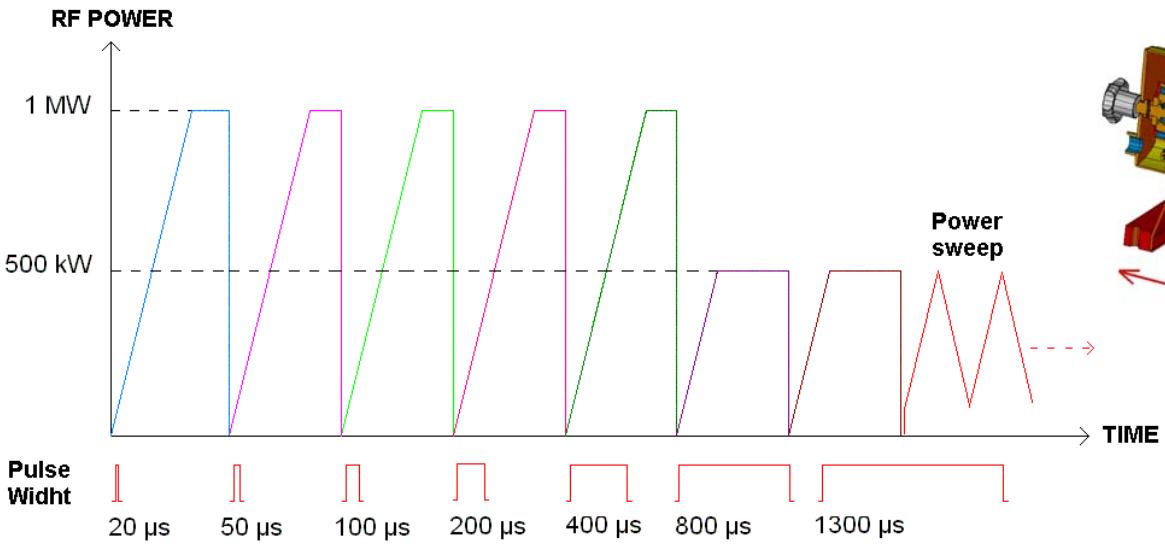
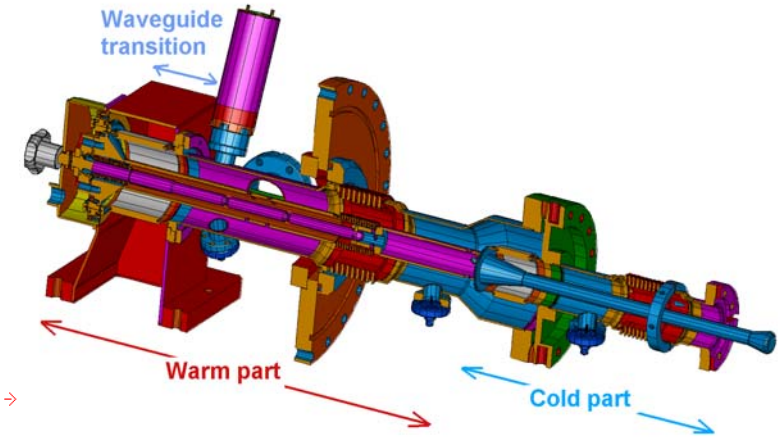
RF CONDITIONING AND TESTS ON TTF-III POWER COUPLEURS AT LAL (Interlock thresholds)

Hassen Jenhani

Laboratoire de l'Accélérateur Linéaire (LAL), Centre Scientifique d'Orsay – Bât. 200 – B.P. 34, 91898 ORSAY Cedex (France)

RF conditioning procedure principle





DESY conditioning procedure parameters :

Vacuum	1st threshold	2 x 10^{-7} mbar
	2nd threshold	4 x 10^{-7} mbar
	Vacuum interlock limit	1 x 10^{-6} mbar
e- current	Current interlock limit	5 mA
Light	PM interlock limit	1 Lux
Temperature	I. R. detector limit	85 °C
Arcs	If any	
Repetition rate	2 Hz	
Control loop	30 s	

