

DE LA RECHERCHE À L'INDUSTRIE



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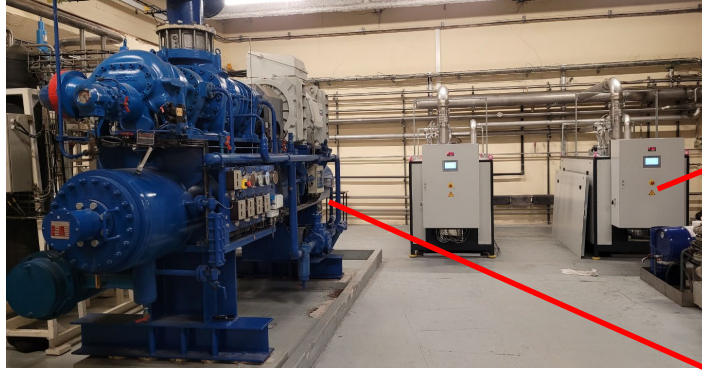
TEST FACILITIES FOR CAVITIES AT CEA SACLAY

Claude MARCHAND
CEA Paris-Saclay

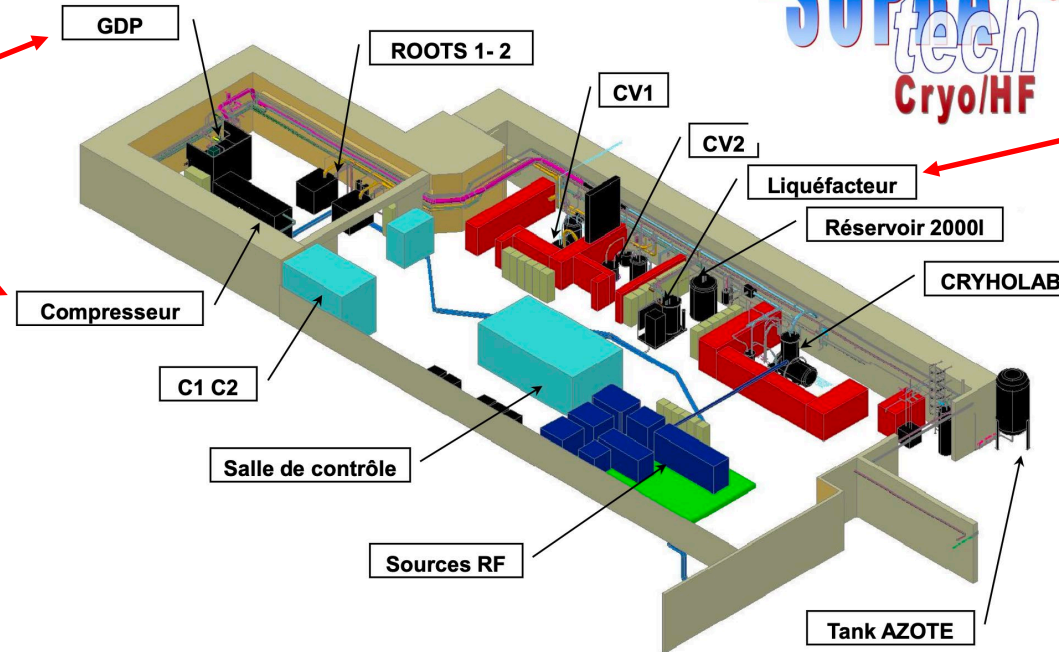
- Presentation of CEA infrastructures for cavity testing:
 - Cryoplant
 - Vertical cryostats + cavities tests
 - Horizontal cryostat
- Cavity preparation
- Testing setup
 - Magnetic shielding
 - Diagnostics
- Cryomodule test bunker
- RF power sources



CRYOPLANT PARAMETERS



- MYCOM compressor 80g/s
- 2 horizontal LEYBOLD pumps
- 100 m³ He buffer



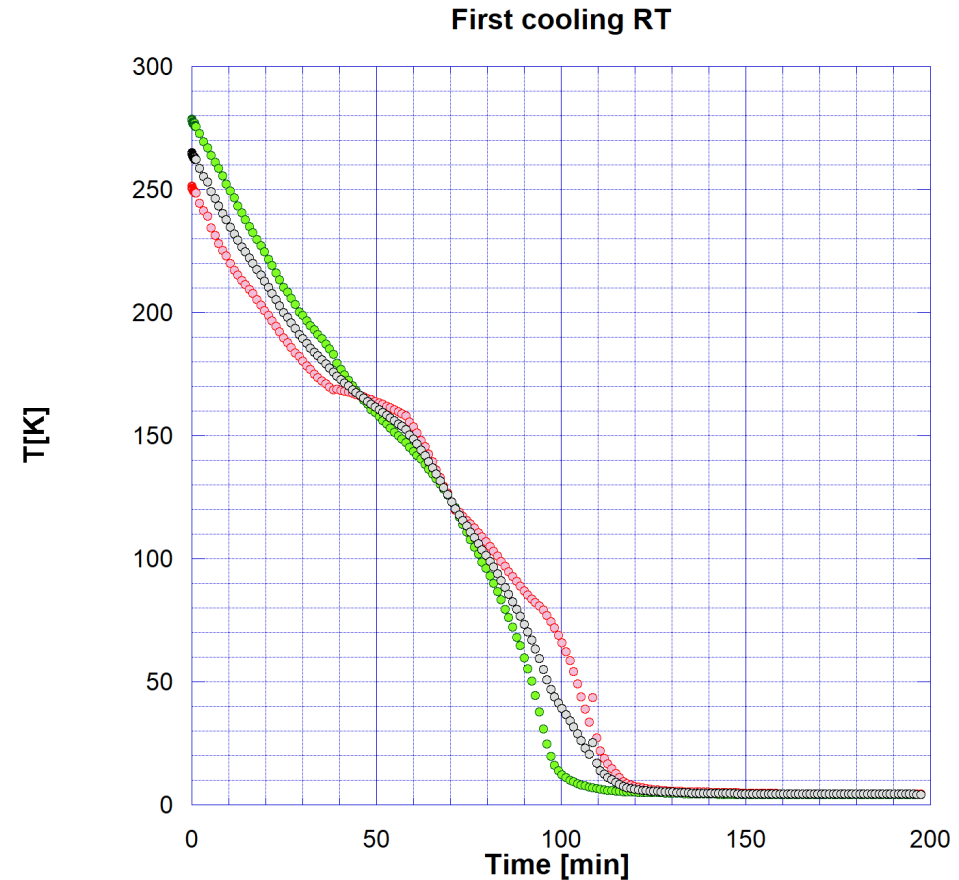
- Hélial type AIR LIQUIDE liquefier + 2000l buffer tank
- >140l/h LHE at 4K

- Each VC has in addition a 2000l buffer tank + pumps
- >allow to get 1.7K LHE

- A test of a monocell R&D cavity in CV1 consumes ~500l LHE and takes 7 minutes to go from 150K to 50K
- A test of a SARAF HWR cavity in CV2 consumes ~1000l LHE at 4K, and takes 23 minutes to go from 150K to 50K
- A test of an ESS elliptical cavity in CV2 consumes ~2000l LHE at 2K, and takes 36 minutes to go from 150K to 50K

CAVITY COOL DOWN PARAMETERS IN VC

Cooldown of 9 cell LCLS2 tanked cavity



- A test of a monocell R&D cavity in CV1 consumes ~500l LHE and takes 7 minutes to go from 150K to 50K
- A test of a SARAF HWR cavity in CV2 consumes ~1000l LHE at 4K, and takes 23 minutes to go from 150K to 50K
- A test of an ESS elliptical cavity in CV2 consumes ~2000l LHE at 2K, and takes 36 minutes to go from 150K to 50K

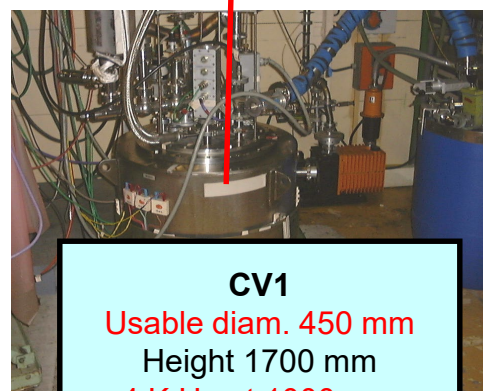
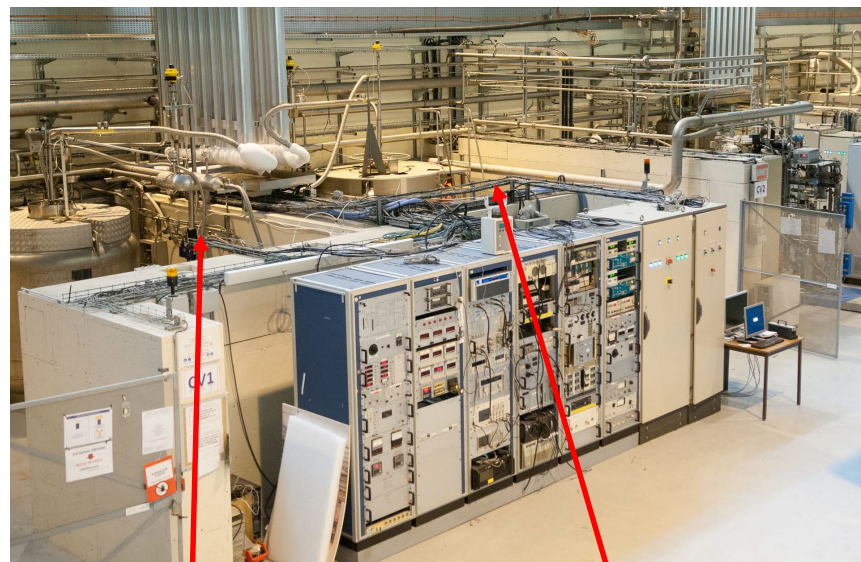
VERTICAL CRYOSTATS

