Tune analysis, 7/5/14

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Task

- Consolidate the different tune analysis methods and put data together

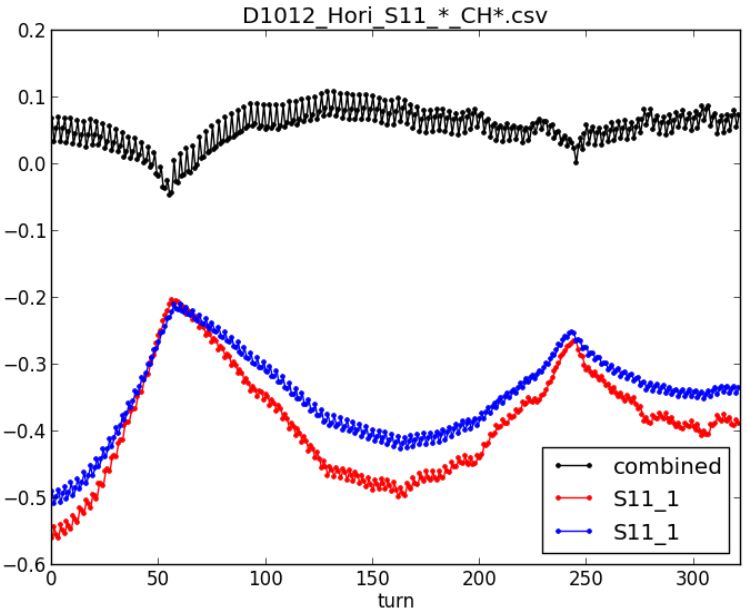
Methods

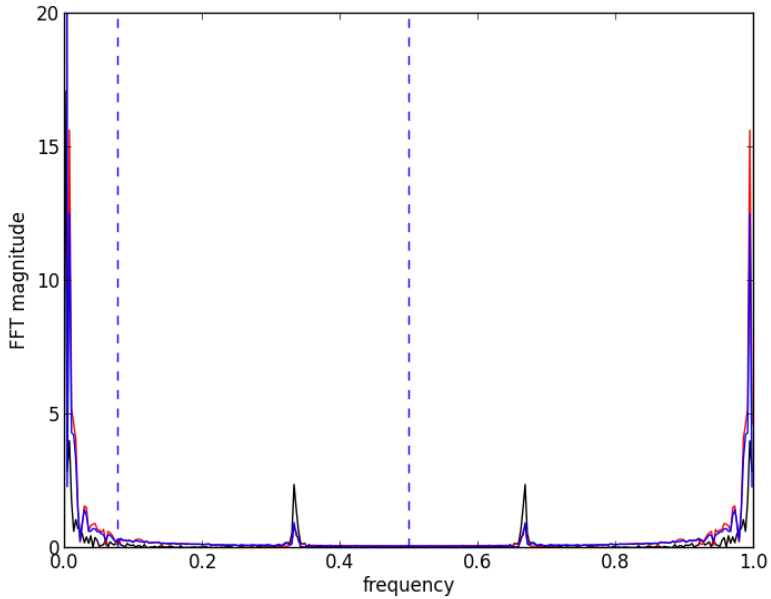
- David first extracted the turn-by-turn peaks, FFT of peak values used to calculate fractional tune.
- Chris R took FFT of entire signal and looked for sidebands of harmonics of revolution frequency. Histogram of sideband widths should give fractional tune.
- Both calculates could probably be improved using NAFF.
- Other methods Kuriyama-san and Ishi-san not included so far.

Data

- 2/4/14, Tacc_500usec.tar.gz only
- Scope ch 1-4 = S7up, S7dw, S11_1, S11_2
- Scan D current from 890 – 1110 A.
- Filenames indicate whether a horizontal perturbation or injection offset in vertical plane was applied (“Hori” or “Vert” in filename) to increase magnitude of coherent oscillations in the respective planes.

