This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.

UPPSALA UNIVERSITET

FREIA

Test stands in Uppsala University

I.FAST/AMICI/ETIAM workshop @ DESY

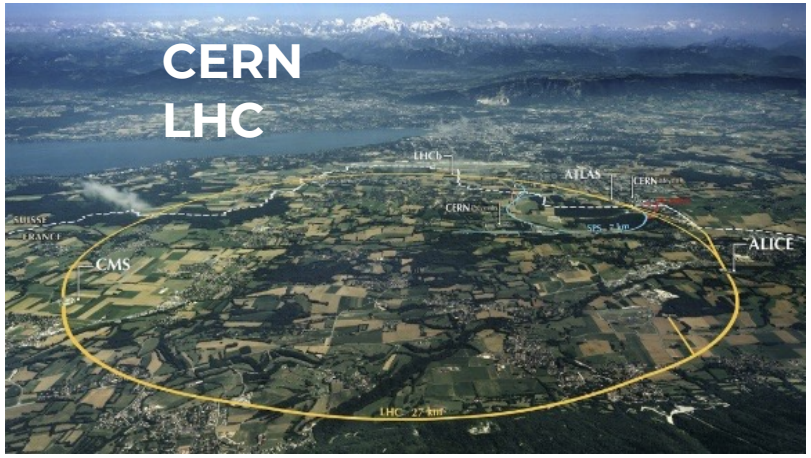
Akira Miyazaki on behalf of FREIA team

iFAST

ACCELERATOR AND MAGNET INFRASTRUCTURE FOR COOPERATION AND INNOVATION

Outline

- Introduction of the FREIA laboratory
- Test stand 1: vertical cryostat GERSEMI
- Test stand 2: horizontal cryostat HNOSS
- Test stand 3: vertical cryostat μGERSEMI
- Summary of test stands
- Potential needs of cavities (1.3 GHz) for our future compact XFEL project



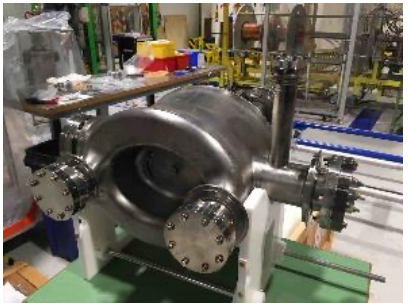
Scientific infrastructure

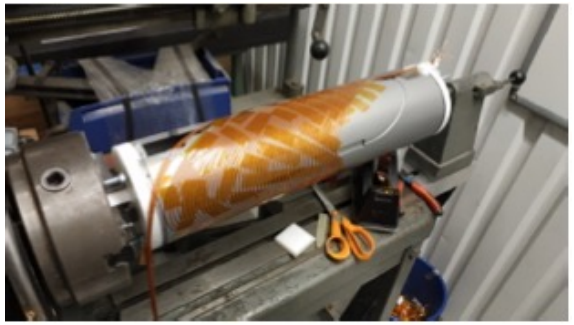
Particle physics
Nuclear physics

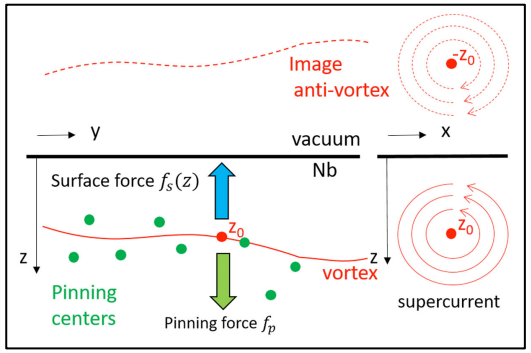
FREIA

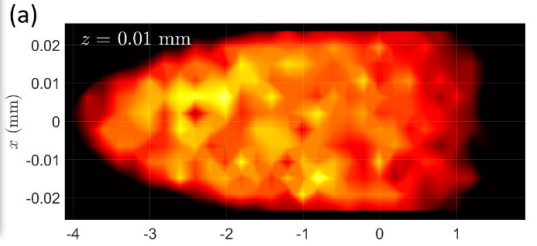
Condensed matter physics
Material science

Basic R&D





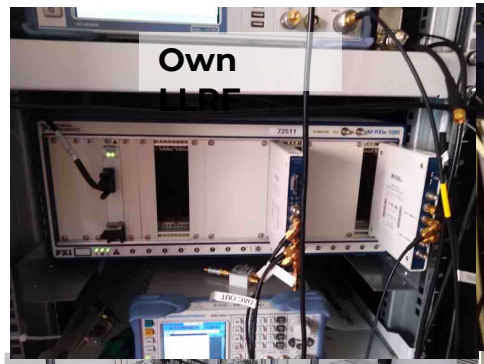


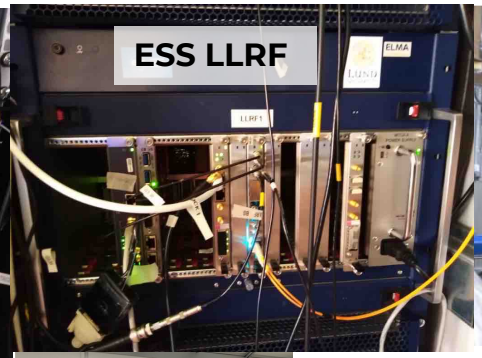


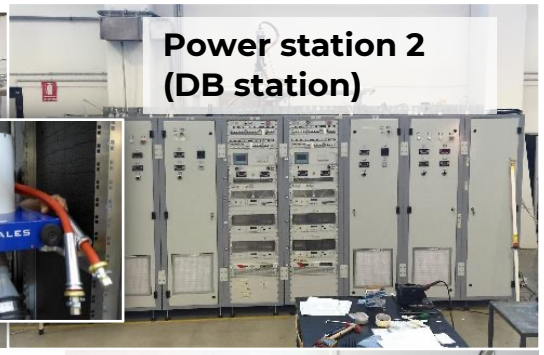
The FREIA team: experts from different field

