e+/e- Vertical Beam Dynamics during CESR-C Operation

I. **Introduction**
II. **e+ turn-by-turn vertical dynamics**
III. **e- turn-by-turn vertical dynamics**
IV. **Summary**

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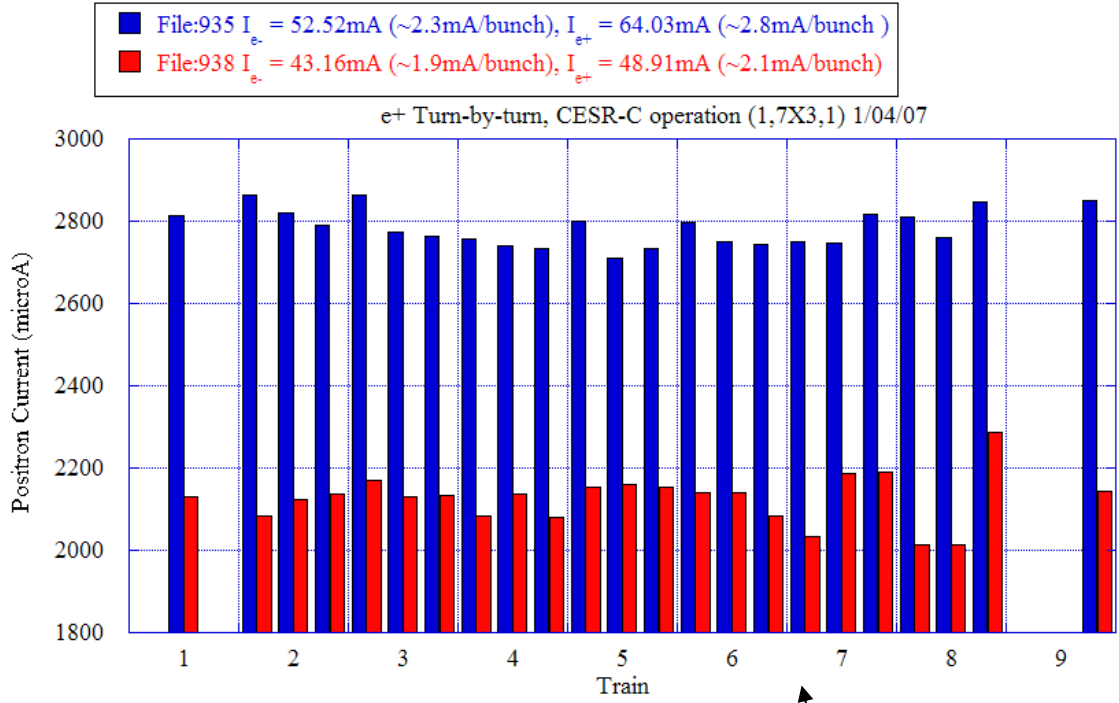
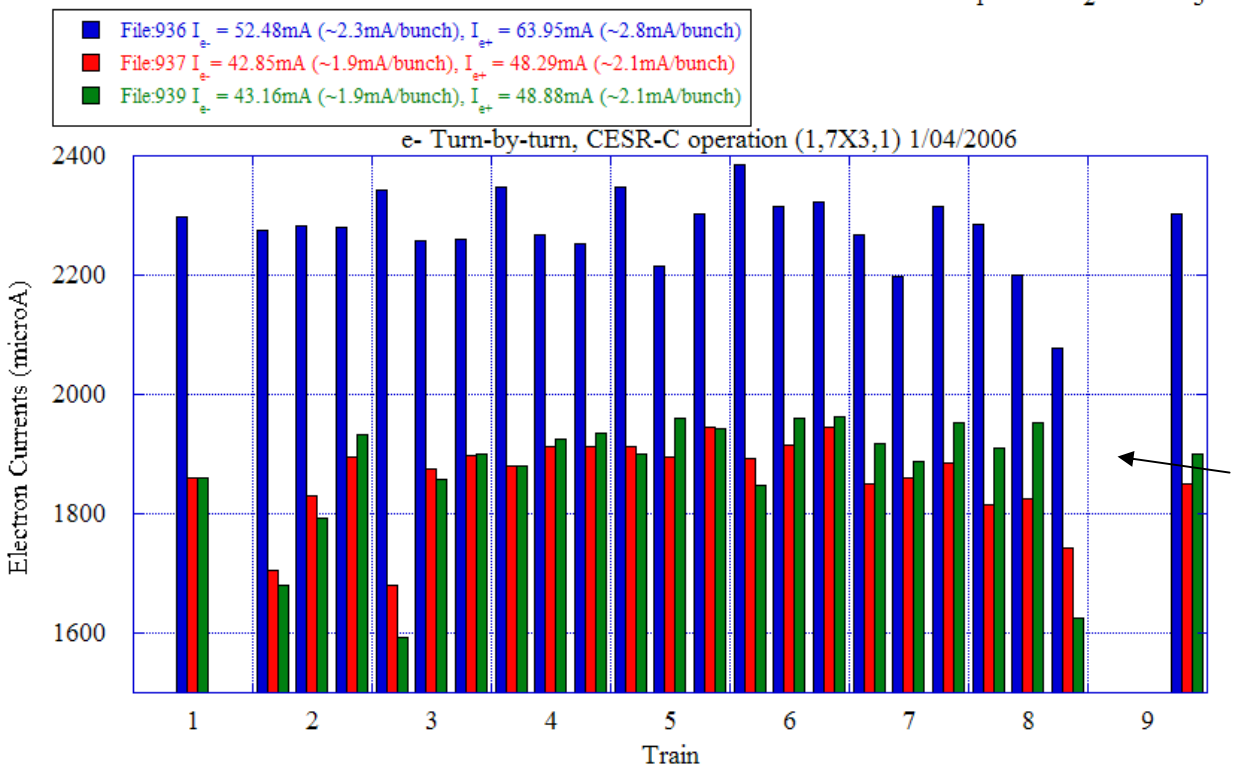
I. Introduction

e+/e- CESR-C
1,7x3,1 Pattern
Single bunch currents

Turn-by-turn vertical beam distribution measurements made at the beginning and end of a CESR-C run and the end of a 2nd CESR-C run (a different fill). Δt=32 min between the first two measurements. Δt=74 min between the 2nd and 3rd measurement. The 2nd measurement was made for electrons only.





e+ current/bunch
Lifetime does not appear to follow a particular pattern.

e- current/bunch
Injection determines the current pattern at high I. For low I, lifetime does not appear to follow a particular pattern.

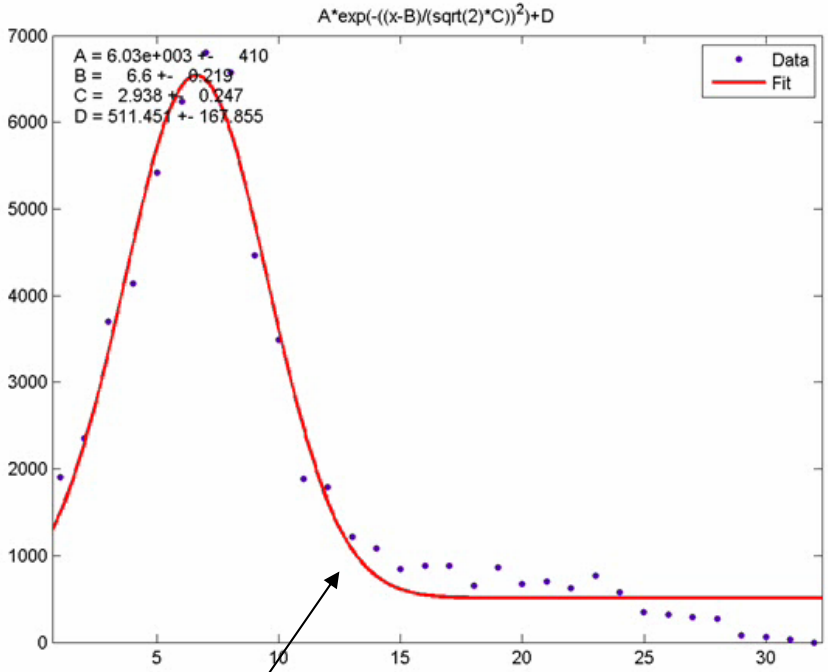
II. e+ turn-by-turn measurements

e+ single bunch vertical bunch distributions from the PMT array.

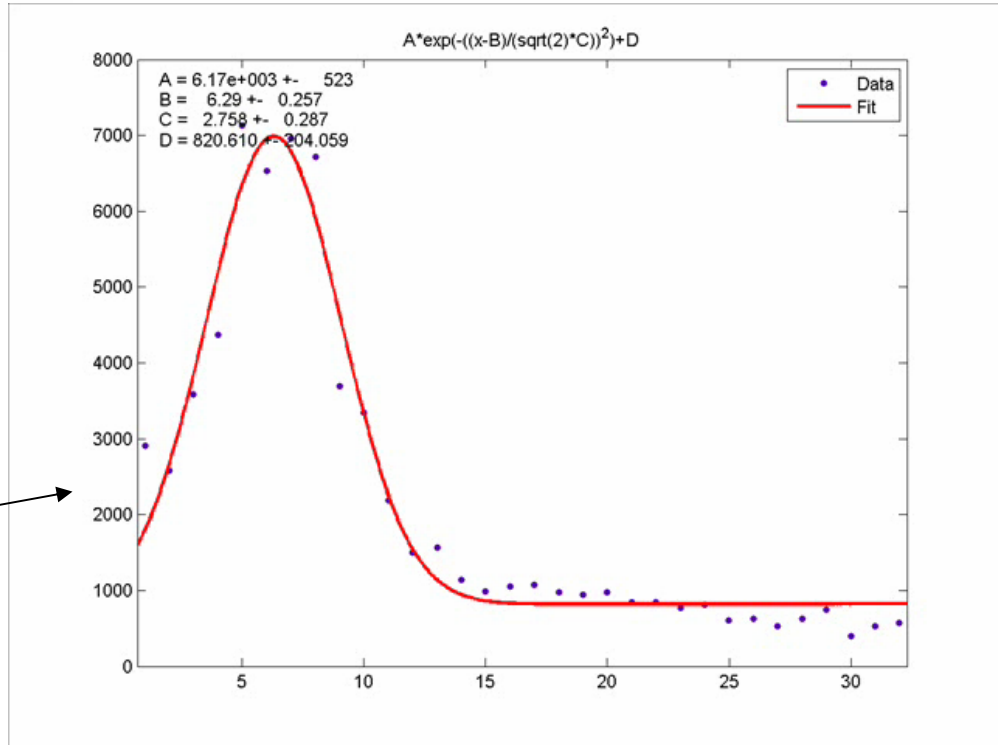
•10,000 turns of all 23 e+/e- bunches.

