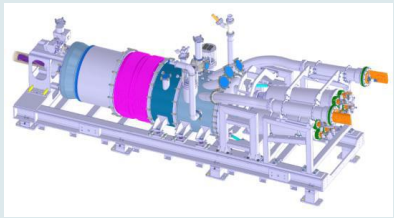
DFHX



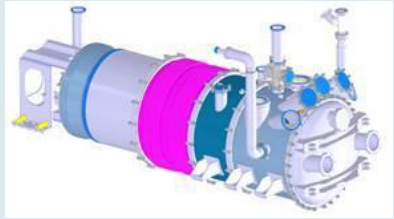
Parts of the Swedish supply



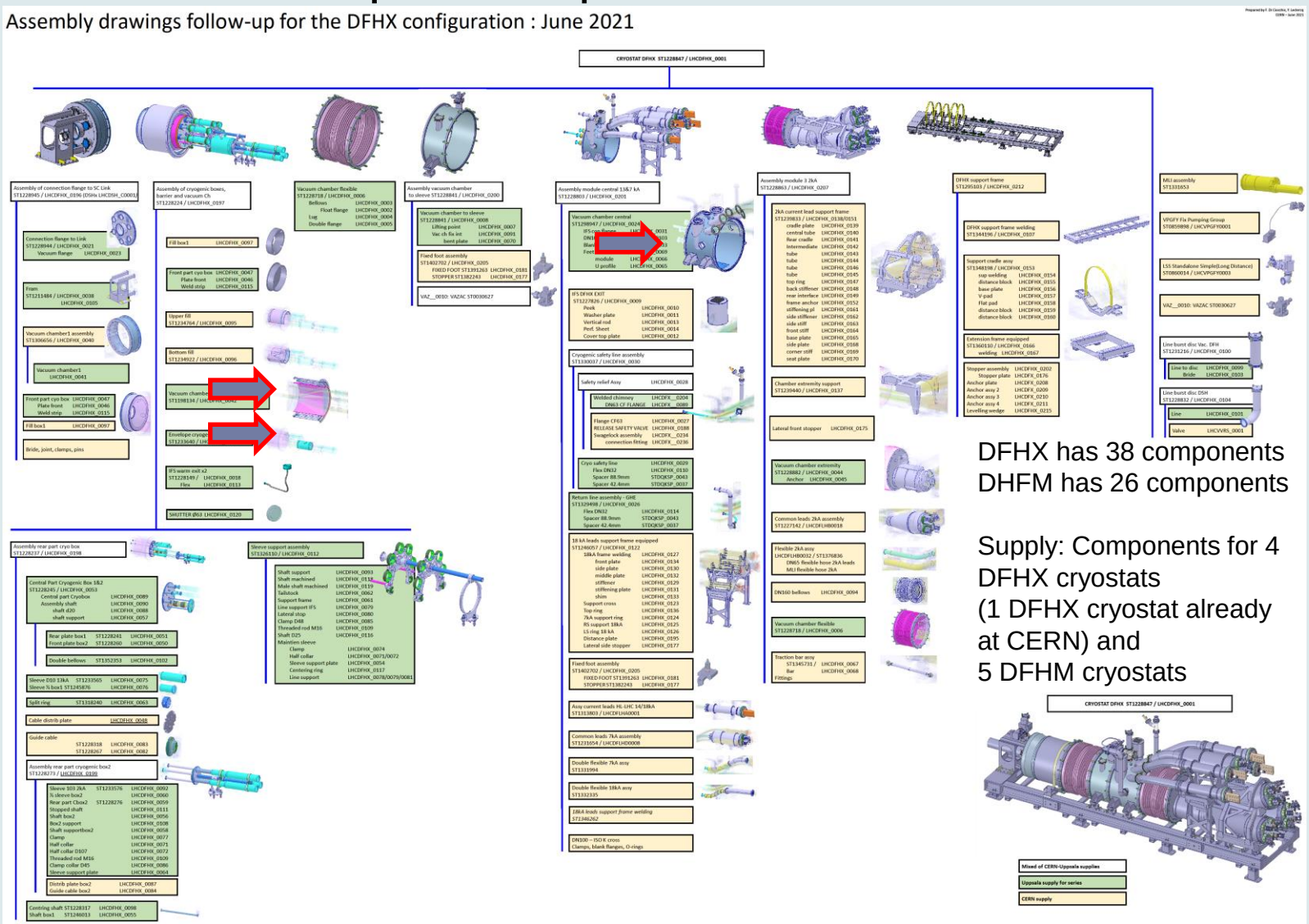
DFHM



Parts of the Swedish supply

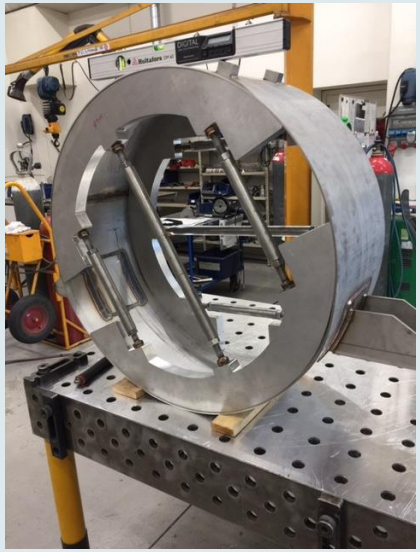


The DFH components with the arrow ⇨ indicating the three most complex components



We are working since 3 years with a Swedish firm RFR Solutions for this firm to deliver in-kind the series of some 38 components for each of the 4 DFHX cryostats and 26 components for each of the 5 DFHM cryostats. The final drawings of these components were made available by CERN in summer 2020. RFR has since then studied these drawings and manufactured, on order from CERN, 6 of the some 38 DFHX components. CERN meanwhile has manufactured the remaining components and the first DFHX cryostat is currently being assembled at CERN for first tests early 2021.

One of the 6 components at RFR



Closeup showing deformation caused by the weld

View of one of the workshop halls at RFR

RFR have judged 3 components as very risky from the point of view of satisfying the required mechanical tolerances. The management of welding deformations and subsequent mechanical adjustments during the assembly of the subcomponents of these 3 complex components is a major challenge, requiring extensive experience.

One of the 3 complex DFH components at CERN being refitted by the speaker

The second complex DFH component being surveyed by Paul Cruikshank

The third complex DFH component with Paul and Thibaut Coiffet (EN-MME)

Knowledge Transfer