Two vertical cryostats



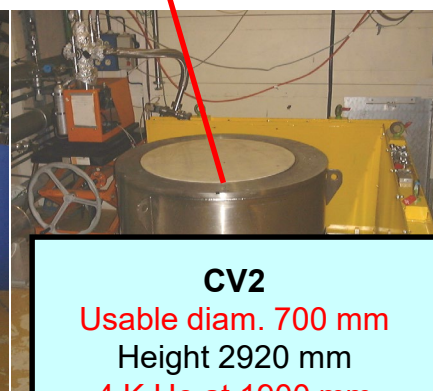
CV1

Mono-cell cavities for
surface preparation R&D



CV1

Usable diam. 450 mm
Height 1700 mm
4 K He at 1000 mm
1.7 K He at 600 mm



CV2

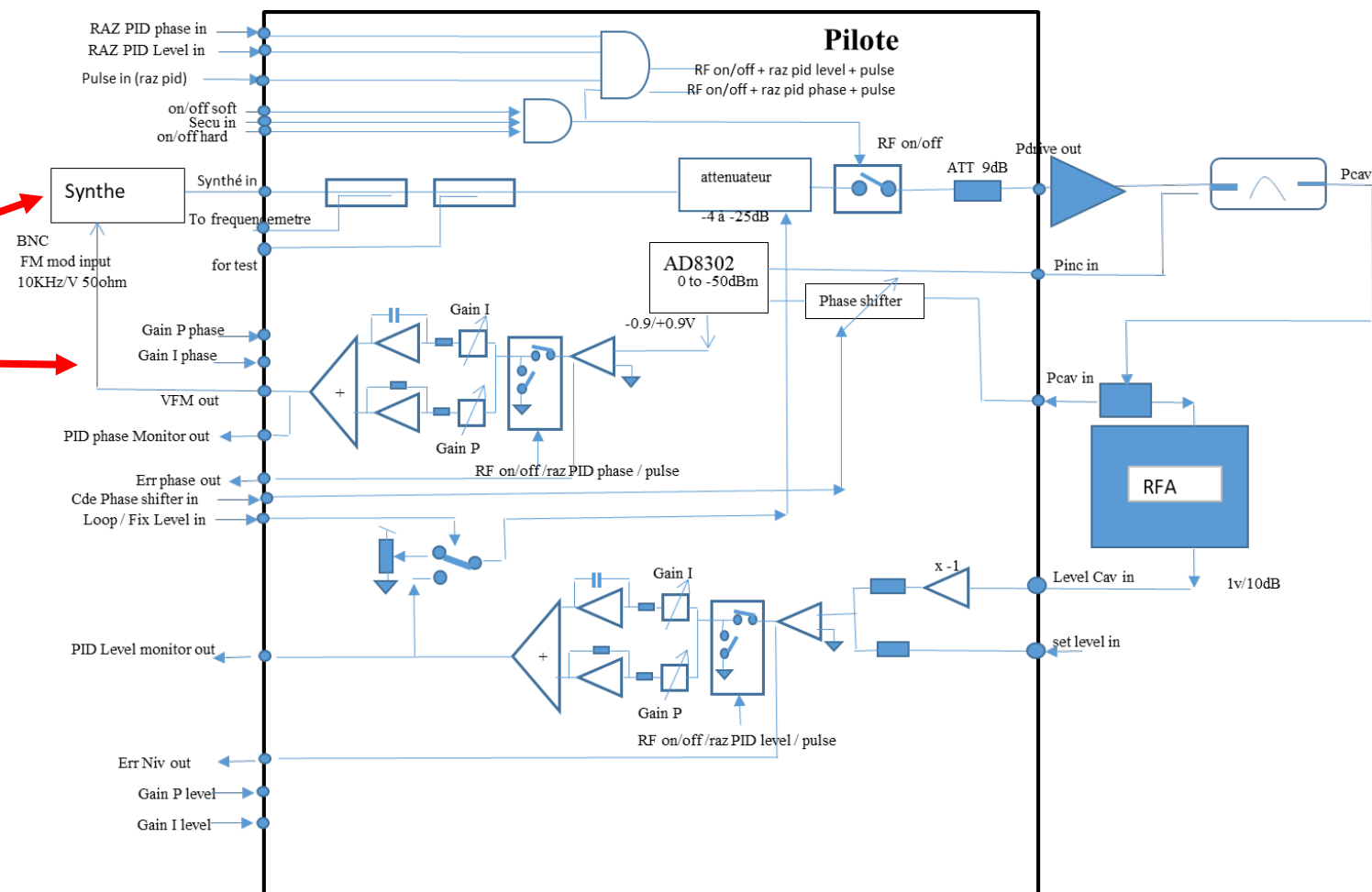
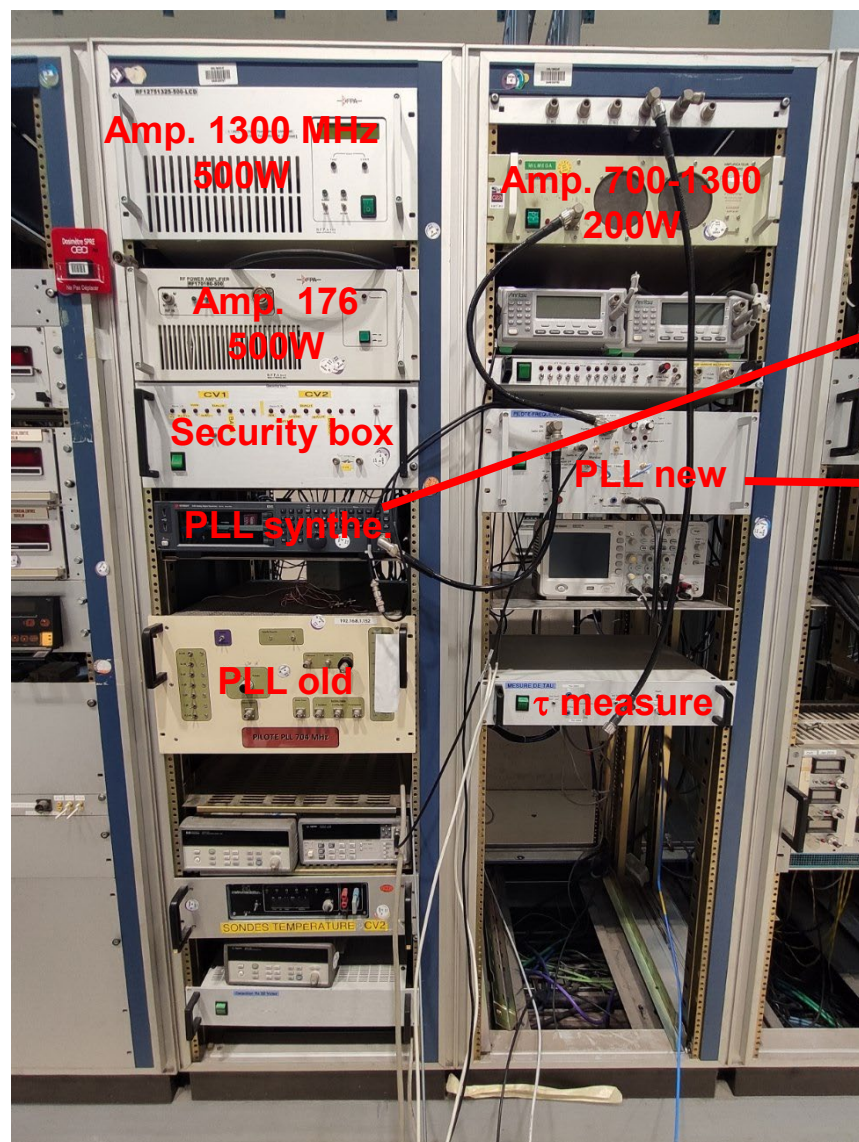
Usable diam. 700 mm
Height 2920 mm
4 K He at 1900 mm
1.7K He at 1200 mm



CV2

Cavities with and wo tank
(ESS, IFMIF, DONES,
SARAF...)