•Reflections in the optical system required that the vertical profile be moved to one side.

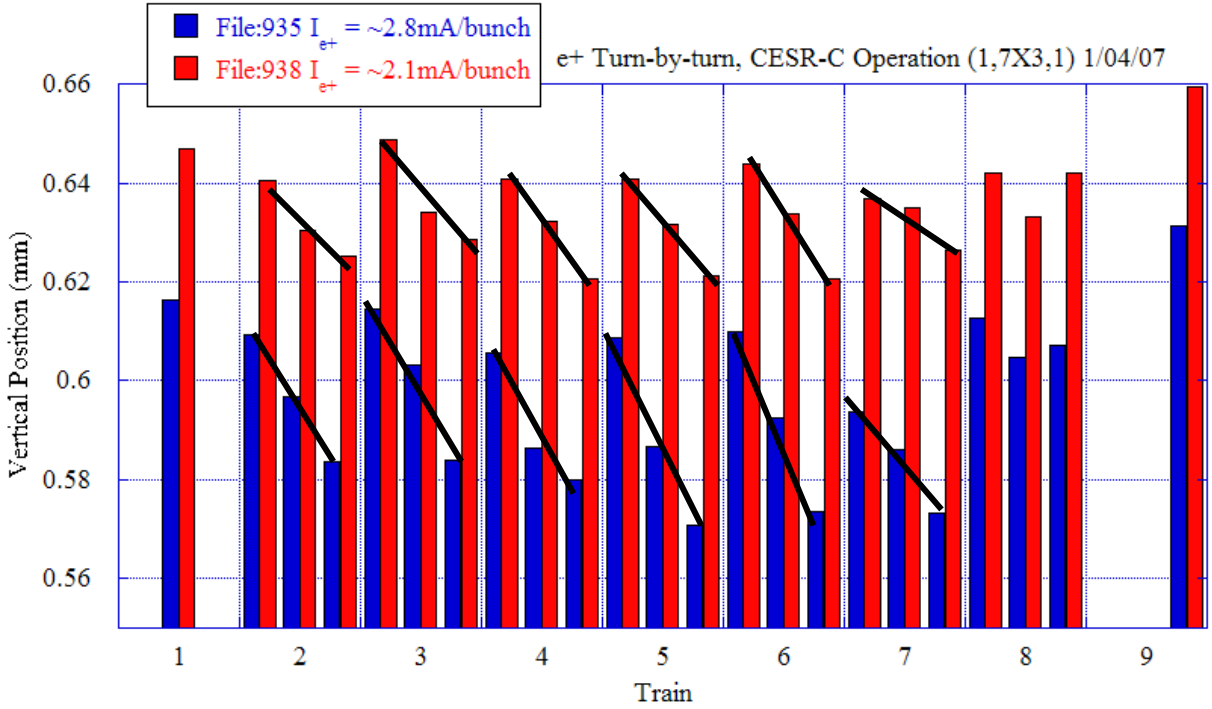
• High I File:935 I_{e+}= 2.8mA/bunch



e+ Bunch 4 Train 1
1st ten turns (movie)



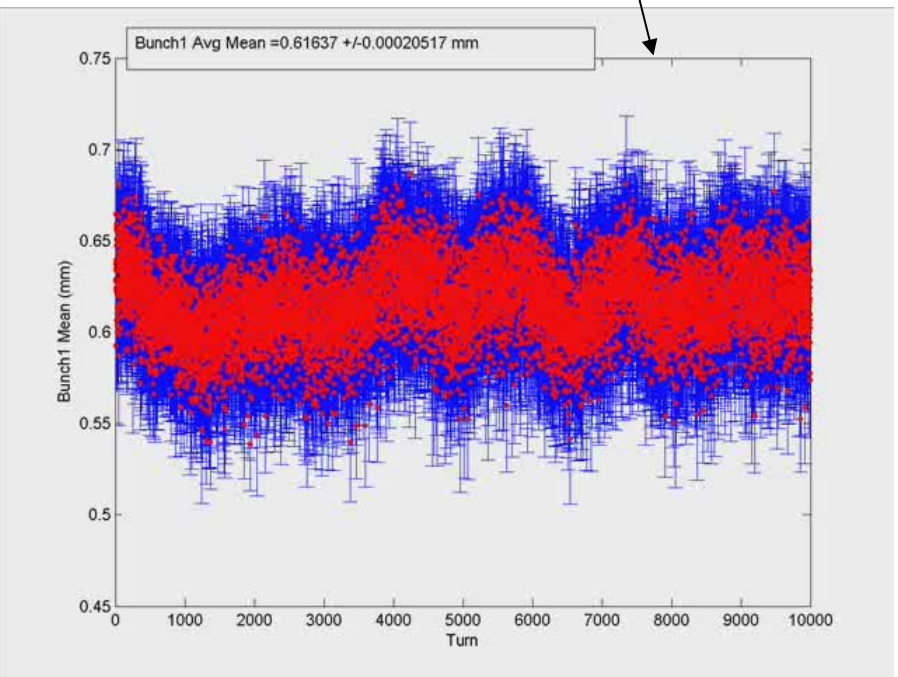
e+ Bunch 2 Train 4
1st ten turns (movie)



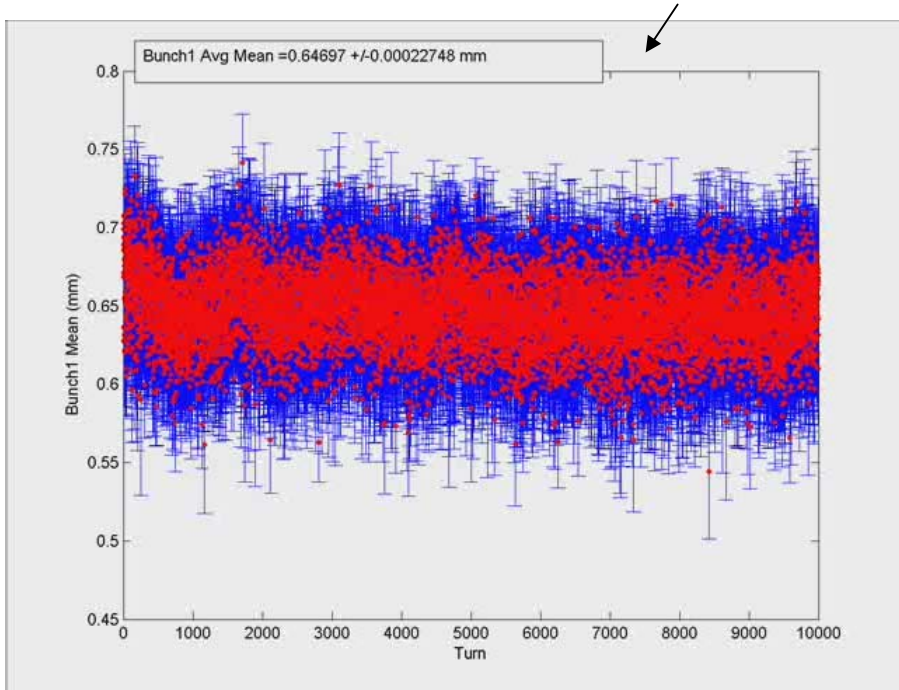
e+ Vertical Position

- e+ mean vertical position along the train-offset was included to have the plots coincide.
- Mean vertical position for 10,000 turns for 54 bunches.
- Low frequency vertical oscillation is denoted for all 54 bunches.
- At high I, a significant drop in vertical position is denoted along the train.

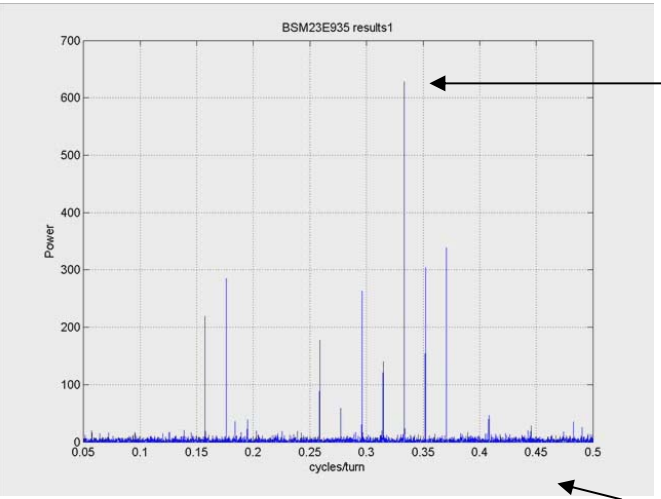
High I File:935 I_{e+}=2.8mA/bunch (movie)

