LHC Superconducting Cavities

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- Problems
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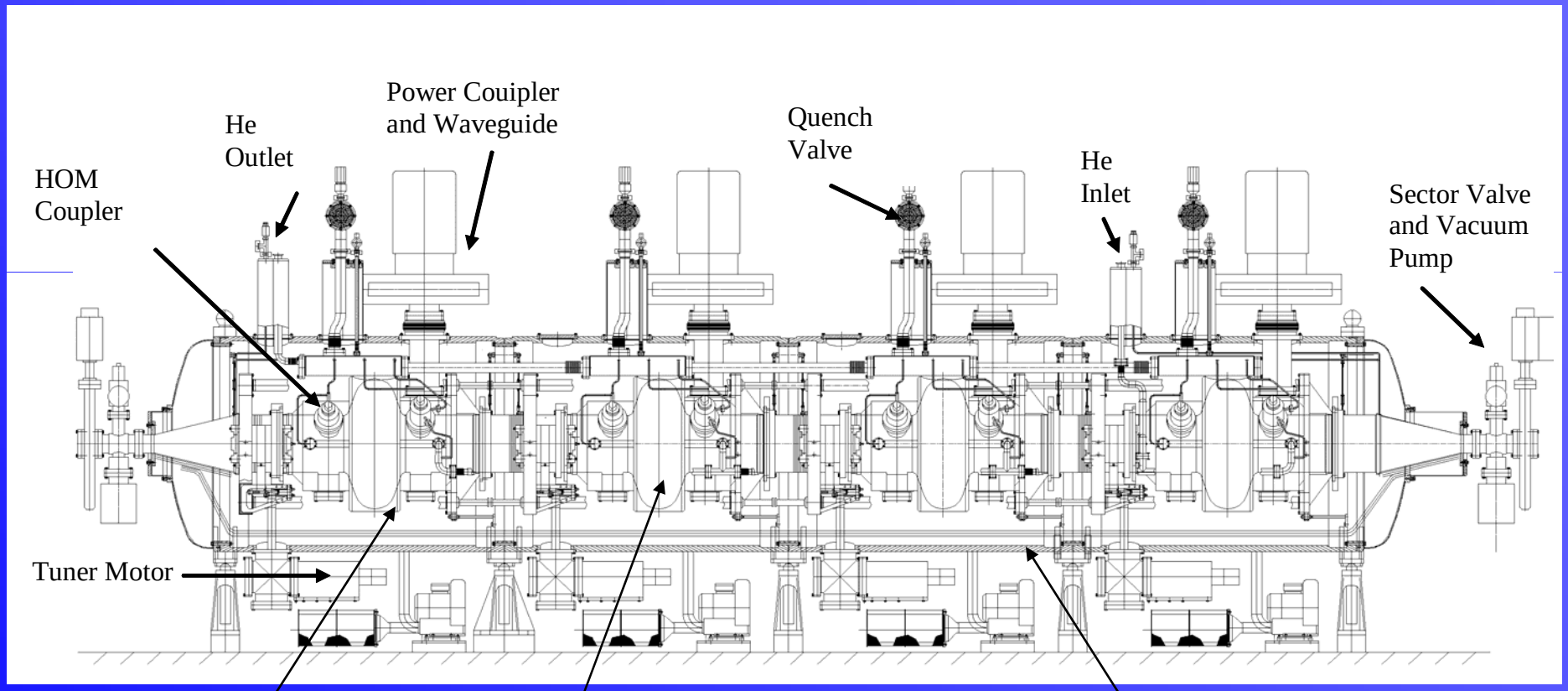
- Commissioning
- Status & conclusions

Presentation

- Module main parameters
  - 4 single cell cavities Cryo-module
  - Modular design from 2 to 6 cavities
  - Cell-to-cell distance 3λ/2 at 400 MHz
  - 3 main He connections : L He inlet, gas outlet and warm recovery line
  - Cone extremities He capillaries
  - Temperature probes redundancy
  - 150 W static losses at 4.5 Kelvin
  - 2 ion pumps at each ends with vacuum valves
  - Second beam tube inside cryostat, 420 mm spacing

