

Tuners Status Summary

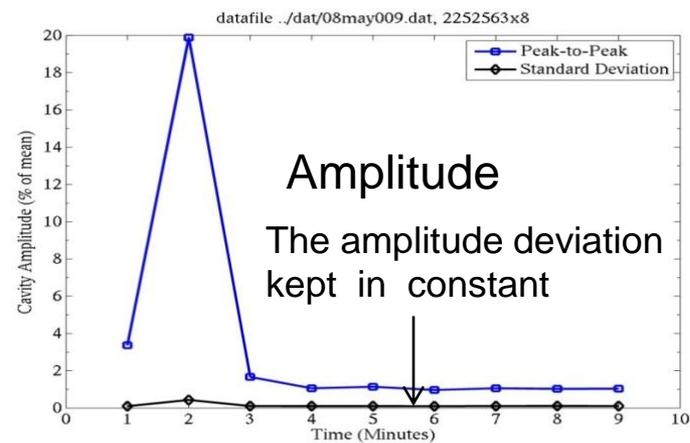
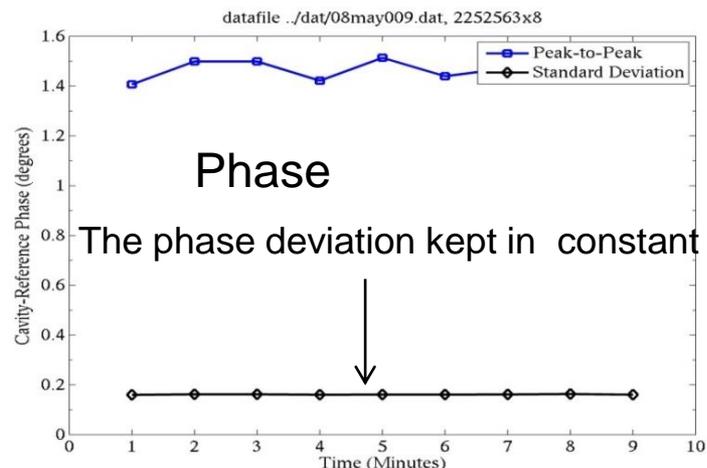
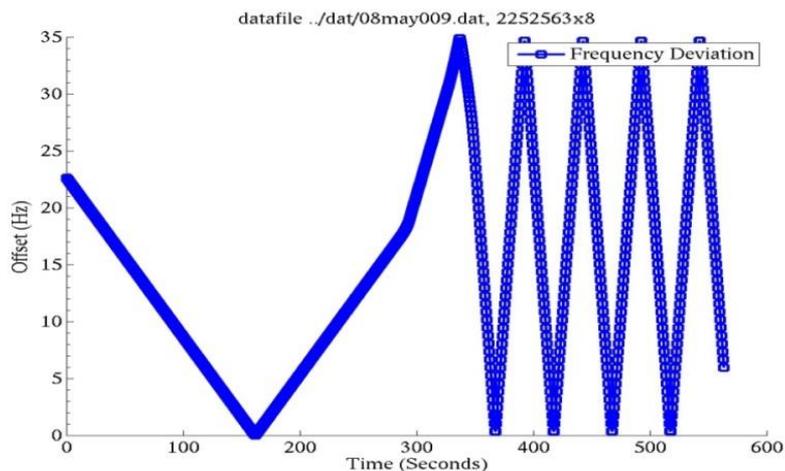
Cavity Type	Prototype Status	FRIB Design Optimization (based on R&D experience)	Status of Optimized Tuner	Plan to finalize
80.5 MHz $\beta=0.041/0.085$ QWRs	Externally actuated tuner plate deformation, stepper+piezo Running automatically in ReA3 for 1.5 years	Puck tuner for ReA3 refurbished cavity to increase tuning range $\pm 30\text{kHz}$	Used puck tuner for ReA3 refurbished cavities ReA3 coldmass assembly to be finished end December 2012 and CM module to be completed in mid April 2013.	System test in ReA3 in Summer-Autumn 2013.
322 MHz $\beta=0.29/0.53$ HWRs	Scissor Tuner Tested in TDCM-1 Magnetized material in C-flex, noisy on motor operating too expensive to replace none magnetized material, no way to Dewar test	Considering ANL type pneumatic tuner as an alternative to the baseline after TDCM-1 test, Significant operational experience at ANL, reduced noise due to pressure control, can be tested in vertical Dewar, easier to ensure absence of magnetizable material	Pneumatic tuner design completed in September, fabricated in October, completed offline warm tests and cold (4K) tests in November 2012. Results shows good agreement with simulated performance, pneumatic tuner cost 50% of the scissor tune Assembled control system in April 2013 Tuner performance test End of April - May 2013	Dewar test on 0.53HWR Roark 1 st vendor development cavity in Summer 2013.

