Tune measurements through PLL excitation and I/Q Detector in FPGA (and some other TMBF stuff)

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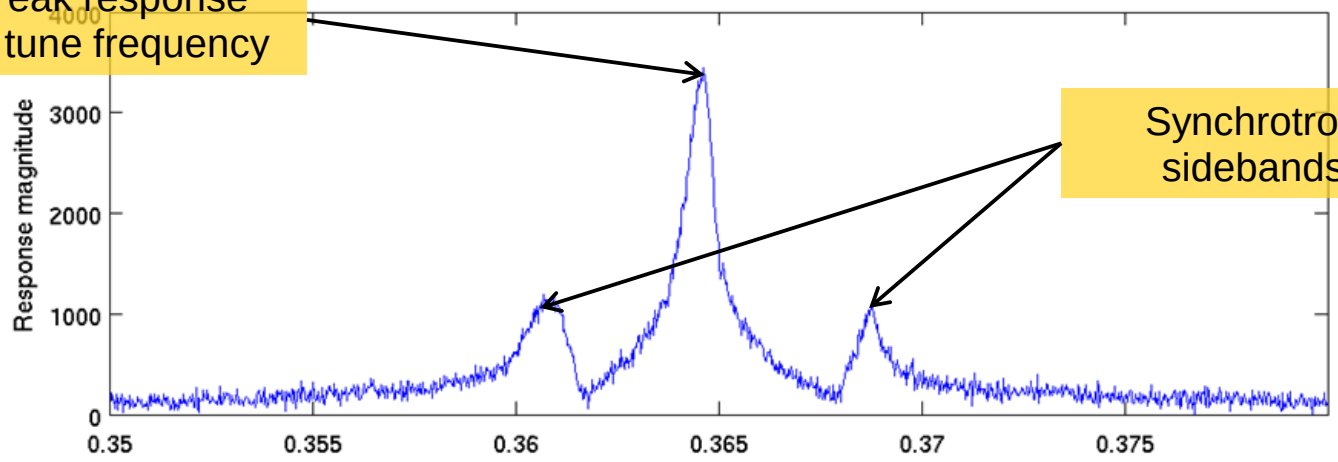
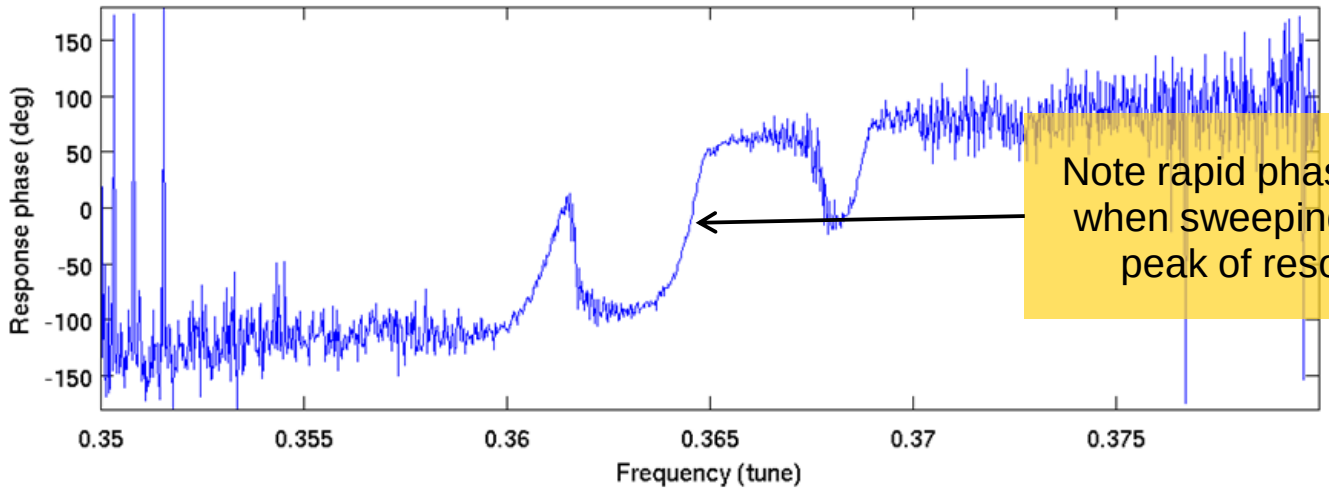
Tune Measurement

