

R100 Microphonics

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Reporting on work by

Kirk Davis, Mike Drury, Leigh Harwood,
John Hogan, Kurt Hovater, Thomas Plawski,
Mark Wiseman, etc.

The Problem

- Vibrations of the superconducting cavities (microphonics) change the frequency of the cavity
 - Because the resonant frequency of the cavity is very narrow, the cavity can go off resonance
 - This increases the fraction of RF power that is reflected back from the cavity
 - More RF power is needed to provide the required gradient
 - RF control module can lose lock
 - Loses ability to control the cavity

Hardware Description

- R100, C100 cavities are nominally identical
 - No stiffening rings
 - Welded into helium vessel
- R100 cavities were made at JLab
- C100 cavities were made by RI
- Anecdotal evidence that RI cavities are stiffer than JLab cavities
 - Work hardening?



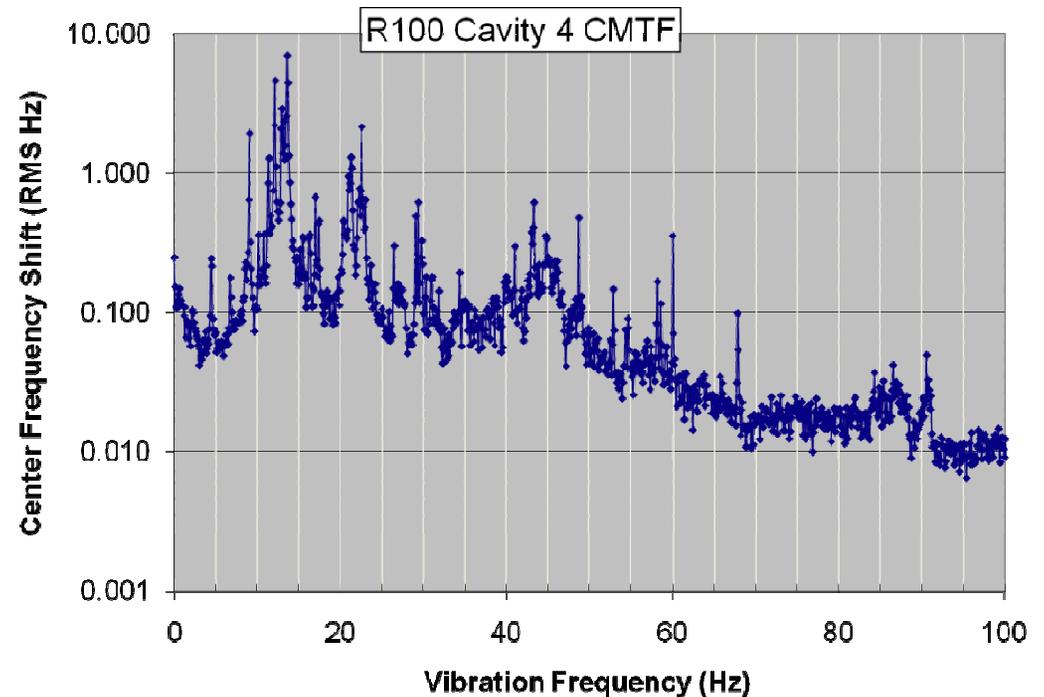
Numbers

- “Admiral” cryomodule in the FEL 1 Hz
 - “Admiral” is now installed in CEBAF at SL21
- Renaissance in CMTF 0.5 Hz
- HTB with 2 C100 cavities in CMTF 2 Hz
- R100 in CMTF 7-20 Hz
- Spec for C100 in CEBAF ~ 5 Hz

CMTF – Cryo-Module Test Facility in the Test Lab

Example of Data

- 13 Hz vibration prominent
 - Variable during the day
 - Likely noise in CMTF*
- 2 Resonances ~20 Hz
- 2 Resonances ~45 Hz
 - Both likely to be cavity resonances



* Breaking news: 13 Hz associated with heavy return gas load to Kinney pump

Priority 1 – Why

- Two possible causes
 1. Higher vibrations in the Test cave
 - Historically ~twice as bad as the CEBAF tunnel
 - Is it worse now due to TEDF or cryogenics changes?
 2. Cryomodule more susceptible to vibrations
 - Cavities floppier?
 - Tuners, etc. not as well supported?
- First priority is to determine the leading cause