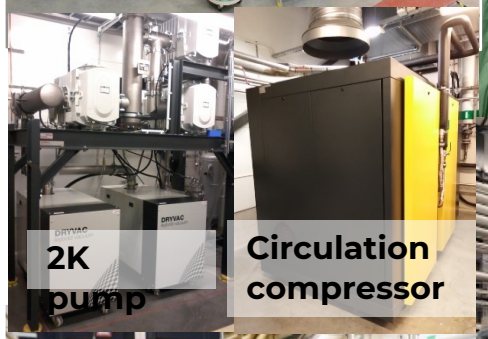
FREIA infrastructure

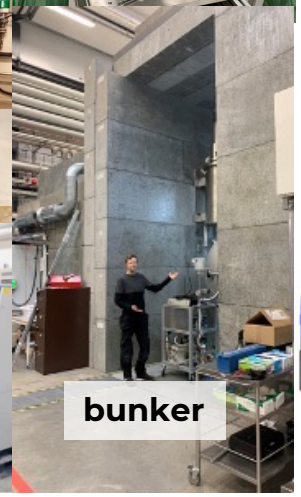
R. Ruber et al 2021 JINST 16 P07039







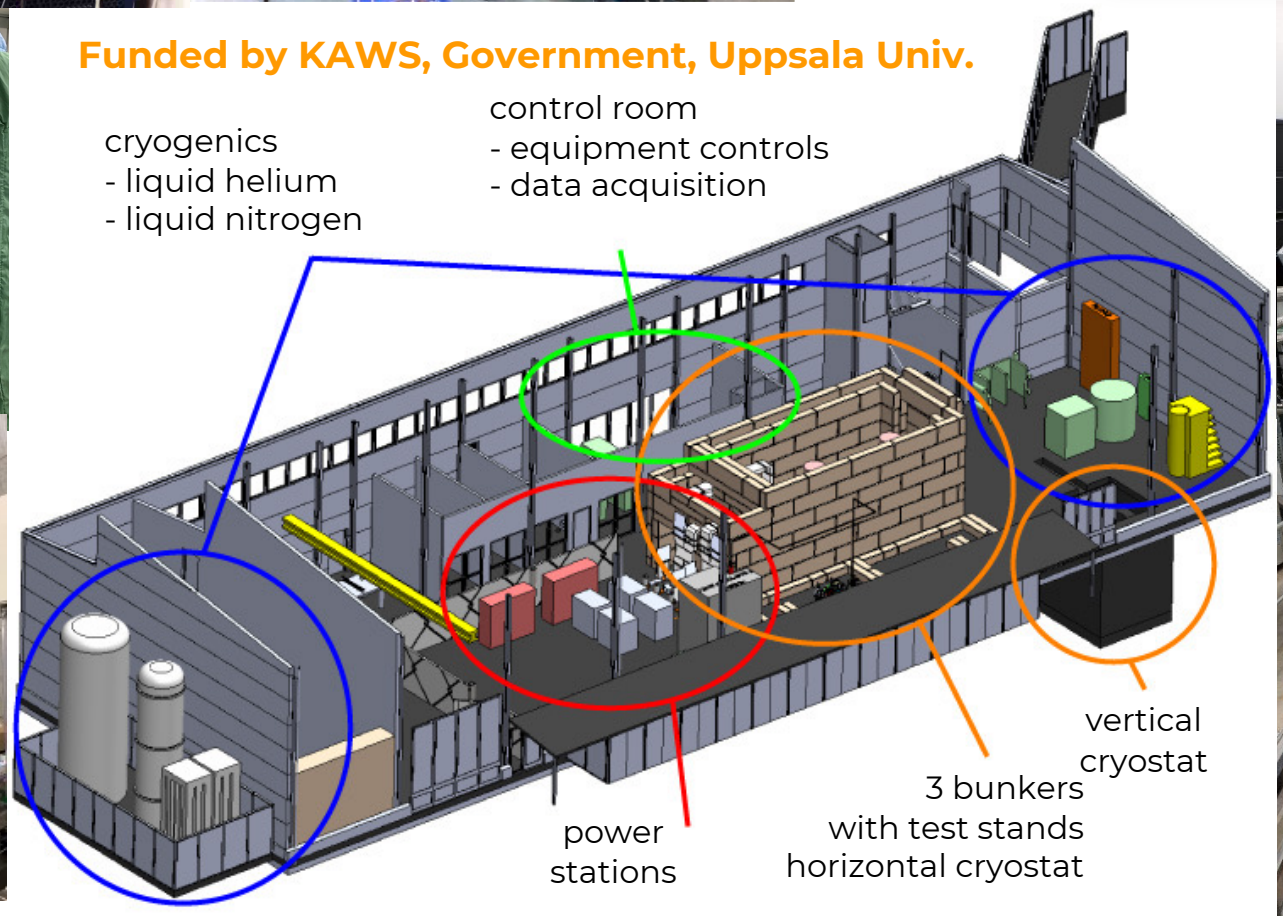


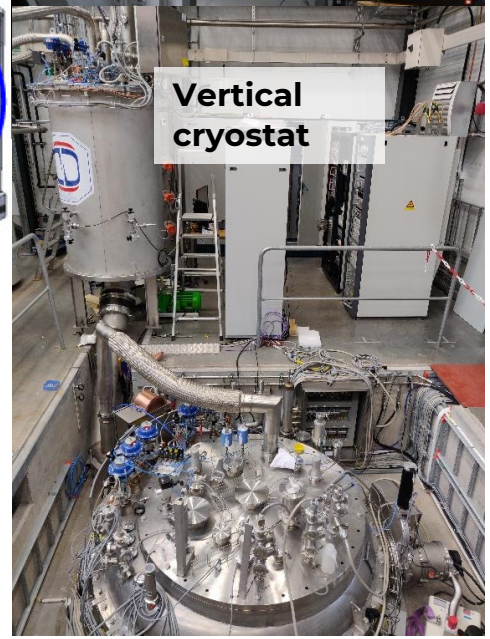


Funded by KAWS, Government, Uppsala Univ.

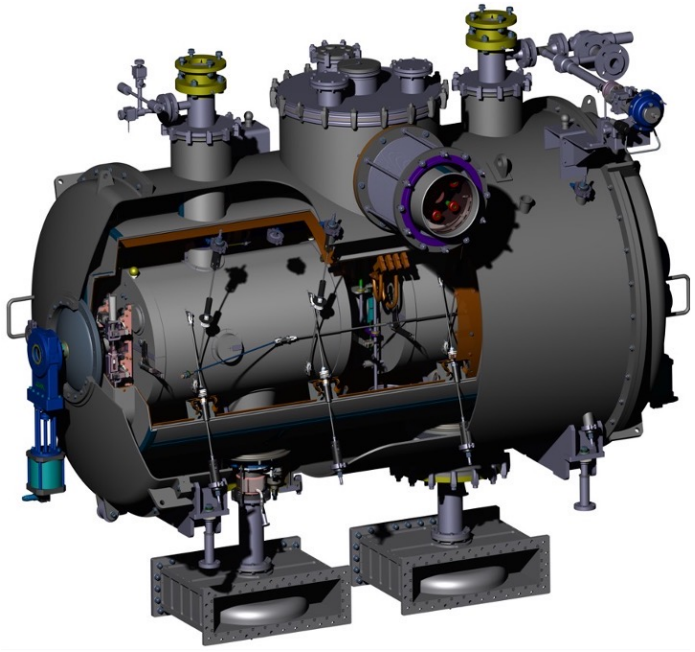
cryogenics
- liquid helium
- liquid nitrogen

control room
- equipment controls
- data acquisition

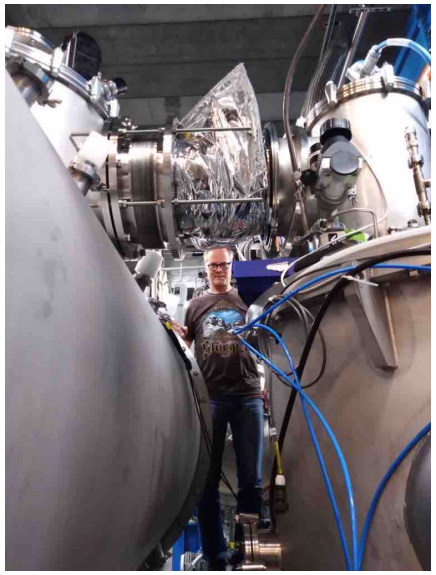




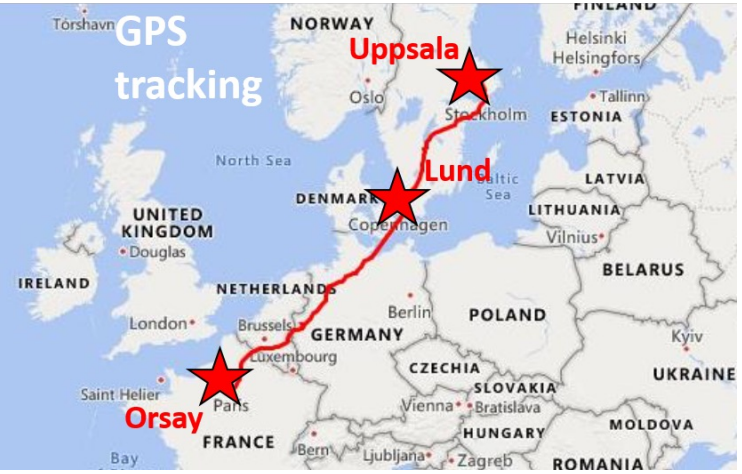
Present main project: ESS double spoke modules



