HOM Beamline Absorber and RF Input Coupler for the Cornell ERL Main Linac

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Outline

- HOM beamline absorber
  - Requirements
  - 1st generation absorber
  - New RF absorber studies
  - 2nd generation absorber
- RF input coupler for the main linac
  - Requirements
  - Design
- Summary

HOM beamline absorber

Requirements

1st generation absorber

New RF absorber studies

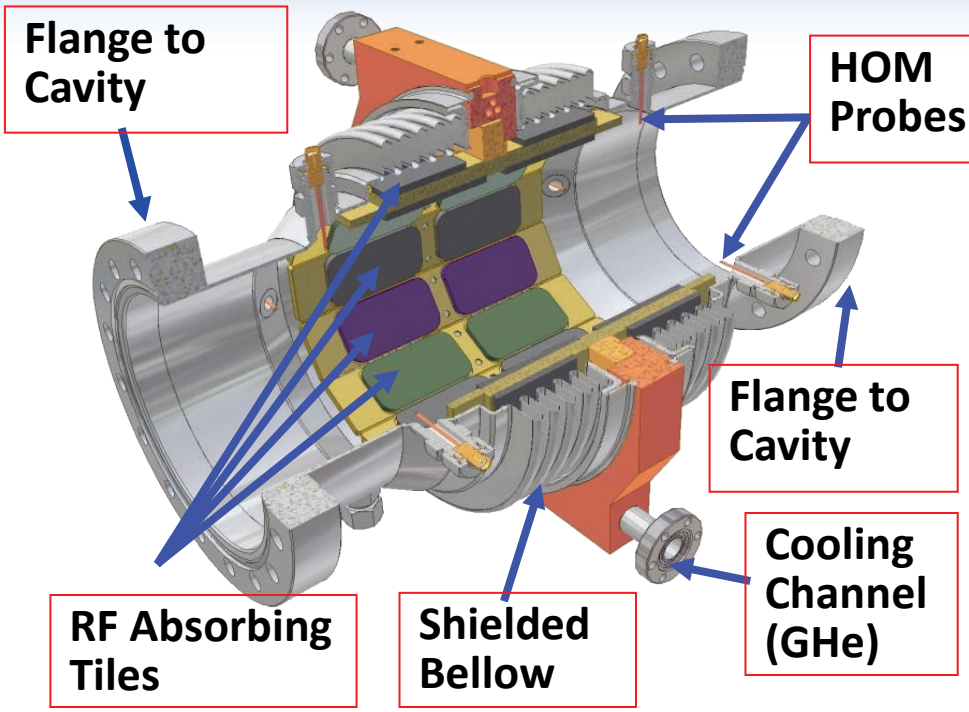
2nd generation absorber

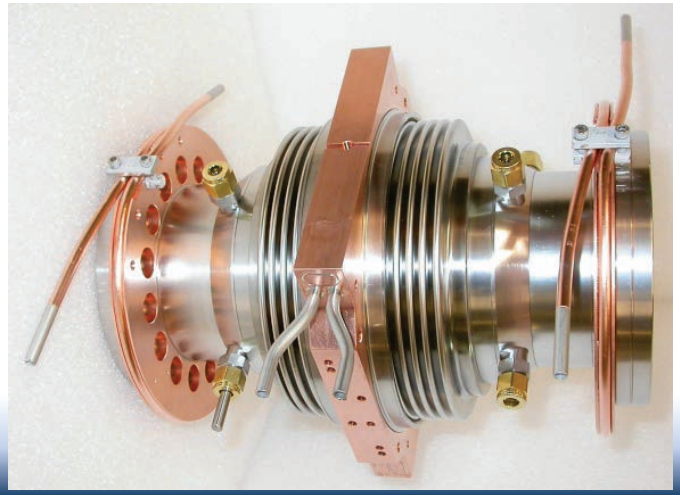
Requirements

- HOM power absorbed by beamline loads located between cavities at cryogenic temperatures
  - Average power: 140 W per load
  - Peak power: 400 W per load
  - Broadband: 1 to >100 GHz
  - Include bellow section between cavities
  - Low static heat load to cavity beam tubes at 1.8K
  - Cleanable

