L-BAND RESONANT RING FOR TESTING OF RF WINDOWS FOR ILC

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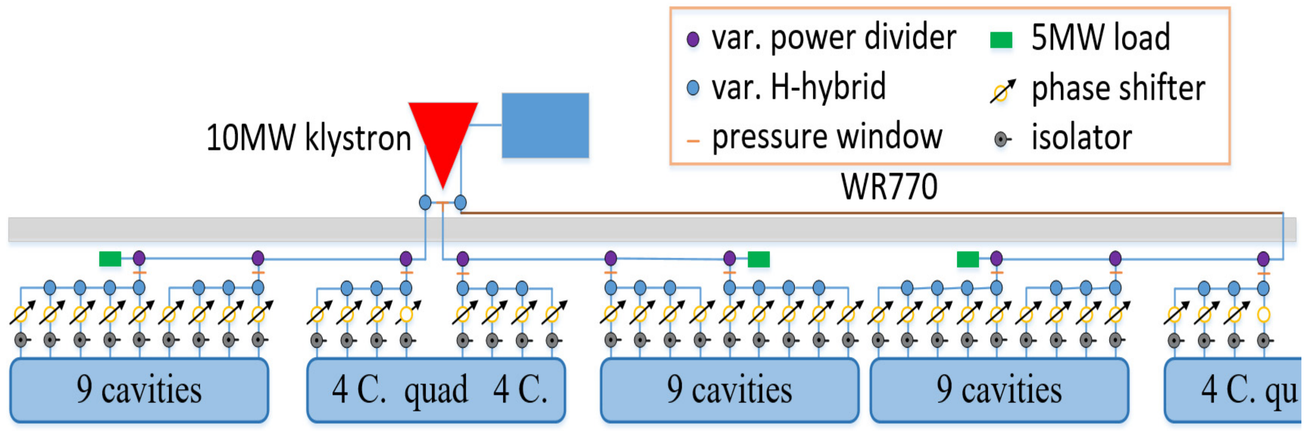
THPO003

Introduction

- 10 MW multi beam klystron drives 39 cavities in the power distribution system (PDS) for international linear collider (ILC).
- Power at RF window after var. power divider is 1.1 MW.
- Testing power of RF window is expected to be higher than 4.4 MW considering maximal standing wave.
- Variable hybrid, phase shifter, and 500 kW circulator is developed in super conducting RF test facility (STF).
  - Resonant ring is constructed with these RF components to verify principle.
- Resonant ring has been modified for high power operation.



Power distribution system for ILC

Theory of resonant ring

- Resonant ring is closed loop of waveguide system which can amplify power.
- Maximal power gain is decided by one turn loss and k_1.

➢ Maximal Gain (G_{max}) when one turn phase is integer times 2π

$$G'_{max} = \frac{1}{1-e^{-2\alpha L}} \xleftarrow{k_1 = e^{-\alpha L}}$$

➢ Maximal Gain (G_{max}) when $k_1^2 =$ loss.

$$G_{max} = \frac{1-k_1^2}{\left(1-k_1 e^{-\alpha L}\right)^2} \xleftarrow{\beta L = N \times 2\pi}$$

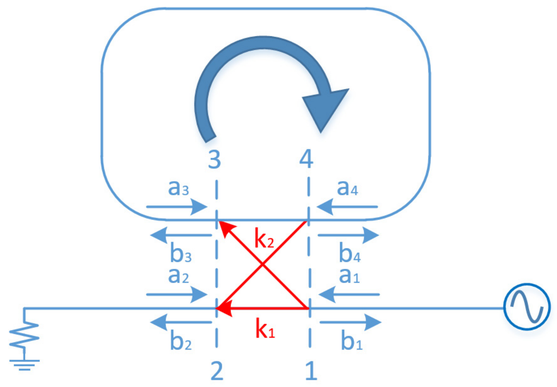
➢ a_i & b_i are voltage.

➢ k_1 & k_2 are voltage coefficient.

➢ Assume: no reflection.

