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Swedish collaboration –

FREIA orbit corrector magnets testing plans and DFH components production status

Maja Olvegård

On behalf of the FREIA team

Special thanks to:

Rocio Santiago Kern, Johan Eriksson, Kevin Pepitone, Akira Miyazaki and Tord Ekelöf

HiLumi HL-LHC PROJECT

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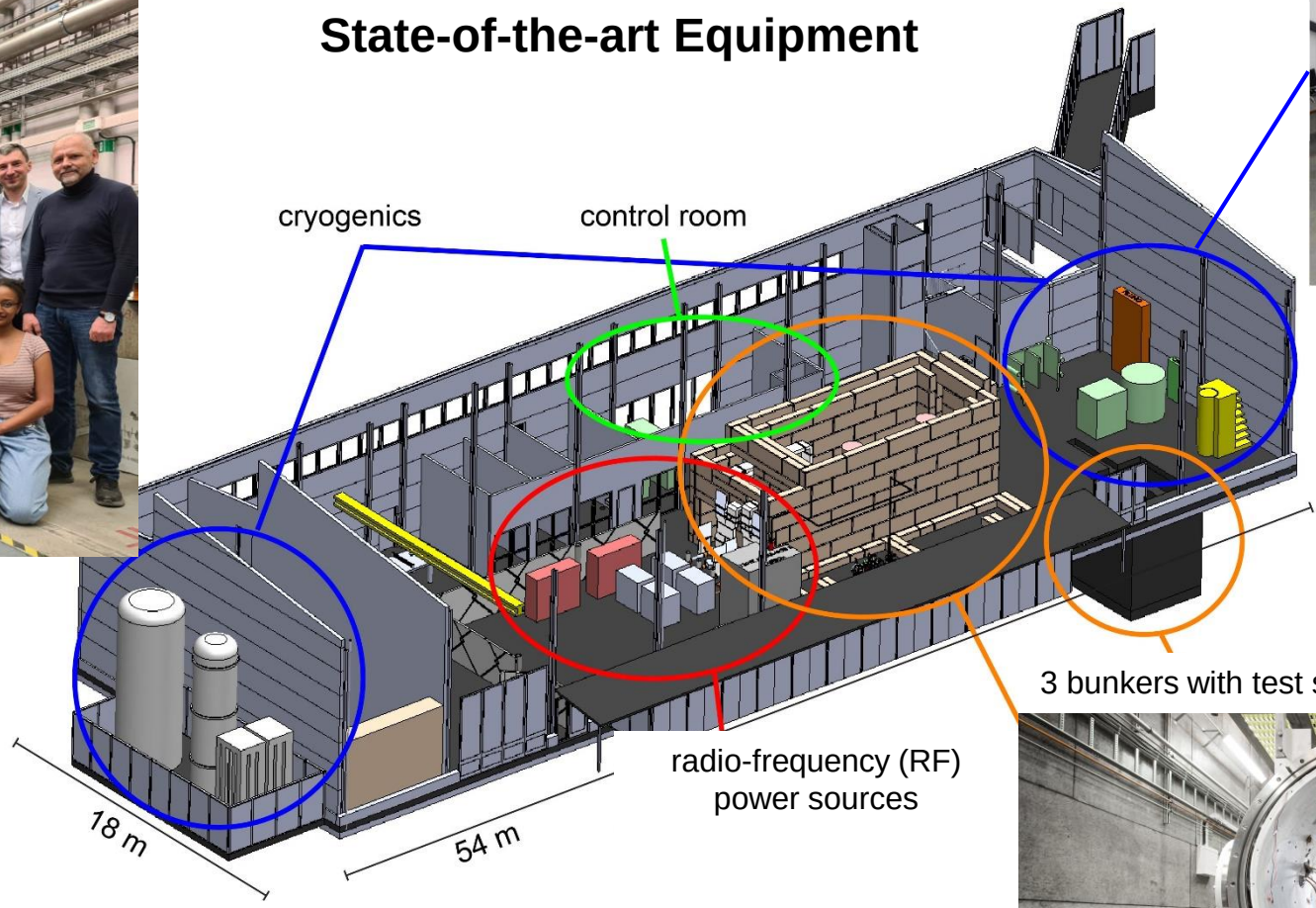
FREIA

Facility for Research Instrumentation and Accelerator Development

State-of-the-art Equipment



Delivery of cryogens
to the whole university

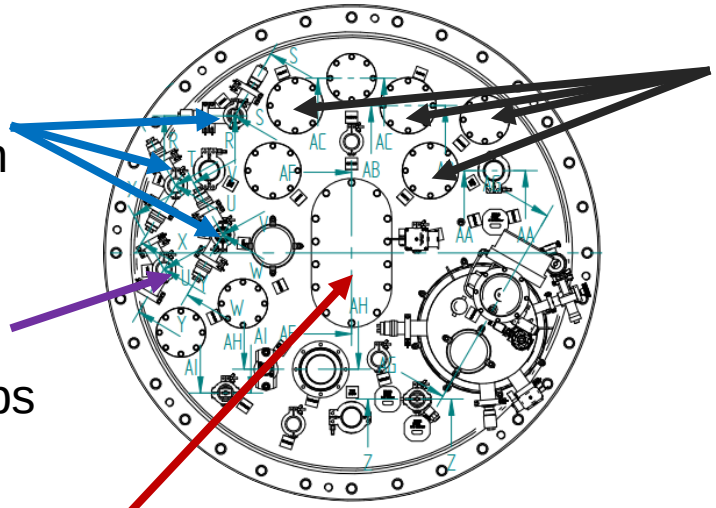
3 bunkers with test stands & a horizontal cryostat

