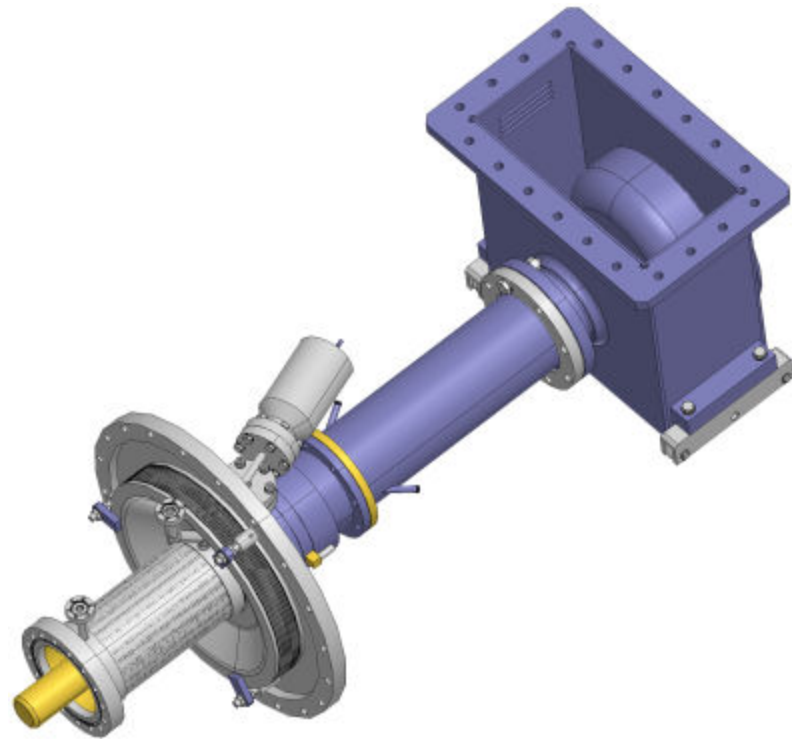
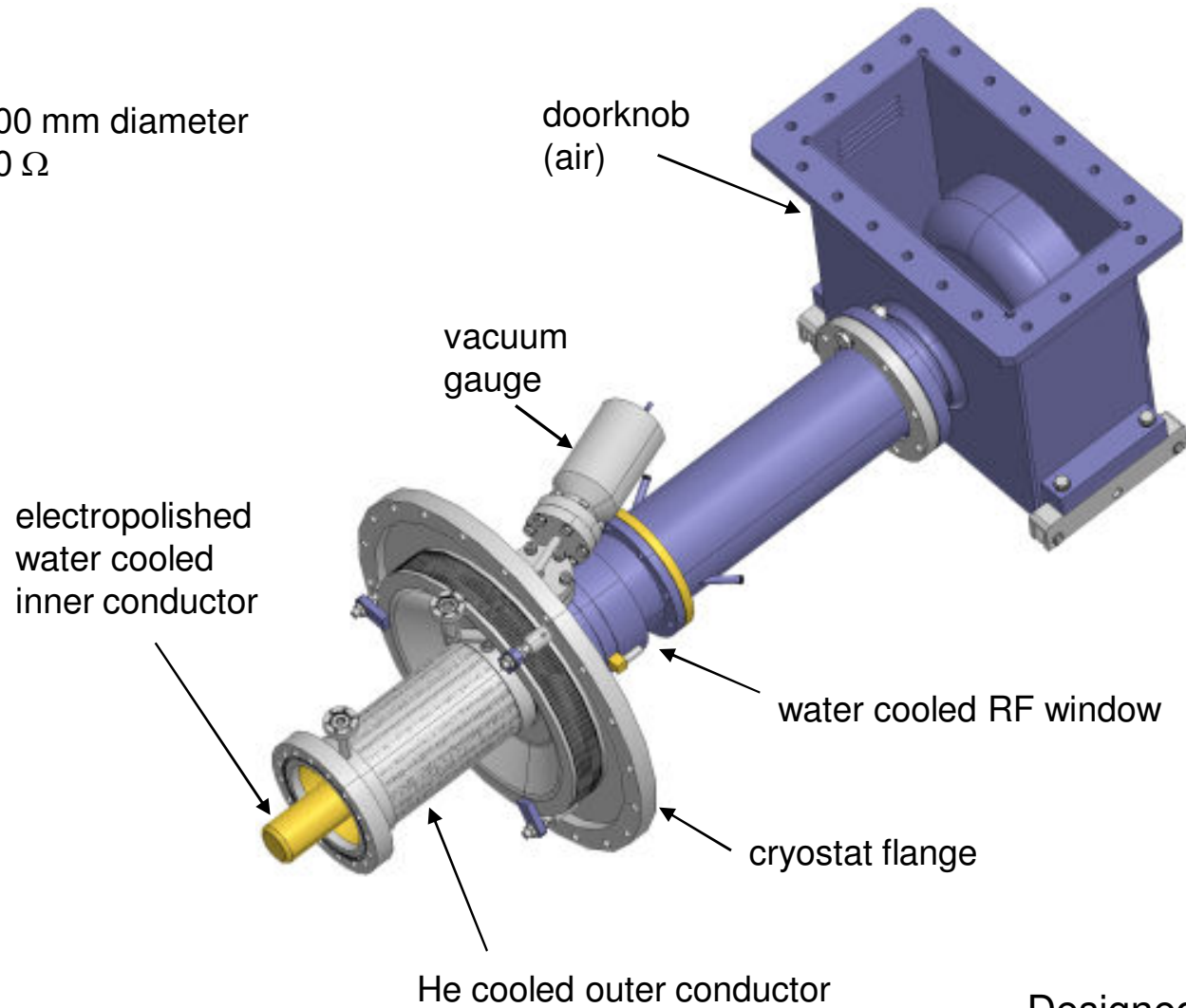