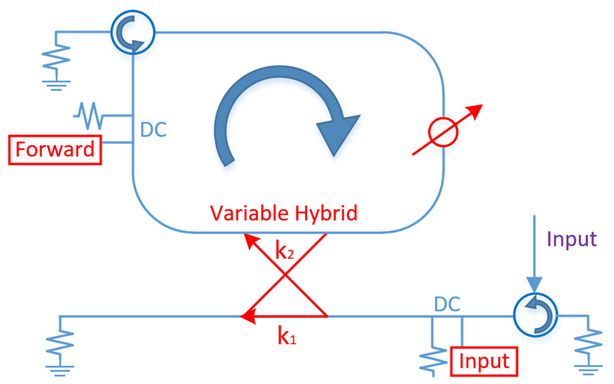
$$b_1 = a_2 = a_3 = b_4 = 0$$

$$G = \frac{|b_3|^2}{|a_1|^2} = \frac{k_2^2}{1 + k_1^2 e^{-2\alpha L} - 2k_1 e^{-\alpha L}\cos\beta L}$$

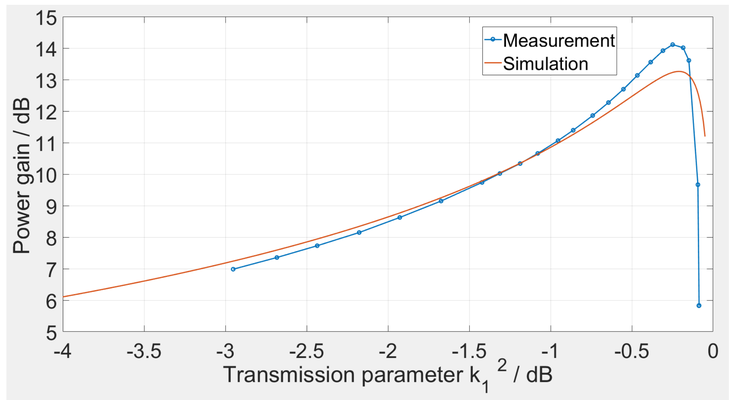


Basic structure of resonant ring

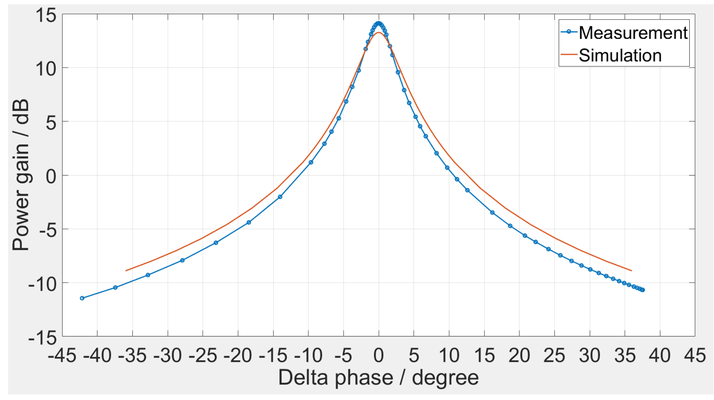
Simulation and measurement of resonant ring



Structure of resonant ring for 500 W testing

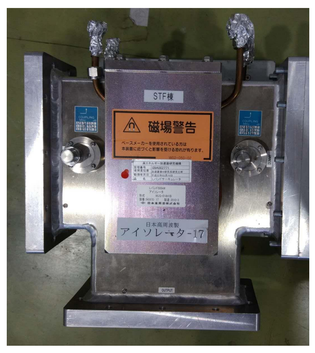


Measured and simulated power gain compared with k_1^2

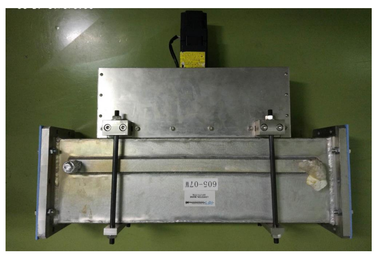


Measured and simulated power gain compared with one turn phase drift.

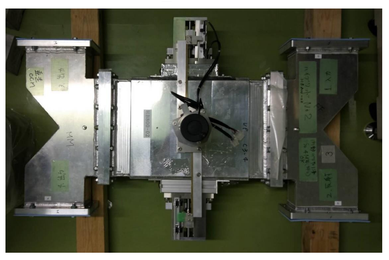
- G_{max} when $k_1^2 =$ loss.
- G decrease fast when $k_1^2 <$ loss.



500 kW circulator.