Funded by KAW, UU and Swedish government, inaugurated in 2013

GERSEMI

- Superconducting magnets at 4.3 K and 1.9 K, at atmospheric pressure
  - Up to 350 kJ
- Two inserts, with and without lambda plate

Top view

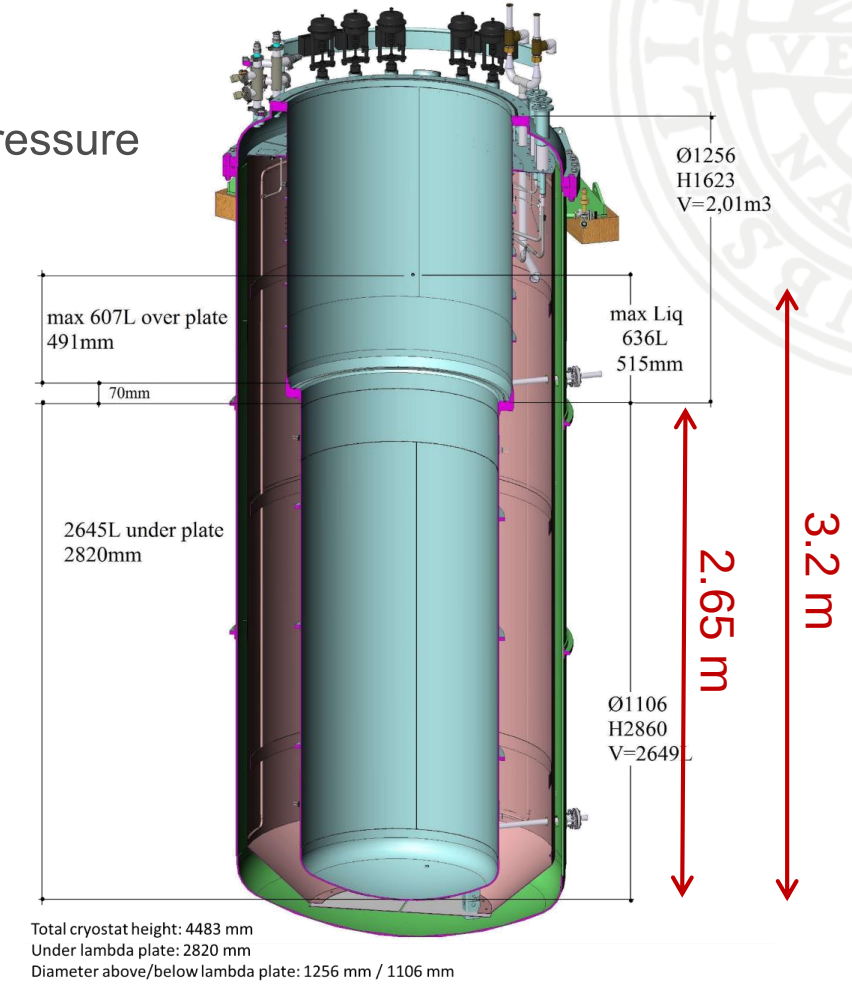


Cryogenics instrumentation

4 current lead

Up to 36 voltage taps

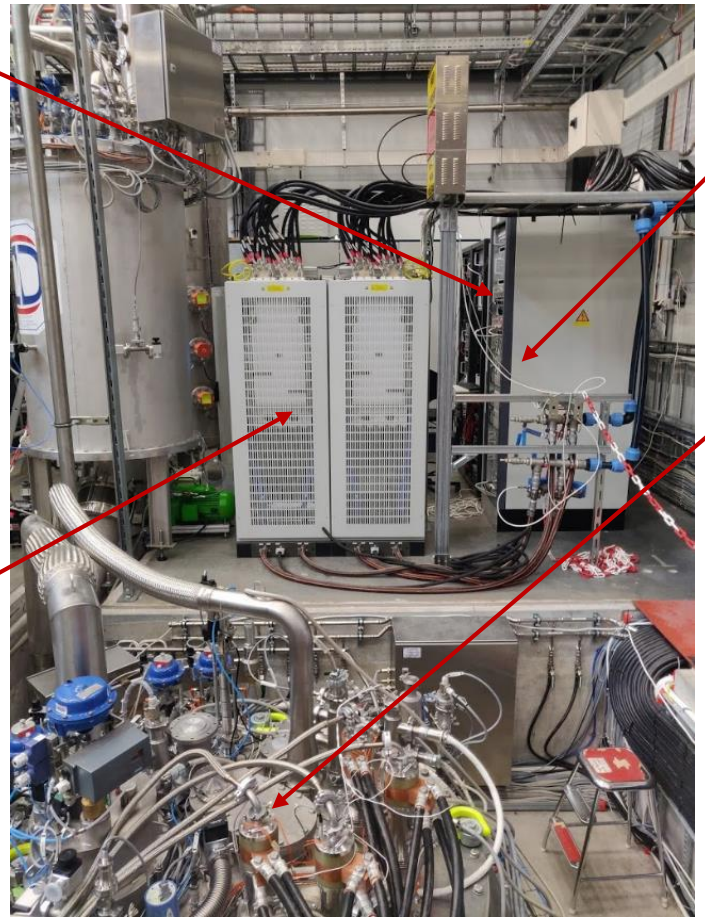
Magnet measurement (under development)



