Status of the SRF systems at HIE-ISOLDE

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CERN, Geneva, Switzerland

SRF2015 WHISTLER

SRF2015

17th International Conference on RF Superconductivity

Whistler Conference Centre

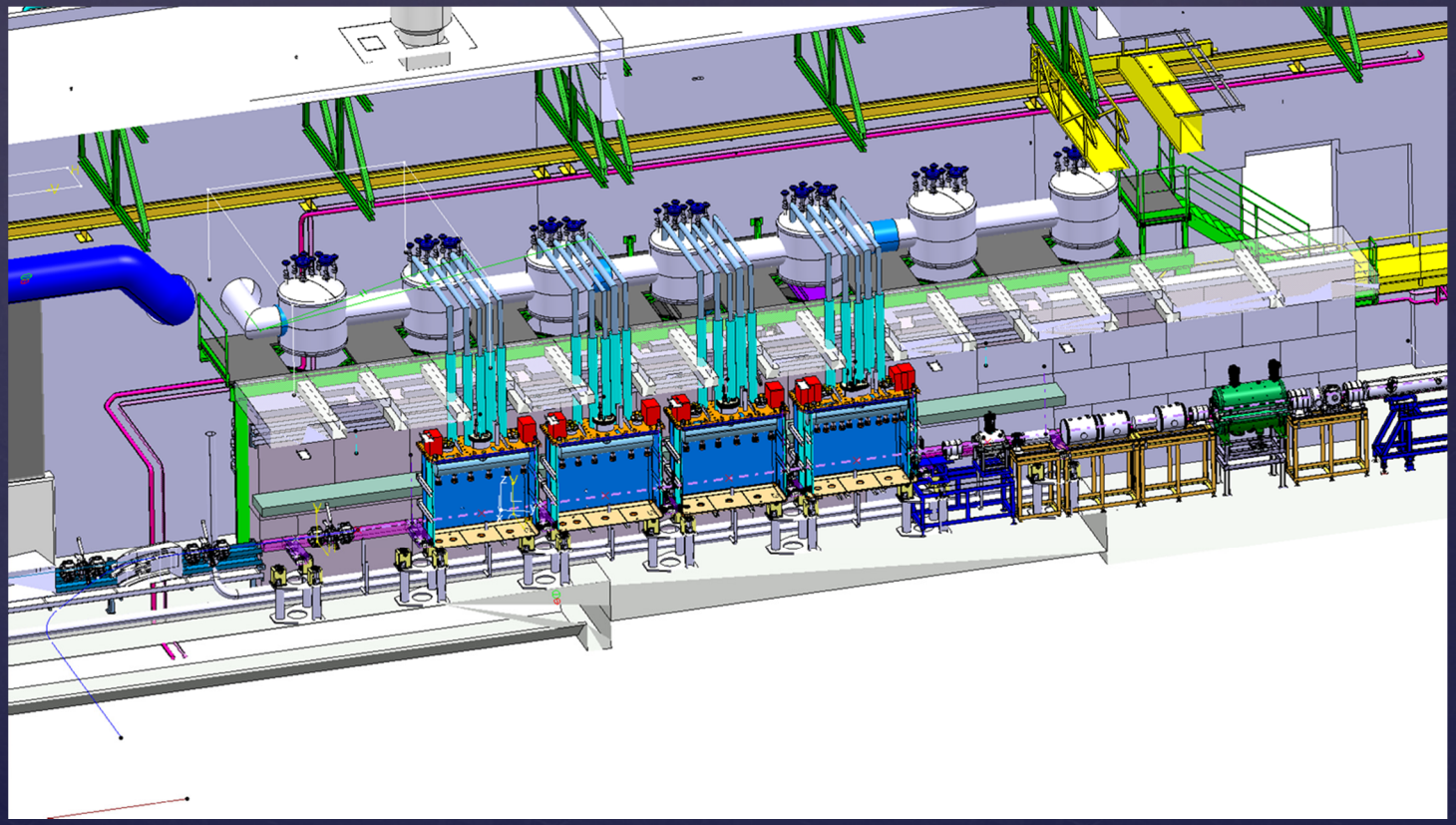
September 13-18 2015

Contents

- HIE ISOLDE project roadmap
- Series production of Nb/Cu QWR
- First cryomodule assembly experience
- Cryomodule commissioning experience
- Summary and outlook

The HIE ISOLDE project at CERN

HIE-ISOLDE aims at boosting the energy of the Radioactive Ion Beams of REX-ISOLDE from 3 MeV/u up to 10 MeV/u (A/q < 4.5) by means of a SC linac



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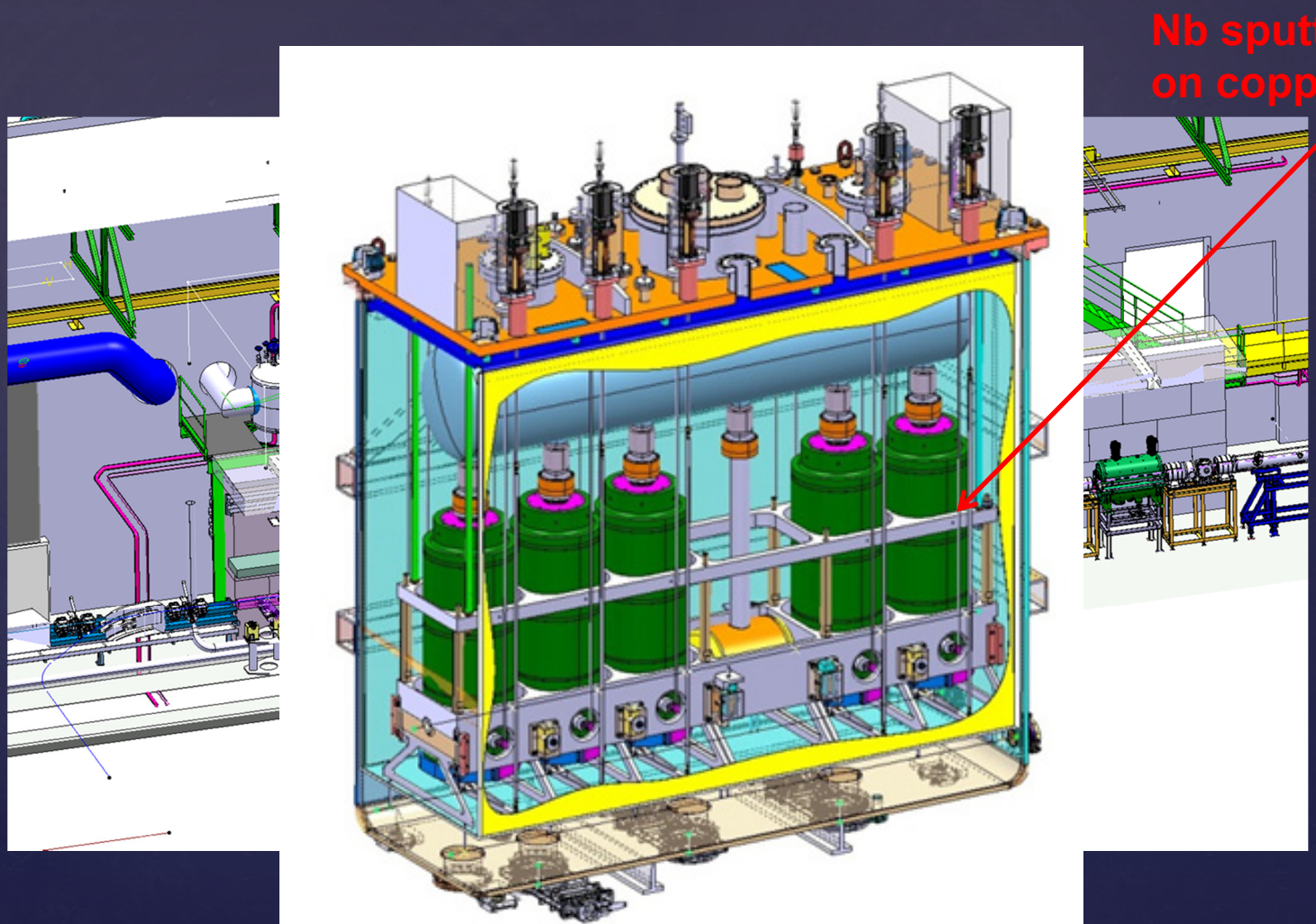
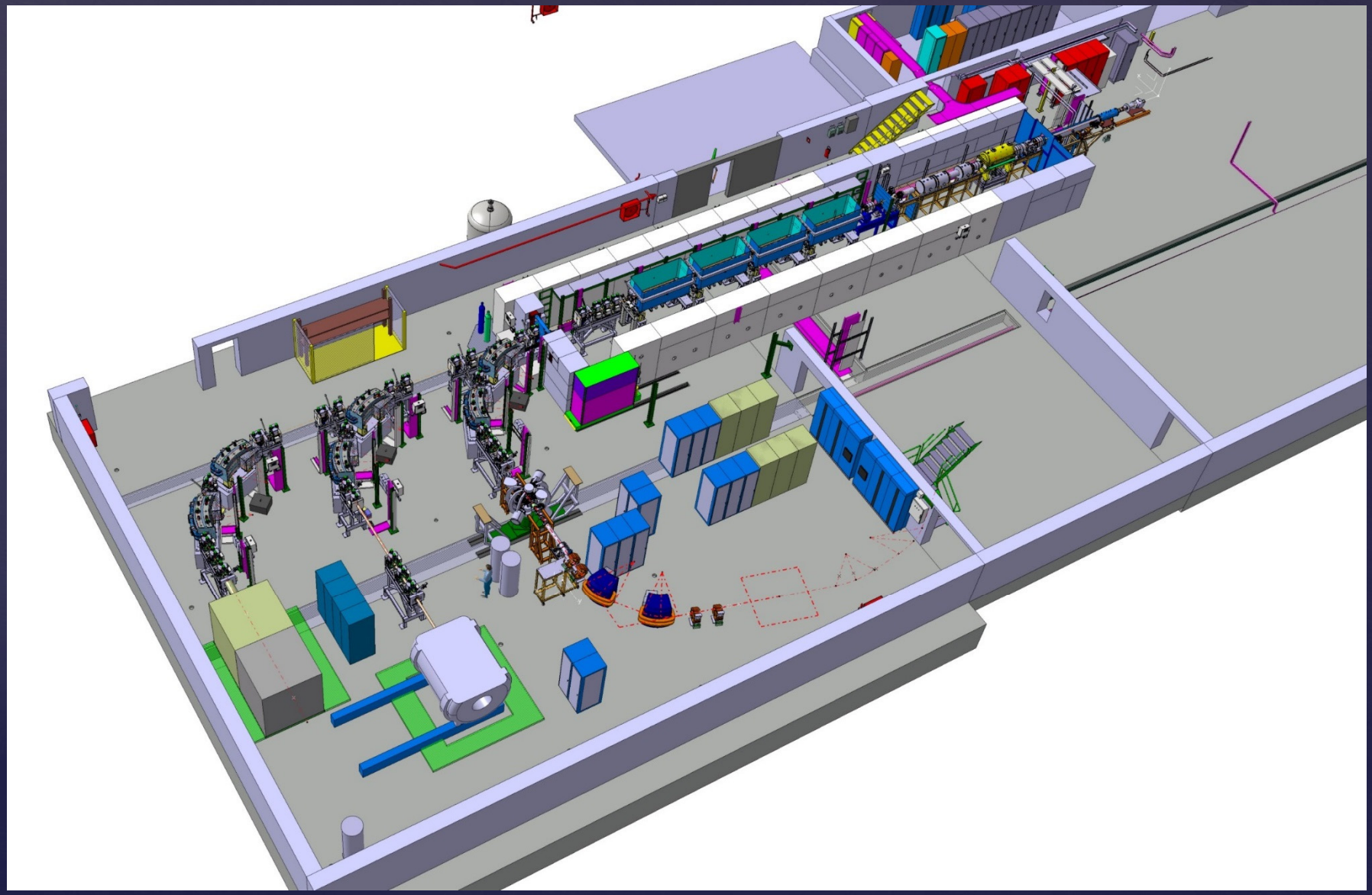