1st Generation HOM Absorber

- Uses small RF absorber tiles, brazed to metal plates
- 3 absorber materials: Ceramic 137Zr10, ferrite Co2Z and ferrite TT2
- Direct gas cooling of 5K and 80K intercepts
- Used in the injector module
  - achieves strong HOM damping and high power handling (tested with heater up to 200W)
- Few issues:
  - Relatively complex (large # of tiles)
  - Difficult to clean
  - Charging up of absorber tiles by beam (especially 137Zr10)





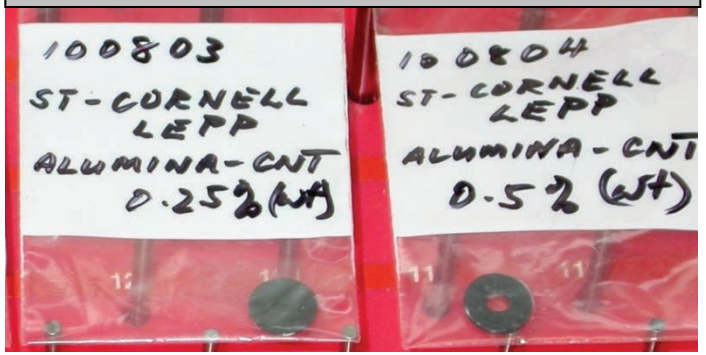
Matthias Liepe, ERL 2011

New RF Absorber Studies

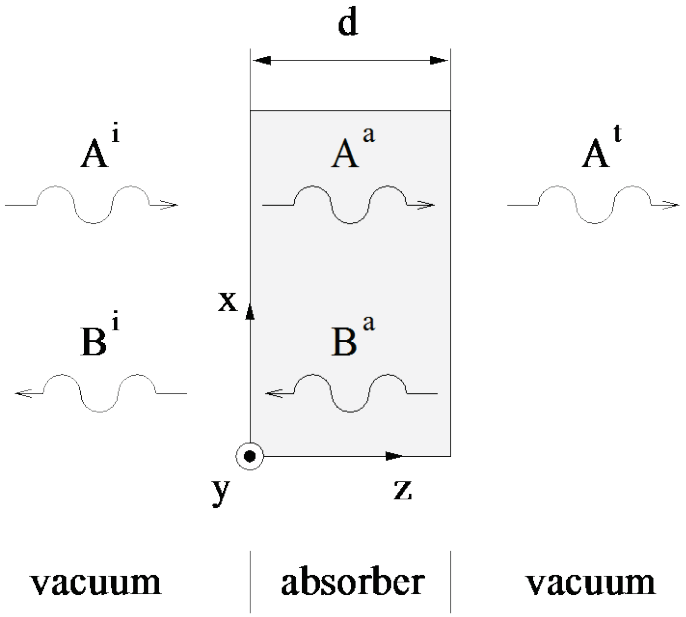
- Extensive research program to find better RF absorbing materials which
  - are effective at 80 K
  - absorb over the required wide frequency range (1 GHz to >100 GHz)
  - are vacuum compatible and radiation hard
- Two good candidates
  - Graphite loaded SiC
  - Carbon-nanotube loaded ceramics