Satellite equipment

Data acquisition and PLC

- 48 high frequency channels
- 72 low frequency channels
- 1 uQDS, universal quench detection system for symmetric quenches
- Polarity switch



Power converters 2x2 kA

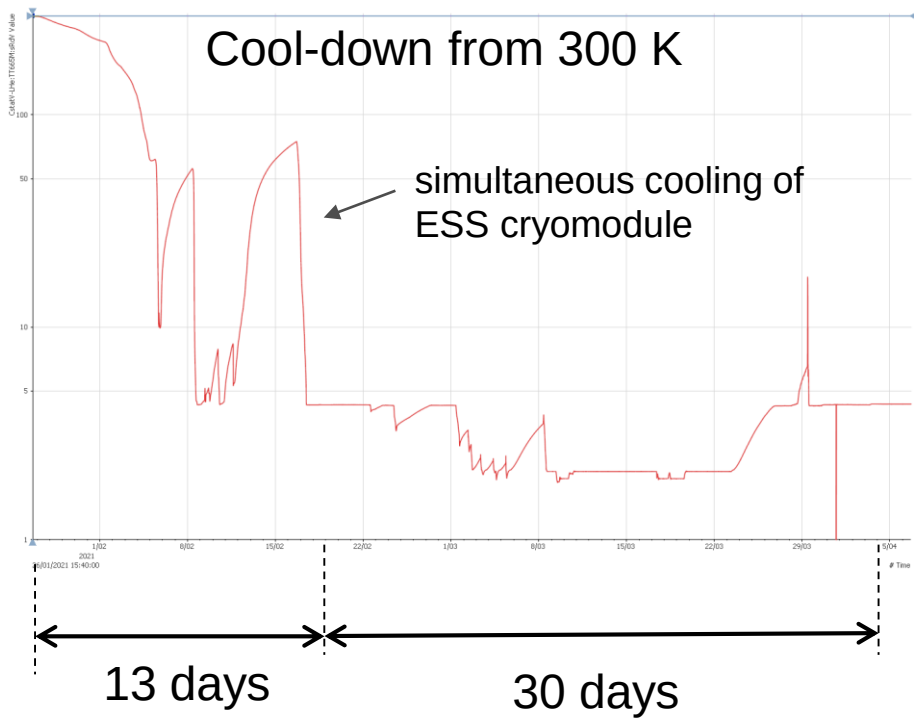
Magnet insert, fully equipped

Two energy extraction units

Software for the DAQ system provided by CERN

