Status of the TTF3 RF Power Coupler

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At the University of Tokyo

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overview

- First TTF3 specification for TESLA
- Development history
- Operation experience
- Developments and improvements for XFEL
  - Conditioning time
  - Bellow supports
  - RF contacts
  - Other improvements
  - Capacitor replacement proposal
- What has to be improved further

European XFEL

TESLA specification

frequency	1.3 GHz
operation	pulsed: 500 µsec risetime, 800 µsec flat top with beam
two windows	• safe operation • clean cavity assembly for high gradients
2 K heat load	0.06 W
4 K heat load	0.5 W
70 K heat load	6 W
isolated inner conductor	bias voltage, suppressing multipacting
diagnostic	sufficient for safe operation and monitoring

European XFEL

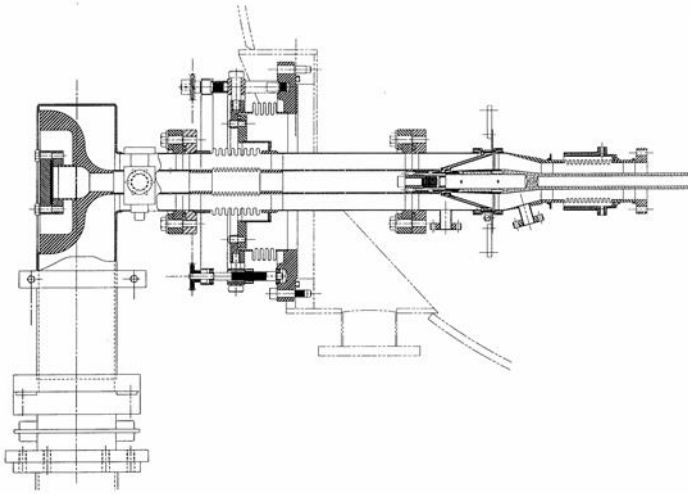
TESLA specification

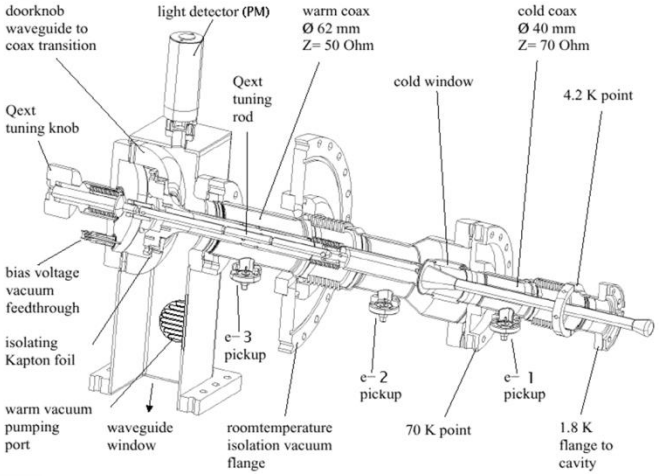
	TTF	TESLA 9-cell / upgrade	TESLA superstructure / upgrade	TESLA X-FEL Supplement
peak power + control margin (27%)	250 kW	250 kW / 500 kW	555 kW / 1110 kW	150 kW
repetition rate	10 Hz	5 Hz	5 Hz	10 Hz
average power	3.2 kW	3.2 / 6.4 kW	3.6 / 7.2 kW	1.9 kW
coupling (Qext)	adjustable (10^6 - 10^7)	fix ($3*10^6$)	fix ($2.5*10^6$)	adjustable ($4.6*10^6$)
cavity position during cool down	flexible (15 mm longitudinal)	fix point (4.5 mm longitudinal)	fix point (4.5 mm longitudinal)	fix point (4.5 mm longitudinal)