Test & assessment at **FREIA laboratory in Uppsala**

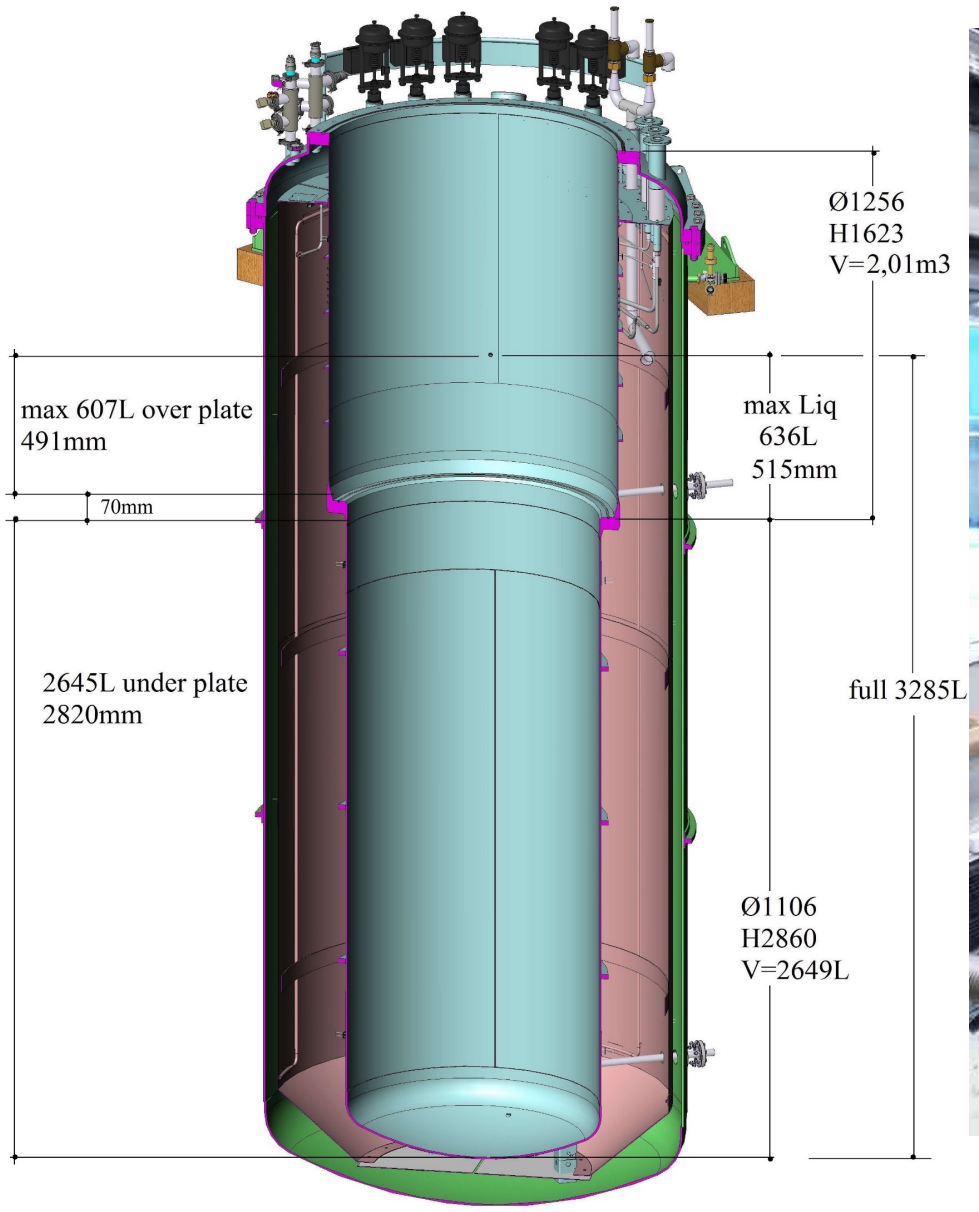



Assembly in **IJCLab**



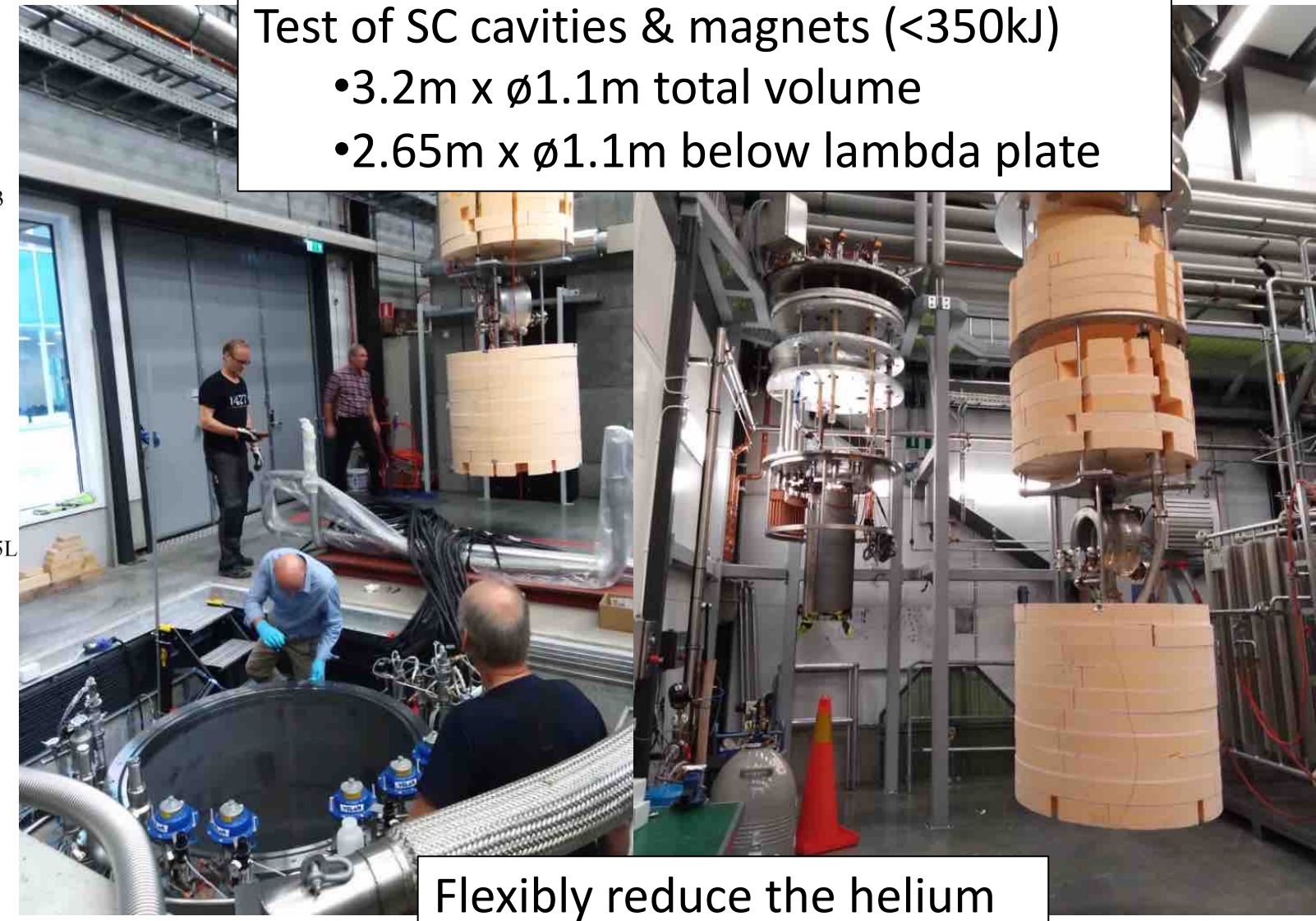
9/13 modules approved → Installation in **ESS**


Vertical cryostat GERSEMI



Test of SC cavities & magnets (<350kJ)

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

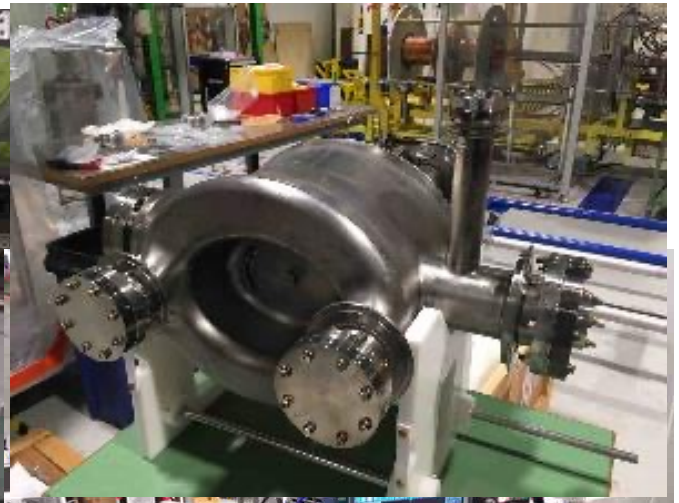


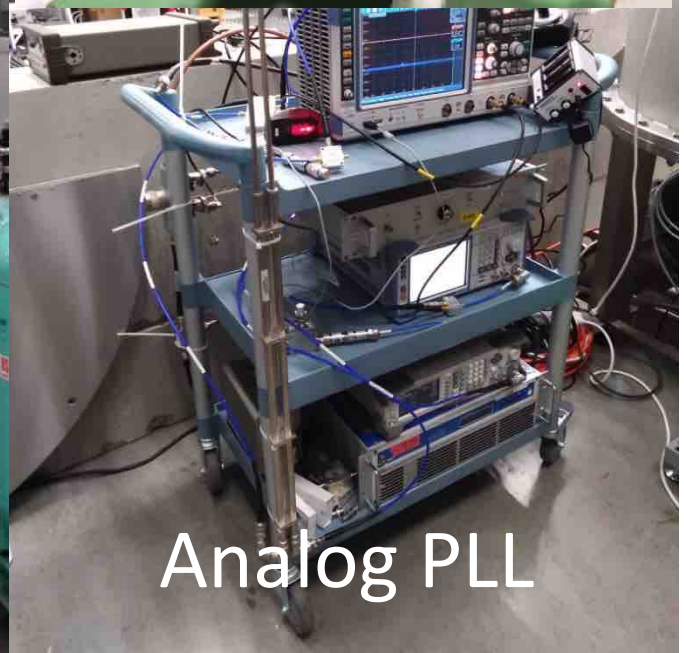
Flexibly reduce the helium volume by cryogenic foams

