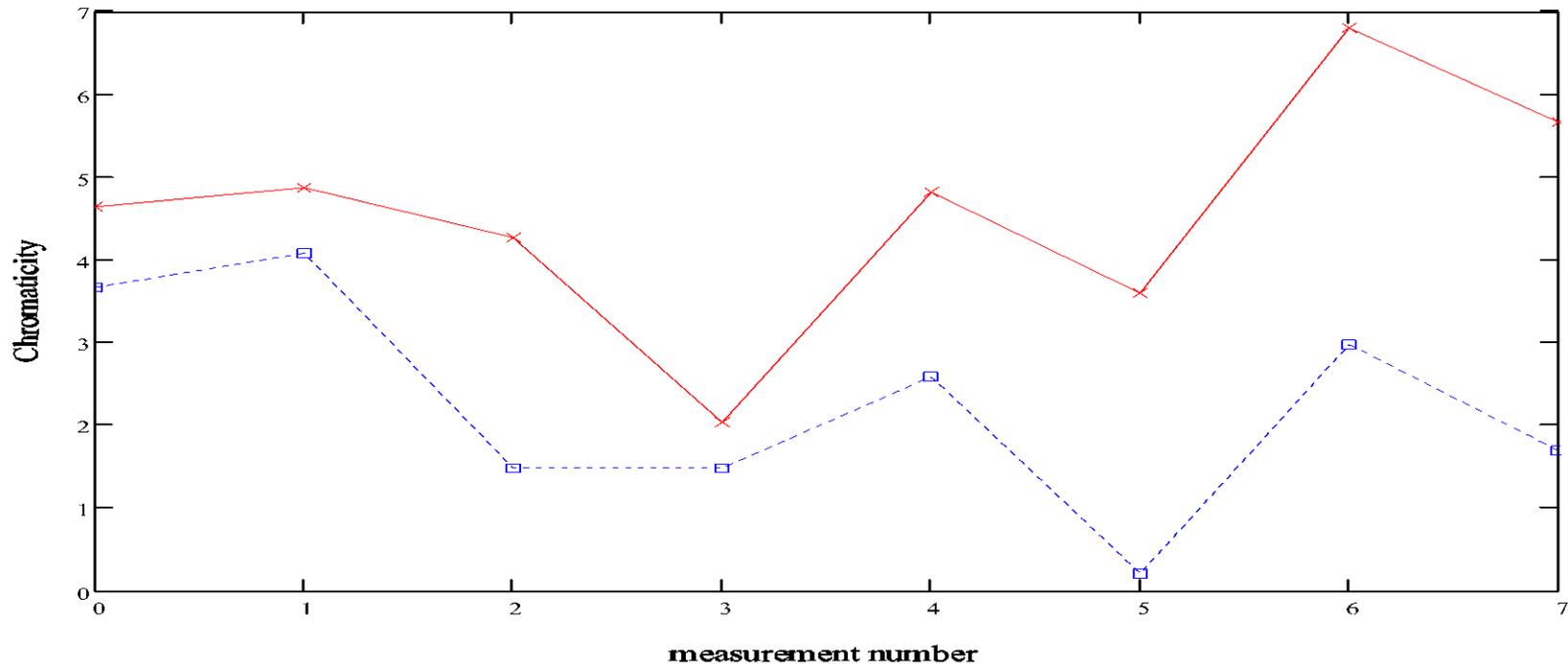


Effect of Higher Order Chromaticity and Impedance on linear Chromaticity in RHIC

- Motivation: Results from Tevatron and simulation. Can we observe an effect in RHIC?
- Expected Effects in RHIC
- Set up the Study

Motivation:



In developing several chromaticity applications for the Tevatron C.Y Tan and I had noticed a consistent difference between linear chromaticity measurements for coalesced and uncoalesced proton with precisely the same optics. For several years we didn't have a good answer as to the cause of this effect. We had explored possible emittance effects and high Dispersion effects, but none of these provided a consistent story. However in simulation work for another paper I had noticed that 2nd order chromaticity together with wakefields could effect the beam in a complex manner.

The introduction of 2nd Order Chromaticity Causes a Shift in the dispersion curves apart From the effects of Impedance.

