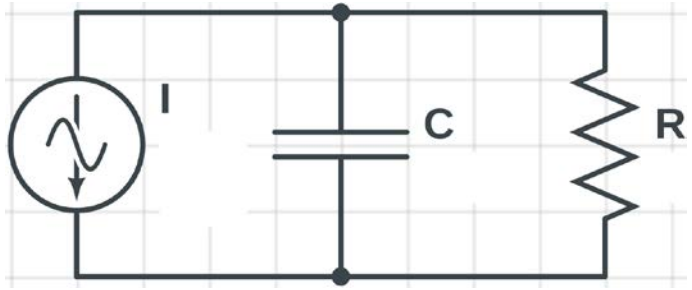
200MHz TWC: 628MHz-coupler improvement

Content

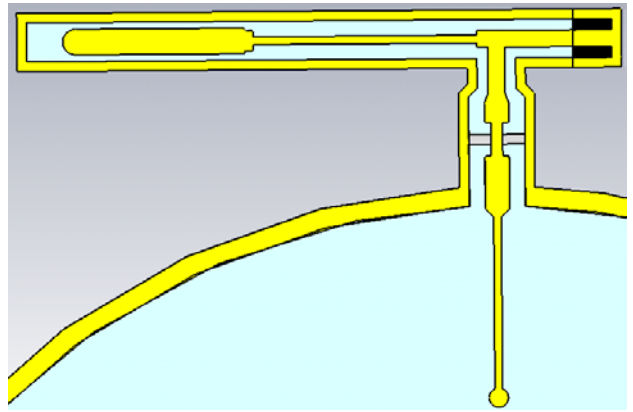
- More work on 628-coupler improvement
- What is limiting the current 628MHz-coupler?
- General overview/ insight

Circuit model of coupler for 628MHz-mode

- Approximation of cavity & coupler with equivalent generator circuit
  - Only for 628MHz mode and very simplified



C: probe capacitance
I: displacement current
R: load



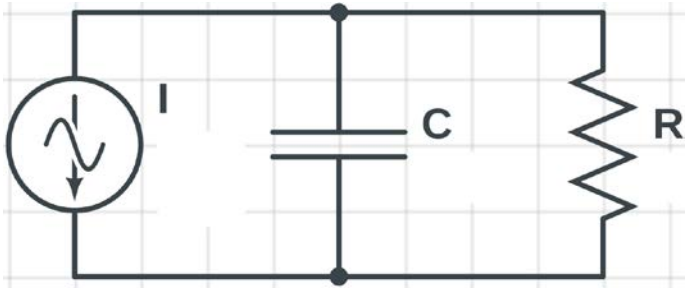
- Power extracted from HOM:

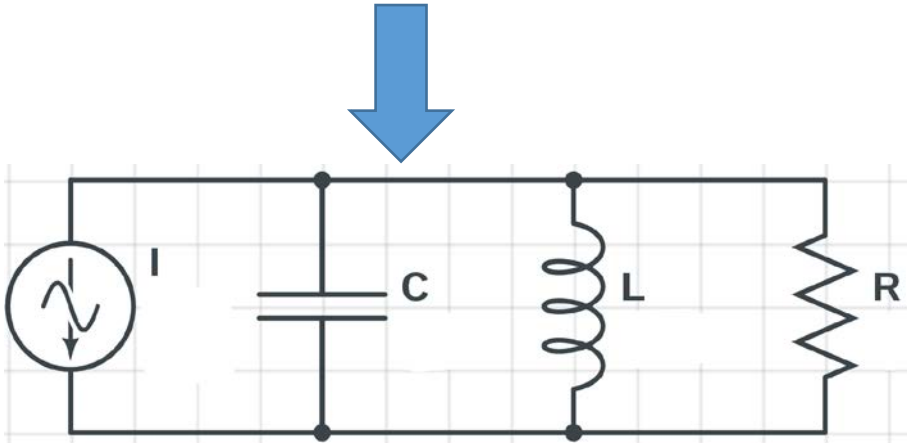
$$P = \frac{1}{2} I_0^2 Re\{Z\} = \frac{1}{2} I_0^2 * \frac{1/R}{(1/R)^2 + (\omega C)^2}$$

