

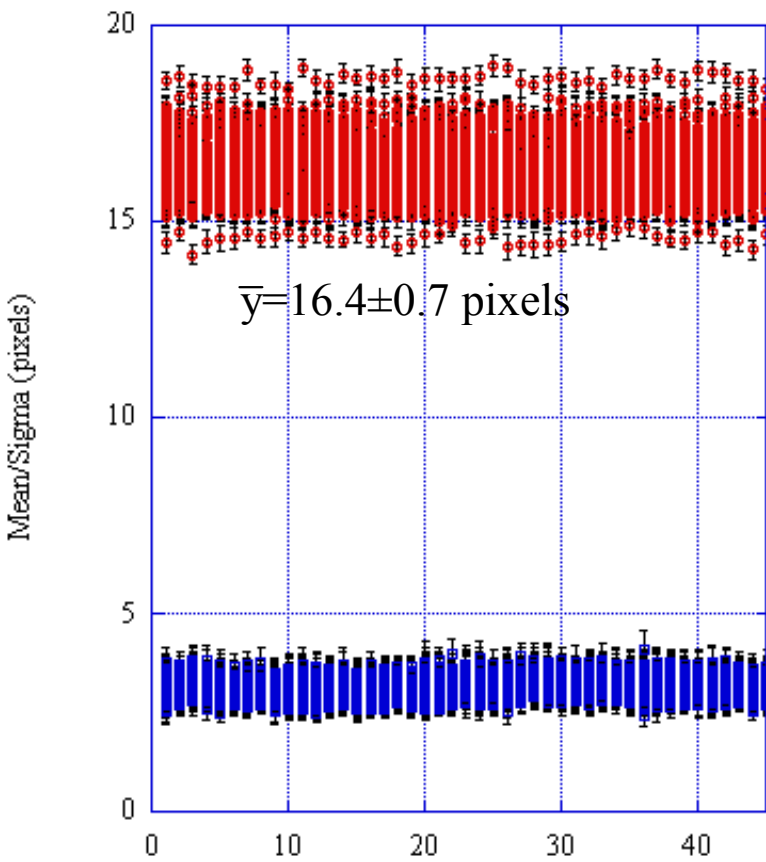
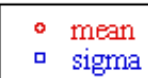
# CESR-c 1x45 e<sup>+</sup>/e<sup>-</sup> Vertical Beam Size

Quantify the relative vertical beam size change along a for 45 bunch e<sup>+</sup>/e<sup>-</sup> trains as a function of current at CESR-c energy. The measurements were made with the PMT array on 4/24/2006.

## Measurements

- I. CESR-c e<sup>+</sup> 1x45 vertical beam size and tune
- II. CESR-c e<sup>-</sup> 1x45 vertical beam size and tune
- III. Summary

e+ Beam Size I=0.5mA/bunch



$\bar{y}=16.4\pm0.7$  pixels

Bunch in Train

$\bar{\sigma}_v=3.1\pm0.2$  pixels

Centroid and  $\sigma_v$  for bunches 1-45  
(100 measurements for each bunch)

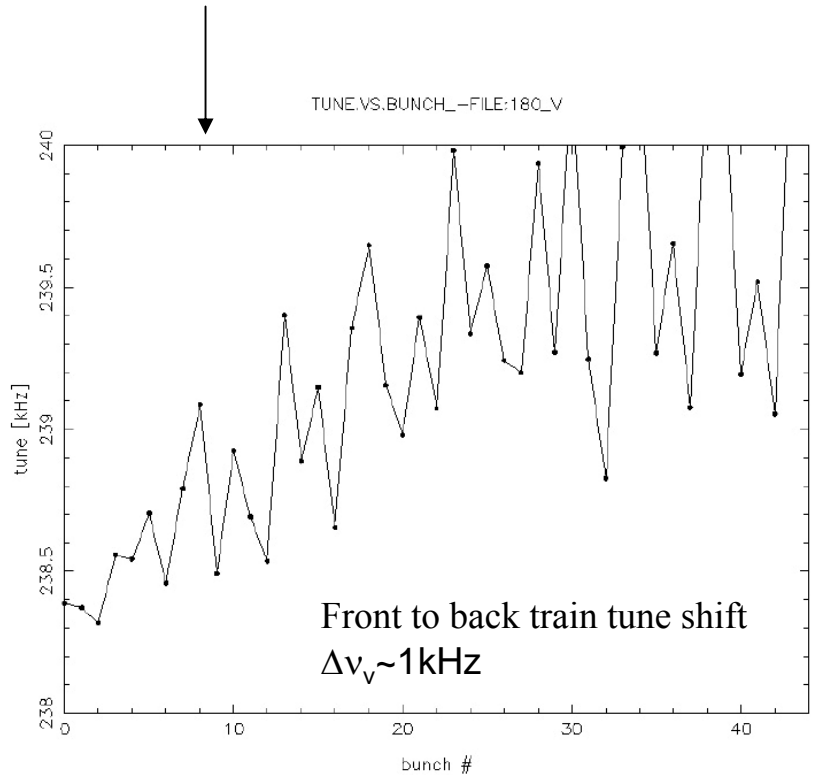
## I. CESR-c e+ Vertical Beam Size

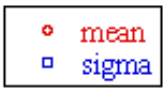
e+ 1x45 PMT set for 100 turn average/10K turns