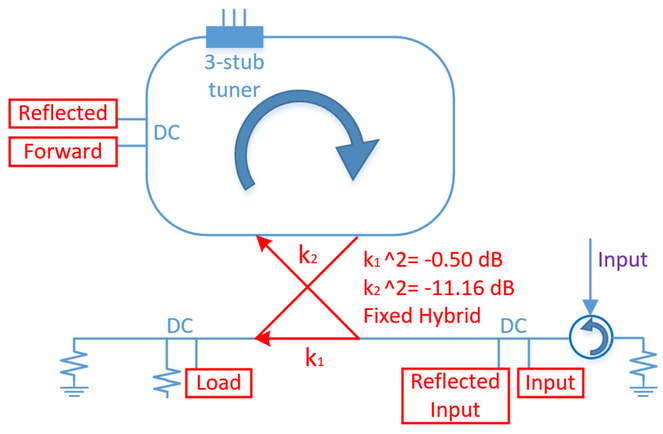
Phase shifter.



Variable hybrid.

- Phase shifter is used to change one turn phase.
- $k_1^2 =$ loss $= -0.21$ dB.
- Measurement: $G_{max} = 14.12$ dB
  3 dB width: 4.0°, 3.58 mm for 1.3 GHz
- Simulation: $G_{max} = 13.26$ dB
  3 dB width: 5.4°, 4.84 mm for 1.3 GHz

Preparation for high power test



Structure of resonant ring with 3-stub tuner

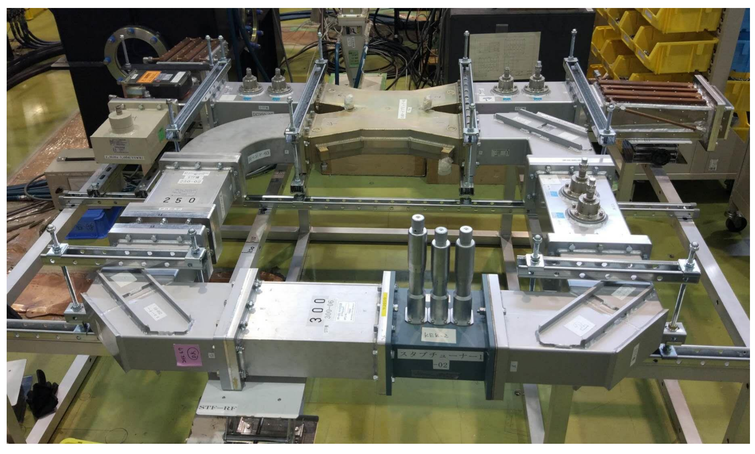
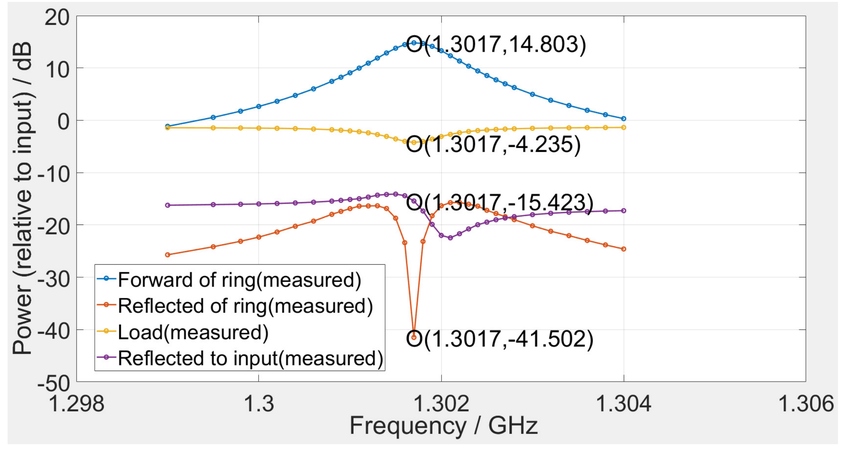


Photo of resonant ring with 3-stub tuner



Measured responses of fully tuned resonant ring with input of 500 W

Conclusion:

- Difference of forward and reflected power of ring is 56.31 dB.
- Maximal power gain is 14.803 dB. Circular power can be more than 5 MW by input from 800 kW modulated-anode klystron.

Future plan:

- High power operation of the resonant ring will be started after preparation being finished.
- New RF window for the LPDS of ILC is designed in STF at the same time.

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