Fermilab

Managed by Fermi Research Alliance, LLC for the U.S. Department of Energy Office of Science

Characterization of the MEBT Bunching Cavity

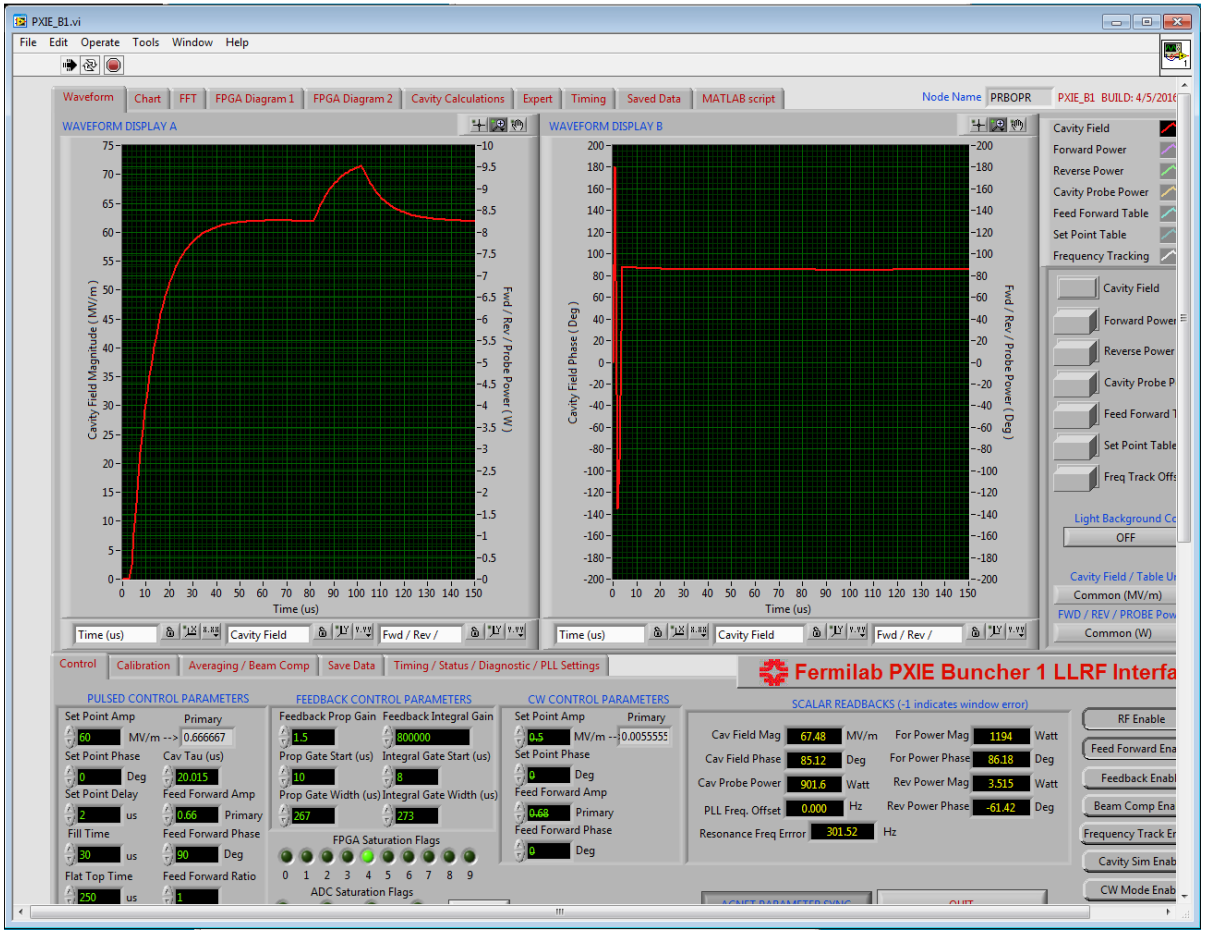
Jim Steimel

PIP-II Technical Meeting

13 September 2016

Phase Calibration & Beam Loading

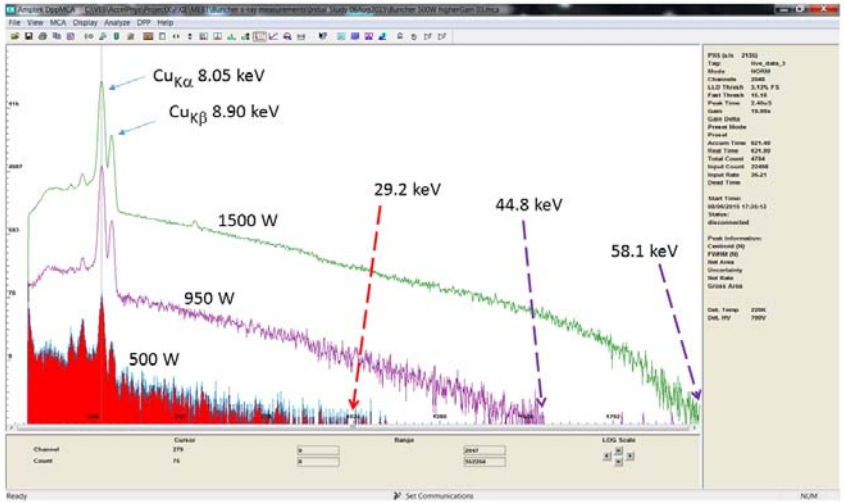
- Take advantage of beam loading to determine acceleration phase in cavity.
- Plot at right shows effect of beam loading when cavity field is tuned 180 degrees out of phase with beam.
- Beam loading amplitude is maximized and effect of beam on relative phase is minimized.
