



UPPSALA
UNIVERSITET



Uppsala Technological infrastructure GERSEMI

17 November 2022

Kévin Pepitone



17 November 2022

Gersemi - Pepitone

iFAST

INFN
LASA
Istituto Nazionale di Fisica Nucleare
Laboratorio Acceleratori e Superconduttività Applicata

**SUPERCONDUCTING MAGNET
WORKSHOP**

LASA, MILAN (IT) 17-18 NOVEMBER 2022

TEST FACILITIES FOR SUPERCONDUCTING MAGNET



FREIA
laboratory



GERSEMI



Insert



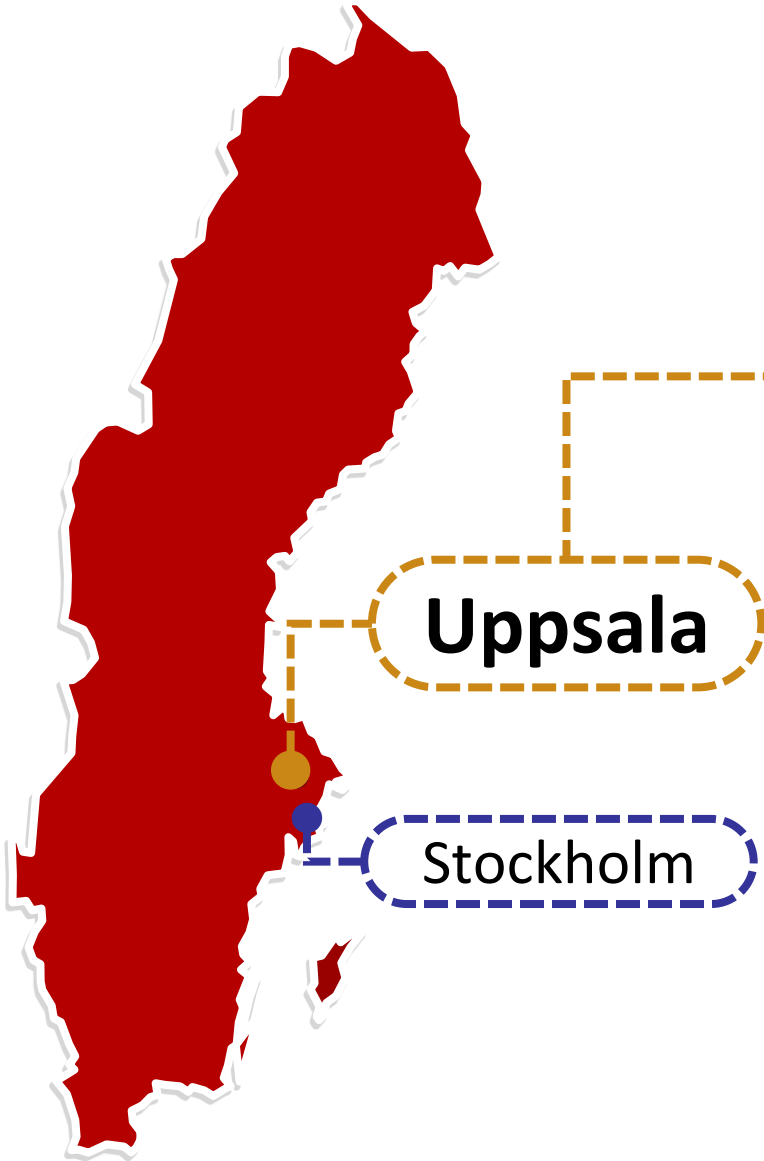
Conclusions



The FREIA laboratory



Facility for Research Instrumentation and Accelerator Development





The FREIA laboratory

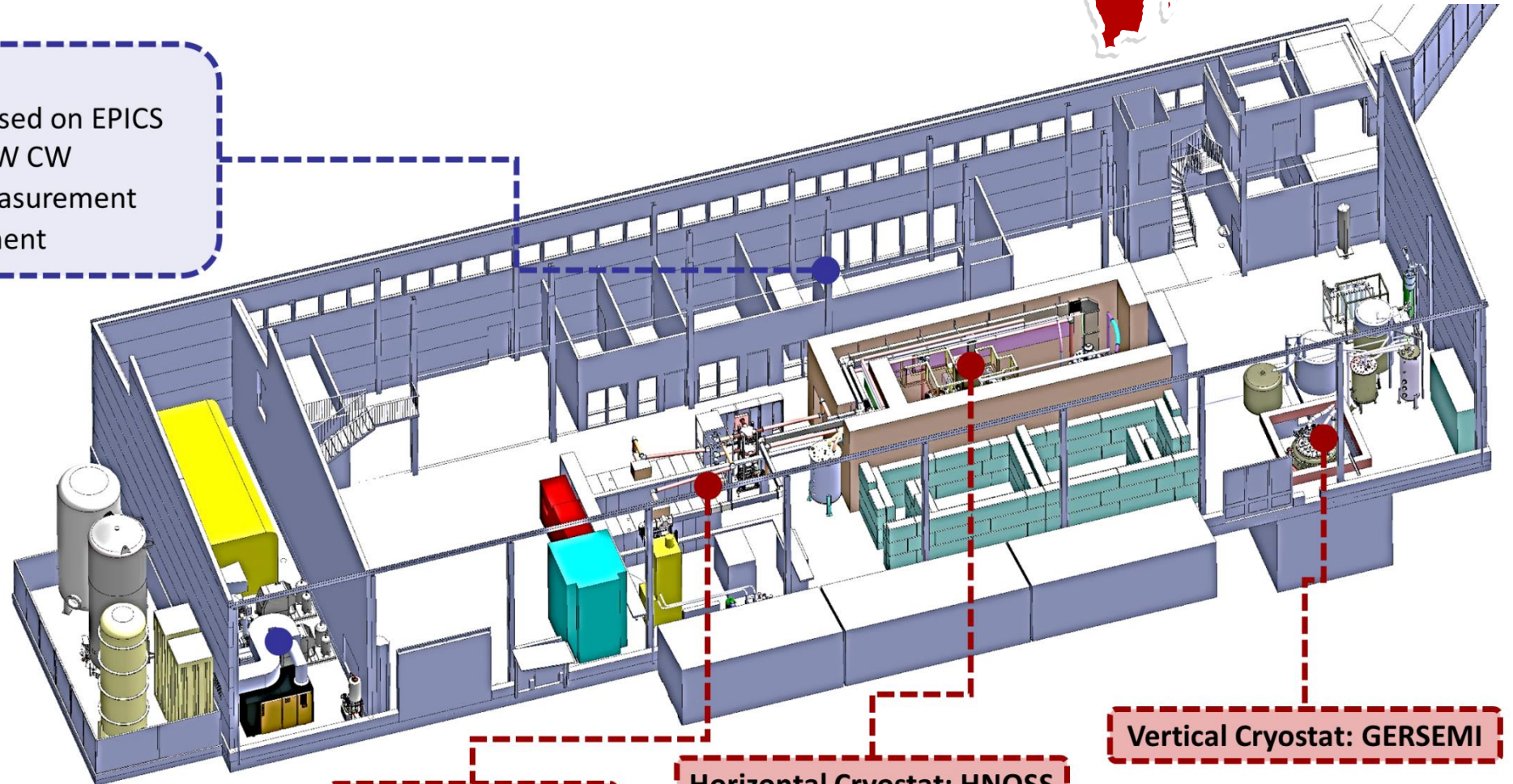
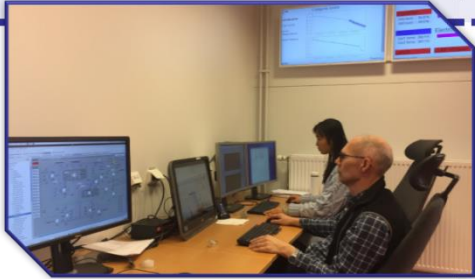


