Chromaticity, Machine Studies

- Phase Modulation Method
- PLL - Radial Loop Method
- Head - Tail Method
- Other methods
  - Classical Method
  - Decoherence
  - Schottky Cavity
  - Using the RF Dipole???

Chromaticity, Machine Studies

D. McGinnis, Fermi Lab Tech Note, PBAR #656, (Feb 16, 2001)

Modulated RF phase

BPM

$$\phi_r = \omega_r t + \frac{\Delta\phi_{rf}}{h}\cos(\Omega_{mod} t)$$

$$x_{pu} = \sqrt{\beta_{pu}}\, A\cos(\phi_\beta)$$

Difference Current from BPM

$$I_\Delta = \frac{\omega_r q_b}{2}\frac{A}{\sqrt{\epsilon_{max}}}\sum_{k=0}^{\infty} C_k \sum_{n=-\infty}^{\infty} J_n(Z)\cos(\omega_{k,n} t + \psi)$$

$$Z = \left(k \pm Q_0 \mp \frac{\xi}{\eta}\right)\frac{\Delta\phi_{rf}}{h}$$

May fail during Gamma-Transition

$$\omega_{k,n} = (k \pm Q_0)\omega_r + n\,\Omega_{mod}$$

$$\psi = k\,\phi_{r_0} \pm \phi_{\beta_0}$$

"The complication of the Bessel functions can be removed if the ***vector signal analyzer*** is capable of ***phase demodulation***. The ***sign*** of the chromaticity can be determined by observing the modulation spectrum at both betatron sidebands."

Chromaticity, Machine Studies

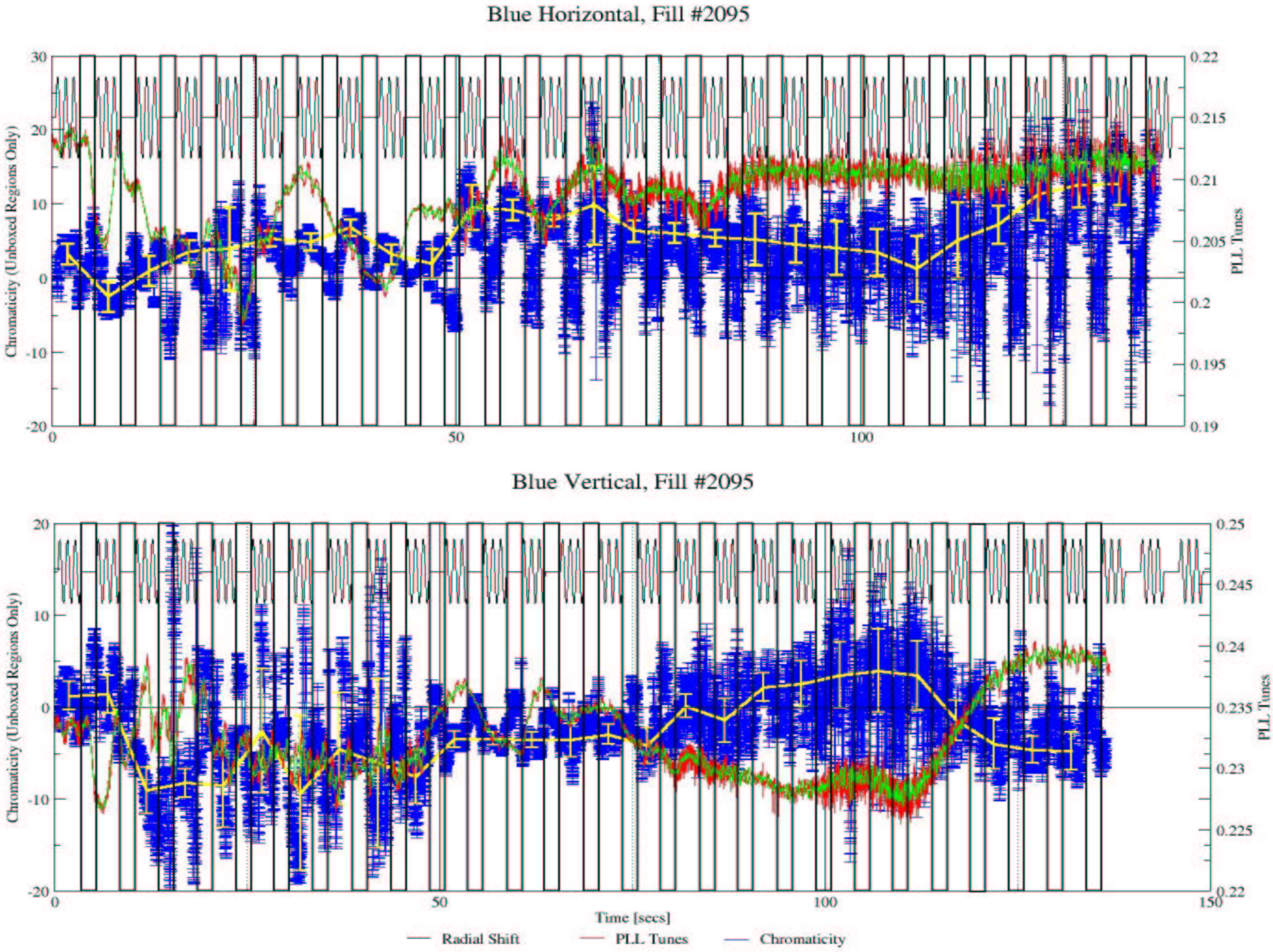
- Apply $\pm 0.2mm$ sine wave to the radial steering
- Fit the tunes to the following function with ω at $1Hz$

$$\nu(t) = A\sin(\omega t) + B\cos(\omega t) + Ct^2 + Dt + E$$

- With linear regression, find A, B, C, D and E and deviations
- Chromaticity is found from the coefficients A and B

$$\xi = \pm\sqrt{A^2 + B^2}\,\frac{\alpha R}{\Delta R}$$

- The sign is found by the angle between A and B


Blue Horizontal, Fill #2095
Chromaticity (Unboxed Regions Only)
PLL Tunes
30
20
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0.22
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0.205
0.2
0.195
0.19
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Blue Vertical, Fill #2095
Chromaticity (Unboxed Regions Only)
PLL Tunes
20
10
0
-10
-20
0.25
0.245
0.24
0.235
0.23
0.225
0.22
0
50
100
150
Time [secs]
Radial Shift
PLL Tunes
Chromaticity