Peak response at tune frequency

Synchrotron sidebands



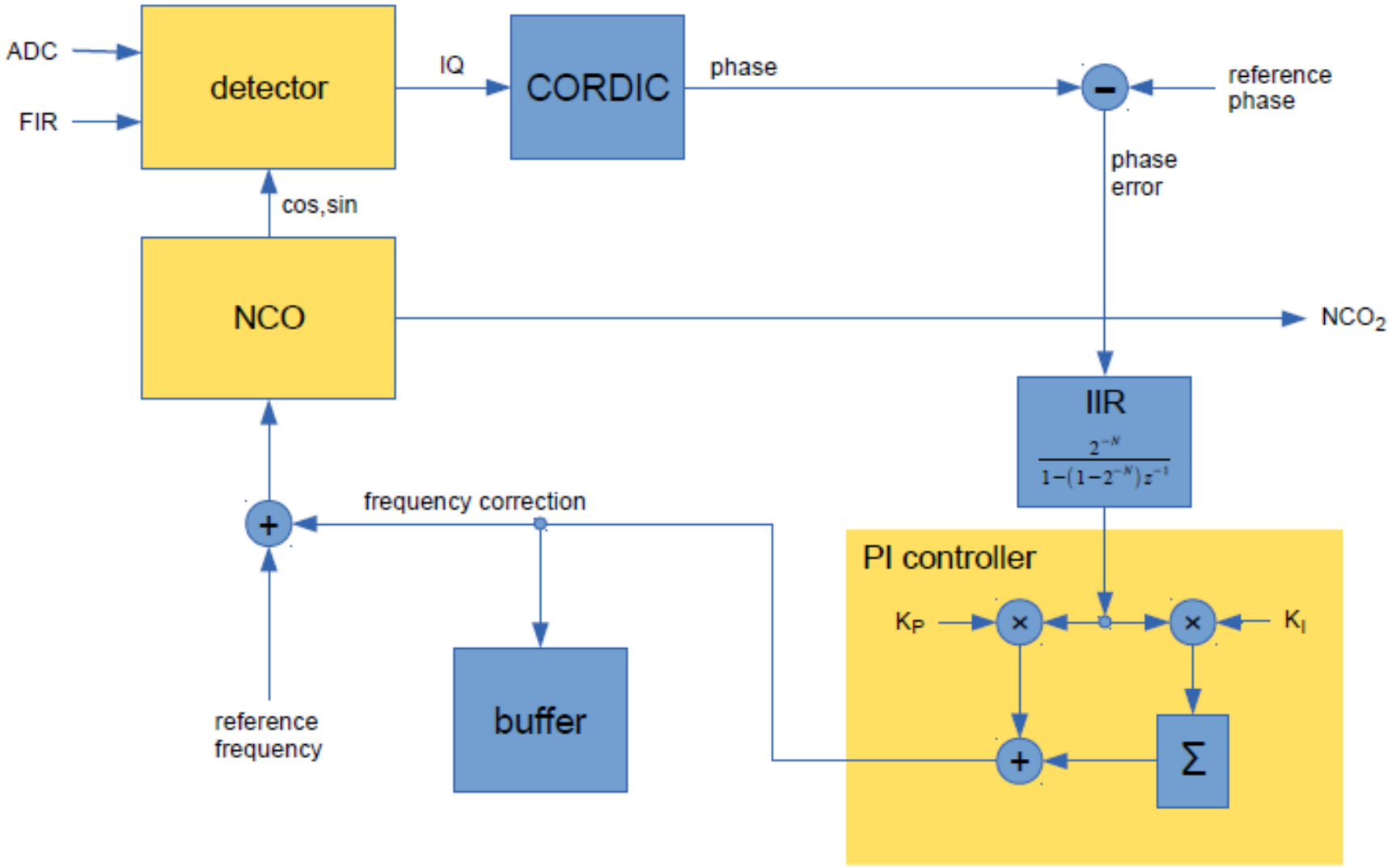


Note rapid phase change when sweeping through peak of resonance

Tune Phase Locked Loop

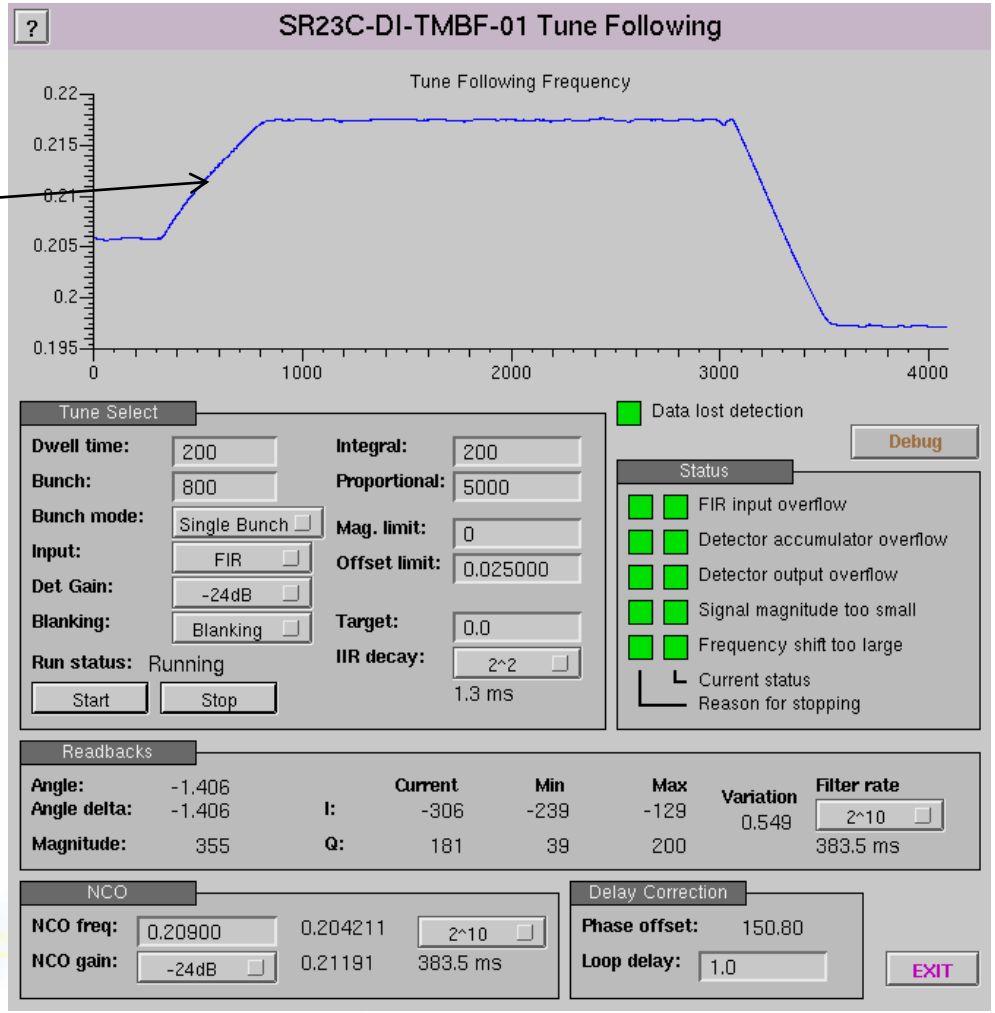
- Take advantage of rapid phase change through tune frequency peak
- Measure phase at, eg, 2.6 kHz (every 200 turns)
- Run simple controller to track frequency to keep phase at target value
- Result is high update rate tune measurement
- Can quickly measure tune width by stepping phase through $\pm 45^\circ$