→ $P_{i+1} = P_i - \Delta P$

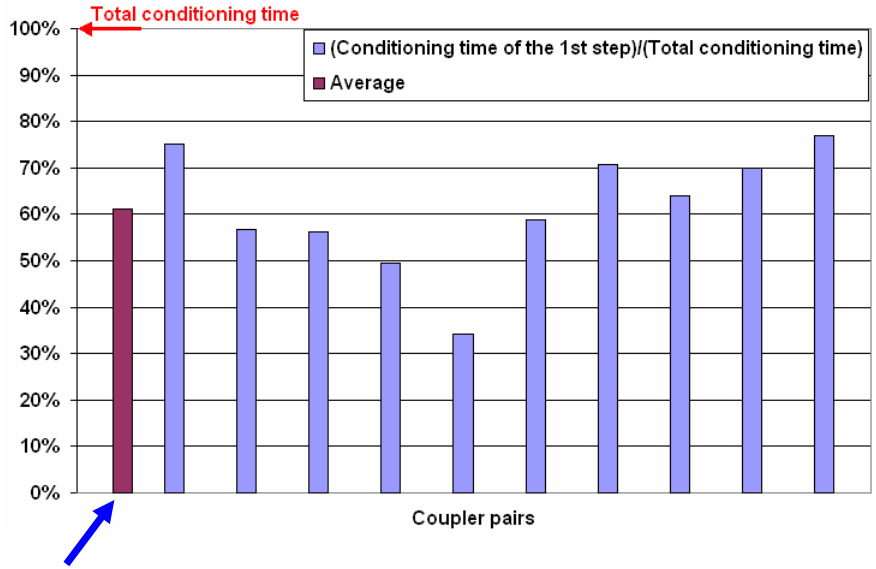
→ $P_{i+1} = P_i - 4x\Delta P$

Stop power immediately

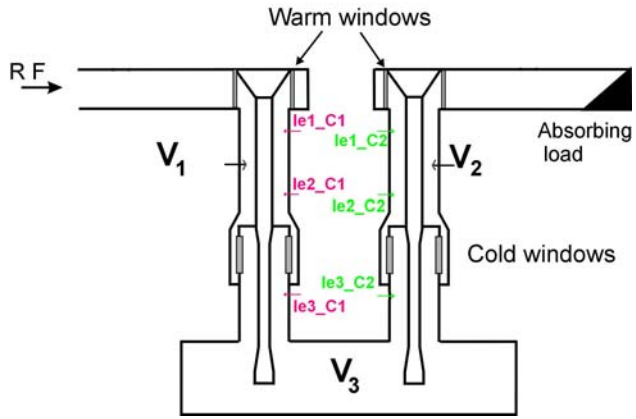
Coupler RF conditioning

Large spread of conditioning time ≈50 h to ≈ 200 h

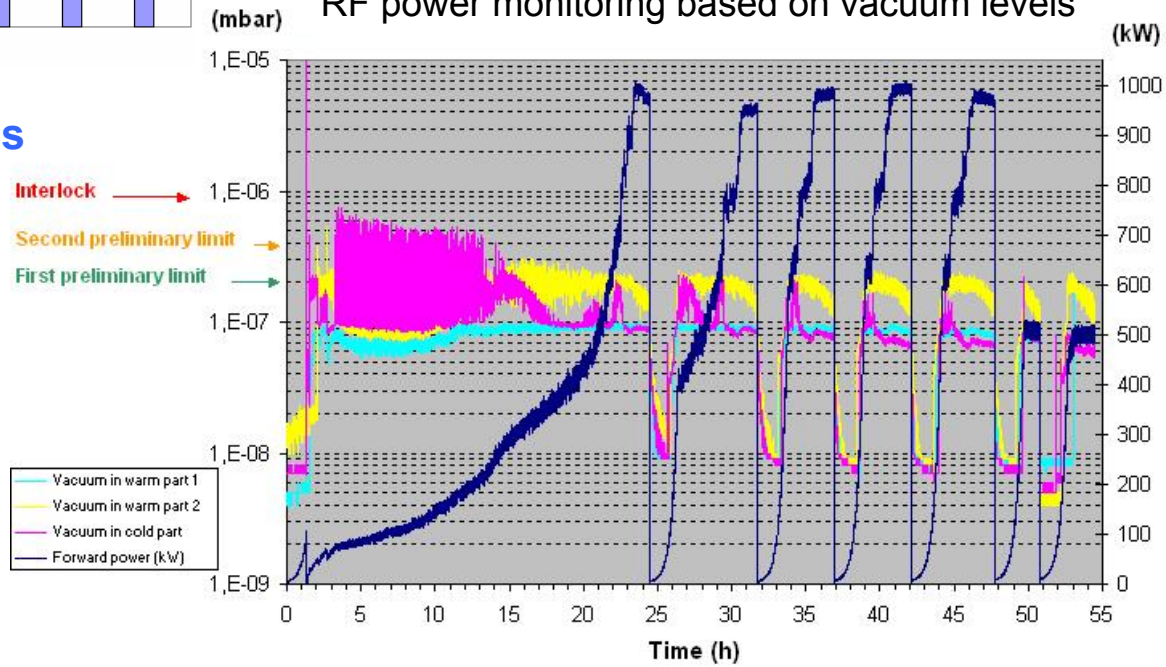
The first conditioning step is the most time consuming



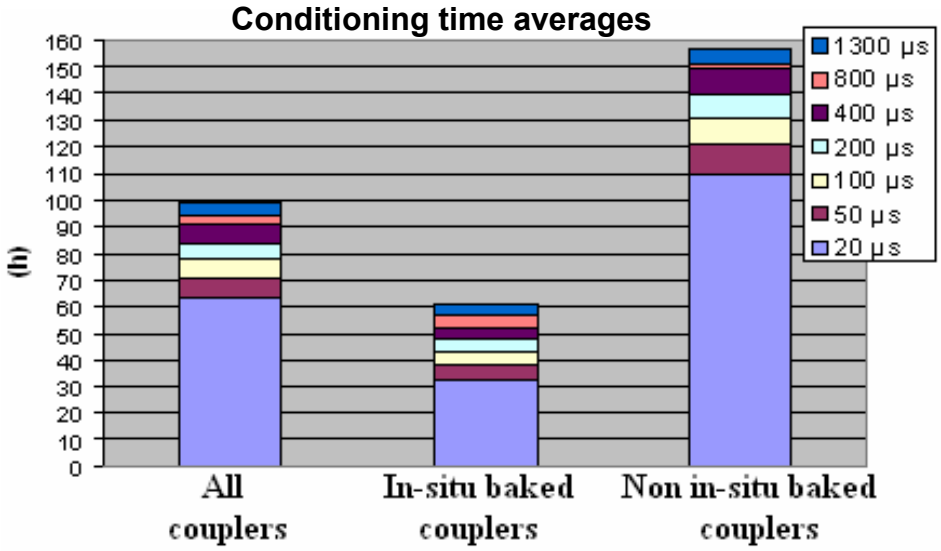
Average of conditioning time at 20µs



RF power monitoring based on vacuum levels



In-situ baking effect



In average in-situ baked conditioning time ≈ 40% of the non in-situ baked one for the TTF-III couplers

We have to verify that this huge difference is not due to some dissimilarities between pairs of couplers

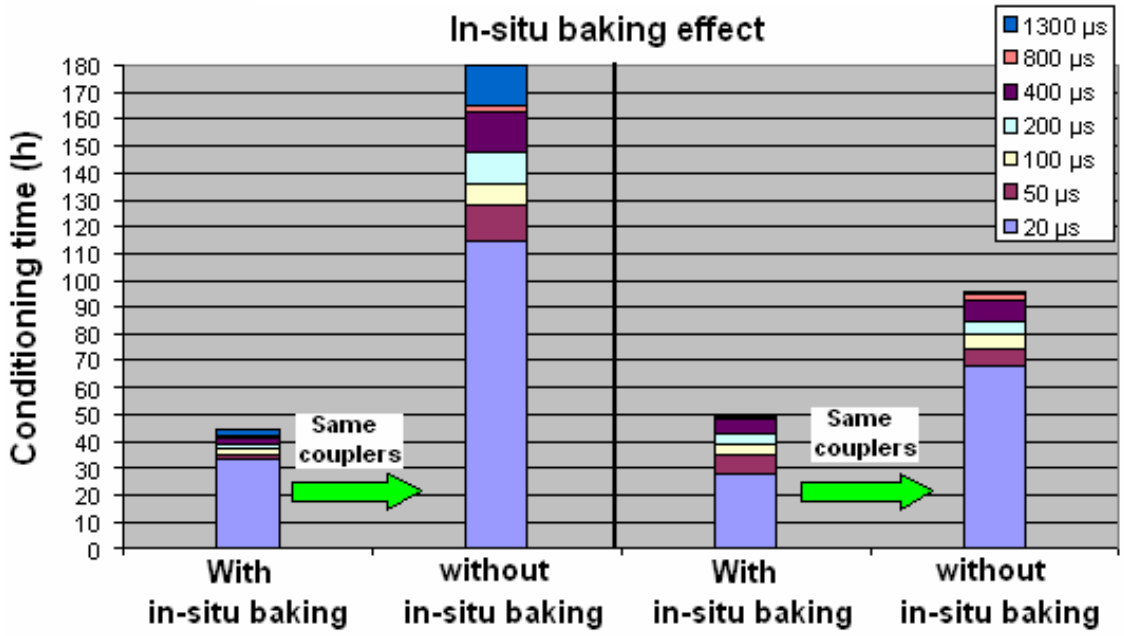
Verification :

Exp1:

$T_{CondBaked} / T_{CondN.Baked} = 25\%$

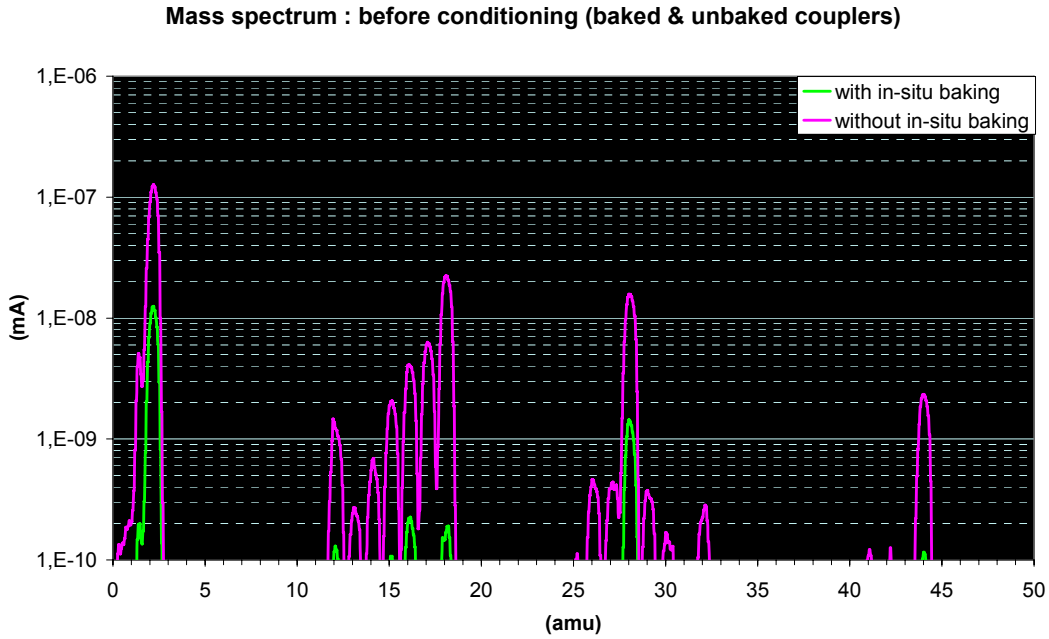
Exp2:

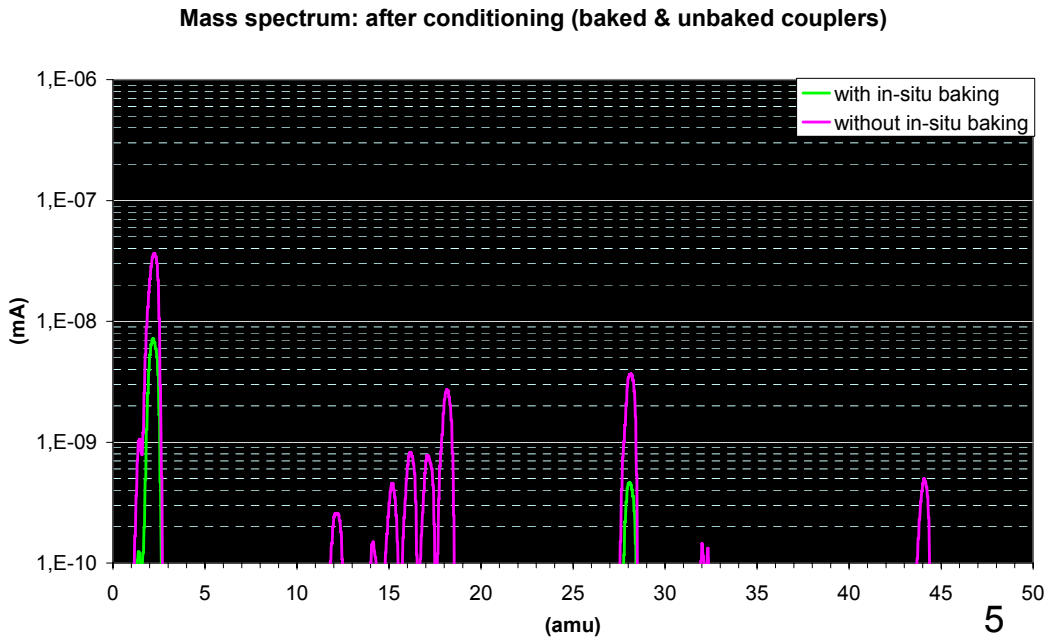
$T_{CondBaked} / T_{CondN.Baked} = 52\%$



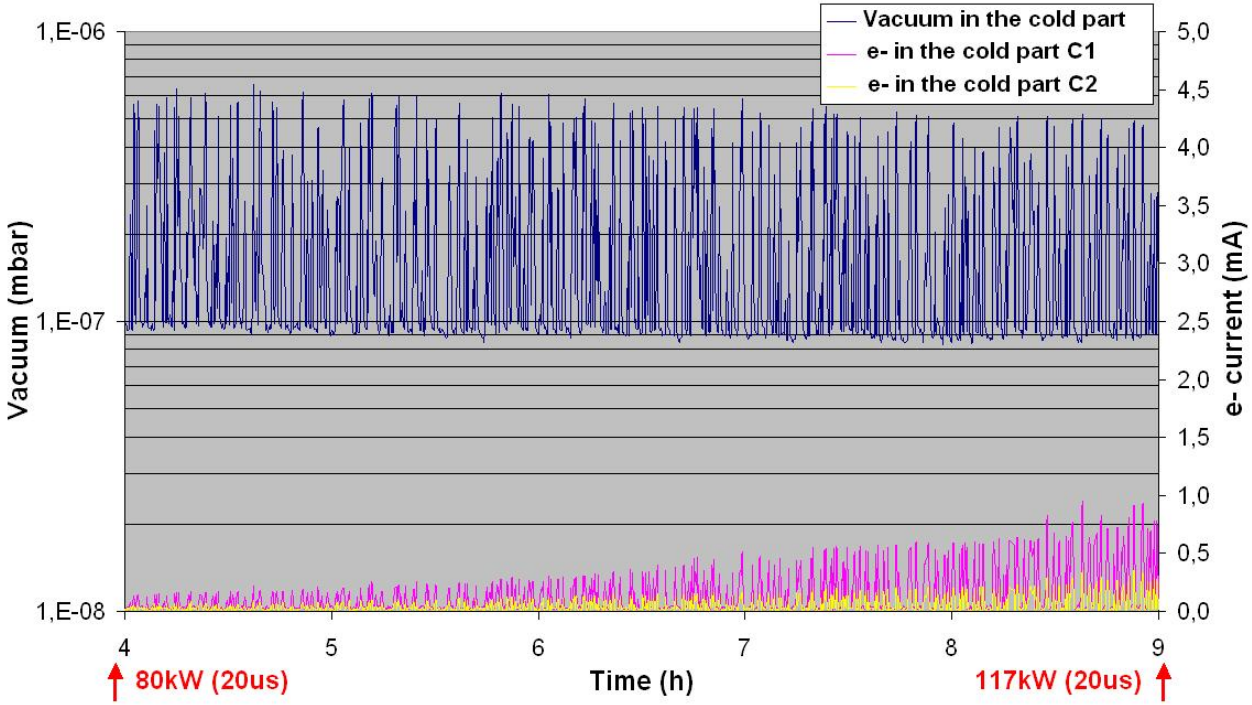
Spectra comparison

Despite the long conditioning time in the non in-situ baked case, we can't reach vacuum levels as good as in the in-situ baked one.





Optimisation of the vacuum thresholds (1)



During conditioning, there were periods in which the conditioning progress were slowed down by continuous vacuum level fluctuations in the absence of significant e- current signals (5h to rise power from 80 kW to 117 kW in this example).

Low electron bombardment action on surfaces during this periods.

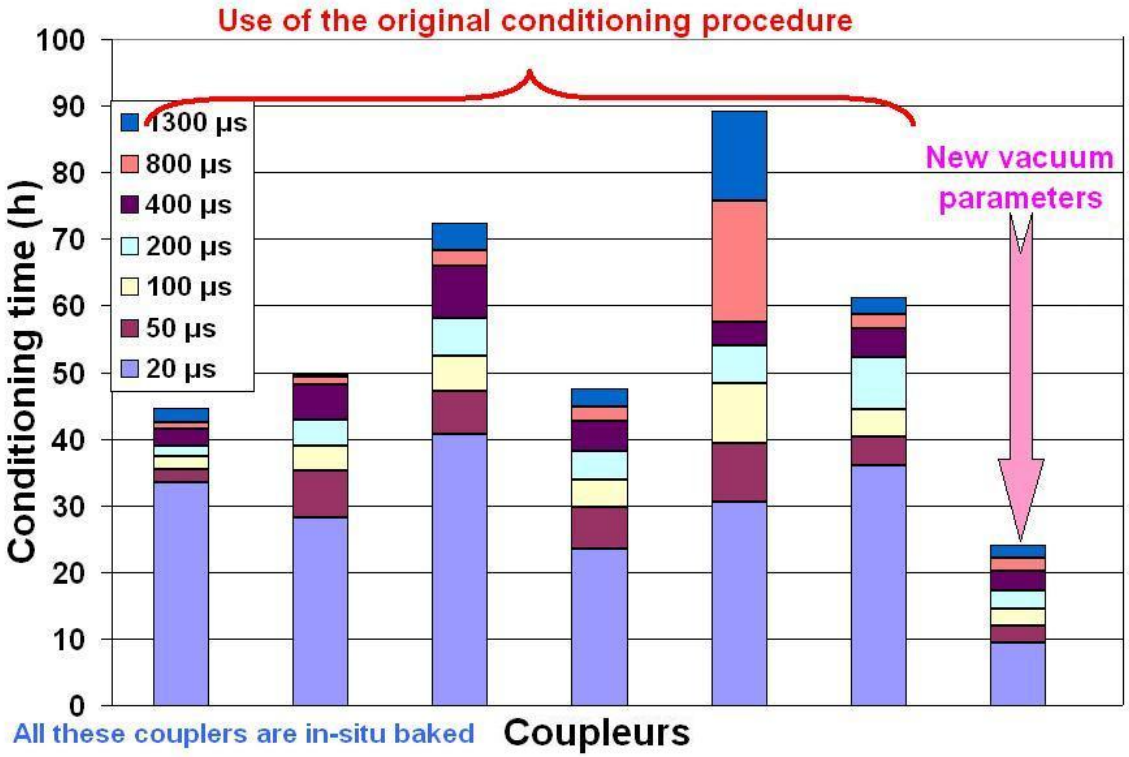
Possible solution: Using **6 10^{-7} mbar** as a first threshold may avoid this conditioning stage