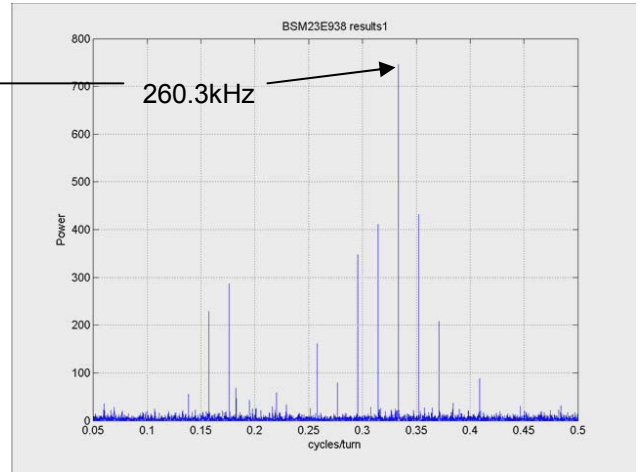


Low I File:938 I_{e+}=2.1mA/bunch (movie)



e+ vertical position oscillation- FFT of vertical position for 9,000 turns



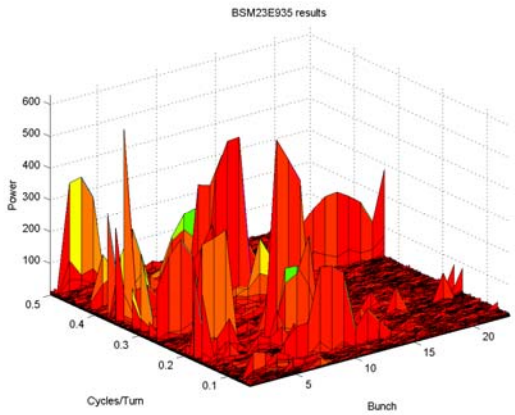


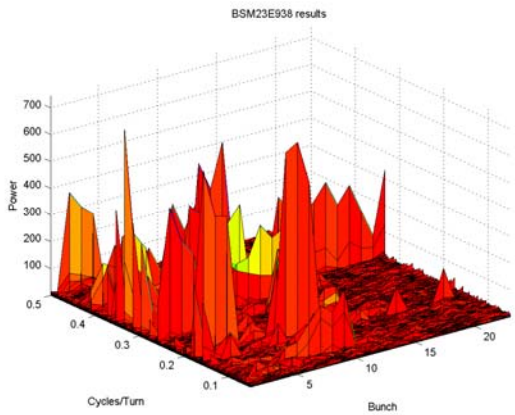
- FFT of vertical position for each bunch
- Vertical position peak oscillation frequency at ~ 260.3kHz.
- Many oscillation frequencies show up at power comparable to that of the main oscillation frequency.
- The vertical tune was measured as 255.4kHz at 12:54 pm on 1/4/07, with I+=60mA, I-=50mA.

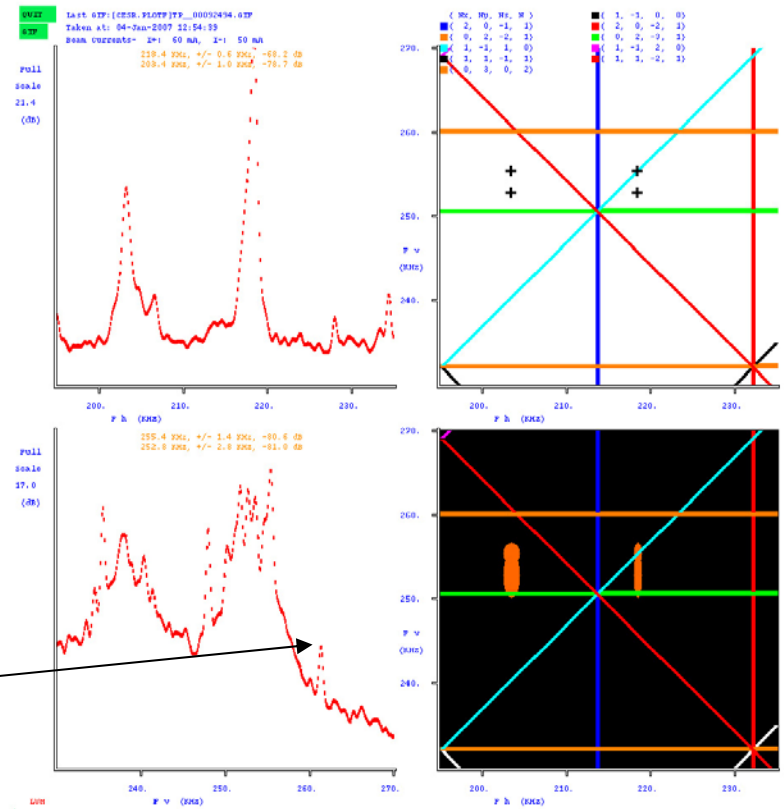
High I File:935 I_{e+}=2.8mA/bunch

movies

Low I File:938 I_{e+}=2.1mA/bunch

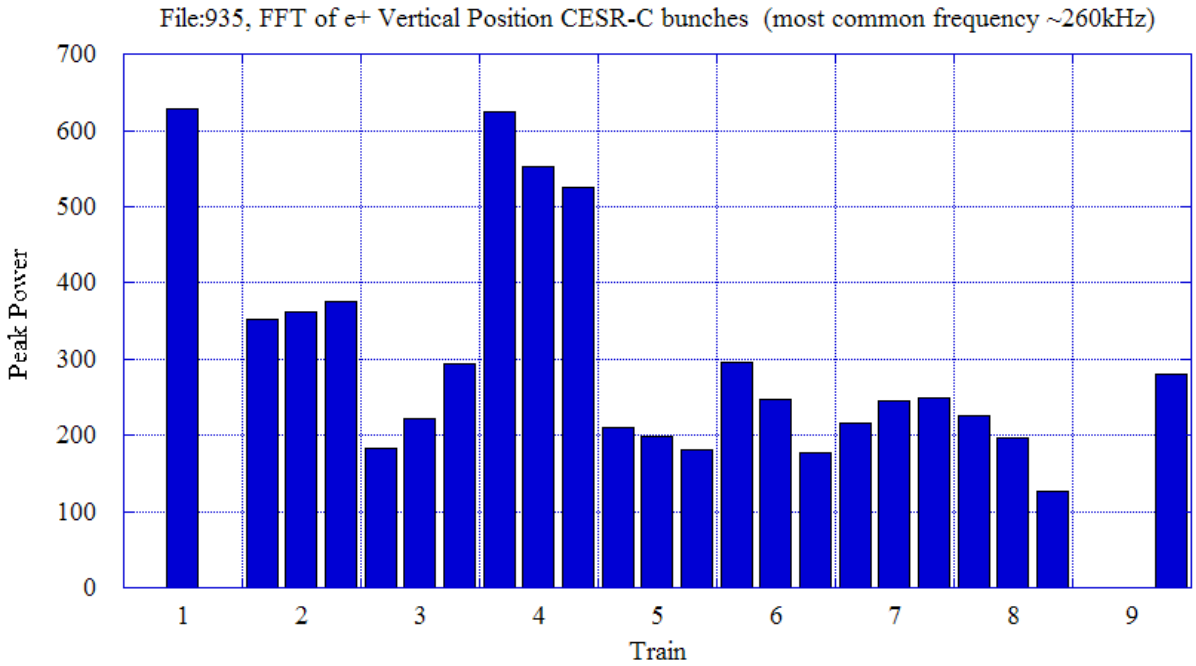


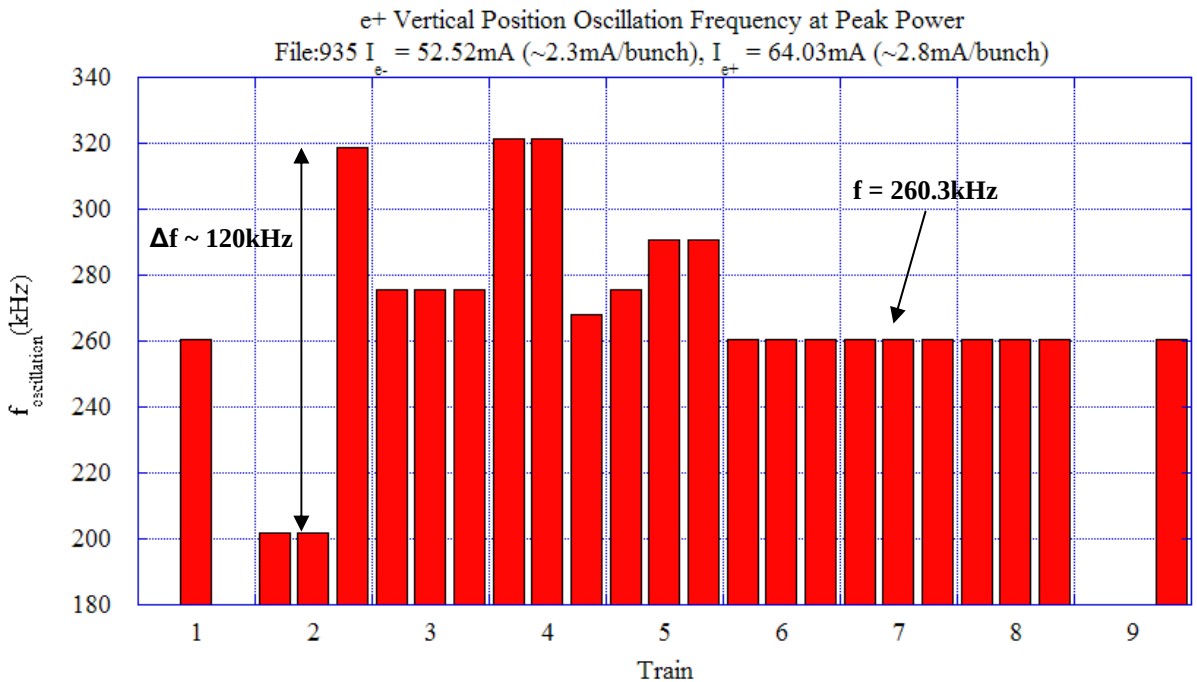




This peak appears very near to the 260.3kHz oscillation frequency that shows up consistently in this date's measurements.