Tune Phase Locked Loop

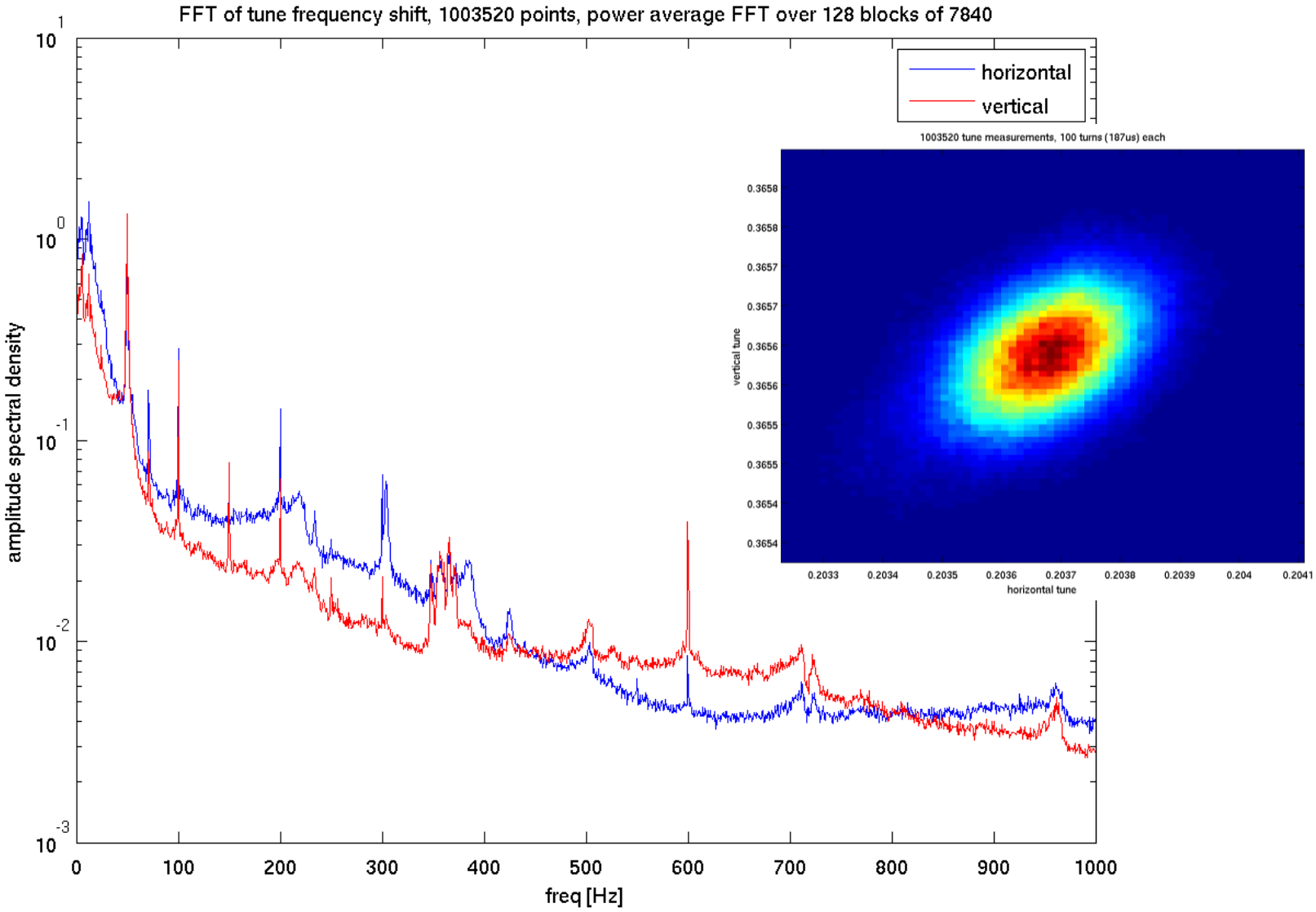


Tune PLL Screen

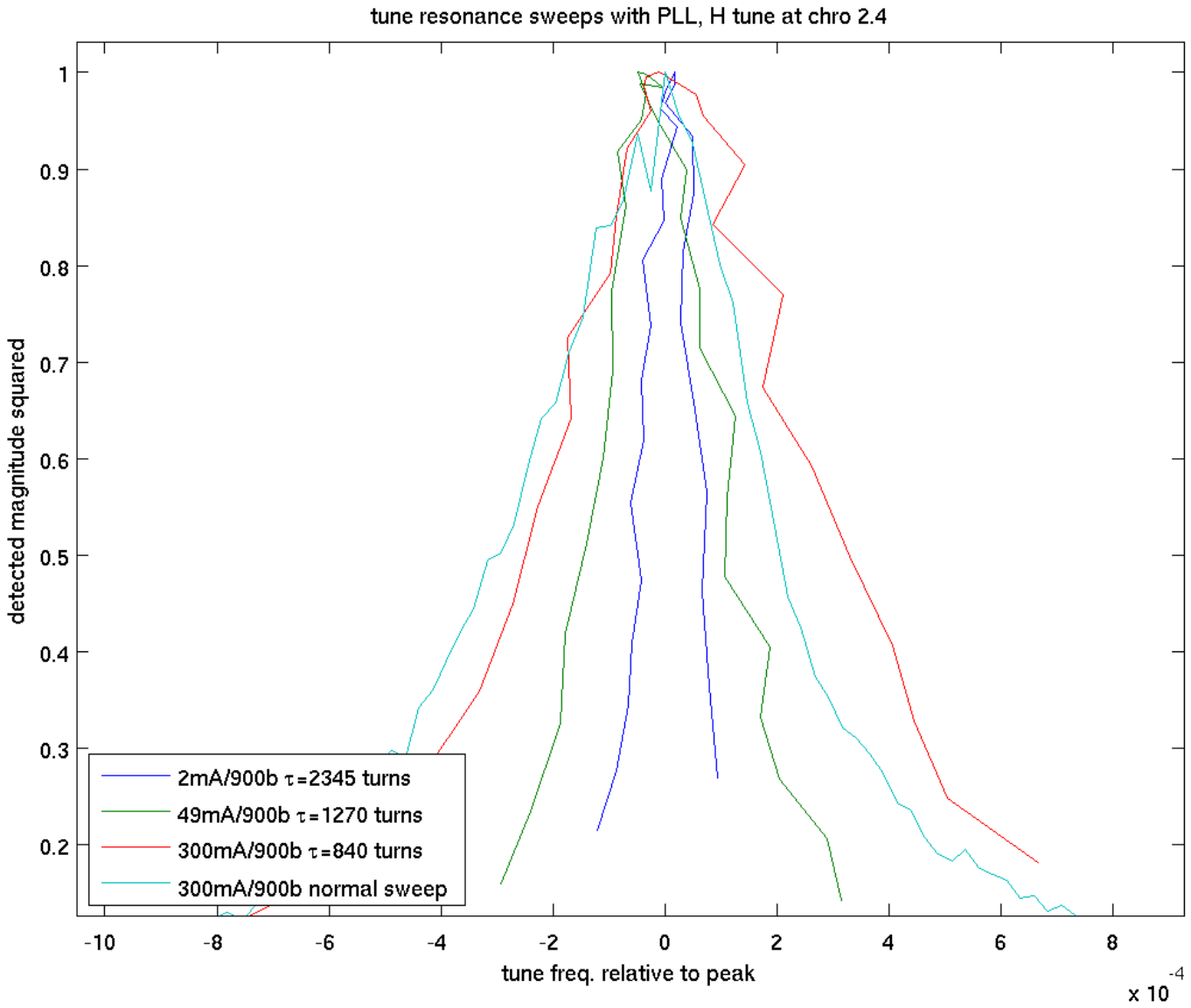
BBA orbit changes cause changes in tune



H and V tune 1e6 samples



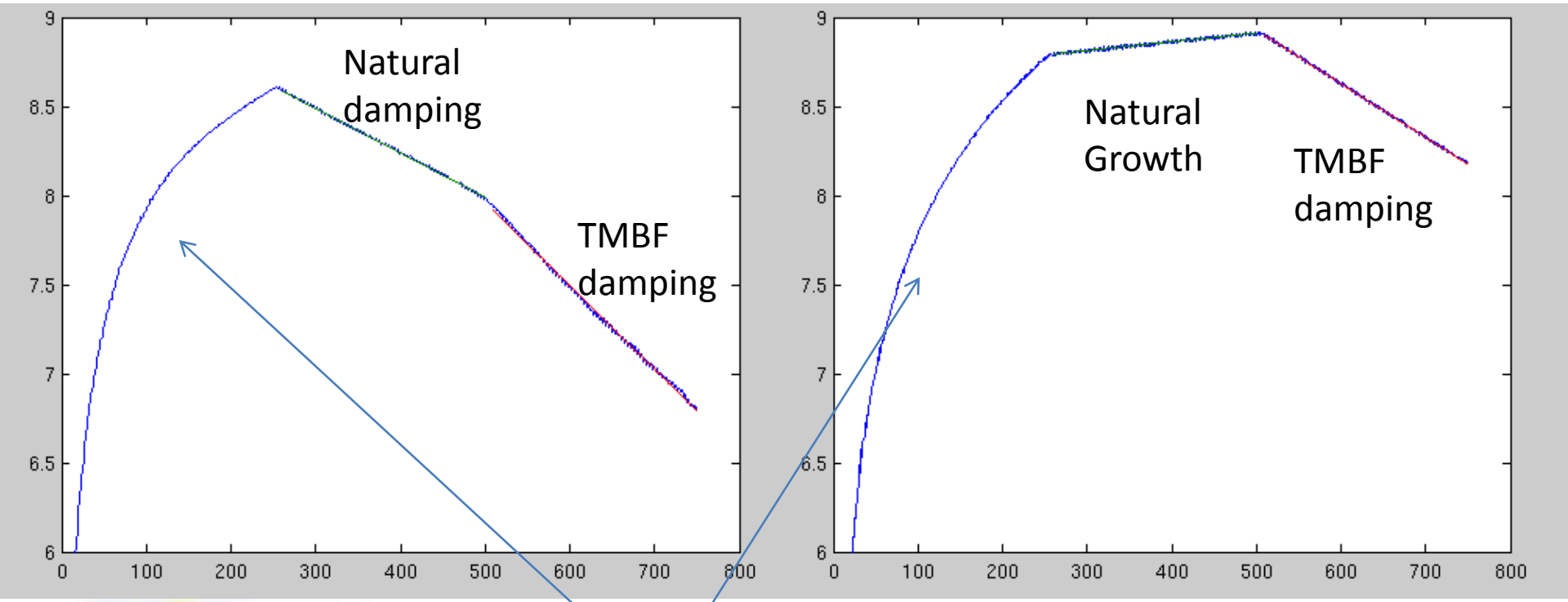
Tune Line Width



