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14th International Conference on RF Superconductivity

SPIRAL 2 CRYOMODULES TEST RESULTS AND STATUS

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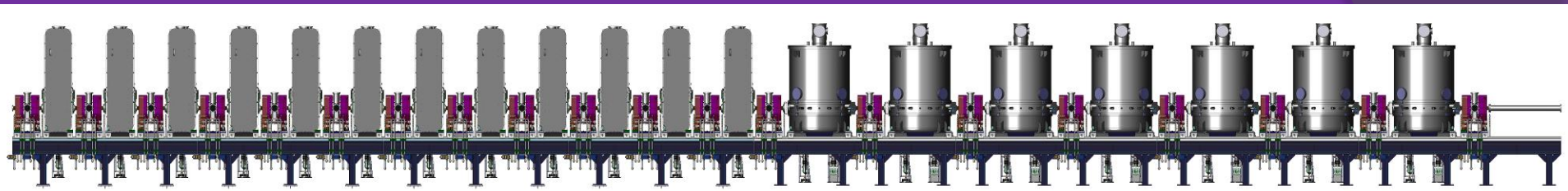
On behalf of cryomodules A and B teams

OUTLINE

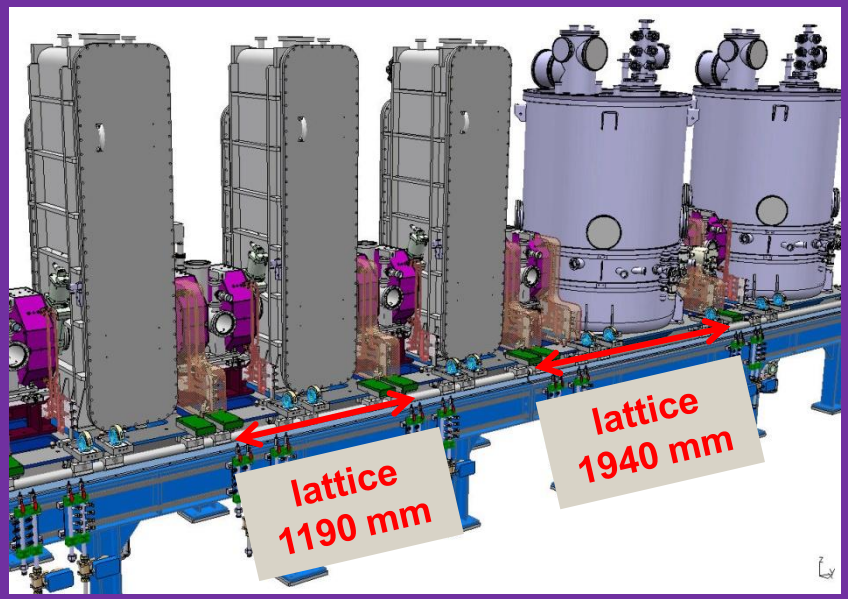
- SPIRAL2 Linac layout & parameters
- Cryomodule A and B tests
  - Cryogenic losses
  - Power coupler & cavity performances
  - Tuning system
- Production status
  - Cryostats
  - Cavities
  - Power couplers