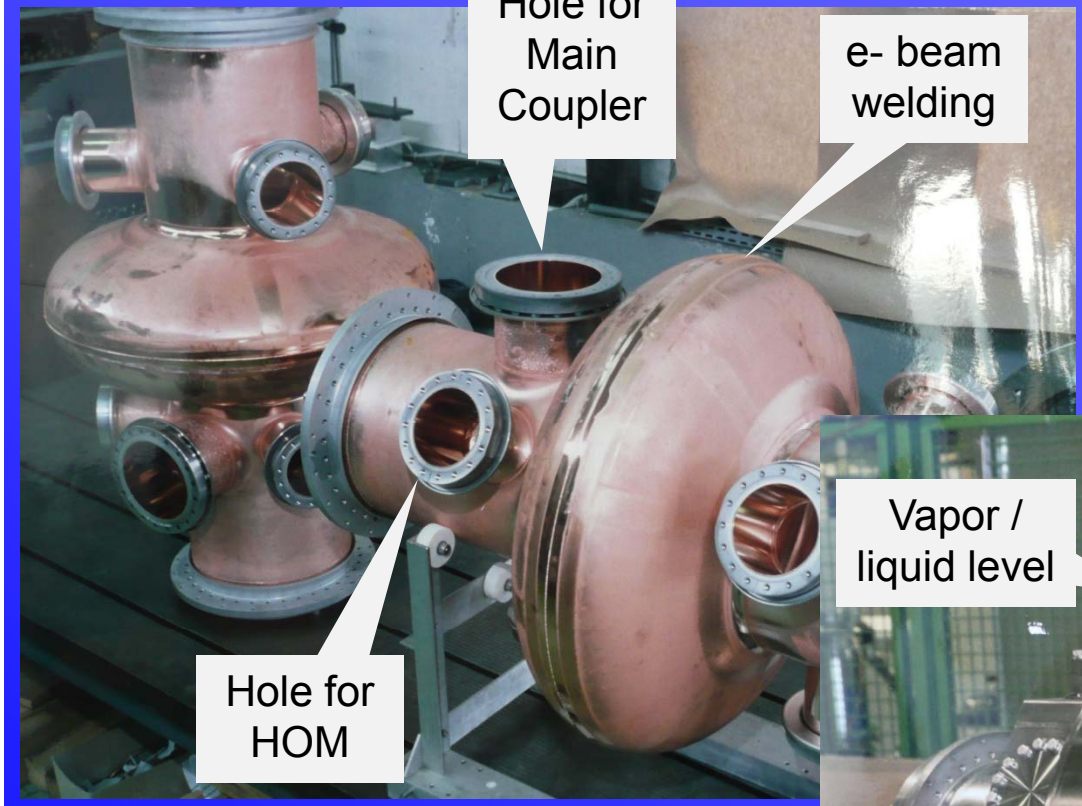
Presentation



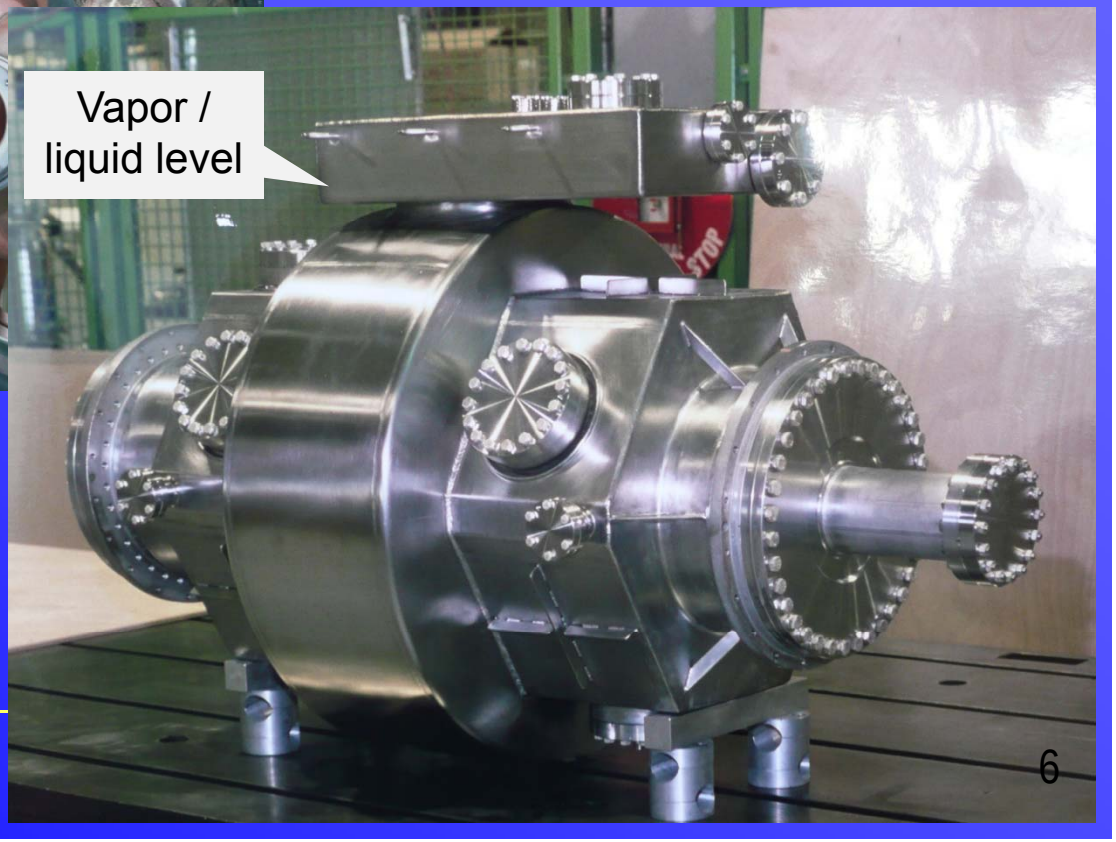
Presentation

- Cavities main parameters
  - 1-2 μm Niobium film sputtered on 3 mm Co Cavity
  - Cavity length λ/2
  - R/Q = 44 Ω, 300mm diameter beam tube
  - Acceleration field : 1 MV at injection & 2 MV at high energy
  - 300 kW CW Main Coupler with polarization, variable antenna length :10000 < Ext Q > 200000
  - External tuner motor, range 400.790 MHz +- 90 kHz
  - 4 SC HOMs of 2 types ; dipole and broad band
  - 80 liters of L He at 4.5 Kelvin in He tank
  - He dome for safety valve & He level probe