# Saclay 1MW 704 MHz power couplers



# 704 MHz -1 MW power coupler

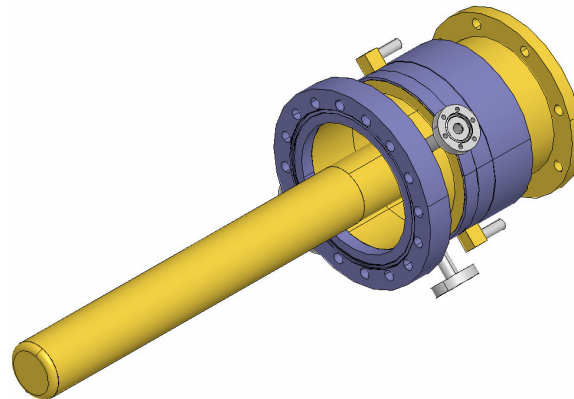
100 mm diameter  
50  $\Omega$



Designed for 1MW, 10%DC

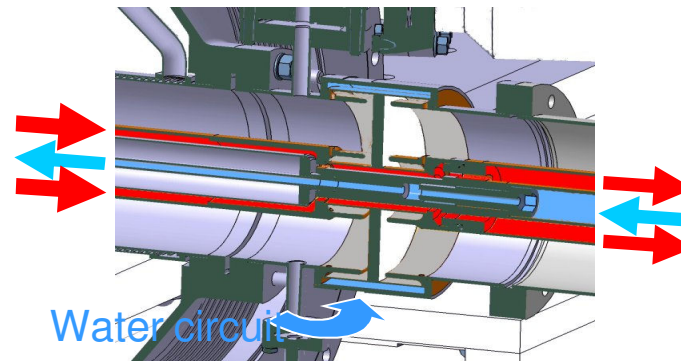
# Coupler - window

- KEK like design , disk window matched with chokes
- water cooling of the antenna and the internal braze of the ceramic



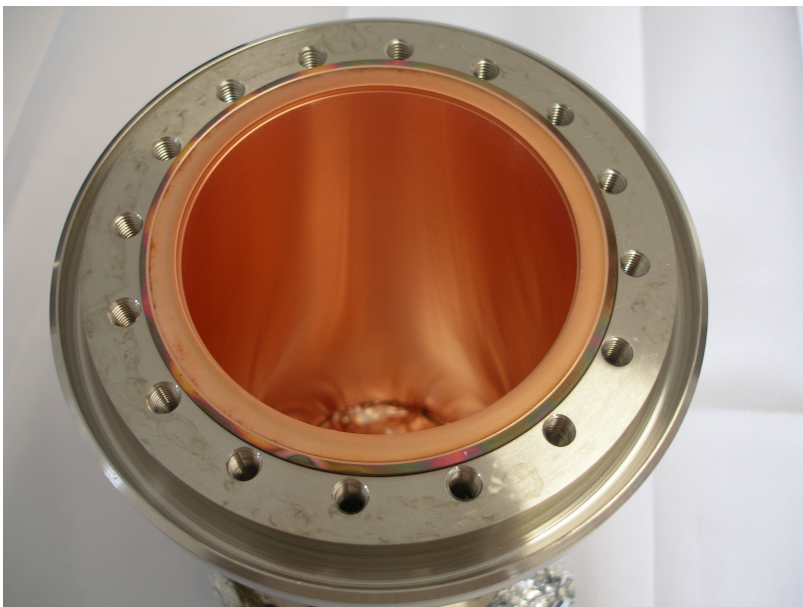
internal conductor dissipation  
for 100kW average incident power

	P int (W)	dens. int (W/m <sup>2</sup> )
TW	100	870
SW	200	1740



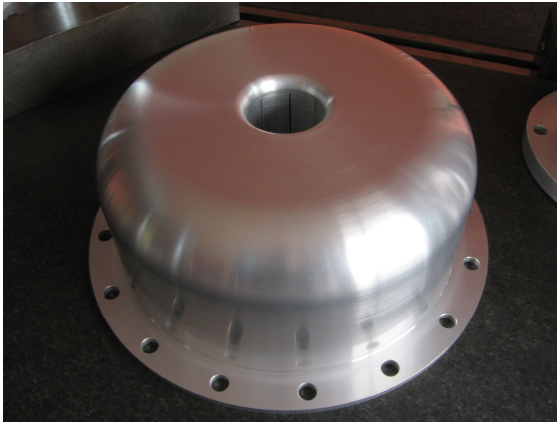
# Coupler – outer conductors

- Double wall design, GHe counter-flow
- The He outlet is inside the cryostat, so freezing the outer flange risk is limited ( we could measure 150K at the He outlet, without condensation)
- Copper deposition on the inner surface performed by CERN using magnetron sputtering (S. Calatroni, O. Neupert).





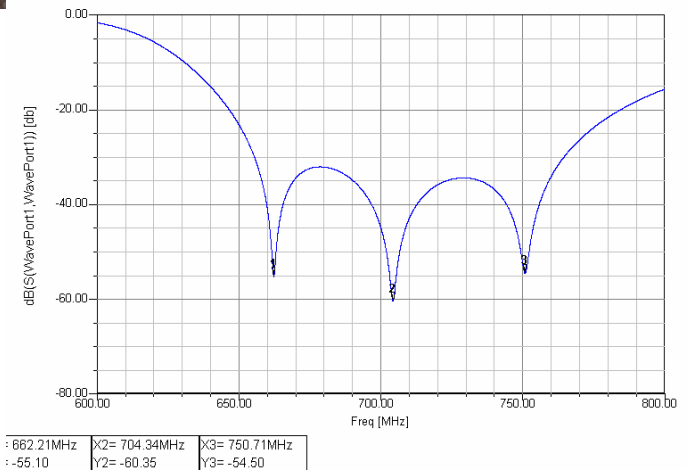
# Coupler – doorknobs



- Al + alodine surface treatment
- knob fully machined



air-side connection of  
water cooling channels



# Coupler & stand preparation

- parts ultrasound cleaning, high purity water rinsing
- assembly in clean room (couplers+coupling box)
- couplers always handled in vertical position
- clean room compatible handling tools
- rail and cart system to move heavy parts
- 200 °C 48h in-situ baking of the vacuum parts

# Assembly of the couplers in class 10 clean room





# 704 MHz coupler test stand

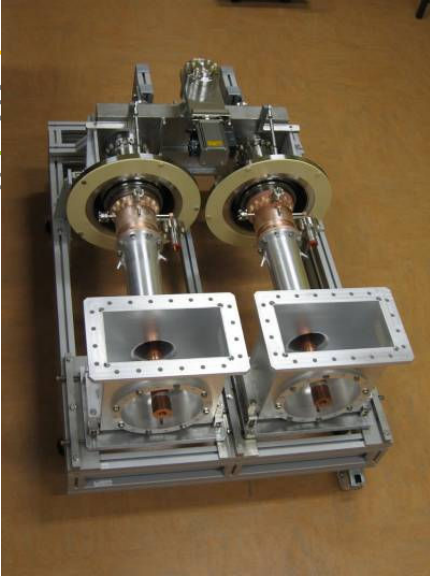
Couplers are conditioned in horizontal position