We are now discussing with CERN that RFR engineers and technicians will come to CERN to follow the welding and adjustment techniques together with CERN experts, for one or two of each of the complex components, with the aim that RFR would then be in a position to manufacture the remaining series of the 3 complex components.

This necessary knowledge transfer step, added to the fact that DFH detail drawings did not exist in November 2019 when the cost estimate was fixed, does not cover all costs at RFR. We are currently negotiating with the Swedish funding agencies and with CERN in order to make the funding meet the costs.

Conclusions

1. We have tested, and measured the Q value of, a DQW crab cavity at full field in the FREIA vertical cryostat. We are now ready to test more such cavities. CERN, however, does not have a need for such tests at this moment. We will remain stand-by, should the need arise.

2. We have tested, and measured the current in, a dipole test-magnet at full field in the FREIA vertical cryostat. We are ready to test a series of LHC corrector magnets and understand that such magnets will soon start to be delivered to Uppsala.

3. The complete and final technical drawings of the DFHX and DFHM series cryostats exist since the summer 2021. The components of the first DFHX cryostat have been produced at CERN and RFR and are currently being assembled for complete functional tests of the first DFHX cryostat in early 2021. We are currently discussing technical details of how RFR shall, with the assistance of CERN, be able to manufacture also the most complex of the DHF components of the remaining 9 cryostats. Component complexity and knowledge transfer will lead to some cost increase, the funding of which still needs to be negotiated. Time is getting critical for producing the DFH cryostats.