Calculation on the performances of the pumping system has been worked out in order to chose new vacuum thresholds

Optimisation of the vacuum thresholds (2)

The new chosen values:

First threshold :	**$6\ 10^{-7}$ mbar**
Second threshold:	**10^{-6} mbar**
Vacuum interlock limits:	**$5\ 10^{-6}$ mbar**



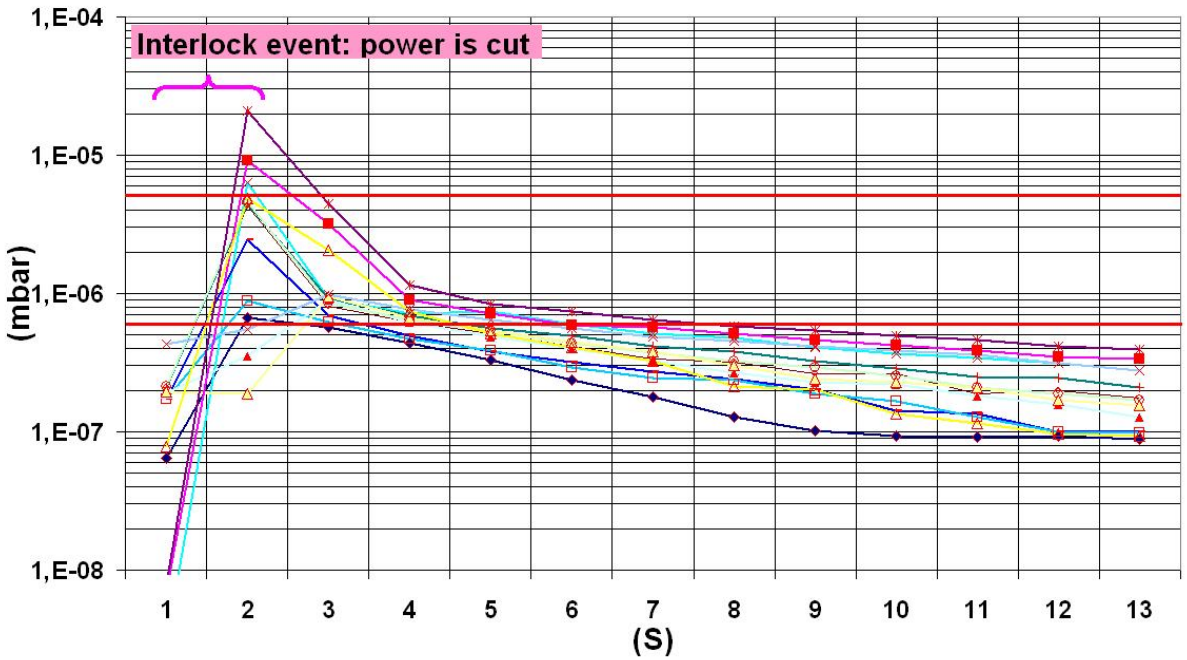
The duration of these steps depends only on the time required by the monitoring program to increase the RF power

Optimisation of procedure speed (1)

The power control loop duration is 30 s

Criteria :

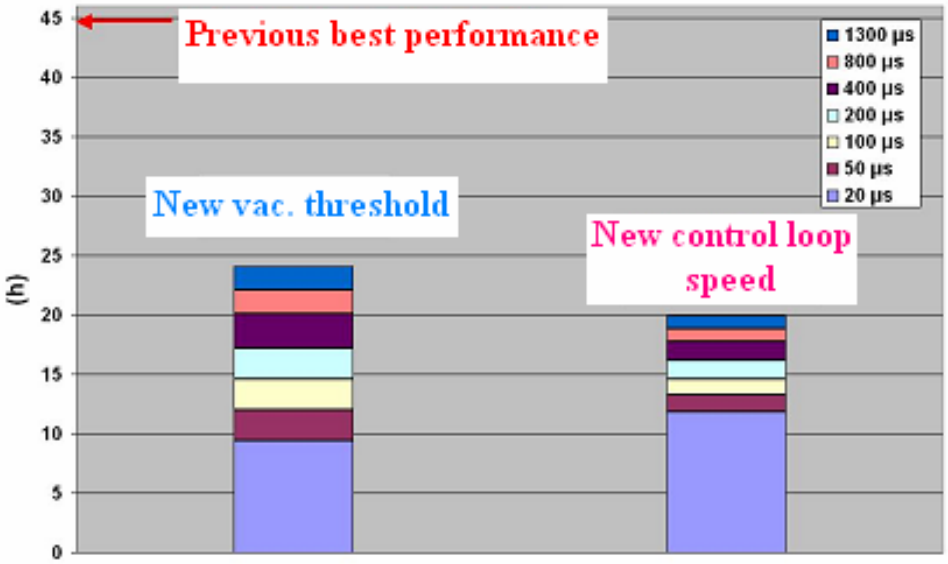
"The pumping system should have enough time to pump a pressure rise near to the vacuum interlock limit ($5x10^{-6}$ mbar) down to less than the first threshold value ($6x10^{-7}$ mbar) during only one delay time of the loop, if the event causing this vacuum burst vanishes."