High β section, beam lines, experiments



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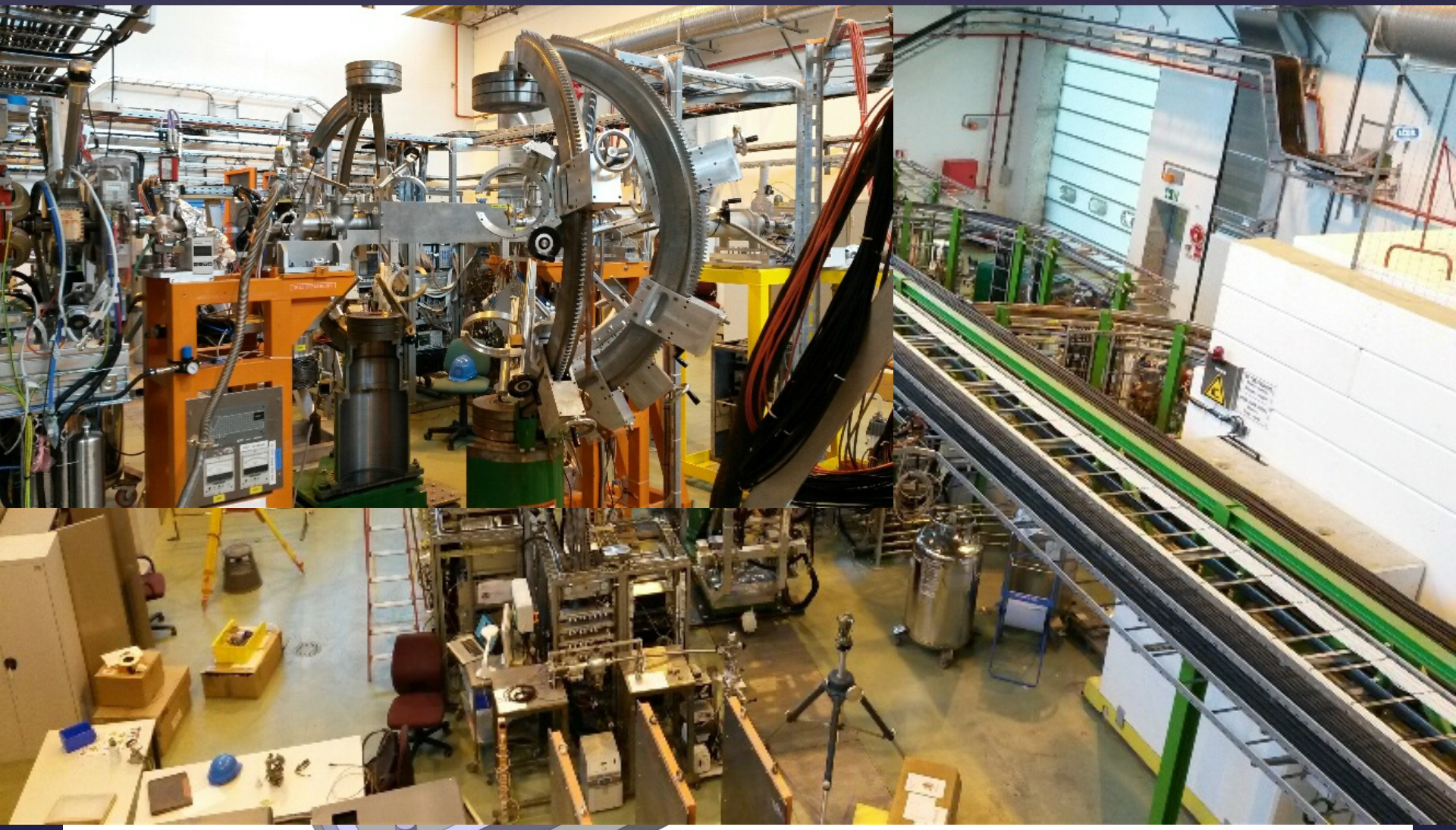
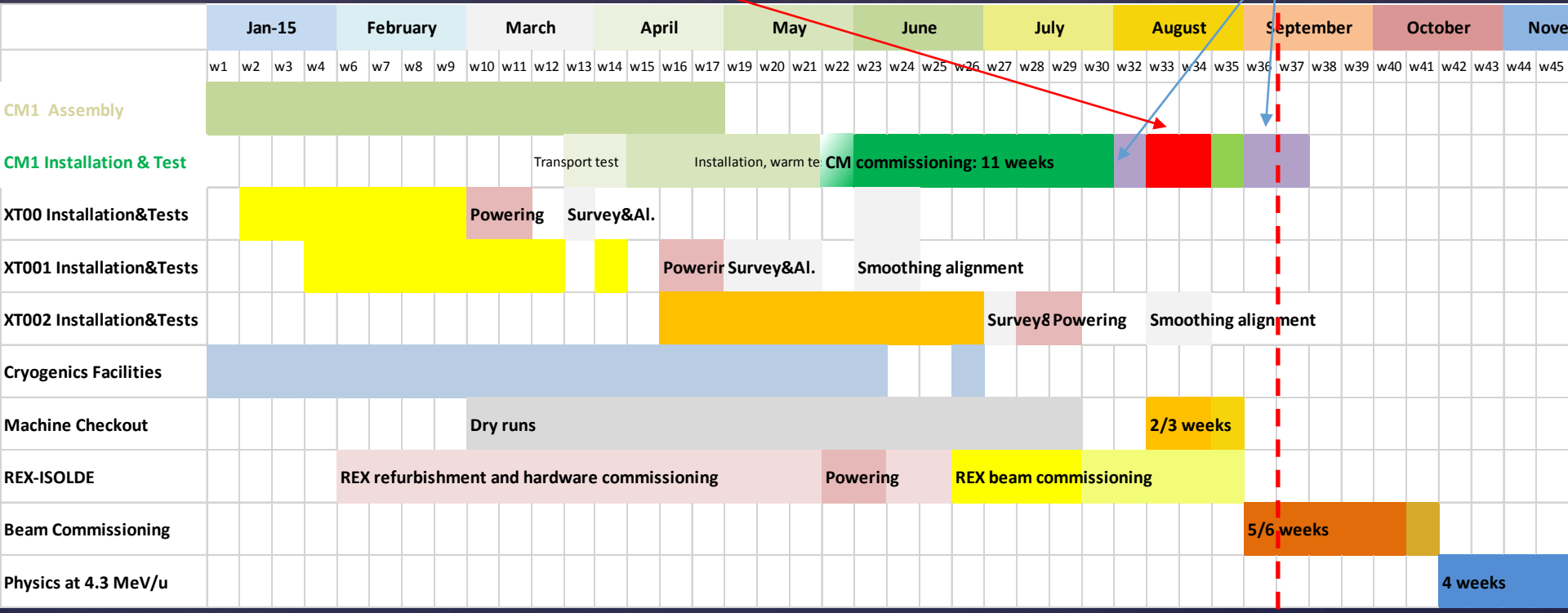


High β section, beam lines, experiments

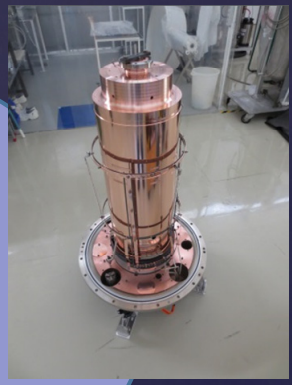
HIE ISOLDE roadmap for 2015

Cryogenics incident (burst disk rupture) Aug 12th

Tests on RF power limits



Series production of Nb/Cu QWR



Start: Cavity reception

Cavity tuning

Surface treatment

Rinsing cleanroom assembly

Niobium coating

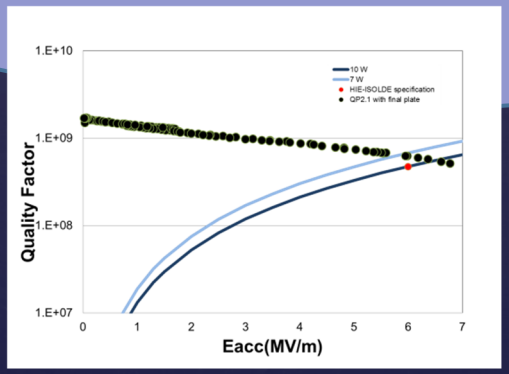
Ultrapure water rinsing (dust free) Cavity closure