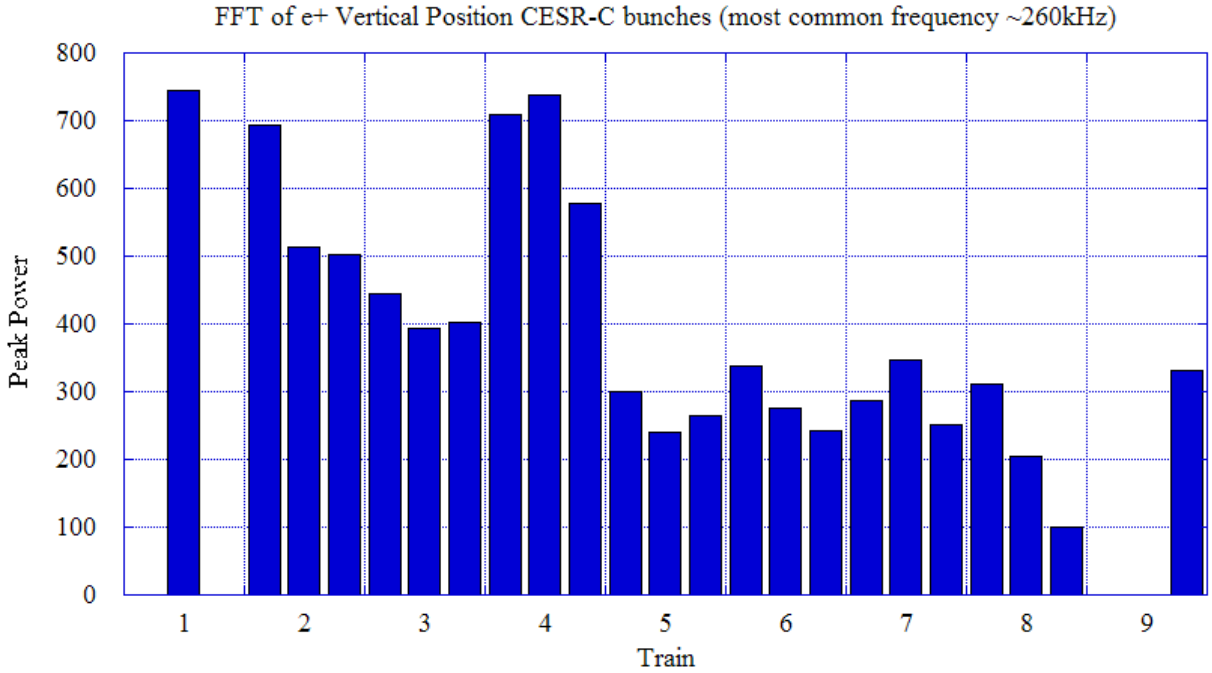
e+ vertical motion-Power and Frequency of Oscillation, High I File:935 I_{e+}=2.8mA/bunch



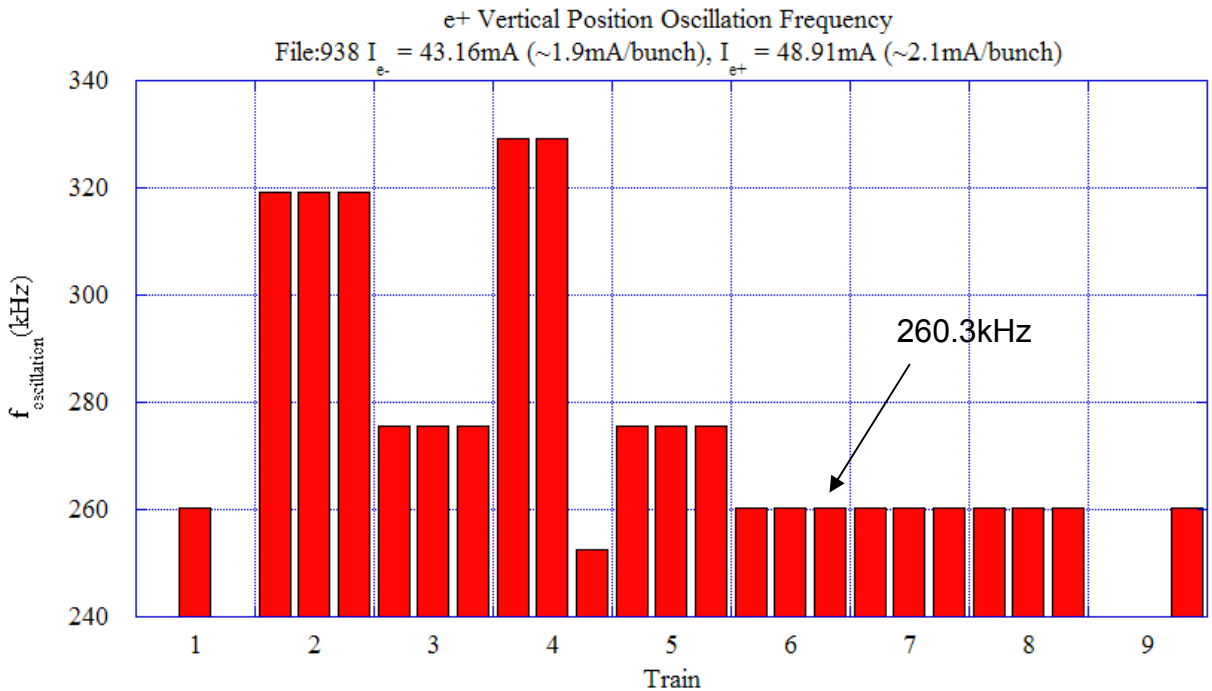


- Trains 1 and 6-9 share the same peak oscillation frequency (260.3kHz), near the measured vertical tune.
- Note that a small peak in the vertical tune measurement appears to be very near to 260.3kHz (see previous slide).
- Bunches in trains 2-5 have widely varying peak oscillation frequencies. The power of the 260.3kHz line decreases drastically for these bunches, to near the noise level for most cases.

e+ vertical motion-Power and Frequency of Oscillation, Low I File:938 I_{e^-}=2.1mA/bunch

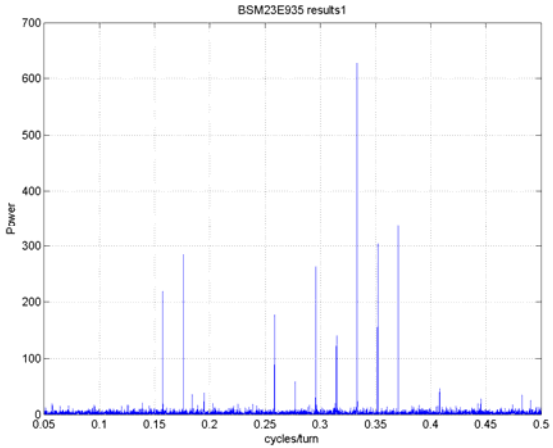


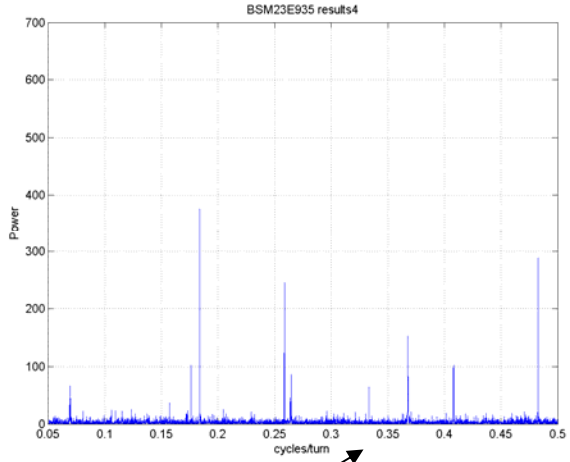
- Trains 1 and 6-9 share the same peak oscillation frequency (260.3kHz).
- Peak oscillation frequencies vary between trains 2-5, but in all but the last bunch of train 4, each bunch in the train displays the same peak oscillation frequency.

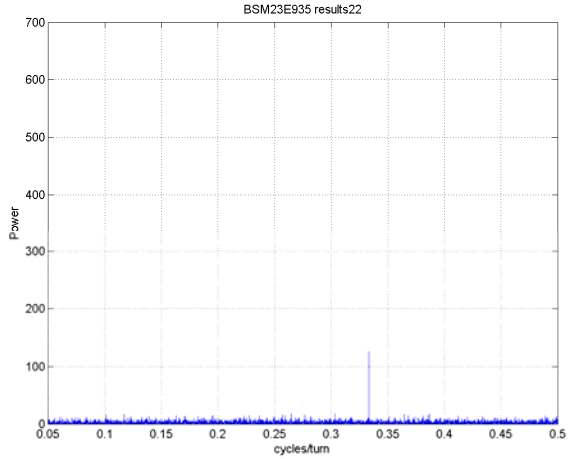


Peak oscillation frequencies, corresponding to the peak powers above.

e+ FFT power dependence on vertical position oscillation amplitude– High I







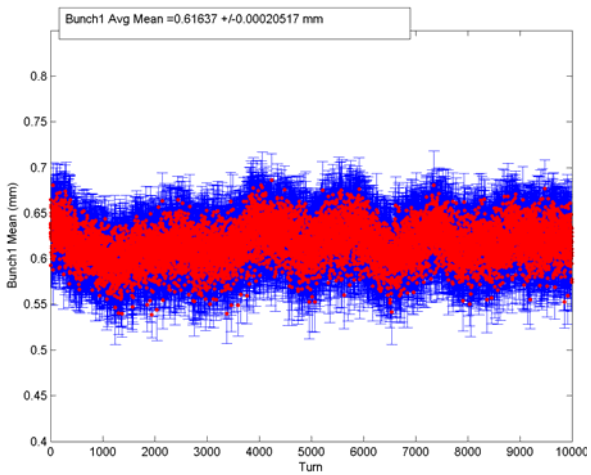
Bunch 1
Peak Power=628@260.3kHz
y_{avg}=0.616mm
Std=0.020mm

