THPB073

BEAMLINE SILICON CARBIDE HIGHER ORDER MODE DAMPER FOR THE ADVANCED PHOTON SOURCE UPGRADE HARMONIC CAVITY*

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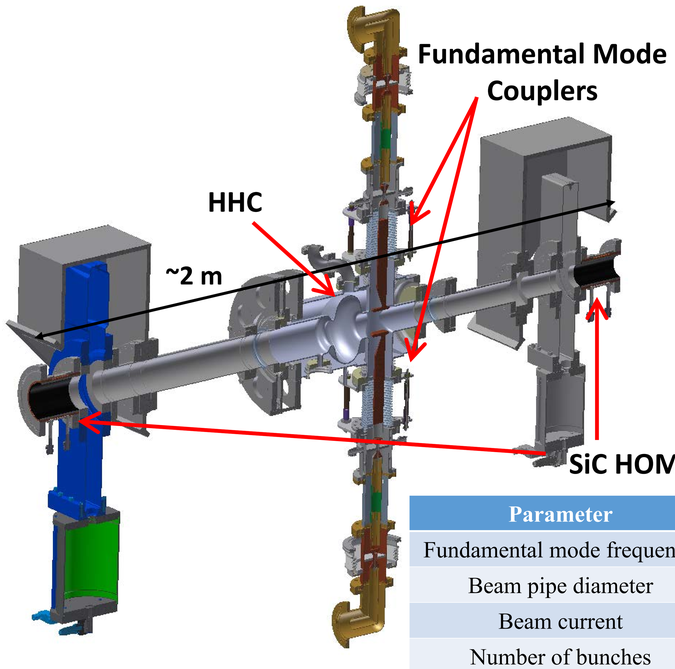
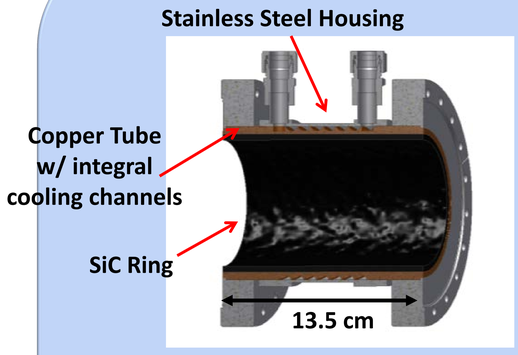
A superconducting higher harmonic cavity (HHC) is under development for Advanced Photon Source Upgrade based on a Multi-Bend Achromat lattice. The HHC improves the Touschek lifetime and the single bunch current limit by lengthening the bunch. A TESLA-shaped single-cell 1.4 GHz (4th harmonic of the main RF) cavity will be used. Monopole and dipole higher order modes (HOMs) will be extracted primarily along the beam pipes and damped in a pair of 'beamline' silicon carbide (SiC) HOM dampers. These water-cooled SiC dampers will be placed just outside of the cryomodule. Maximum power dissipation in both SiC HOM dampers is estimated to be 1.7 kW at the beam current of 200 mA total and 4.2 mA max/bunch with the bunch length of RMS >50 ps. The SiC cylinder is cooled by a precision fit copper sleeve with water cooling channels. The thermal contact conductance at the interface between SiC and copper has been experimentally measured. In this paper, we will present design details of the SiC HOM dampers and experimental results of the thermal contact conductance at the interface.