Test cryostat preparation

RF test

End: Cavity storage

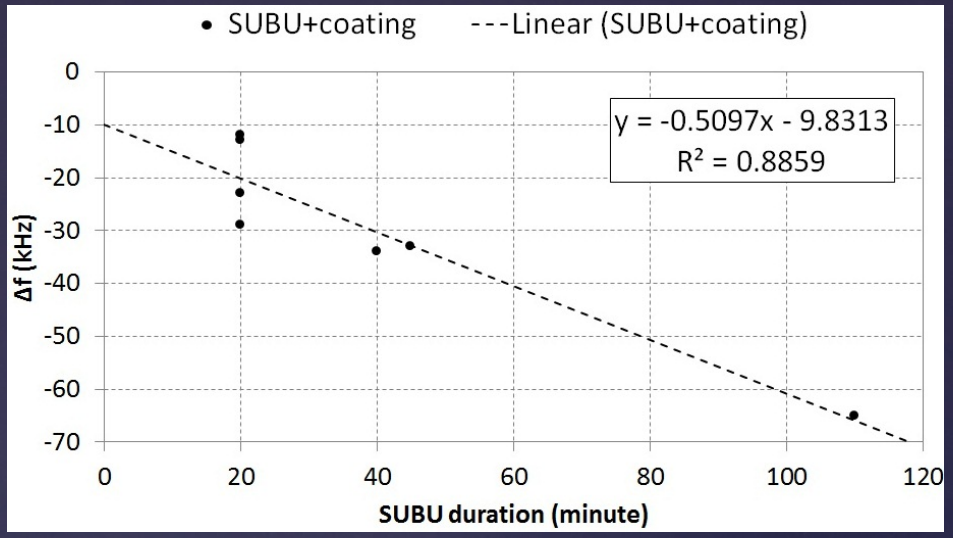
6 weeks production process

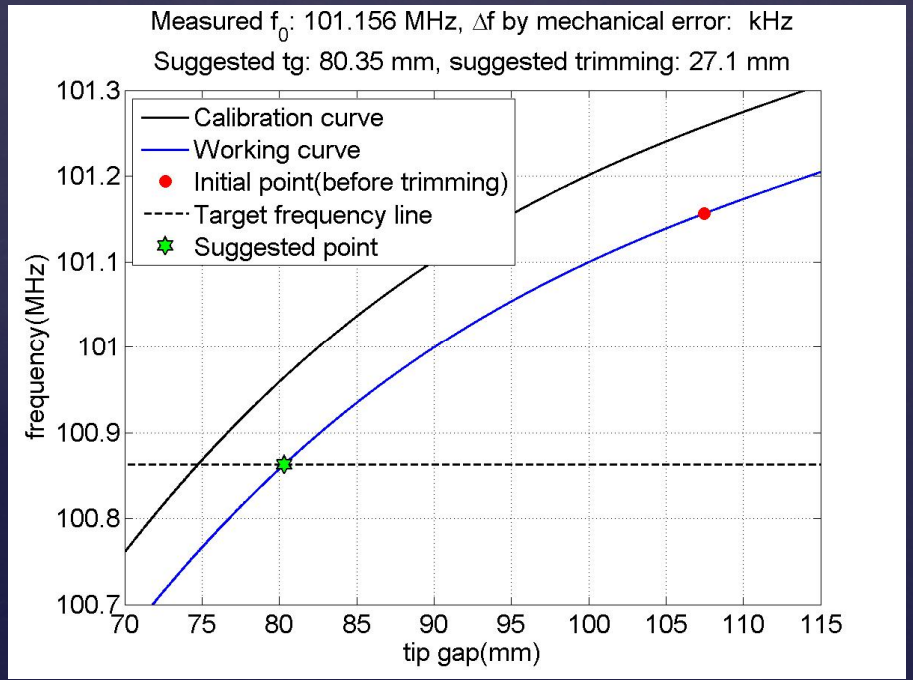


THPB060

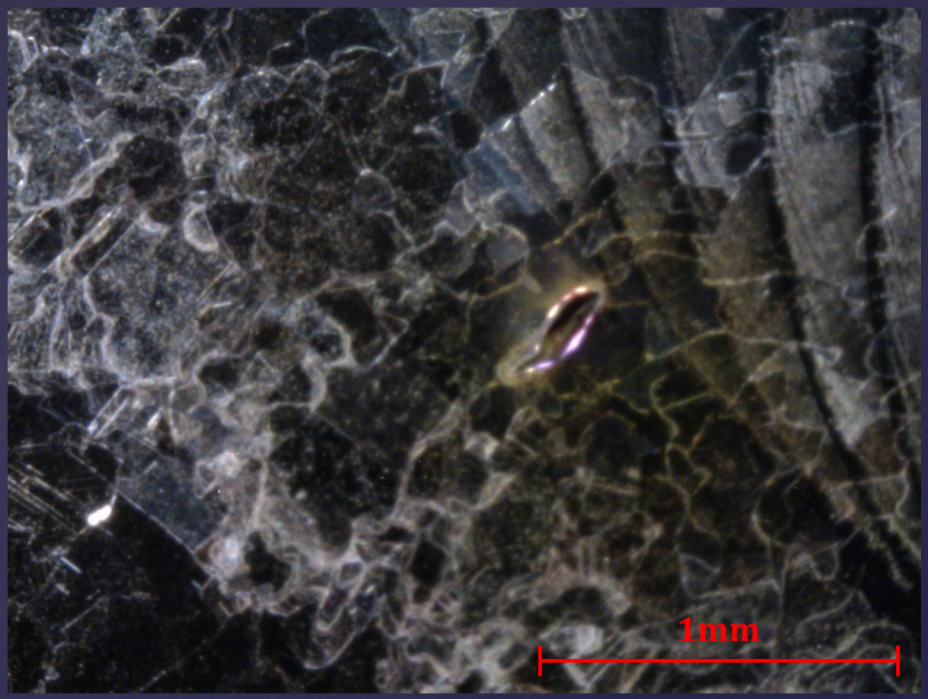
Cavity tuning

influence variables	frequency shift (kHz)
295 K to 4.5 K and air to vacuum	+371 +/- 5
chemical etching 40’	-27 +/- 3
Nb coating	-7 +/- 5





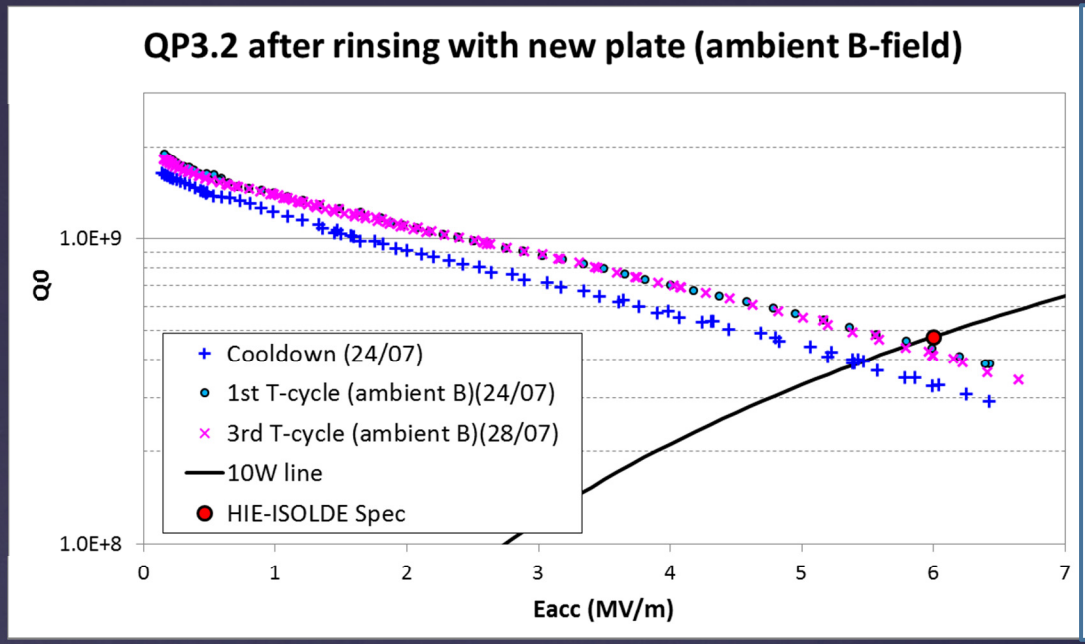
Copper cavity substrates: quality issues

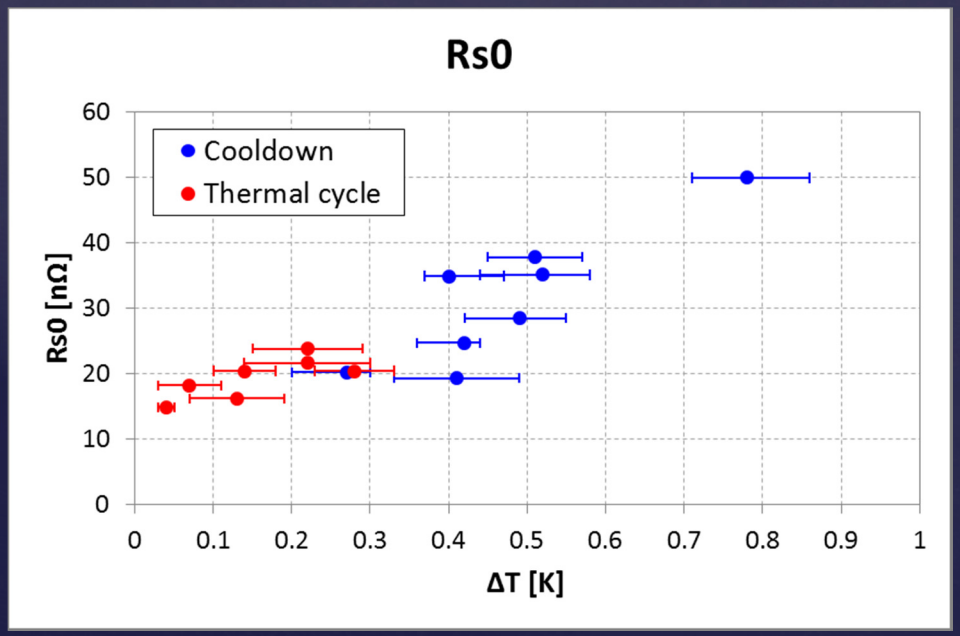


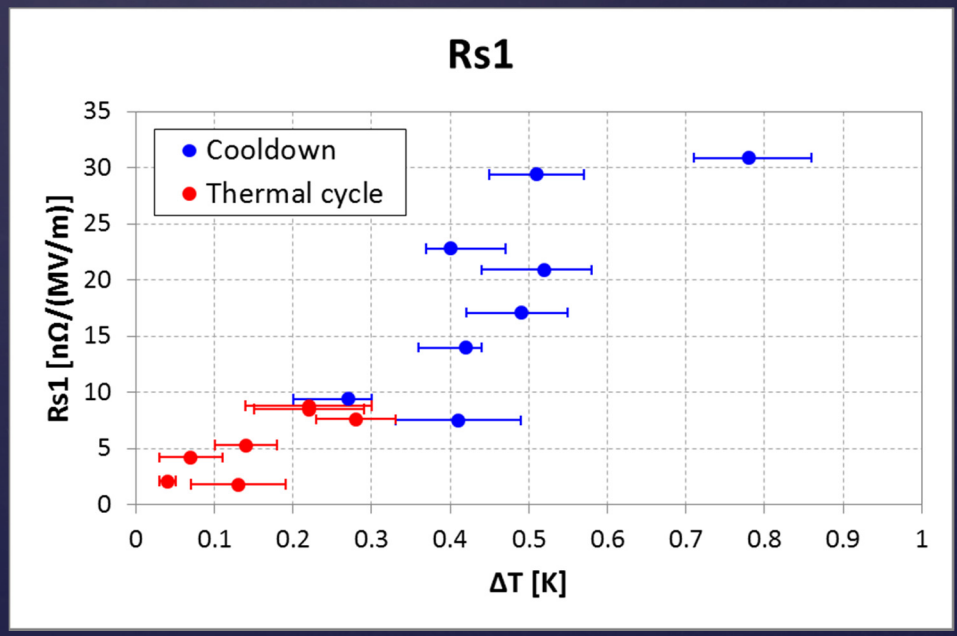
- Appearance of surface defects (looking like cracks) in the HAZ of the EB weld at the cavity top.
- Shrink fit and weld stopped at the supplier
- Investigations ongoing at CERN
- One cavity singled out for destructive analysis