Example: Tuner Control Speed Test Result

Demonstrated Stable Cavity Operation with Tuner at 2 K

- Tuner follows the frequency modulation within BW and keeps cavity phase and amplitude in constant
- Demonstrated stable operation with tuner at 2K

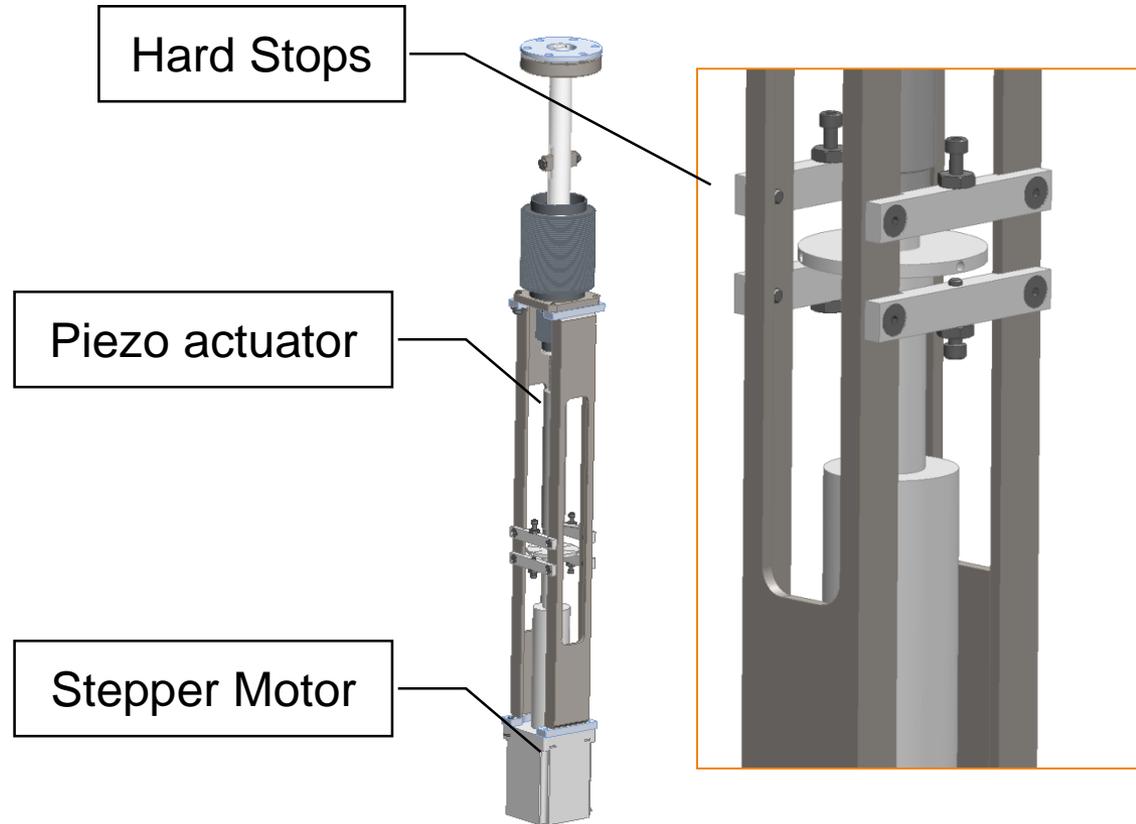
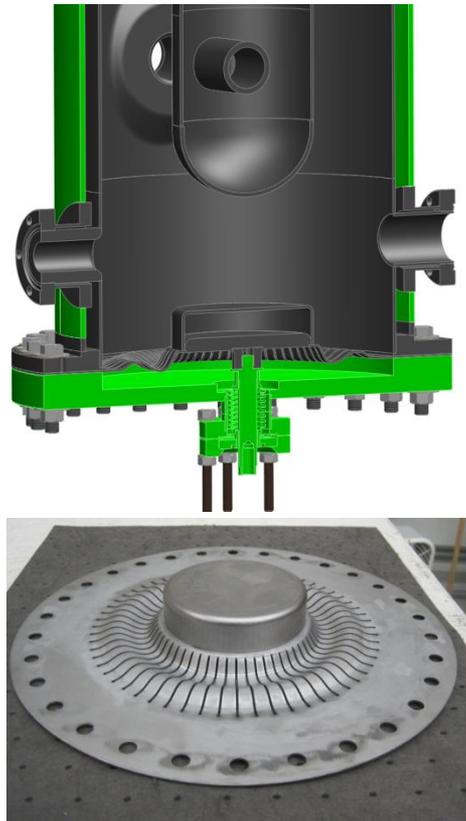
Active frequency modulation within a band width