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

Superconducting test programs for HL-LHC

Double Quarter-wave crab cavity

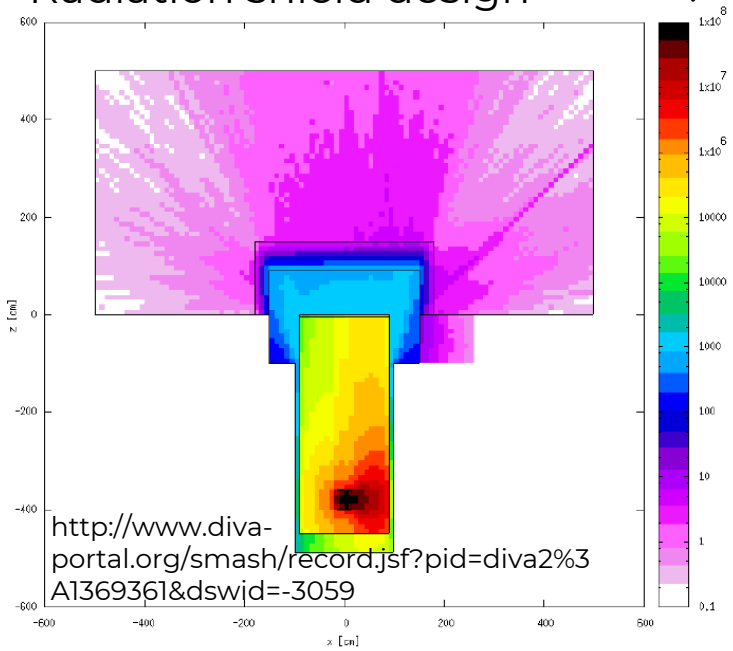


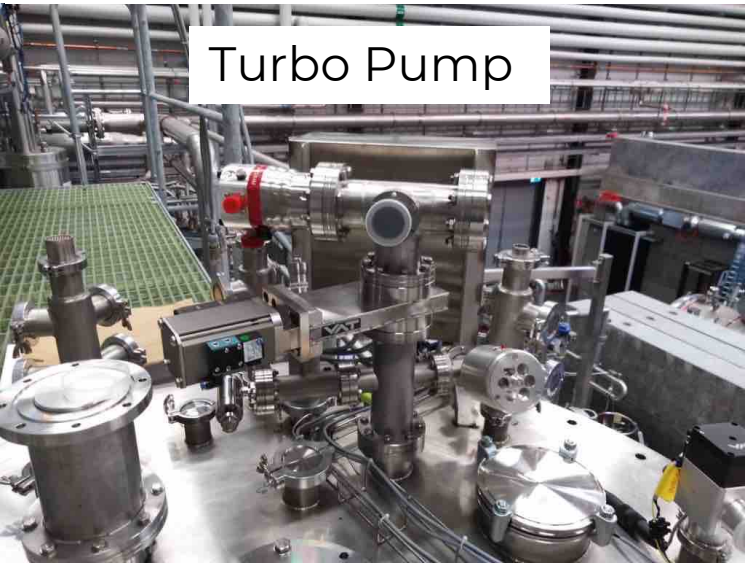


LHC MCBC corrector magnet

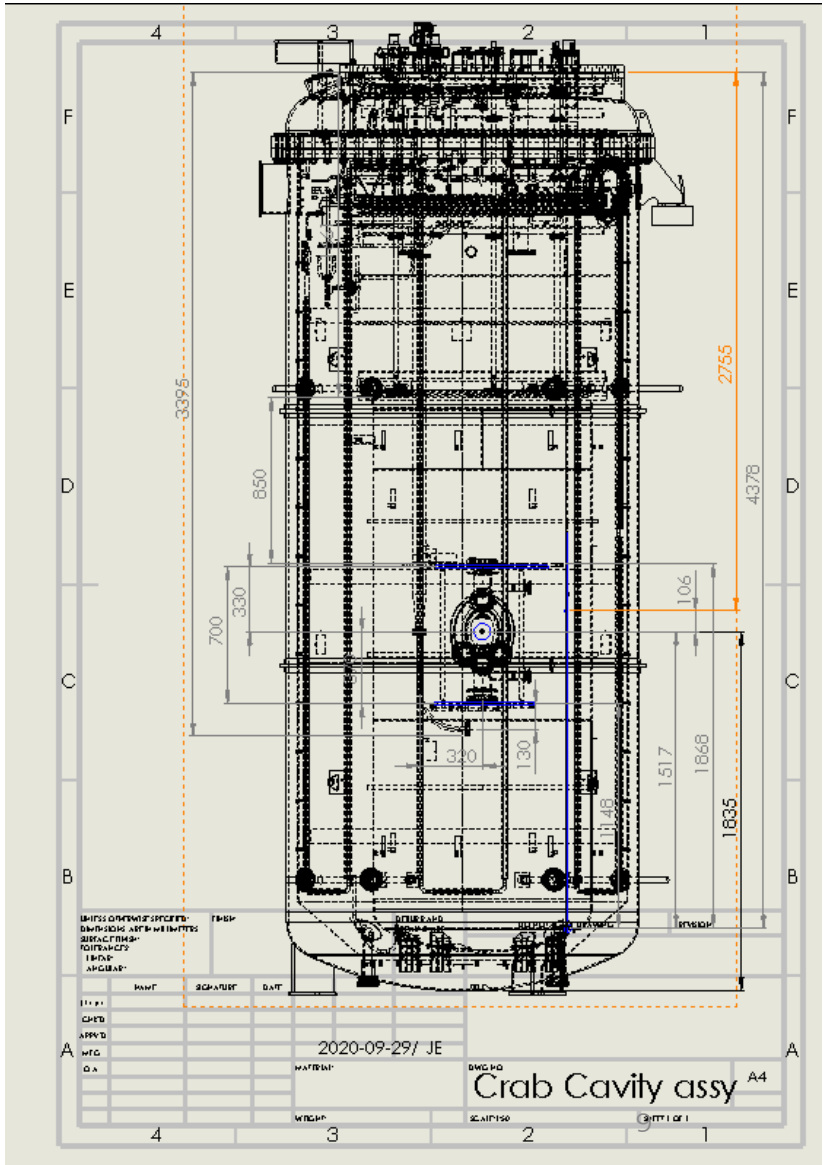
Radiation shield and cavity insert

Radiation shield design

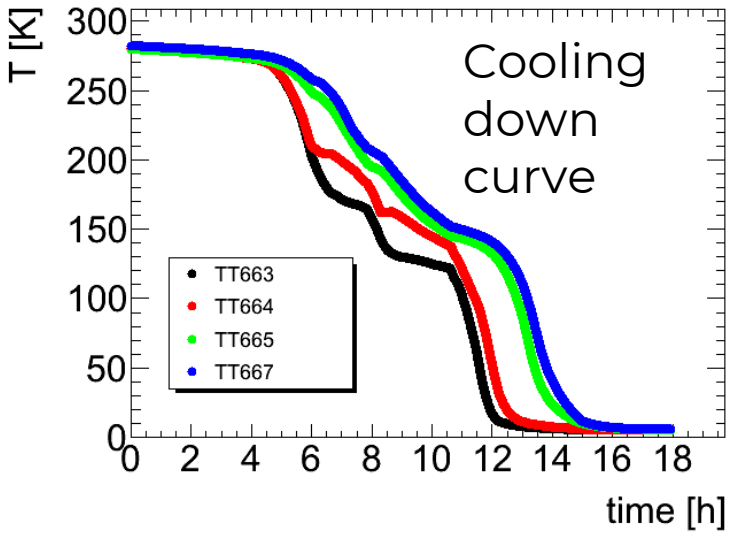


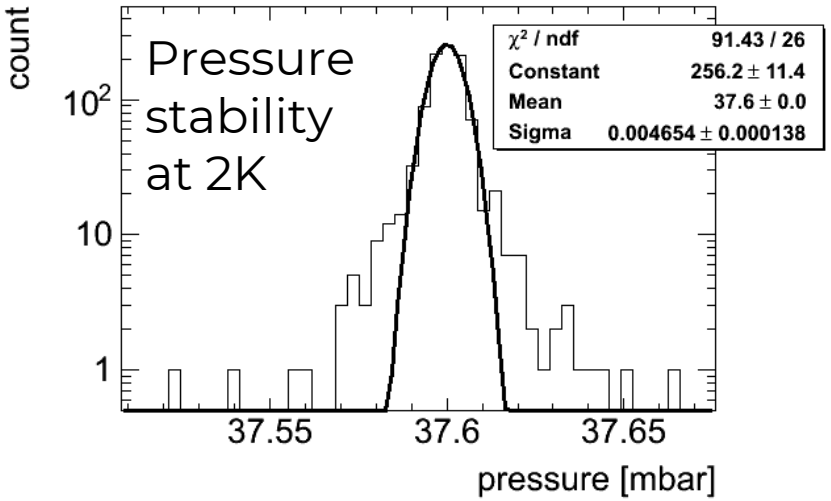


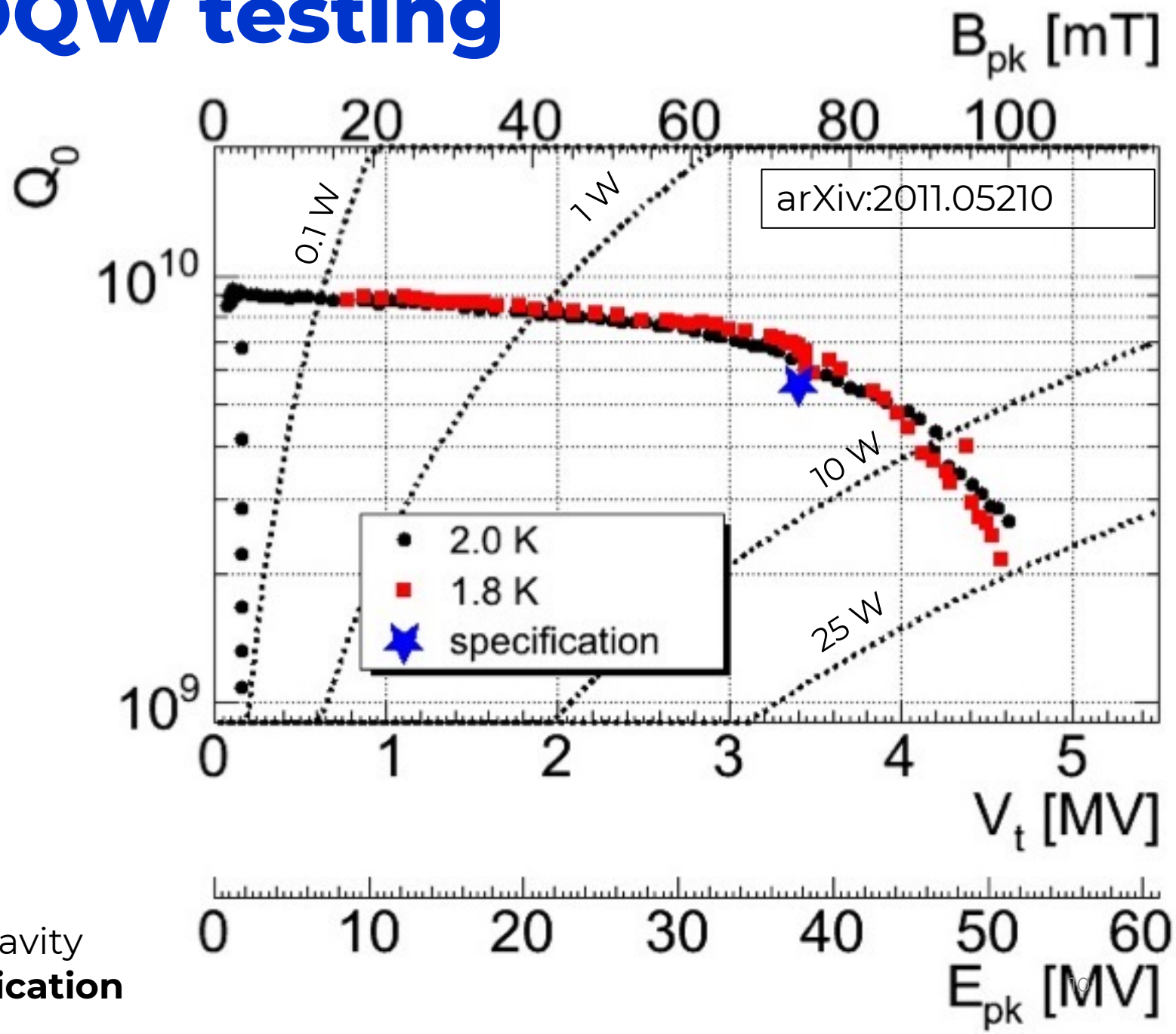
Mechanical design of the supporting structure