Uppsala

Stockholm

Control Room

- The overall control system is based on EPICS
- Self-excited loop, 352 MHz, 1 kW CW
- LLRF controls and RF power measurement
- Standard measurement equipment



RF stations

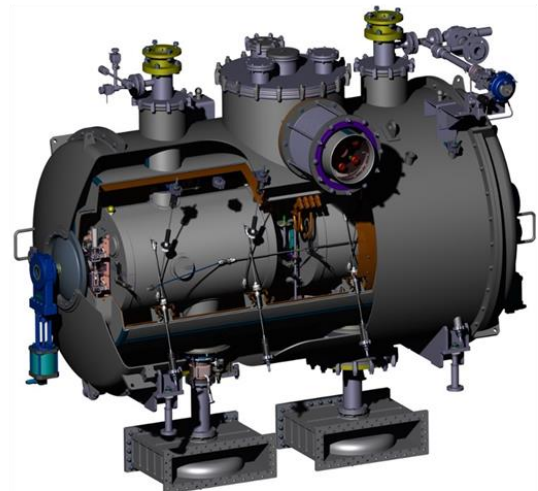
Horizontal Cryostat: HNOSS

Vertical Cryostat: GERSEMI

<https://arxiv.org/abs/2103.05265>

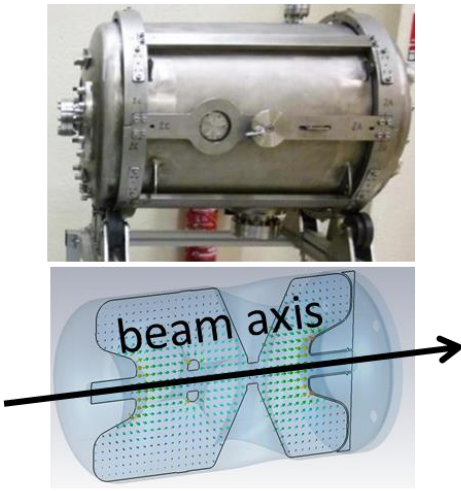
International collaboration for ESS double spoke modules

Cryomodule



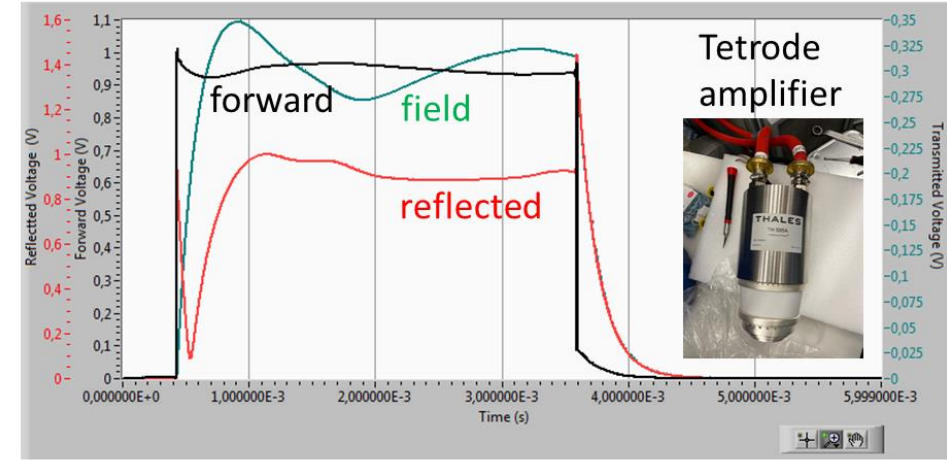
Assembly in IJCLab @ Orsay

SC spoke cavity (bulk Nb)

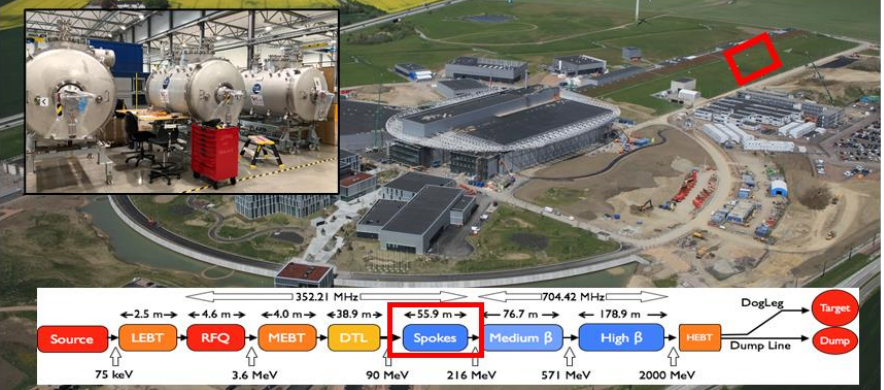


Assessment in FREIA

9MV/m 400 kW (3.2 ms 14 Hz pulse)



8/13 approved for ESS @ Lund



Akira
Miyazaki

Cryo system:

- 2000 L dewar (+ 1000 L extra dewar)
- 140 L/h liquefier
- 19.2 m³ high pressure storage at 200 bar
- 255 m³/h compressors (to pump the gas bag)
- 100 m³/h Kaeser
- 100 m³ gas bag

Users:

- Gersemi
- ESS cryomodules tests
- COW
- LHe delivery (approx. 300 L/week)





GERSEMI

Gersemi (Old Norse* "treasure") is the daughter of the fertility-goddess **Freyja** in Norse mythology.