VERTICAL CRYOSTATS: ELECTRONICS



VERTICAL CRYOSTAT CV1

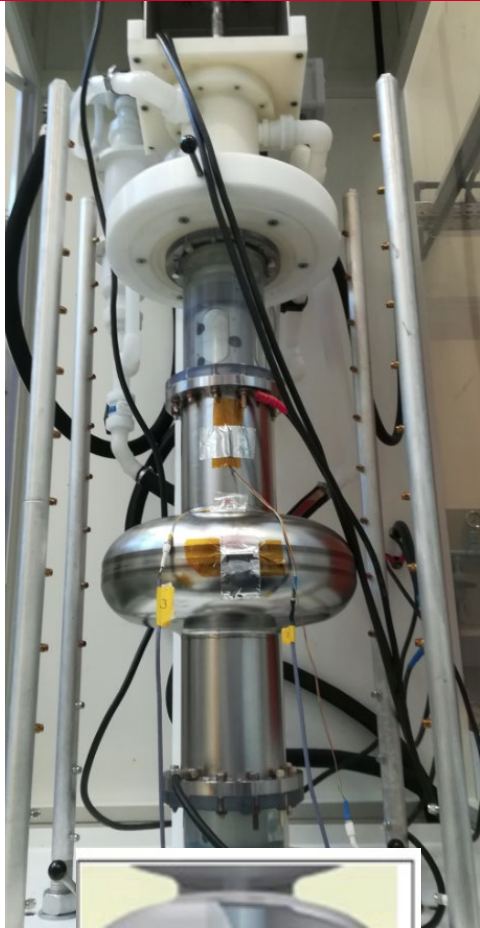
TEST STAND NAME				
No	Property name	Value	Unit	Comment
1	LHe volume	50	L	
2	Operating temperature	4/1.7	K	
3	Diameter / size	0.45/1	m	
4	Number of inserts	2		
5	RF Frequency	88/176/700-1300	MHz	
6	Maximum Incident power	200/200/500	W	Depends on frequency
7	Additional instrumentation	X-ray/Mag/Second sound		Future: B-map, X-ray map
8	Typical testing rate (Vts / year)	1 / week		
9	Possibility to test naked cavities		YES	
10	Infrastructure for small intervention		YES	

VERTICAL CRYOSTAT CV2

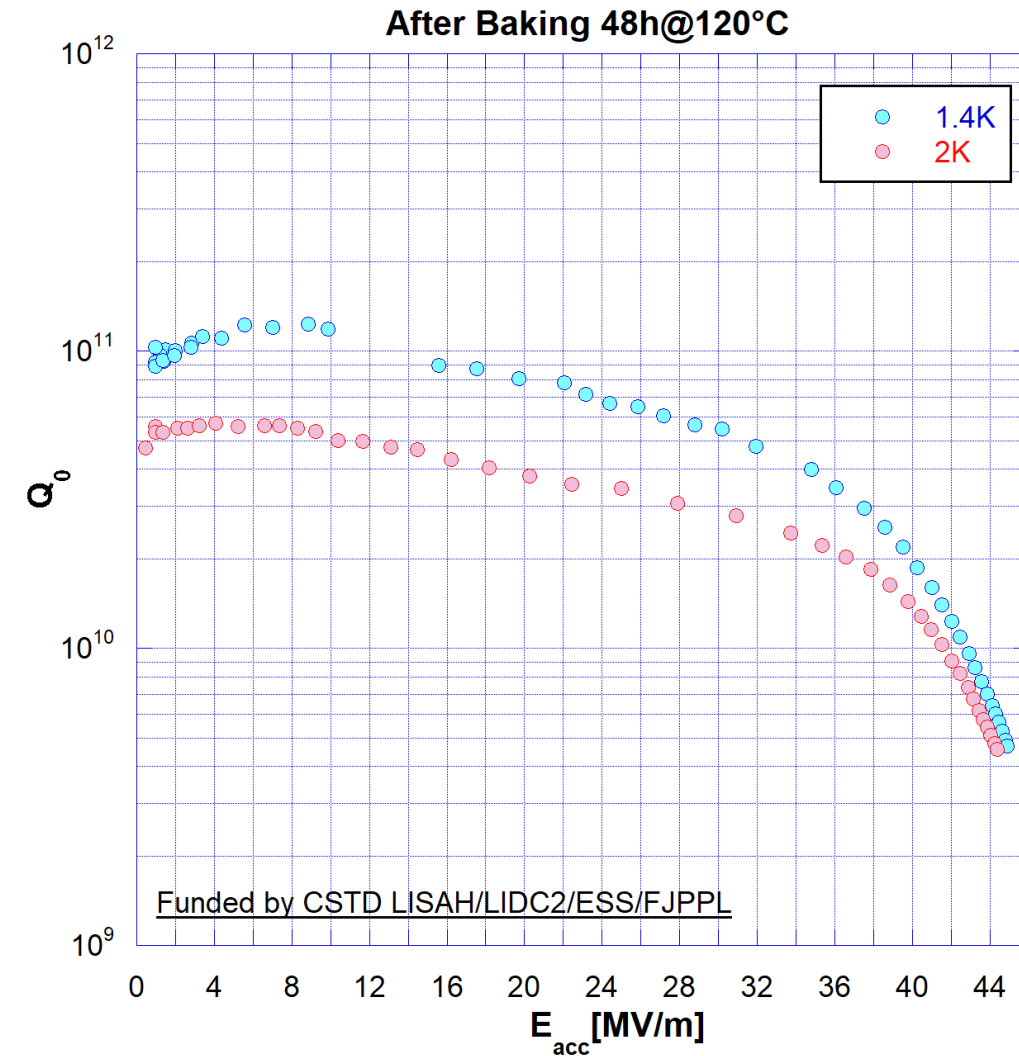
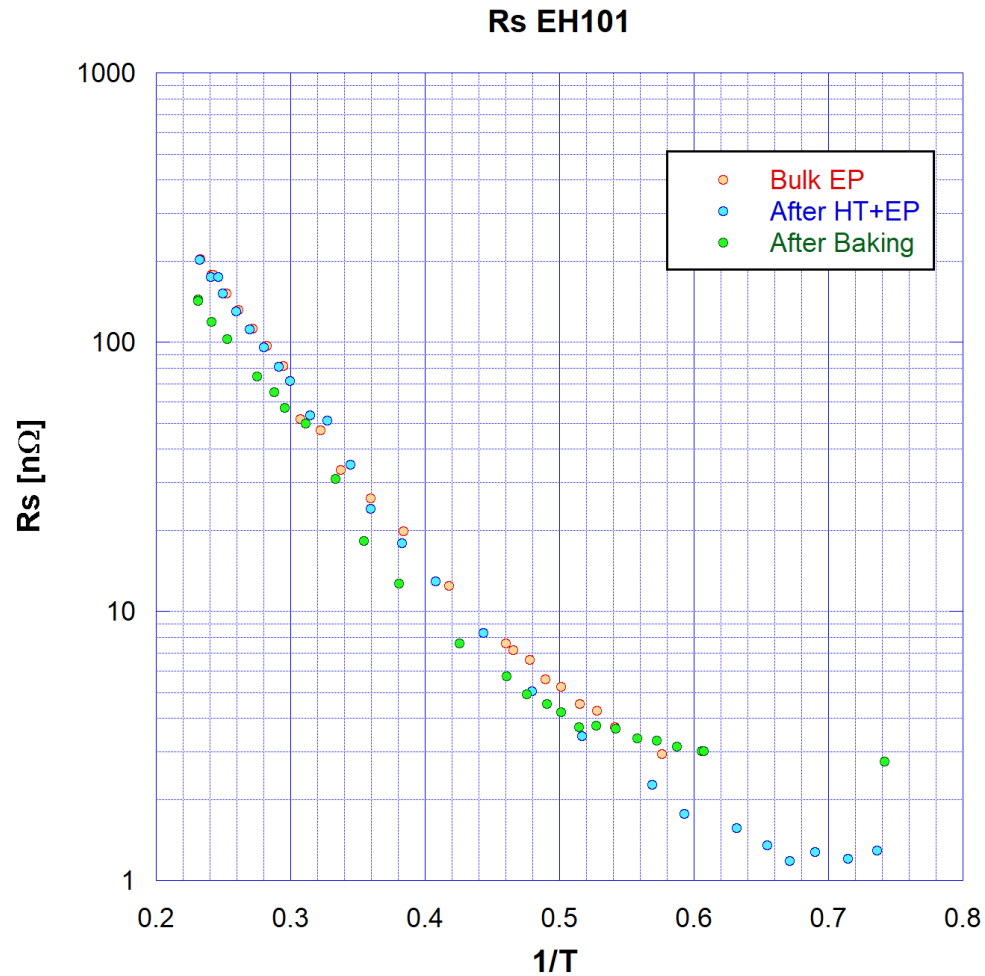
TEST STAND NAME

No	Property name	Value	Unit	Comment
1	LHe volume	200	L	
2	Operating temperature	4/1.7	K	
3	Diameter / size	0.7/1.7	m	
4	Number of inserts	3		
5	RF Frequency	88/176/700-1300	MHz	
6	Maximum Incident power	200/200/500	W	
7	Additional instrumentation	X-ray/Mag/Second sound		Future: B-map, X-ray map
8	Typical testing rate (Vts / year)	1 / week		
9	Possibility to test naked cavities		YES	
10	Infrastructure for small intervention		YES	