SC LINAC



Beta 0.07 energy section — Beta 0.12 energy section

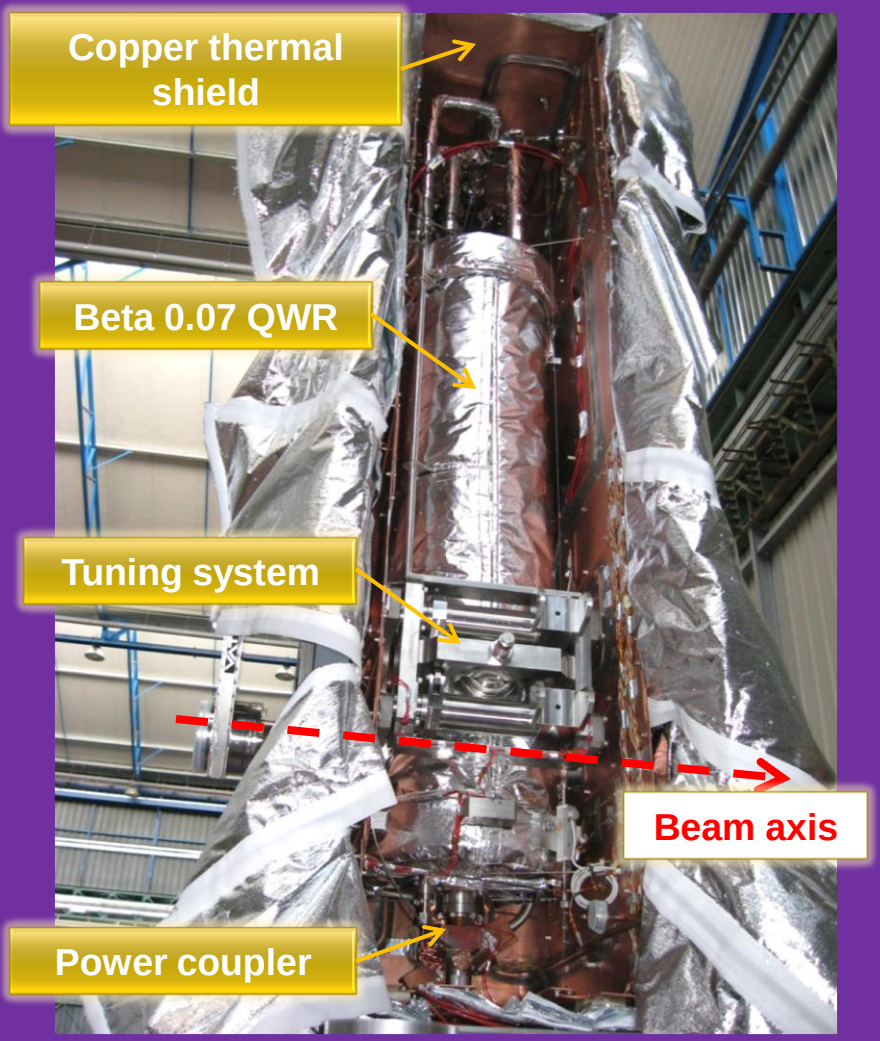
L~35 m



Cryomodule A	Cryomodule B	Power coupler
CEA Saclay	IPN Orsay	LPSC Grenoble

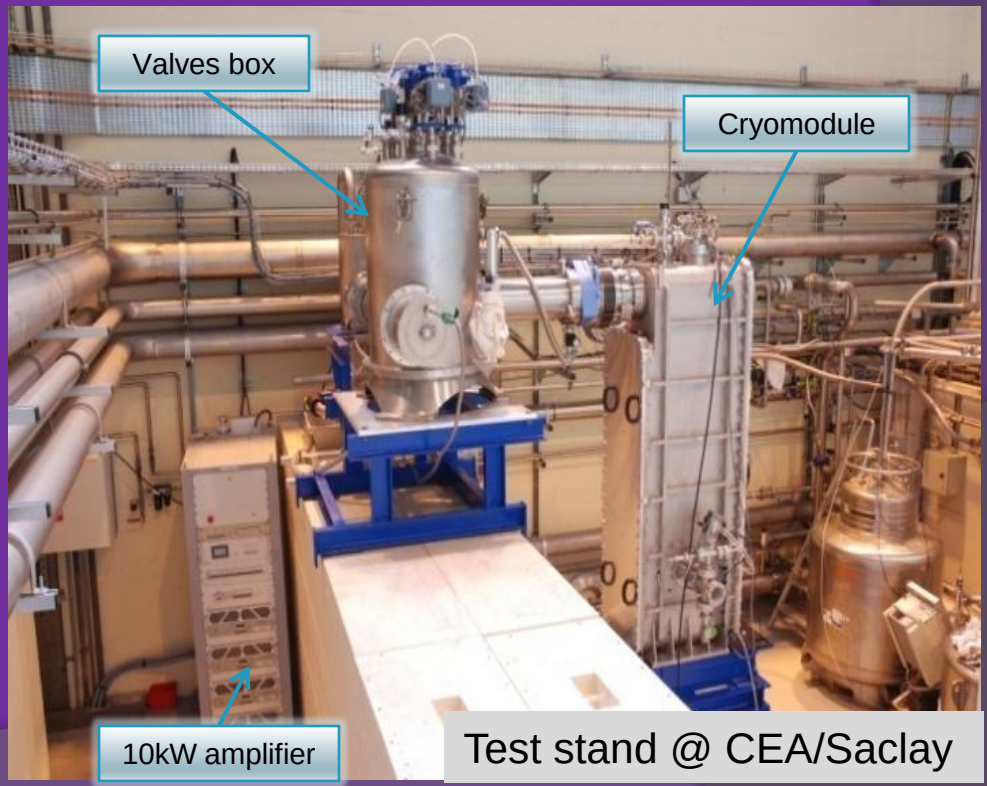
Cryomodule	A	B
Valve-to-valve length [mm]	610	1360
# cavities	12	14
f [MHz]	88.05	88.05
β_{opt}	0.07	0.12
Epk/Ea	5.36	4.76
Bpk/Ea [mT/MV/m]	8.70	9.35
r/Q [Ω]	599	515
Vacc @ 6.5 MV/m & β_{opt}	1.55	2.66
Lacc [m]	0.24	0.41
Beam tube ∅ [mm]	38	44

Cryomodule A



Specifications:

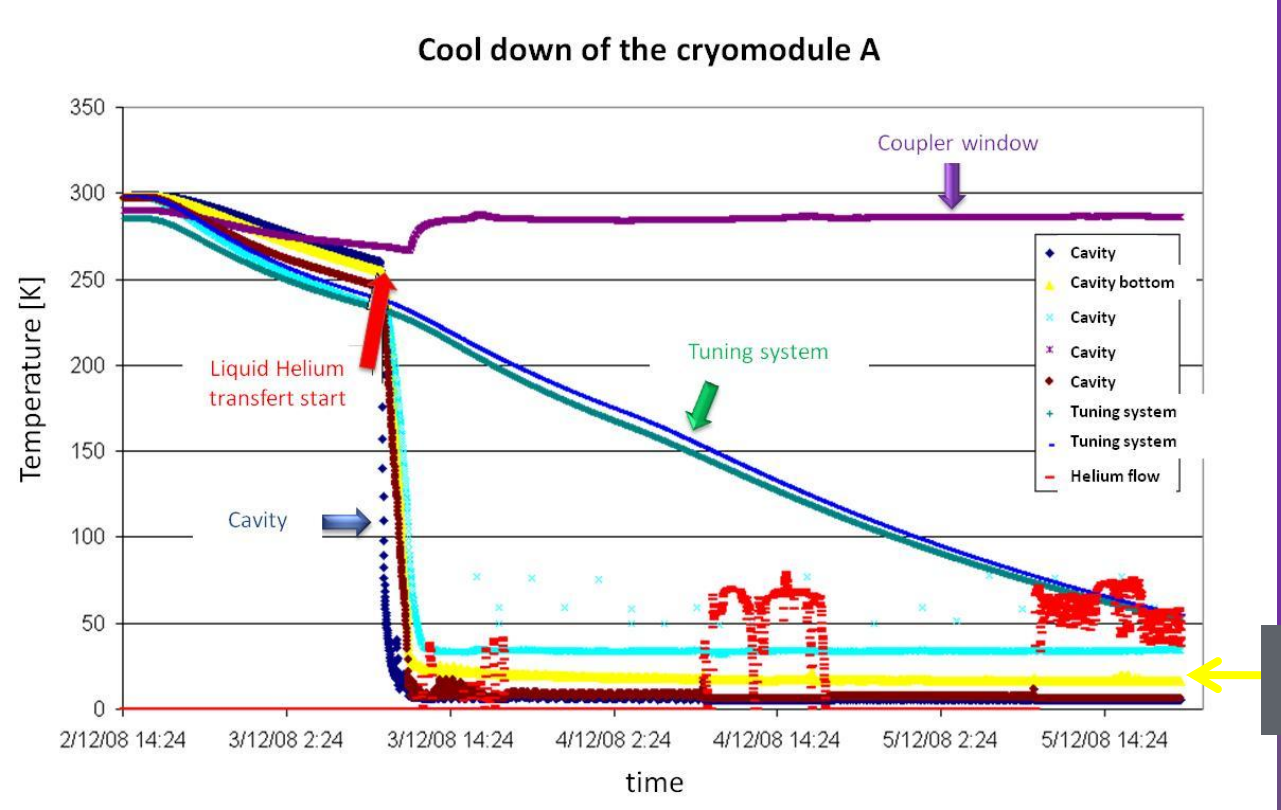
- T = 4.5 K
- E_{acc}=6.5MV/m & P_{cav}< 7W
- Cryomodule static losses < 8.5 W
- $P_{coupler}$ = 10kW max