https://arxiv.org/abs/2108.10648

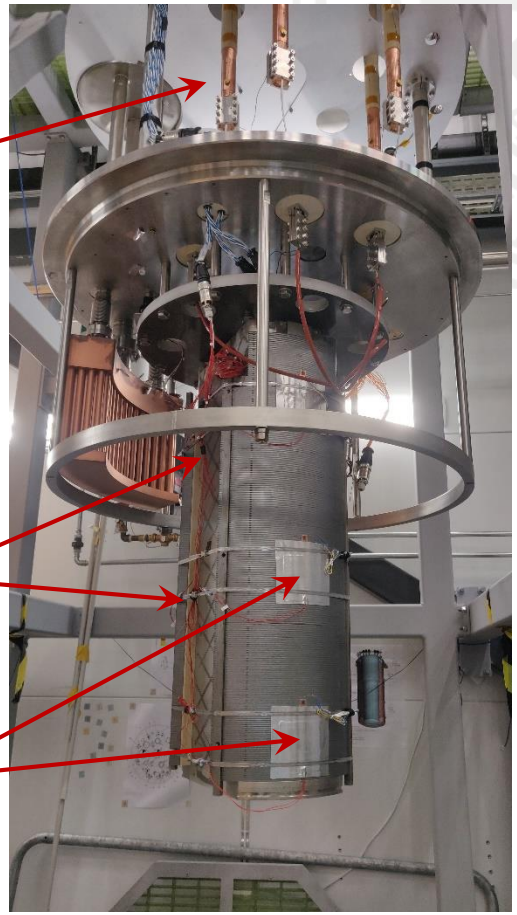
Commissioning: MCBC Cool-down



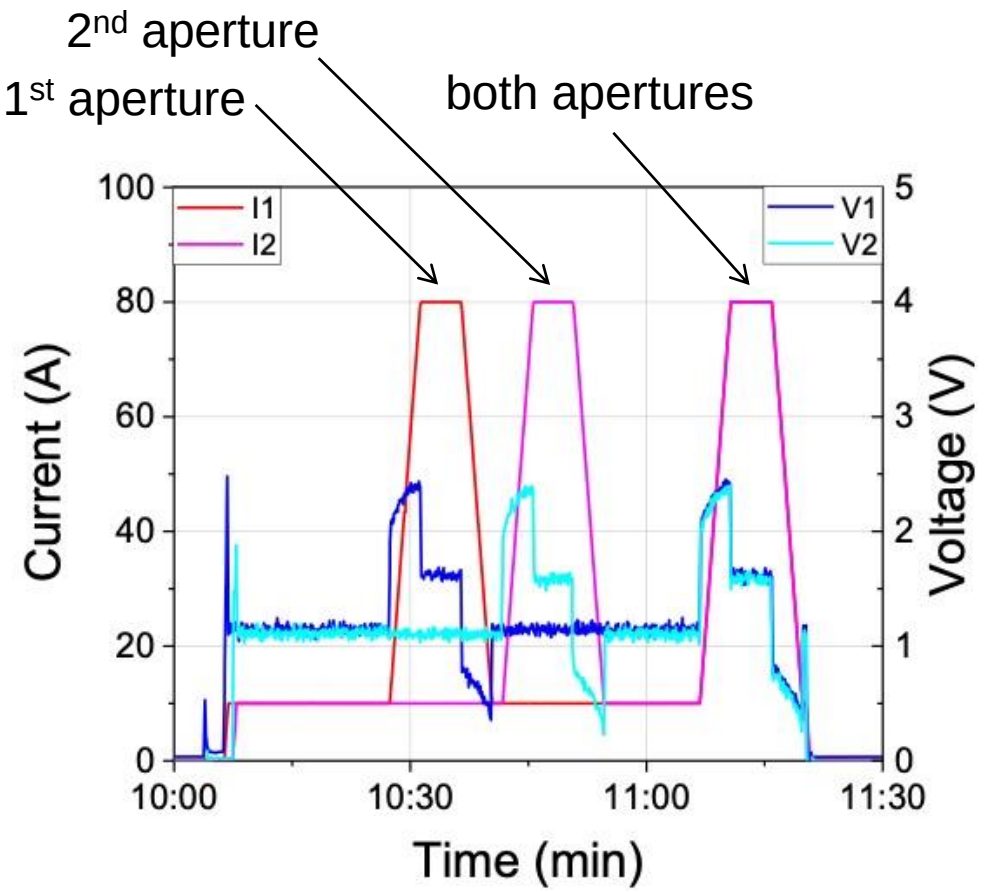
Level probe, voltage taps, temperature sensors…

temperature sensors

heaters



Commissioning: MCBC Powering at 1.9 K

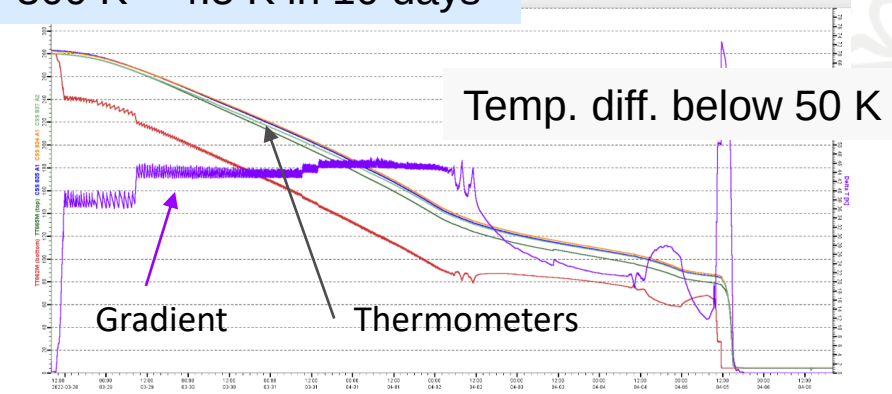


We reached the nominal current of 80 A, corresponding to a peak field of 2.5 T.