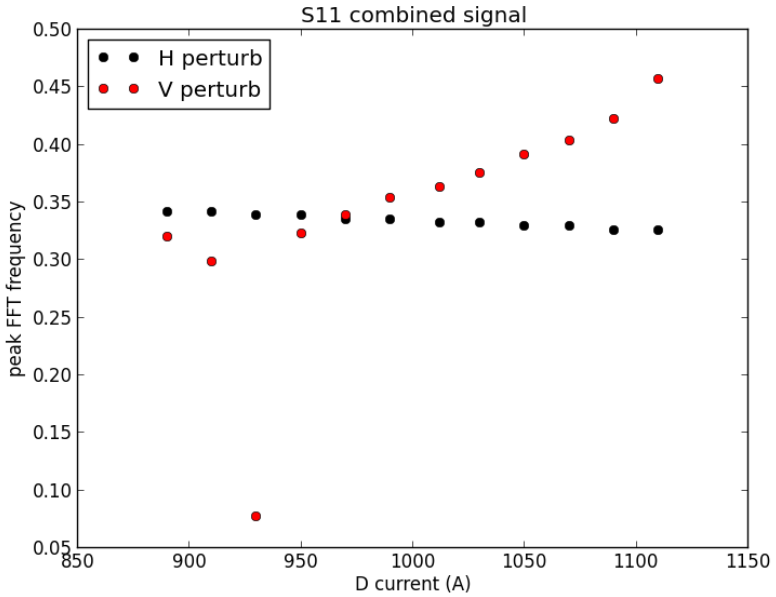
“FFT of peaks” method





- Extract peaks from data. Subtract baseline voltage. Take FFT.
- Betatron oscillations take about 3 turns. Seems reasonable to ignore low frequency components in FFT.
- Dotted vertical lines in figure on right indicate range included in search for maximum FFT component.

S11 FFT results (1)



- With vertical perturbation (injection offset) the frequency rises with D current. The monitor may simply be picking up the betatron oscillation in the vertical plane (as seen in data from 1/4/14).
- For the horizontal perturbation case the frequency falls with D and is in a much smaller range, 0.32-0.34. This may be the fractional part of the horizontal tune.

“FFT all data” method

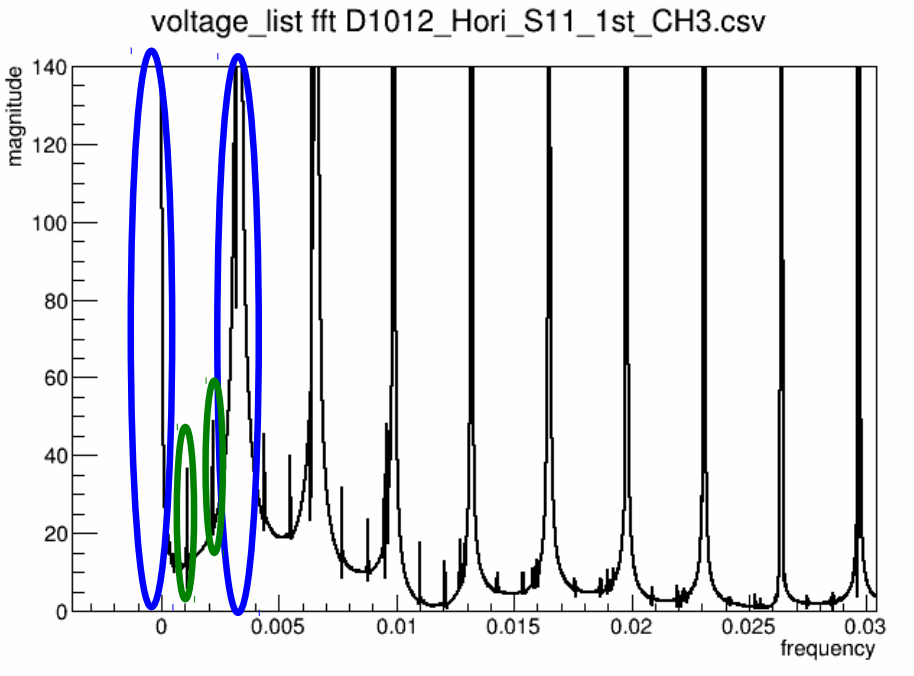
Find principle peaks (blue)

Search for subpeaks (green)

