12th International Workshop on RF Superconductivity, Cornell University, Ithaca, New York, USA- July 10-15, 2005

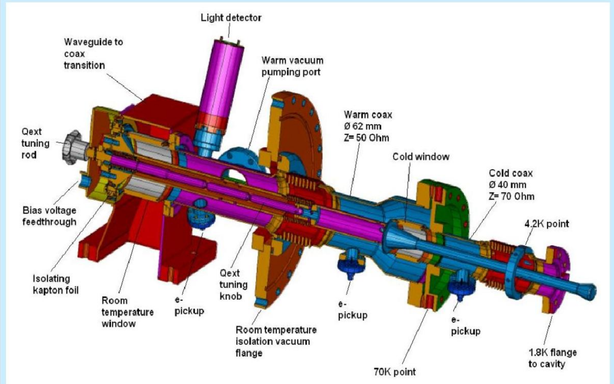
PREPARATION AND CONDITIONING OF THE TTF VUV-FEL POWER COUPLERS

HASSEN JENHANI
LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE
IN2P3-CNRS et Université PARIS-SUD
Centre Scientifique d'Orsay - Bât 200 - B.P. 34
91898 ORSAY Cedex (France)

Introduction

The current TTF-III coupler design has been adopted for the superconducting accelerator XFEL since 2003. This coupler model may also be a good candidate for the ILC project. In the framework of a DESY/LAL collaboration, 40 TTF-III couplers have to be room temperature processed at Orsay. Analysis of the couplers behavior may lead to an optimization of the conditioning procedure.

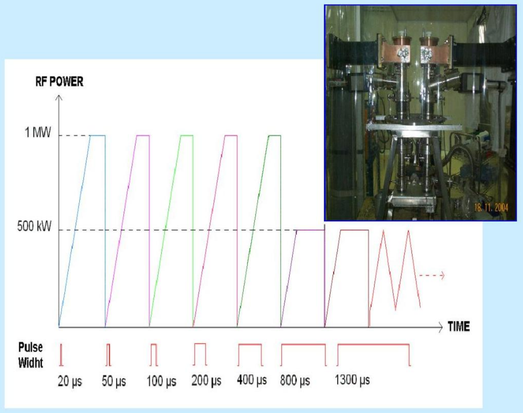
TTF-III coupler



X-FEL specifications :

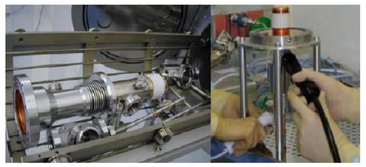
- Frequency : 1,3 GHz
- Pulse : 500 μs rise time and 800 μs flat top with beam
- Repetition rate : 10 Hz
- Peak power : 150 kW
- Coupling : $Q_{ext} = 10^6 - 10^7$

Conditioning procedure



Power monitoring based on vacuum levels.
Hardware security guaranteed by interlocks : (protection thresholds)
·Vacuum limit : 10^{-6} mbar.
·E- current limit: 5 mA.
·Light activity limit : 1 Lux.
·Any spark.

Coupler preparation



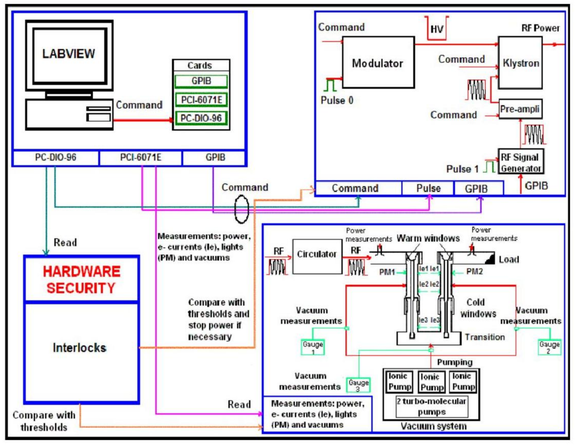
In the class 1000 clean room

- Clean all coupler parts in the ultrasonic bath at 50°C using the Tickopur R33 detergent.
- Rinse them with ultra pure water until the resistivity of the draining water becomes higher than 14 Mohm.cm

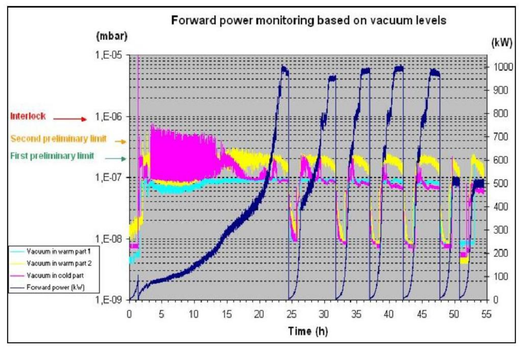
In the class 10 room

- Let the all the rinsed elements dry for sufficient time
- Blow these parts with filtered ionized nitrogen at a pressure of 4mbar (For the cold parts and transition only) using a particle counter witch must count less than 10 particles of 0.3 microns per cubic foot. If not parts must return to the ultrasonic bath.
- Put all the parts in oven and bake them at 150°C for 35 to 40 hours.
- Leak test using helium gaz.