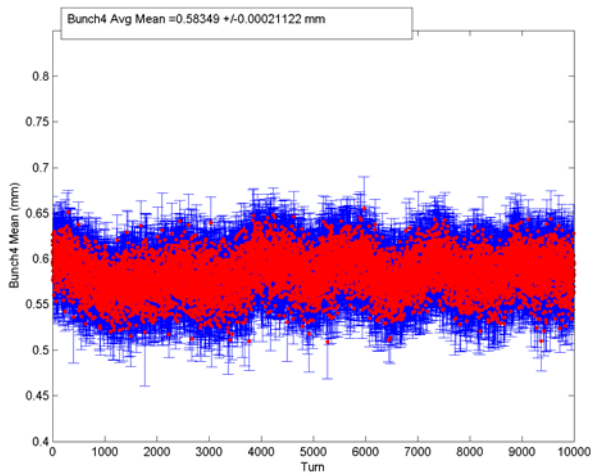
Bunch 4
Peak Power=376@318.6kHz
y_{avg}=0.583mm
Std=0.021mm

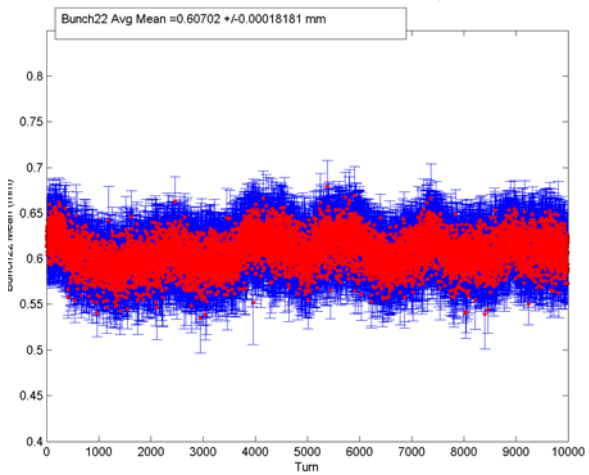
Bunch 22
Peak Power=125@260.3kHz
y_{avg}=0.607mm
Std=0.018mm

File:935 I_{e+}=2.8mA/bunch

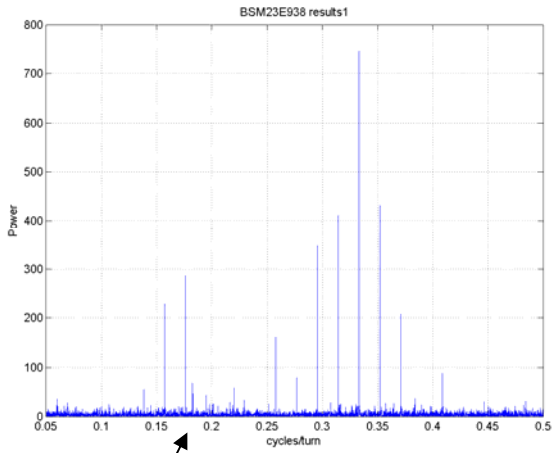
- Many frequencies are apparent, but they do not appear to correlate with the amplitude of vertical position oscillation.

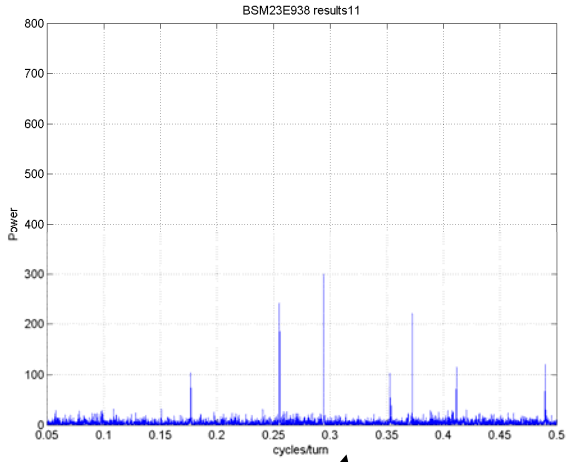


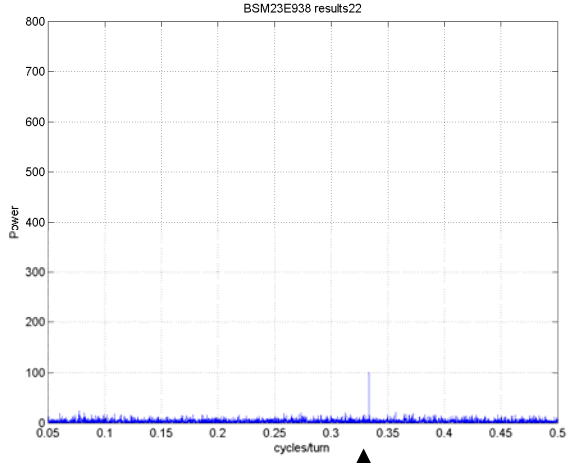




e+ FFT power dependence on vertical position oscillation amplitude– Low I





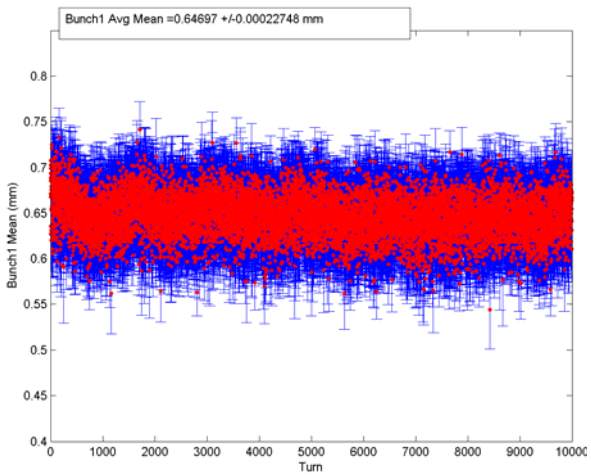


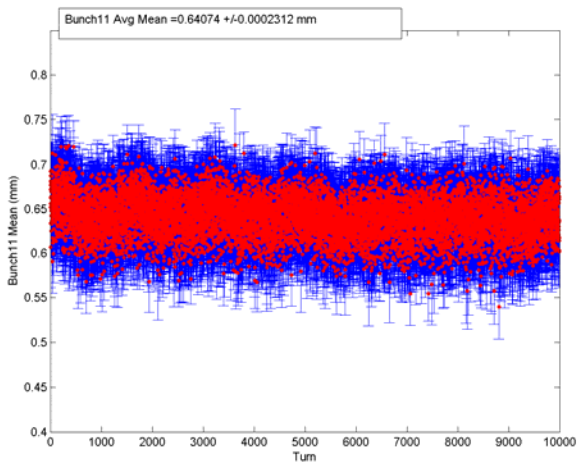
Bunch 1
Peak Power=745@260.3kHz
y_{avg}=0.647mm
Std=0.023mm

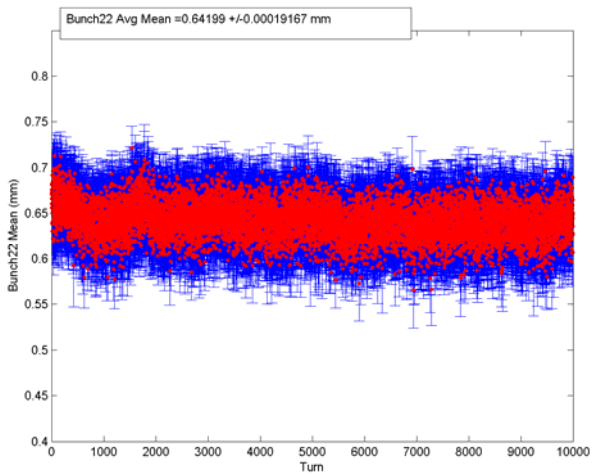
Bunch 11
Peak Power=299@275.4kHz
y_{avg}=0.641mm
Std=0.023mm

Bunch 22
Peak Power=100@260.3kHz
y_{avg}=0.641mm
Std=0.019mm

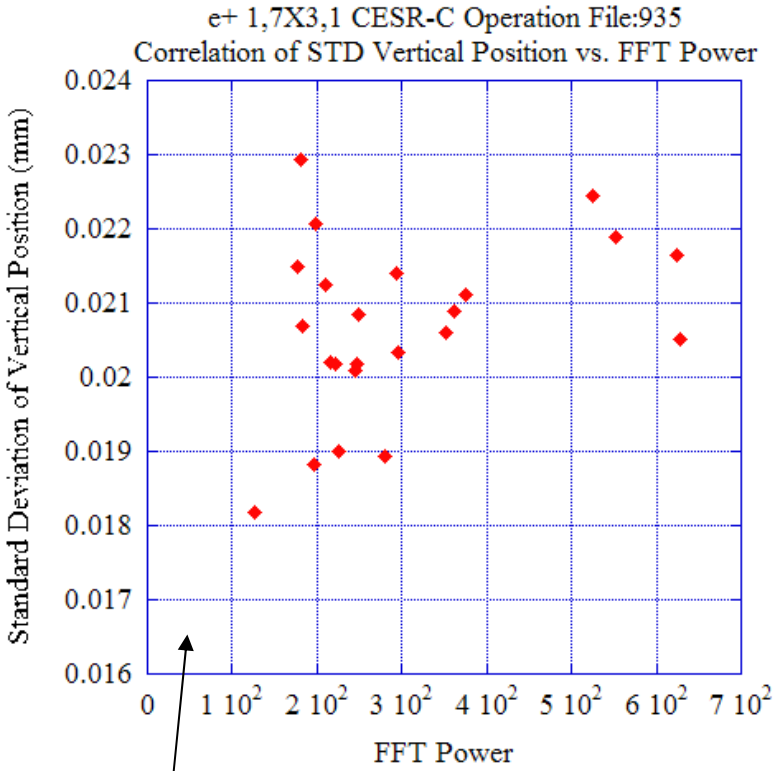
File 938 I_{e+}=2.1mA/bunch
•The oscillation amplitude appears to be relatively constant.