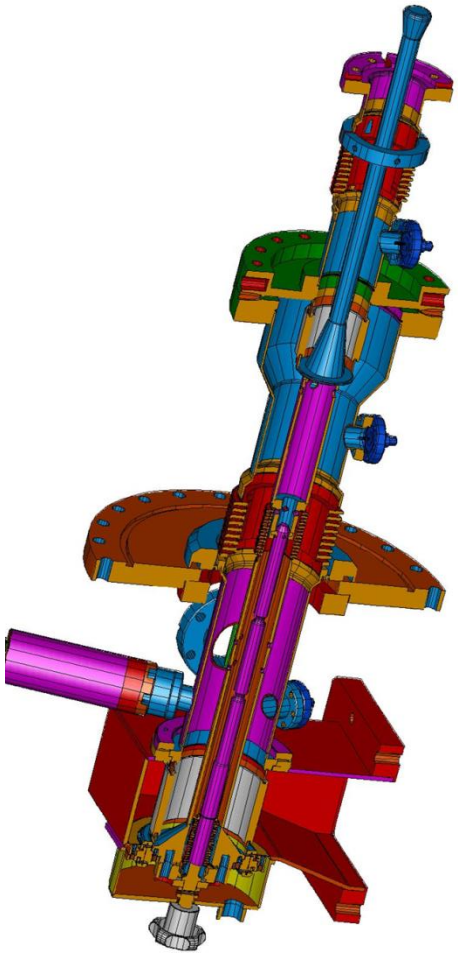
European XFEL

Development history

	Fermilab	TTF2	TTF3
cold window	conical	cylindrical	cylindrical
warm window	wave guide	wave guide	cylindrical
Bias	no	yes	Yes
fabricated	16	20	>100







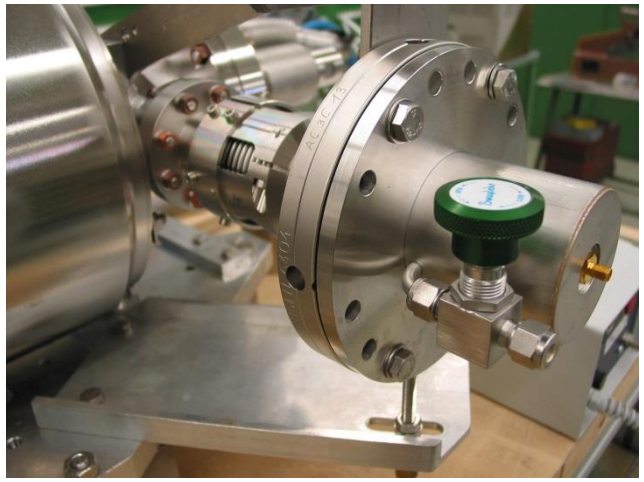
Operation experience

- 32 TTF3 couplers are in operation in FLASH
  - More than 1.5 Mio coupler x hours of operation
  - Forward power varies: 150 to 300 kW, 2-10 Hz, 1.3ms
- Long run test of EP cavities in the horizontal cryostat
  - This test includes all auxiliaries like power coupler, HOM coupler, tuner…
  - Gradient: 35 MV/m
  - Max forward power: 600 kW
  - RF on time 2400 hs, at 600 kW 1100 hs
  - No breakdowns in the coupler
- High gradient test with beam (in module ACC1)
  - Gradient: 35 MV/m
  - Gradient calibration with beam

Developments and improvements for XFEL Conditioning time

Conditioning time was improved:

- all parts are stored under dry Nitrogen
- warm side of cold window is now always under dry Nitrogen
- time on air during assembly is minimized by using an dry nitrogen flow during assembly to the module
- On test stand 1-2 days
- On module 3-4 days