-> raise induced current I
-> compensate probe capacitance C
-> decrease load R

Compensation of probe capacitance

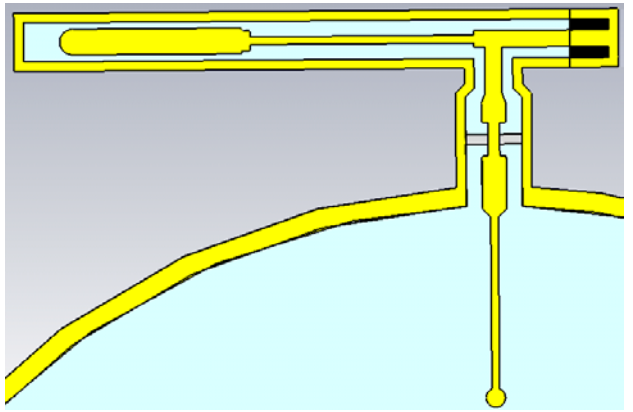
- Place an inductance for compensation

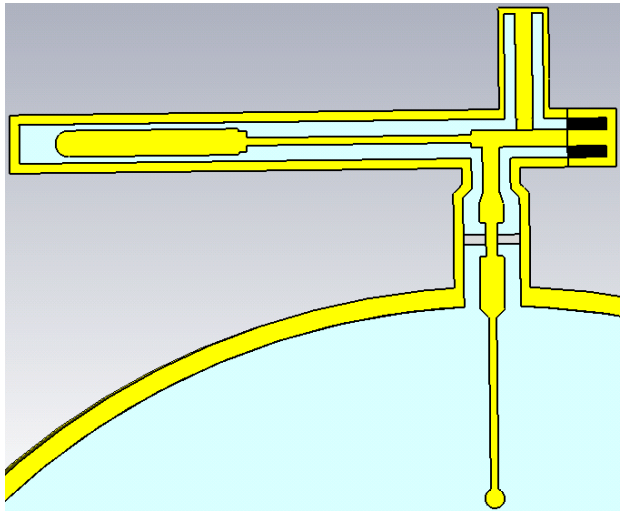




$$P = \frac{1}{2} I_0^2 Re\{Z\} = \frac{1}{2} I_0^2 * \frac{1/R}{(1/R)^2 + (\omega C)^2}$$

$+j\omega L = +j38\Omega$
@628MHz

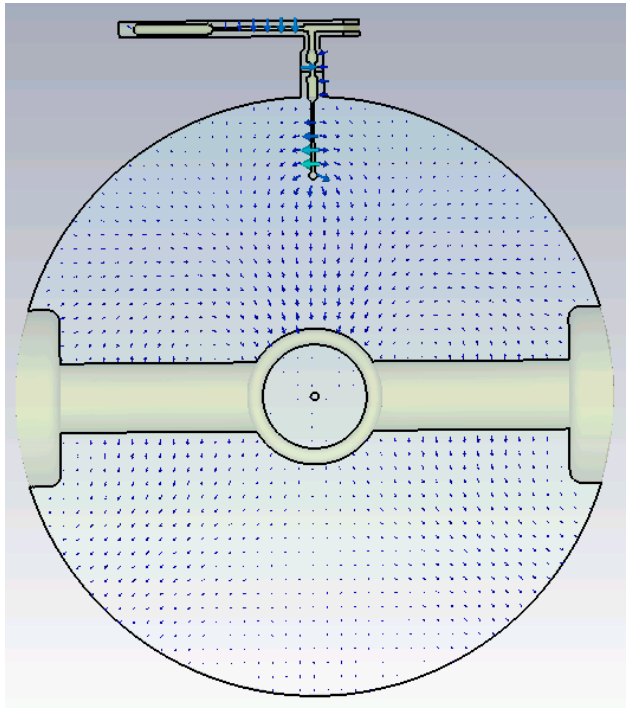


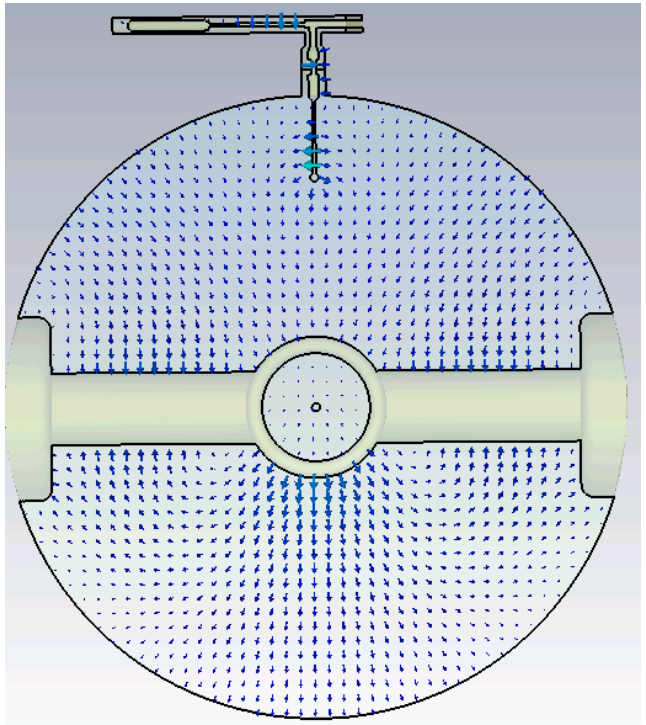


L: compensating inductance

Compensation of probe capacitance

- Evaluate performance with the two 628MHz degenerate modes





Damping one mode increases the other of the two degenerate modes!