- This process could be used to investigate cavity impedance when beam current is well understood.

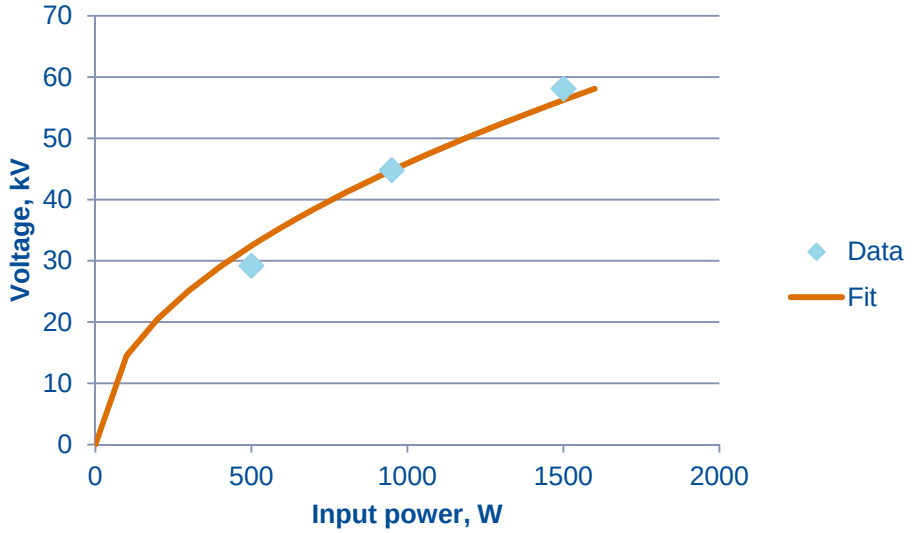


First Amplitude Calibration

- Plots at right (from Vic Scarpine) show first attempts at testing x-ray detector for use as cavity field profile.
- The detector was not fully calibrated for this measurement.
- These results show about a 20% smaller shunt impedance than simulations (from Gennady Romanov) predict.

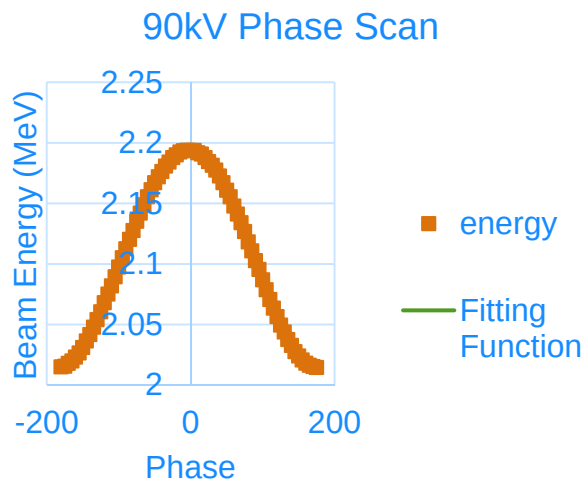
Initial Preliminary Buncher X-ray Measurements – 06Aug2015