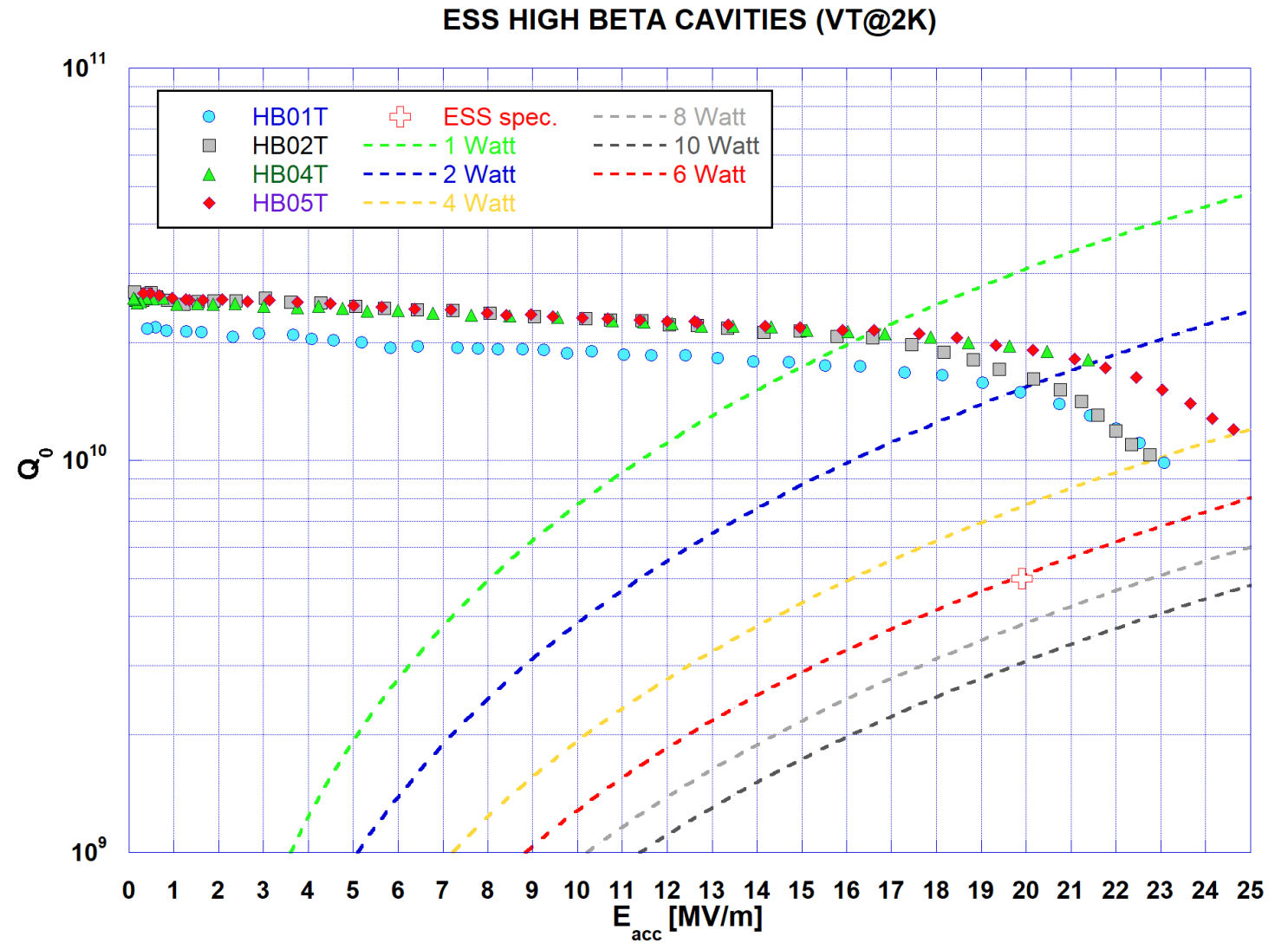
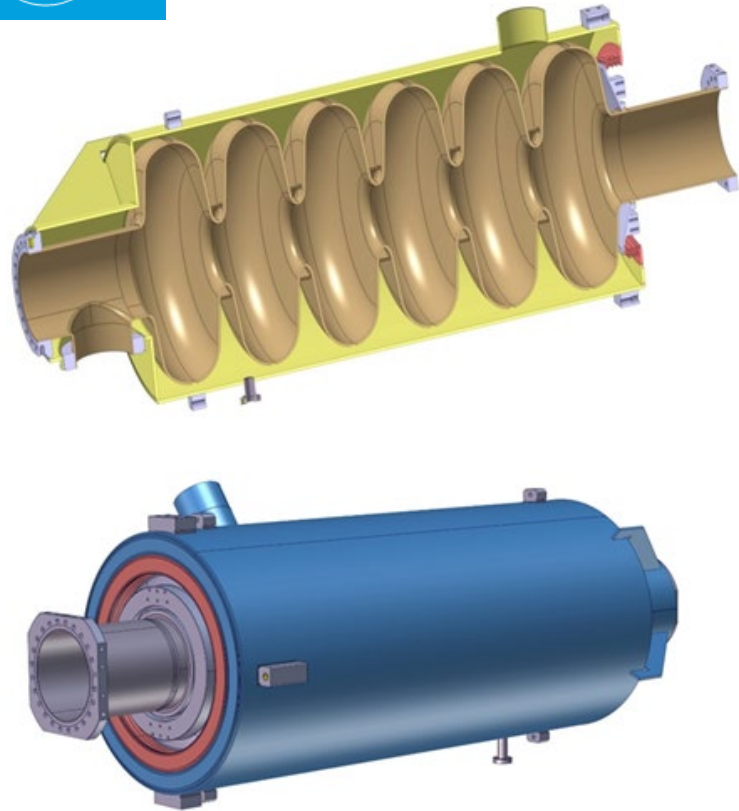
VC TEST R&D 704 MHZ



VEP
'Ninja' Cathode



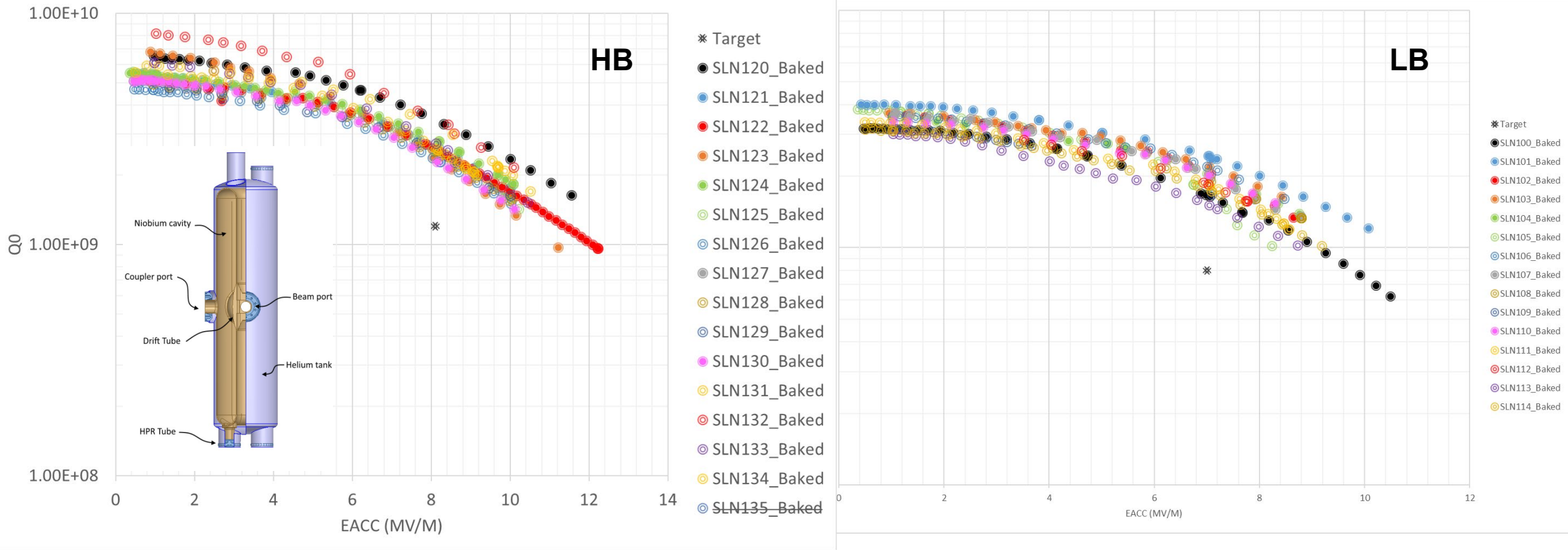
VC TEST ESS HIGH BETA PROTOTYPE JACKETED



VC TEST SARAF LB & HB SERIES CAVITIES



SARAF: 14 LB HWR, 14 HB HWR, all surface prepared at CEA and tested in VC

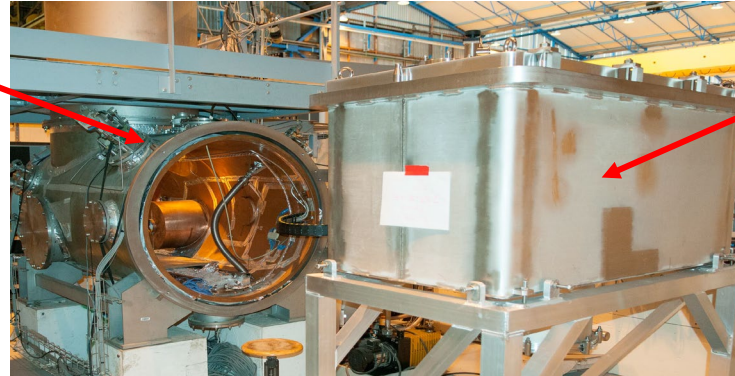


HORIZONTAL CRYOSTAT

One horizontal cryostat

CryHoLab (Cylindrical cryostat)