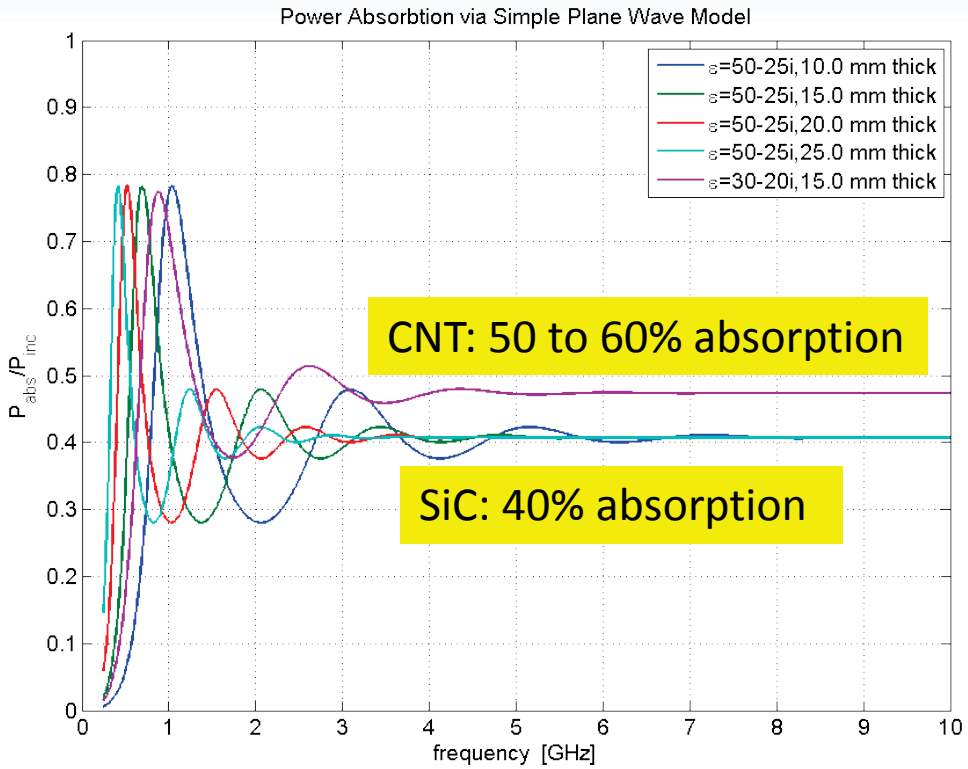
SiC Absorber Ring

Carbon-Nanotube Absorber



SiC vs. CNT Absorber

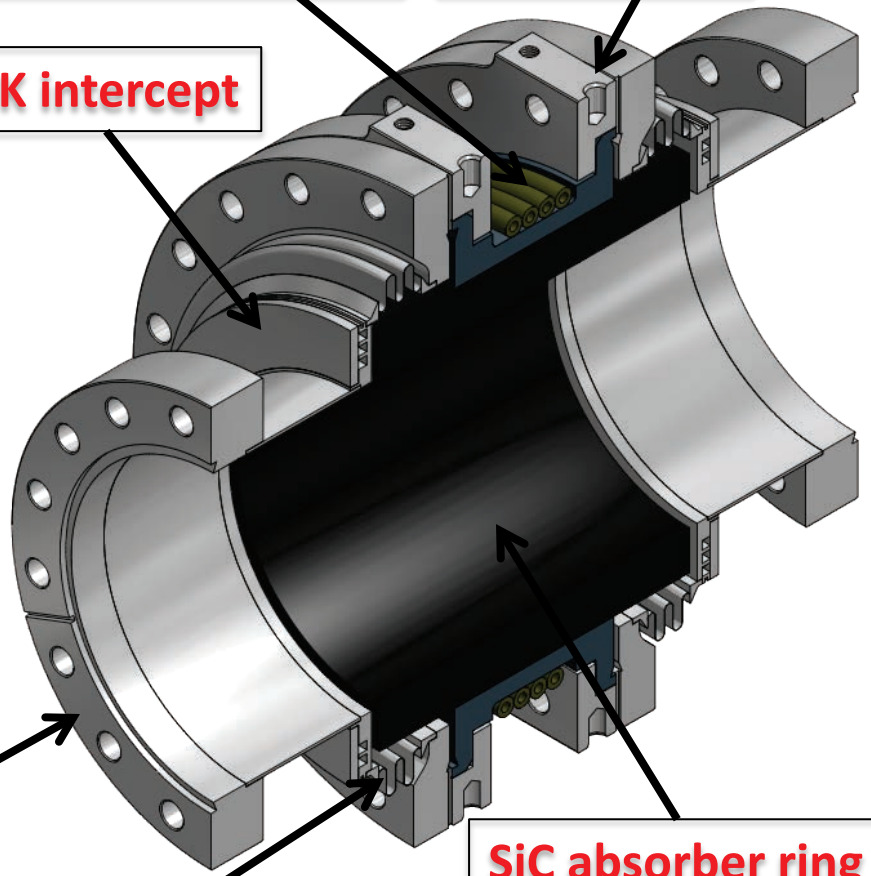




- Both: very broadband, temperature independent, good DC conductivity
- CNT absorber: smaller epsilon, so less reflection
  - But: currently available only in small samples

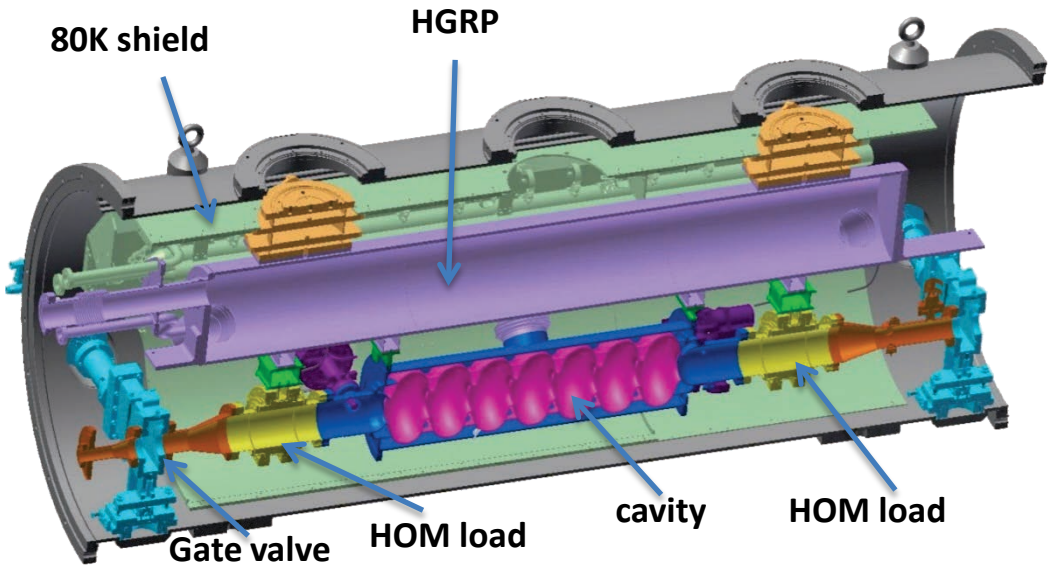
2nd Generation HOM Absorber

- Same basic principle as 1st generation load
  - Bellows shielded by absorber
- But: Greatly simplified
  - One SiC absorber ring instead of many tiles
  - Can be disassembled for cleaning



Next Steps

- SiC absorber rings on hand
- Fabrication of prototype loads has started
- First test on cavity in 1-cavity test module by end of 2012



RF input coupler for the main linac

(for injector coupler, see talk on injector operation)