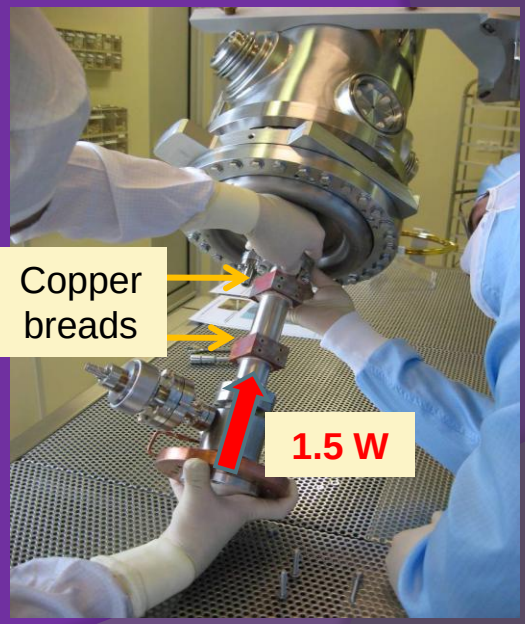


Test stand @ CEA/Saclay

Cool down

- Thermal shield cooled down first during 1 day
- Cavity cool down 250K→4K: < 1 hour (excepted cavity bottom)
- Tuning system: T_{final} = 20K within 4 days
- Static losses: 6.5 W (SPIRAL2 specs <8.5W)
- Losses during continuous LHe transfer losses (w/o RF): 35 W