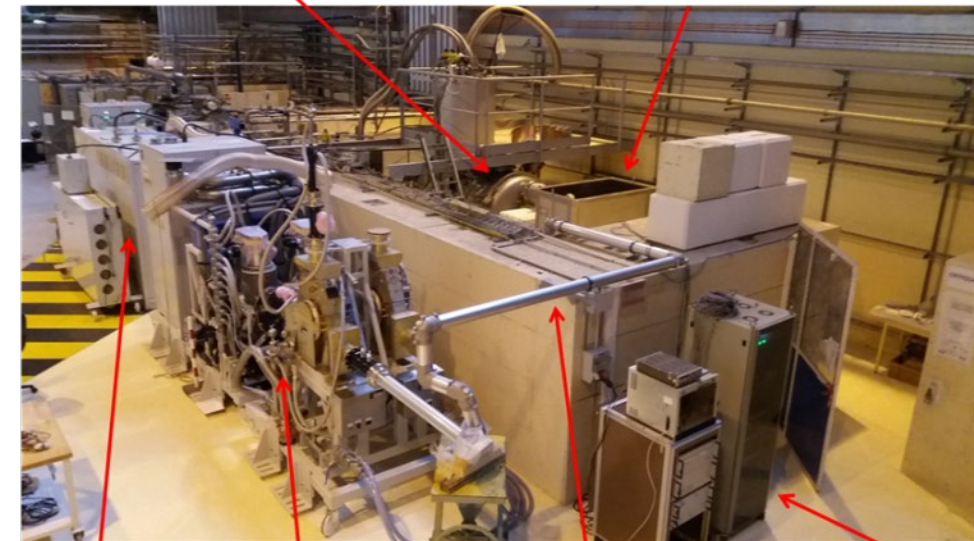
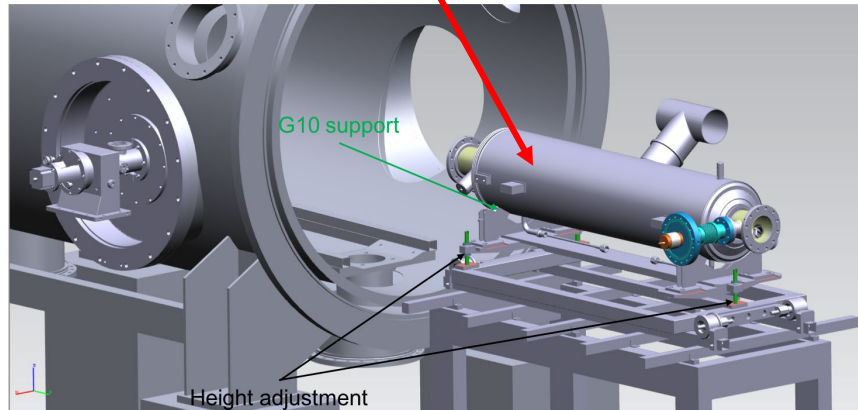
RF power tests of fully
equipped elliptical cavities
with He tank, tuners and
FPC
(ESS, LUCRECE)



CryHoLab

SaTHoRI extension (Rectangular cryostat)

RF power tests of HWR
cavities with He tank, tuners
and FPC
(IFMIF, DONES)
SaTHoRI



HVPS with
dummy load

2x105 kW RF Module

Coaxial line

Sathori LCS and
instrumentation

HORIZONTAL CRYOSTAT: CRYHOLAB

TEST STAND NAME				
No	Property name	Value	Unit	Comment
1	LHe volume		L	Only jacketed
2	Operating temperature	4/1.7	K	
3	Diameter / size	0.7/1.5	m	
4	Number of inserts	0		
5	RF Frequency	Any	MHz	To be provided
6	Maximum Incident power	Any	W	To be provided
7	Additional instrumentation			
8	Typical testing rate (Vts / year)			
9	Possibility to test naked cavities		NO	
10	Infrastructure for small intervention		YES	

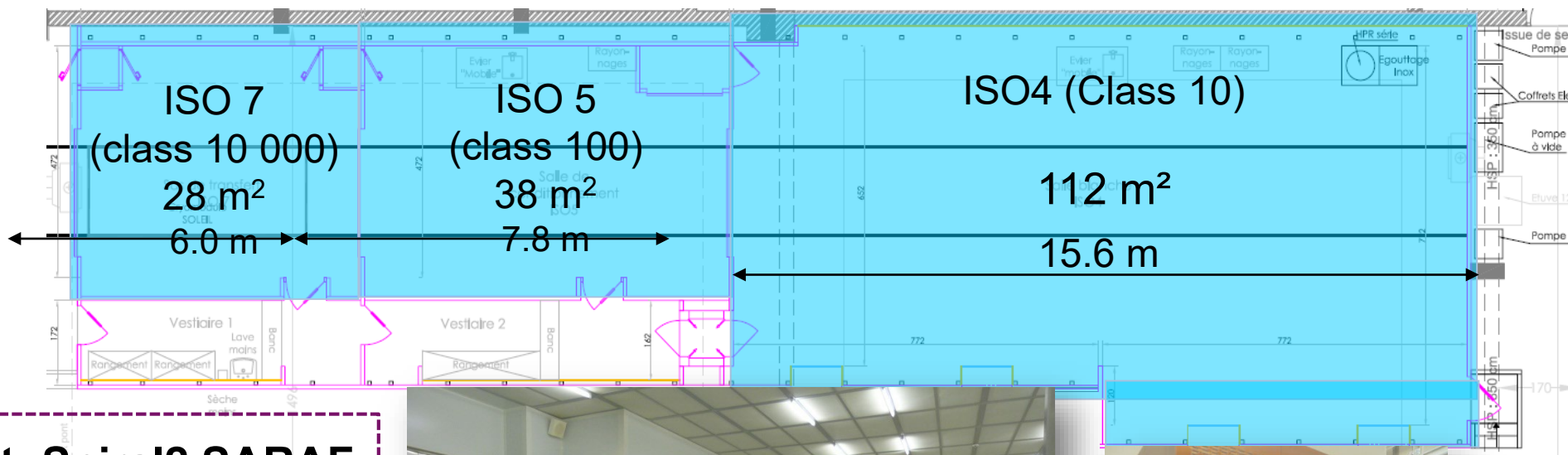
HORIZONTAL CRYOSTAT: SATHORI

TEST STAND NAME				
No	Property name	Value	Unit	Comment
1	LHe volume		L	Only jacketed
2	Operating temperature	4/1.7	K	
3	Diameter / size	0.7/0.8/1.7	m	
4	Number of inserts	0		
5	RF Frequency	Any	MHz	To be provided
6	Maximum Incident power	Any	W	To be provided
7	Additional instrumentation			
8	Typical testing rate (Vts / year)			
9	Possibility to test naked cavities		YES	
10	Infrastructure for small intervention		YES	

CAVITY PREPARATION: CLEAN ROOMS

SUPRA
tech
Chimie/SB

Hall 124 North: XFEL, ESS cryomodule assembly



Hall 124 East: Spiral2, SARAF



CAVITY PREPARATION: SURFACE PREPARATION



Integrated chemistry cabinets (BCP)



- Standard BCP etching
 $\text{HF}, \text{HNO}_3, \text{H}_3\text{PO}_4$: 1/1/2.4
200 l tank

Vertical electropolishing cabinet



$\text{HF}, \text{H}_2\text{SO}_4$
300 l tank

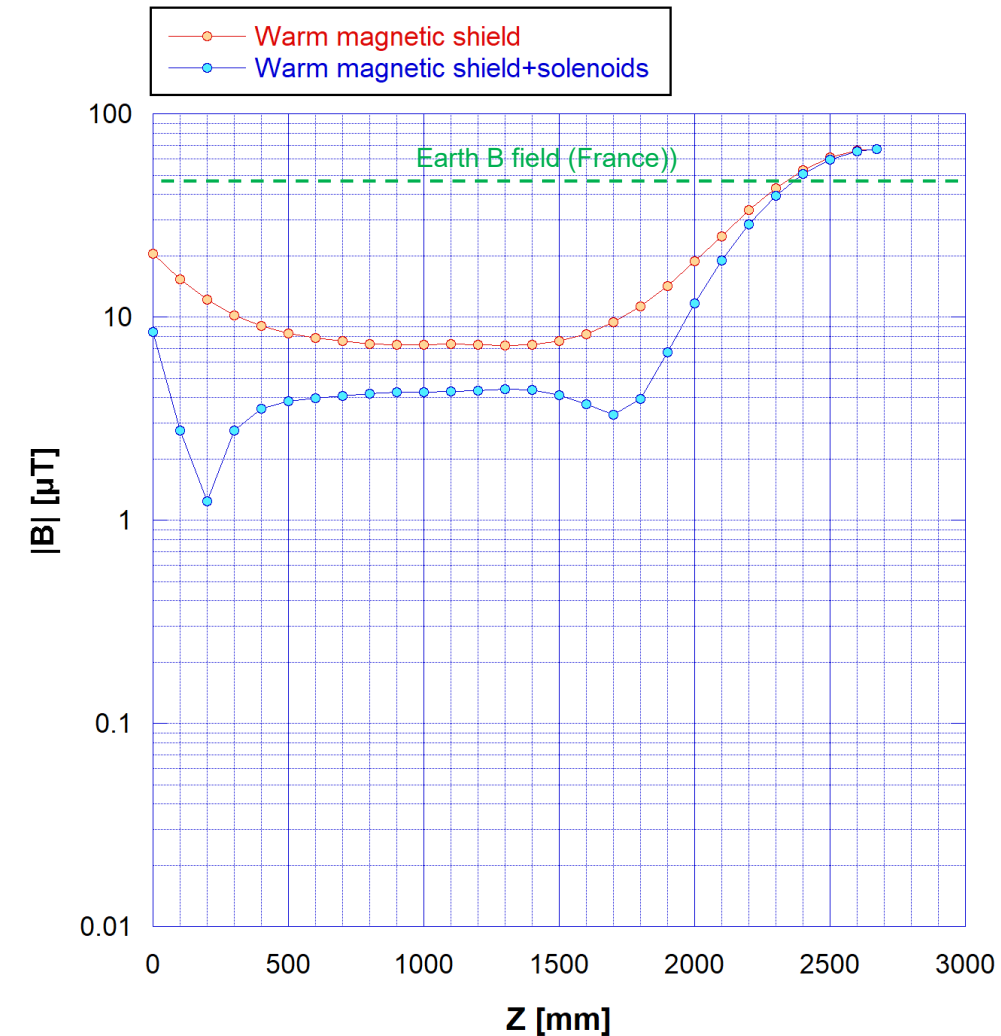
High pressure rinsing



Capacité :