RF power source : 1 MW klystron 2ms 50Hz

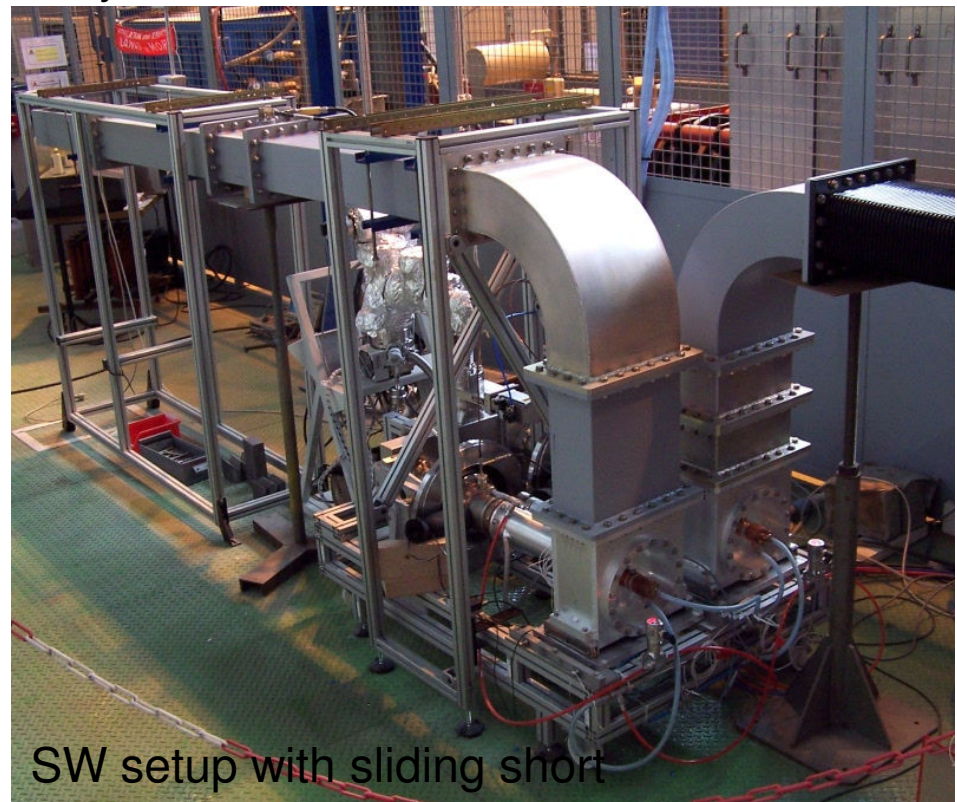
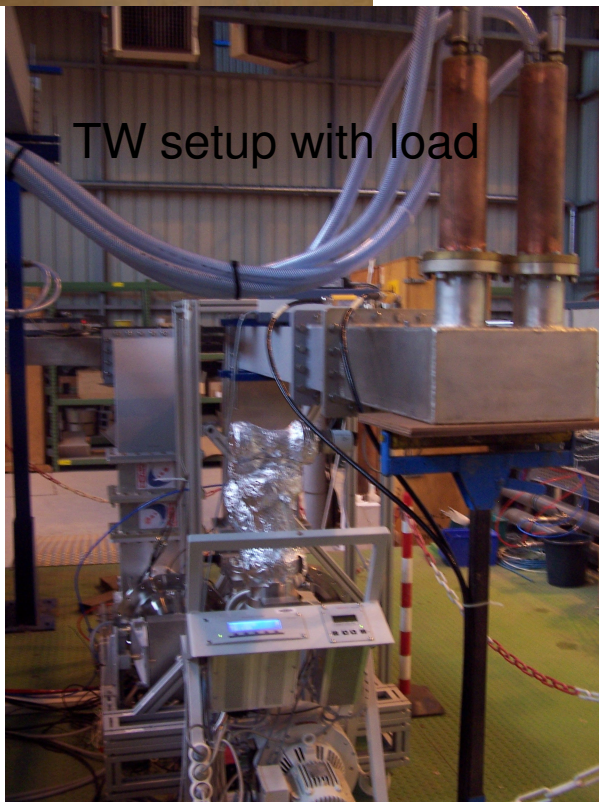
Pulsed HV power supply : 110 kV 2.5 A HVPS and modulator