Repeat for first 10 principle peaks

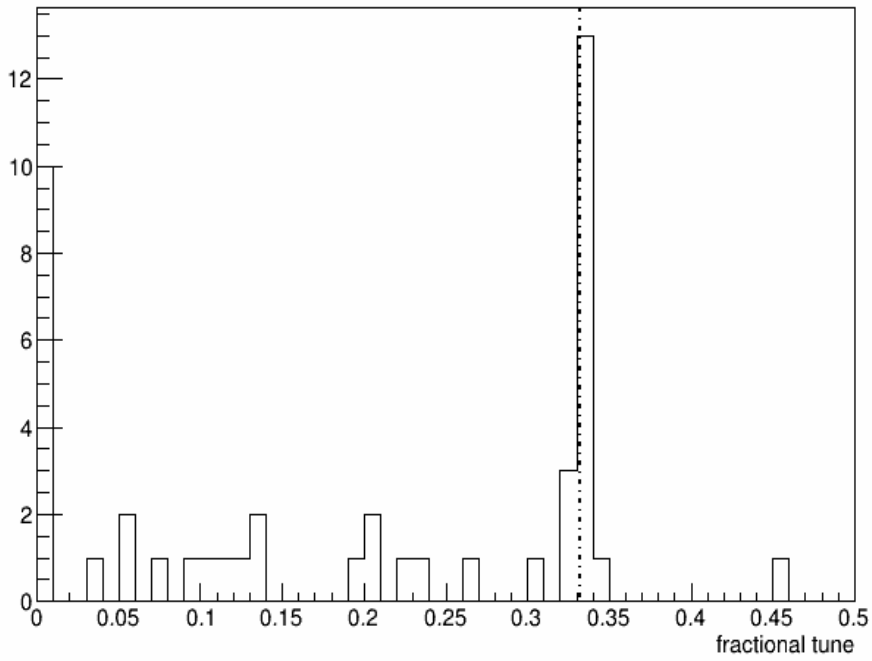
Calculate tune only in range 0 – 0.5

- If q > 0.5: q = 1-q

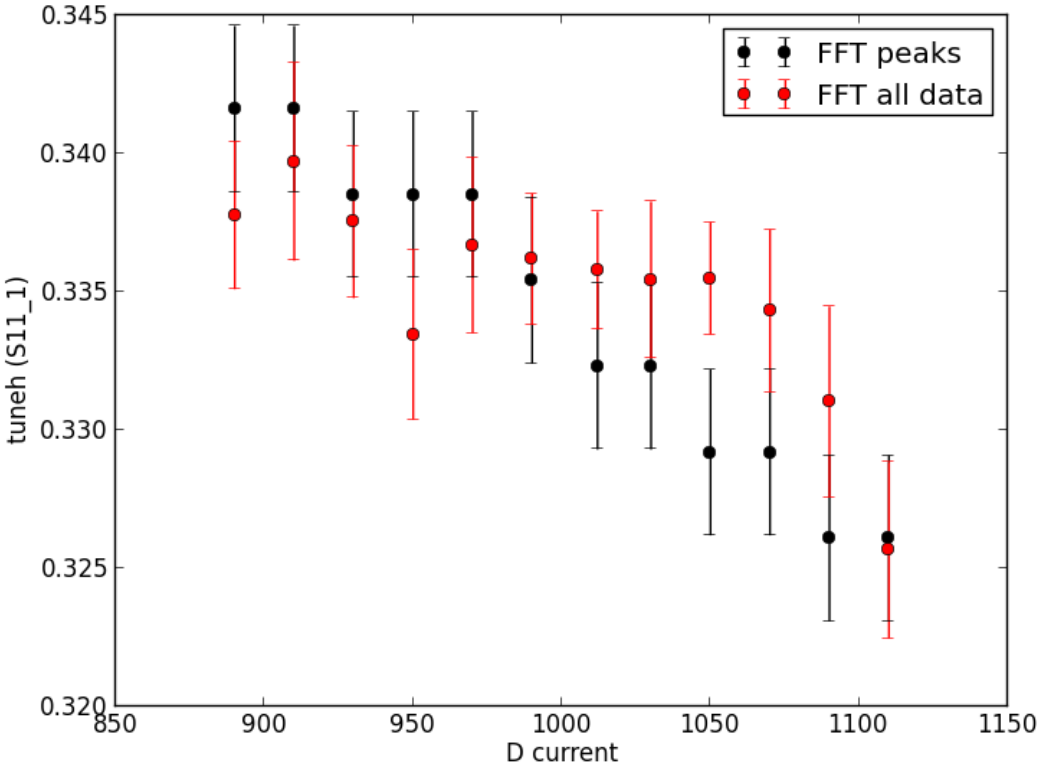


Tune Calculation

- Histogram calculated fractional tunes
- Search for peak in the histogram
  - Take average of peaks in region with tune +/- 0.05
  - Error is RMS/sqrt(n)