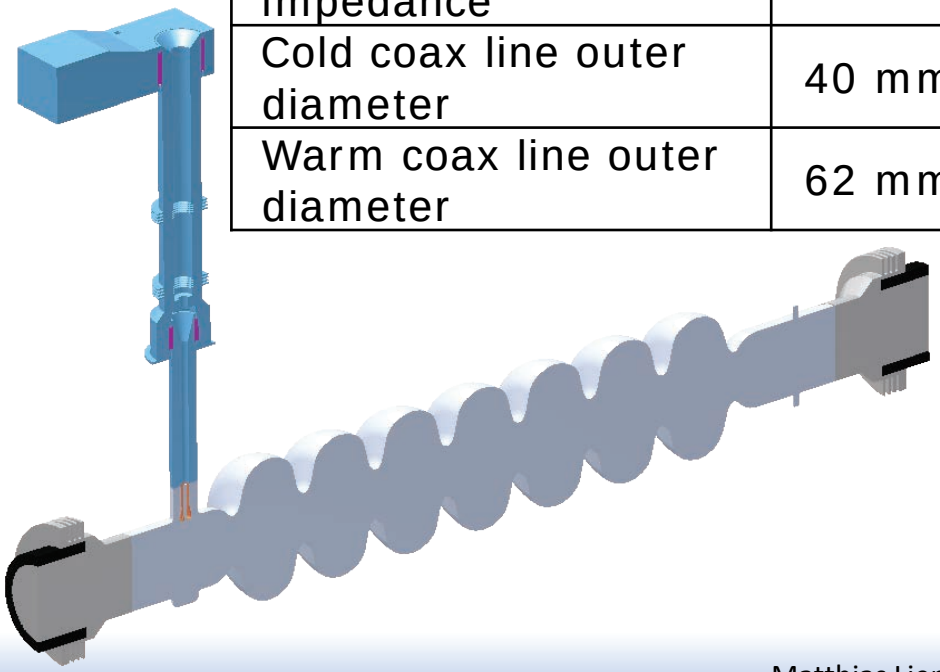
Requirements

Design

Coupler design by Vadim Veshcherevich, Cornell

Main Linac Input Coupler Requirements

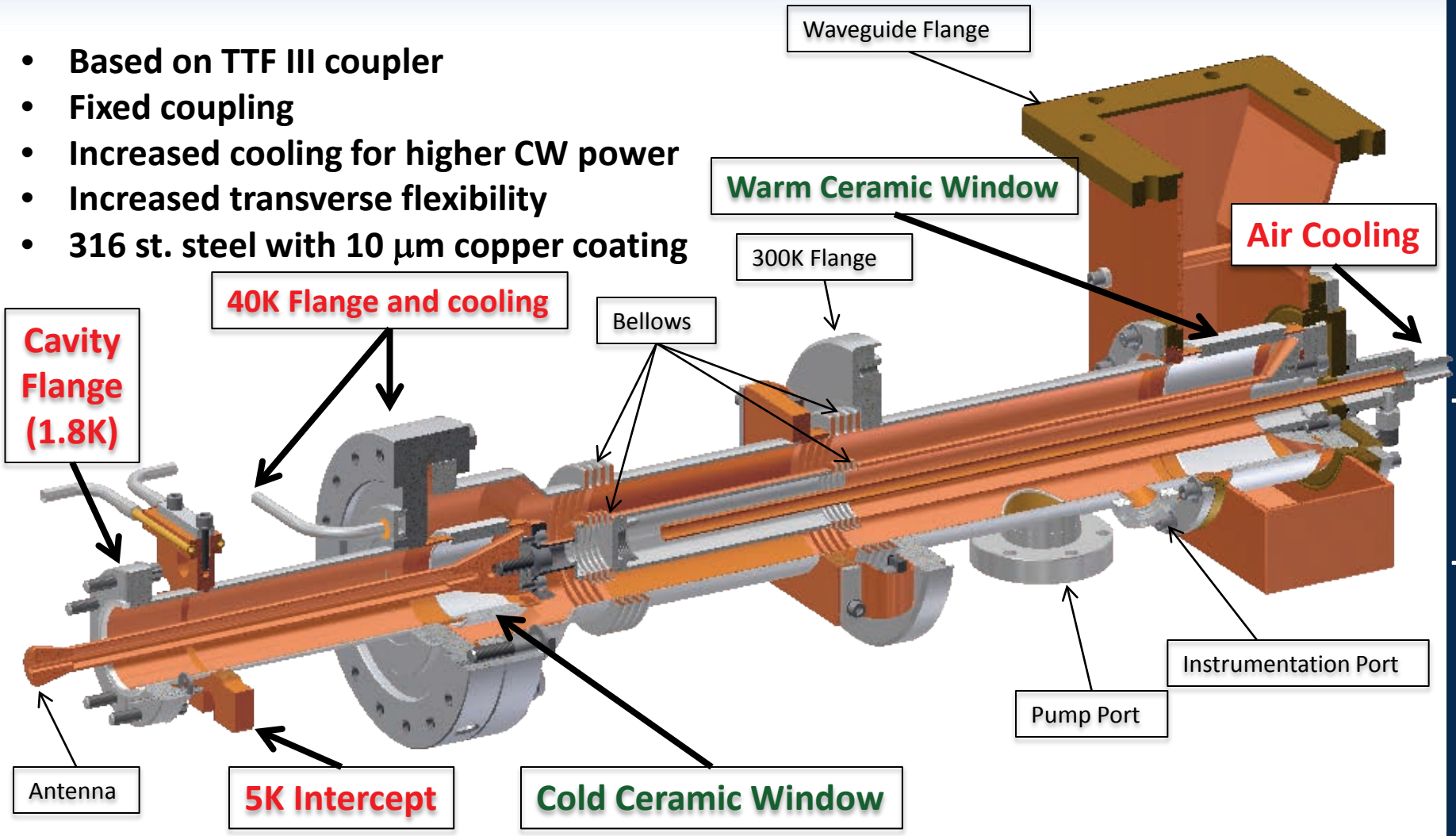
Operating frequency	1.3 GHz
Maximum power (CW)	5 kW
Q_{ext} (fixed)	6.5×10^7
Cold coaxial line impedance	50 Ohm
Warm coaxial line impedance	46 Ohm
Cold coax line outer diameter	40 mm
Warm coax line outer diameter	62 mm