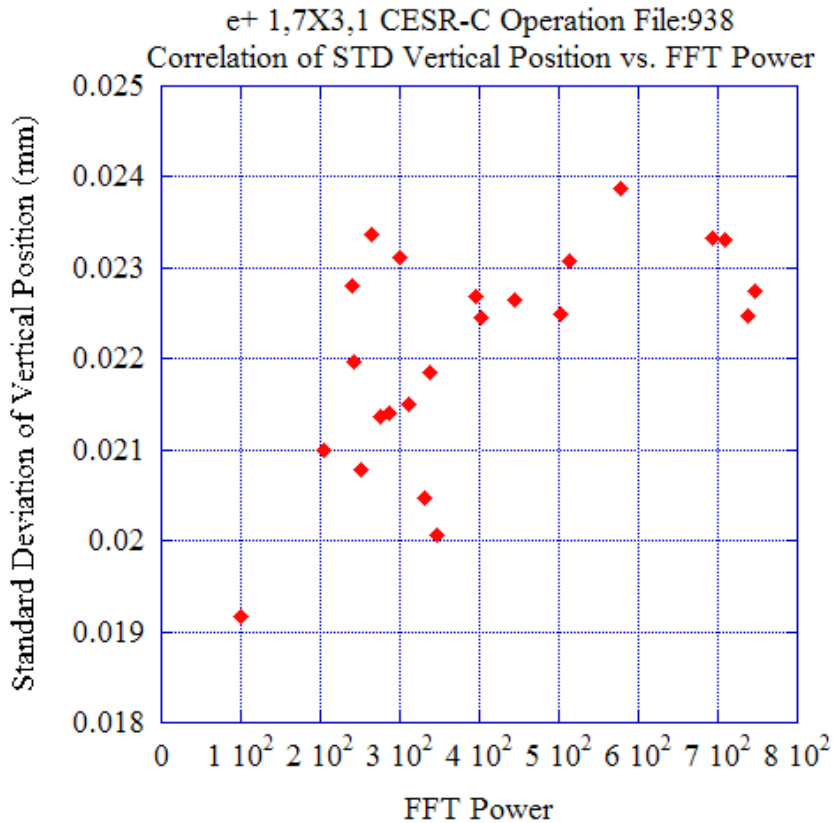
e+ vertical position oscillation amplitude

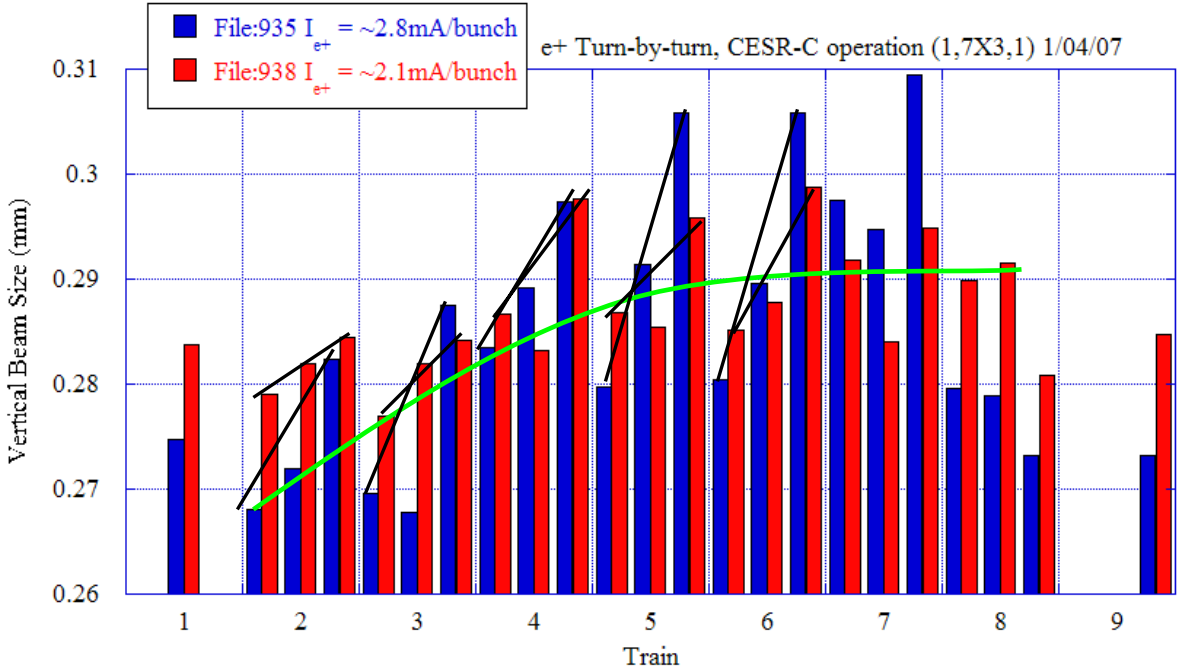


High I File:935 I_{e+}=2.8mA/bunch

There is no apparent correlation between the peak power of vertical position oscillation and the standard deviation in the vertical position measurement. Note: the change in standard deviation is small in these plots.

Low I File:938 I_{e+}=2.1mA/bunch

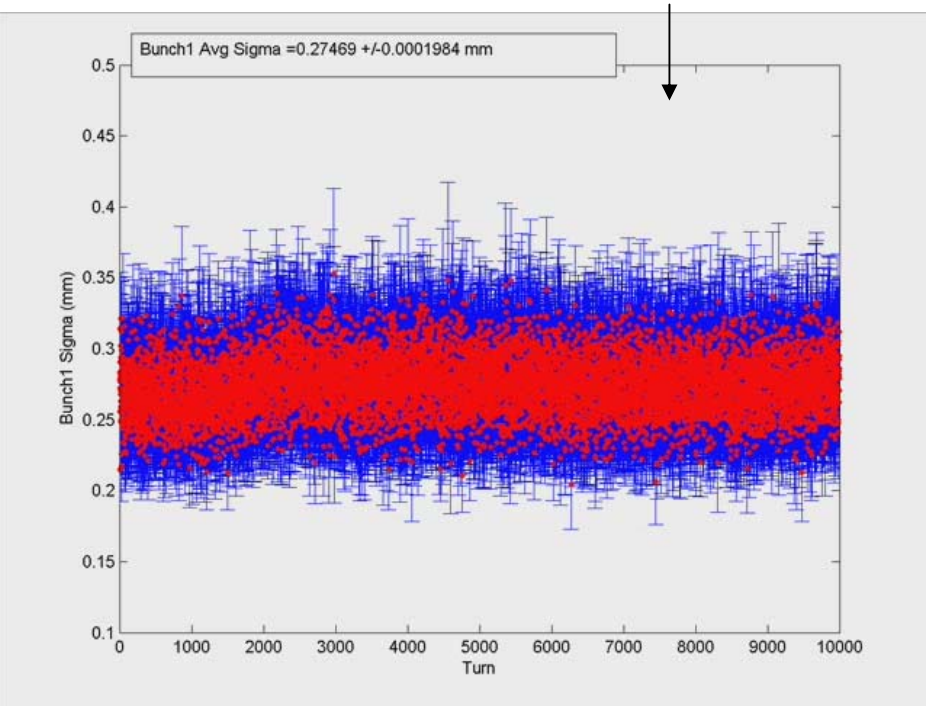




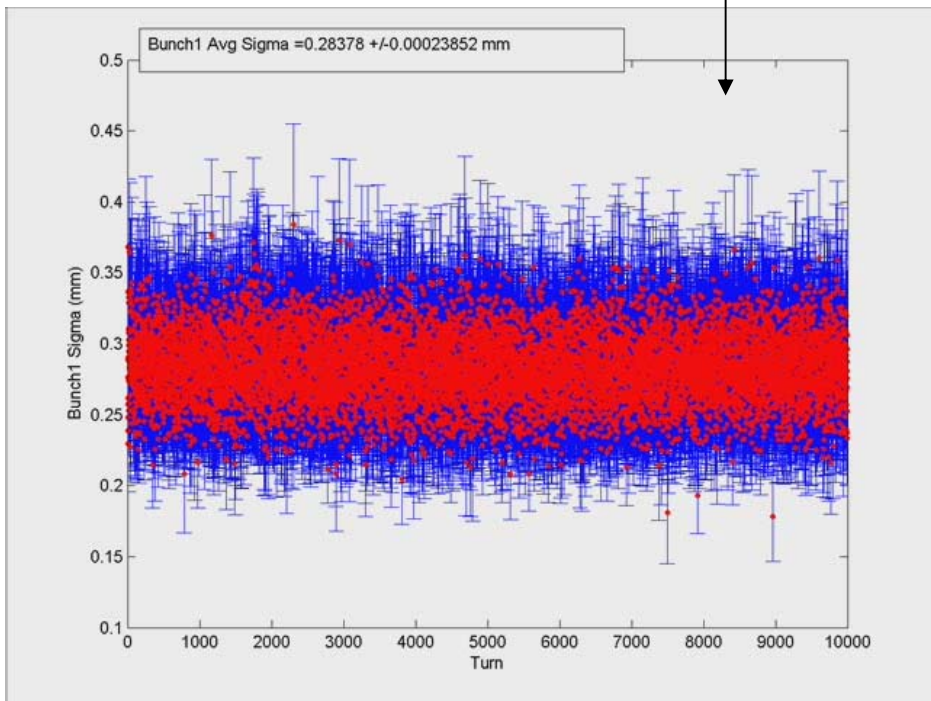
e+ σ_v along the train

- σ_v 10,000 turns for 23 bunches.
- Vertical beam size tends to grow along the train, except in trains 7 and 8.
- There is a general increase in σ_v along all trains, until train 8.

