RESULTS FROM EXTENDED RANGE SRF CAVITY TUNER TESTS FOR LCLS-II HE

C. Contreras-Martinez†, T. Arkan, A. Cravatta, B. Hartsell, J. Kaluzny, T. Khabiboulline, Y. Pischalnikov, S. Posen, and G. Romanov, Fermilab, Batavia, IL, USA

† ccontrer@fnal.gov

WEPS26
FERMILAB-POSTER-24-0031-TD

Cavity Frequency Tuner

- For multi-energy operation in the LCLS-II-HE linac the tuners were modified to meet **the off-frequency operation (OFO)** specification of **1299.535 MHz**
- The tuner must be able to compress the cavity by **-715 kHz (42 mm)** which is roughly 3 times larger range than the LCLS-II tuners
- The LCLS-II-HE tuners were modified from the LCLS-II design by decreasing the tuner lever ratio from 1:20 to 1:16, additional info on [1]
- In the case of cavity 1 the total range of movement is 39 mm (with interference 36 mm) and for the rest of the cavities it is 42 mm

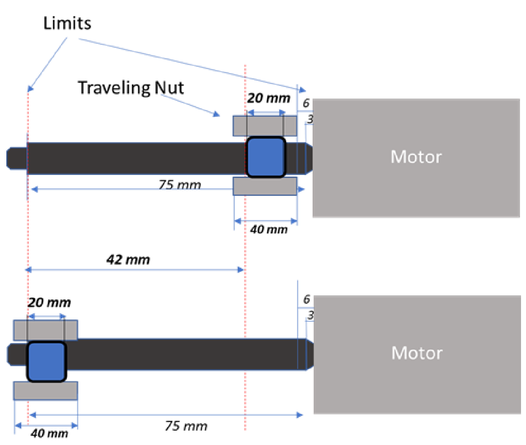

Figure 1: Motor shaft schematic showing the traveling range in mm. The traveling nut is connected to the tuner arm.

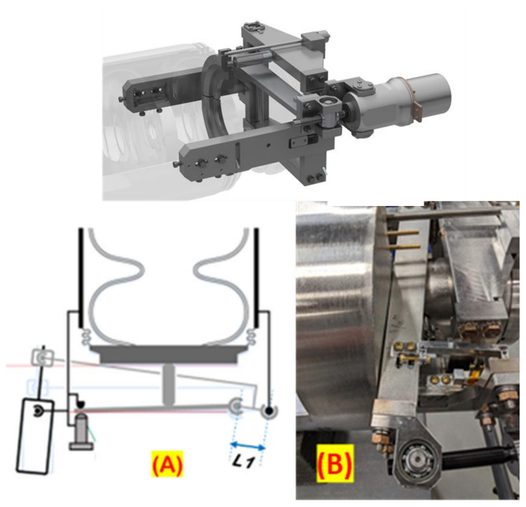

Figure 2 : Diagram of the tuner

Cavity Frequency

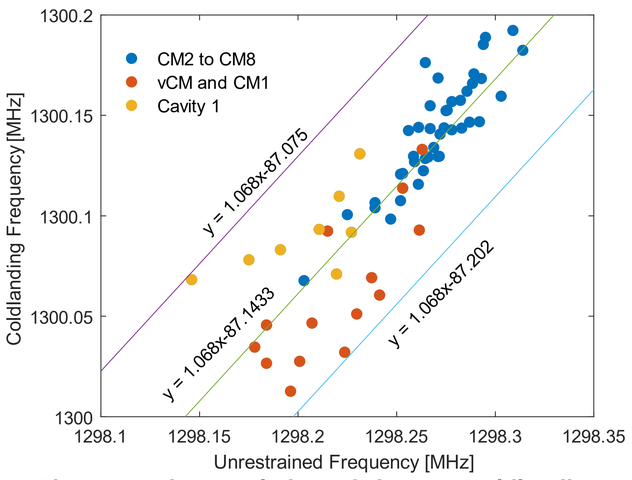

Figure 3: Linear relation of the 2 K coldlanding frequency vs the cavity unrestrained frequency. The main fit is shown as well as the upper and lower limits of the fit.

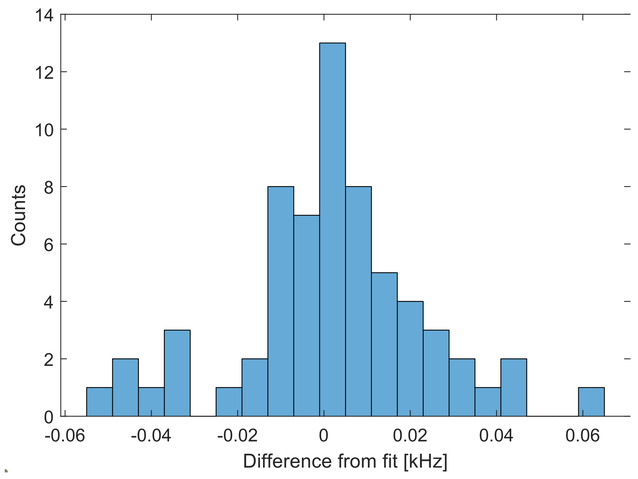

Figure 4: Histogram of the difference between the linear fit and the actual 2 K landing frequency across 64 cavities.