Building

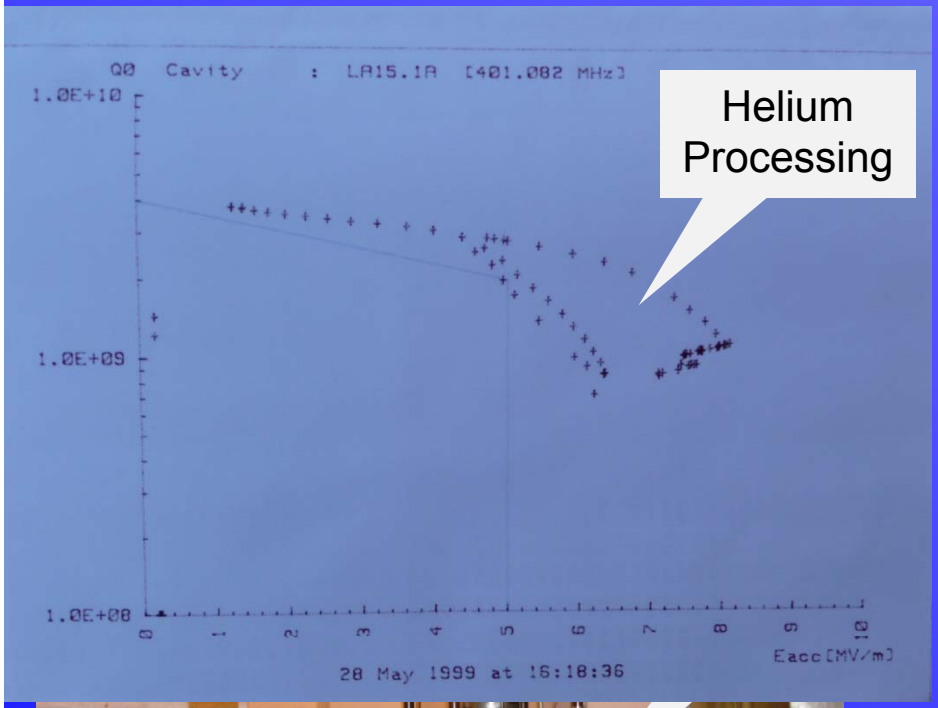


- Copper 400 MHz single cell cavity
  - 4 HOMs



- In its He tank
  - Vapor / liquid separation vessel

Building

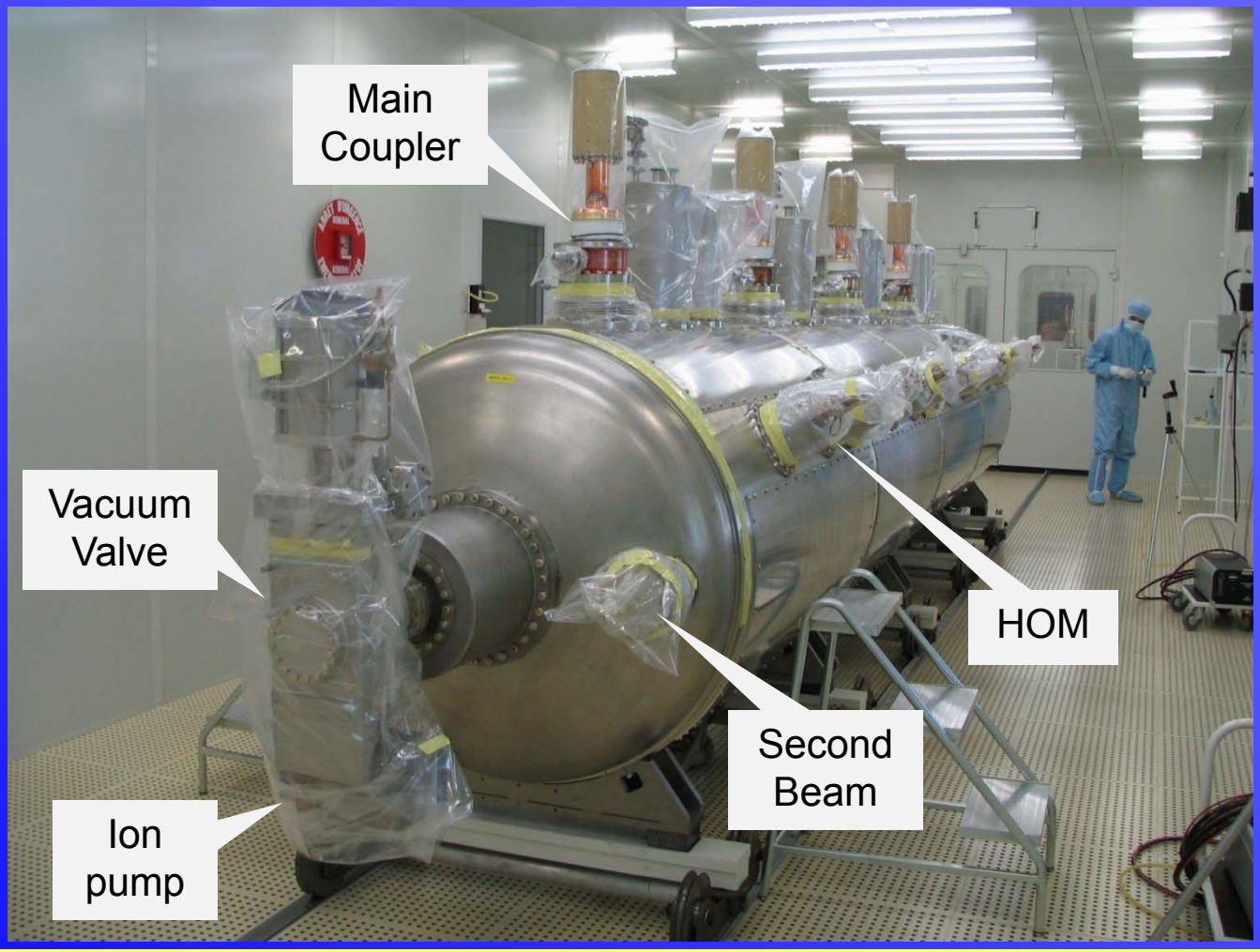


From bare Co cavity :

- Chemical treatment, rinsing
- Niobium sputtering
- Pure water rinsing
- Cavity validation in vertical cryostat by measurement of Q/Eacc. Half of them with He processing
- He tank welding
- Mounting in frame
- Tuning by plastic deformation
- Vacuum tightness