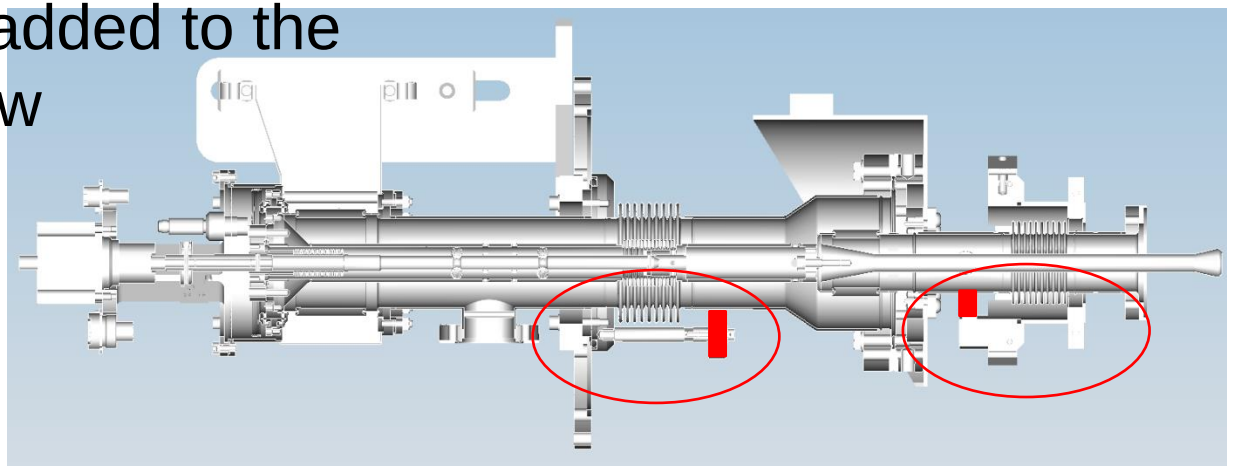
Sealing cap for

the cold window

Developments and improvements for XFEL Bellow supports

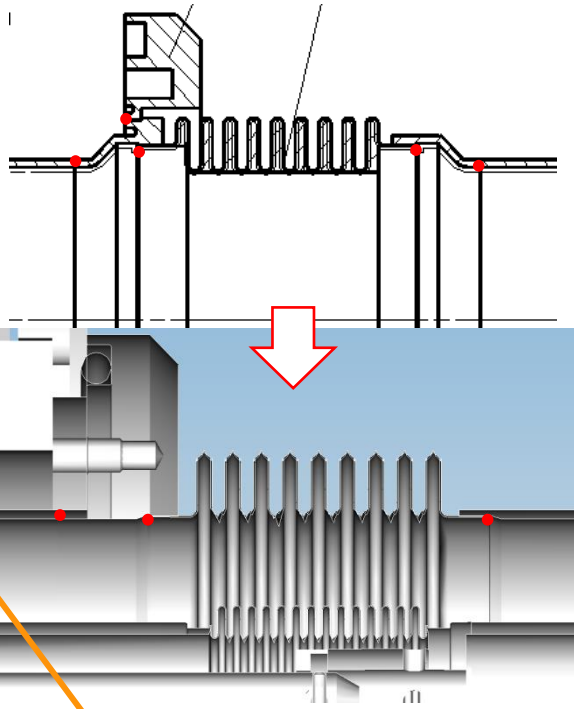
- When the bellows are plastic deformed a lateral deformation takes place
- Module is transported from Saclay to DESY by truck, this adds load to the bellows

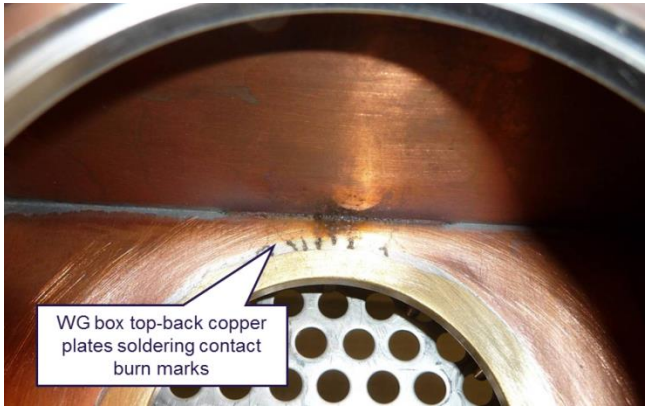
- Two supports were added to the cold and warm bellow