FRIB QWR Tuner Remains as ReA3 Design

Working Well in ReA3 for 2.5 Years

R 681

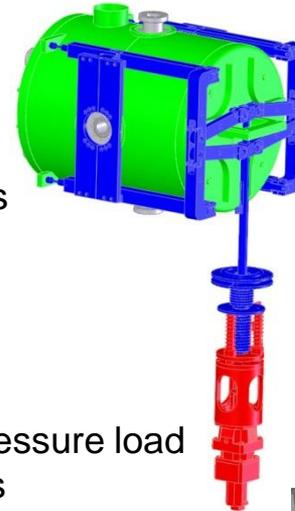


- Increased tunability by welding “tuning puck” to tuning plate, yielding ± 30 kHz tuning range
- Similar tuners have worked well in ReA3 for 2.5 years

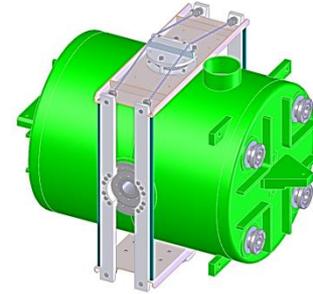
HWR Pneumatic Tuner as New Baseline

- Cold tested scissor tuner in the TDCM-1
 - Tech Note T30802-TD-000404
- Phase lock system working reliably with tuner at 2 K
 - However
 - » Tuner force and speed however not according to expectations
 - » Tuner motion induced extraneous noise in cavities
 - » Replacement of magnetic C-flex material too expensive
- After the TDCM-1 test it was decided to explore the pneumatic tuner as an alternative to the baseline HWR tuner
 - Significant operational experience at ANL
 - Reduced noise due to utilization of pressure control
 - Can be tested in vertical Dewar test
 - Easier to ensure absence of magnetizable material
 - Pneumatic tuner cost is 50% that of the scissors tuner
- Pneumatic tuner test-1 in Nov 2012 (last ASAC)
 - Pneumatic tuner test shows good agreement with simulated performance
 - Control system not yet completed
- Pneumatic tuner test-2 in April – May 2013
 - Demonstration of the full control system