Circulator commissioned with full reflected power, all phases

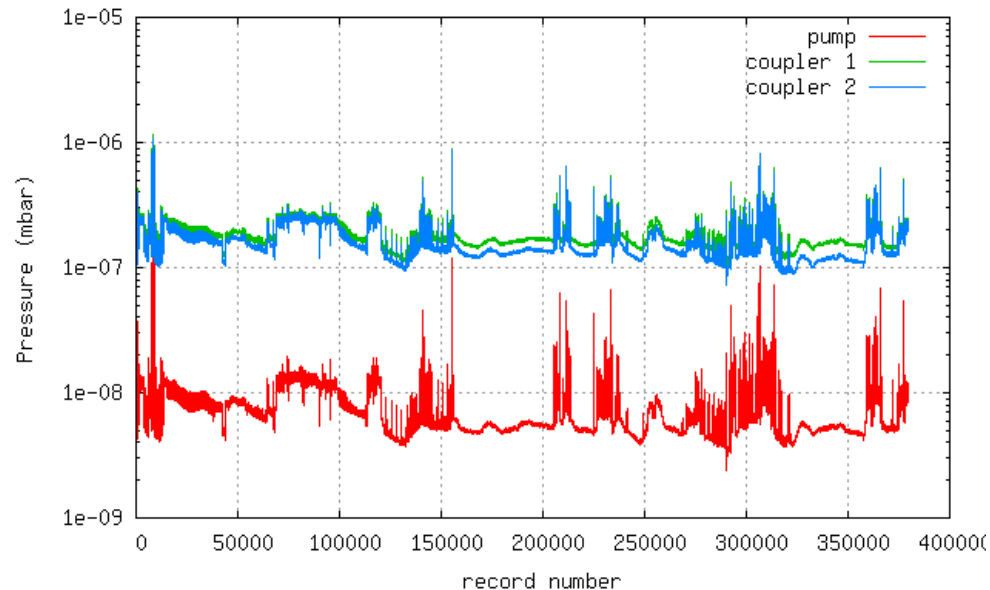
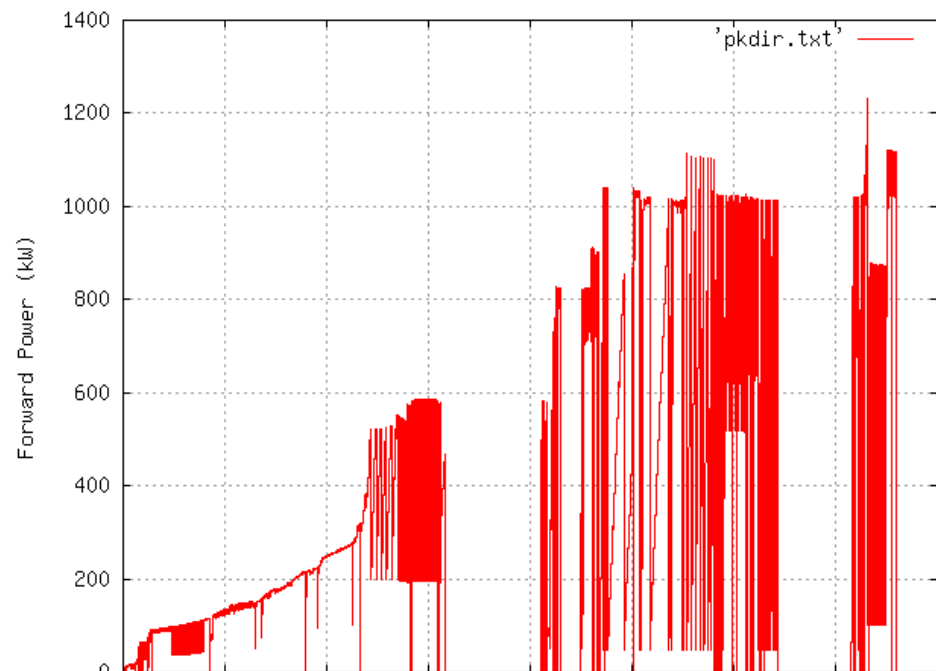
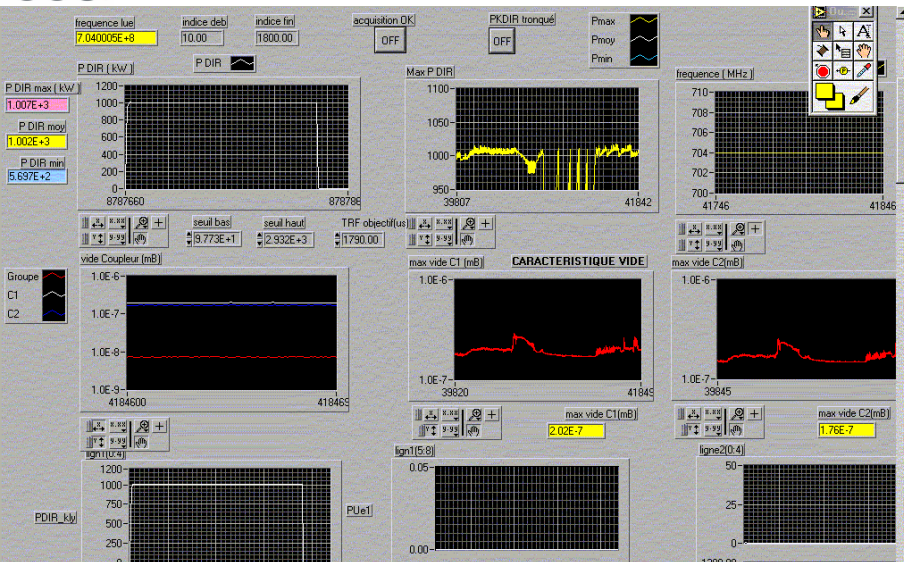
Oil-free pumping (high pressure turbomolecular+scroll pump)



## Fully functional test stand



# Coupler conditioning

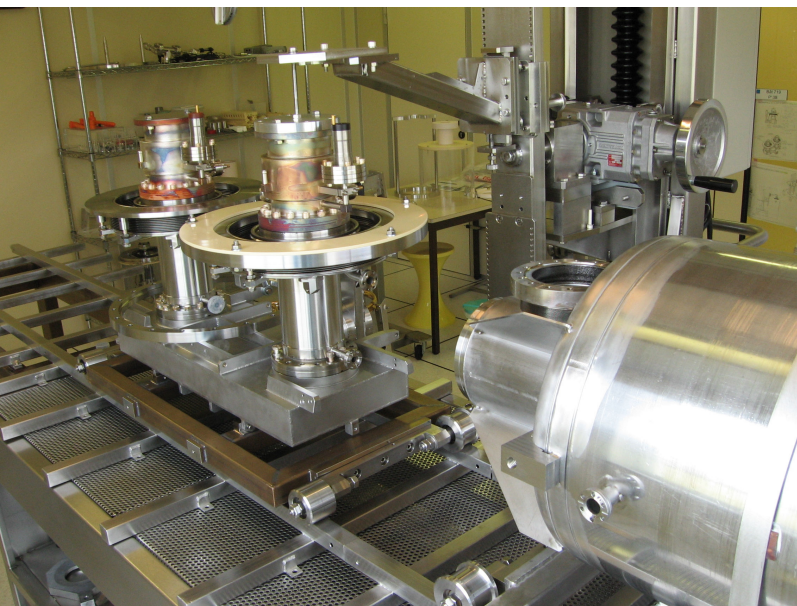
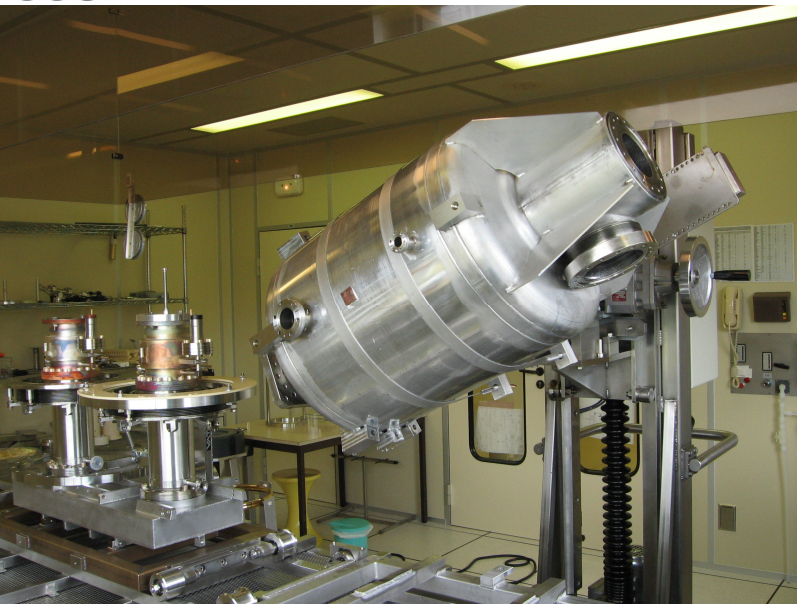


- Maximum en TW 1.2 MW peak @10% DC
- Total duration. 300h
- SW conditioning stopped due to HVPS failure in march09, then had to proceed with the coupler installation on the test SC cavity
- Repair of the 110kV 2.5A still going on, coming back end of november
- Othe HVPS were available at the lab to operate with a lower duty cycle.