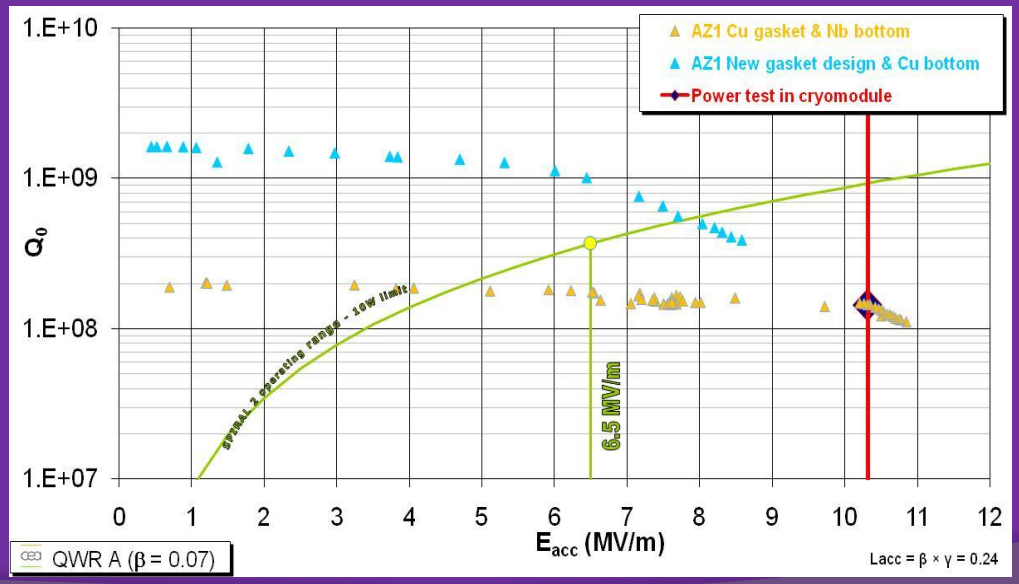


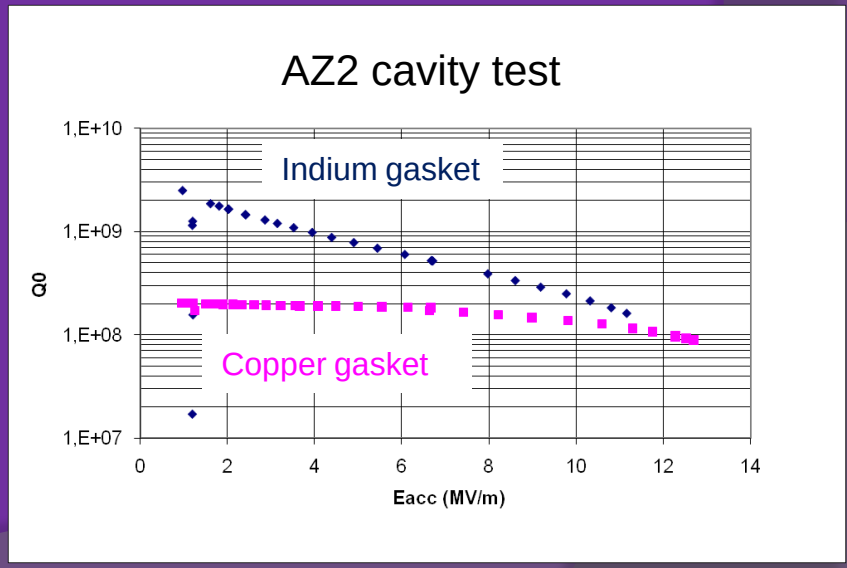


Cavity bottom at ~15 K

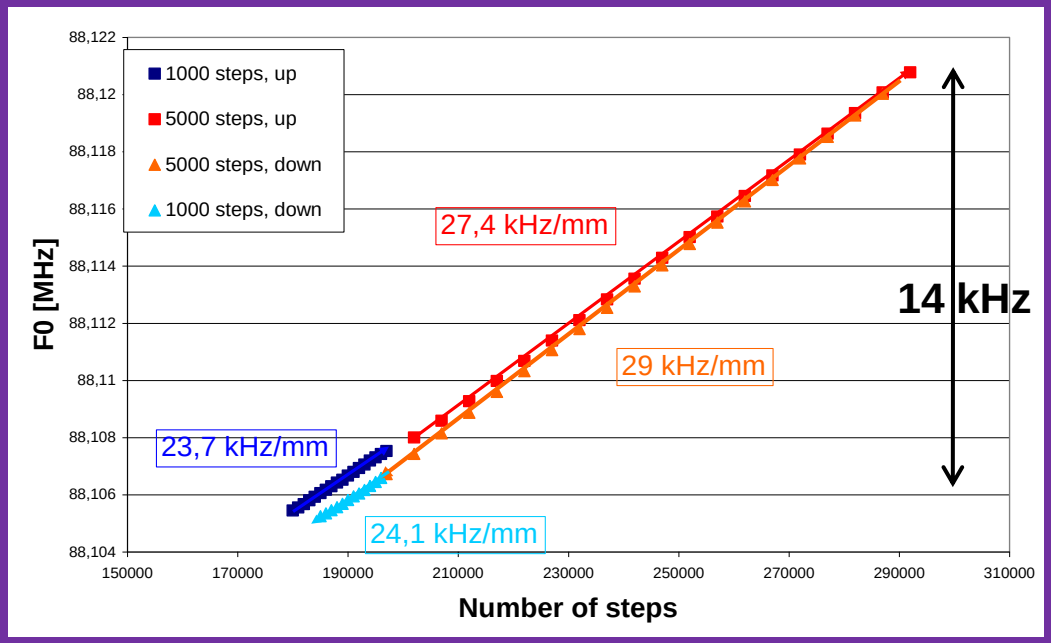
RF performances

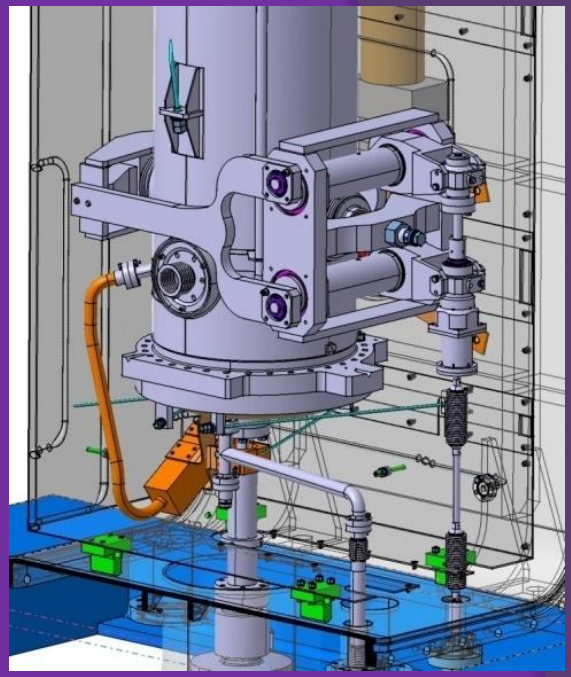
- Power coupler conditioned up to 10 kW CW at 300K and 4K
- Multipacting barriers at 4, 26, 131 and 220 W (passed but not processed)
- External Q: 5.3 10^5 (calculated: 5.5 10^5)
- Cavity AZ1 with low Q_o → 35W @ 6.5 MV/m
- Eacc max = 10.3 MV/m at low duty cycle (5 Hz). P_{cav} >70 W