First result of DQW testing

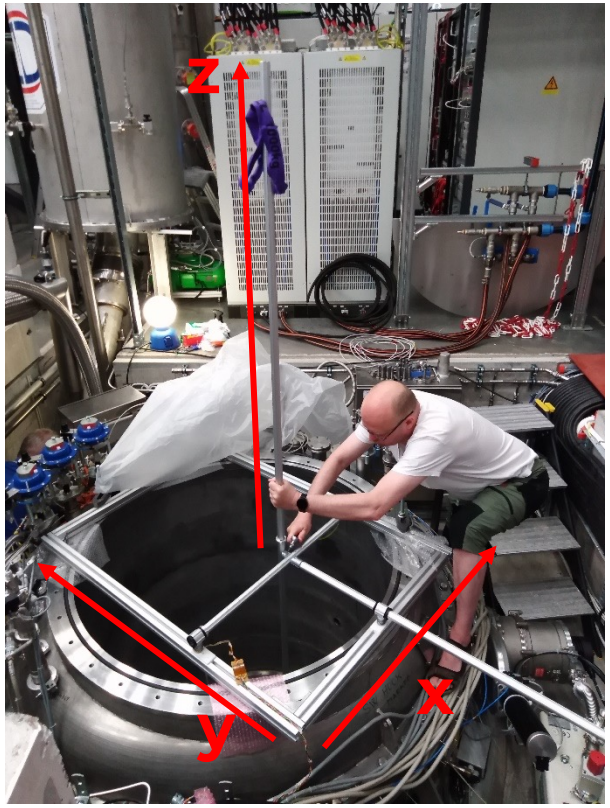


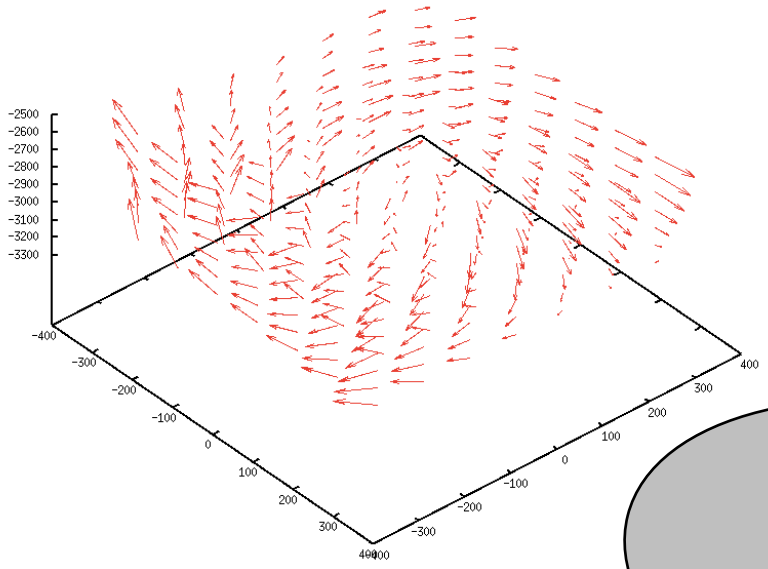


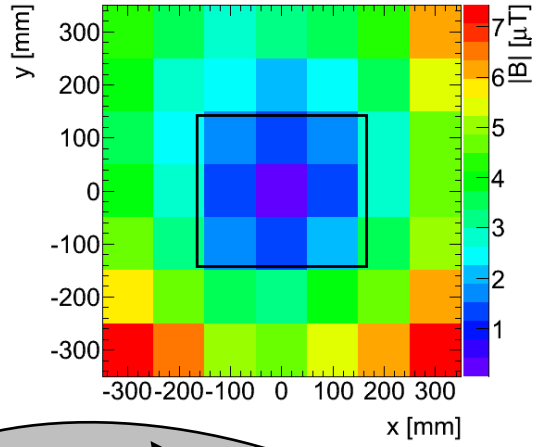


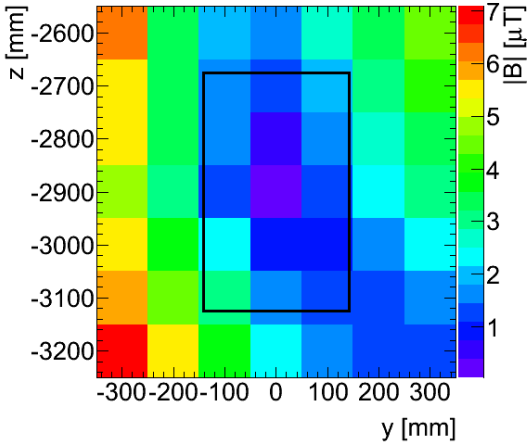
- ✓ Cryogenics nicely worked for the cavity
- ✓ **The result met the project specification**

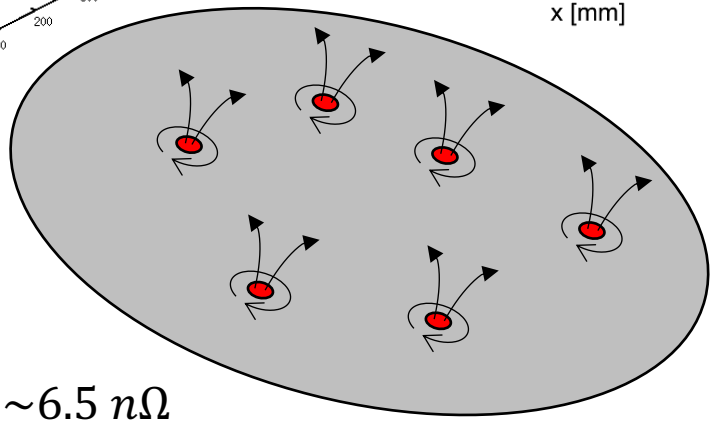
Magnetic field mapping after a magnet test

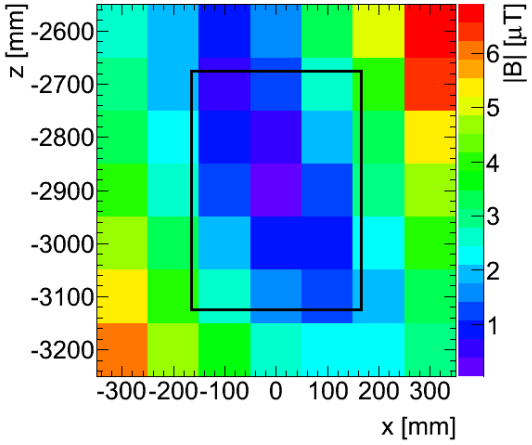










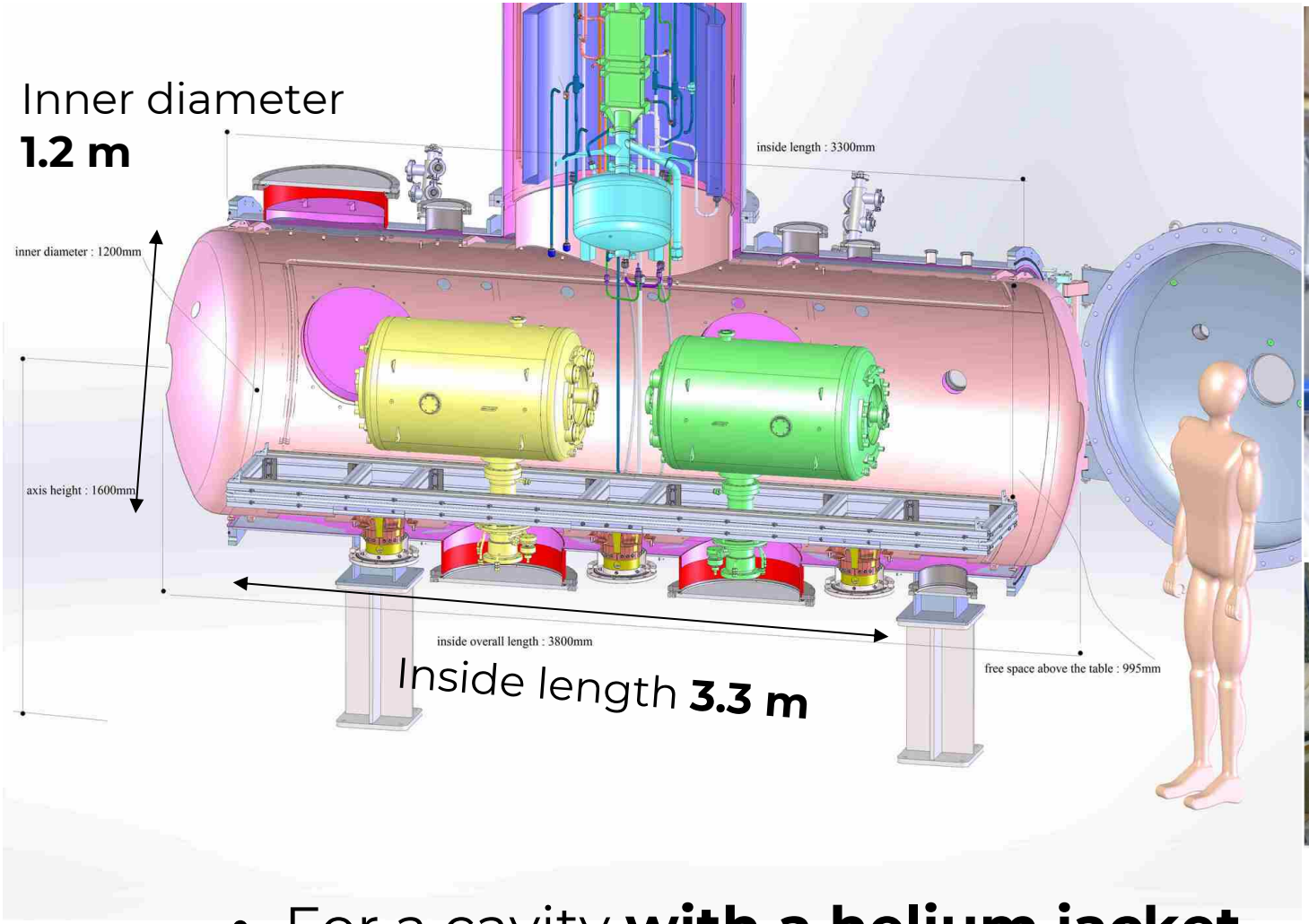


$$R_{\mathrm{mag}} \sim N \times \pi \xi_0^2 \times R_{\mathrm{n}} \sim \frac{B_{\mathrm{ext}}}{2B_{c2}} R_{\mathrm{n}} \sim 6.5\ n\Omega$$

- Hold 3D axis fluxgate sensor (Bartington)
- Helmholtz coils around to compensate the ambient field
- Horizontal scan: -30 cm < x < 30 cm; -30 cm < y < 30 cm
- Vertical scan: -400 cm < z < 0 (cavity center: -290 cm; top flange: 0 cm)