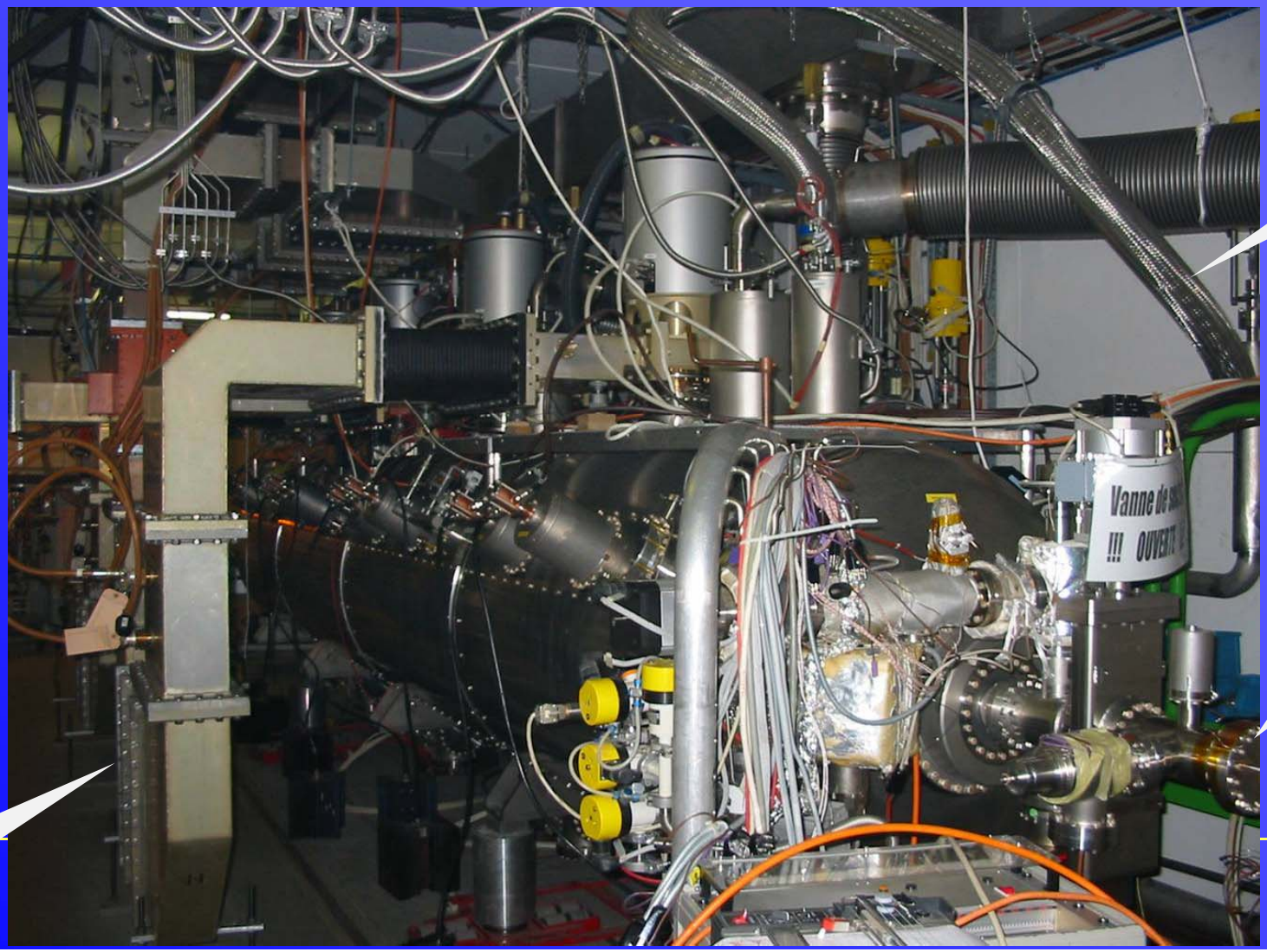
Building

- Assembling 4 Cavities and accessories in Clean Room



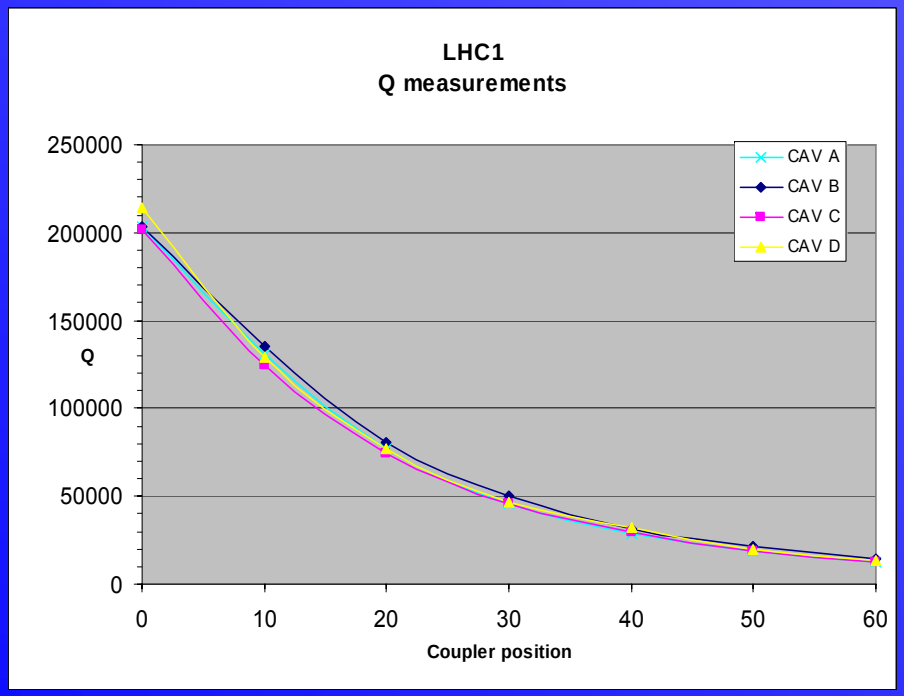
Low level & full power test

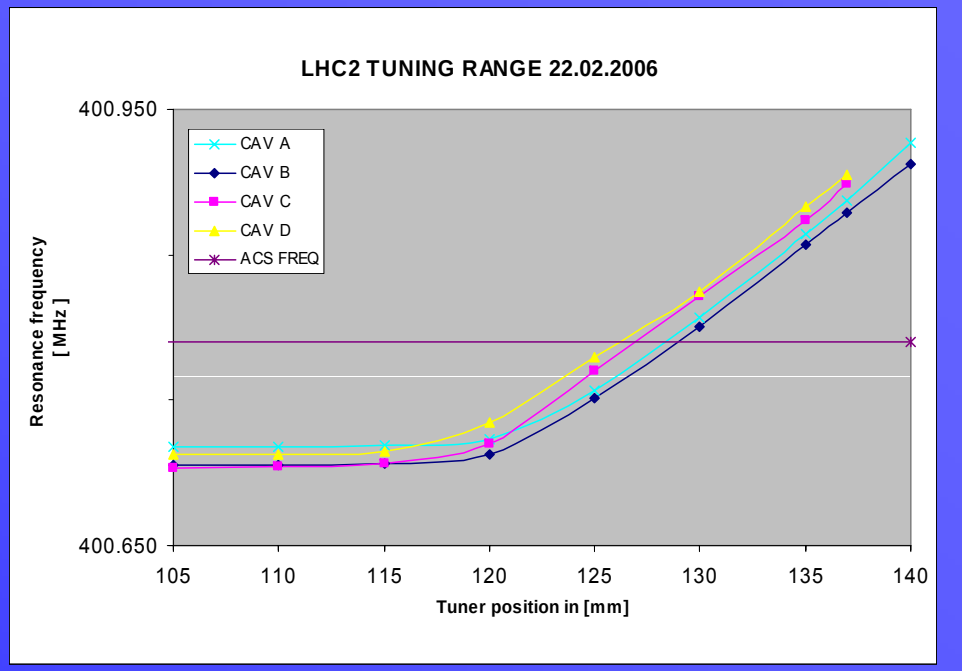
- Transfer of modules to radiation safe bunker
- Connections with cryogenic, RF, controls, e- stoppers