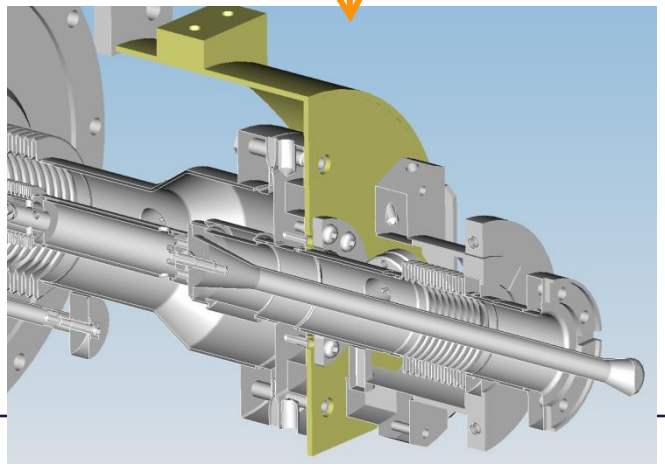


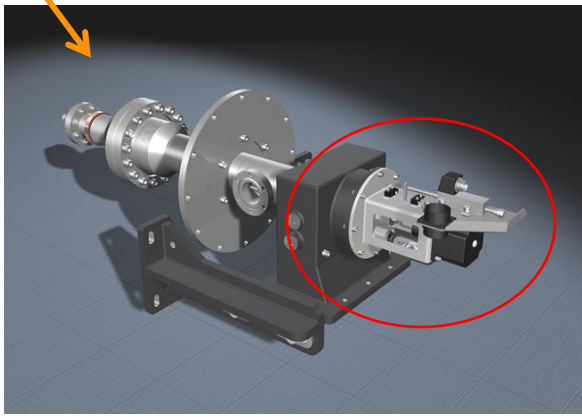
Developments and improvements for XFEL
Other improvements

- Less welds and parts
- Motor driver for Qext tuning
- Thermal connection improved
  - new 4K shield design
  - better contact between shields and coupler flange
  - doubled the copper braids
- Wave guide box brazed from copper plated SS, not soldered