She could be the same figure as Hnoss, another daughter of Freyja.



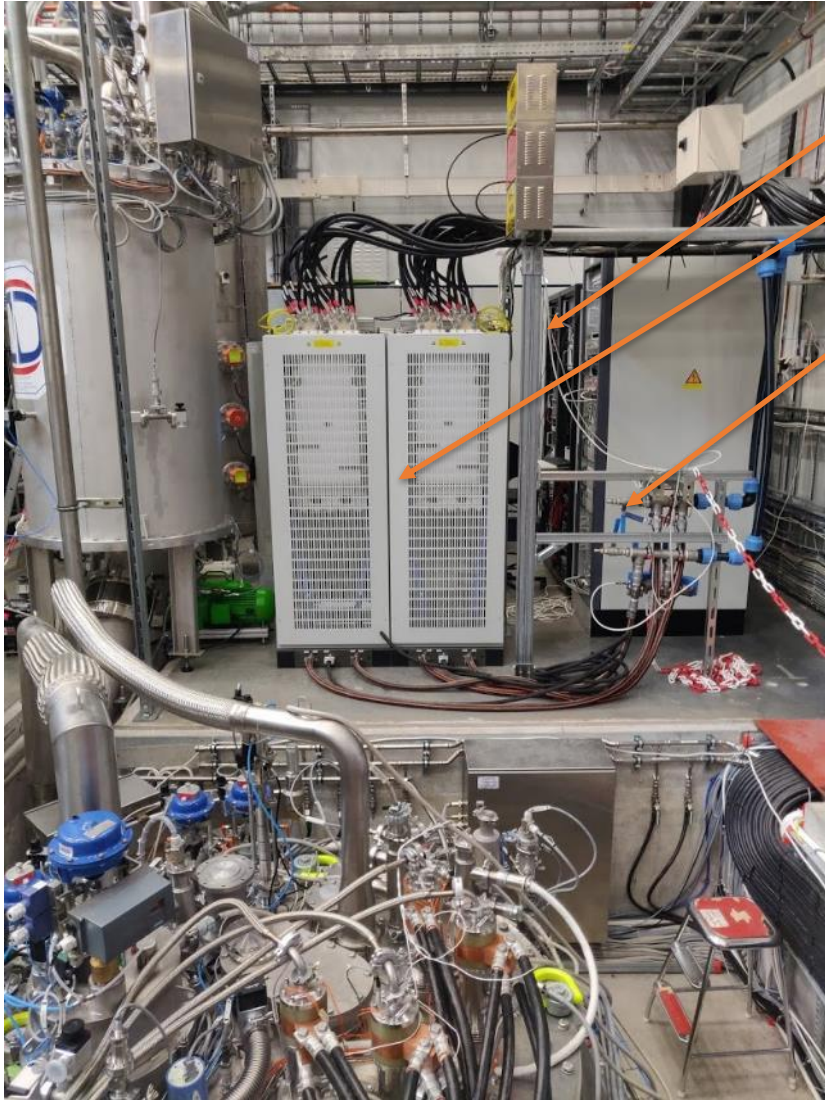
In Norse paganism, **Freyja** (*Old Norse: "(the) Lady") is a goddess associated with love, beauty, fertility, sex, war, gold, and seiðr (magic for seeing and influencing the future).



Freyja (1905) by John Bauer (1882–1918)

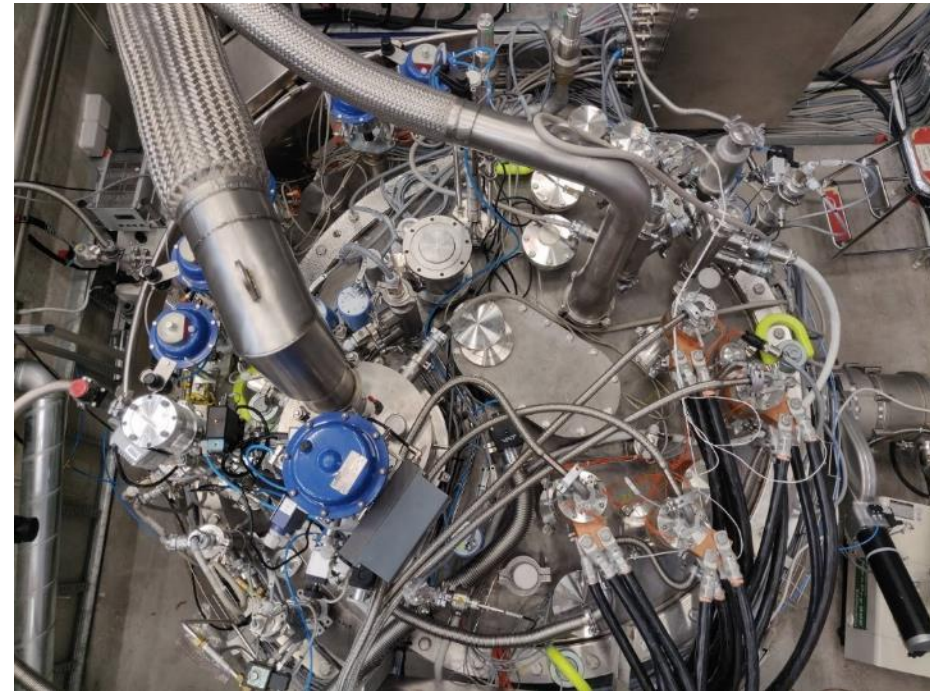
**Old Norse is a stage of development of North Germanic dialects before their final divergence into separate Nordic language*