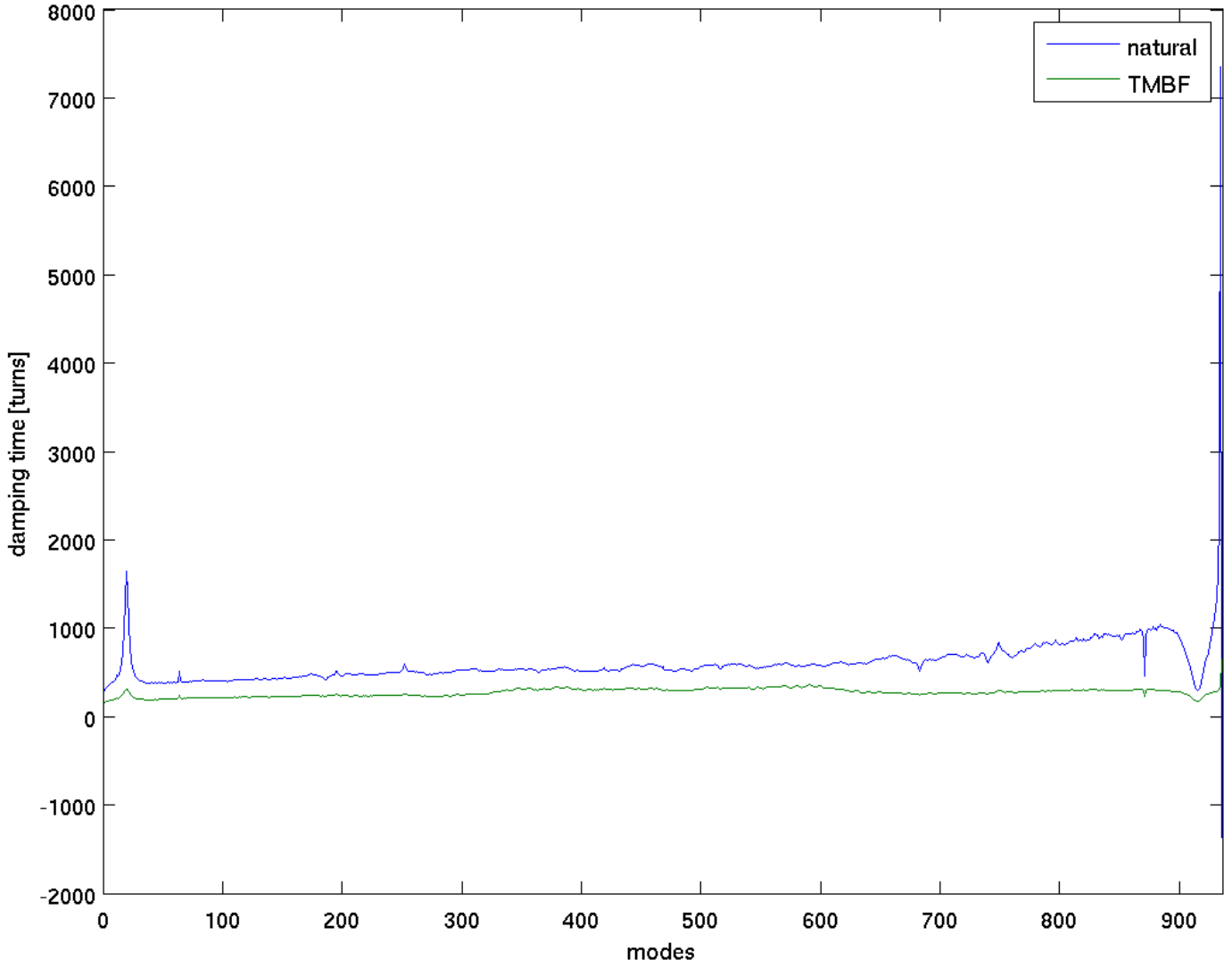
Grow-Damp Multibunch Modes

- We use the sequencer to
  - Start with damped beam (TMBF on)
  - Excite one mode at f=f_rev*(n+q)
  - Switch excitation off, but leave damping off, record mode amplitude turn by turn
  - Switch damping back on, record damping rate, record mode amplitude turn by turn
- Download short waveform of amplitudes over turns (a few 100 points), fit straight lines to log(amplitude), slopes are damping rates
- Scan through all 936 modes (takes 5 minutes)