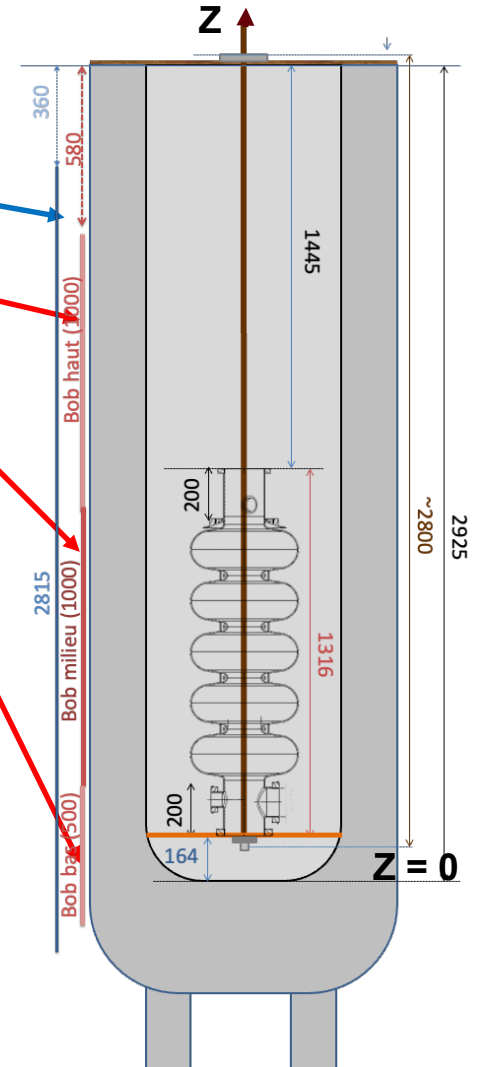
Multi-Cellule jusqu'à 1,50 m
0 – 100 Bars d'Eau Ultra Pure
Débit EUP : 8 – 10 l/mn
Filtration EUP final 0,2 μm
Montée progressive en Pression

TEST SETUP: WARM MAGNETIC SHIELDING

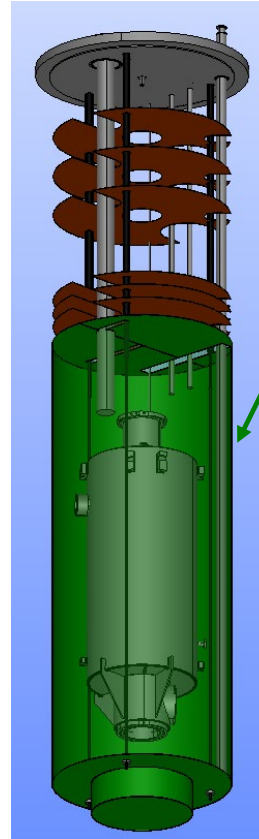
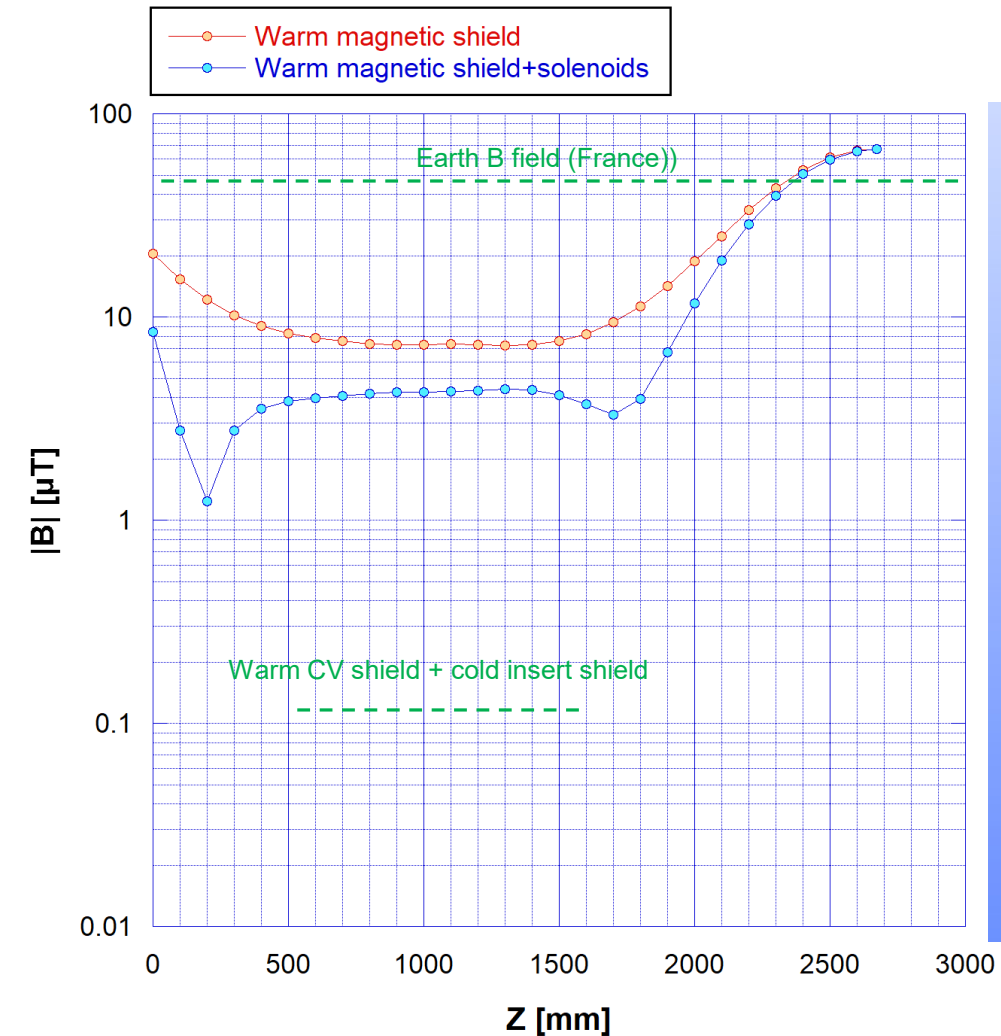


CV2 has a warm magnetic shield
(0.5 mm Conetic)
+ 3 compensation coils
to shield from earth magnetic field

Left: example of B field measured
on Z axis with slidable device



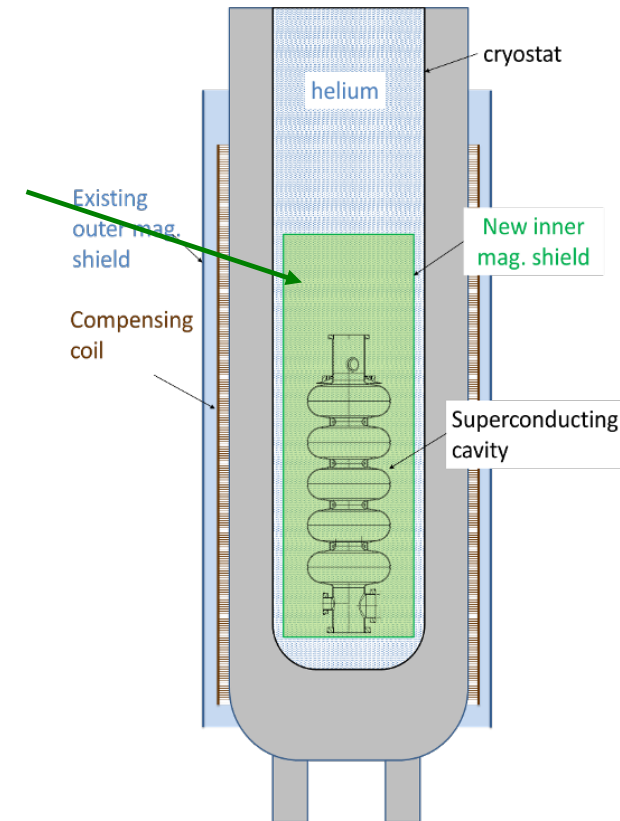
TEST SETUP: MAGNETIC SHIELDING



To improve shielding,
a cold 2mm CryoPhi shield
is added around the cavity
on the insert

-> allows to have way less
than 1 μT remanent field
(typically 0.1 μT = 1 mG)

-> no field trapped during
cool down



TEST SETUP: DIAGNOSTICS



X-ray sensors (PIN diodes)



Second sound (OST)