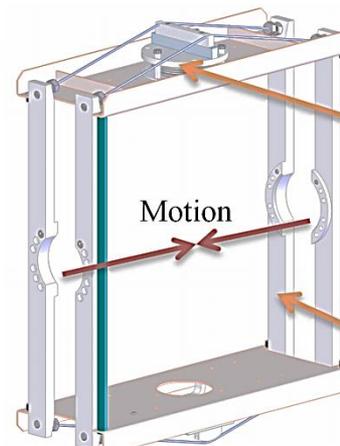
Scissors Tuner



Pneumatic tuner

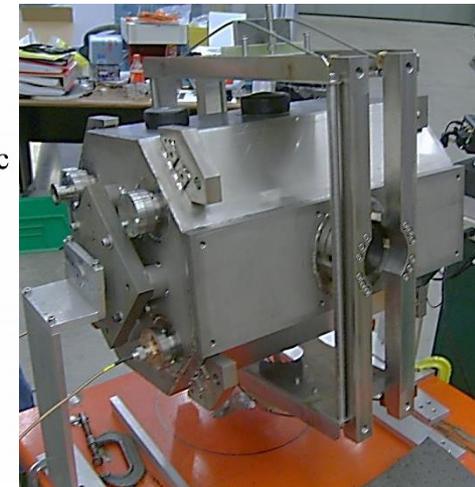


He gas pressure load on bellows



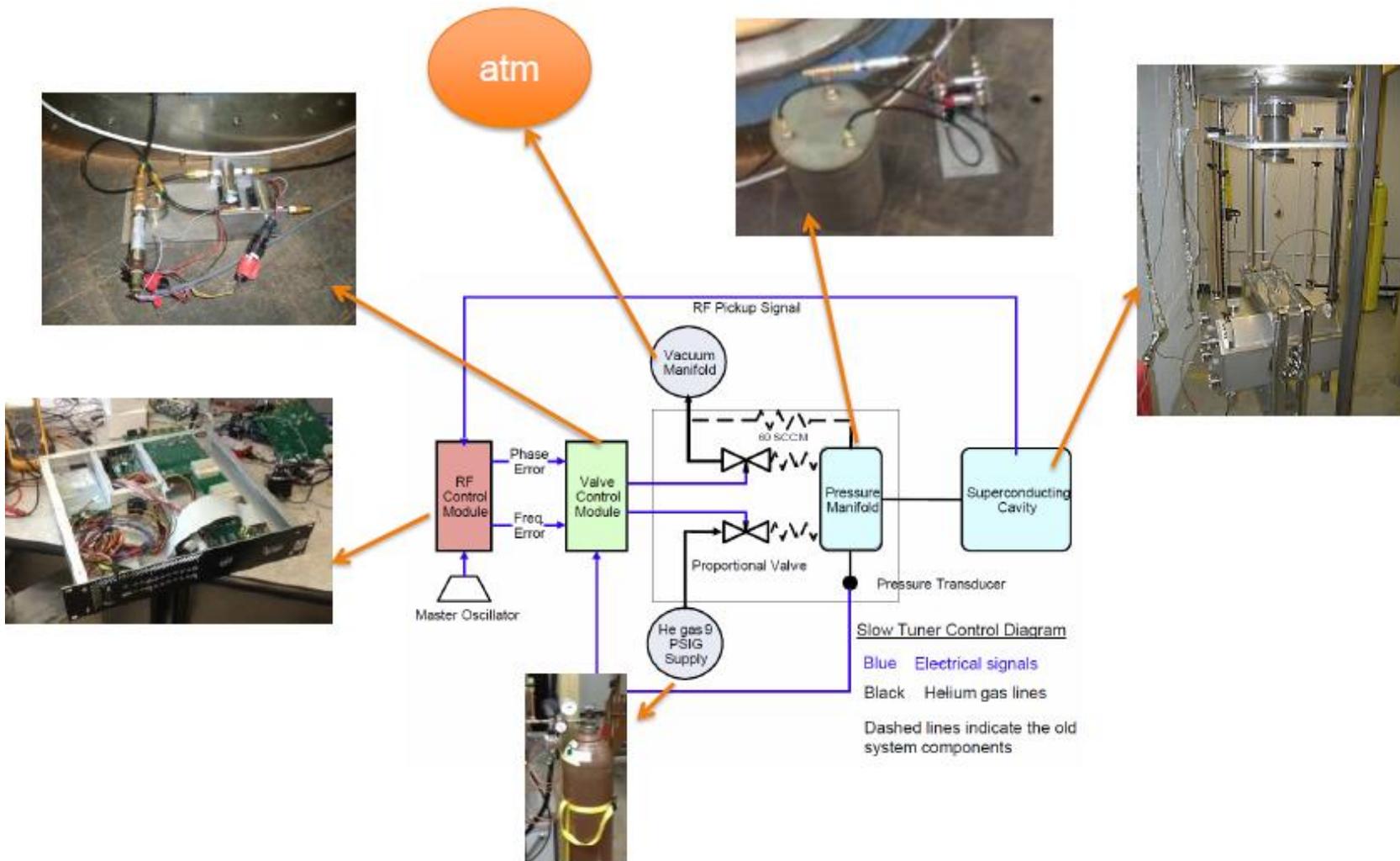
Pneumatic Bellows

Tuning Arms



Cold Test of HWR Tuner with Full Control System on Cavity

Successfully Tested the Tuner Performance



HWR Tuner Test Results

Demonstrated Amplitude and Phase Regulation with Tuner Working at 2 K

- Maximum tuning speed in regulation (phase <math>< 2^\circ</math> peak to peak, amplitude <math>< 2\%</math>)
 - +/- 0.35 Hz/sec
 - Higher speeds (1 Hz/sec) were possible while detuning within the band width
 - The background RF noise was higher than expected in this test (12 Hz peak to peak)
- Maximum tuning speed in self-excited loop (SEL) mode
 - -400 Hz/sec (pressure increasing)
 - +363 Hz/sec (pressure decreasing)
 - To be improved by....
- Df/dP
 - 321 Hz/psi (4.566 kHz/kgcm² (frequency change from tuner pressure)
- Tuner parameter

Full Tuning
Range: 70 PSI

Parameter	Warm Test	Cold Test
Frequency Shift (kHz)	35.6	23.8
df/dx (kHz/mm)	57.8	-
df/dF (Hz/N) [Calculated]	3.3	2.22
dF/dx (kN/mm) [Calculated]	17.2	-
df/dP (kHz/psi) (Piston)	0.52	0.335