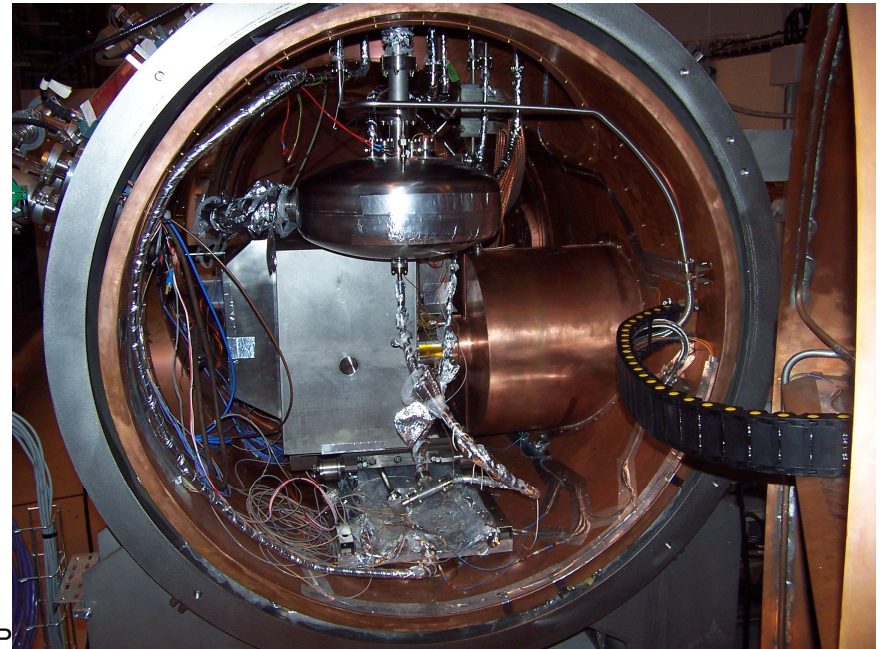
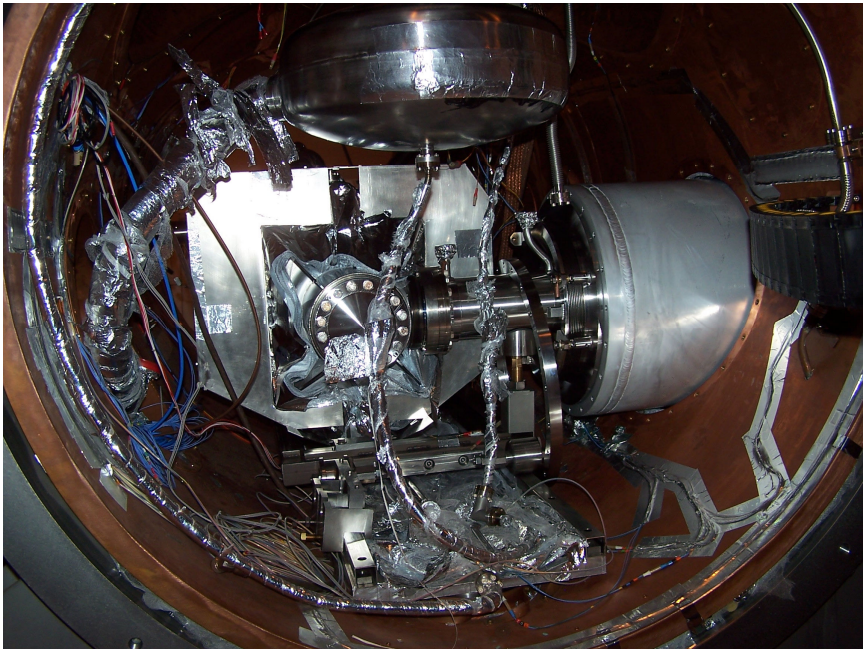
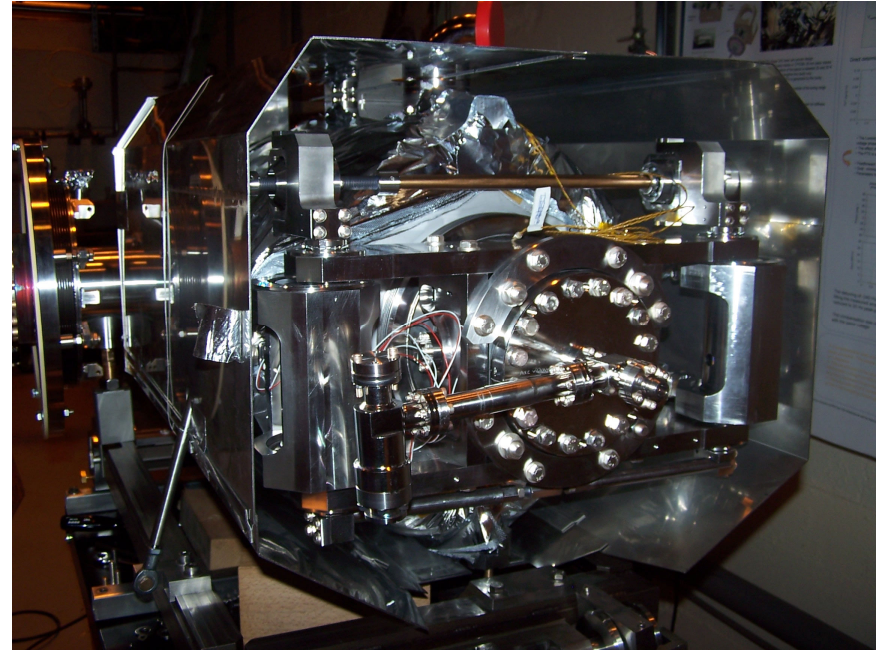
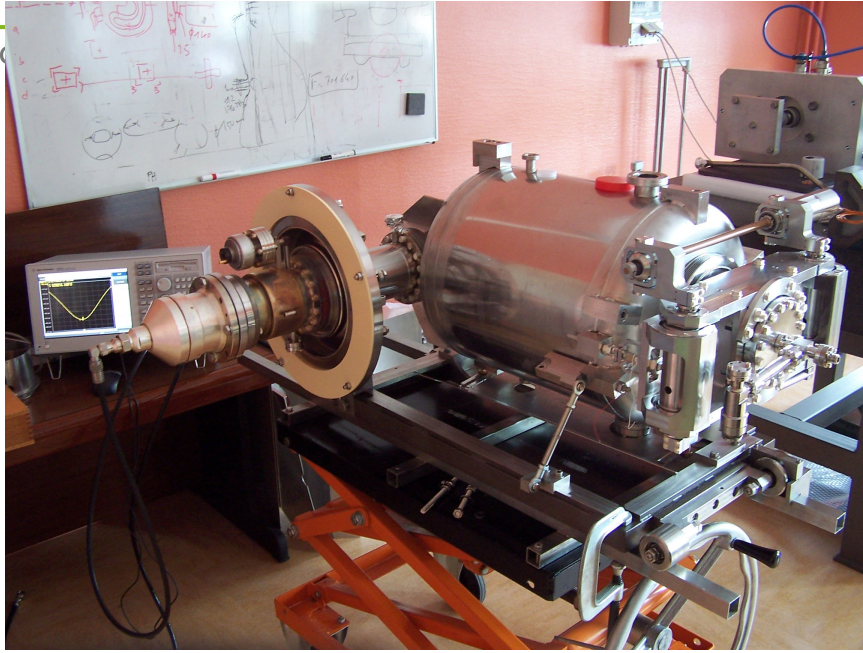
# Coupler transfer on the test cavity