Tuning system

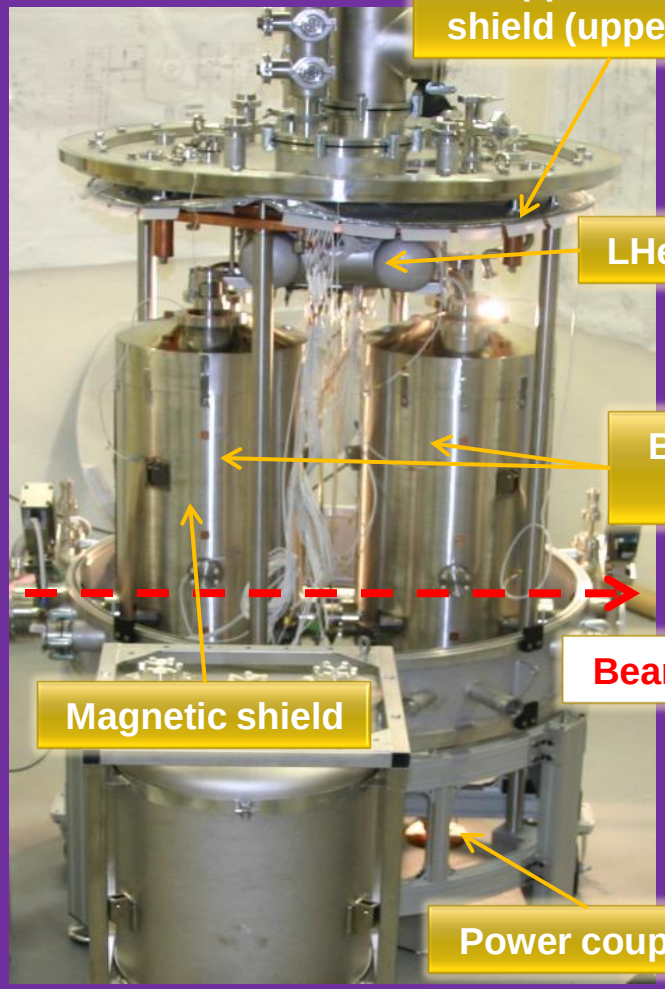




Push-pull tuning system

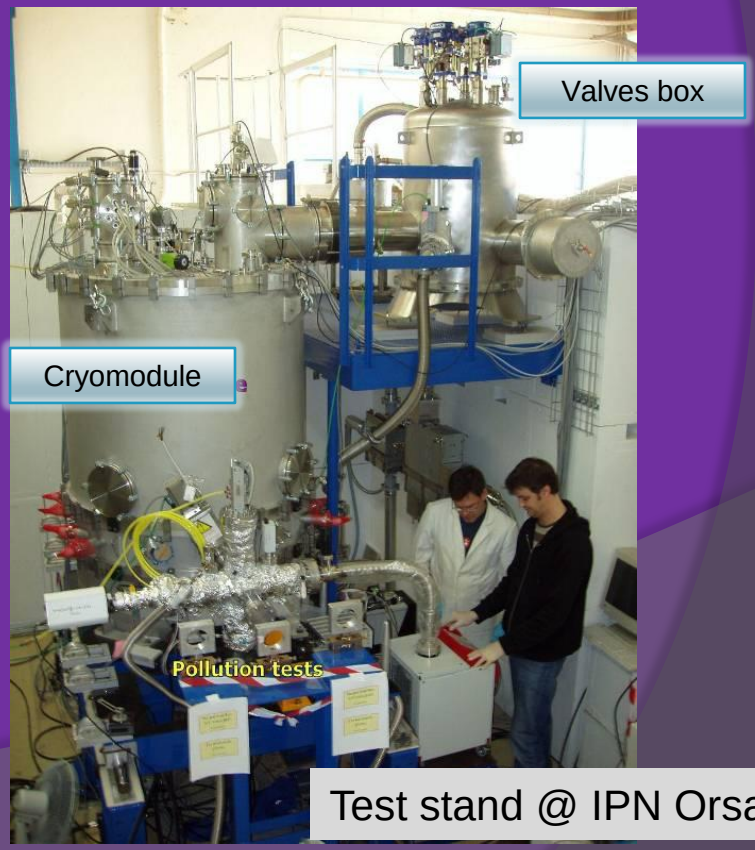
- Tuning system in contact before cool down → -5 kHz (SS shrinkage) ⇒ Shifted away (1.3 mm) from the cavity
- good linearity: 0.15 Hz/motor step
- Sensitivity: ~28 kHz/mm (25 kHz/mm calculated)
- Small backlash
- Tested over 10kHz amplitude (full range: +25 kHz)

Cryomodule B



Specifications:

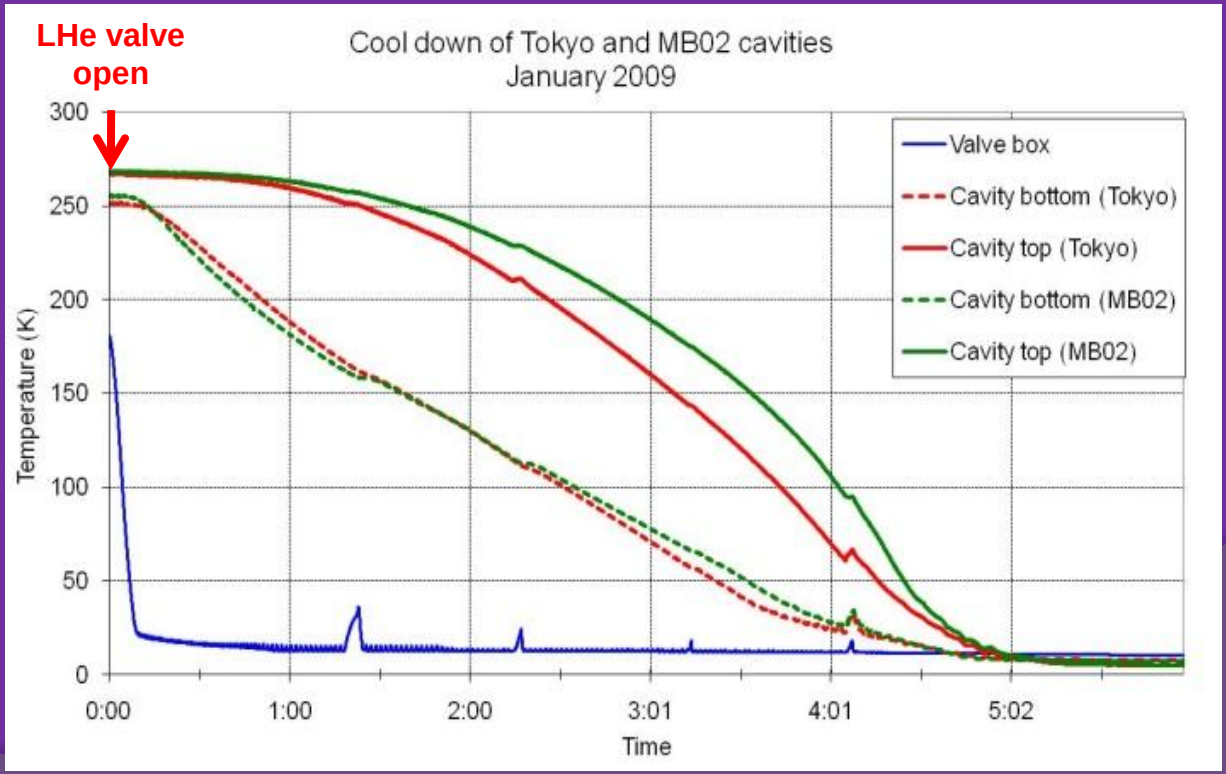
- T = 4.5 K
- E_{acc}=6.5MV/m & P_{cav}< 10W
- Cryomodule static losses < 11 W
- $P_{coupler}$ = 10kW max