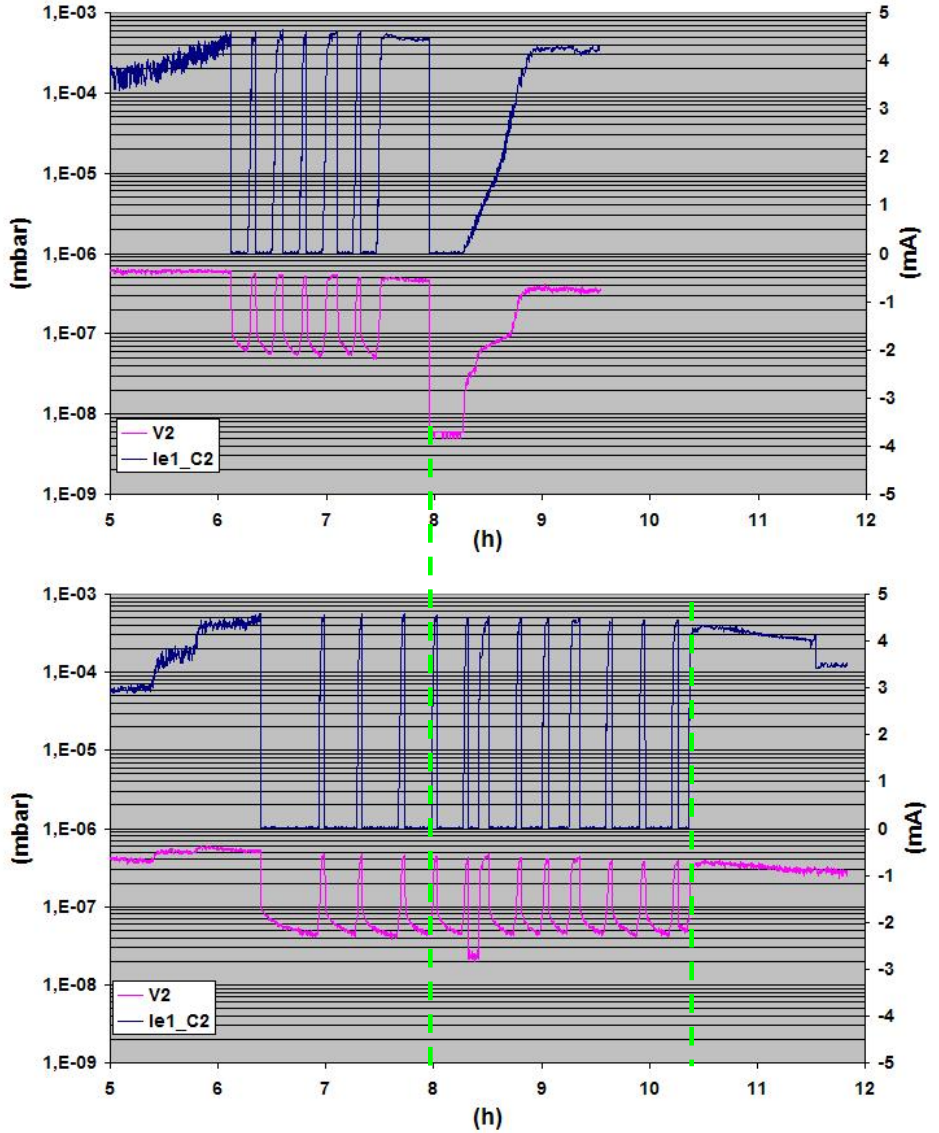
5 seconds can be sufficient to pump down the pressure from $5x10^{-6}$ to $6x10^{-7}$ mbar.

Optimisation of procedure speed (2)

To have a security margin we decide to take three times this value as a new loop time delay: **15 s (3 x 5 s)**



Interlocks at 550 kW (20µs step)

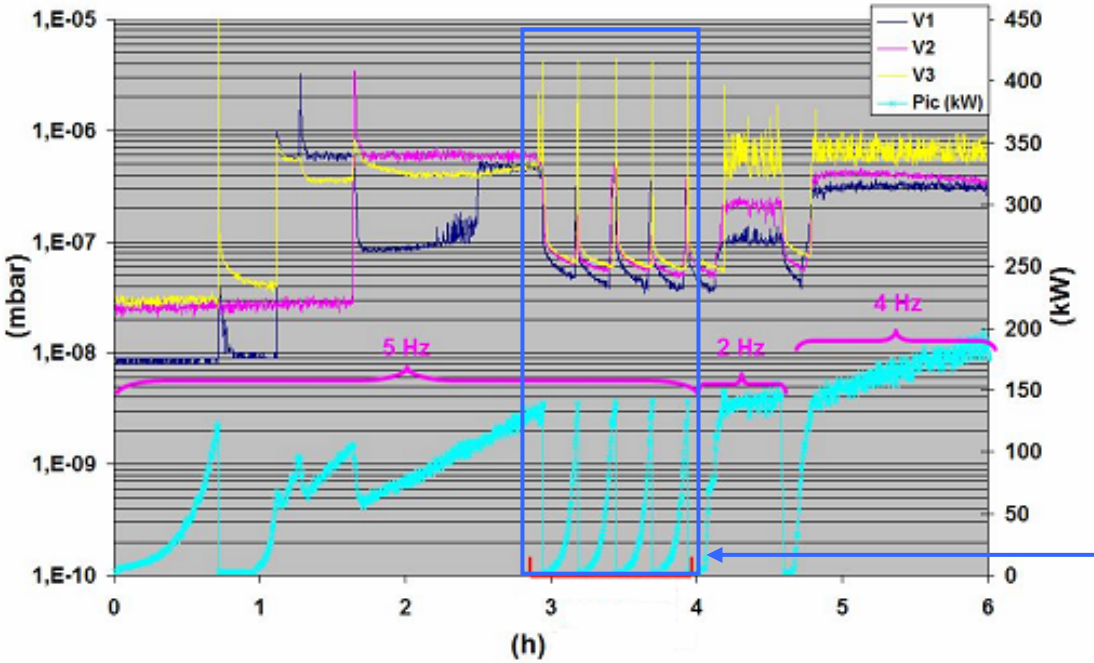


Conditioning time decrease

⇨ **Less e- current magnitude reduction before reaching high power levels in the first conditioning step (20 µs)**