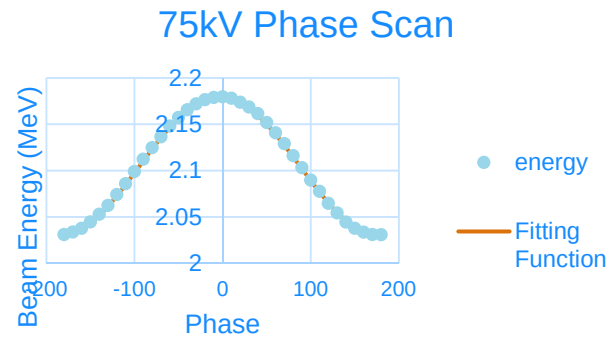


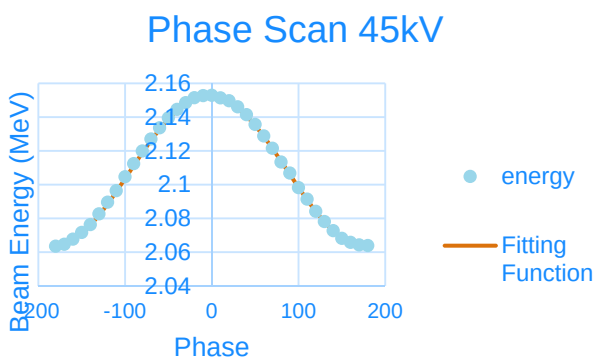


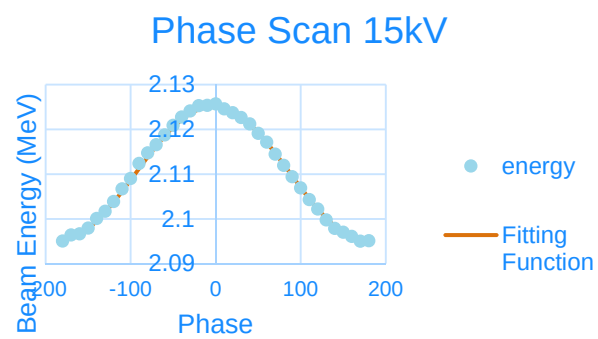
Beam Energy Calibration

- After buncher phase calibration, we performed phase scans.
- Plots at right show beam energy as a function of buncher phase for different amplitude settings.
- The points are plotted against a cosine function at the field amplitude setting.
- The accuracy of the fits are contingent upon our knowledge of the BPM spacing we used to measure time of flight variation.
- I believe we know scale to within 5% accuracy.