Thermal cycle of a 2.2 m CCT magnet (MCBRD)

- Gradient fully controlled during cooldown and warmup.
- Quench detection system, data acquisition and all the auxiliary equipment are fully functional.
- **One thermal cycle takes 17 days.**

300 K – 4.5 K in 10 days



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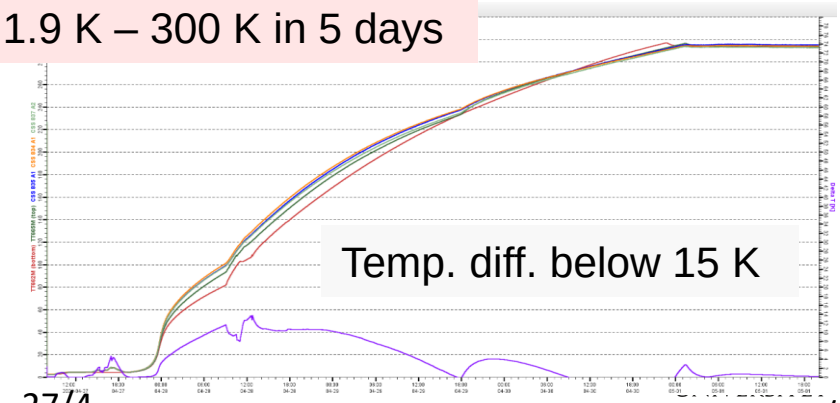
1.9 K – 300 K in 5 days



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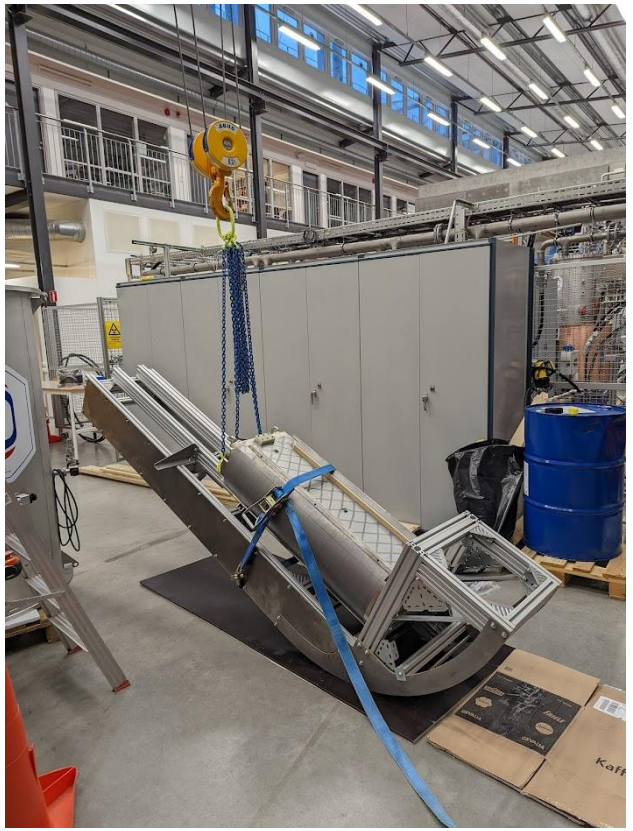
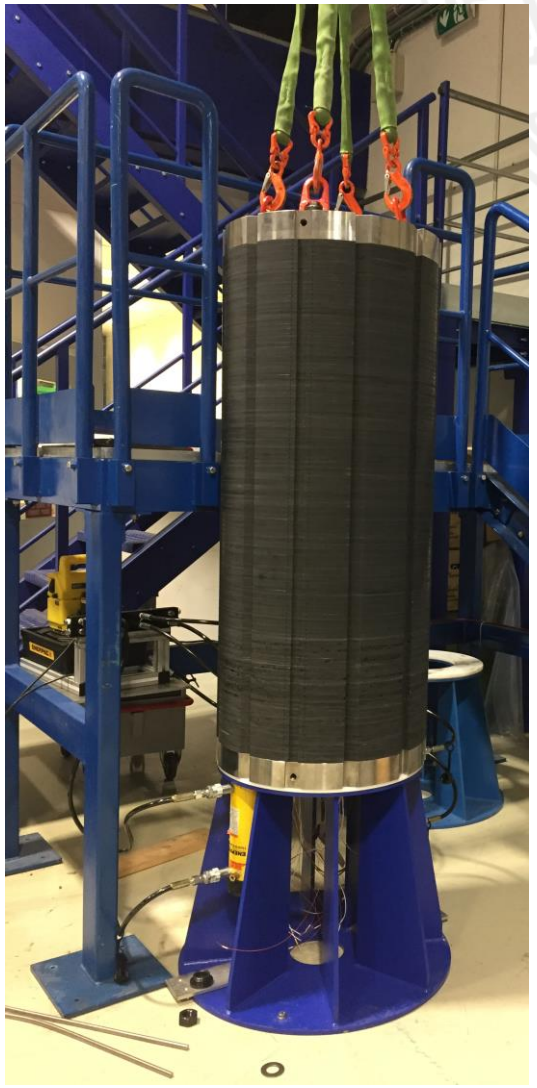
Test plan at FREIA