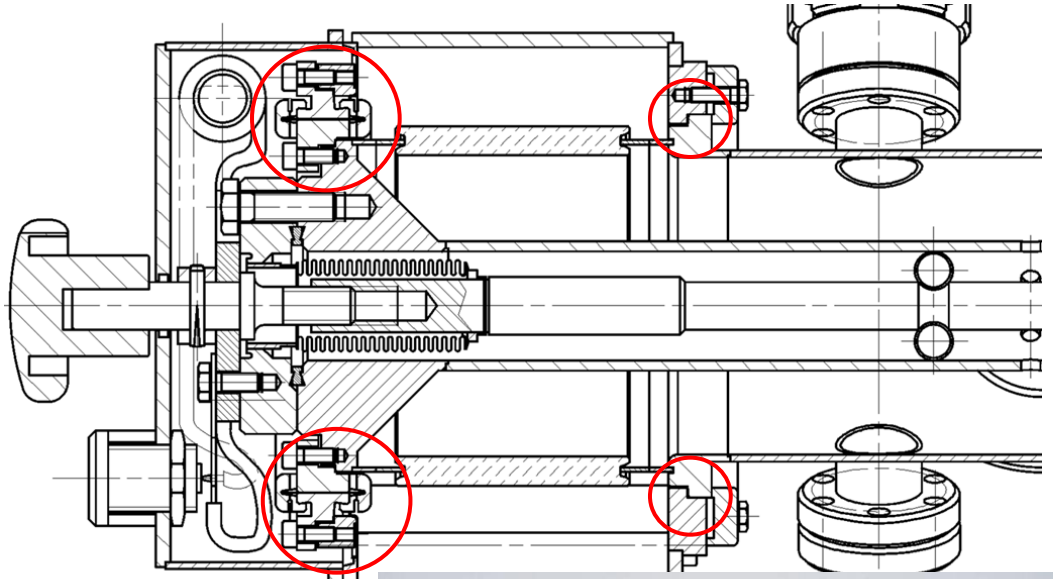


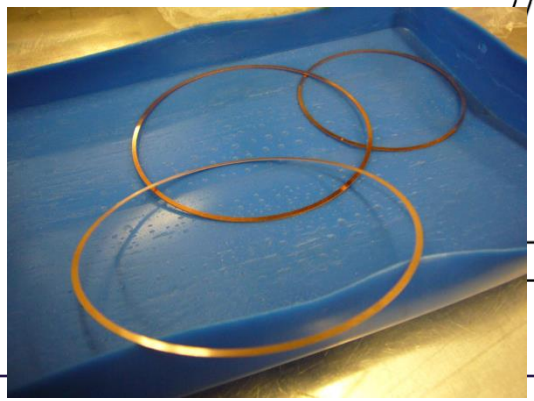


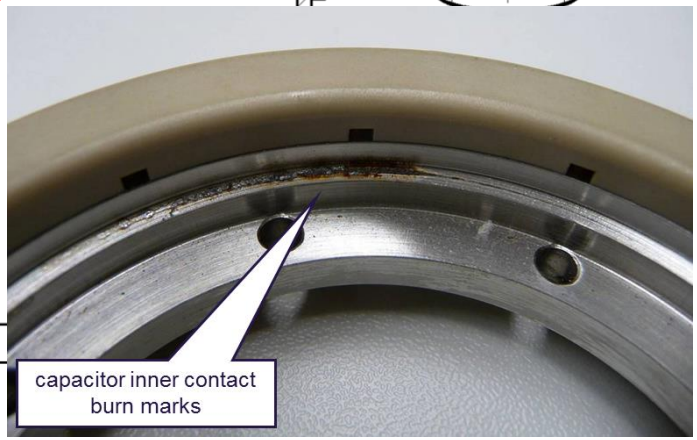
Developments and improvements for XFEL RF contacts

The RF contacts have to be very precisely machined and carefully assembled, otherwise they tend to spark

- New development was stopped
- Soft copper shims are used for better contact

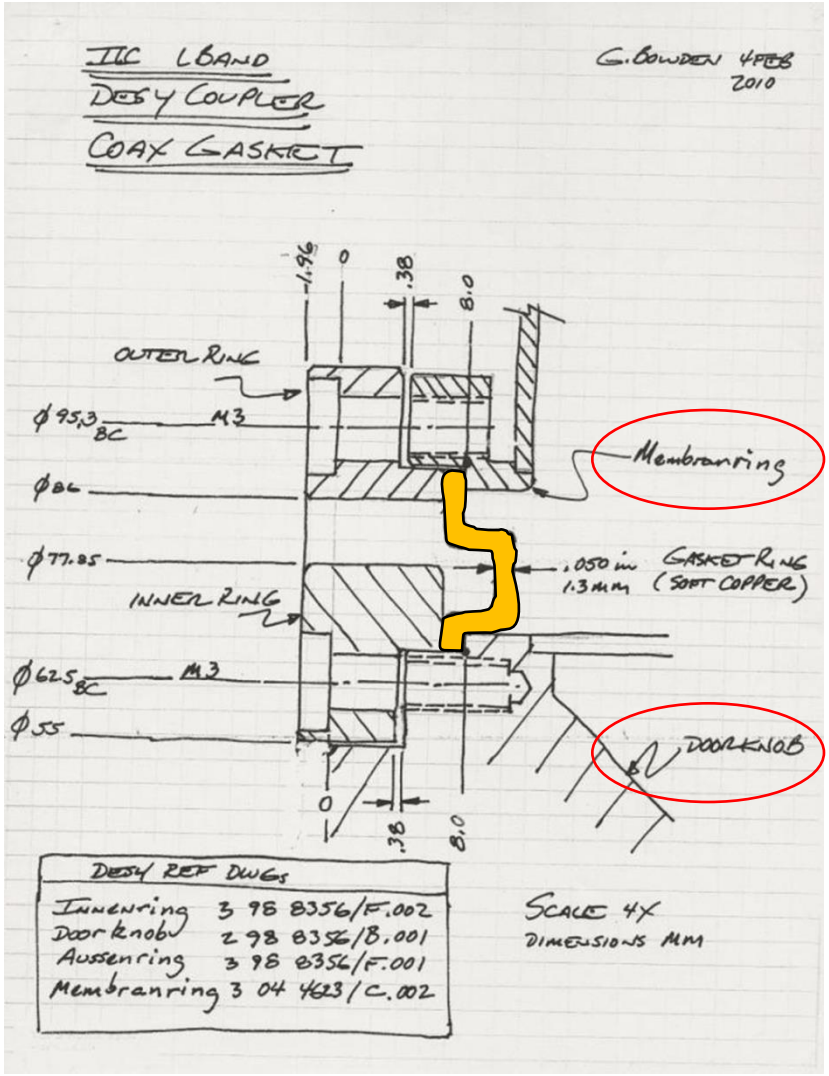






Developments and improvements for XFEL Capacitor replacement proposal

- Proposal from SLAC:
  - Replacement of capacitor by a soft copper ring to improve the RF contact
  - It is tested and used on some couplers
  - Decision for the XFEL will be taken soon (experience in FLASH show that the bias option was never needed.



European XFEL

What has to be improved further

- RF contact at WG box still not satisfactory
- Antenna alignment depends from bellow straightness and has a big influence on Qext

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Keyword

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