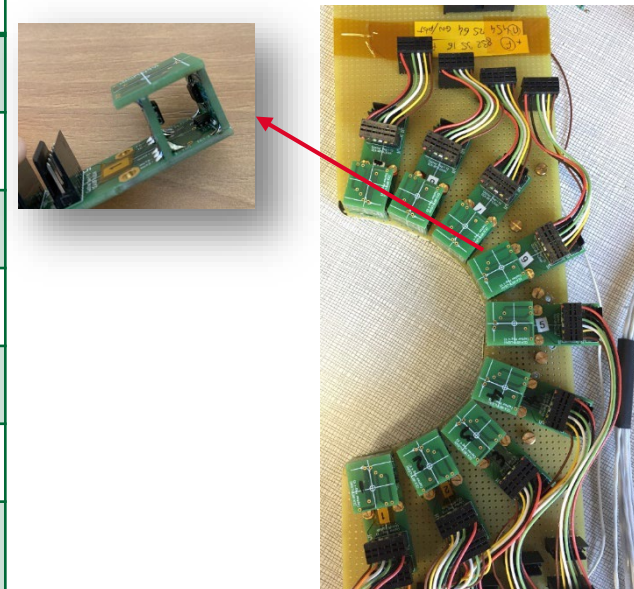


ESS High beta cavity installed in VT stand

Measurements	Device
X-ray	PIN diodes
	NaI(Tl) Scintillators
Magnetic field	Fluxgate
	AMR
Temperature	Cernox
	Carbon resistor
Second sound	Oscillating super leak transducer (OST)

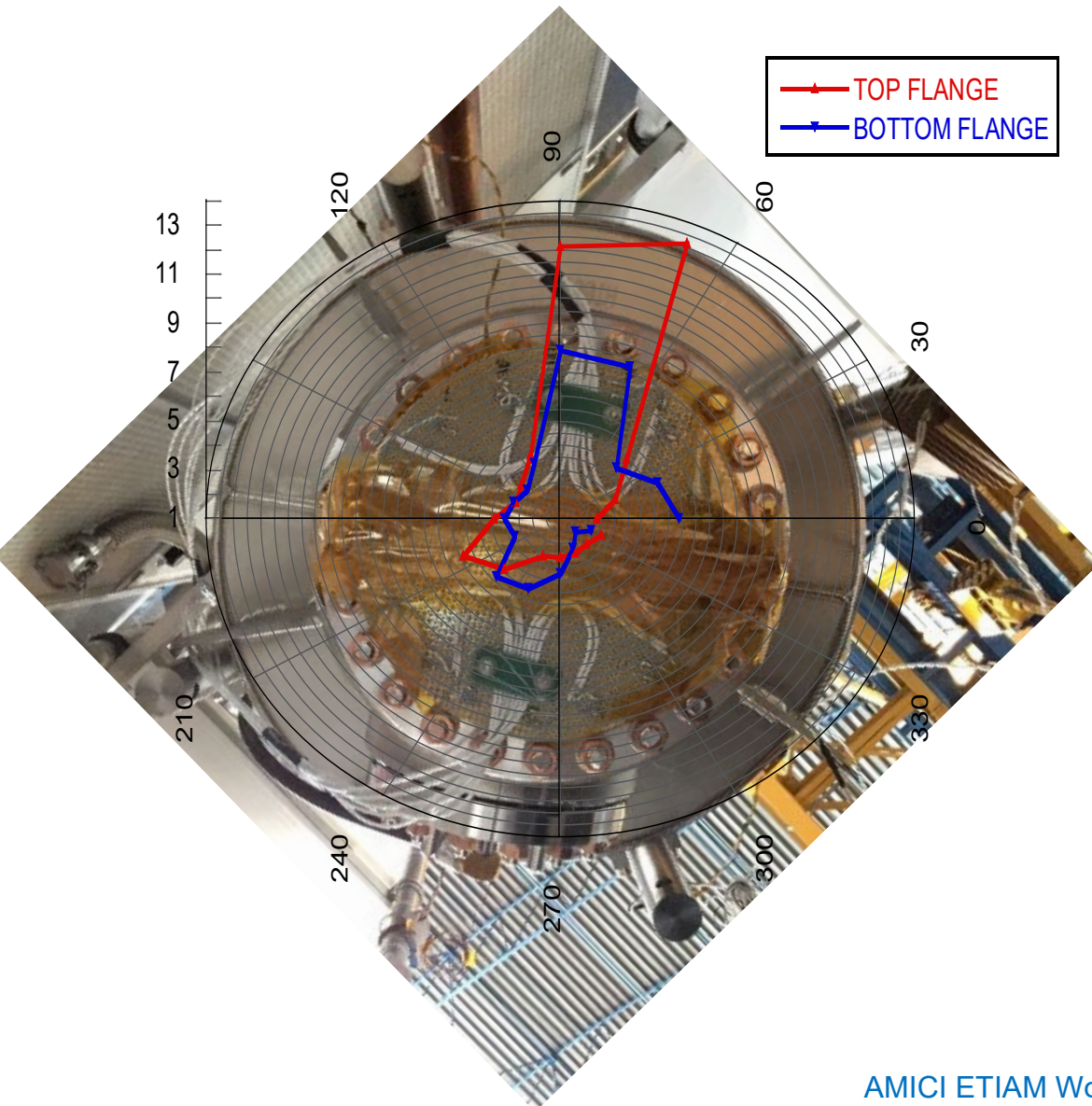
AMR = Anisotropic Magneto Resistance
(cheap: ~10€/sensor)