Test stand @ IPN Orsay

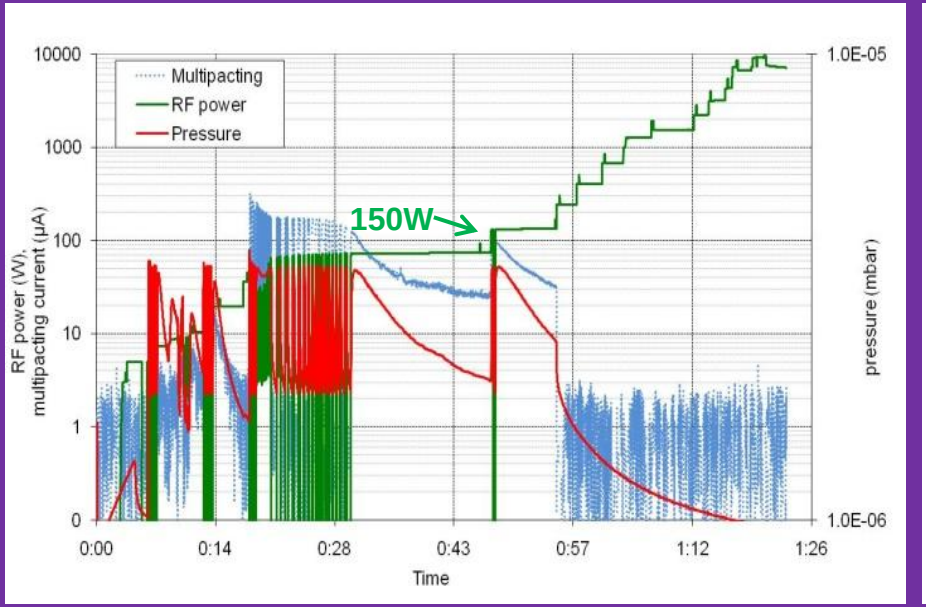
Cool down

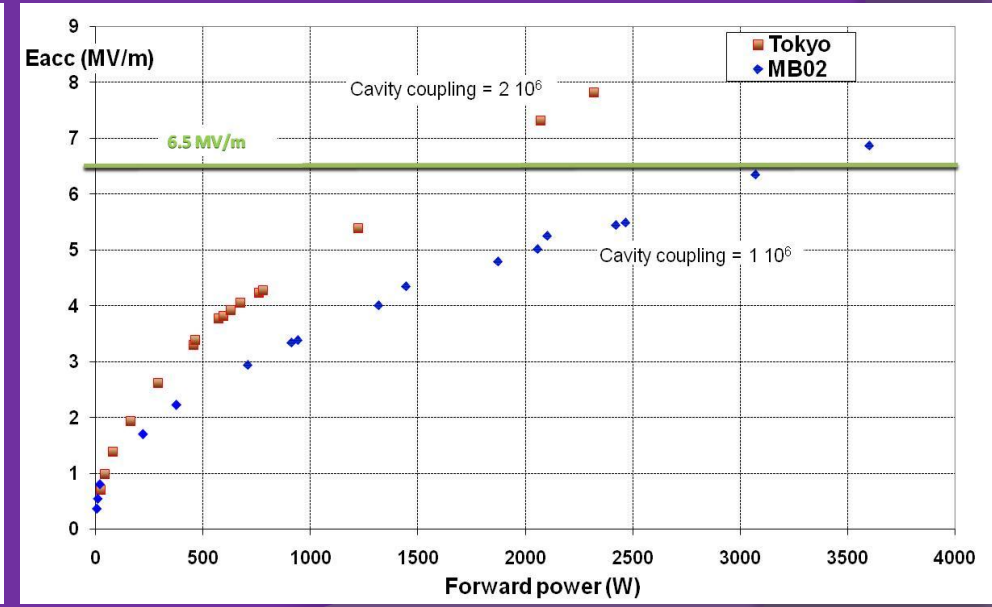
- Thermal shield cooled down first: 300K→80K in 10h
- Cavities cool down 250K→4K: < 5h (~1h between 150K an 50K)
- He bath pressure variation: +/- 2 mbar
- Static losses: 16 W (SPIRAL2 specs <11W) → extra heat load from couplers + bad contacts on copper thermal shield
- Losses during continuous LHe transfer (w/o RF): 32 W