Compensation of probe capacitance

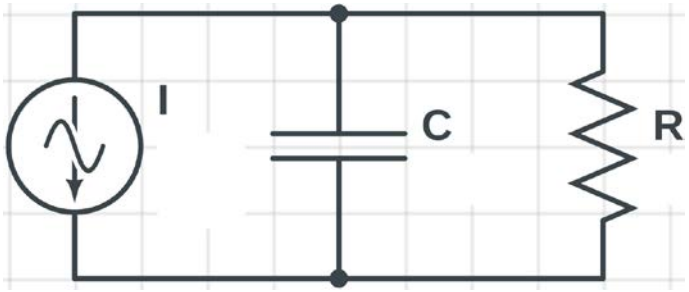
- Single-cell simulations

Present coupler				Compensated coupler			
f [MHz]	Q	R/Q [Ω]	R [kΩ]	f [MHz]	Q	R/Q [Ω]	R [kΩ]
624.5	57	2.6	0.15	625.9	331	6.4	2.13
629.1	755	5.9	4.4	629.7	964	2.7	2.6

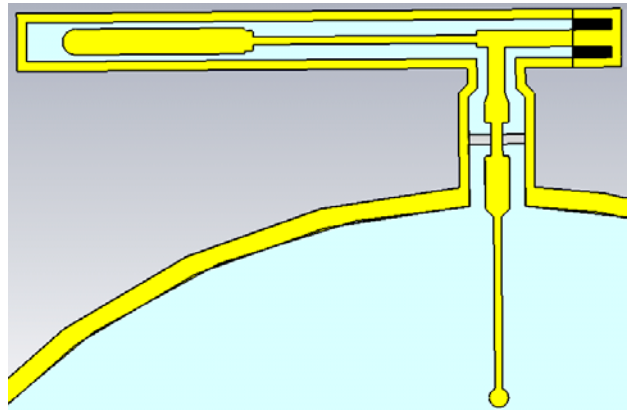
Decrease of a factor 1.7

Reduction of load impedance

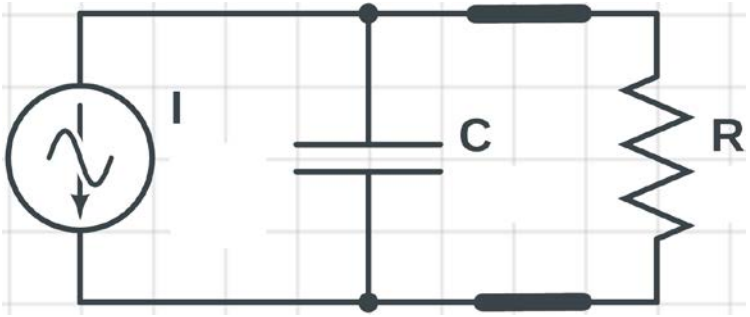
- Use of a λ/4-transformer (narrowband)



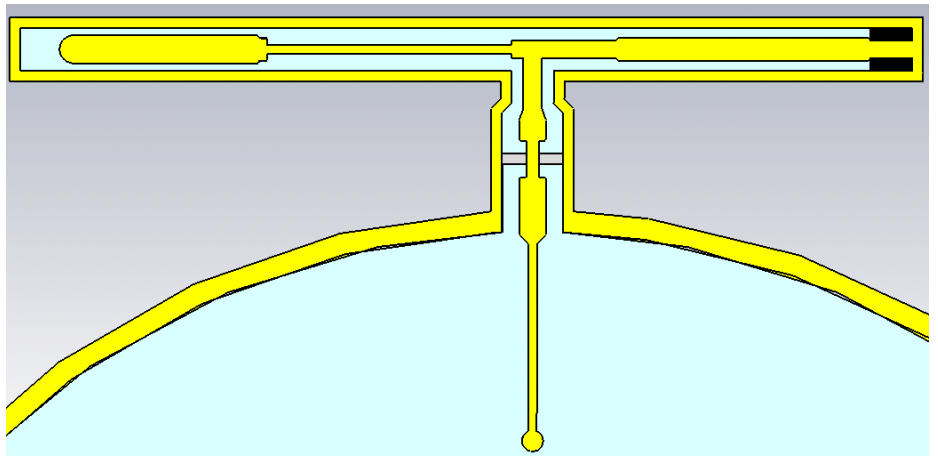
$$P = \frac{1}{2} I_0^2 Re\{Z\} = \frac{1}{2} I_0^2 * \frac{1/R}{(1/R)^2 + (\omega C)^2}$$



L=λ/4



Effective load:
30 Ω
@628MHz



Reduction of load impedance

- Single-cell simulations

Present coupler				Narrowband coupler			
f [MHz]	Q	R/Q [Ω]	R [kΩ]	f [MHz]	Q	R/Q [Ω]	R [kΩ]
624.5	57	2.6	0.15	626.8	210	6.4	1.33
629.1	755	5.9	4.4	629.8	522	2.8	1.46

Decrease of a factor 3.0

Outlook

- Combination of the improvements not easy
- Generator approach made is too simplified
- Model the cavity as a lumped resonance circuit