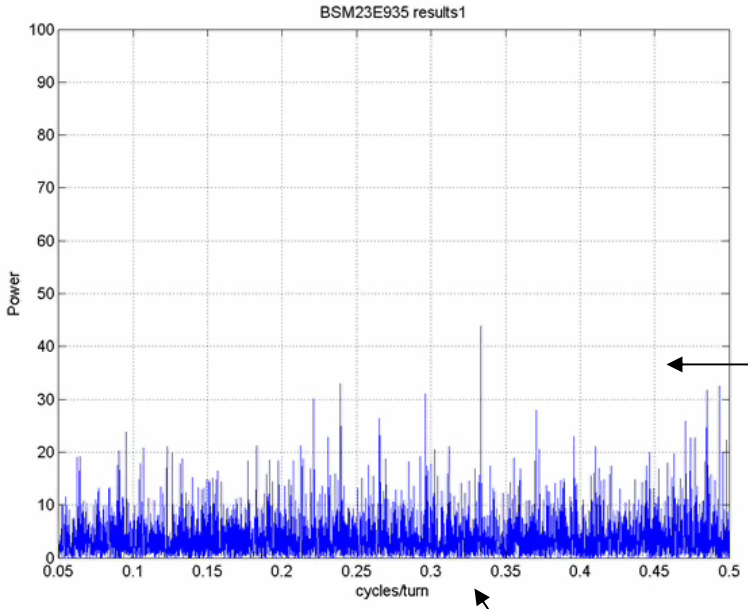
High I File:935 I_{e+}=2.8mA/bunch (movie)



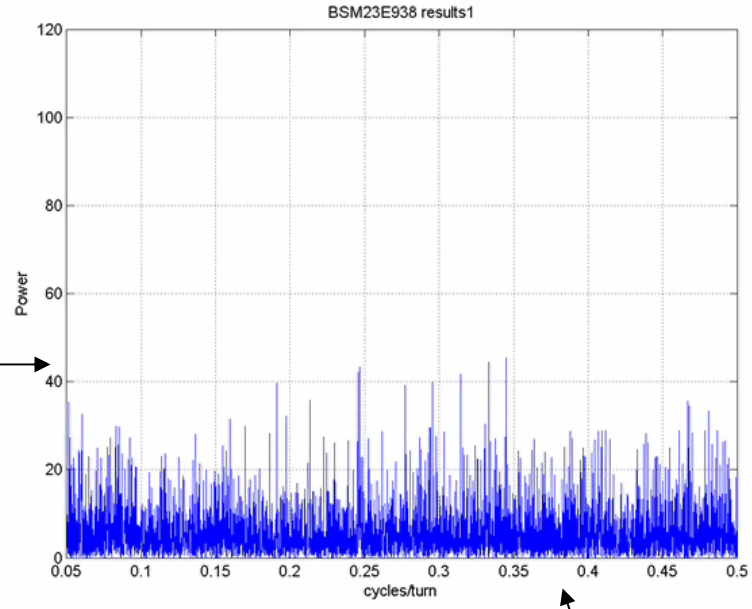
Low I File:938 I_{e+}=2.1mA/bunch (movie)



e+ high frequency σ_y oscillation frequency-FFT of σ_y for 10,000 turns



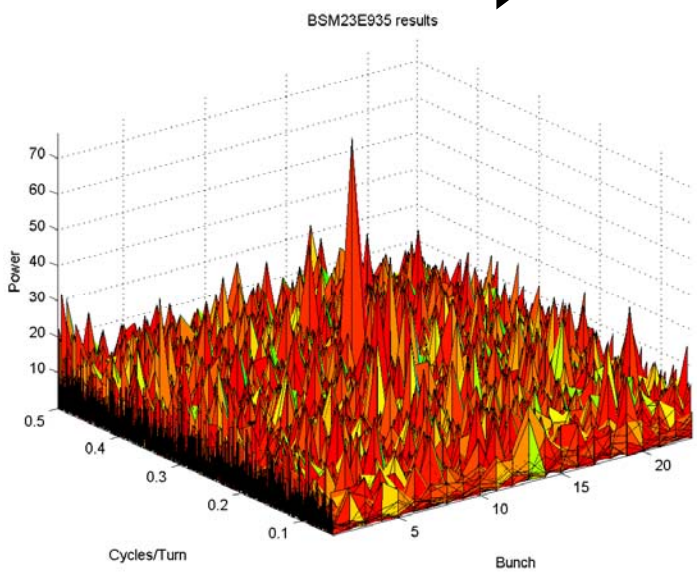
movies

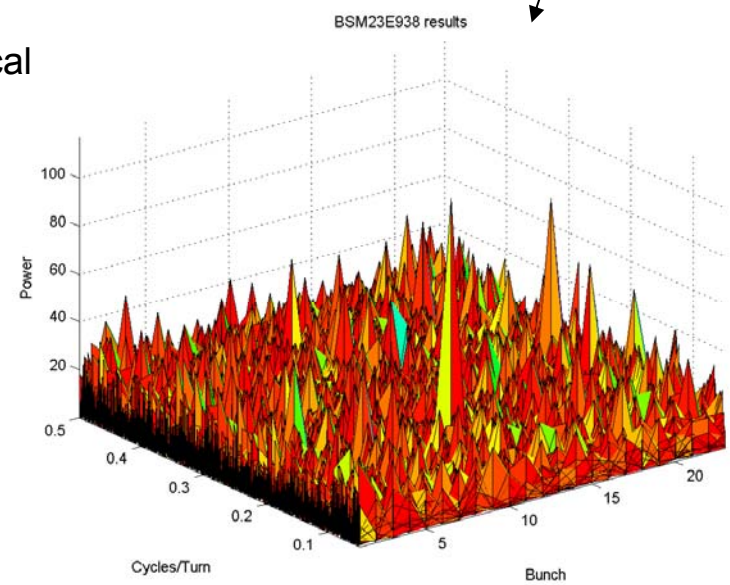


High I File:935 I_{e+}=2.8mA/bunch

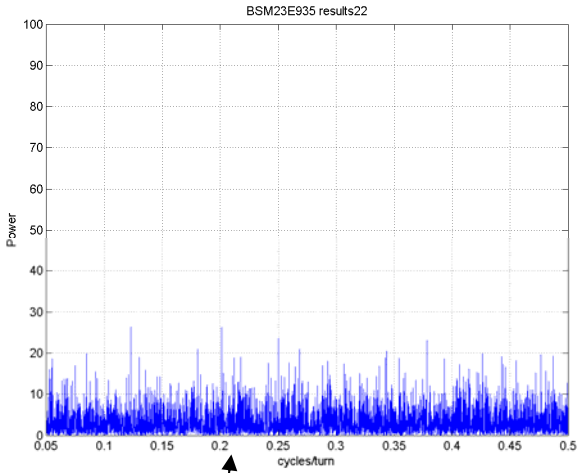
- FFT of σ_y for all 23 bunches
- No clear oscillation frequency in the vertical beam size.

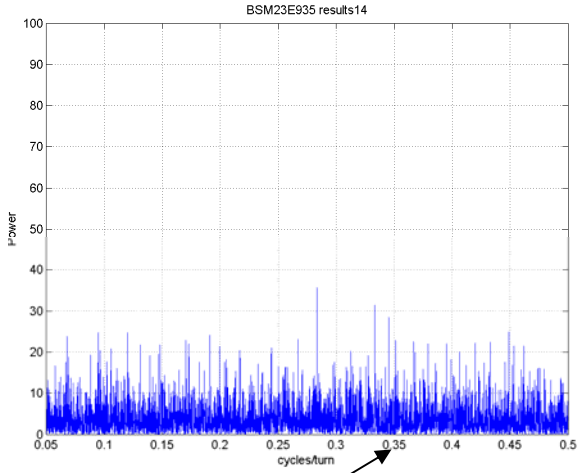
Low I File:938 I_{e+}=2.1mA/bunch

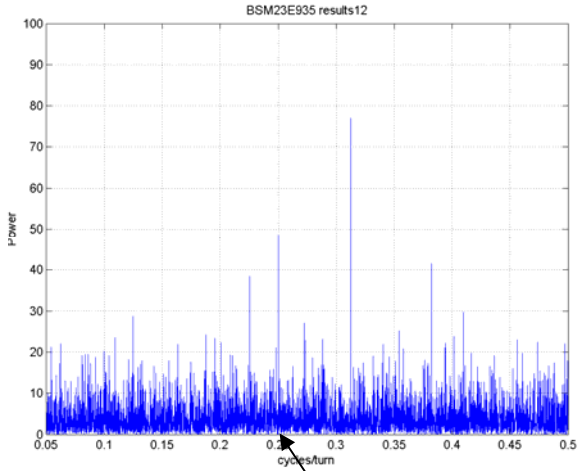




e+ σ_v oscillation - FFT of σ_v - High I





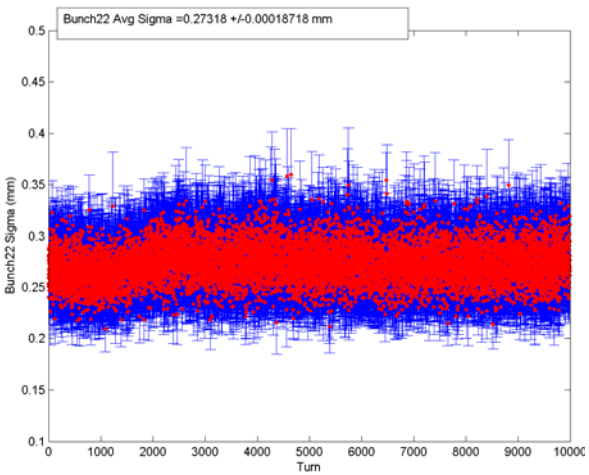


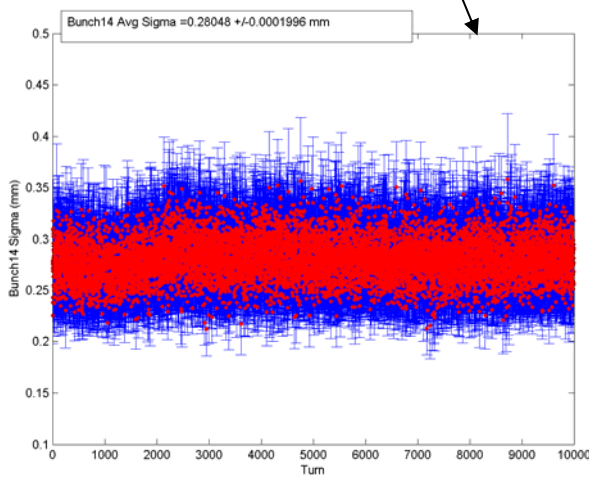
Bunch 22
Peak Power=26@342.4kHz
σ_v=0.273mm
Std=0.018mm