Increase the pulse rate

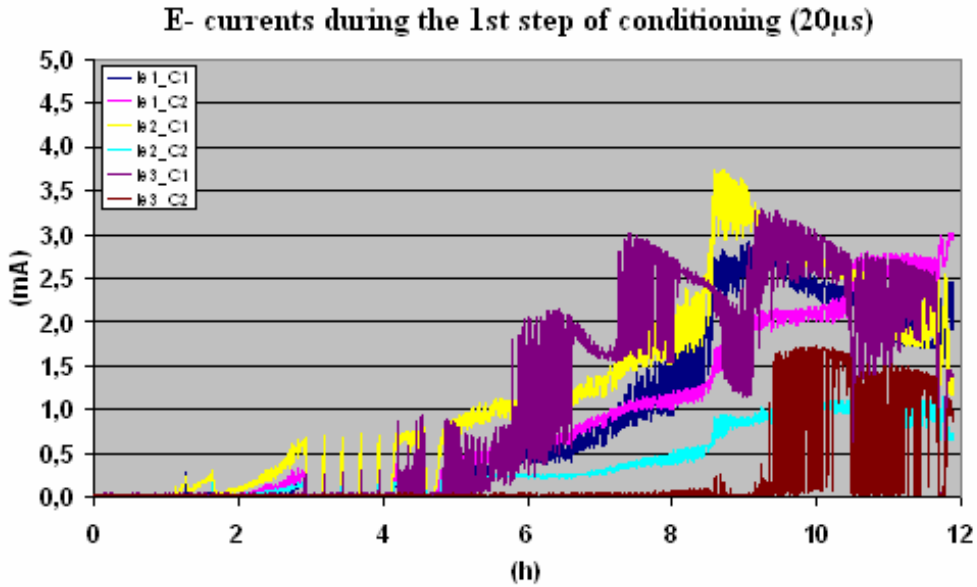
Increase of the pulse rate



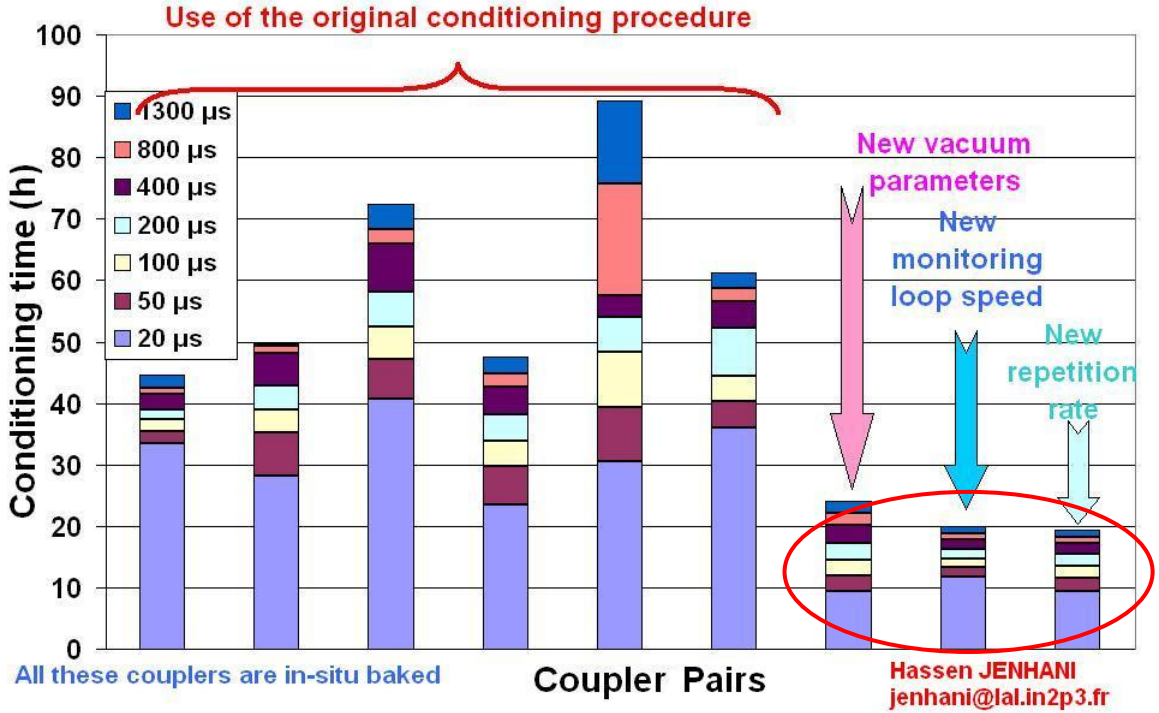
Too much degassing

4 Hz pulse rate => no more e- current interlocks at 550 kW

Conditioning time is also ≈ 20 h



Last conditioning time performances

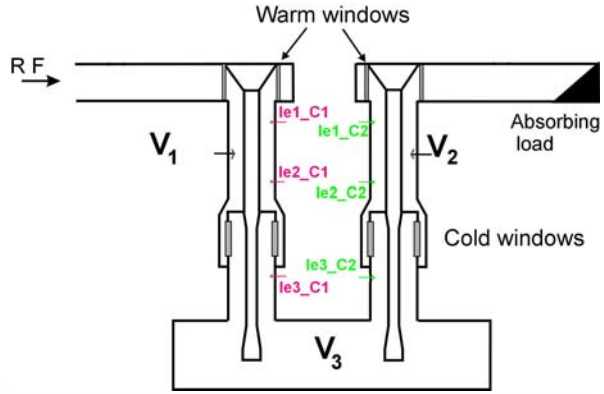


Average ~ 21 h

		First values	Last values
Vacuum	1st threshold	2 x 10^{-7} mbar	6 x 10^{-7} mbar
	2nd threshold	4 x 10^{-7} mbar	1 x 10^{-6} mbar
	Vacuum interlock limit	1 x 10^{-6} mbar	5 x 10^{-6} mbar
e- current	Current interlock limit	5 mA	
Light	PM interlock limit	1 Lux	
Temperature	I. R. detector limit	85 °C	
Arcs	If any		
Repetition rate	2 Hz		4 Hz
Control loop	30 s		15 s

Need more tests

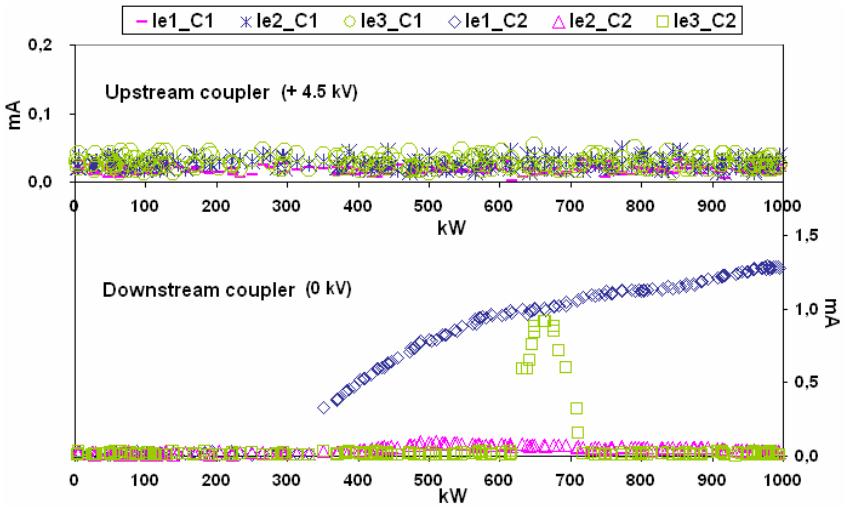
Antenna DC biased TTF-III coupler

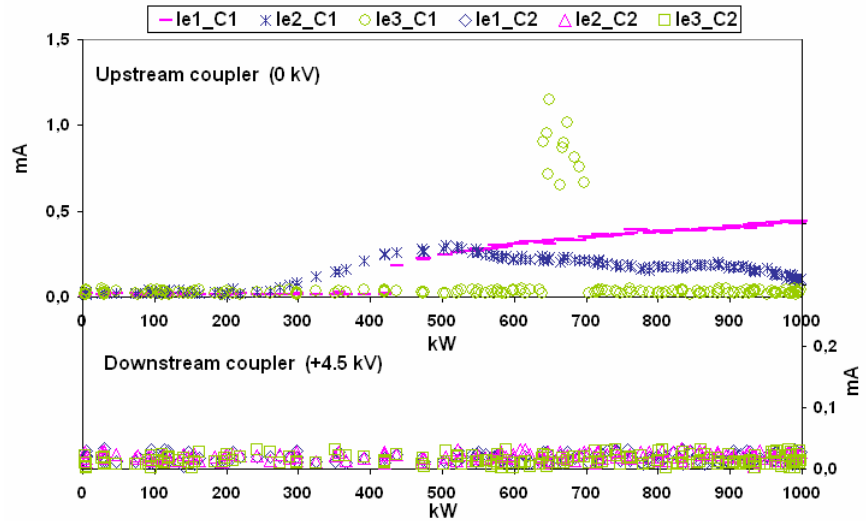


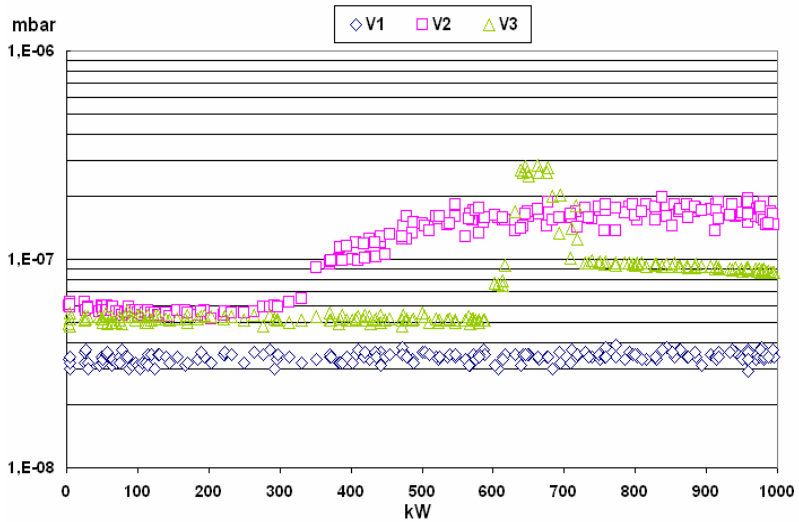
DC bias:

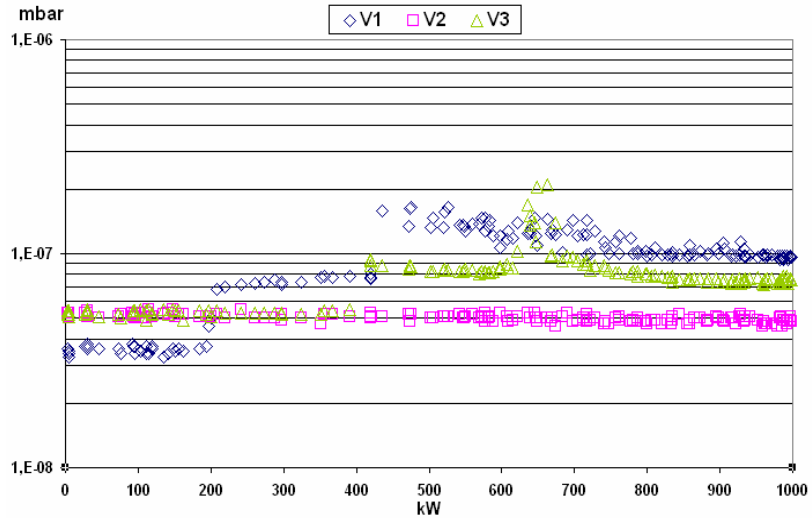
V = + 4.5 kV

DC Bias was applied to already conditioned couplers



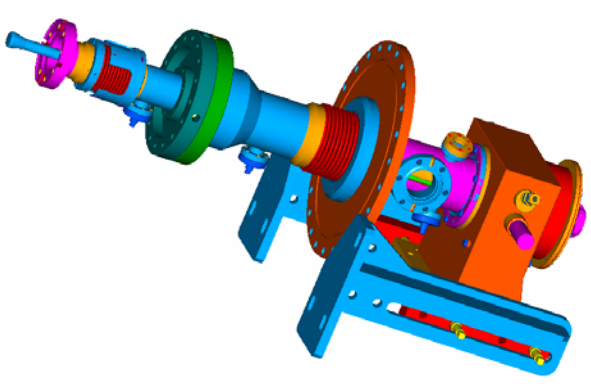






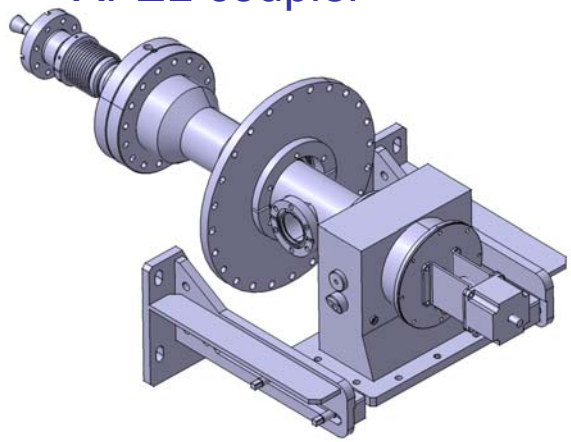
Future

TTF-III coupler



Pick-up & PM diagnostics will be omitted

XFEL coupler



Pick-up E- current acquisition:

- Polarization: 30 V
- Interlock threshold: 5 mA
- Information about the event location:
  - ✓Near warm window
  - ✓Near the worm side of the cold window
  - ✓Near the cold side of the cold window

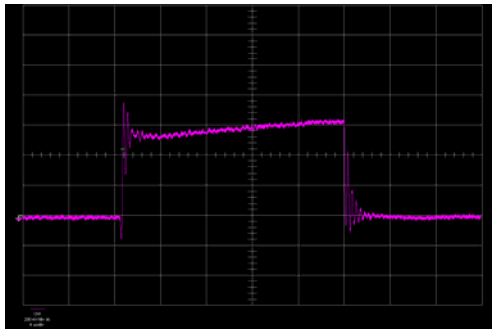
Inner conductor E- current acquisition:

- Polarization: ?
- Interlock threshold: ?
- Information about the event location:
  - No information about the e- event location

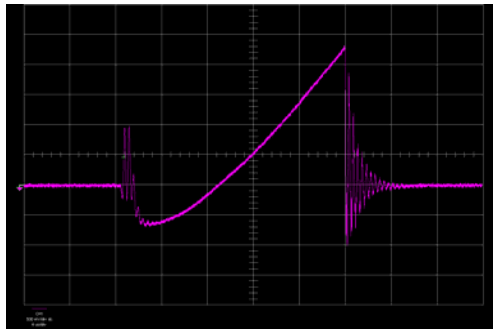
First tests for e- current measurements with the inner conductor

DESY Tests:

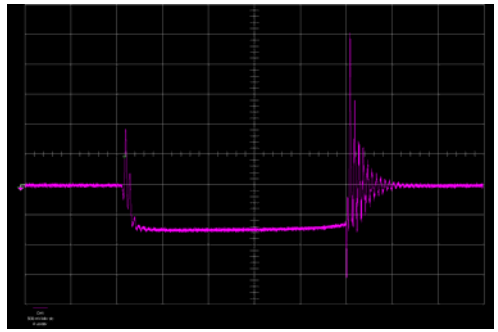
Large dependence of the e- current characteristics (value, shape, and sign) to the polarization value



Bias 0V (20mA, 4ms per div.)



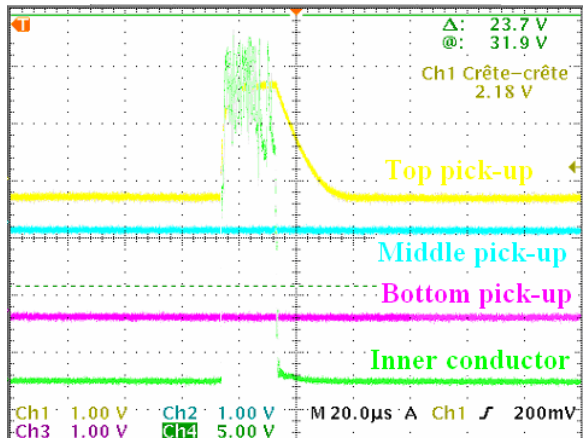
Bias 100V (50mA, 4ms per div.)



Bias 120V (50mA, 4ms per div.)

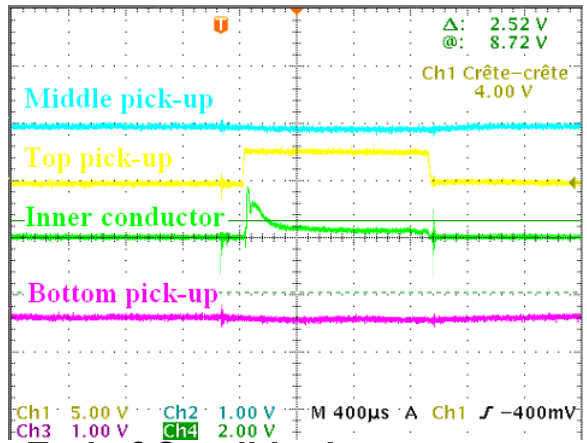
LAL tests: (bias = 30 V)

- Huge current on the inner conductor with large dynamic range during conditioning (up to ~A at the start of conditioning to ~mA at the end)
- No conclusion about a new secure e- currents thresholds relative to the inner conductor acquisition, but there is correlation between vacuum and the measured current rise.