Controls Synoptic

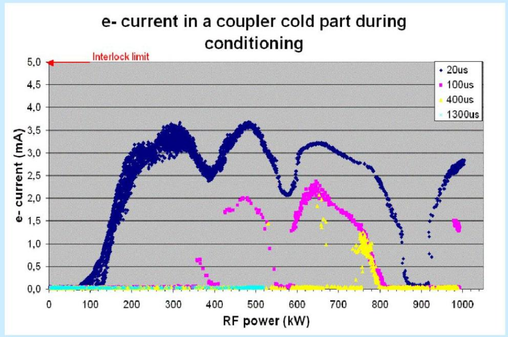


Coupler conditioning



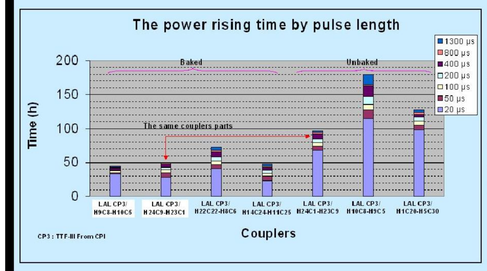
The most time consuming step during conditioning is the first one. Some powerful discharges can be seen especially at the first vacuum burst. This can activate a protection interlock which stops the RF power.

Effect of conditioning on e- current



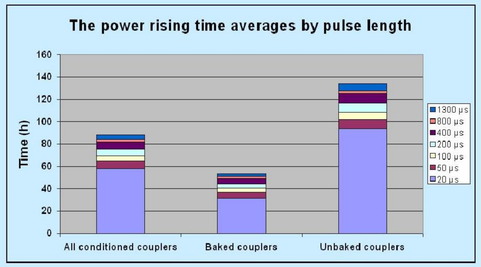
Conditioning acts on coupler surfaces causing a reduction of the SEE. This permits a progressive decrease of the e- currents during the coupler process.

Conditioning summary

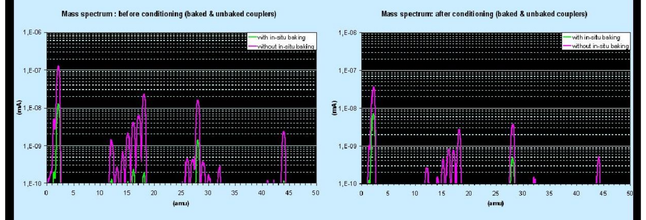


Unbaked coupler conditioning is very time consuming compared to the 150°C baked ones.

Averages done on 7 coupler pairs shows that one can save more than a half of the conditioning time by baking.

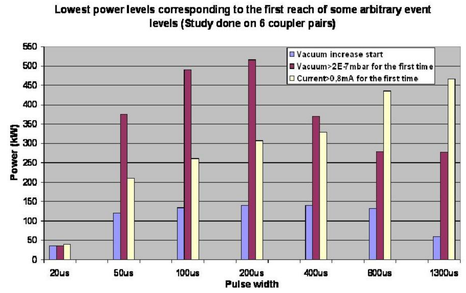


Spectra comparison



Mass spectrometry on coupler cold parts shows the effect of in-situ baking on coupler surfaces.

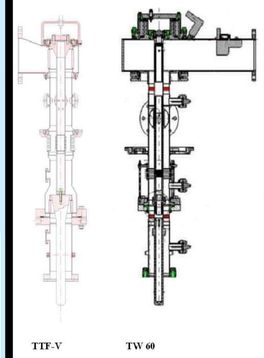
Coupler behavior



This kind of study may help us to speed-up our conditioning procedure safely below chosen power levels in order to accelerate coupler process.

We noticed that at 20us the arbitrary event power levels are reached more rapidly when coupler pairs are not in-situ baked. However, in-situ baked ones have not necessarily the best behavior during the other conditioning steps.

Prototypes



Example of two power couplers designed at LAL

Main differences between 3 coupler models

	TTF-III	TTF-V	TW60
Stage	Tested : Warm and cold tests Industrialization studies	Prototypes manufacturing started (Accel)	Prototypes manufacturing will start soon.
Cold part coax diameter	40mm	62mm	62mm
Cold part impedance	70Ω	50Ω	50Ω
Windows Geometries	Cylindrical	Cylindrical	Disk
Cold Window dielectric losses at 2kW average power*.	0,7W	0,55W	0,8W
Maximum CW power	10 kW at TW 5kW at SW**	No thermal study yet	No thermal study yet
Pumping ports	35mm	35mm	60mm
Polarization system	Capacitor	The same as TTF-III	Simplified (insulating ring)
Antenna tuning system	yes	Not yet	Not yet

* P. Lepercq CARE NOTE 04-037-SRF

** J. Knobloch, "CW Operation of TTF-III Input Coupler", PAC05, USA, May 2005

Conclusion

- Best conditioning time performances for TTF-III were from 45 to 50 h (Minimum conditioning time is 16h30 when there are no events).
- Reducing the conditioning time may be possible by accelerating the RF power rise during the safe power regions. Relaxing the preliminary vacuum limits can also be an alternative solution.
- 150°C in-situ baking saves more than half of the conditioning time and allows one to reach better vacuum in couplers
- Two new coupler prototypes that could be alternatives to TTF-III for the ILC project will be manufactured soon.