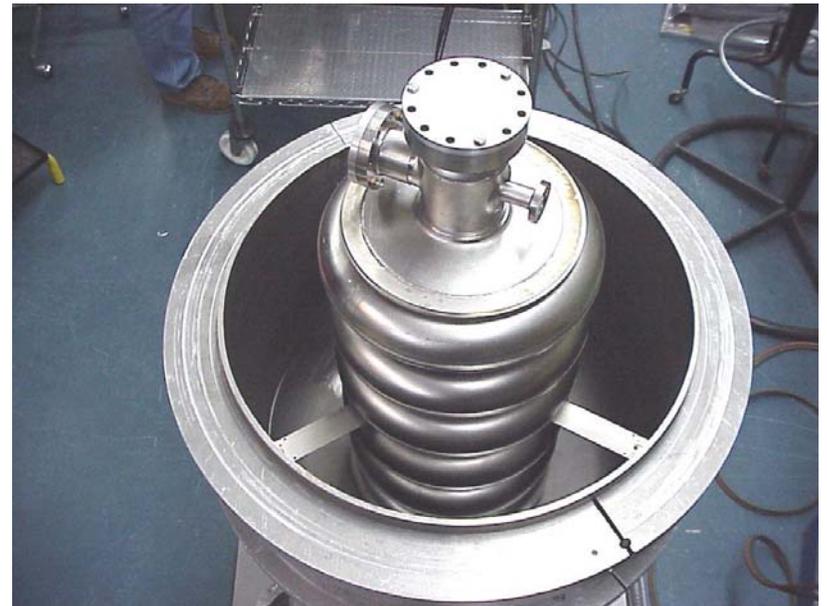
Cryomodule vs Environment

- R100 is currently in the CMTF
 - Installation planned in CEBAF Zone SL23
- Admiral is currently in CEBAF zone SL21
- Use a vibrator near both cryomodules to measure response to external vibrations of known frequency and amplitude
 - If response is similar, problem is CMTF environment
 - R100 should be OK in CEBAF
 - If response is different, the frequency can be correlated to known mechanical differences between the cryomodules
 - Tells us where to look to fix R100 (and therefore C100)
 - First tests in CMTF yesterday swing, more this evening
 - When procedure is wrung out, will repeat in CEBAF

Priority 2 – Develop Mechanical Solutions

- Some possible mechanical solutions can be tested now
 - Increase lateral stabilization of tuner stack
 - Add vibration damping pads under the cryomodule feet
 - Both should be tested with the vibrator
- Develop ideas for mechanical fixes
 - SNS cavities had “spider support”
 - Can we retrofit?
 - Can we use wires under tension?

Mark Wiseman, Kirk Davis, Mike Drury



Priority 2 – Develop Electronic Solutions

- Can new Digital RF Controller stabilize cavities
 - Successful up to ~ 8 MV/m – takes 2.8kW
 - Can stabilize cavity at 15 MV/m – but only for ~ 1 second
 - **Breaking news – without 13 Hz can lock up to 19 MV/m**
- Measure the response of the individual cavities to the piezo-electric transducers (PZTs) installed on the tuners
 - Also affects neighboring cavities (only ~ 5 db isolation)
- Use the PZTs to try and damp the microphonics
- Try and use Lorentz detuning (expansion of cavity as RF power increases) to feedback on microphonics

Priority 3 – Gather Data

- A lot of data is being gathered to be evaluated later
 - Every cavity has been characterized more than once
 - Use PZTs as “listening” devices
 - Are cavity oscillations in sync?
 - Measure CMTF ground motion at regular intervals in a day
 - Try and identify source
 - Kinney?
 - Mechanical vibration?
 - Cryogen oscillations?

12 GeV Project Status

- C100-1 and C100-2 assembly is proceeding
 - On track for installation into CEBAF as planned
- String assembly of C100-3 is ready to begin
 - On hold waiting for more information from R100
- Welding of helium vessels onto cavities is on hold
 - Pending decision on whether mechanical support is required (“spider”)

Outlook (Andrew's opinion)

- Problem is serious, but not intractable
- Solution will most likely be a combination of several different fixes
- My preference is for passive fixes first, feedback second
- I do not see a reason to advance R100 installation
 - I expect modified R100 to be installed in CEBAF as planned
 - Commissioning order may change????
- We will be judged by how well we address this problem – not by the problem itself