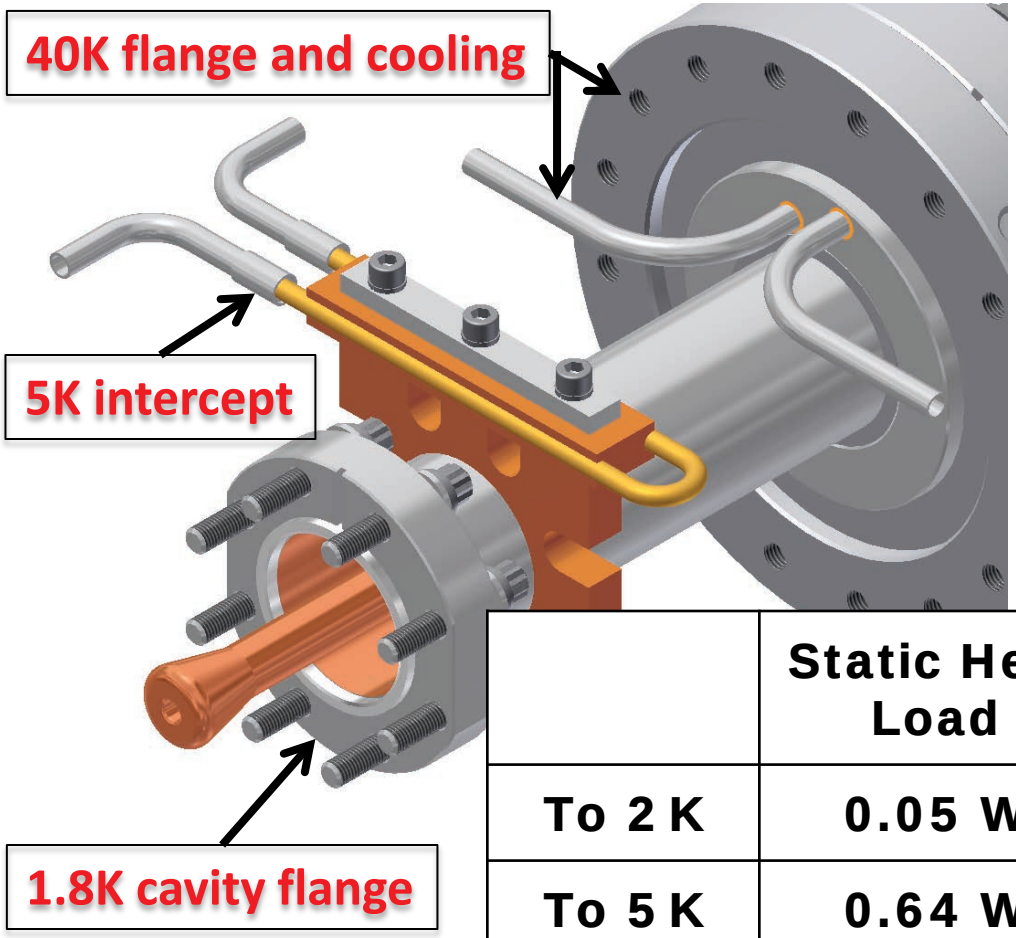
- **5 kW peak RF power (2 kW CW average)**
  -> need sufficient cooling
- **Coaxial coupler**
- **2 window design** (40K, 300K)
- **Large transverse flexibility**
  -> Cavities can move during cool down (<2mm transv., <10 mm longitudinal)
- **Fixed coupling**
  -> reduced complexity, cost
  -> waveguide 3-stub tuner can be used to adjust coupling

Main Linac Input Coupler Design

- Based on TTF III coupler
- Fixed coupling
- Increased cooling for higher CW power
- Increased transverse flexibility
- 316 st. steel with 10 μm copper coating



Input Coupler Cooling for 5 kW CW

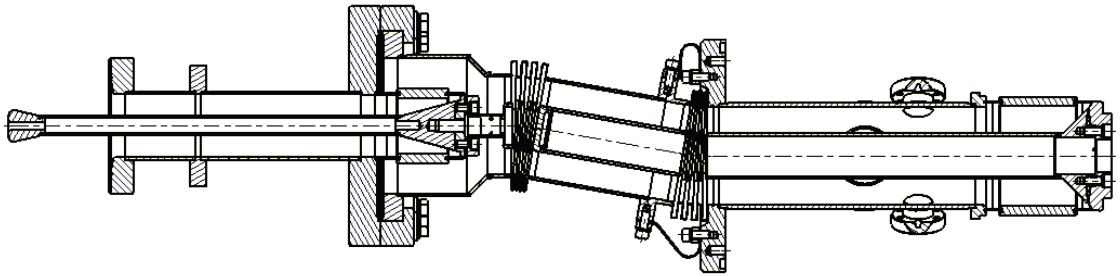


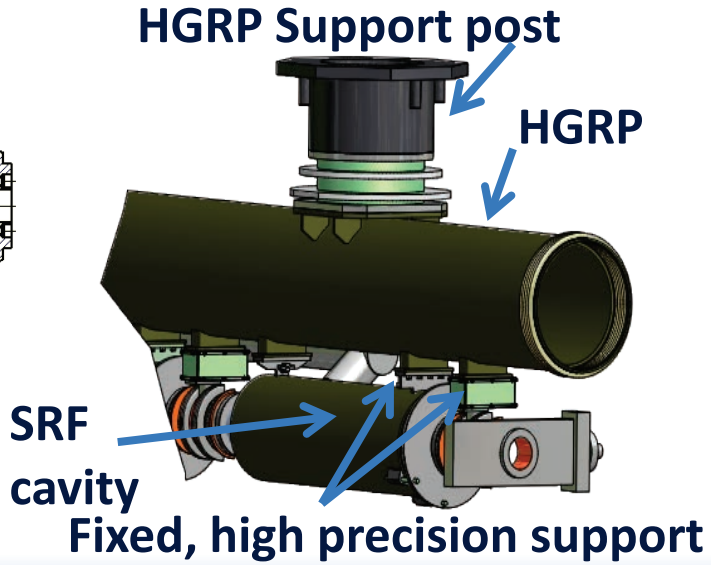
- 5K and 40K direct He gas cooling
- Air cooing of inner conductor