Vertical beam size at I=0.5, 0.75, 1.0 mA/bunch

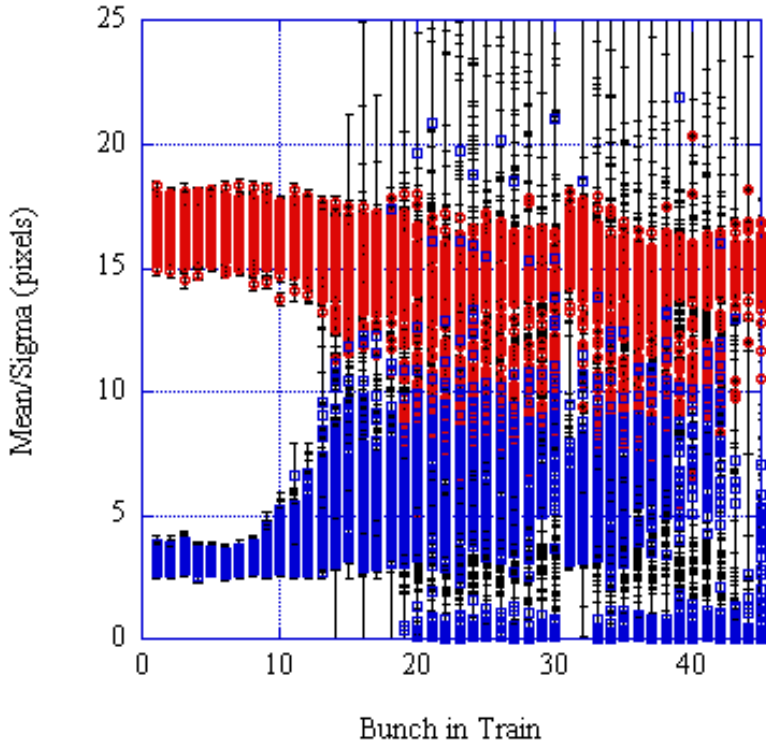
I=0.5mA/bunch      Stable beam centroid and  $\sigma_v$

Vertical tune along 45 bunch train





e+ Beam Size I=0.75mA/bunch



e+ I=0.75mA/bunch

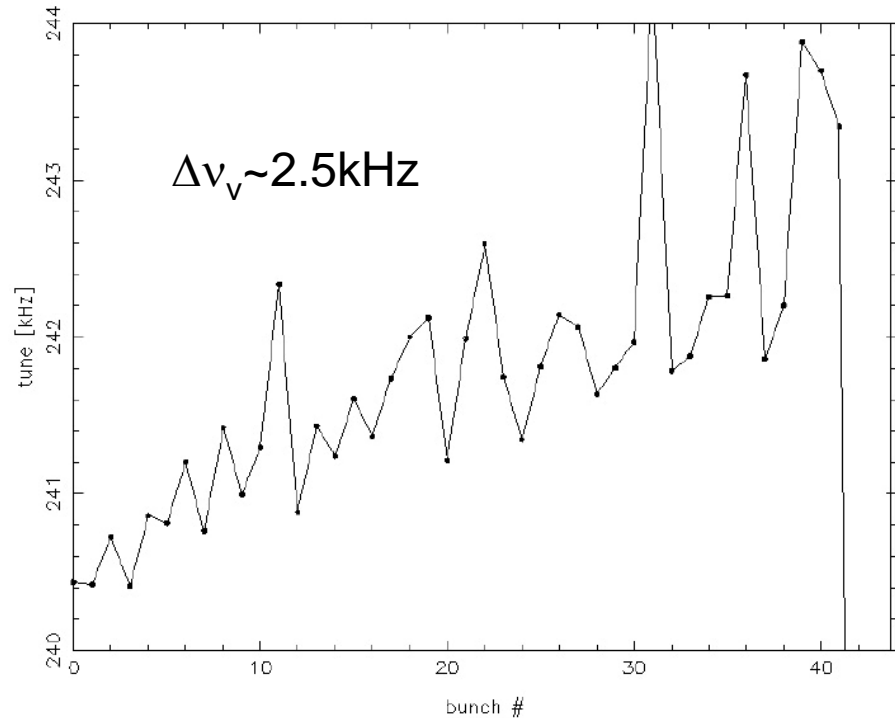
Instability threshold is observed between 0.5-0.75mA/bunch.  $\sigma_v$  growth and centroid oscillation at ~bunch 10.