→ Good to check the homogeneity of the magnetic field inside the cryostat

Horizontal cryostat HNOSS for jacketed cavities

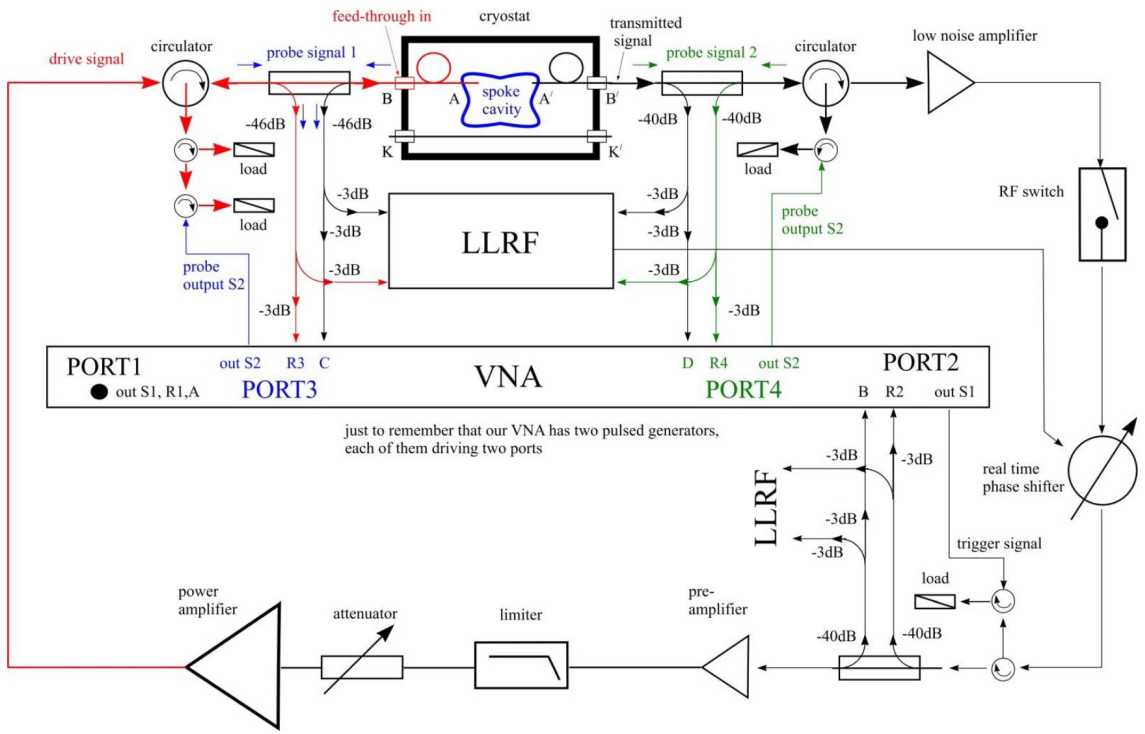


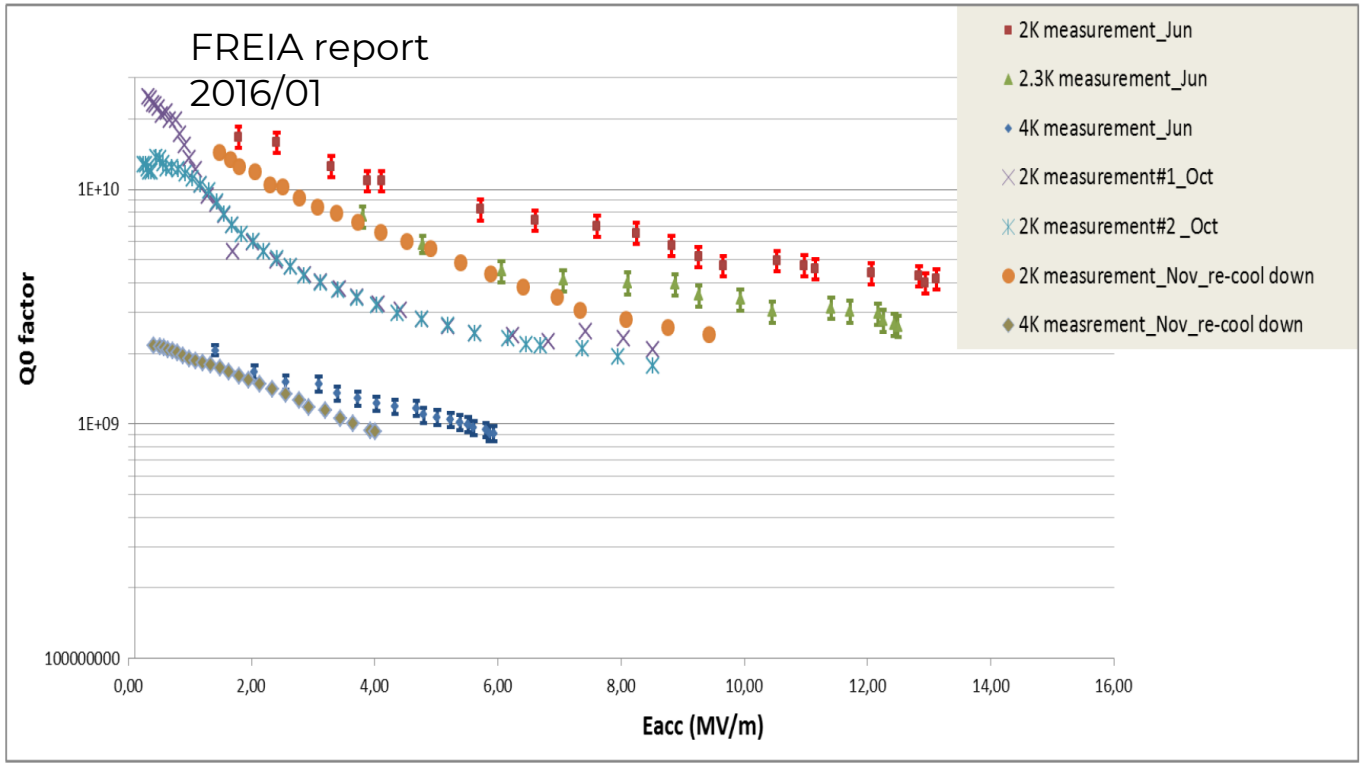
H. Li et al, NIMA 927, 63 (2019)
H. Li et al, LINAC 2018, THOP066

Figure 2: left #1 (Romea); middle #2 (Giulietta); right #3 (Germaine)

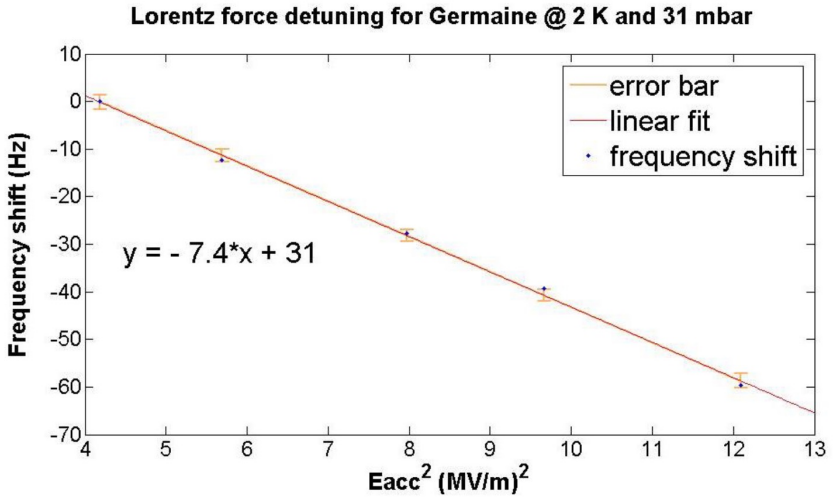
- For a cavity **with a helium jacket**
- Ideal for **coupler testing**: FPC, HOM
- **Multiple cavities** may be tested at the same time

He-jacketed cavity testing at HNOSS

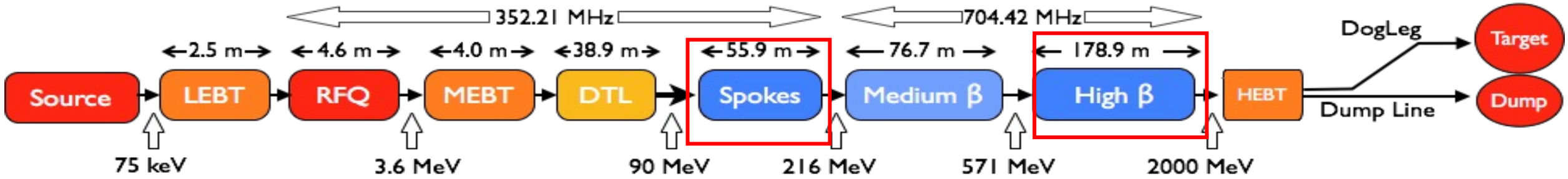


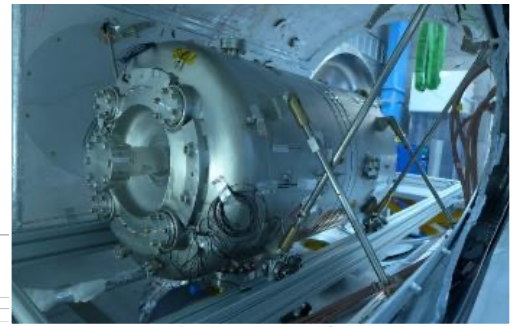


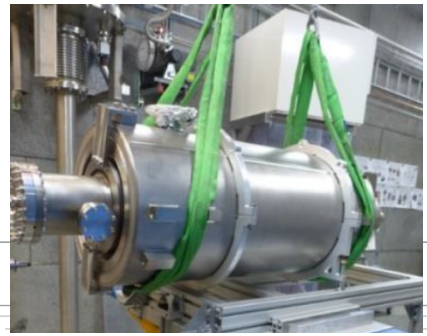
- Our LLRF card is equipped with Self-Excited-Loop (SEL) to lock critically coupled cavities
- **Q vs E and other standard measurements can be performed in HNOSS if the cavities are equipped with He jackets**