<https://en.wikipedia.org/wiki/Gersemi>



- Data acquisition and PLC
- Energy extraction units
- Power converters 2x2 kA

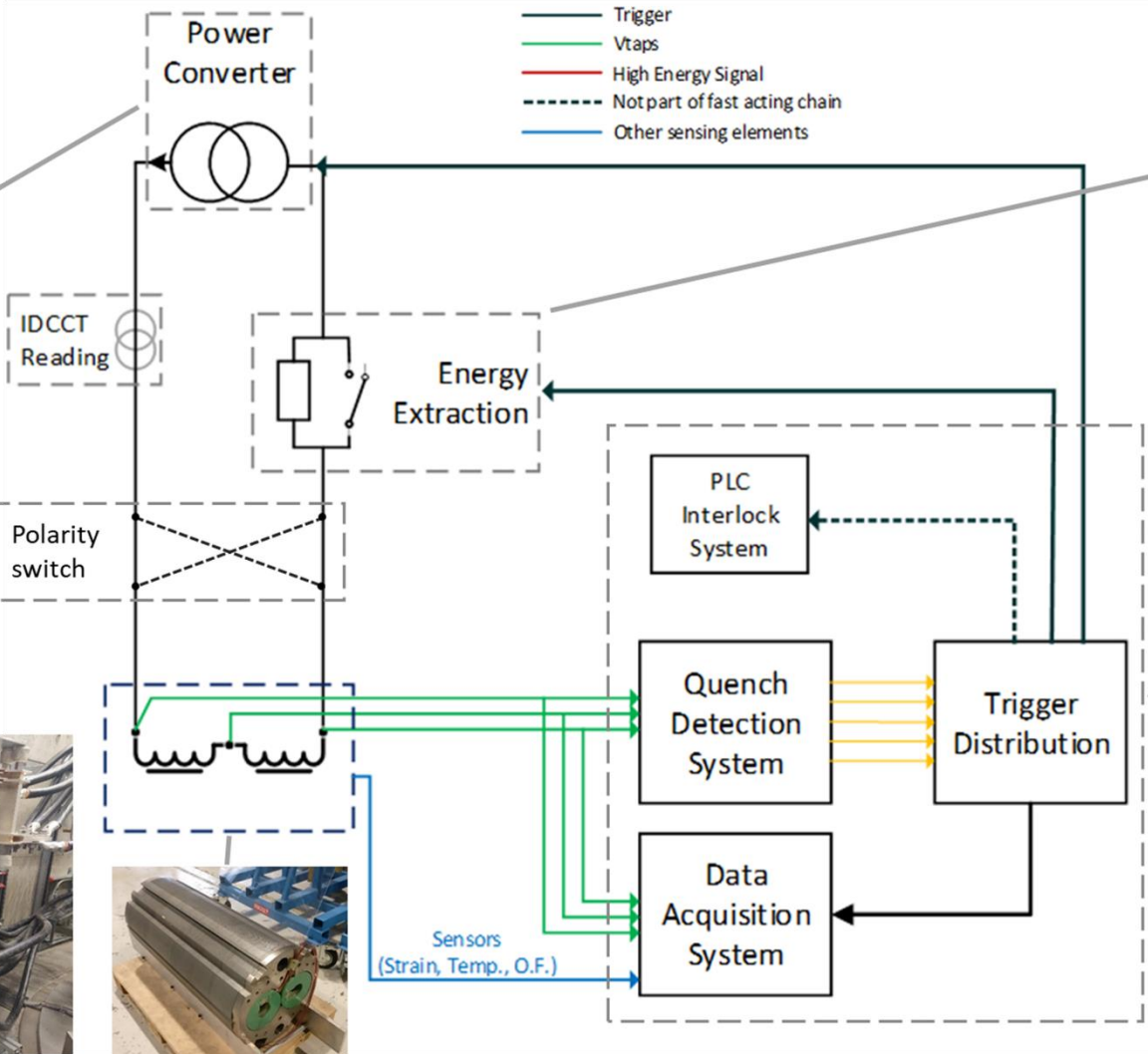
Magnetic insert fully equipped



Power converters can provide a maximum of 2×2 kADC for a maximum voltage of 10 VDC in one quadrant



Polarity reversing switches have been installed to operate in four quadrants



IGBT based energy extraction units
Dump resistors between 77 mΩ and 3200 mΩ



DAQ
72 LF channels
64 HF channels
DMM
10 channels crate
Safety
20 PotAim cards
1 uQDS
PLC



Settings RCH1

RAMP PLEP

REF:PLEP:ACCELERATION	0.000	0.000 A/s ²
REF:PLEP:EXP_FINAL	0.000	0.000 A
REF:PLEP:EXP_TC	0.00000	0.0000 s
REF:PLEP:FINAL	0.000	0.000 A
REF:PLEP:INITIAL	0.000	0.000 A
REF:PLEP:LINEAR_RATE	0.000	0.000 A/s

PLEP Mode: Not ARMED RUN

DCB1 DCB2 Debug

PC State: **FAULT**

Settings RCH2

RAMP PLEP

REF:PLEP:ACCELERATION	0.000	0.000 A/s ²
REF:PLEP:EXP_FINAL	0.000	0.000 A
REF:PLEP:EXP_TC	0.00000	0.0000 s
REF:PLEP:FINAL	0.000	0.000 A
REF:PLEP:INITIAL	0.000	0.000 A
REF:PLEP:LINEAR_RATE	0.000	0.000 A/s

PLEP Mode: Not ARMED RUN

PC State: **FAULT**

DCBreaker: MAG-EE-1:

Parameter	Current Reading	Current Status
Continuous total current	2000 A	Load current line 1
Overload factor	120 %	Load current line 2
Overload time	30 s	Total current
Peak current	2500 A	Overload
		Pressure 1
		Pressure 2
		Pressure delta
		Overpressure
		Tsense 1
		Tsense 2
		Tsense delta
		Pyrofuses ready (8V)
		Pyrofuses ok (8V)
		Rtemp 1
		Rtemp 2
		Rtemp delta
		Controller temperature
		Module 1 voltage VCE path
		Module 1 voltage VF path
		Module 1 voltage VF path
		Module 1 voltage VF path
		Module 1 voltage breaker
		Module 2 voltage VCE path
		Module 2 voltage VF path
		Module 2 voltage VCE path