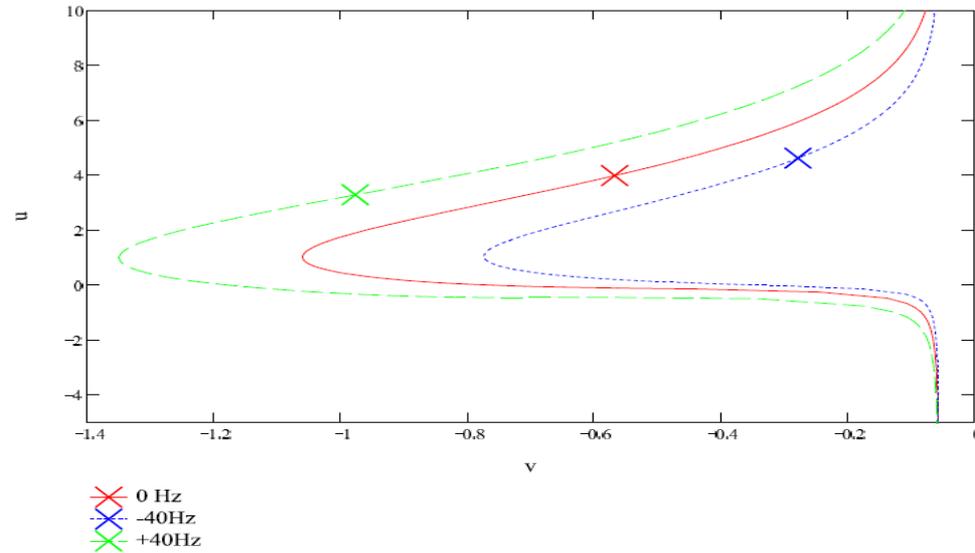
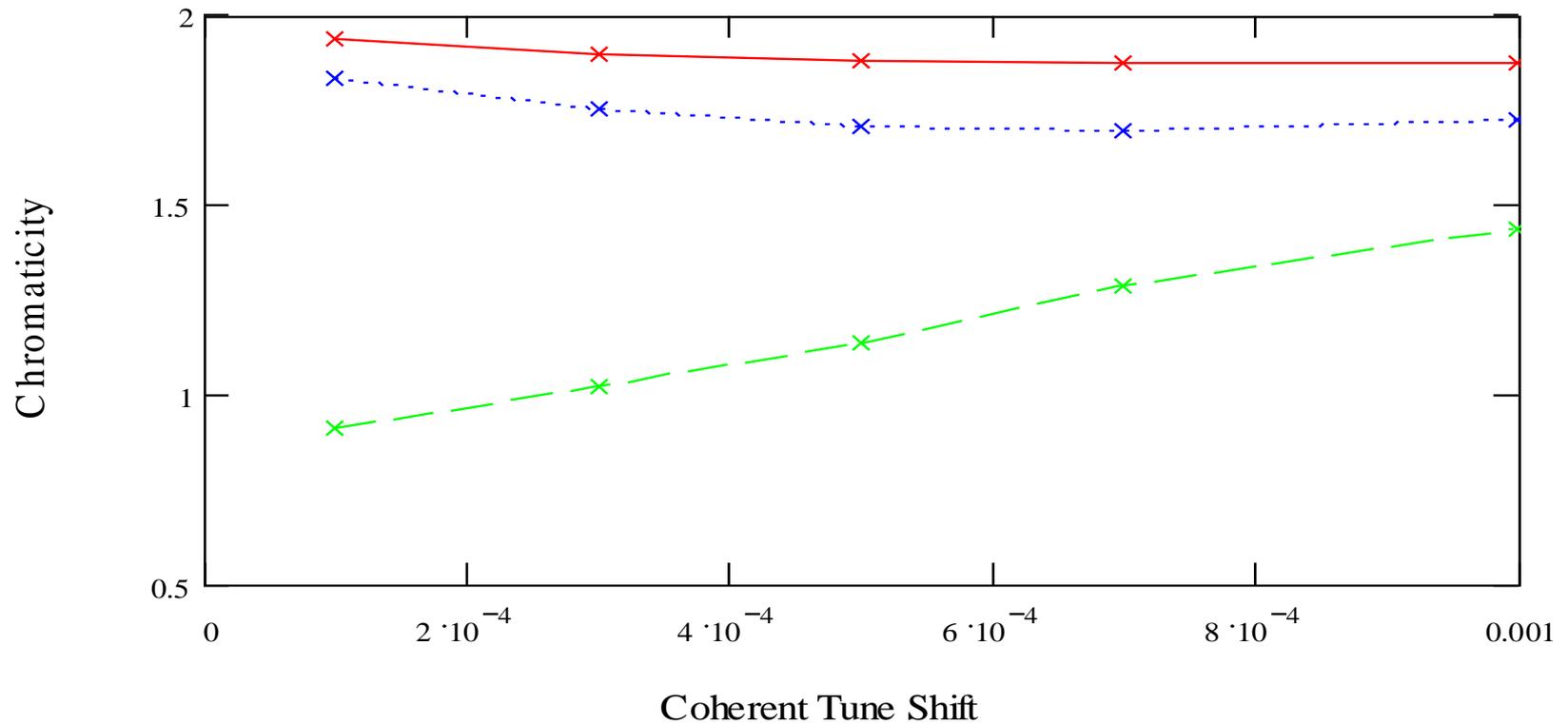


FIG. 3: The normalized u versus v curves for a Gaussian distribution is plotted with growth rate $\text{Im}(\Omega_c) = -0.031\sigma_\omega$ for three δ_0 offsets (40, 0, -40) Hz in the presence of second order chromaticity set to -4000 units. Unlike Fig. 1, the curves are now separated for each δ_0 . The 'x' symbols mark the position of the coherent tune shifts for each δ_0 .

In this case different momentum generate different u - v curves .
This introduces an additional momentum dependence which alters the linear Chromaticity measured.

Gamma=25.9, sigma dp/p = 0.3e-3



*** Q'' = 1000

*** Q'' = 2000

*** Q'' = 4000

Summary of what we expect

Based on the approximation using the Dispersion Integral solution we estimated the effect for the RHIC machine . The effect depends strongly on the strength of the 2nd order Chromaticity . Based on the observed coherent tune shift in the RHIC~ 1-3e-4 at 4000 units of 2nd Order Chromaticity the effect could be > 1 unit of Chromaticity. At more modest levels we found at 200 units of 2nd order Chromaticity the effect to be < 0.07 units. This is perhaps well within any usual measurement error.

Rules of Thumb:

1. higher sigma dp/p higher effect
2. higher 2nd Order Chromaticity higher effect
3. Effect of Coherent tune shift peaks between 1 – 3 e-4 depending on Energy.

Plans for the Study

- Objective to determine response of linear Chromaticity to Intensity
 1. Using $1e9$ particles per bunch for protons measure linear and higher order chromaticity and determine bunch length at injection.
 2. Tune to get linear chromaticity = 2 units and 2nd order 2000 units
 3. Dump and re-inject with slightly higher intensity, repeat Chromaticity measurement and record tune.
 4. Repeat 4, ten times stepping intensity by a factor of 10 each time..or until coherent tune shift moves $\sim 2e4$.
 5. If time permits perform experiment with different bunch lengths.