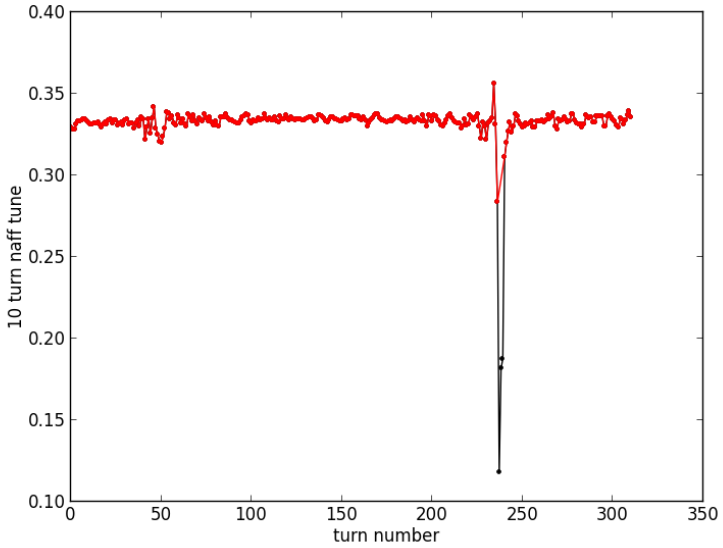
Example comparison of resulting tunes

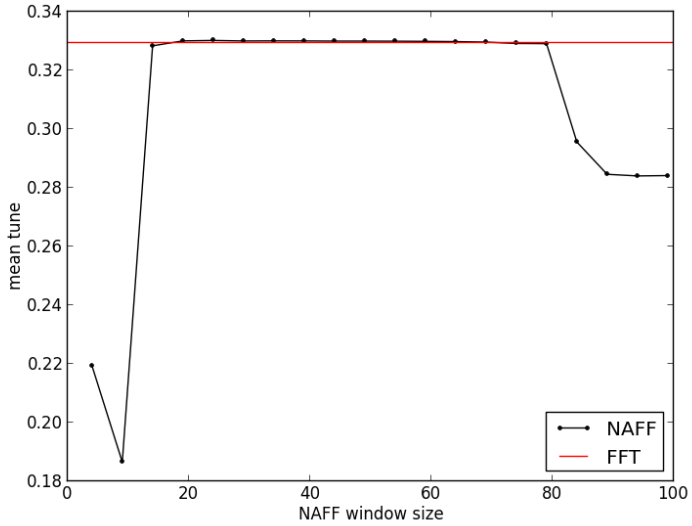


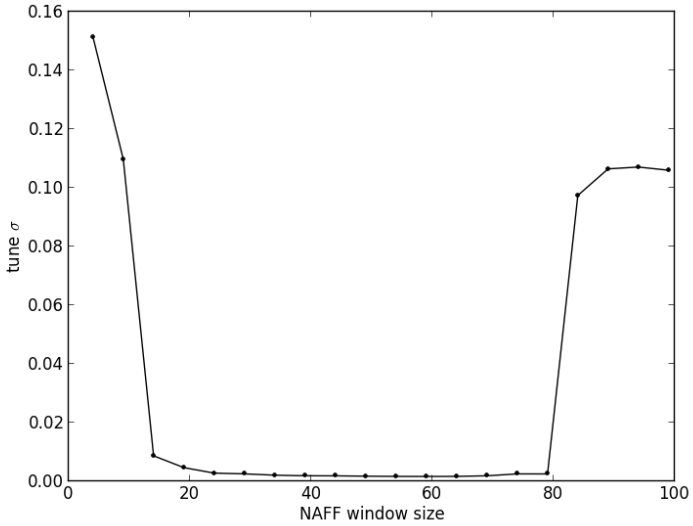
- Error bar for “FFT peaks” is simply 1/N where N~ 300 turns
- For “FFT all data” it’s rms/sqrt(n)

NAFF

- Decide on NAFF window size.
- 30 turns looks reasonable







NAFF vs FFT example