TUPB077

Surface resistance vs. temperature gradient across T_c







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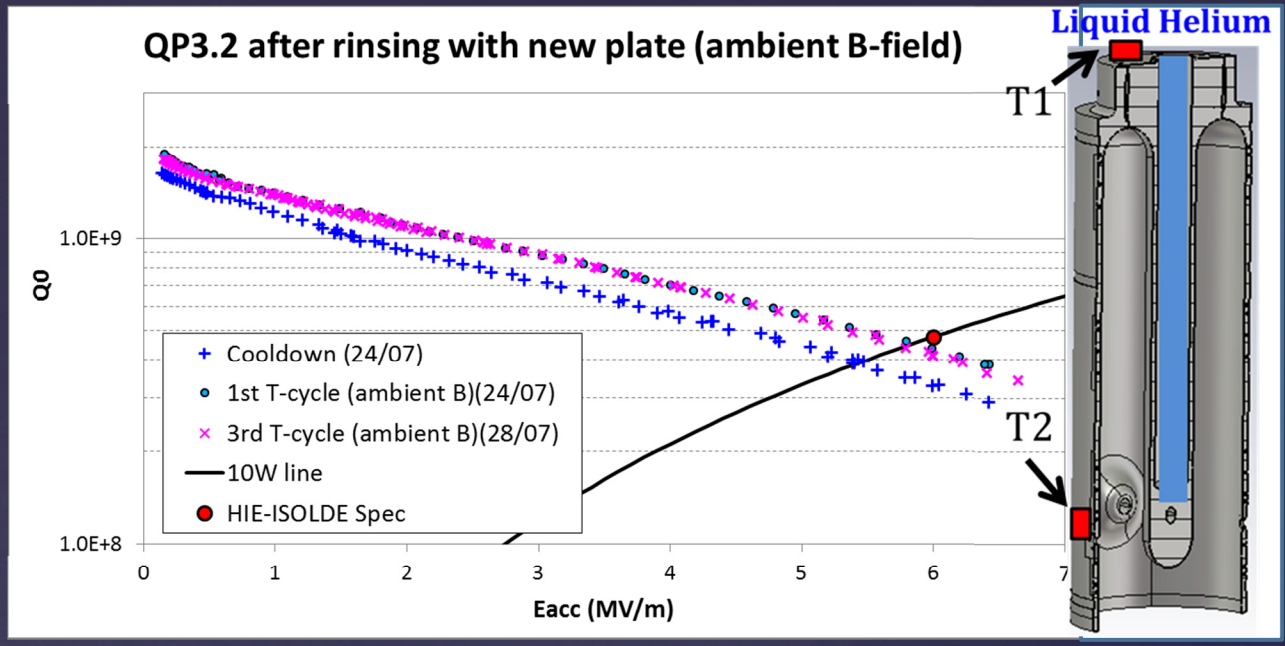
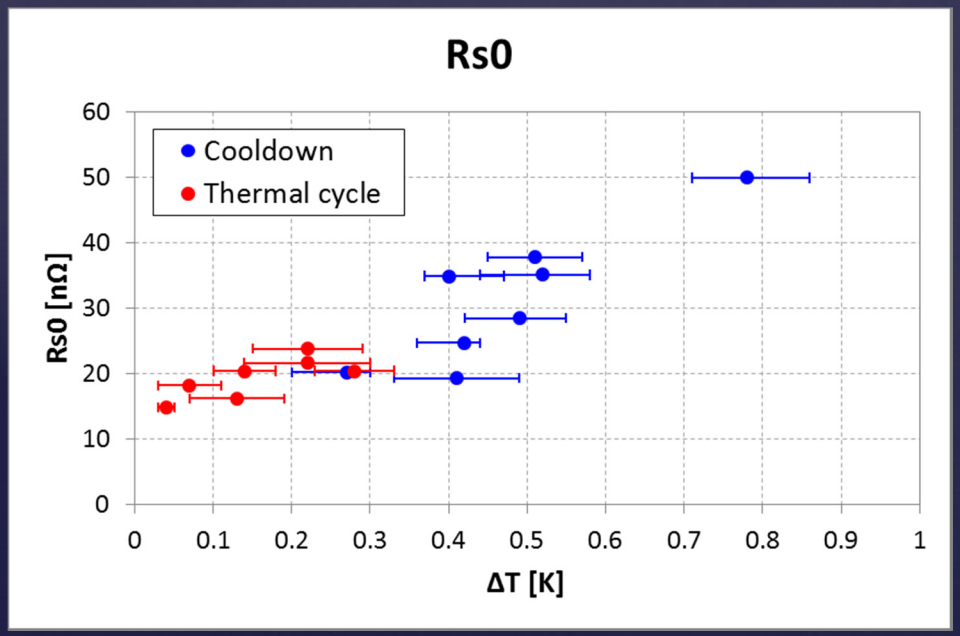
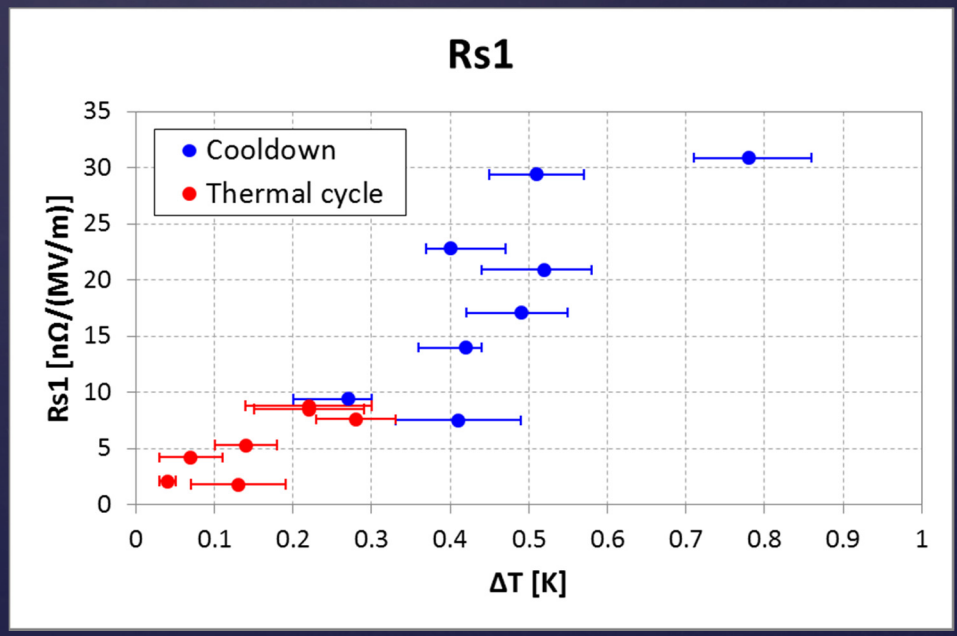
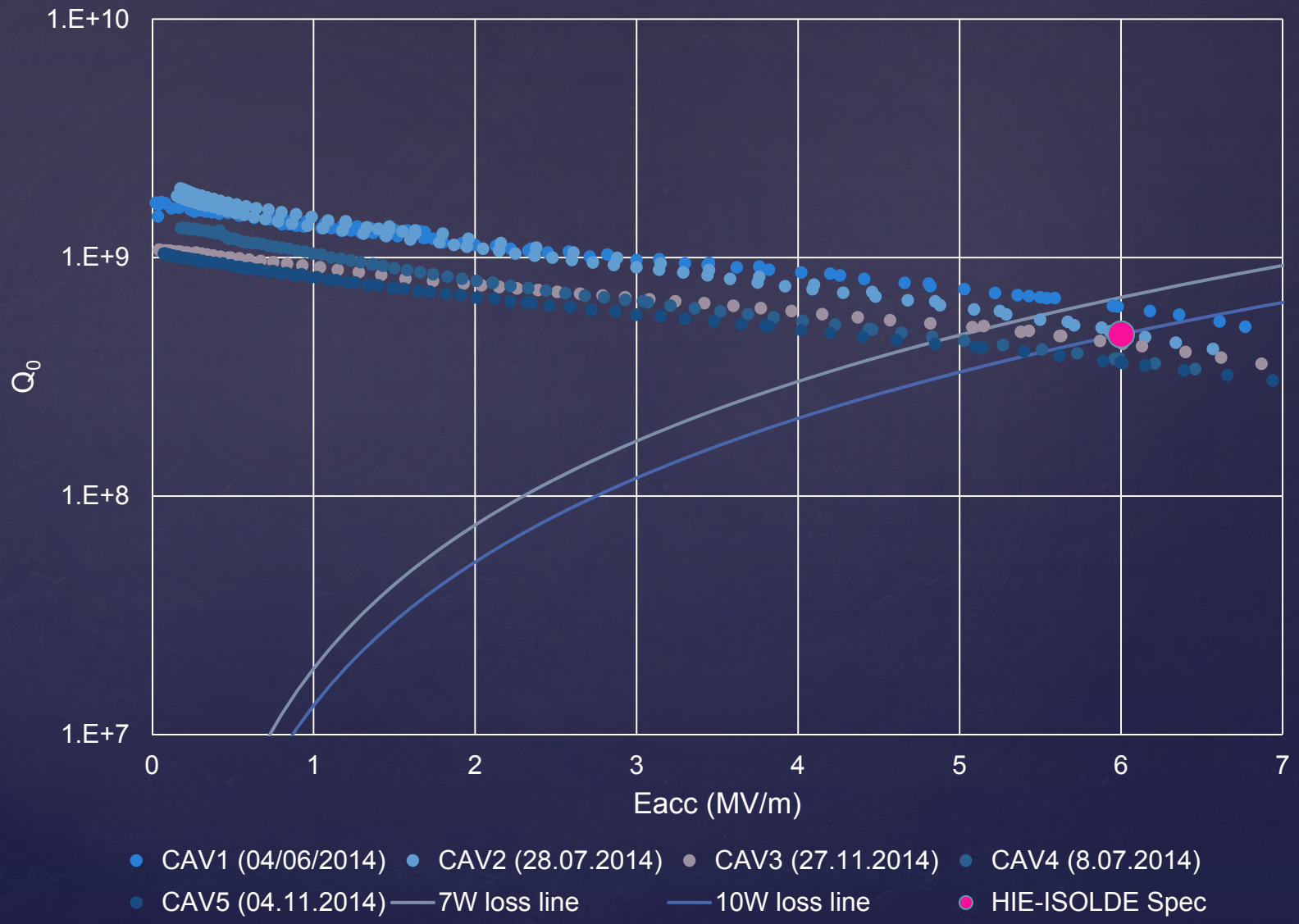


