BNL 56 MHZ HOM DAMPER FABRICATION AT JLAB

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Abstract

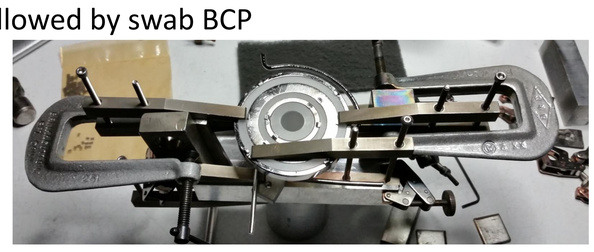
The Higher-Order Mode (HOM) Dampers for the Relativistic Heavy-Ion Collider's (RHIC) 56 MHz cavity at Brookhaven National Laboratory (BNL) are currently being fabricated at JLab. The coaxial damper is primarily constructed with high RRR niobium, with a combination of niobium and sapphire rings as the filter assembly. Several design changes have been made with respect to the performance of a prototype damper – also fabricated at JLab – which was found to quench at low power. The production dampers are being tuned and tested in the JLab vertical test area (VTA) prior to delivery. Two HOM dampers will be delivered to BNL; they are to be used in the RHIC in November, 2015. This paper outlines the challenges faced in the fabrication and tuning process.

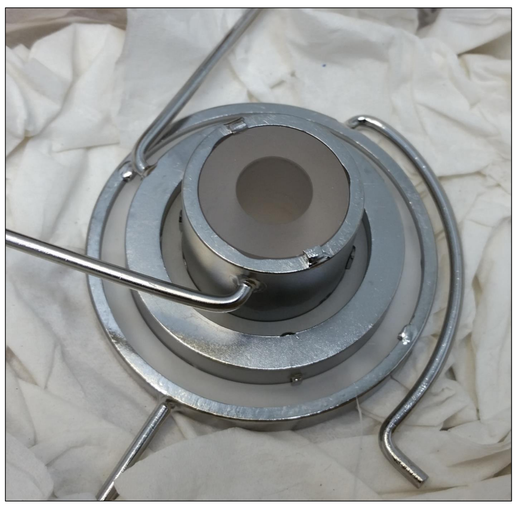
Introduction

- Two dampers to be delivered to BNL for the 225° and 270° (named BNL01 and BNL03 respectively) positions on the RHIC cavity
- A series of design changes occurred since the prototype's fabrication, with the aim of removing the presence of InCuSil braze material, due to overheating.
- JLab tasks included developing an assembly sequence, fabricating parts, welding, chemistry, tuning and testing.
- Dampers are scheduled to be completed and delivered to BNL by late September 2015

Filter Assembly

- Sapphire rings are held inside Nb rings using 1mm thick Nb "stoppers, electron-beam welded (EBW) onto Nb rings (see main photo insert)
- Special clamps were fabricated out of reactor grade Nb (photo below). In addition to holding the stoppers in place, they served as heat sinks so as to not crack the sapphire, which is susceptible to point heat loads
- After EBW, the sharp edges of the stoppers were rounded using a silicon carbide abrasive. This was followed by swab BCP





MAIN INDUCTOR
The main axis of the damper, the copper rod within conductively cools the Loop, which is the area of highest heat generation

LOOP
Positioned inside cavity as coupling mechanism

N-CONNECTOR

END CAP

FILTER ASSEMBLY
The Filter Assembly is a capacitor made up of concentric Niobium and sapphire rings. The filter assembly is connected to the Tuna Can by means of 1/8" diameter Inductor Rods. Movement of the Filter Assembly along the Main Inductor is the damper's primary tuning mechanism

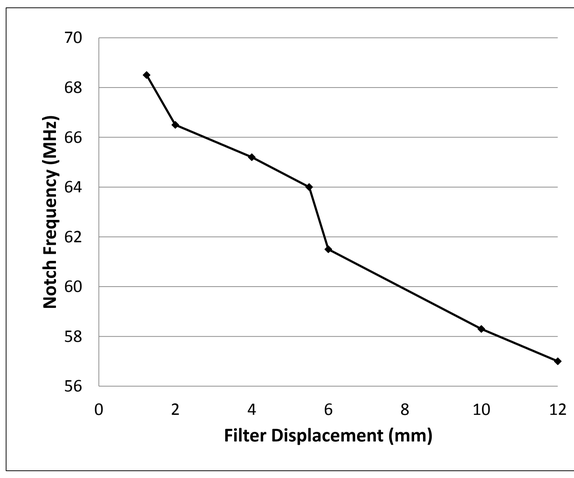
COOLING TURRET
Titanium tubes TIG welded on to these turrets allow the flow of liquid helium. The latter cools a copper heat sink inside the turret, and conductively cools the Main Inductor

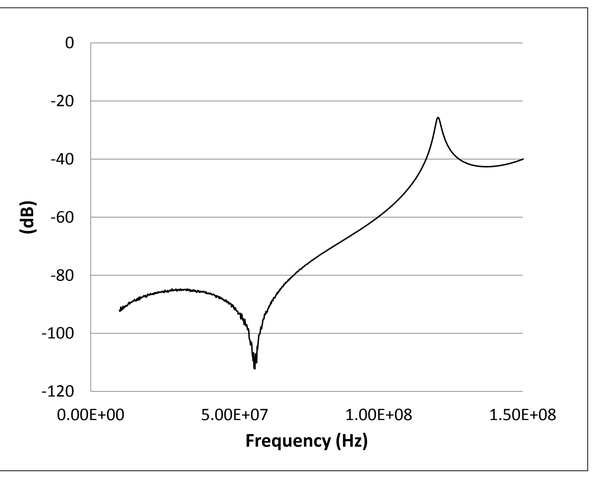
SAPPHIRE BRIDGE

TUNA CAN

Tuning

- Damper tuning is achieved by moving the Filter Assembly along the Main Inductor, towards the End Cap
- Tuning frequency is measured via network analyzer, which records the S21 feedback. The main feature is the location of the first notch, which should be at 56.3 MHz.
- Prototype damper required 3mm of filter movement for tuning. Due to design changes, the production dampers behaved very differently; BNL01 required 11.5mm and BNL03 required 12mm (photo right).
- Graphs below show the notch frequency as a function of filter displacement for BNL03 (left) and the S21 data for BNL03 at the end of tuning (right). The notch is at 57.0 MHz; BNL01 was tuned to 56.3 MHz
- Large displacement required modified end caps to be fabricated. Note the bent Inductor Rod in the photo on the right
- Part of the Sapphire Bridge assembly is a #2-56 NbTi threaded rod, designed to fix the Filter Assembly in place after tuning. These had to be resized, from the original 0.6 inches to 1.01 inches in length.
- No further displacement is possible, as the Inductor Rod would be forced to come into contact with the Nb ring, shorting the circuit





Further Work

1. End Cap to be EBW to seal the Tuna Can
2. Titanium cooling tubes to be TIG welded to turret and NbTi Flange
3. Tubing to be pressure tested to 37psig, and damper chamber to be leak checked to 1 x 10^{-12} Torr L/s of helium
4. Cavity side of damper (from end of Loop to NbTi Flange) to receive 15 micron BCP.

References

[1] N. Huque, E. F. Daly, W. Clemens, G. McIntyre, Q. Wu, S. Seberg, S. Bellavia, "*BNL 56 MHz HOM Damper Prototype Fabrication at JLab*", IPAC15, Richmond, USA (2015)
[2] N. Huque, "*56 MHz High Order Mode Damper Fabrication for Brookhaven National Laboratory*", JLab Technical Note, February 2014

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