Low level & full power test

- Module Cool down in SM18
  - Measurement of frequency and tuner range

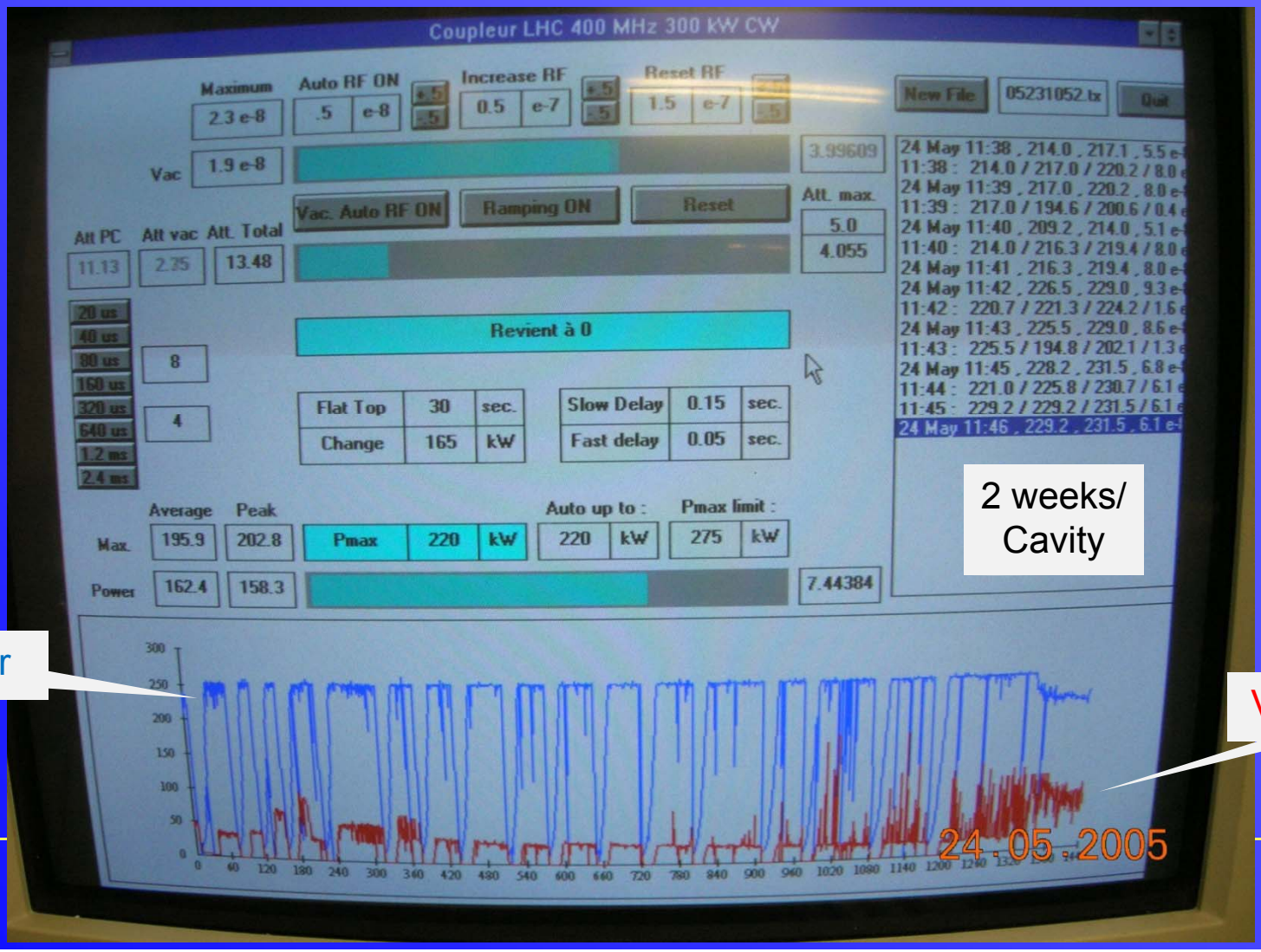




- Q ext versus power coupler position
- Calibration of antenna signal

Low level & full power test

- Conditioning to coupler full power 300kW CW.
- Raising acceleration field to 1.5 times nominal