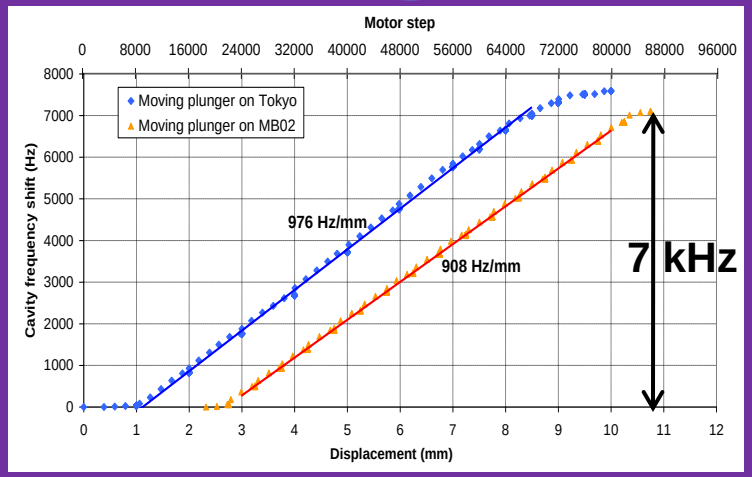
RF performances

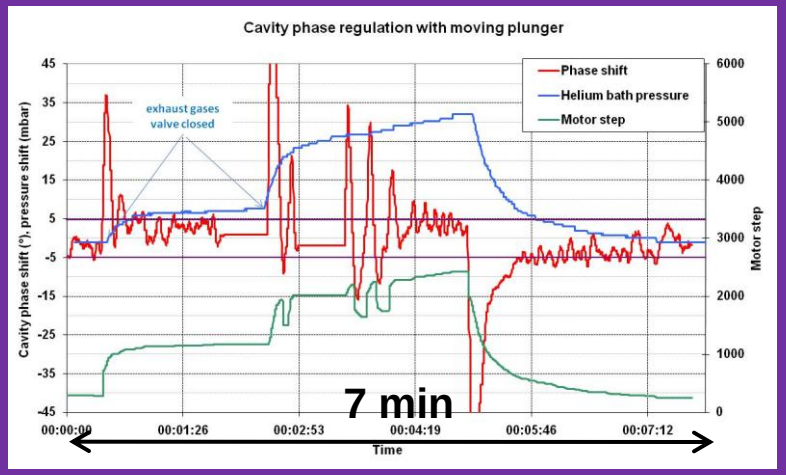
- Power coupler conditioned up to 10 kW CW at 300K and 4K
- Multipacting barriers & vacuum deterioration only up to 150W
- Eacc max = 7 MV/m & 8 MV/m (~9 MV/m in vertical cryostat) → tuning system with SC plunger (chemical treatment of only 20 µm → defect → quench)

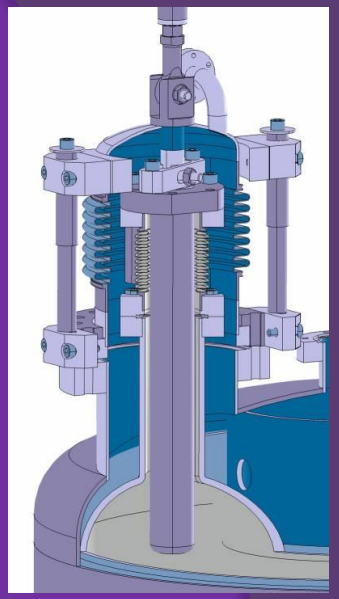




Tuning system







Nb plunger

- Coarse tuning: introducing the plunger ⇒ from +20kHz to +50kHz
- Fine tuning: moving the plunger (+/- 4mm)
  - Sensitivity: ~1 kHz/mm (1.15 kHz/mm calculated)
  - Good linearity: 0.12 Hz/motor step
- Small backlash (70Hz)
- Compensation up to ΔP=30mbar and variation rate of 0.4 mbar/s

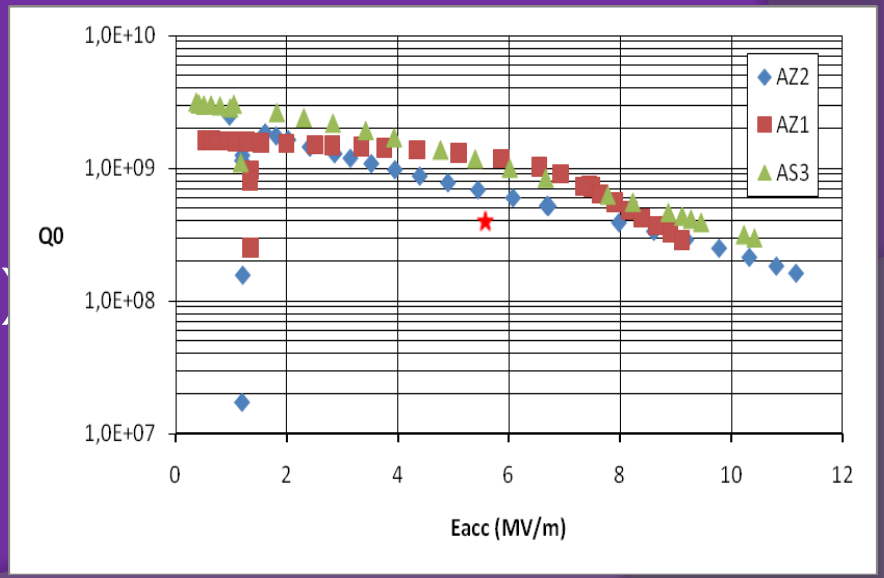
Status on components production

Cryomodule A

- Fabrication started in June 2009 (11 cryostats)
- First cryostat delivered in January 2010
- Cryostats #2-#10 : from July to December 2010 (3 batches)

Cavities A

- Fabrication in 2 phases (2 +10 cavities) started in June 2008
- The first two cavities (AZ2 & AS3) tested and validated this year
- 10 remaining cavities between May and July 2010