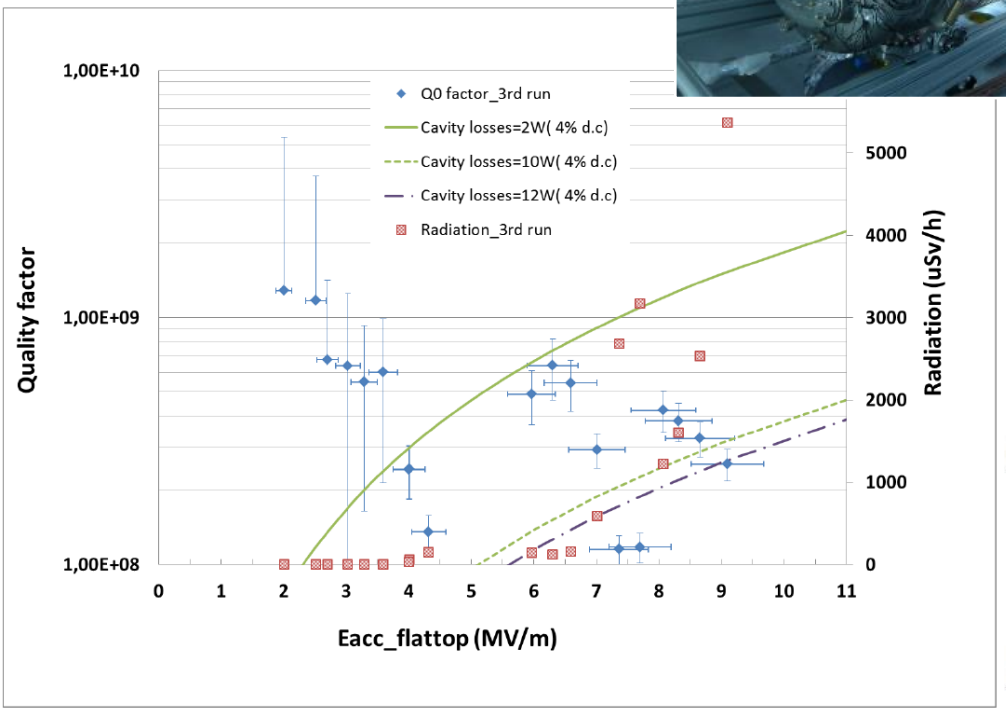
Cavity testing with power couplers & tuners