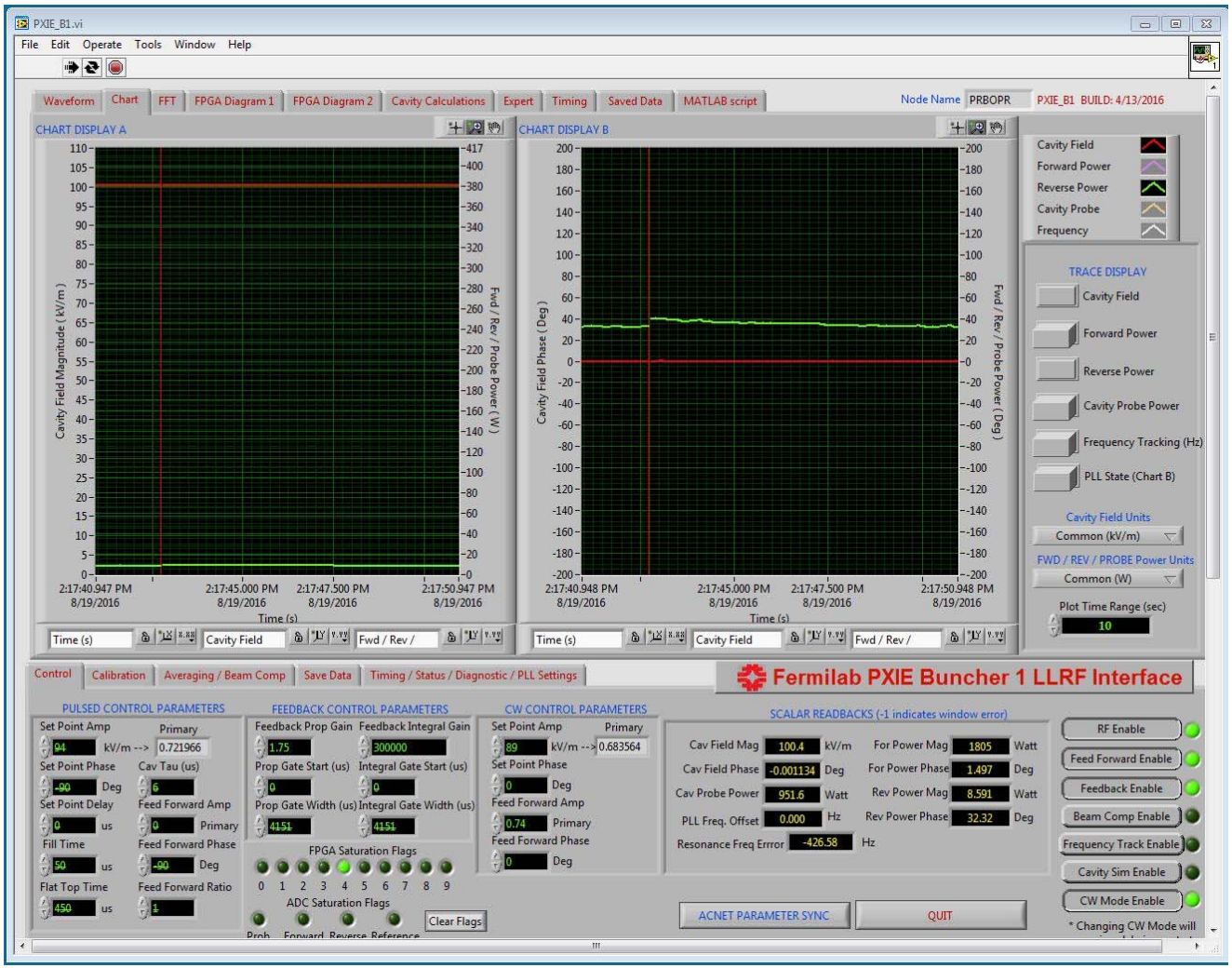






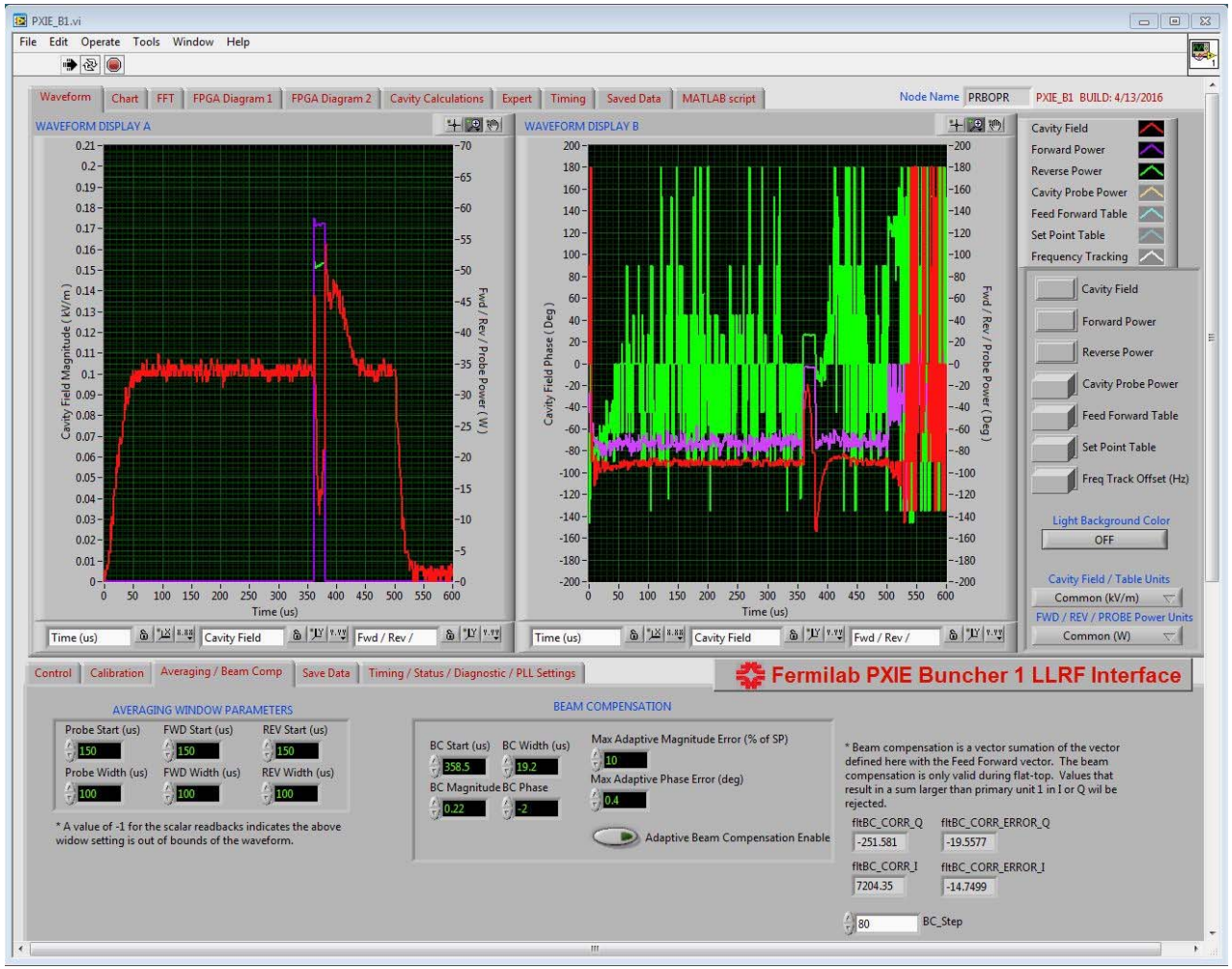
Comparison to Simulation

- After amplitude calibration, right plot shows CW operation at 100kV (max) accelerating voltage setting.
- Drive power measured is 1800W while simulated power expected is 1400W.
- This is consistent with x-ray measurements.