Conditioning has just started:

20 µs pulse; max current 2.4 A



End of Conditioning:

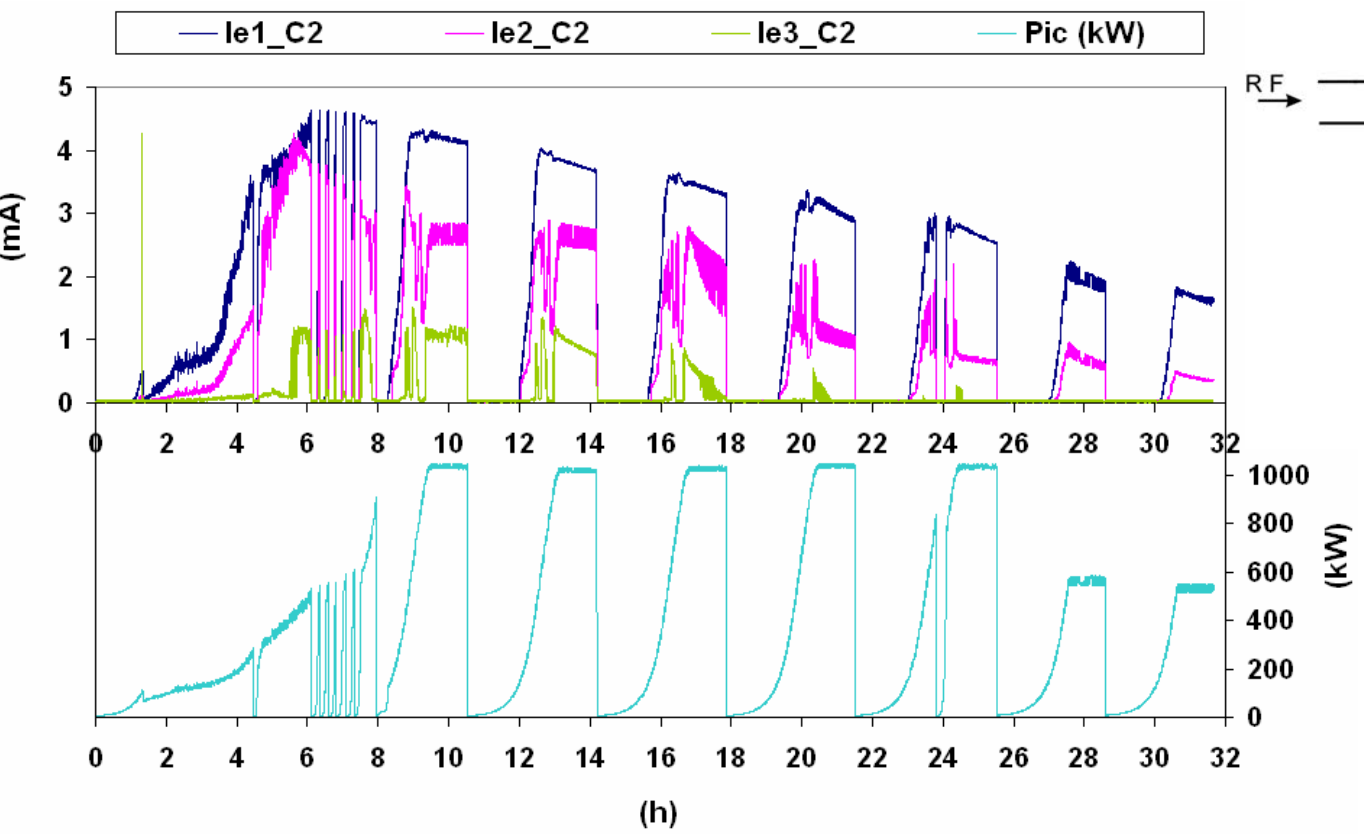
1300 µs pulse; current ~ few mAs

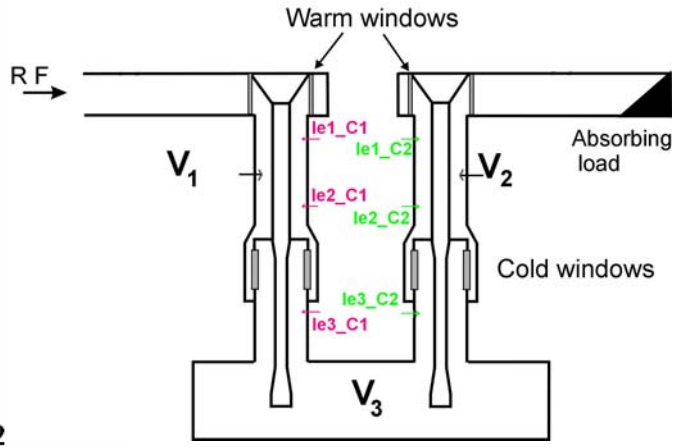
More experiments are needed to establish new e- current thresholds

Conclusion

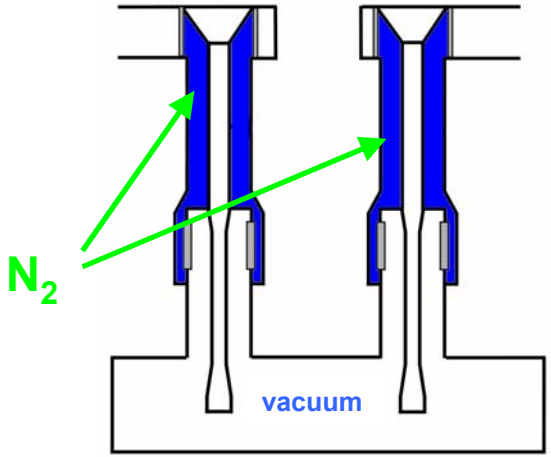
- New conditioning time performances : ~20 h
- 4.5 kV DC bias of the inner conductor seems to be efficient to stop e- activity on TTF-III coupler
- More tests are needed to find the best way to use the coupler inner conductor for e- current measurements

Example of e- pick-ups signals (Polarisation = 30 V)





Storage effect on conditioned couplers

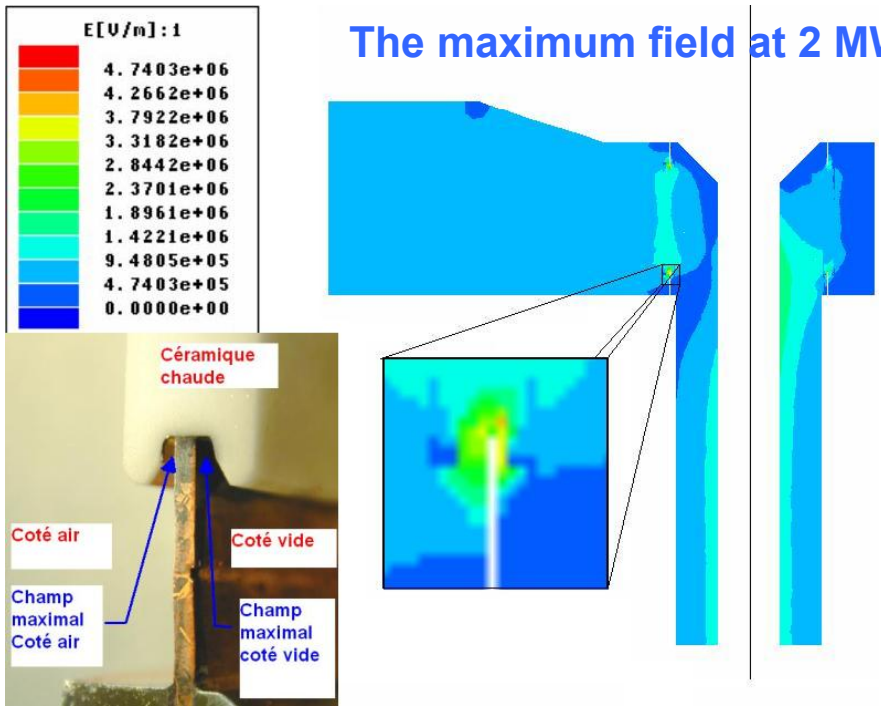


ΔT: [Duration of the second conditioning (after storage)] – [Time of the processing program]

Experiment N°	In-situ baking before the 1st conditioning	Storage duration	ΔT
1	yes	Few hours	0
2	no	1.5 month	58 h
3	yes	2 months	3 h

The current storage procedure seems to preserve the conditioning memory if couplers were in-situ baked before their conditioning

2 MW power test on TTF-III coupler (TW)



The maximum field at 2 MW

20 µs

Conditioned TTF-III couplers (Pmax = 1 MW) don't need extra conditioning to reach 2 MW at 20 µs.