- Contract signed between Uppsala and CERN summer 2022
- Test five magnets
  - MCBXF
    - single-aperture
    - nested corrector dipole
    - 1.5 m long.
  - MCBRD
    - Double-aperture
    - 2.2 m long





https://espace.cern.ch/HiLumi/WP3/SitePages/MCBXF.aspx

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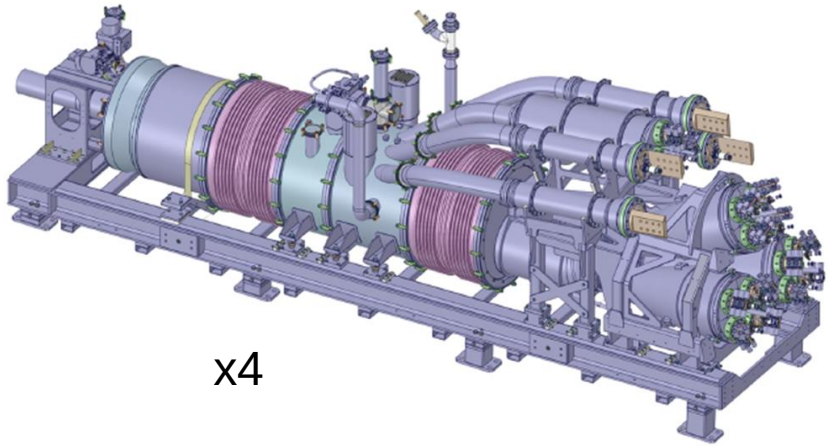
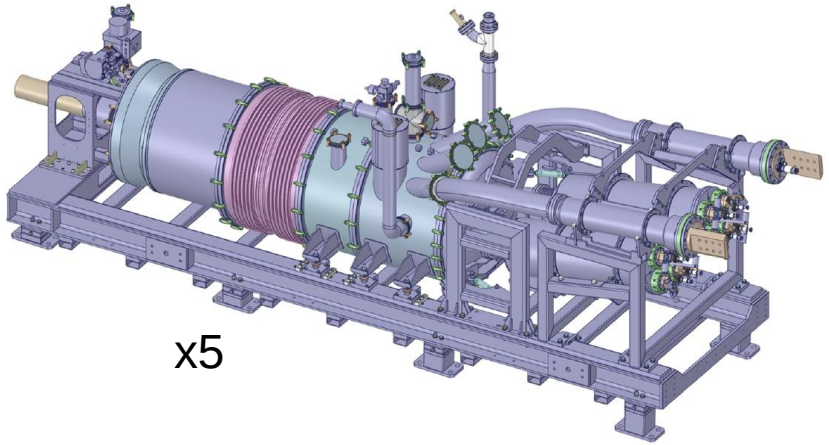
DFH delivery

- Uppsala to supply parts for
  - DFHX (4)
  - DFHM (5)
- Design and drawings made by CERN
- Manufacturing at
  - Uppsala University Workshop
  - RFR Solutions
  - CERN
- Uppsala supplies parts to CERN
  - Quality assurance
- Inspection, acceptance, assembly made at CERN



x4



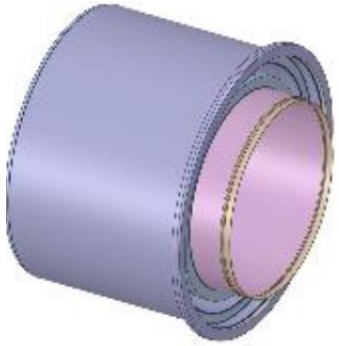
x5

One cryostat every two months. First delivery November 2022.

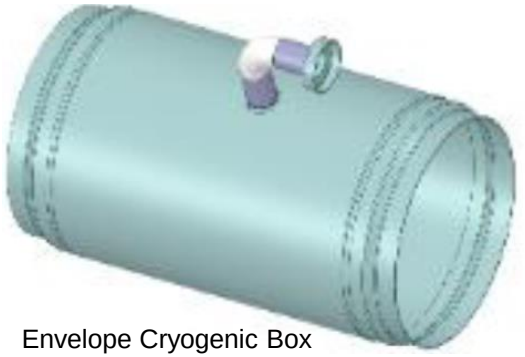
Knowledge transfer

- Three particularly complex pieces
  - Welds, leak checking, etc.
- CERN will produce these pieces for the first two sets
- RFR Solutions and Uppsala learn from these and produce the remaining seven sets.

Vacuum chamber central
LHCDFHX_0024



Vacuum chamber for thermal dissipation
LHCDFHX_0042



Envelope Cryogenic Box
LHCDFHX_0049

Rocío Santiago Kern, Johan Eriksson

Current Status

- **UU workshop**
  - 95% of parts ready
- **RFR**
  - Procurement of all material complete.
  - Manufacturing ongoing for parts approved by CERN.
  - Documentation for remaining parts almost finished.
- **CERN**
  - Currently working on vacuum barrier
  - Next phase for knowledge transfer in 1-2 weeks