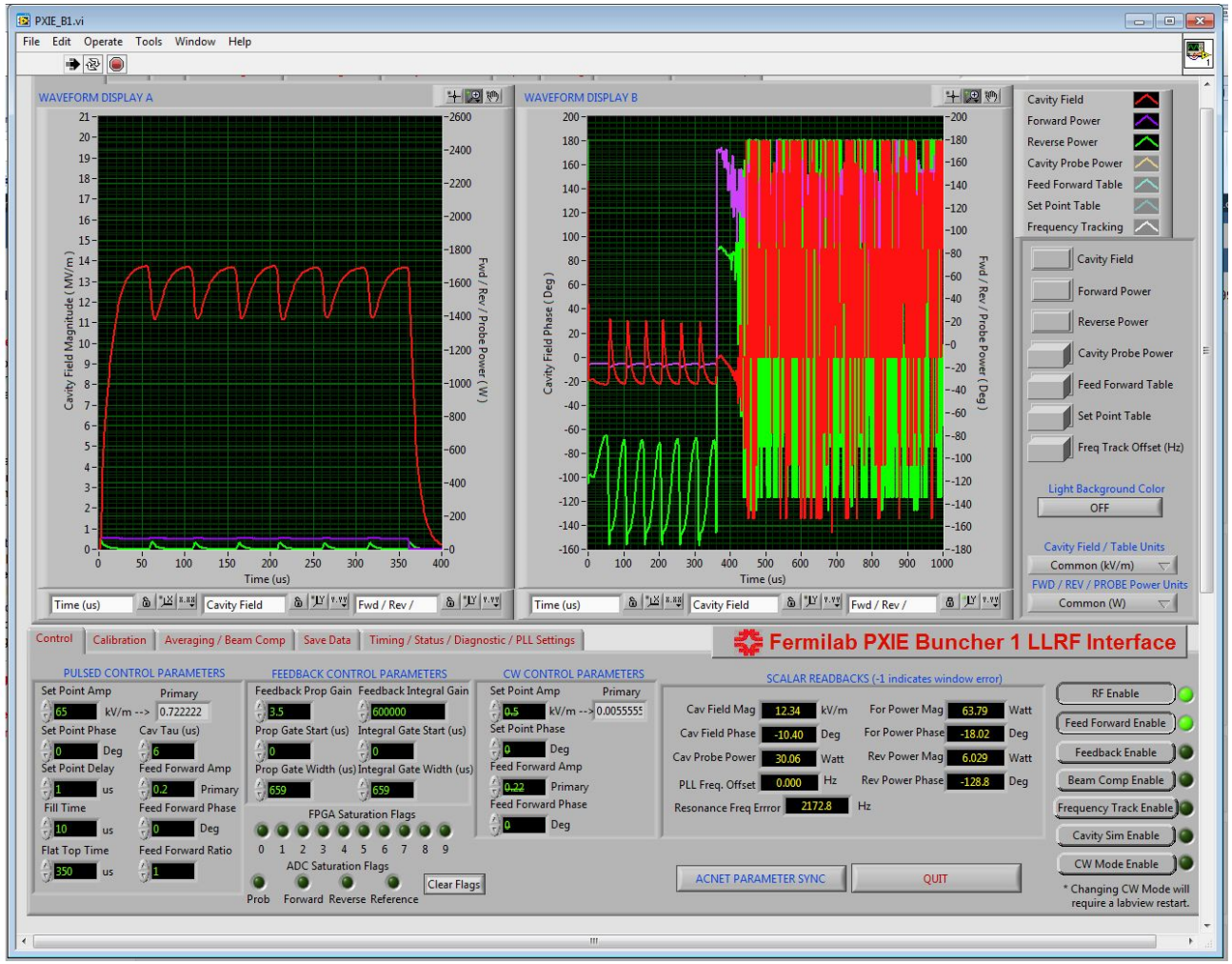
Beam Loading Compensation

- LLRF system feedback and feedforward beam compensation commissioned.
- Plot at right shows effect of beam compensation tuning.
- Cavity field set-point at 100V and beam loading effect reduced by a factor of ~100.
- Reliable, low voltage operation of cavity a valuable feature for verifying RFQ beam energy.



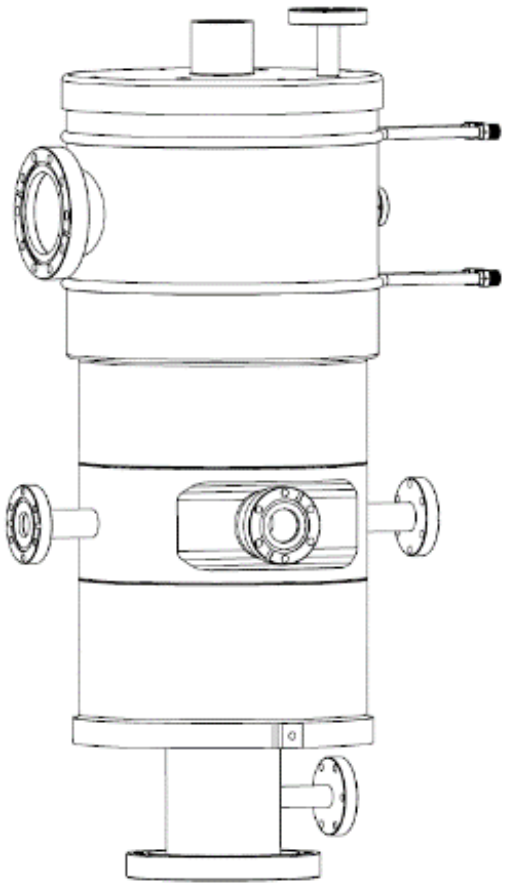
Multipacting

- This cavity has significant multipacting issues.
- The plot at right shows the signature of cavity multipacting in pulsed mode.
- This was cleared up with about 45 minutes of CW operation at low field.
- The cleaning is not sustained, and we see signs of low voltage multipacting in pulsed mode within 2 days of CW operation.