Thermal gradient: $\Delta T = T2 - T1$

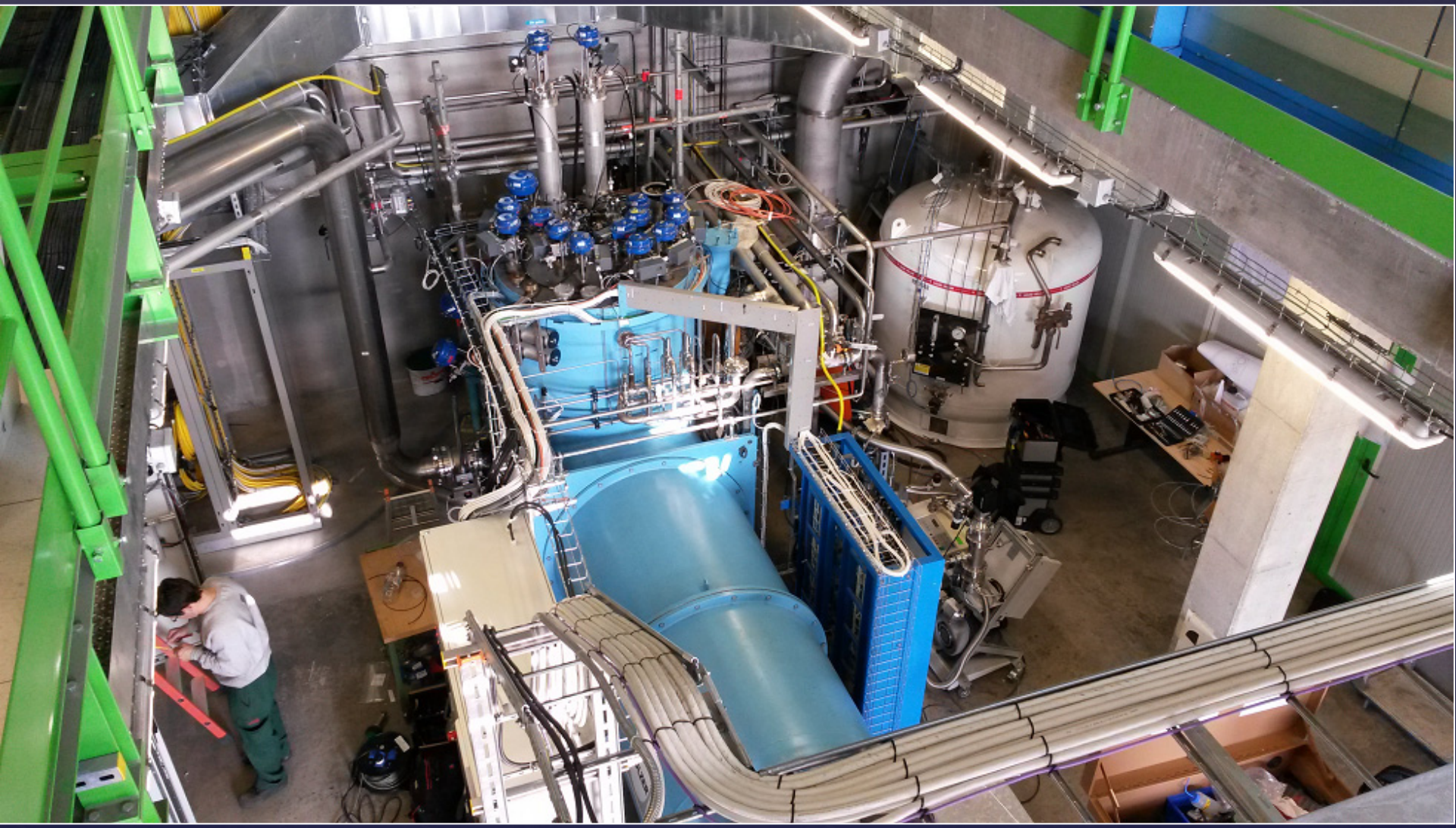




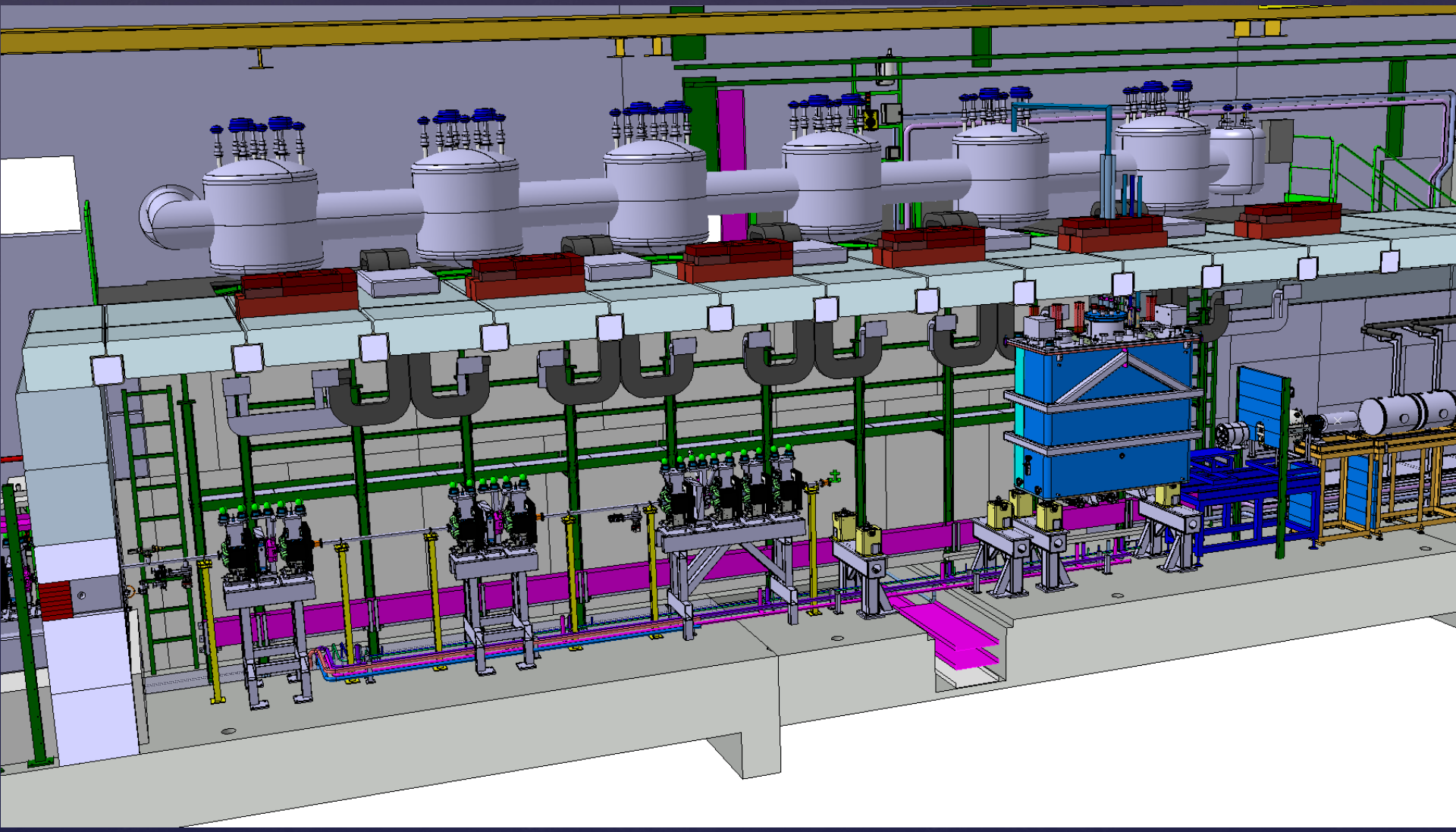
Vertical test performance (CM1 cavities)