Fast Power Abort 1

Interlock Key 1

24V PS Aux1

24V PS Aux2

Quench status

Polarity switch pos 1

Polarity switch pos 2

Fast Power Abort

Flash Boxes

High Voltage Flash Box

High Current Flash Box

Le Helium Flash Box

Fast Power Abort 2

Interlock Key 2

24V PS Aux1

24V PS Aux2

Quench status

Polarity switch pos 1

Polarity switch pos 2

Fast Power Abort

Polarity Switch 1

Motor Dir OK

PC Status OK

Switch MTR

Polarity

Polarity Switches

Motor direction to

Motor direction to

To Pos1 To Pos2

Power Permit PC-1

Interlock Key 1

24V PS Aux1

24V PS Aux2

Quench status

DAQ status

Lead 1 Temperature OK

Lead 2 Temperature OK

Power Permit

Power Permit PC-2

Interlock Key 2

24V PS Aux1

24V PS Aux2

Quench status

DAQ status

Lead 3 Temperature OK

Lead 4 Temperature OK

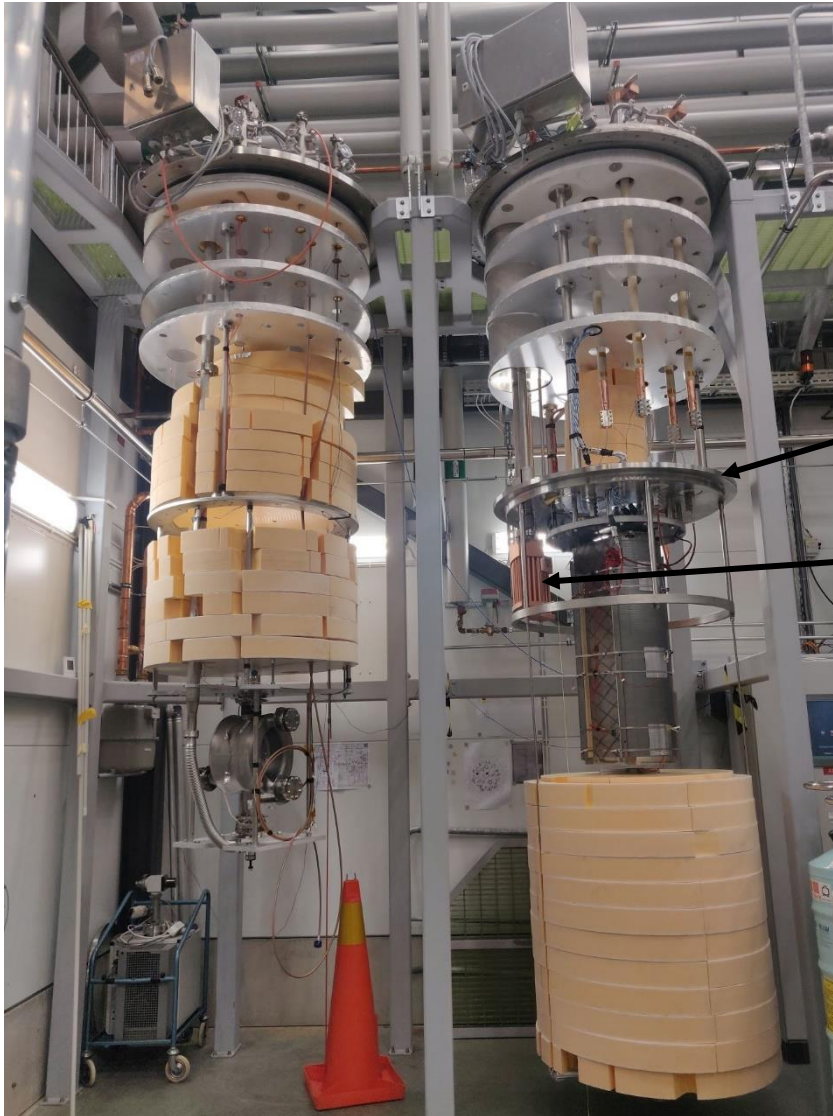
Power Permit

Konrad
Gajewski



Insert

Liquid insert

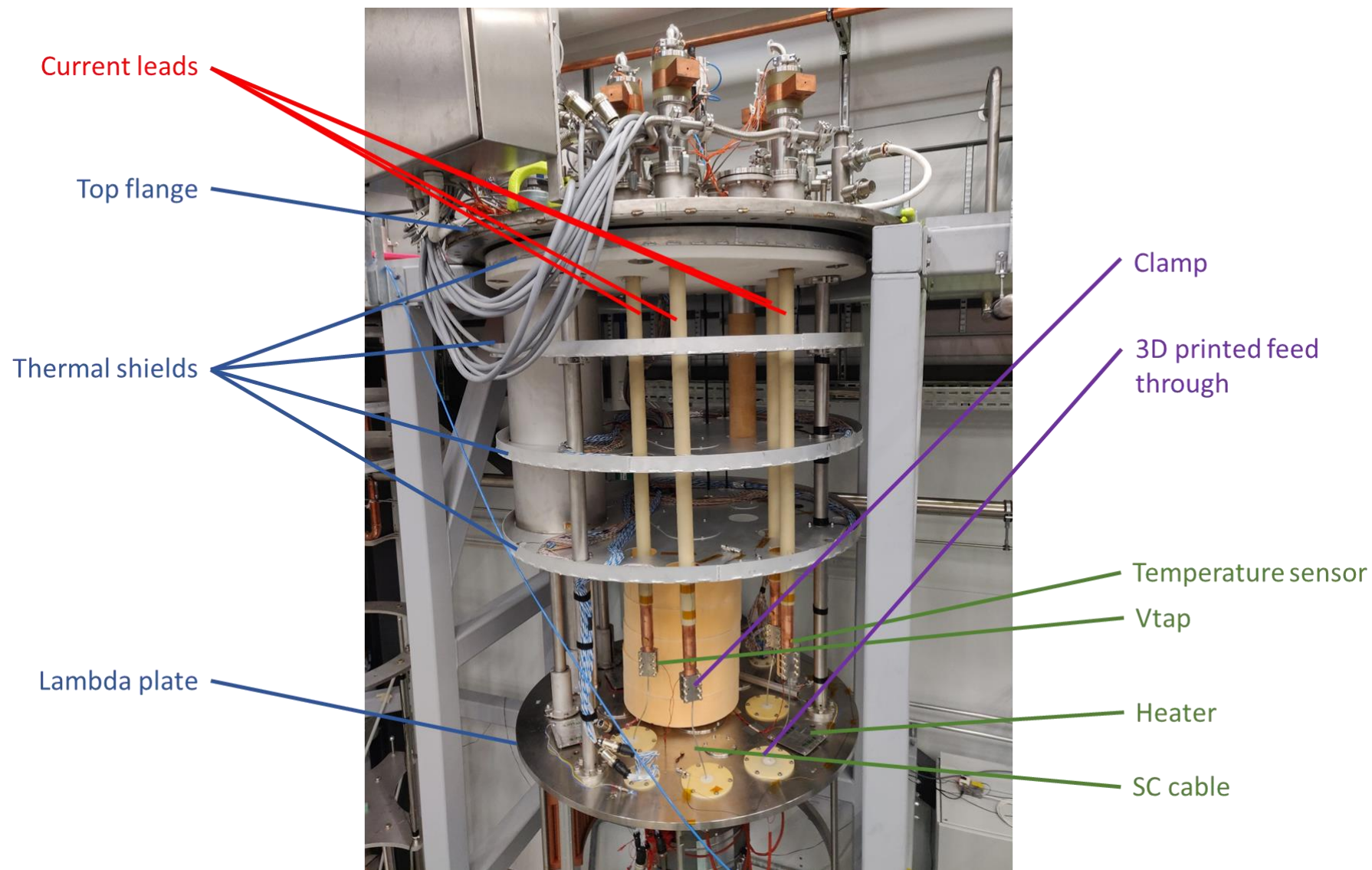


Magnetic insert

Operation:

- **Lambda plate** to separate 2K pressurized helium from 4K helium
- **Heat exchanger** with sub-atmospheric 2K helium to cool the pressurized 2K helium

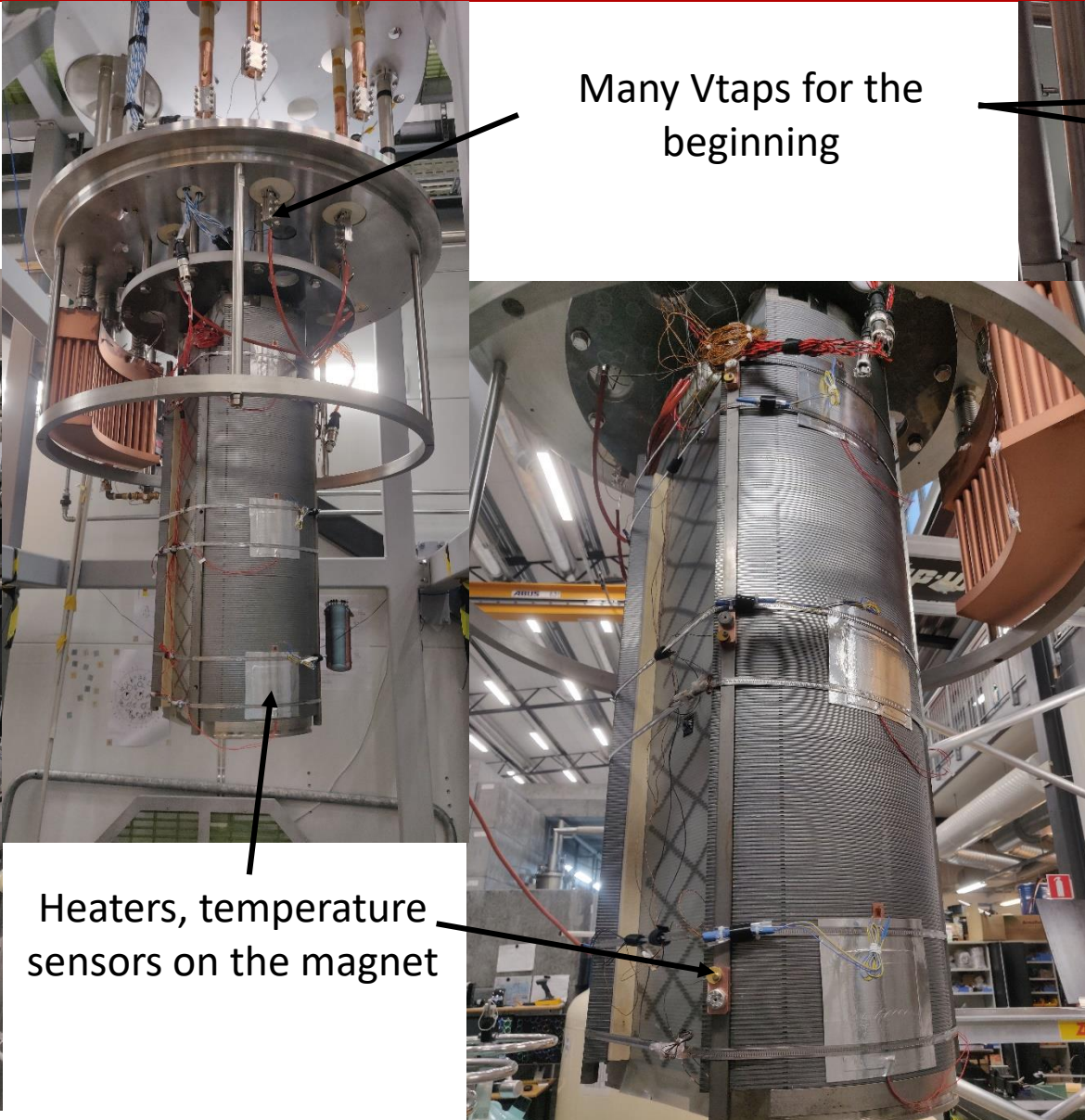
Magnetic insert – Above the lambda plate



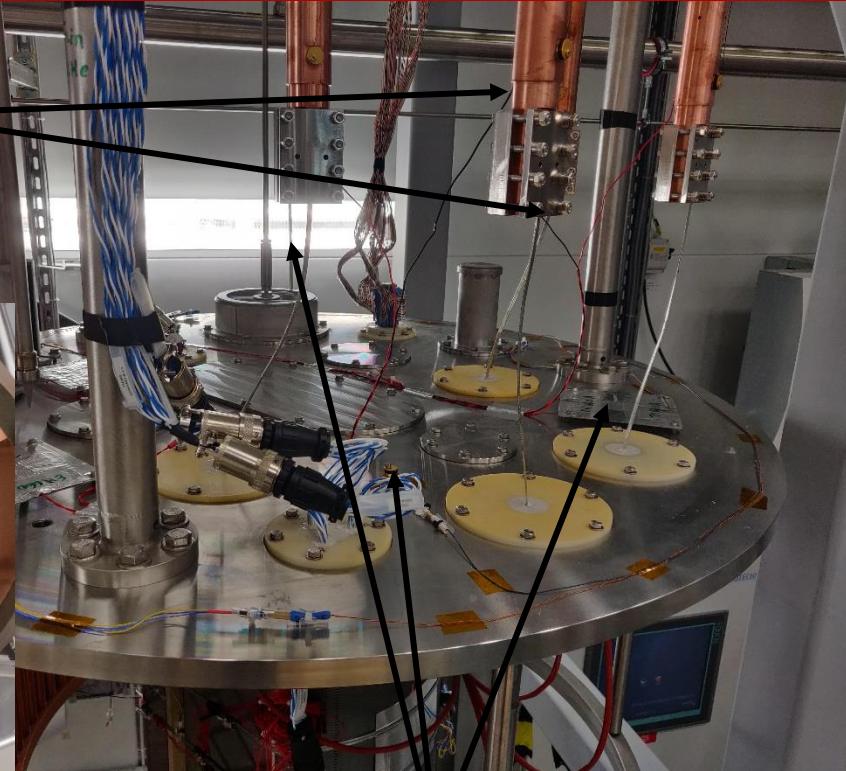
Cable thermalized
Heaters, temperature
sensors