- The tuner has a limit of compression therefore the cavity frequency is monitored to ensure this limit won't be reached
- There is a linear relation between the cavity unrestrained frequency and the frequency at 2 K (see Fig. 3)
- Using the linear fit and the variance of the fit (see Fig 4.) an estimate can be obtained for the 2 K frequency from the unrestrained frequency
- If necessary, the cavity can be tuned (via the tuner) to be below the threshold

Tuning to OFO

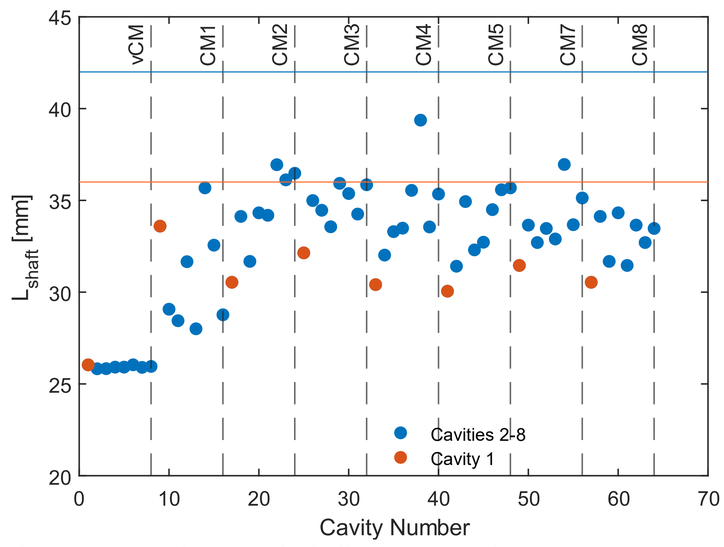

Figure 5: Traveling nut shaft displacement from 2 K coldlanding frequency to 1299.535 MHz. Note cavity 1 and the rest of the cavities are colored differently.

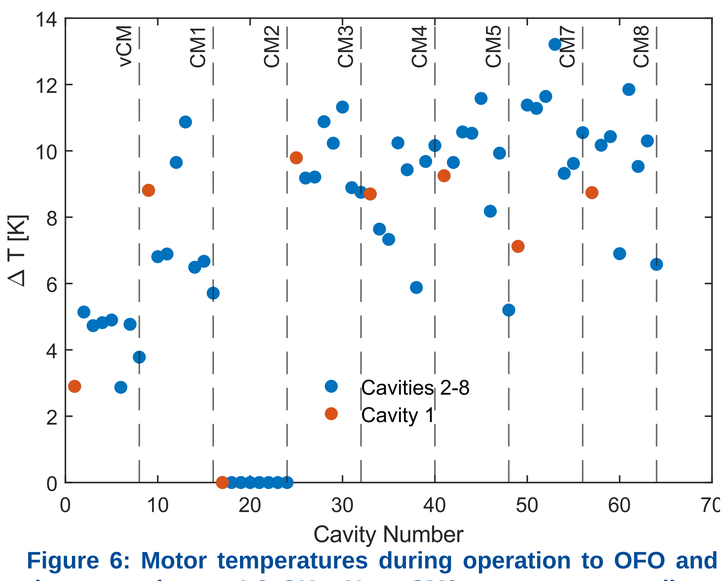

Figure 6: Motor temperatures during operation to OFO and then returning to 1.3 GHz. Note CM2 temperature readings were malfunctioning.

- From the 2 K coldlanding frequency the tuner is used to reach OFO
- Figure 3 shows the calculated displacement based on the number of steps of the traveling nut on the shaft to reach OFO
- All cavities reached OFO without tripping the limit switches
- For cryomodules 2 through 8 the displacement was larger due to a higher 2 K coldlanding frequency (see Fig. 3)
- The motor temperature increase from the start of tuning at 1.3 GHz until brining it back is shown in Fig. 6
- The highest temperature increase was 13 K, nominally the motor temperature is at ~ 20 K
- This whole process takes ~ 1.5 Hrs

Conclusion

- Eight LCLS-II-HE cryomodules were tested successfully at FNAL for OFO operation
- **It was demonstrated that the tuners were able to bring all 64 cavities to the OFO setpoint**
- **This was achieved by changing the tuner geometry and by ensuring the cavity frequency was not out of the range of the tuner**

This manuscript has been authored by Fermi Research Alliance, LLC under Contract No. DE-AC02-07CH11359 with the U.S. Department of Energy, Office of Science, Office of High Energy Physics