Plans for Delivery of Final Cavities

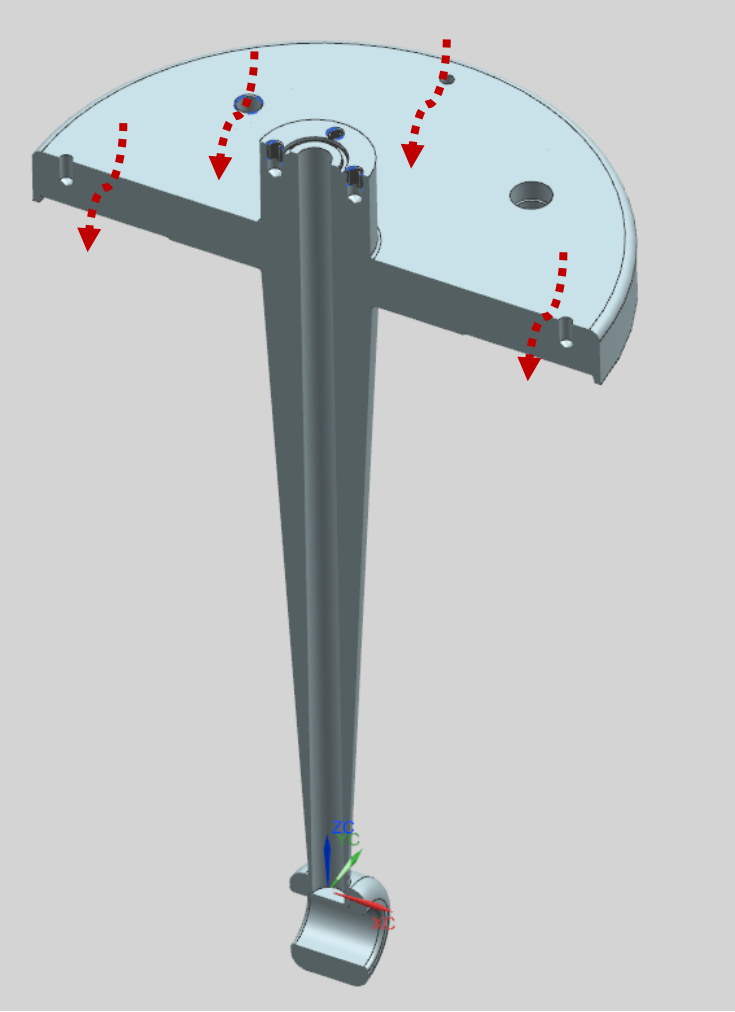
- Three more cavities under construction with HiTech vendor.
- Stem assembly has been brazed, but there are issues.
- We still need to understand final schedule in light of process changes required.

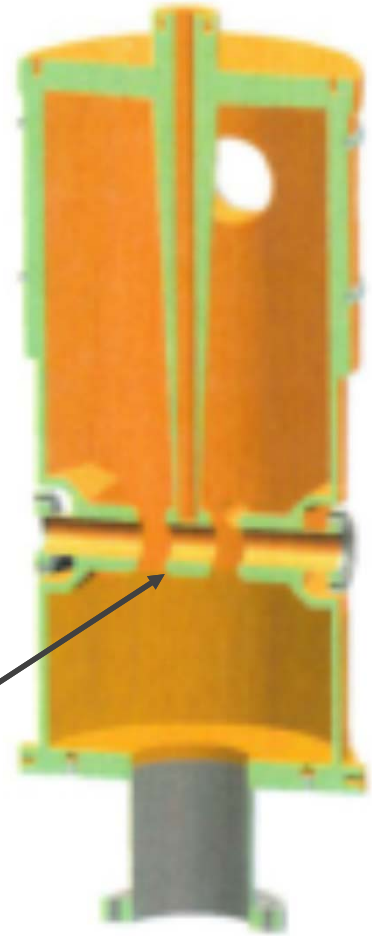


Stem assemblies leak

- **#1** Has leaks at alignment, mounting, and water jacket holes with a combined background **>5x10-5**.
- **#2** Has leaks at the mounting holes **> 2x10-6**
- **#3** Has leaks at the water jacket mounting holes **>5x10-6**

IMPORTANT: It is not out of the question that other smaller leaks exist. The larger leaks must be repaired before smaller leaks can be ruled out.



Problems with Beam Tube Alignment

- After brazing, beam tube at stem found to be 0.5mm too low.
- Current plan is for HiTech to perform a controlled deformation of top plate to put end of stem back to concentricity.
- Outer conductor will be brazed and re-examined for unexpected growth.
- Final braze will be lower temperature and will fix leaks in stem.