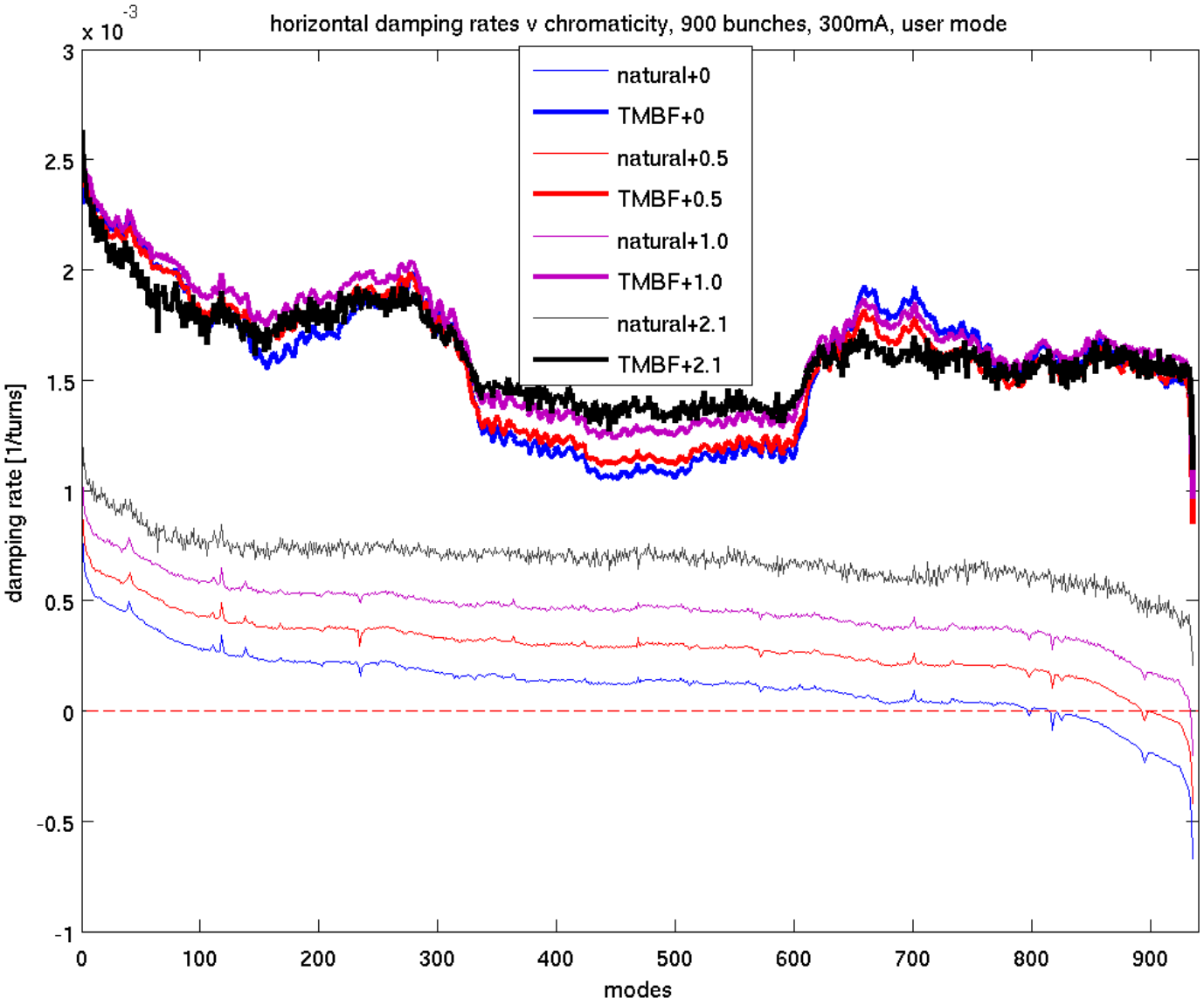
Example Modes



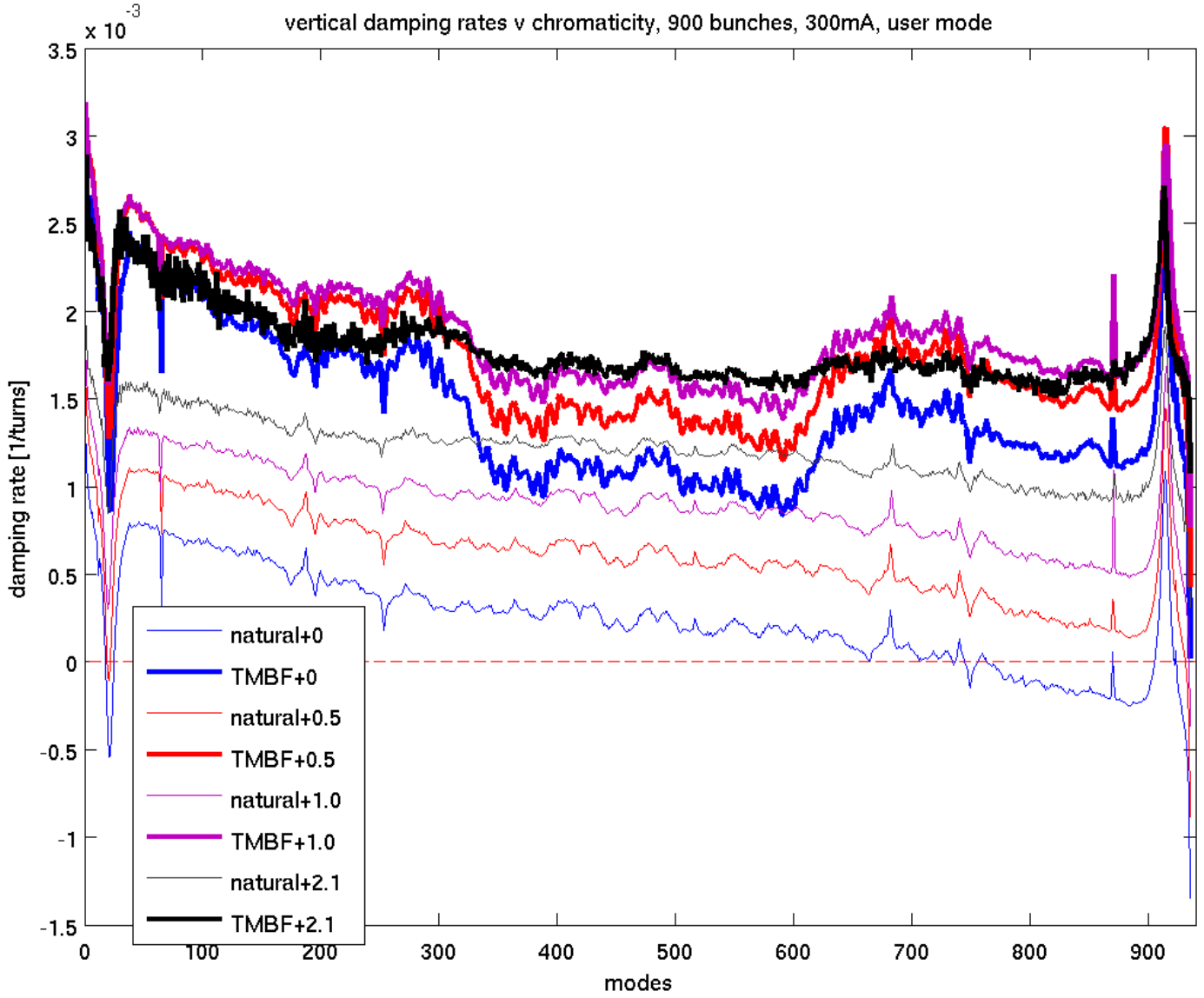
Example Damping times



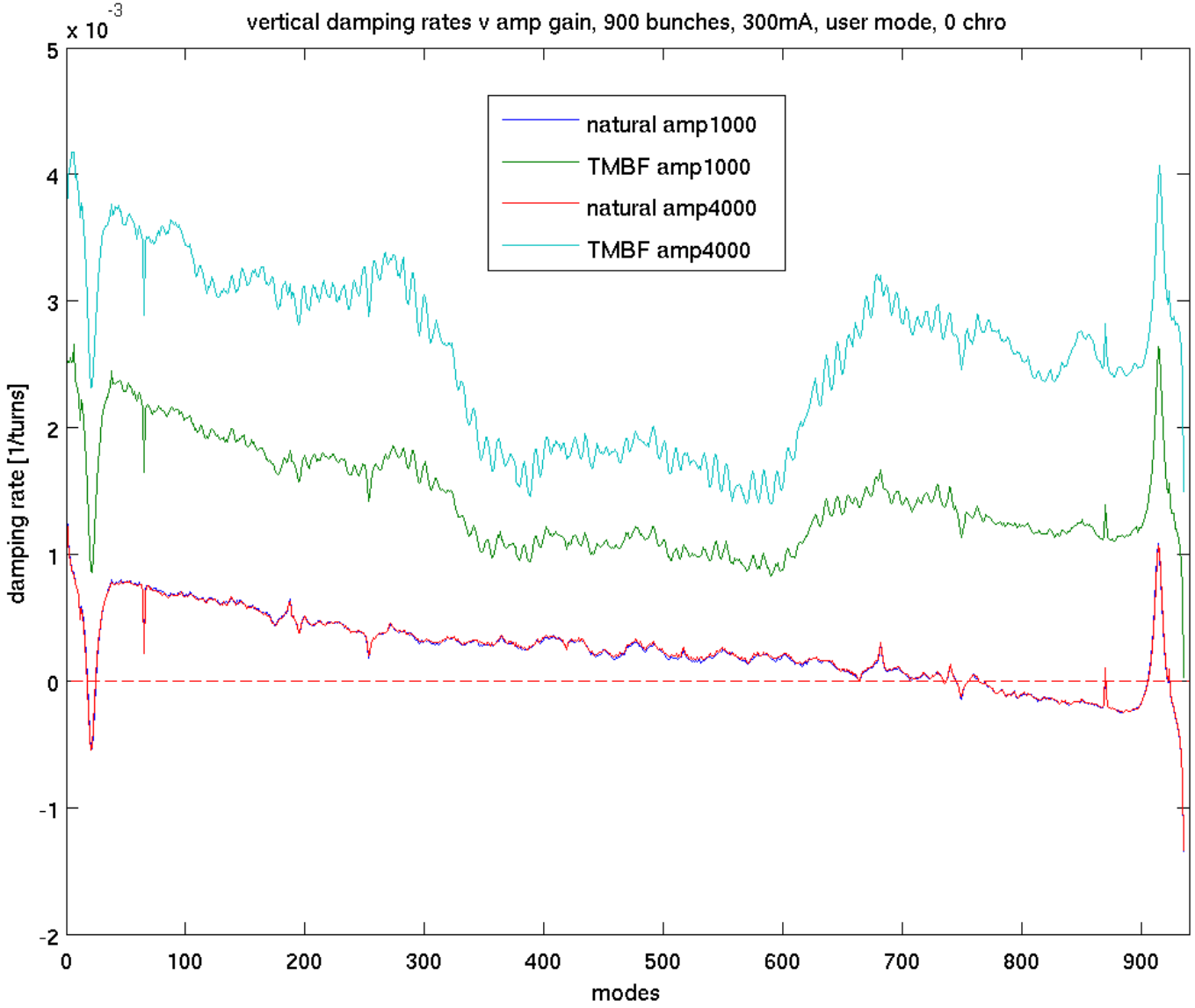
H Damping Rates v Chromaticity



V Damping Rates v Chromaticity



More Gain, Faster Damping



Summary / Issues

- Where do these tune movements originate from? How stable are tunes elsewhere?
- We can measure multi-bunch tune resonance line widths and mode decay rates, will these give the same information?
- What do all the features in the damping rate scans mean?