

Summery of the power coupler session at the LCWS13 workshop

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ILC specification

- Power requirements
 - We recommend to match the coupler to 30 MV/m for reduced filling time and smaller Qext range
 - Max coupler power at operation 450 kW (for 8.8 mA, 10Hz, Eacc=31.5 MV/m \pm 20%)
 - RF processing to at least four times max input power \sim 1.8 MW up to 500 us at test stand TW
 - Surface field not a problem for both designs, i.e. 40mm and 60mm are both ok
 - Should check flattop regulation at 25 MV/m and Qext \sim 1e7 (LFD)
 - TW testing on test stand up to 1.8MW has to be done for both: TTF3 and STF2
- Q-ext
 - Variable coupling is needed, remote operation
 - QL tuning range: 2-7x10⁶ is needed, but we recommend 1-10 x 10⁶
 - 1-10·10⁶ is achieved with TTF3
 - STF2 has to be improved
- Antenna alignment:
 - Design should be \pm 2mm
 - For TTF3 coupler the most sensitive parameter is a horizontal antenna shift/tilt. 3mm shift change QL by \sim 20%. Vertical tolerances are relaxed.
 - For STF-2 coupler this is not issue, mechanical design guarantee small shift.
 - TTF3 has to be improved

- Cryogenic loss:
 - Coupler contribution to cryogenic losses at 2K is ~5%. = not critical.
 - Major contribution from coupler is 70K
- Conditioning time
 - Both designs are ok
 - The nominal conditioning time of < 50h is achieved/demonstrated.
- Multipacting
 - DESY and SLAC simulations, tests and operation show no problem with TTF3
 - STF2 will be simulated, tests show no problem
- One vs. two windows
 - Many single window coupler are successful under operation
 - The single window would need to seal-off the cavity before the cavity-string installation into the cryomodule.
 - Single window coupler for ILC would need complete new development and test program of coupler (and module)
 - But it could be a significant cost saving
- Compatibility
 - Cavity and attached parts (power coupler, tuner, HOM coupler, feedthroughs, He vessel, thermal connections, magnetic shield...) are tuned/balanced, it is not easy to exchange only parts of this composition
 - STF2 coupler design does not fit in the compatibility requirements of the TDR (40mm cavity coupler flange)

- Cost
 - CPI: STF2 price is 1.9 higher
 - Toshiba: STF2 slightly lower price
 - RI: about same price
 - Industrial study of STF2 for design optimization and cost reduction is recommended
 - The TTF3 coupler mass fabrication has to be investigated

Recommendation:

- STF2 coupler has to demonstrate stable long time (>6 month) beam operation in a CM (TTF3 coupler has a long history in FLASH)
- The ILC management recommend an adapted STF2 design with 40mm cavity flange. In this case more development steps have to follow in order to realize the compatible design. The new design has to be proven with beam operation.
- The concept of plug compatibility has to be further developed in view of a spare part concept. We recommend spare modules, not individual parts.
- An industrial study of mass production for both designs is recommended
- Industrial study of STF2 for design optimization and cost reduction is recommended

ILC RF Power Coupler design criteria comparison

	ILC Spec	TTF3 / XFEL	STF-2
Frequency	1.3 GHz	1.3 GHz	1.3 GHz
Operating pulsed RF power	450	100 .. 600 kW	450
Operating RF pulse length / rep.rate	1.65 ms / 5 Hz	1.3 ms / 10 Hz	1.5 ms / 5 Hz
Max. RF conditioning power (20 .. 500μs)	1.8 MW	1 MW	1.2 MW
Max average power	3.7 kW	4.5 kW (tested and calculated limit)	3.0 kW (not the limit, but tested)
copper coating inner/outer conductor	nn	30 μm / 10 μm	25 μm / 10 μm
copper coating RRR	nn	30 .. 60	10-20
Max. cryogenic losses at 2K / 4.2K / 70K dynamic + static	need to check	0.06 W / 0.5 W / 8 W static+dynamic	0.06W / 0.8 W / 9 W simulated static
window	2 windows	2 cylindrical	2 disc
Warm coax		60 mm, 50 Ohm	82 mm, 50 Ohm
Cold coax		40 mm, 75 Ohm	60 mm, 43 Ohm
Qext range	1.0 – 10 x10 ⁶	1.0 – 15×10 ⁶	2.0 – 6.0×10 ⁶
bias	yes	yes	no
lateral movement	5mm (including fabr. Error)	± 15mm	± 5mm
max surface field (inner cond cold part) @500kW TW		1MV/m	0.5MV/m
max voltage, (inner cond cold part) @500kW TW		14kV	7.5kV
MP levels		150 kW, 250 kW, 450 kW	
Insertion loss		less 0.1 dB	