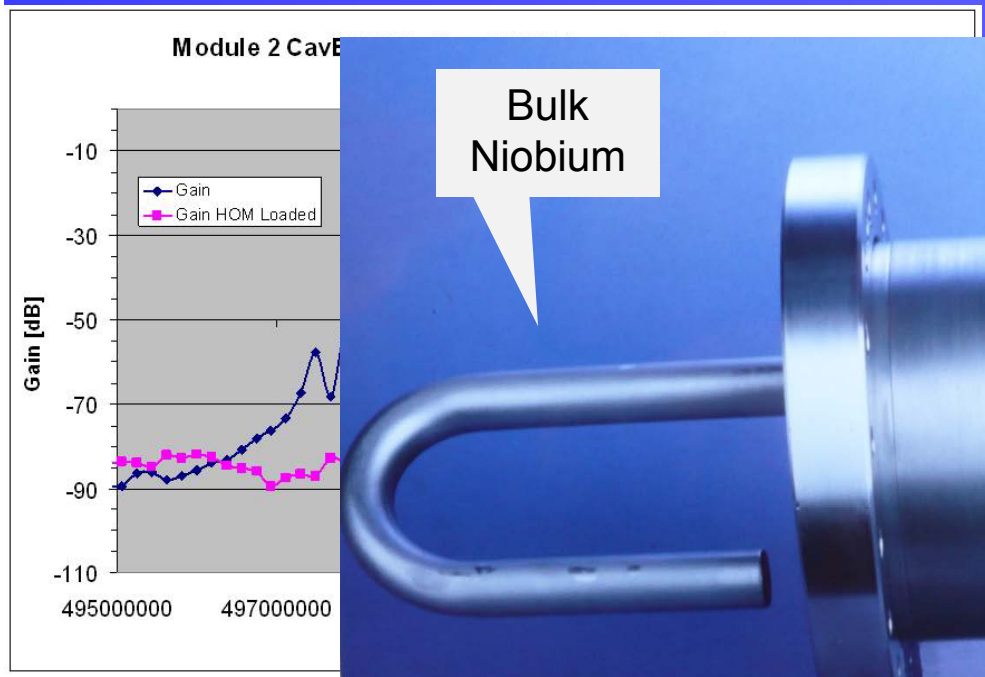
2 weeks/ Cavity

Power

Vacuum

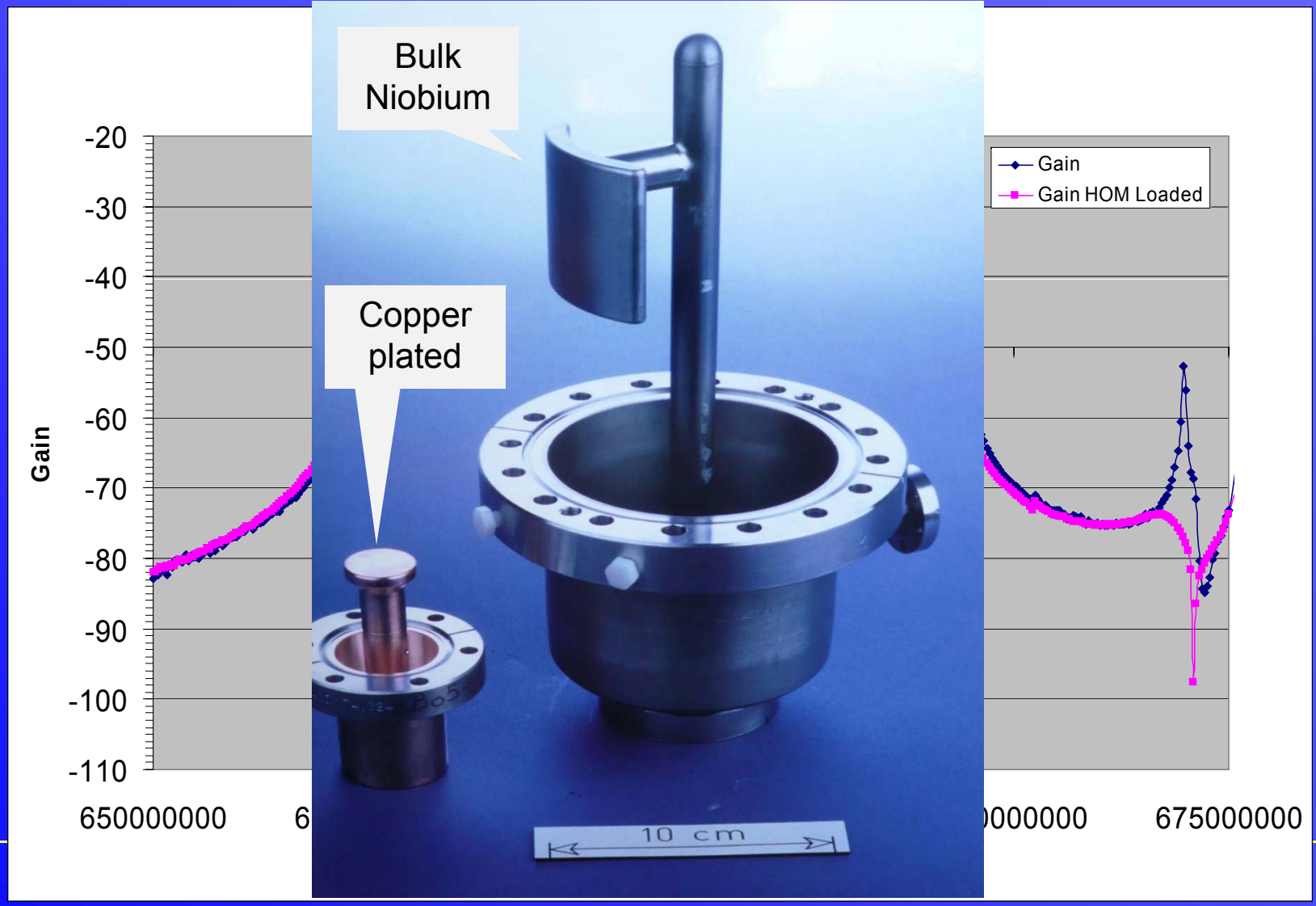
Low level & full power test

- Dipole Mode (TE111) HOM damping efficiency



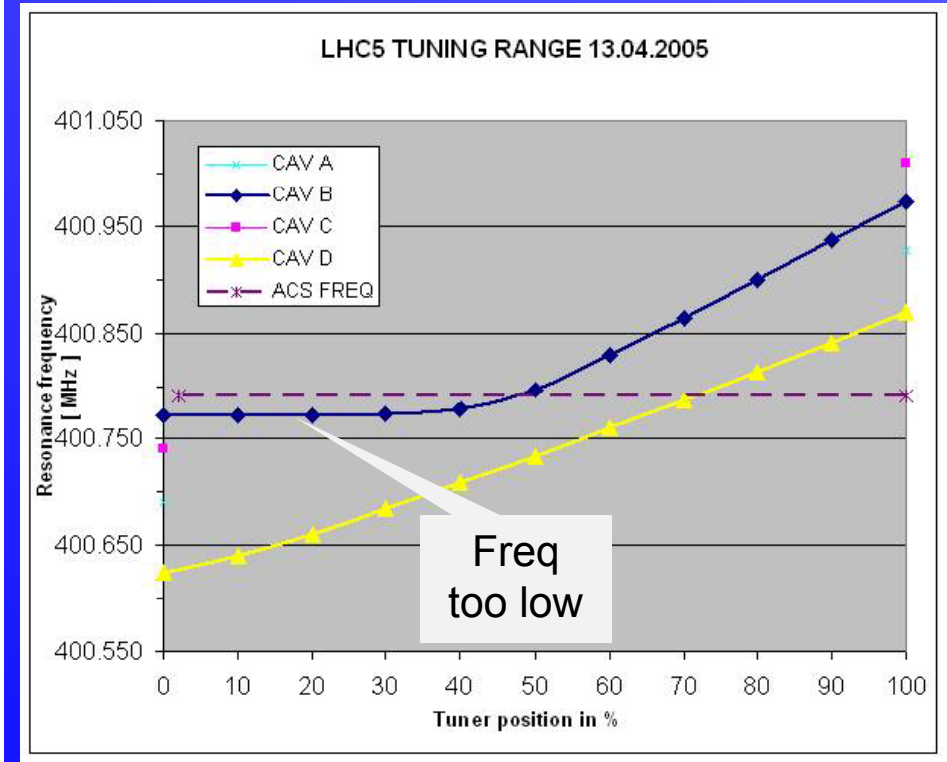
Low level & full power test

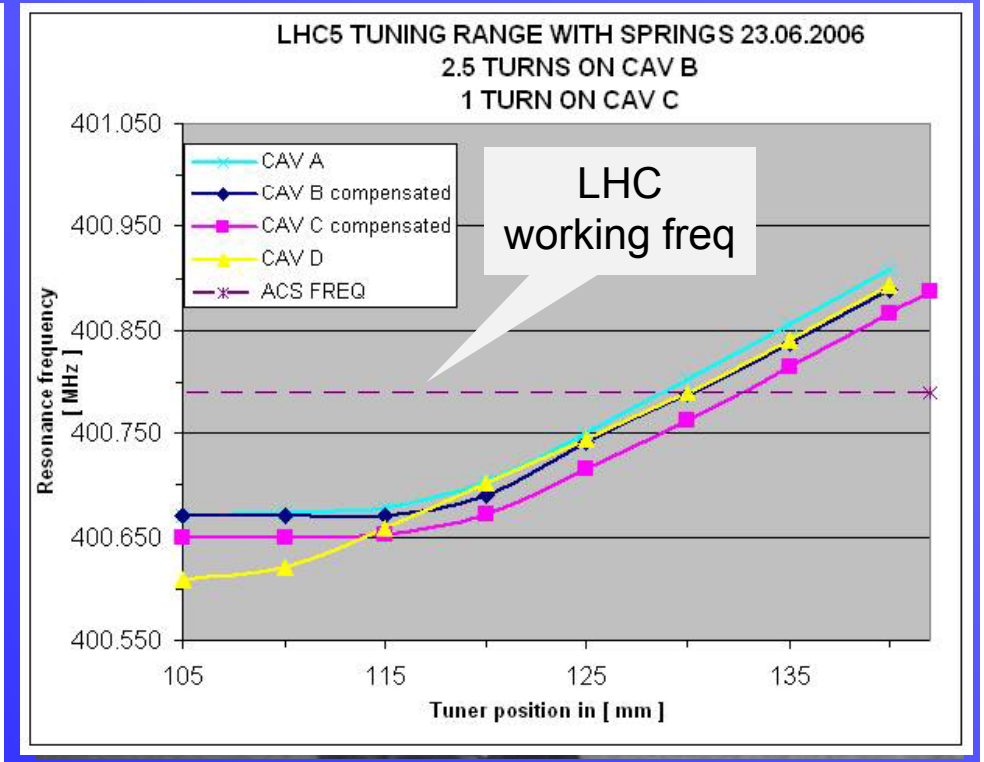
- Broad-band HOMs for higher modes