Many Vtaps for the
beginning

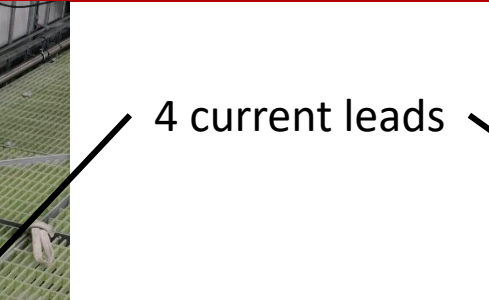
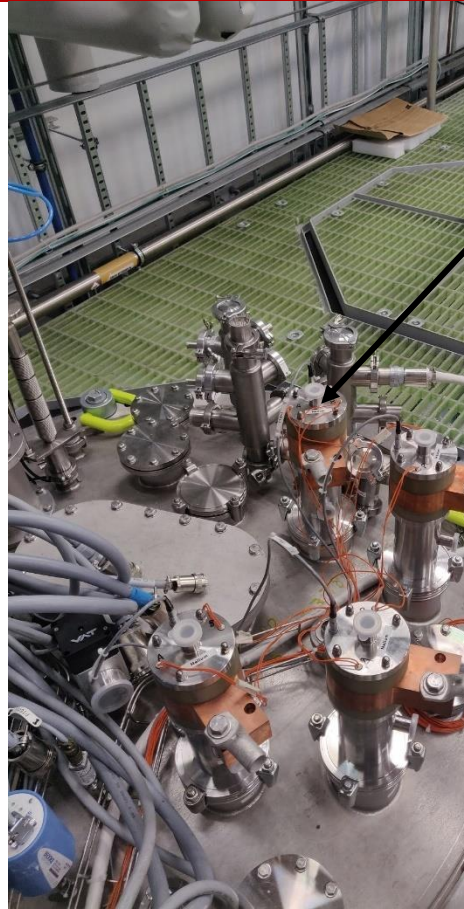


Heaters, temperature
sensors on the magnet



Heaters, level prob and temperature
sensors on the lambda plate

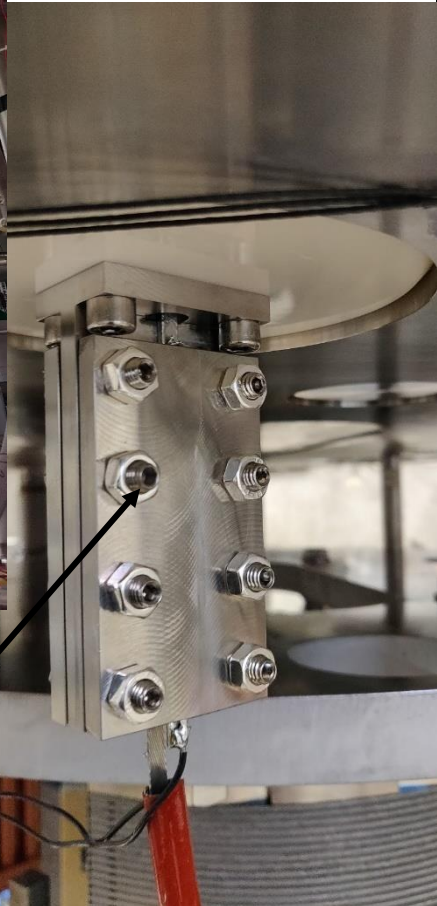
Current leads



4 current leads



Connections above
and below the
lambda plate





Level probes with and without protection

2m³ of foam to save a lot of helium and be more efficient/faster



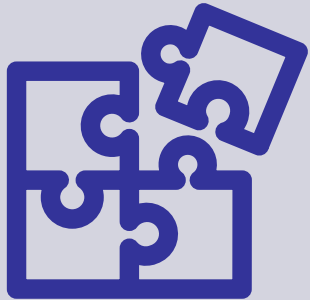


Conclusions



Gersemi is a mix of in-house developed solutions

- Design
- PLC
- Infrastructure
- Cabling
- Insert
- Control system



and CERN turnkey solutions

- Software
- QDS
- Energy extraction and control system
- Power supplies and control system