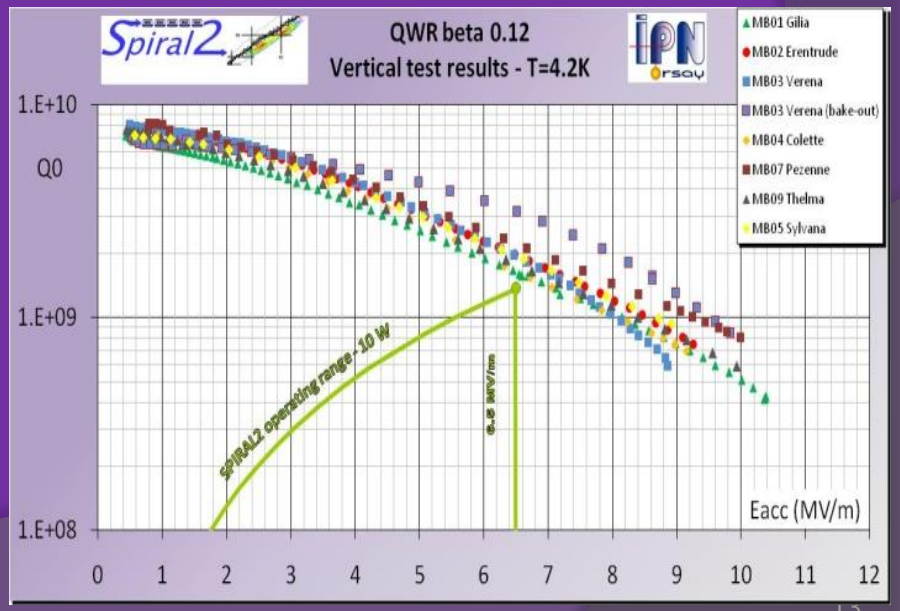
Status on components production (con't)

Cryomodule B

- Fabrication started in March 2009 (6 cryostats)
- First cryostat in November 2009
- Cryostats #2-#5 every 2 months

Cavities B

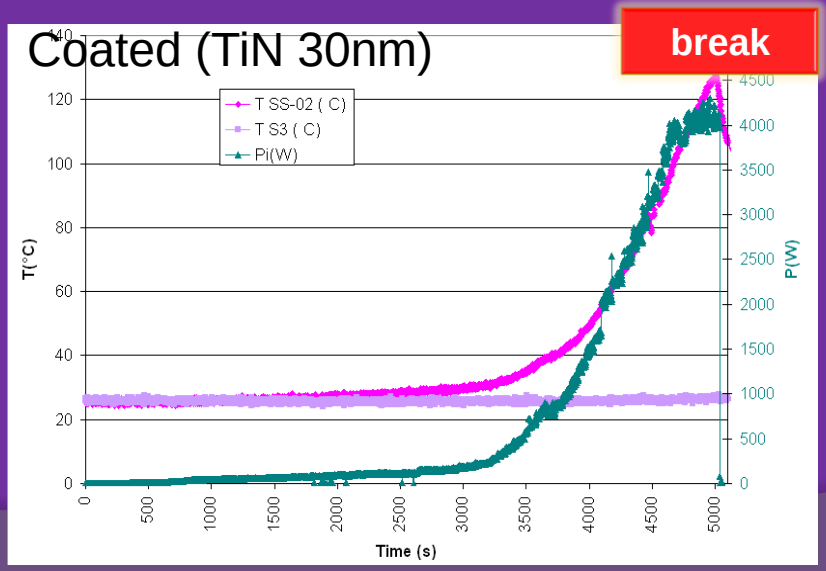
- 10 cavities delivered
- 7 cavities tested and validated
- 1 cavity repairing: frequency too high → local chemistry in H field area
- 6 more cavities in October/November 2009

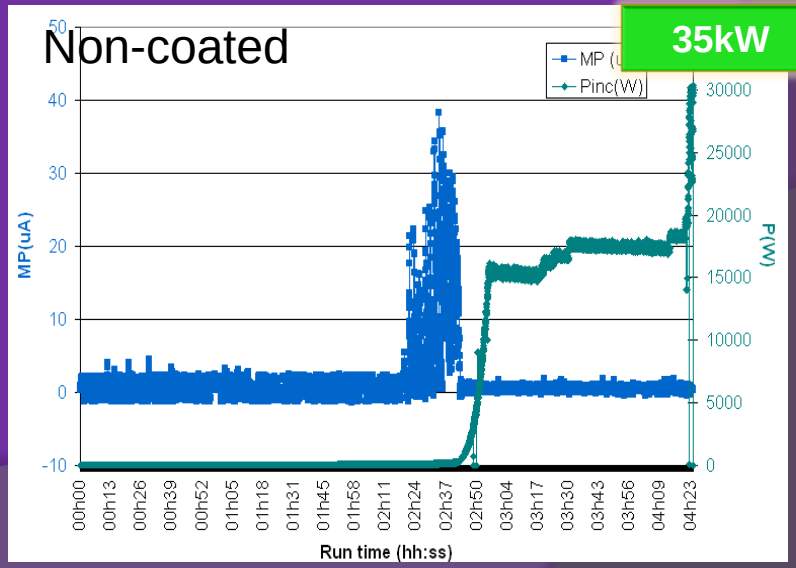


Status on components production (con't)

Power couplers

- Fabrication of 30 couplers started in September 2008
- First batch (5 couplers) delivered and tested
  - 2 TiN coating (30nm): break at 4kW & 7kW
  - 1 TiN coating (1nm): ok up to 35kW
  - 2 non-coating: ok up to 35kW
- 2nd batch of 5 couplers (non-coated) in October 2009
- End of conditioning: mid-2011





Thank you

- Pierre Bosland (CEA)
- Yolanda Gomez-Martinez (LPSC)