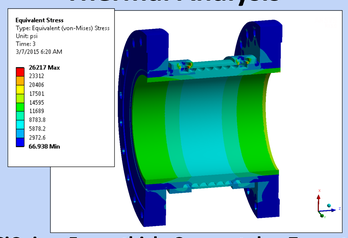
Parameter	Value
Fundamental mode frequency	1.408 GHz
Beam pipe diameter	104/70 mm
Beam current	200 mA
Number of bunches	48/324
Bunch charge	15.3/2.2 nC
Bunch repetition rate	13/88 MHz
Bunch length	>50 ps
HOM power	1.7 kW total (~1 kW/ ~0.7 kW)
Operating temperature of HOM absorbers	Room Temperature

Design

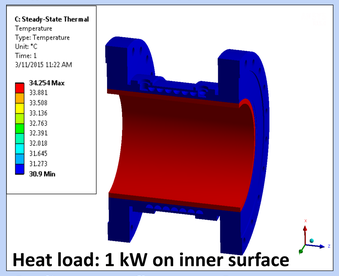


- Shrink fit SiC ring: 0.1 mm diameter interference
- Mechanically safe; max stress on SiC is a factor of 6 lower than the compressive strength
- Temperature rise on the inner surface will be ~4°C at 1 kW heat load.

Mechanical and Thermal Analysis

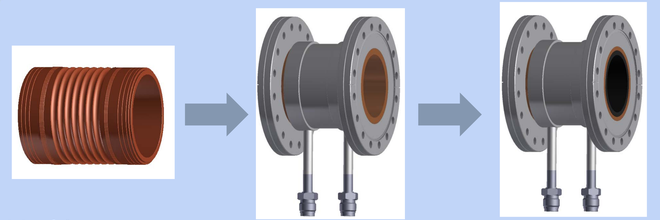


SiC ring: 5 mm thick, Copper tube: 7 mm thick



Heat load: 1 kW on inner surface
Cooling water flow rate: 2 gpm
TCC at shrink fit interface: 10^4 W/m²K

Fabrication Plan

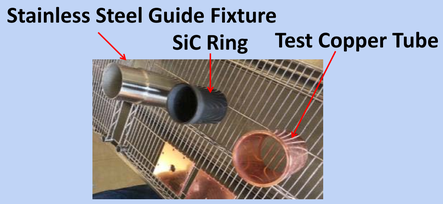


Machine copper tube | Braze to stainless; Precision bore via wire EDM | Shrink fit SiC ring

Parts Machined for the Larger damper

Prototype Tests

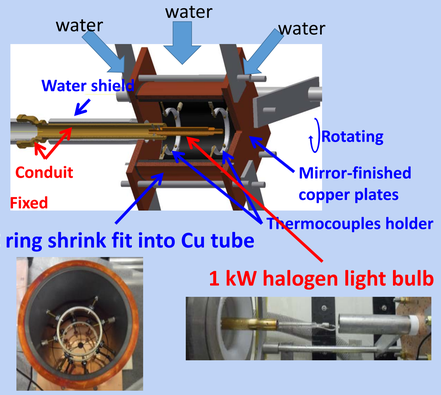
Test Shrink Fit



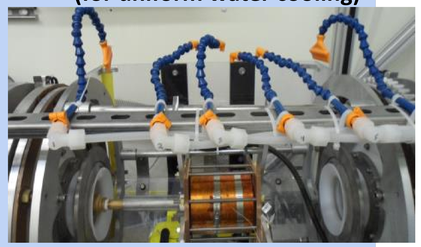
Heat up in furnace

Assemble at RT

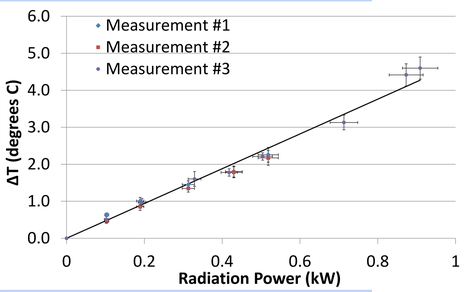
Measurement of Thermal Contact Conductance



Measured in ANL's SRF Cavity EP System (for uniform water cooling)



- Used real SiC ring and the same size test copper tube
- Inside of copper tube was EDMed and polished
- The copper tube was heated up to ~150°C; test shrink fit was successful
- Thermal contact conductance at the shrink fit interface was measured with a radiative heat source. Measured TCC per area is $10^4\ W/m^2K$



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