Problems

- Tuning range: too high natural frequency of half of the cavities
  - Despite warm plastic deformation, after a series of thermal cycling, some of the cavities went back to a too high frequency at rest





  - Corrected by adjustable tuning springs compensation

Problems

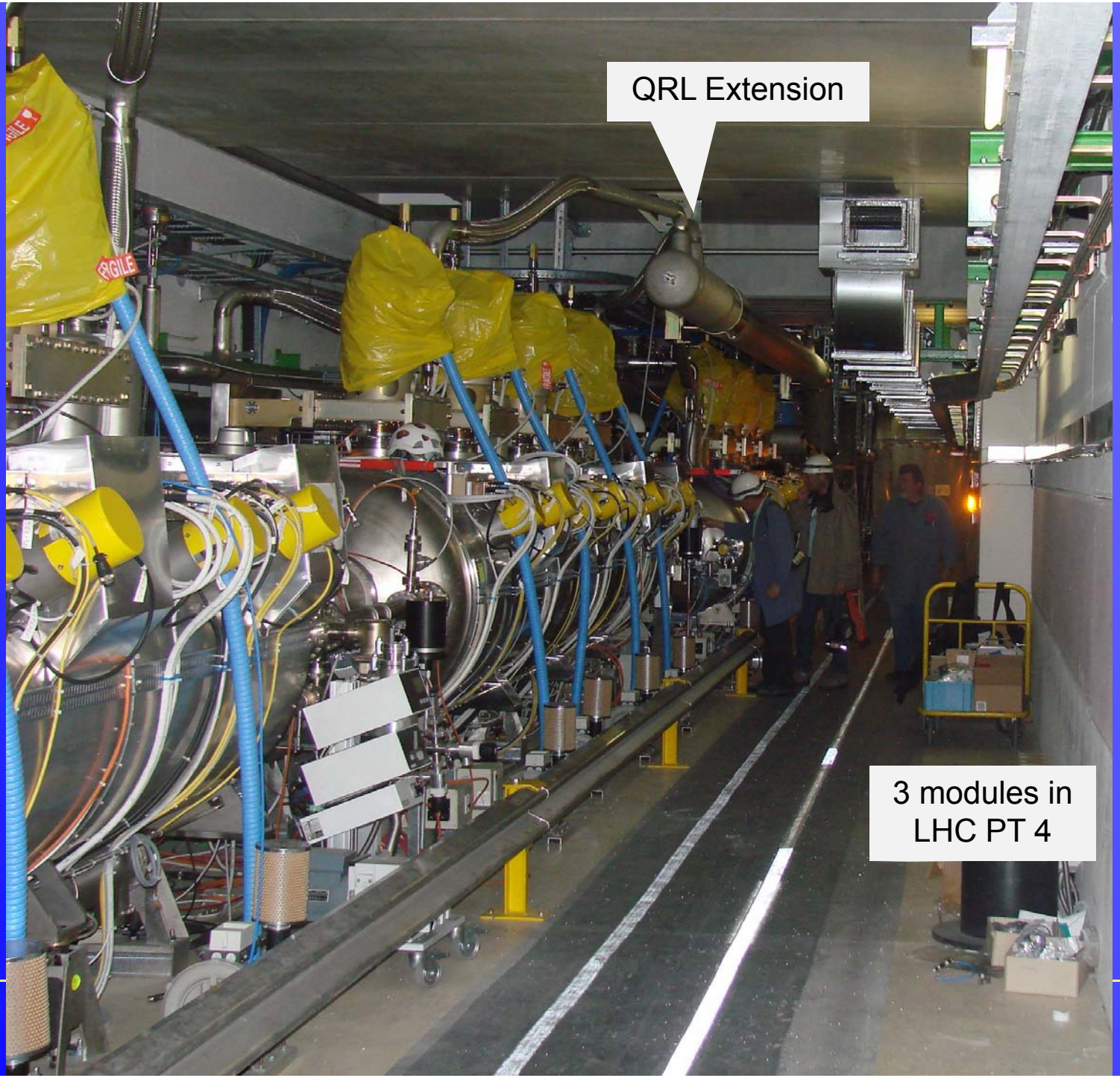
OUUUPS !