	Static Heat Load	Dynamic Heat Load	Total Heat Load
To 2 K	0.05 W	0.06 W	0.11 W
To 5 K	0.64 W	0.32 W	0.96 W
To 40 K	3.78 W	5.94 W	9.72 W

Mechanical Flexibility of the Coupler

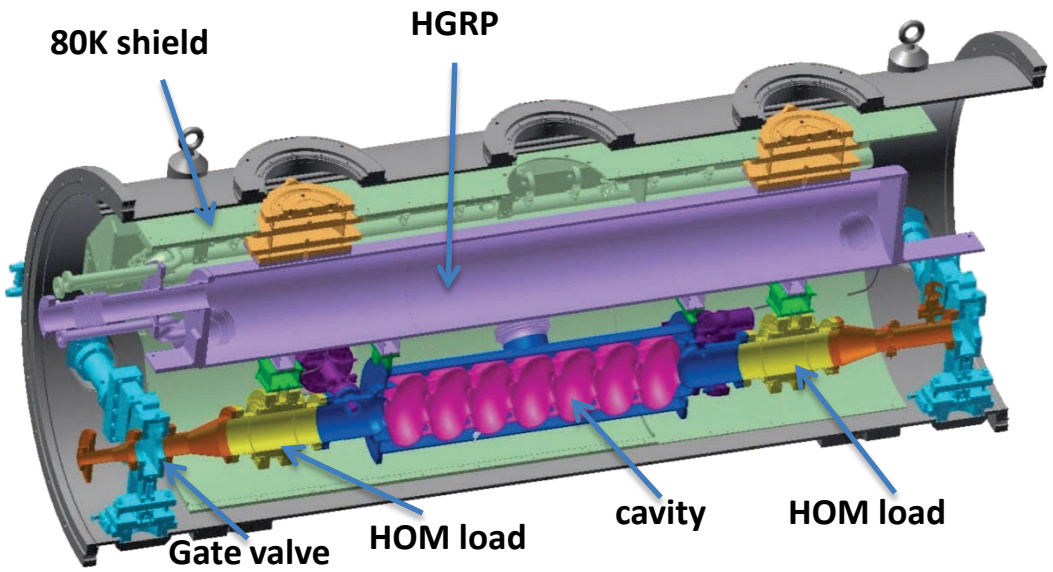
- Two bellows at outer and inner conductor each
  - -> >10mm transverse offset supported
  - -> Maintains alignment of the cavity antenna!
  - -> Cavities can be mounted to HGRP and move longitudinal during module cool down





Next Steps

- Two prototype couplers are under fabrication
- First RF test in early 2012 (at room temp.)
- First test on cavity in 1-cavity test module by end of 2012



Summary

Summary

- HOM beamline absorber:
  - 2nd generation HOM absorber designed and under fabrication
    - Simple design with SiC ring absorber
    - Strong, broadband RF absorption
    - Cleanable
- RF input coupler for main linac:
  - Design finished
    - Based on TTF III with increased cooling
    - Increased cooling for 5 kW CW
    - >10 mm transverse flexibility
    - Fixed coupling to simplify design and reduce cost
  - Prototypes under fabrication; test in 2012

The End

Thanks for you attention!

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