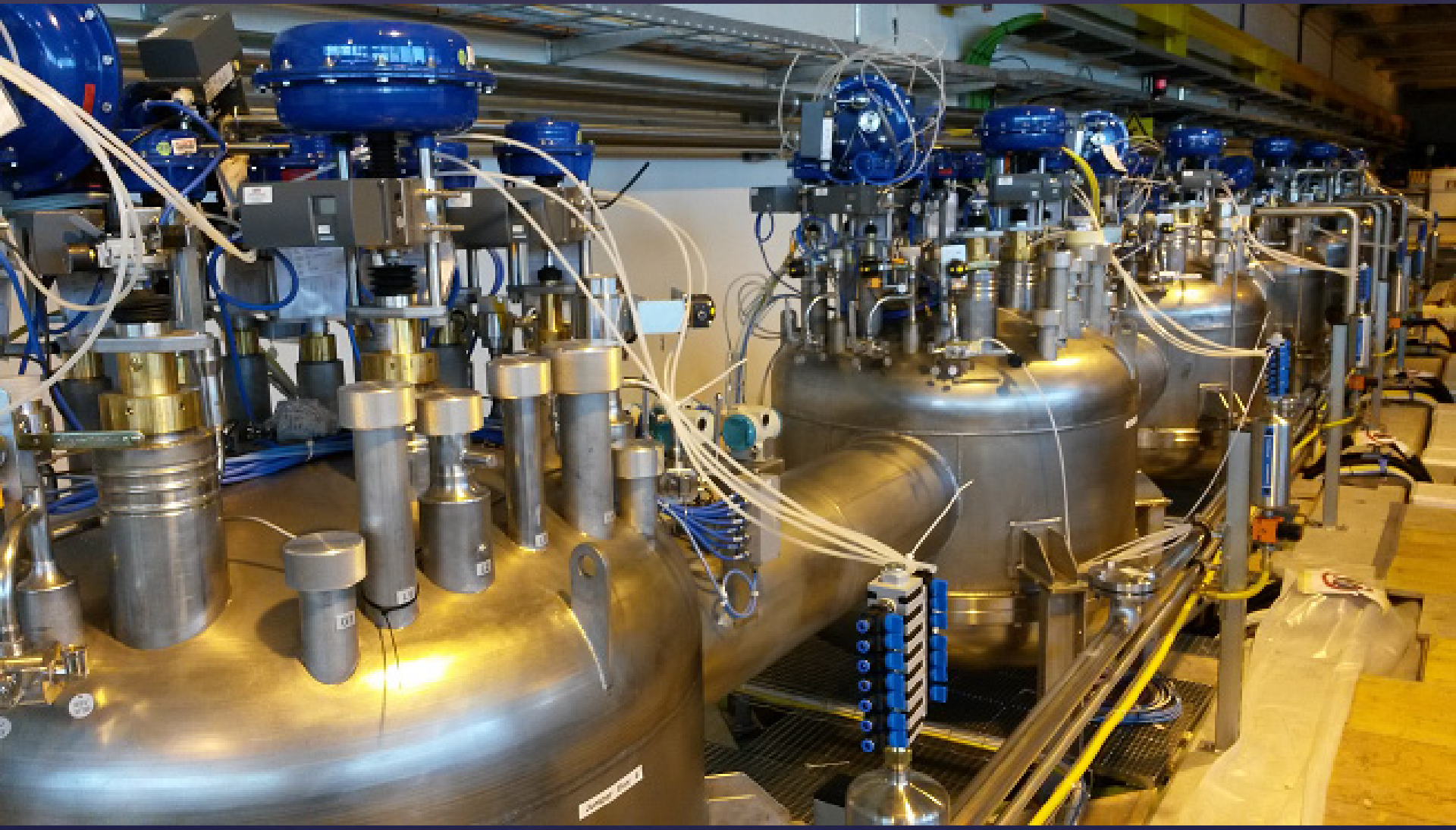
HIE ISOLDE Cold Box installation



Cryogenics distribution system



Cryogenics distribution system



Cryomodule assembly: infrastructure

Cryomodule assembly: early stages

Final leak test without cavities

Cavity mounting

5 cavities

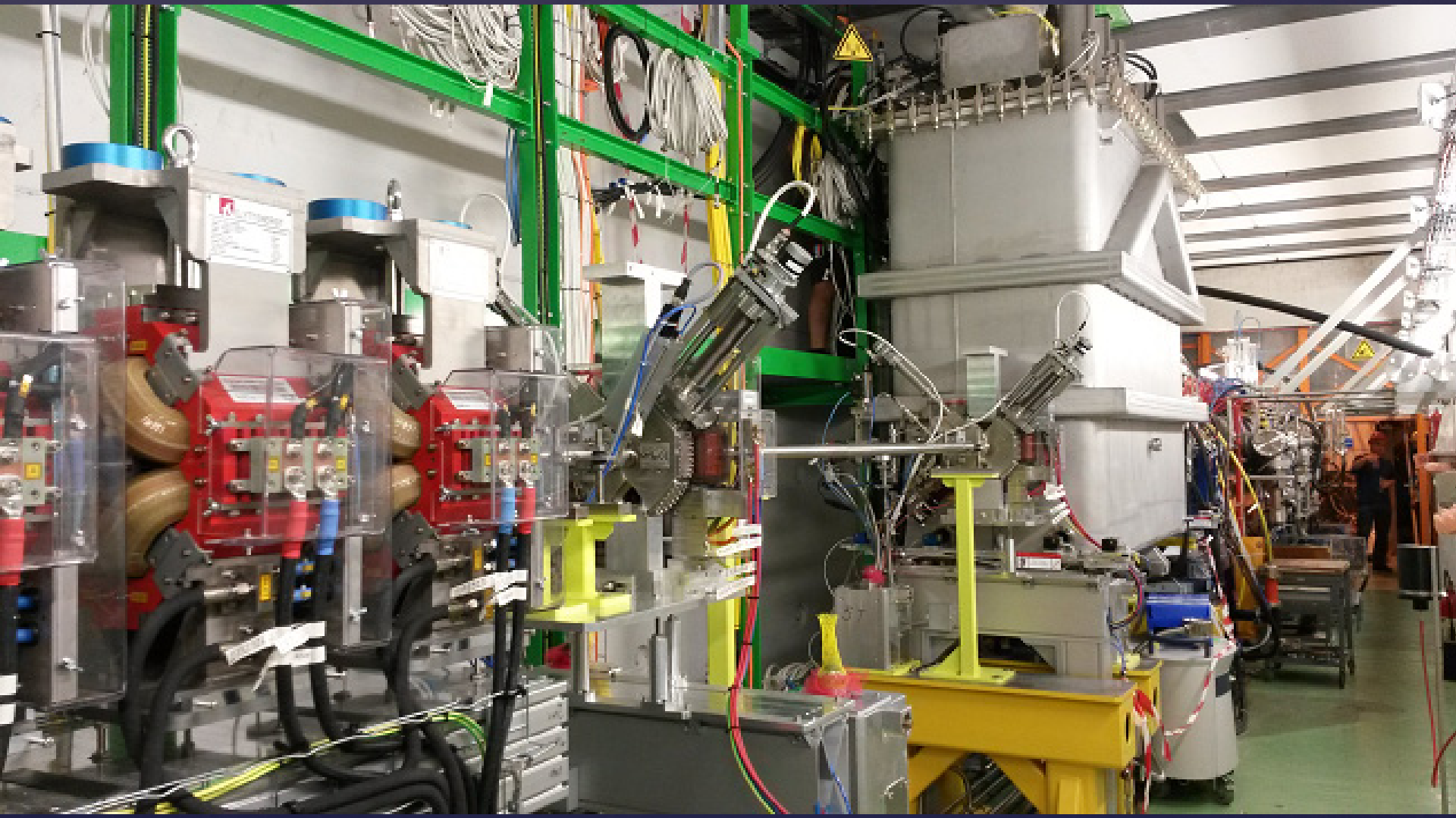
With tuners (and couplers)