9 measuring points

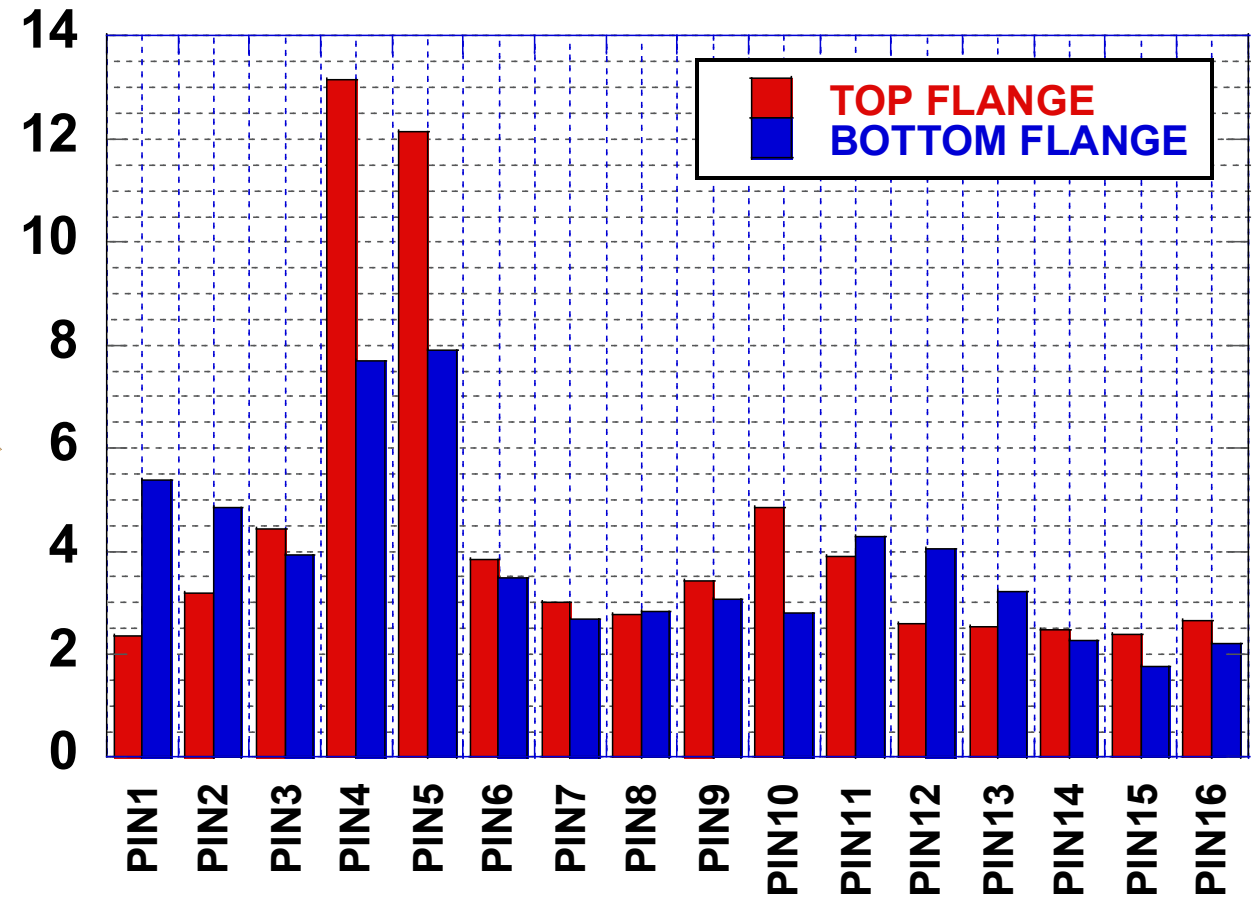


3 sensors setup(X Y Z) adapted for
1.3GHz single cell cavity

TEST SETUP: PIN DIODES FOR X-RAY MEASUREMENTS



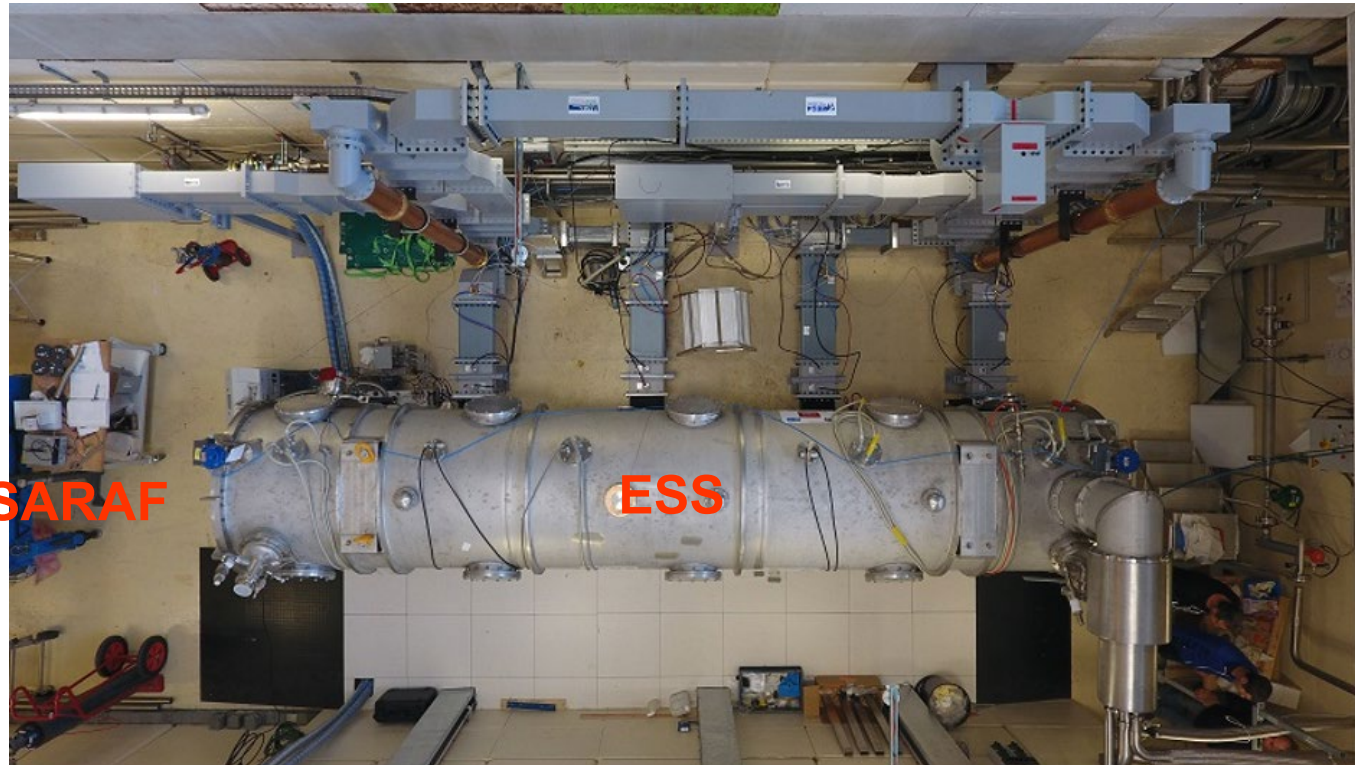
ESS high-beta prototype HB01 with small pin diodes on top and bottom flanges



ESS/SARAF CRYOMODULE TEST BUNKER

ESS+SARAF test bunker:

- ESS: 1-→4 RF splitting, allows test of up to 2 cavities simultaneously at 704 MHz
- SARAF: separate 176 MHz RF source

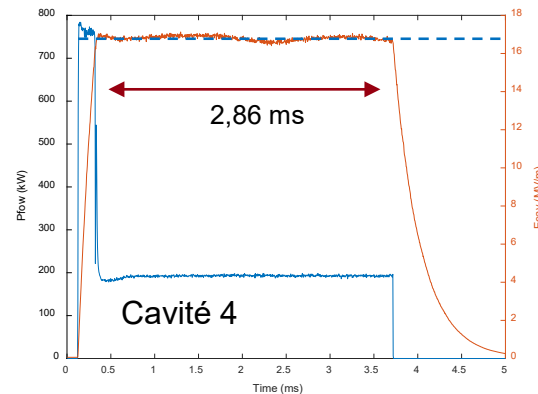
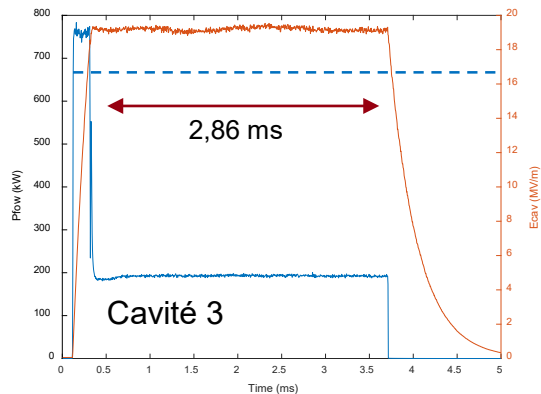
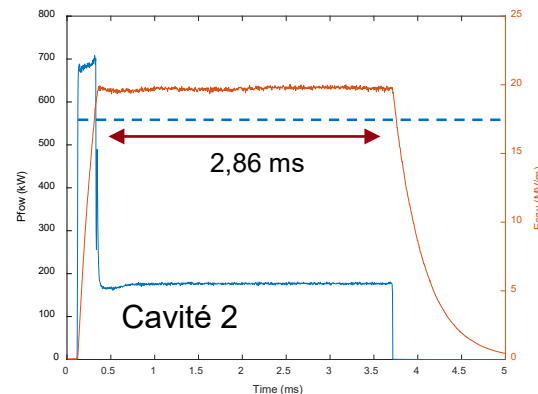
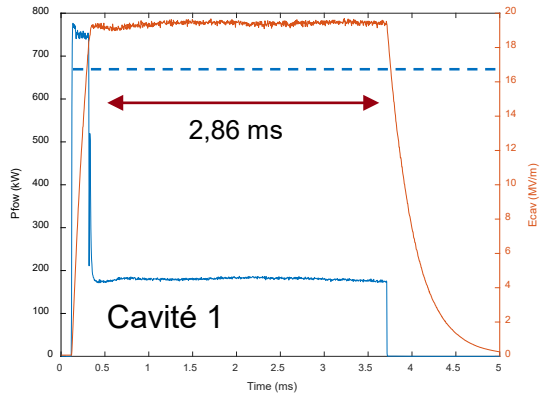


ESS CRYOMODULES TEST



CEA ESS contract:

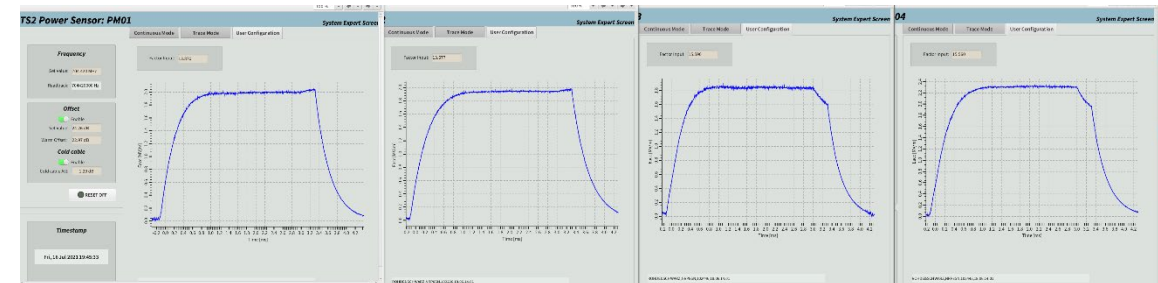
- assemble 9 MB + 21 HB CM
- test 6 CM (3 MB + 3 HB)



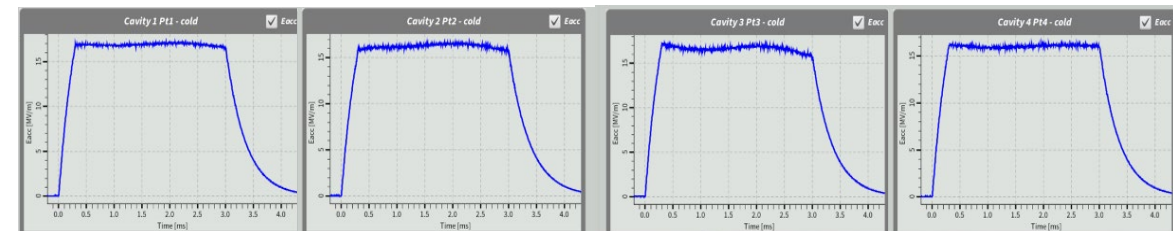
So far:

- assembled 7 MB (missing cavities for 2 others)
- assembled 3 HB + 4 ongoing
- tested 3 MB + 2 HB: **all cavities at nominal field**
- ("last" HB CM ready for test in November)

CM01 (MB) test at CEA



CM03 (MB) retest at ESS



704 MHz HIGH POWER KLYSTRONS



- Two 704 Mhz pulsed RF power sources (up to 3.6 ms and 14 Hz rep. rate):
 - CPI VKP7952A 1.2 MW peak
 - Thales 2182A 1.6 MW peak

Cold tests of equipped
cavities & cryomodules
Conditioning of ESS FPC



Cryomodule
test bunker

THANK FOR YOUR ATTENTION