Thank you for your attention



Spare slides

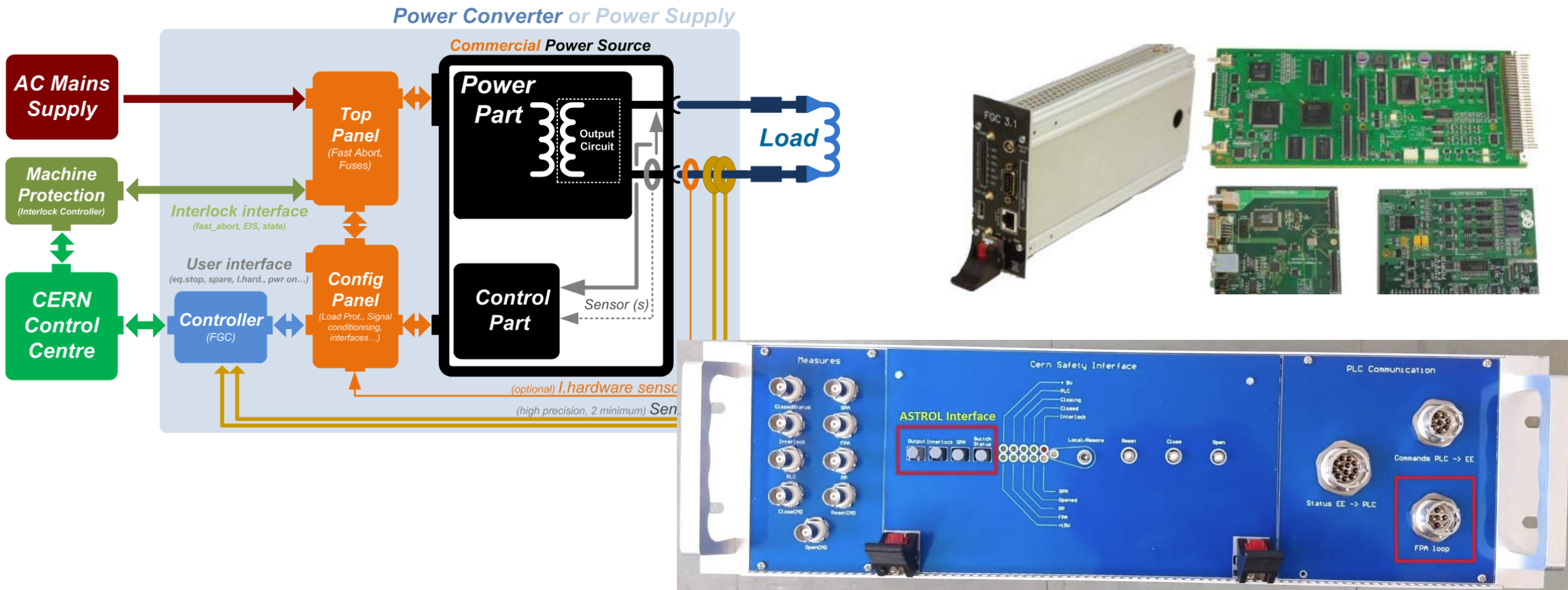


2x COMBO 2kA
80 mΩ power resistance

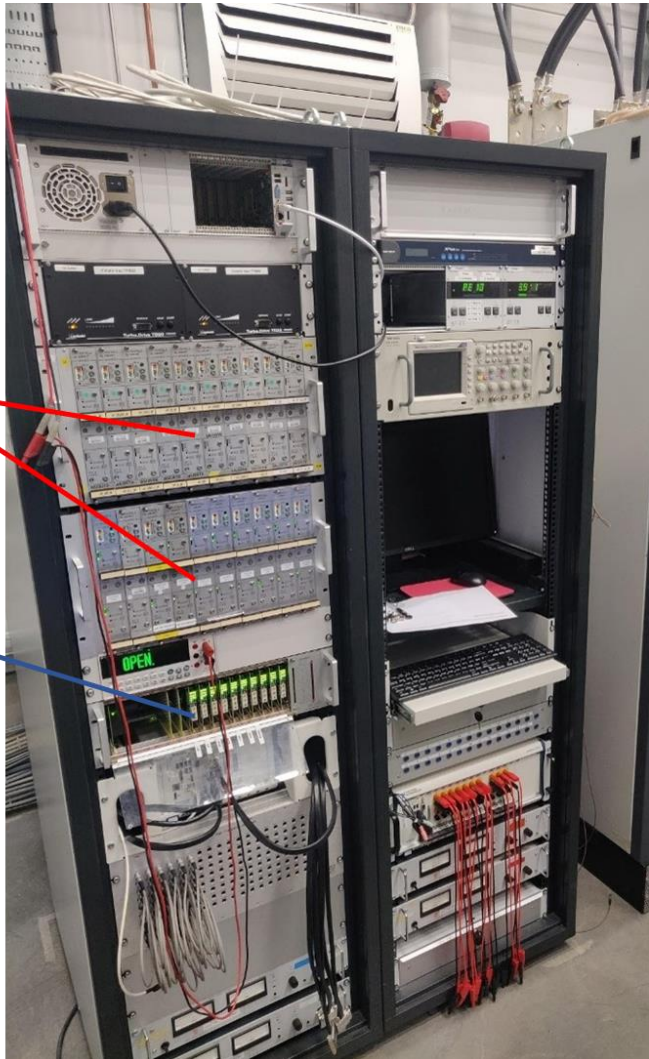
2x EE IGBT

4 x 600 mΩ
2 x 300 mΩ
5 x 700 mΩ

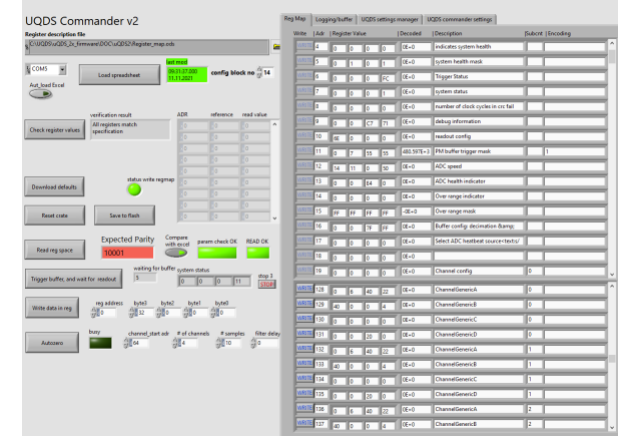
Power converters and energy extraction



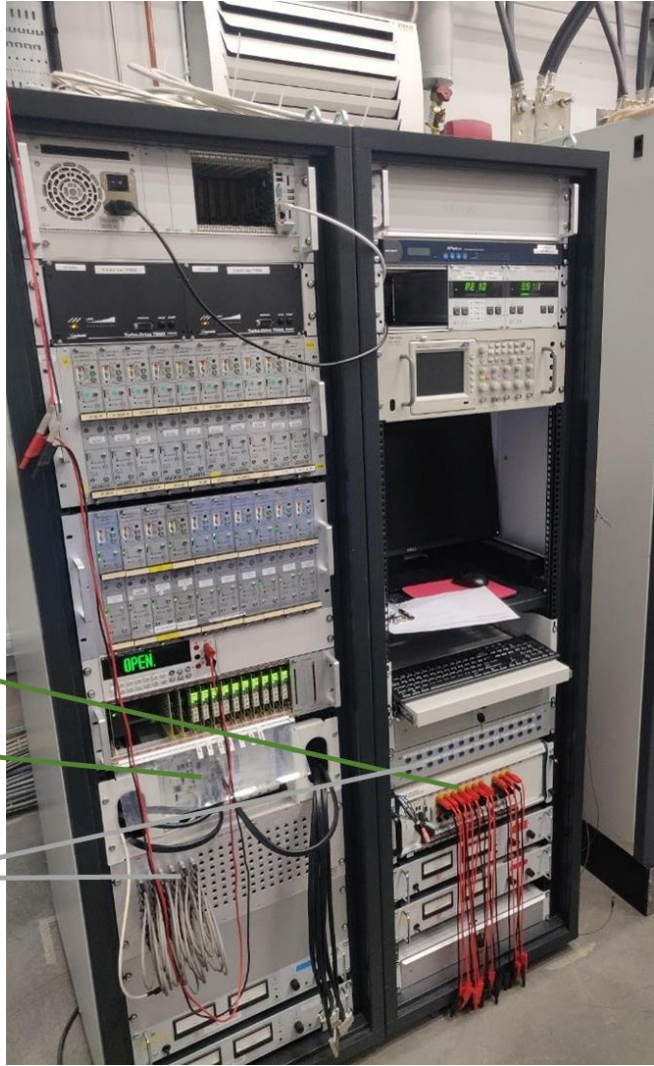
Both are commercial based components with an extra layer to communicate with the CERN system



- 20 PotAim cards
- 7 channels interlocks
 - HF and LF acquisition systems
 - Power converters 1-2
 - Energy extraction 1-2
 - Cryogenics



1 uQDS for detecting symmetrical quenches



DAQ (16 bits)	HF	MF	LF
Max. number of channels to be recorded	48	48	72
Max. differential input voltage	1 kVdc	1 kVdc	1 kVdc
Acquisition frequency	5 - 200 kHz	1 - 5 kHz	1 kHz
Bandwidth of the system	600 Hz		
Thresholds / delays per signal	0 - 1 V / 0 - 1 s		

CERN developed software