- Broken Tuner bellow during tests
  - Due to bad design
  - Found good ones certified by life test
  - Replaced just in time

Please don't look here !

Fatigue break down

- He domes to be modified
  - Old LEP design
  - Modified by longer tubing and replacing several seals by welding


QRL Extension
3 modules in
LHC PT 4

Commissioning

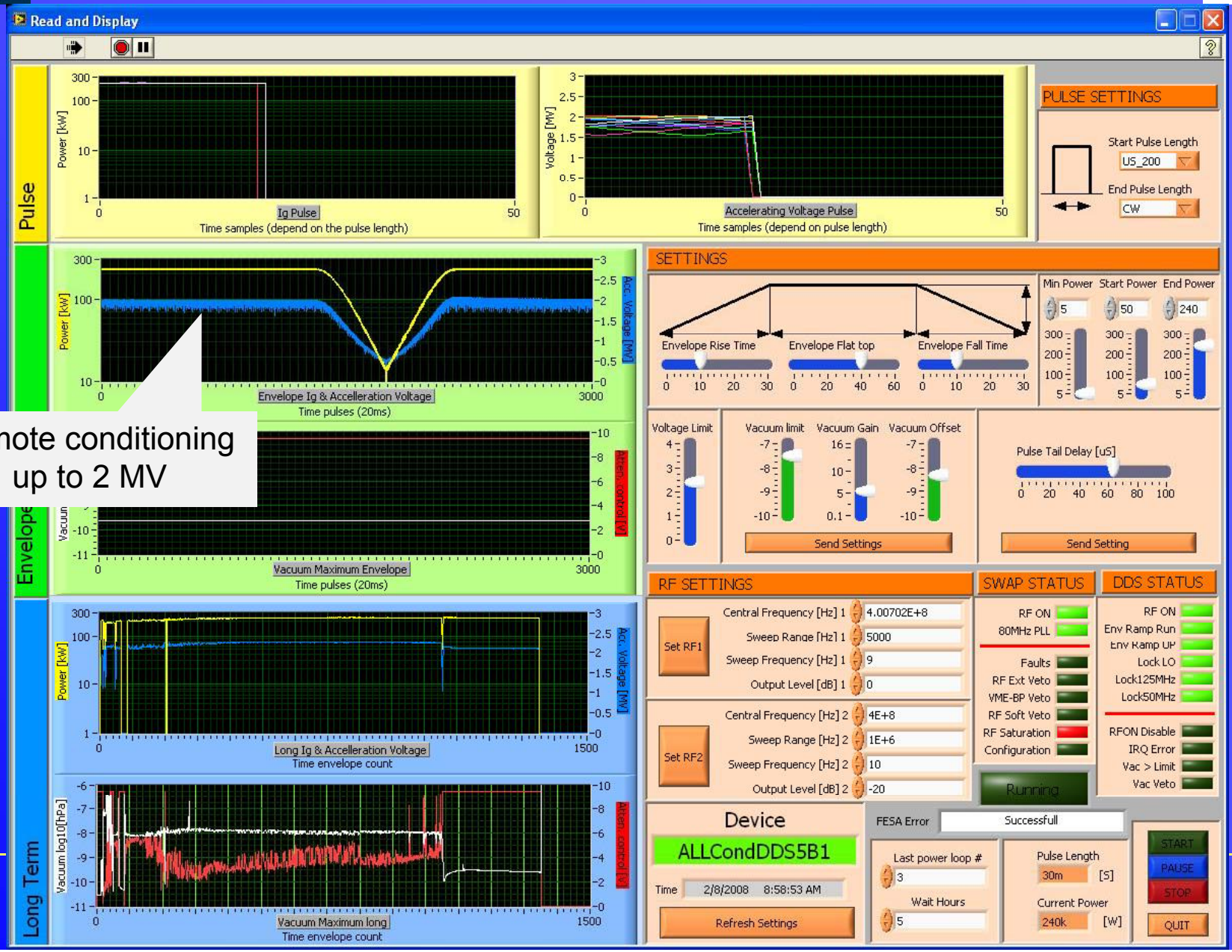
- Interlocks full check (4weeks)
  - 300 kW main coupler very sensible !
  - Remember : in case of ceramic break down, pollution of the whole module to be replaced !
  - Fast RF shut off with vacuum increase, arc detectors, He pressure, RP alarm, RF zone access etc.
- Careful setting up of cryogenic processes (2w)
- Modules cooling down (24hrs)
  - But lost already 4 times all the He through safety valves !

Commissioning

- Conditioning
  - On one module, almost no degassing, just a few quenches, 2 min for recovering
  - On the other one, 1 week of conditioning per cavity
    - Parallel operation, 16 klystrons for 16 cavities
- Low level tuning and amplitude loops closed
- As well as Klystron polar loop

SUCCESS

Commissioning



Remote conditioning up to 2 MV

Status & conclusions

- 4 Modules installed in LHC PT4 Sept ‘06
- Fully connected mid ‘07
- Cool down of 2 Modules Nov ‘07
  - Special care on cryo safety devices & process control
  - Successful validation in full power and field Feb ’08
  - Modules warm now with sector 4-5 for Triplets
- Cool down of the 2 other ones foreseen June ’08
- Beam commissioning ..’08

Acknowledgement

- All AB/RF group members participating
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