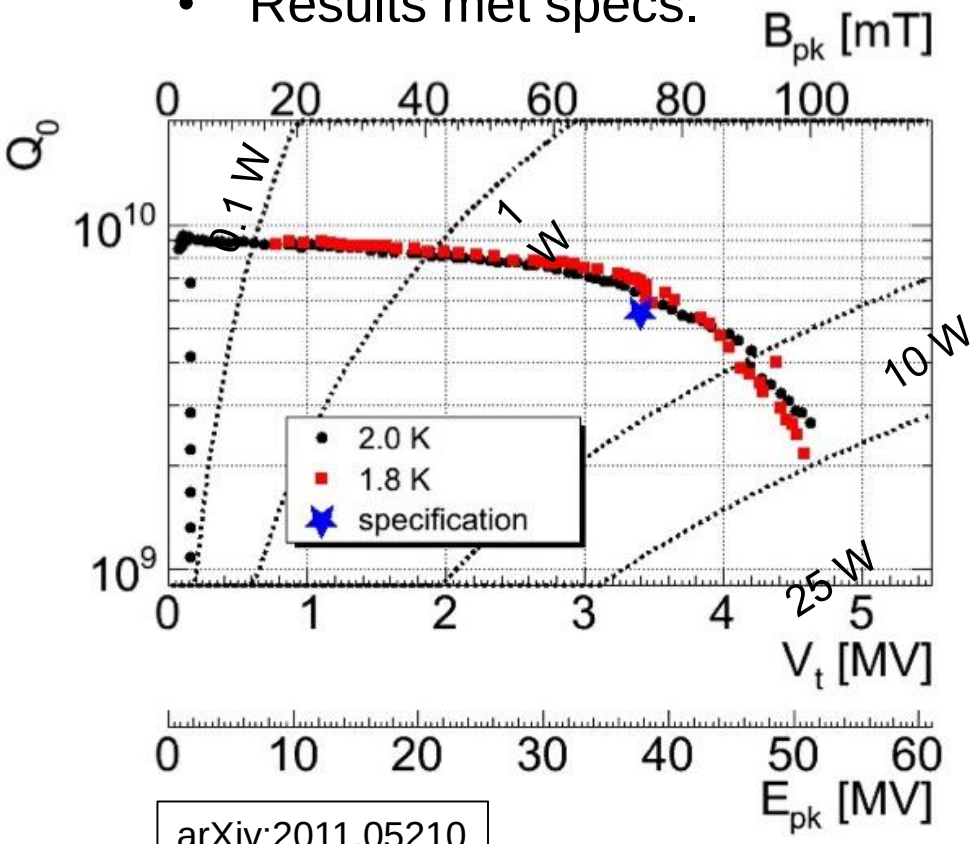
Rocío Santiago Kern, Johan Eriksson

Welcome to FREIA!

Test of Prototype Double Quarter-Wave crab cavity

First test in 2020

- Results met specs.



arXiv:2011.05210

Akira Miyazaki

Second try in 2021

- The pick-up antenna fell off during transportation to Uppsala

Demonstration of UU's clean room

diva2:1599675

Thermal cycle of a 2.2 m CCT magnet

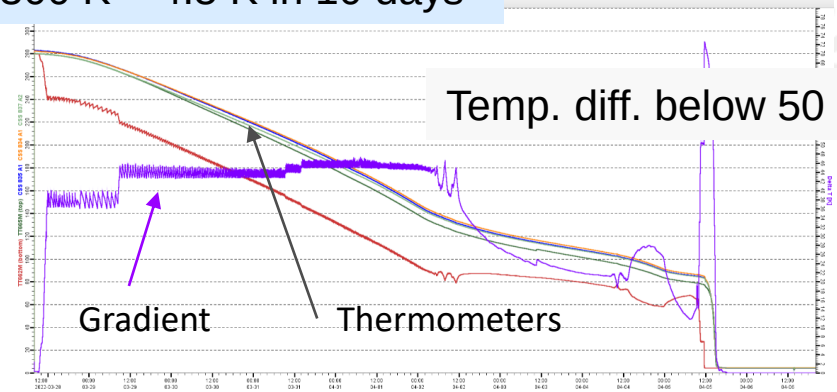
- Cooldown 300 K – 4.5 K: 10 days
- Cooldown 4.5 K – 1.9 K: 36 hours
- Warmup 1.9 K – 300 K: 5 days

➢ **One thermal cycle takes 17 days.**

- Gradient fully controlled during cooldown and warmup (<50 K).

- Quench detection system, acquisition system and all the auxiliary equipment are fully functional.