In class 10 clean room



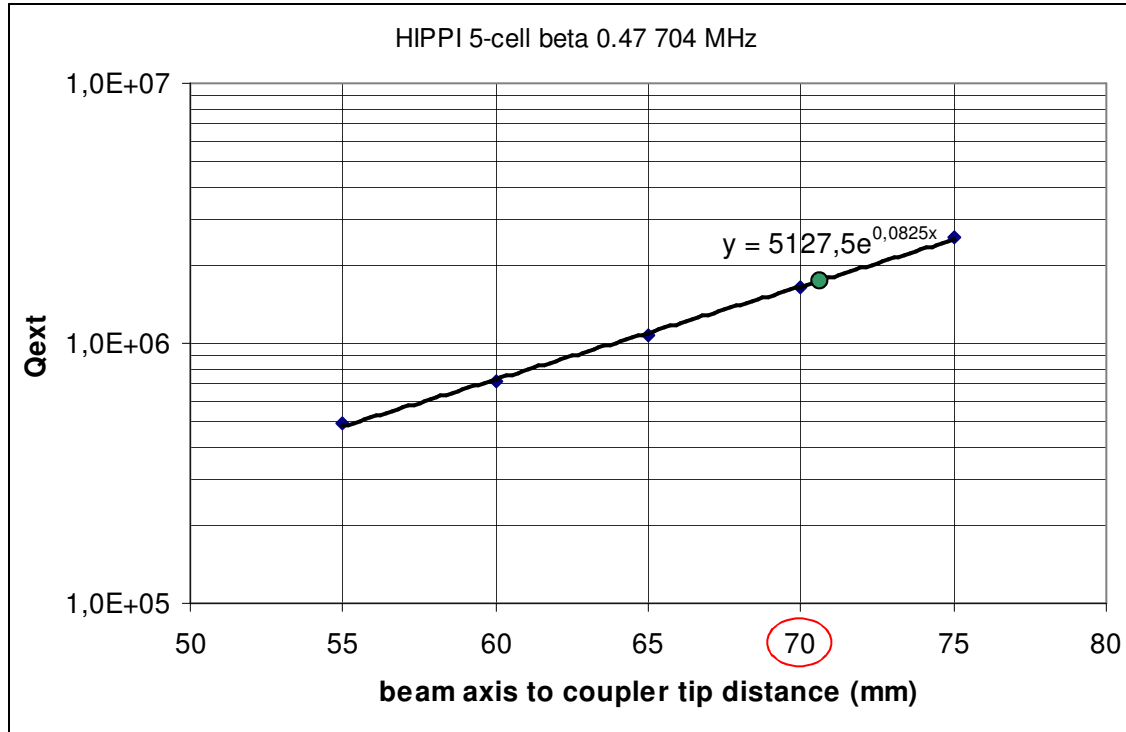


# Cryolab configuration for pulsed tests



# Qext measurements

Frequency = 702.662 MHz at T = 4.5 K  
Bandwidth 380 Hz -> Qext= 1.85e6



theoretical distance 70mm  
Computed Qext = 1.65e6

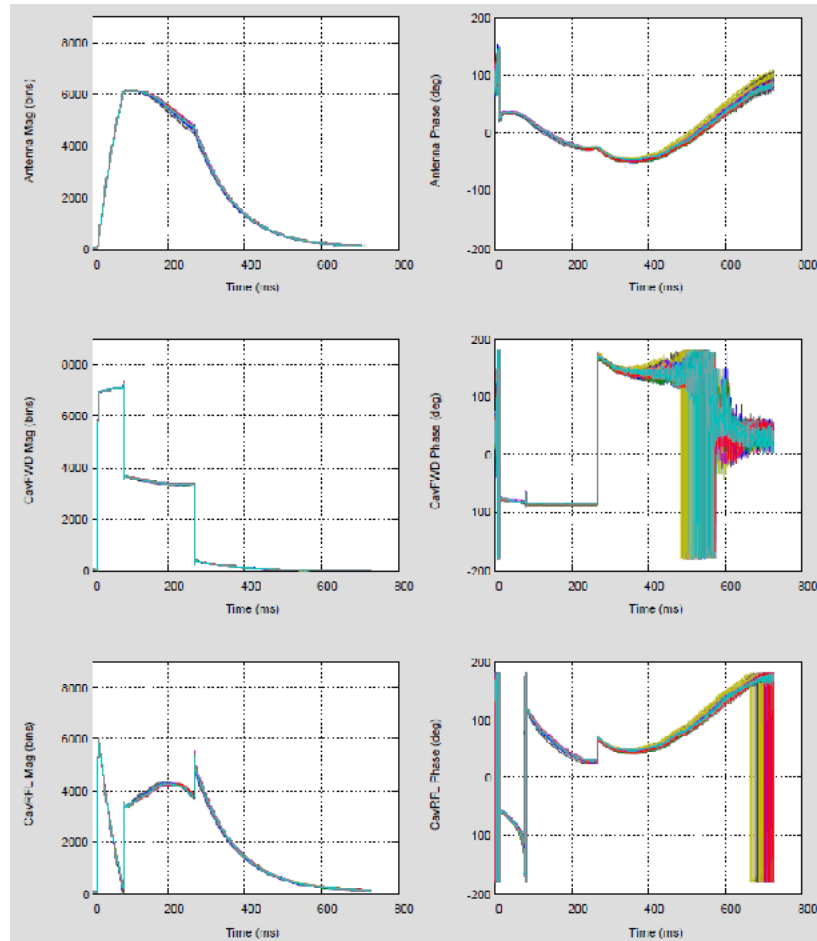
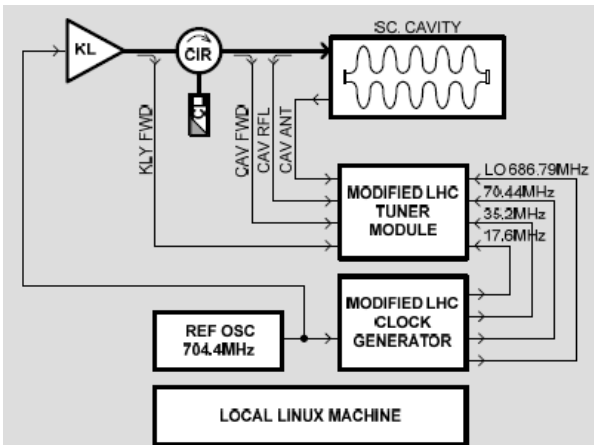
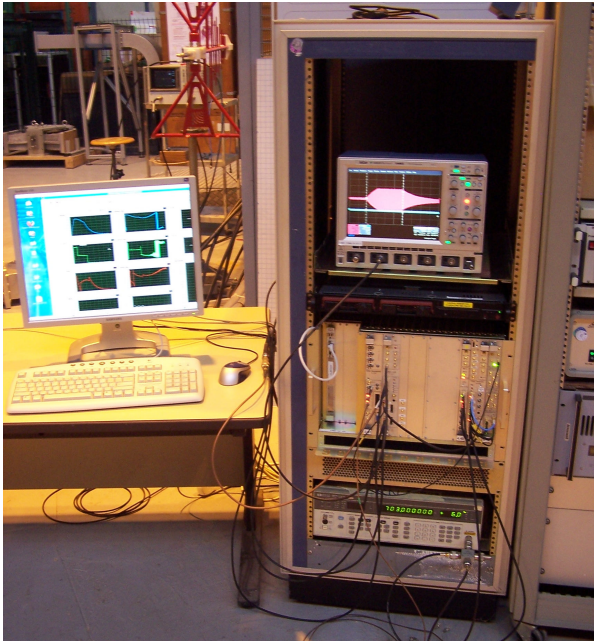
Coupler antenna is 0.91 mm shorter than specified (unexpected shrinkage during electron beam welding of the antenna)