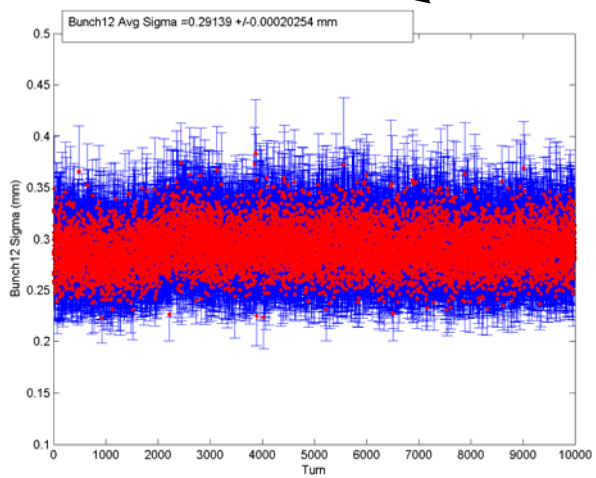
Bunch 14
Peak Power=36@279.8kHz
σ_v=0.280mm
Std=0.019mm

Bunch 12
Peak Power=77@268.4kHz
σ_v=0.291mm
Std=0.020mm

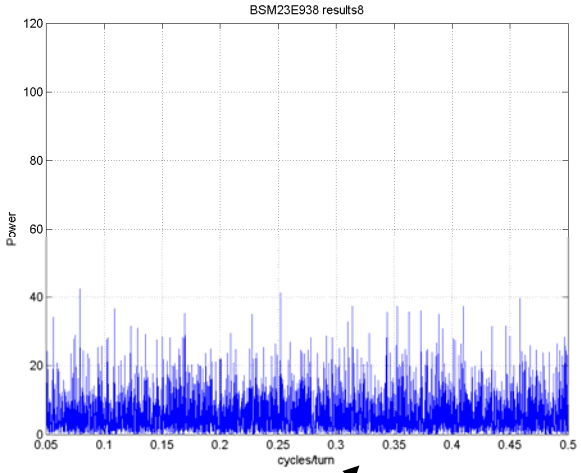
File 935 I_{e+}=2.8mA/bunch
- Noise does not appear to correlate with oscillation amplitude.

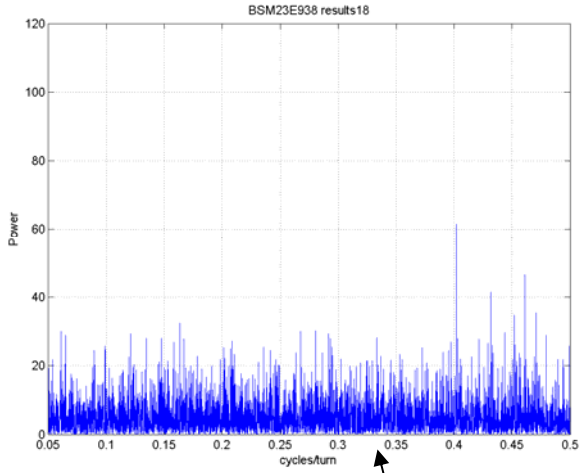


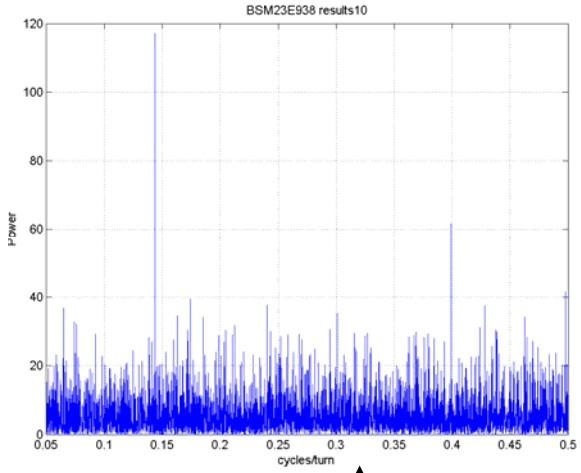




e+ high frequency σ_v oscillation frequency- FFT of σ_v - Low I





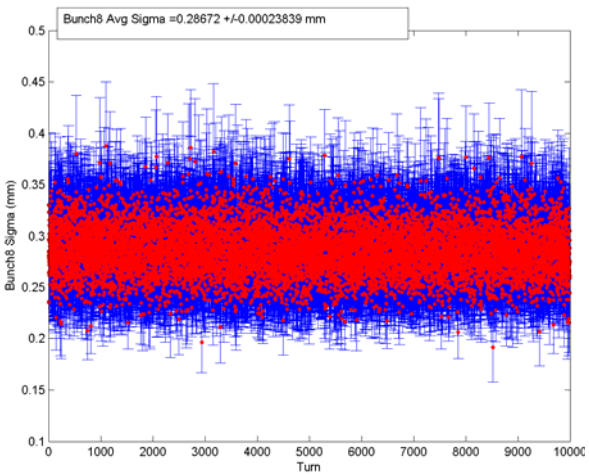


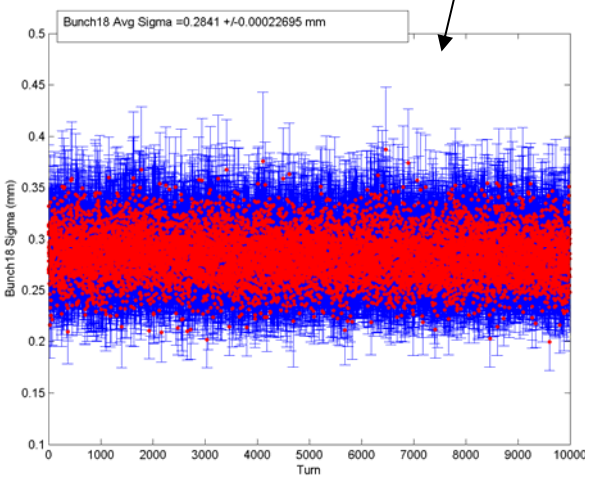
Bunch 8
No distinct peak
σ_v=0.287mm
Std=0.024mm

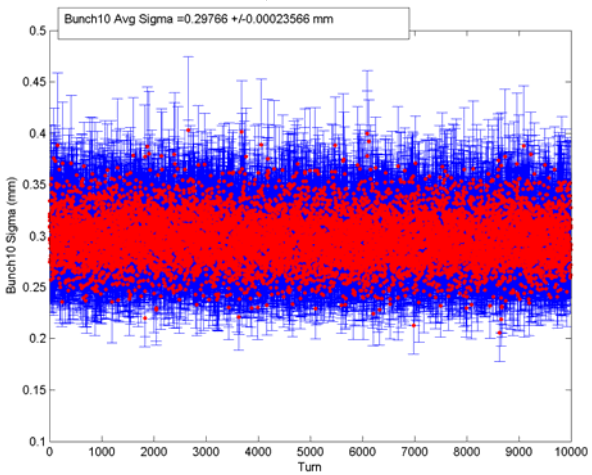
Bunch 18
Peak Power=62@233.4kHz
σ_v=0.284mm
Std=0.027mm

Bunch 10
Peak Power=117@56kHz
σ_v=0.298mm
Std=0.024mm

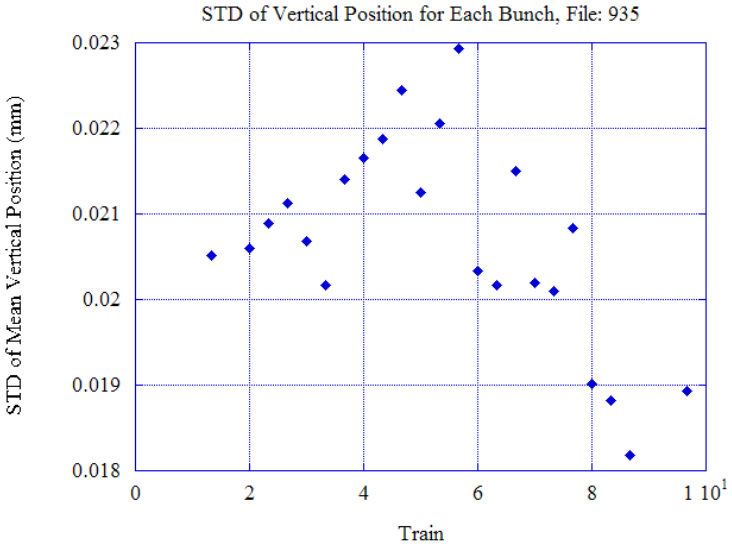
File 938 I_{e+}=2.1mA/bunch
- Noise does not appear to correlate with oscillation amplitude.

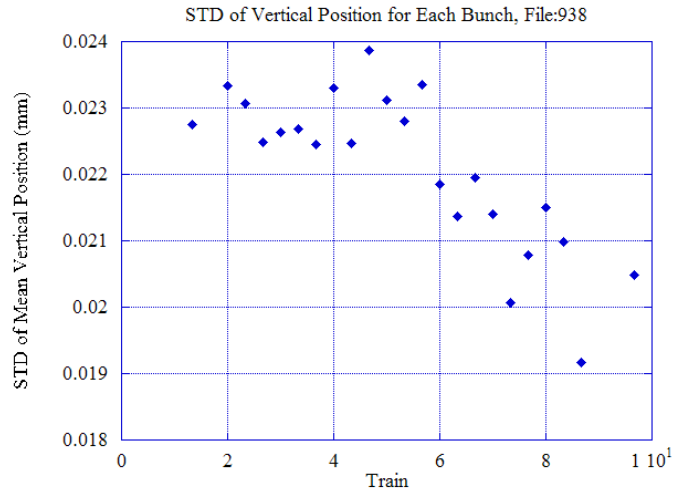






e+ Vertical position and beam size: standard deviations by bunch





- At low I, there appears to be some relationship between bunch number and the standard deviation in vertical position.
- There is no apparent relationship between bunch number and the standard deviation in the vertical beam size.