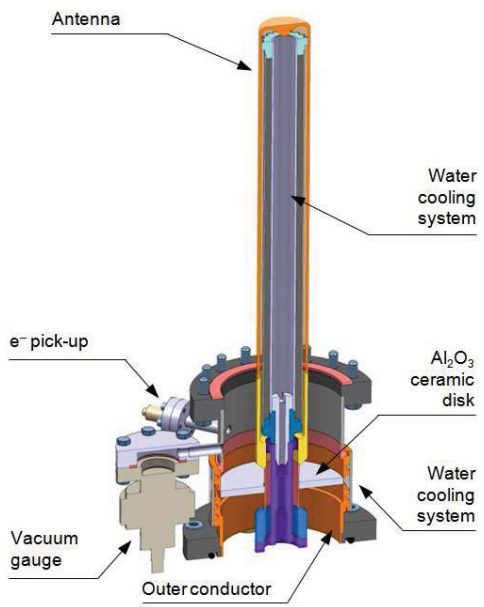




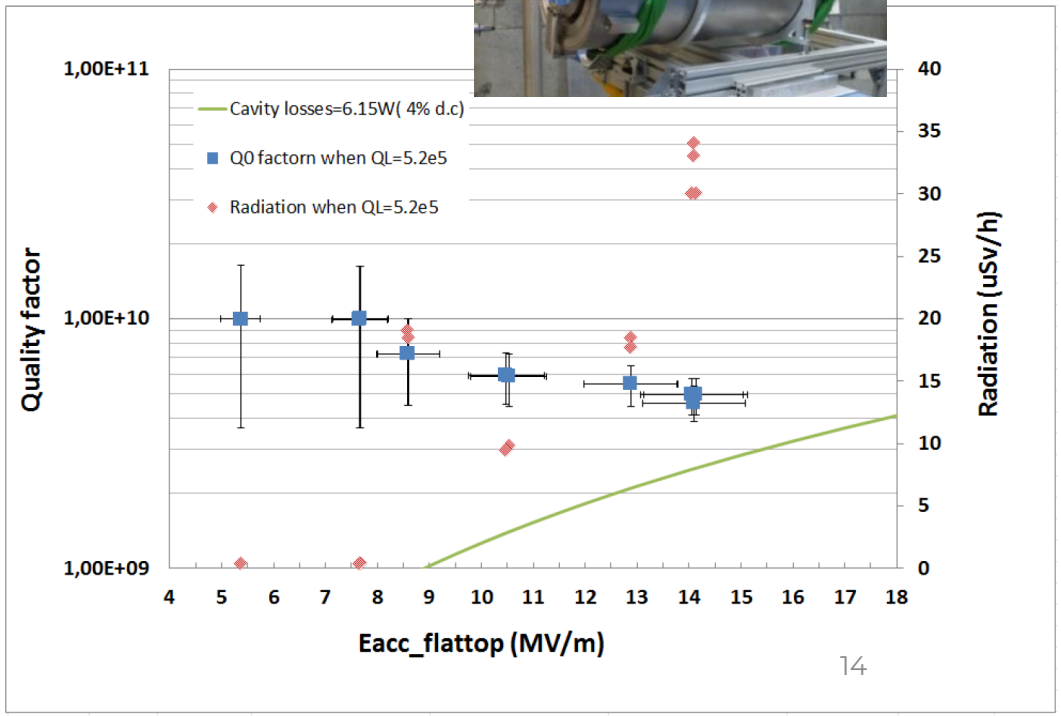


FREIA report 2017/10

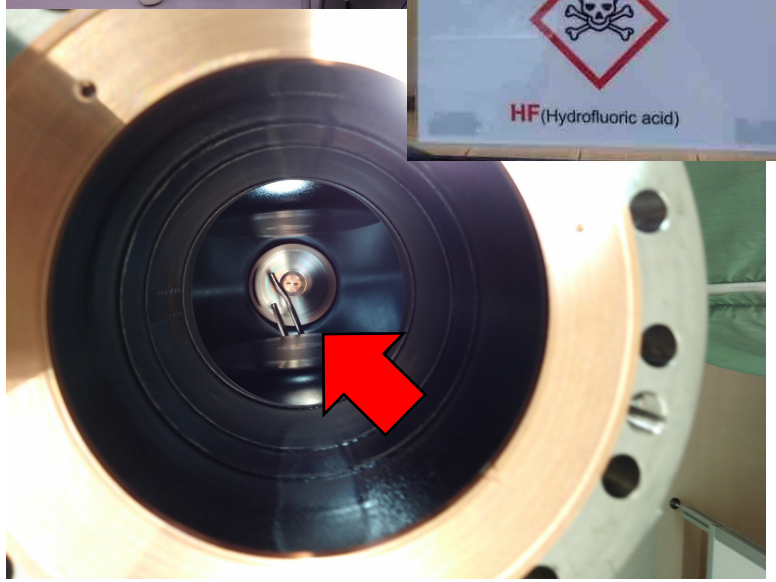




FREIA report 2018/07

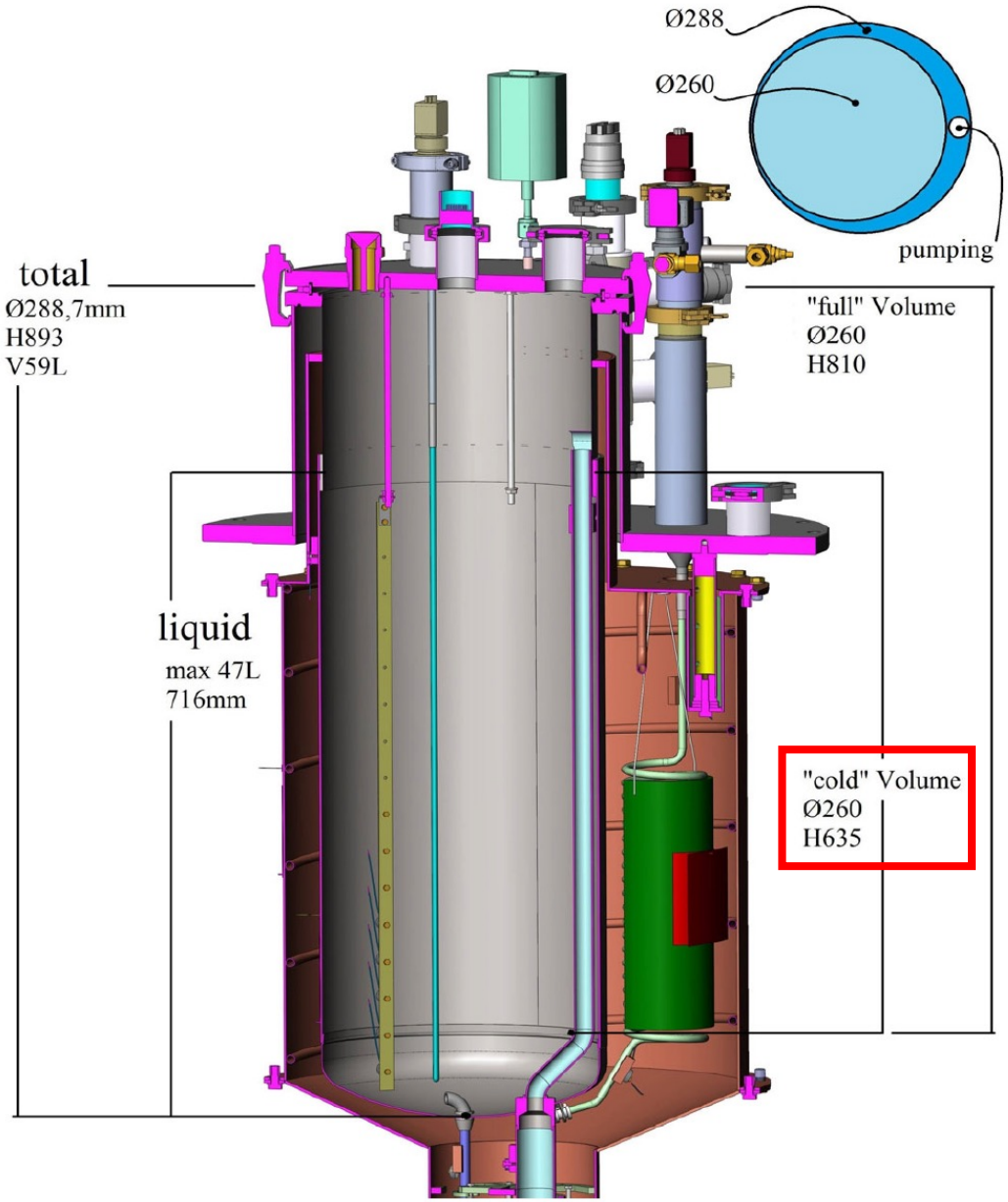


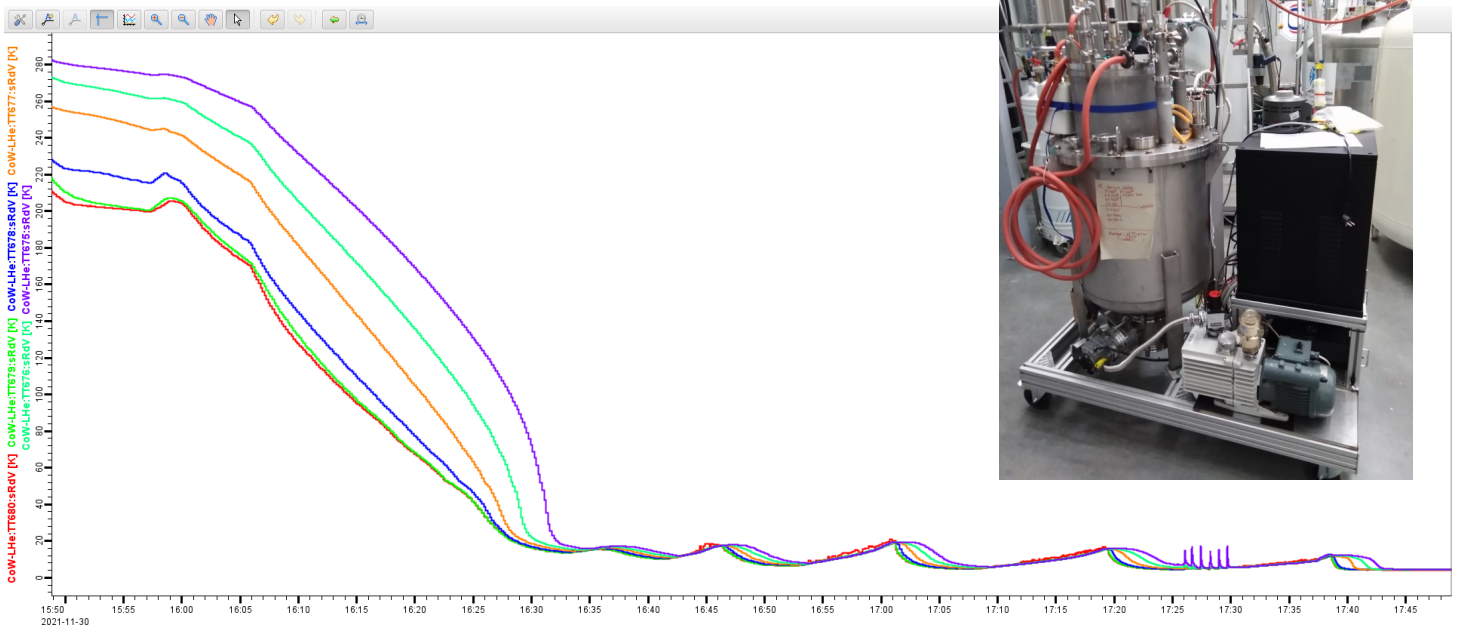
Cleanroom is available for SC activities



✓ A pick-up antenna falling off during transport was fixed in the cleanroom

μGERSEMI (aka "CoW") cryostat





- Mobile cryostat (Cryostat on Wheel) for 4K 1 bar operation newly commissioned
- Flexibly adapt different feedthroughs such as RF coax
- Excellent for testing equipment
- For R&D of small cavities?

FREIA Test stand 1 summary

GERSEMI				
No	Property name	Value	Unit	Comment
1	LHe volume	3300	L	To be reduced
2	Operating temperature	1.8-2.0	K	4K not stable
3	Diameter / size	1.1 / 2.8	m	
4	Number of inserts	1 (+1)		+Magnet insert
5	RF Frequency	352	MHz	To be upgraded
6	Maximum Incident power	100	W	
7	Additional instrumentation	3D fluxgate		
8	Typical testing rate (Vts / year)	0.5-1	Per month	
9	Possibility to test naked cavities	YES	YES / NO	
10	Infrastructure for small intervention	YES	YES / NO	Clean room ISO10

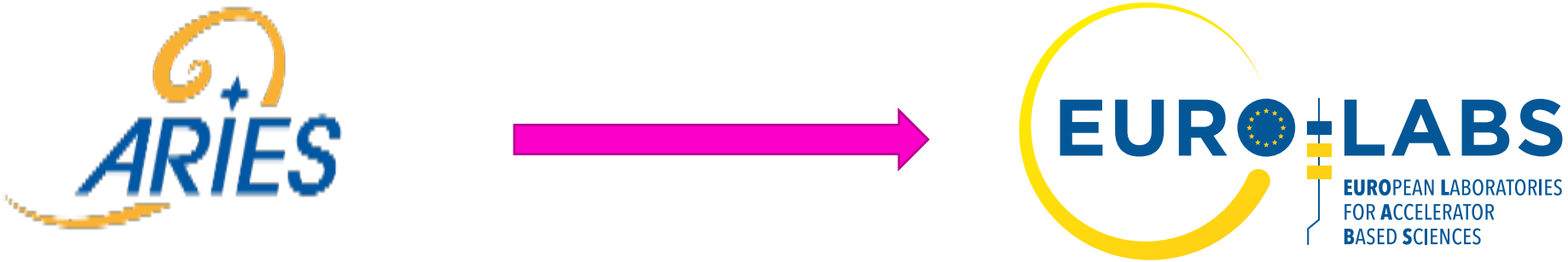
FREIA Test stand 2 summary

HNOSS (Horizontal)				
No	Property name	Value	Unit	Comment
1	LHe volume	He jacket only	L	
2	Operating temperature	1.8-2.0	K	4K not stable
3	Diameter / size	1.2 / 3.3	m	
4	Number of inserts			
5	RF Frequency	352	MHz	To be upgraded
6	Maximum Incident power	100	W	
7	Additional instrumentation			
8	Typical testing rate (Vts / year)	0.5-1	Per month	
9	Possibility to test naked cavities	NO	YES / NO	
10	Infrastructure for small intervention	YES	YES / NO	Clean room ISO10

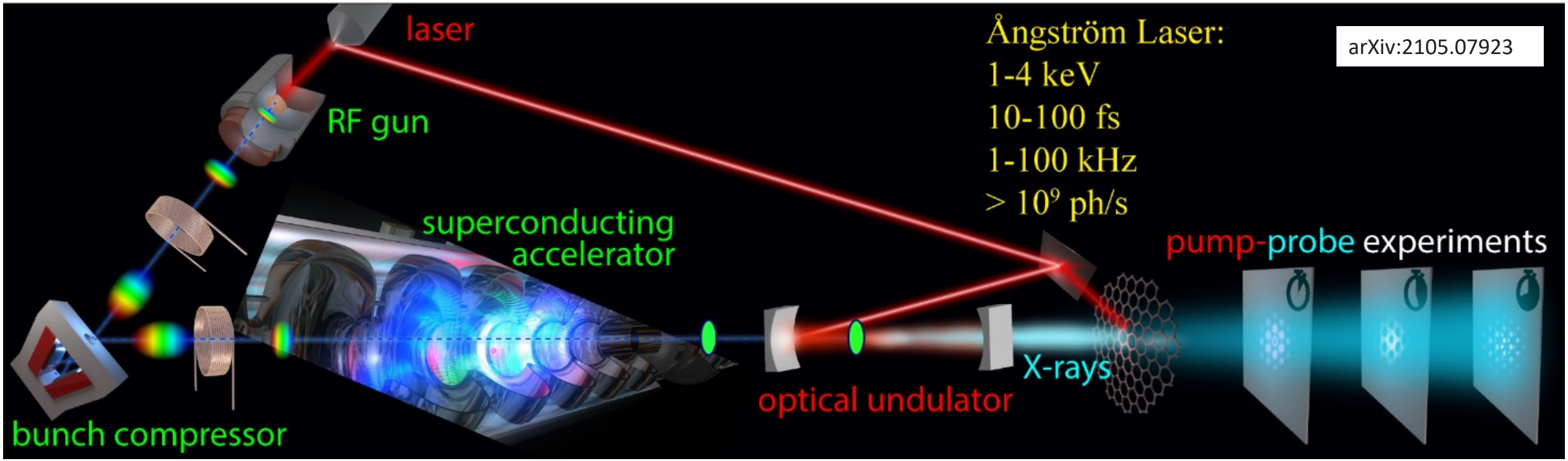
FREIA Test stand 3 summary

μGERSEMI (Cow)				
No	Property name	Value	Unit	Comment
1	LHe volume	47	L	
2	Operating temperature	4.2	K	
3	Diameter / size	0.26 / 0.635	m	
4	Number of inserts	1		
5	RF Frequency	352	MHz	To be upgraded
6	Maximum Incident power	100	W	
7	Additional instrumentation	3D fluxgate		
8	Typical testing rate (Vts / year)	3-4	Per month	
9	Possibility to test naked cavities	YES	YES / NO	
10	Infrastructure for small intervention	YES	YES / NO	Clean room ISO10

Funding to support user R&D



Inverse Compton X-ray source “Ångström Laser”



- CW SRF cavities + high-power short pulsed IR laser
- Short pulsed X-ray with high repetition rate
- Future stage for coherent X-ray source
  - Seeding fine structure in a bunch by Grating + emittance exchange

We need state-of-the-art cavities soon

Foreseen Projects				
Project name (not obligatory)	Frequency	Amount of cavities	Operating temperature	Comment
Angstrom laser	1.3 GHz	1	1.8K - 2 K	3 cell, 40 MV/m
Angstrom laser	1.3 GHz	1	1.8K - 2 K	9 cell (TESLA), 40 MV/m

iFAST

ACCELERATOR AND MAGNET INFRASTRUCTURE FOR COOPERATION AND INNOVATION

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ACCELERATOR
AND MAGNET INFRASTRUCTURE
FOR COOPERATION AND INNOVATION

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.