-> Expected from the actual dimensions Qext = 1.79e6



# RF pulsée

- Feedforward pour la compensation du saut de phase klystron P-P/4
- Conditionnement du coupleur en tout réfléchi à  $F_{drive}=703$  MHz,  $F_{cav}=702.662$  MHz, à 4.5 K
- Installation de la baie de mesure RF du CERN 4 canaux I/Q



pickup cavity  
voltage

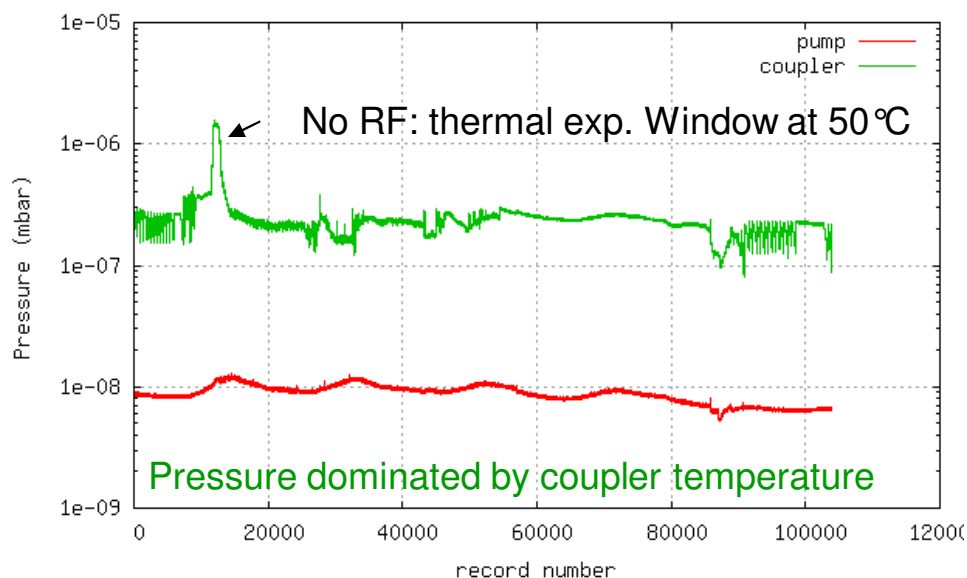
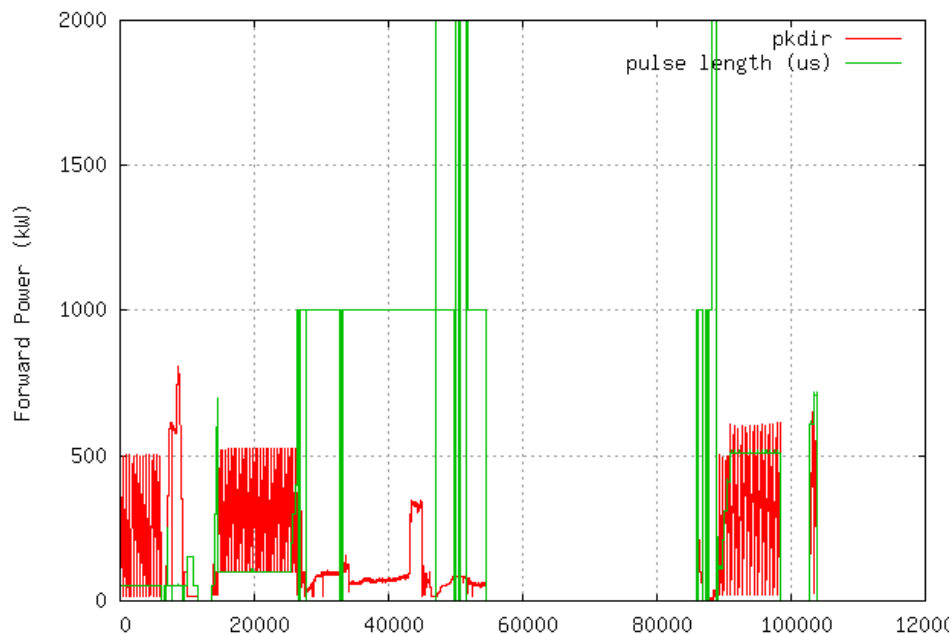
Incident  
 $V_i$