300 K – 4.5 K in 10 days



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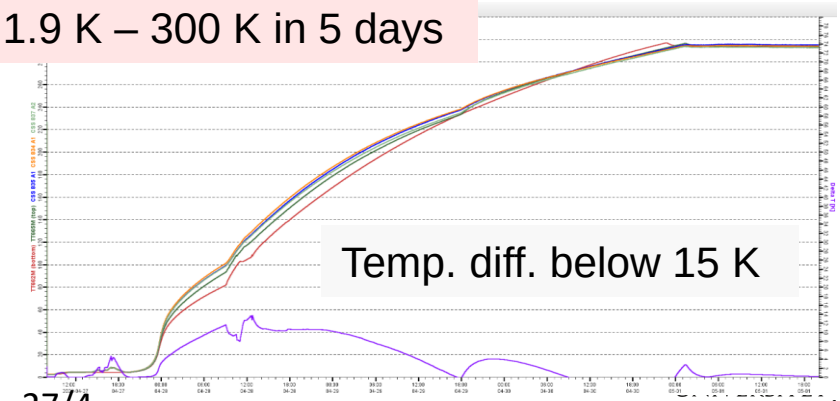
1.9 K – 300 K in 5 days



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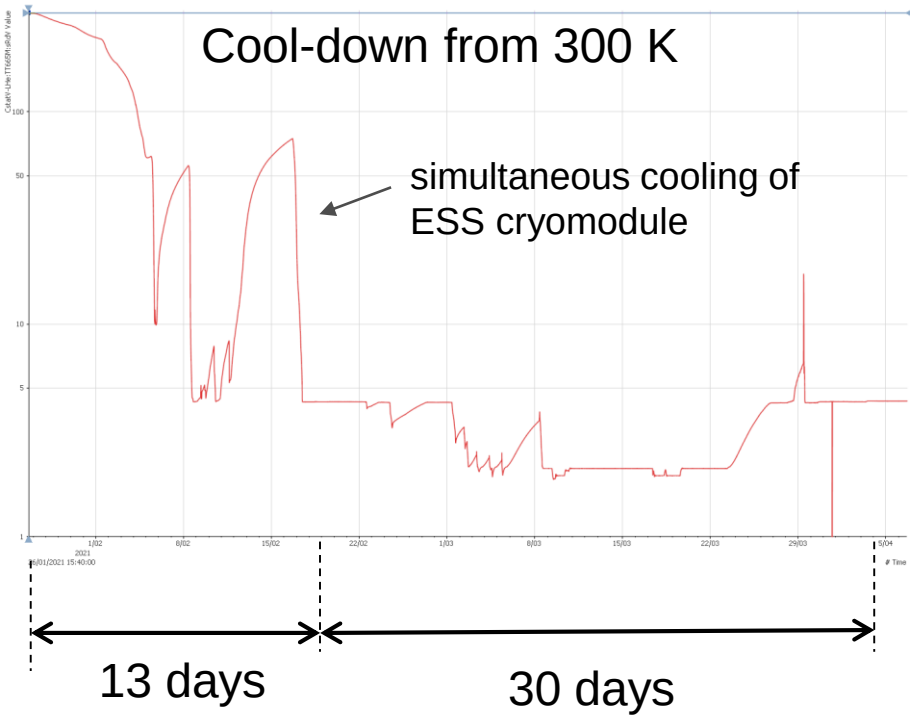
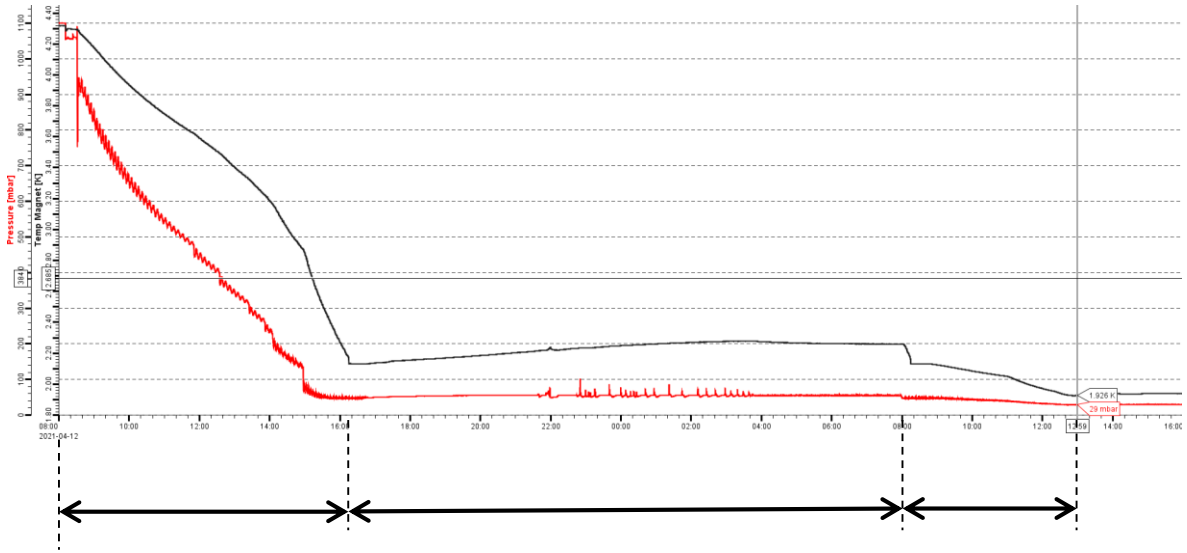
First test of MCBC: Cool-down





4.2 K ➡ 2.1 K
8 h

standby

2.1 K ➡ 1.9 K
3 h

Kévin Pepitone