TUPB106

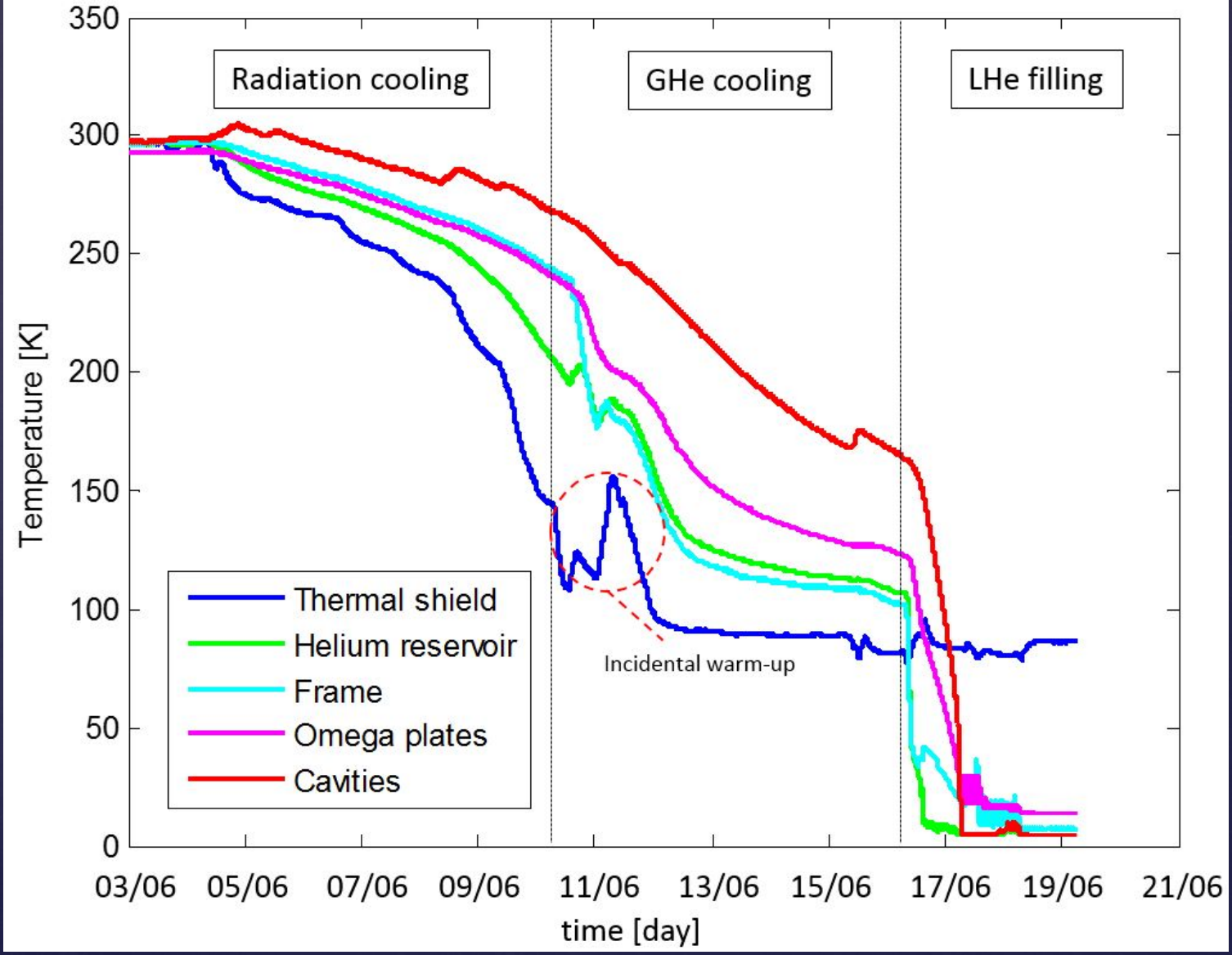
Cryomodule transport

Shield opened for installation

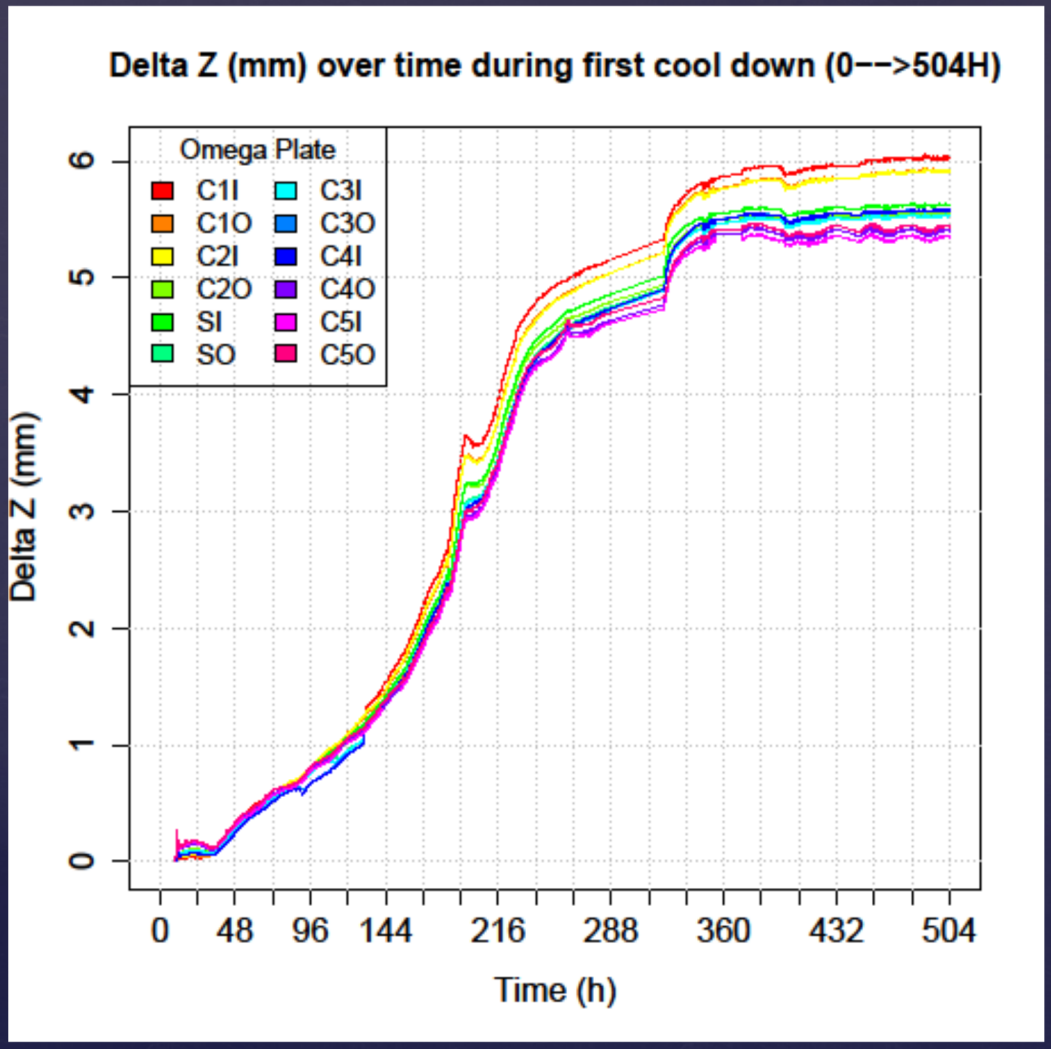
CM1 installed

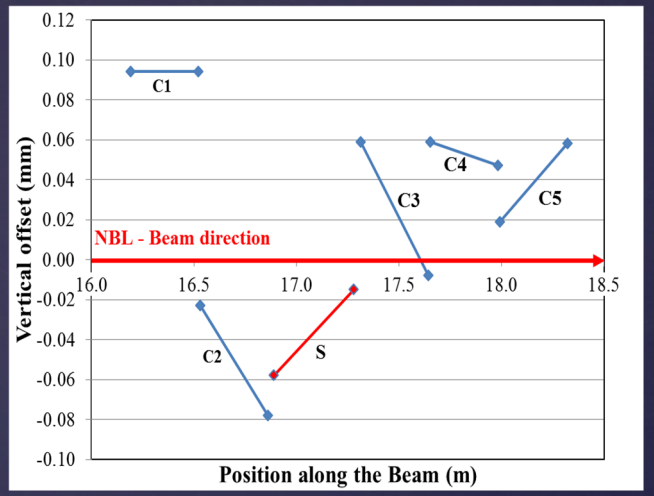


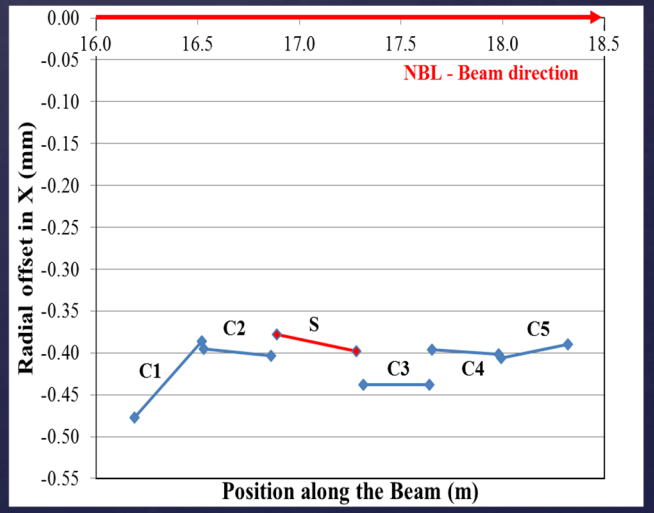
CM1 cool down



Survey and alignment







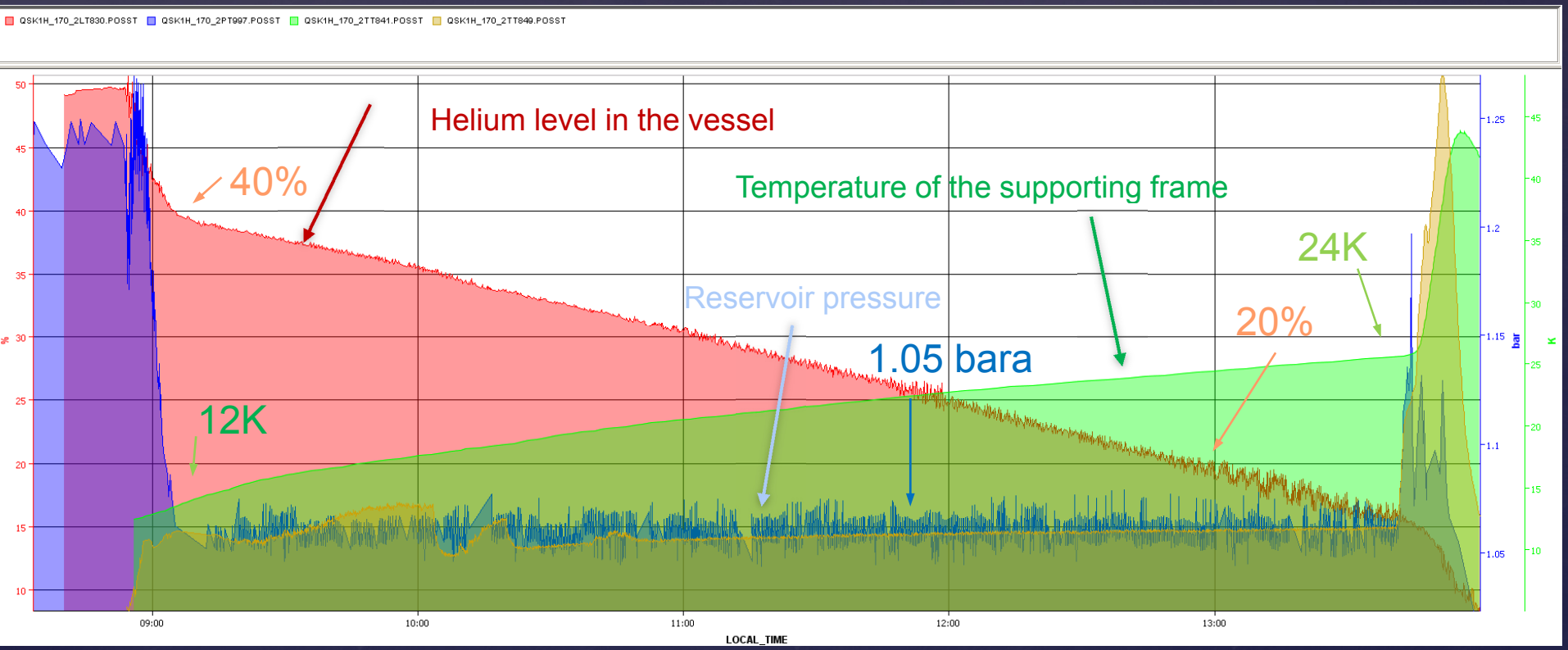
Static heat load at 4.5 K (boil-off test)

Distribution of heat into boil-off of liquid and structure warm-up;

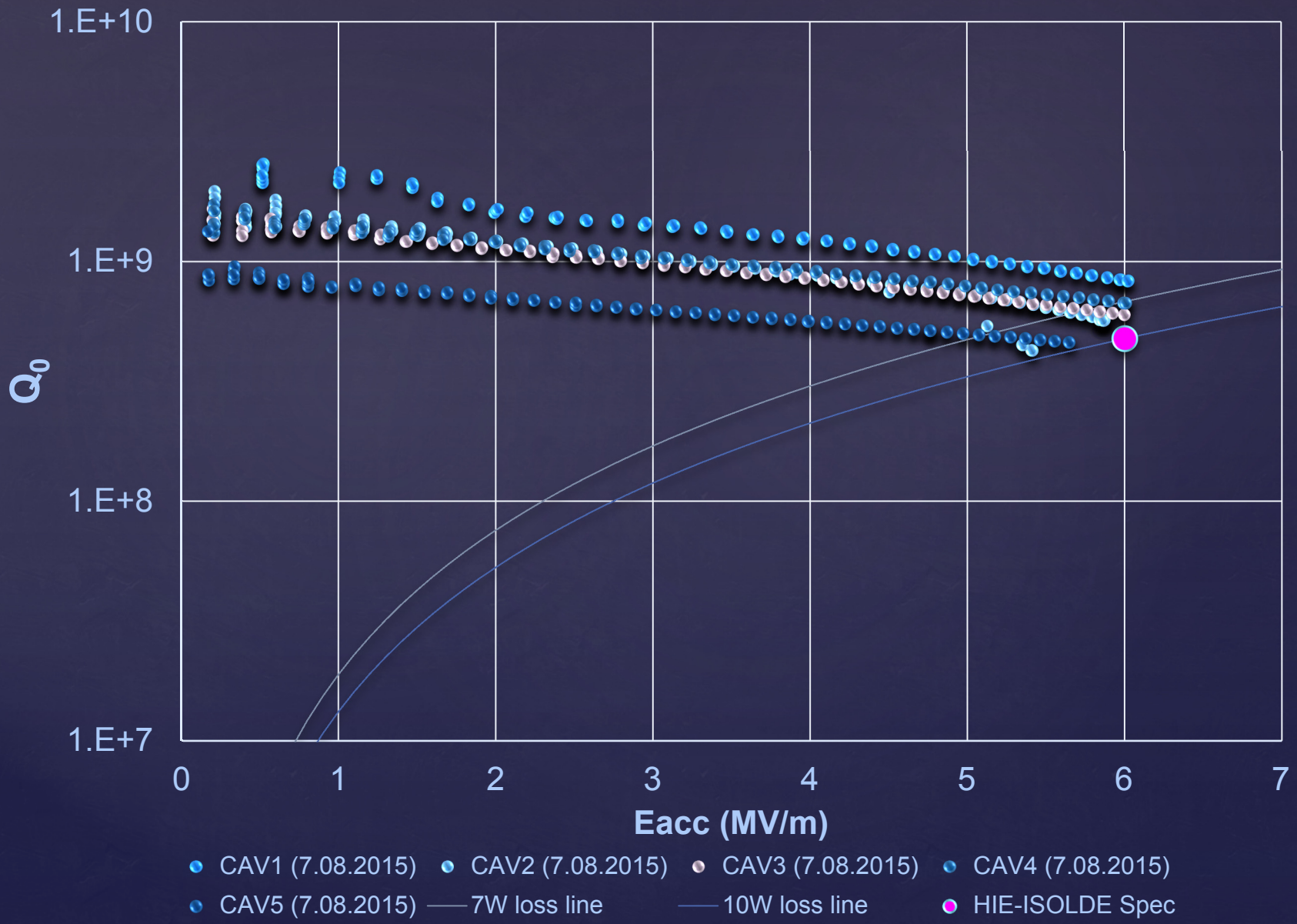
Temperatures on Thermal Shield, Cavities/Solenoid, etc. constant during the test

Measurement results:

- Helium level ~10 l/h: ~7W
- Warm-up frame : ~2.5W

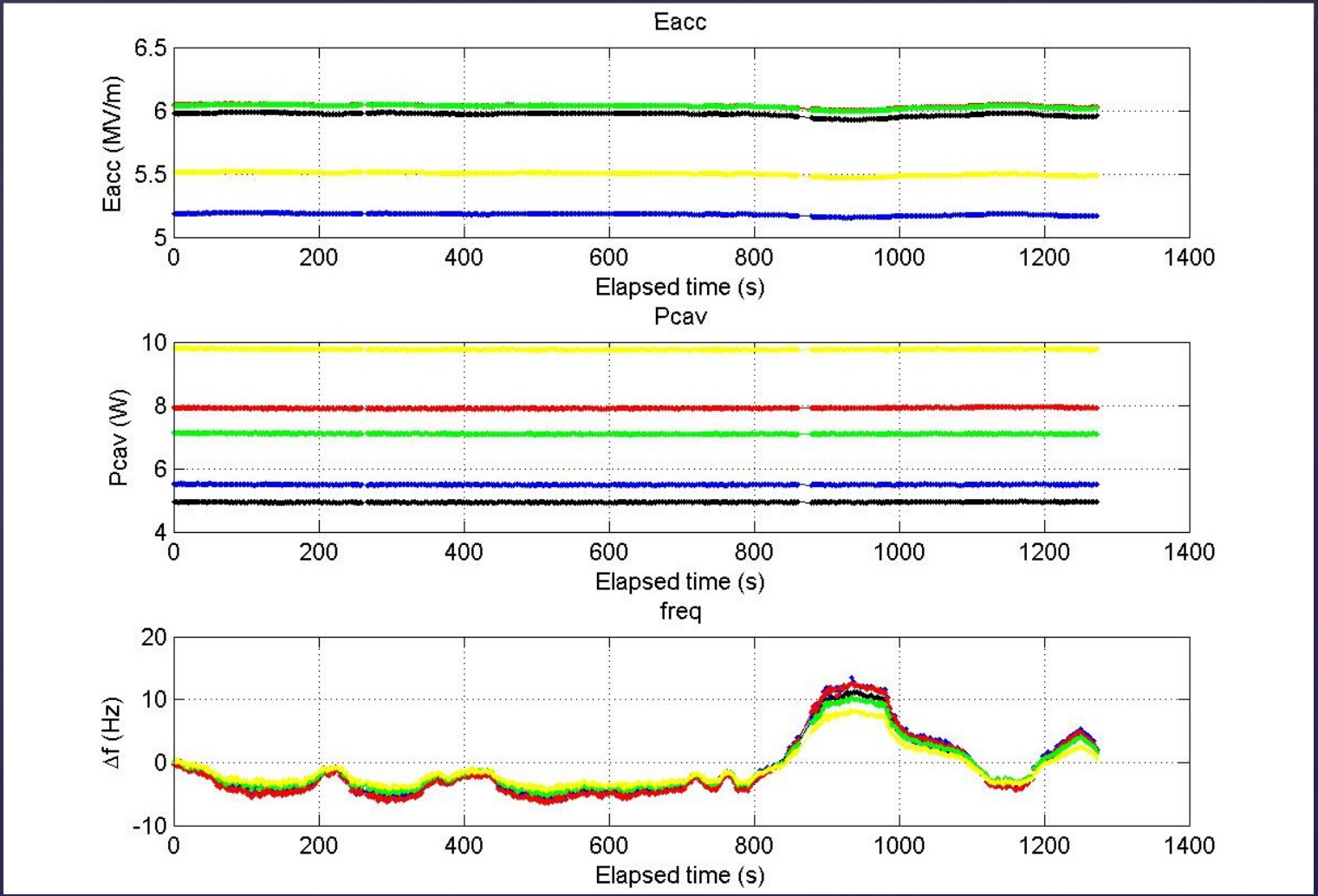


CM1 cavity test results



Combined powering of cavities and solenoid

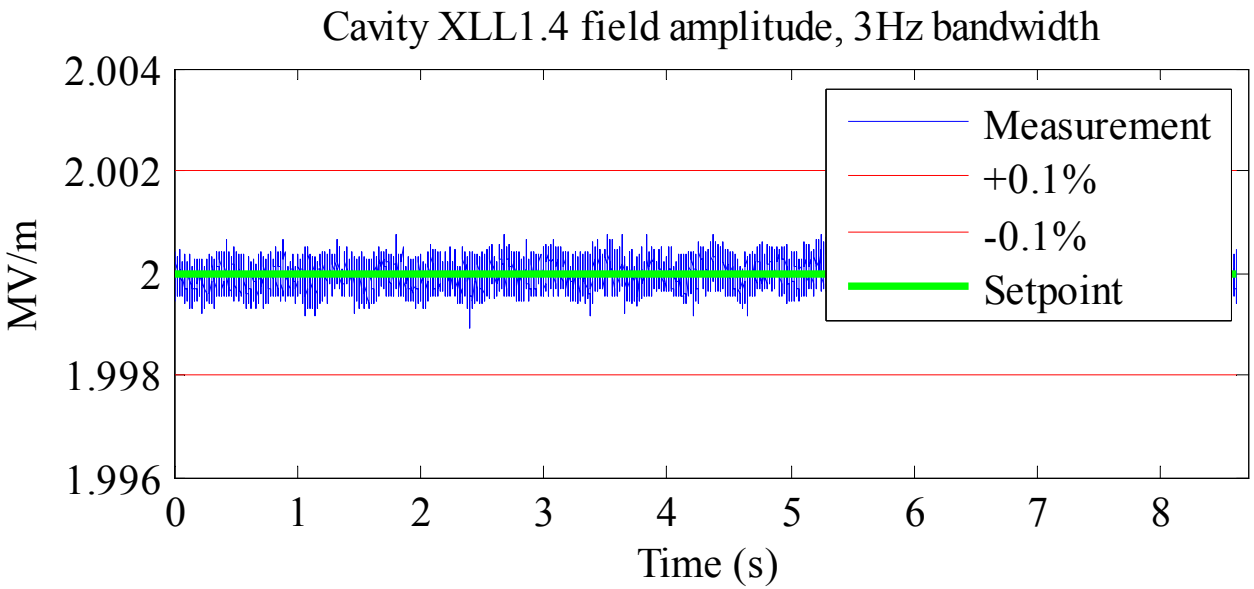
Cav 1
Cav 2
Cav 3
Cav 4
Cav 5

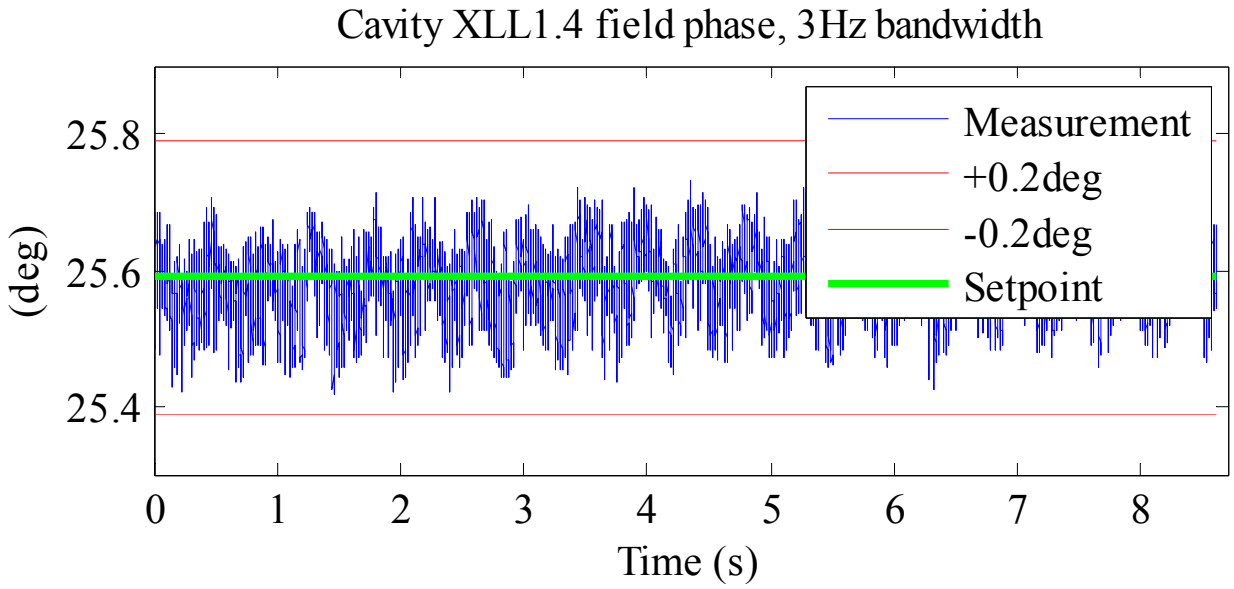


Solenoid current: 0A → 100A → 0A

Pei Zhang

Performance of LLRF system





The trouble with RF input lines

Observation: RF drifts when driving cavities at high power to initially assumed operational bandwidths → thermal effects in the power coupler

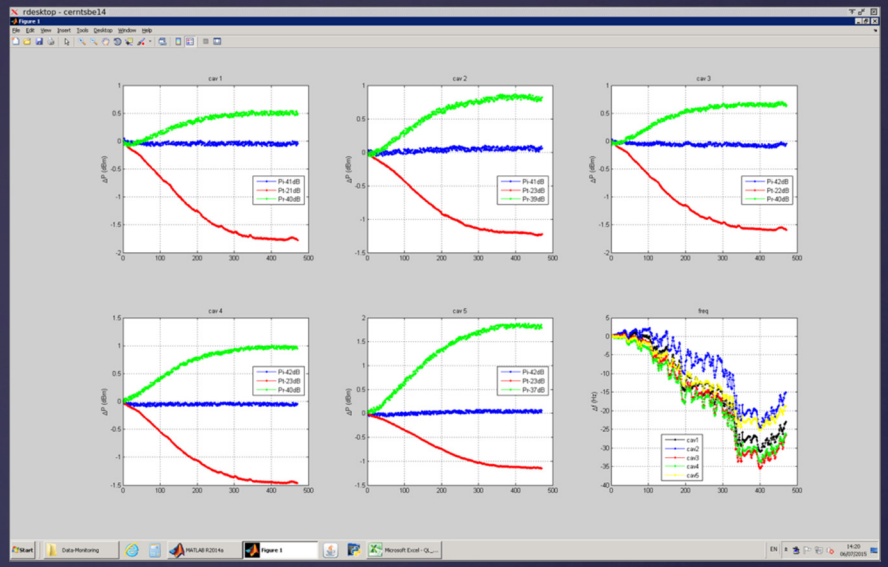
Potential showstopper…

- Dedicated test in vertical cryostat→ permanent damage at 200 W
- Post mortem analysis

- Second test → still OK after 9 hours at 60 W

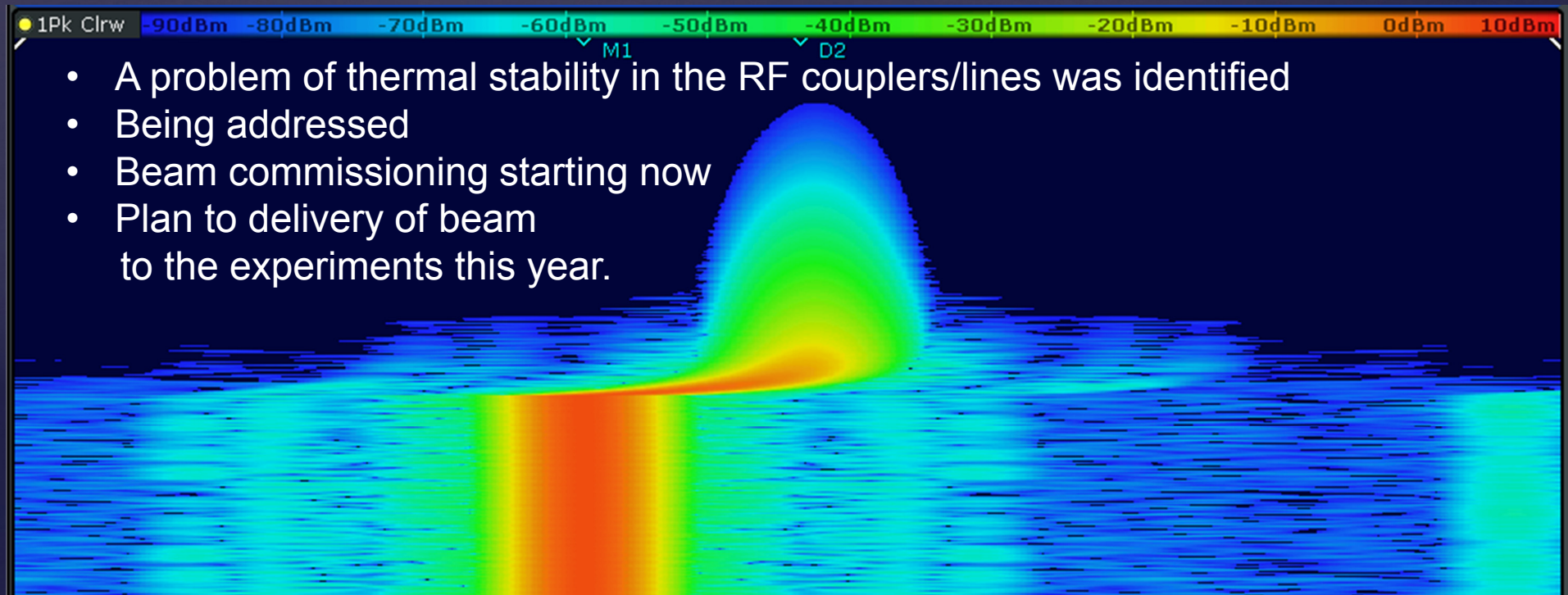
- Task force (simulations and experiments)

- Adapting LLRF loops to reduce bandwidth
- Now 3 Hz (requiring ~ 50 W at nominal) seems possible)



Summary and Outlook

- HIE-ISOLDE project made remarkable progress since last SRF
- All technical infrastructures deployed and operational
- Cavity production ongoing: issue with quality of copper substrates
- Five cavities were delivered on time for installation in a cryomodule.
- The first cryomodule assembly in clean room was successful
- Cryomodule commissioning results globally positive: the vacuum performance, static heat loads, alignment accuracy, performance of the superconducting elements, and that of the low level RF systems were satisfactory.



- A problem of thermal stability in the RF couplers/lines was identified
- Being addressed
- Beam commissioning starting now
- Plan to delivery of beam
  to the experiments this year.