$V_r$

# Conditioning on cavity

- No conditioning done at room temperature on cavity
- Cool down of Cryholab with only the vacuum part of the coupler assembled to monitor the cavity displacement, only 0.1 mm at the level of the coupler window
- Assembly of doorknob and coaxial extension of the coupler.
- Conditioning with reduced duty cycle (spare HV power supply) in full reflection (detuned cavity)
  - start with 100  $\mu$ s pulses 5 Hz ramping power from 20 to 500 kW
  - increase pulse length up to 1 ms, same power ramping :
- conditioning with the cavity/ klystron tuned at 703 MHz, 1.8 K
  - 1ms pulses : up to 80 kW (too much Lorentz detuning on the cavity without compensation)
  - 2ms pulses: 240kW/80kW
- This week : resume of the pulsed tests after cryogenics and HPVS downtime
- Run with detuned cavity going on now 700  $\mu$ s, 600kW, 5Hz Monday, the coupler is conditioned, no more activity

HIPPI couplers conditioning on cryholab



Downtime due to HVPS failure mainly

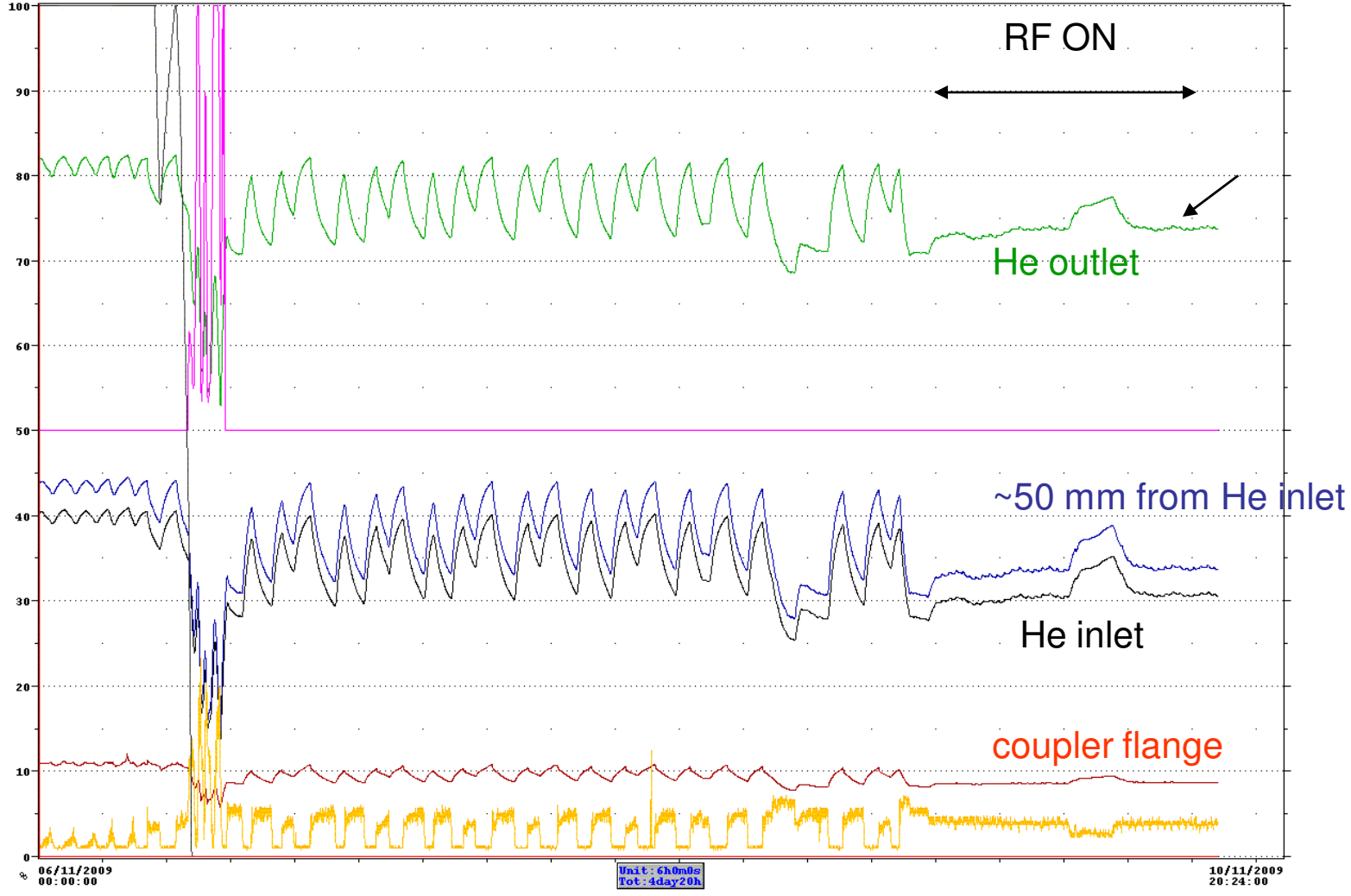


# Thermal behavior

TREND 7: COUPLEUR

TREND ARRAY HISTORICS RECORD PRINT CONFIG ADD-ON

Previous	Next	Main	Command	Views	Survey	Center	Msg/Alm
HIS: 06/11/2009 00:00:15 +0100 GMT		TCP Bytes: 3528	Raf: 1.0 s	Mem: 21/34 MBytes			
TT461	TT462	TT458	TT466	TCV104	FT104	TT417	LT412
120.62	131.08	245.6	32.65	50.0	0.06	121.84	0.15
0.0/300.0	0.0/300.0	0.0/300.0	0.0/300.0	0.0/100.0	0.0/5.0	90.0/110.0	90.0/100.0



# Conclusion

- Couplers performed as expected on the test stand achieving 1.2 MW peak, 120kW average
- After installation on the beta 0.5 cavity in the horizontal test cryostat Cryholab, very small amount of conditioning was necessary to operate in full reflection, well above the necessary power for cavity operation
- Cryo operation was done using a reduced duty cycle (most of the time 1 ms pulses at 5Hz) due to main HVPS failure, and the use of a lower spec'd spare HVPS
- Higher average power test will be resumed as soon as we install the main HPVS again in december
  
- One water leak occurred on the air side due to a misalignment of the inner conductor of the doorknob extension. Most probable scenario: gap between conductors->arcing->arc through the gasket drills a hole-> water leak. This can be avoided with a modification of the dual water/RF connection, the vertical position of the coupler and a shorter doorknob extension.
- Downtime due to High Voltage Power Supplies failure mainly