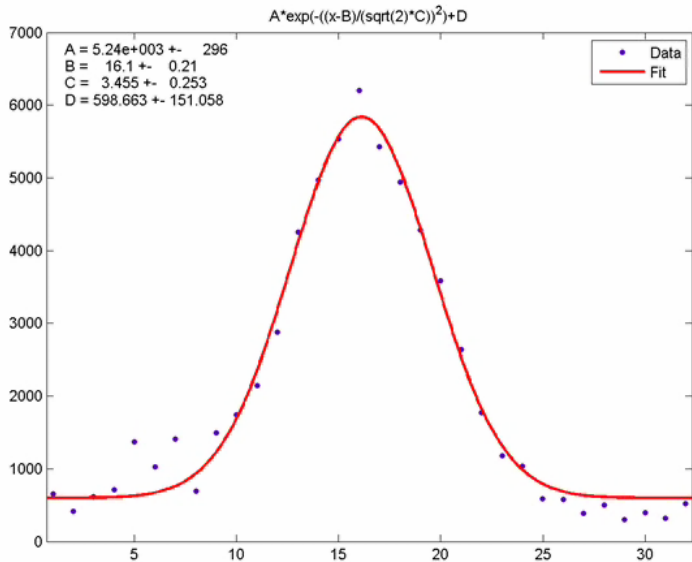
Vertical tune shift  $\sim 2.5\text{kHz}$  along the train

Signature of the electron cloud instability is present:

- Vertical beam size growth along the train
- Vertical tune shift along the train
- Vertical position oscillation

TUNE.VS.BUNCH\_-FILE:183\_V





Bunch 1 Distribution

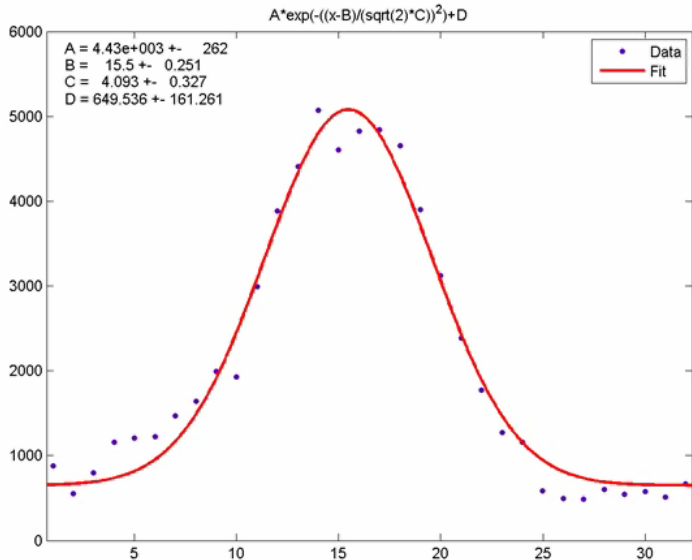
Click to run movie

Movie of e+ vertical distribution for bunch 1, 13, and 20 at  $I=0.75\text{mA/bunch}$

- 100 turn average
- Beam size and centroid oscillation at ~bunch 10.

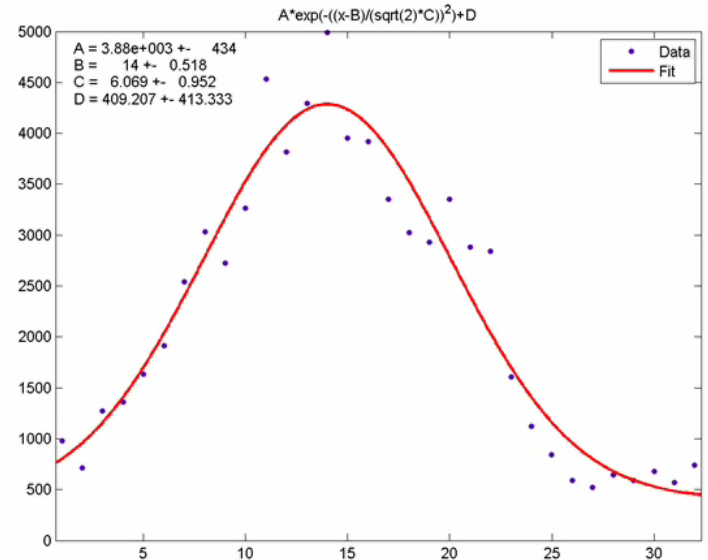
Bunch 13 Distribution

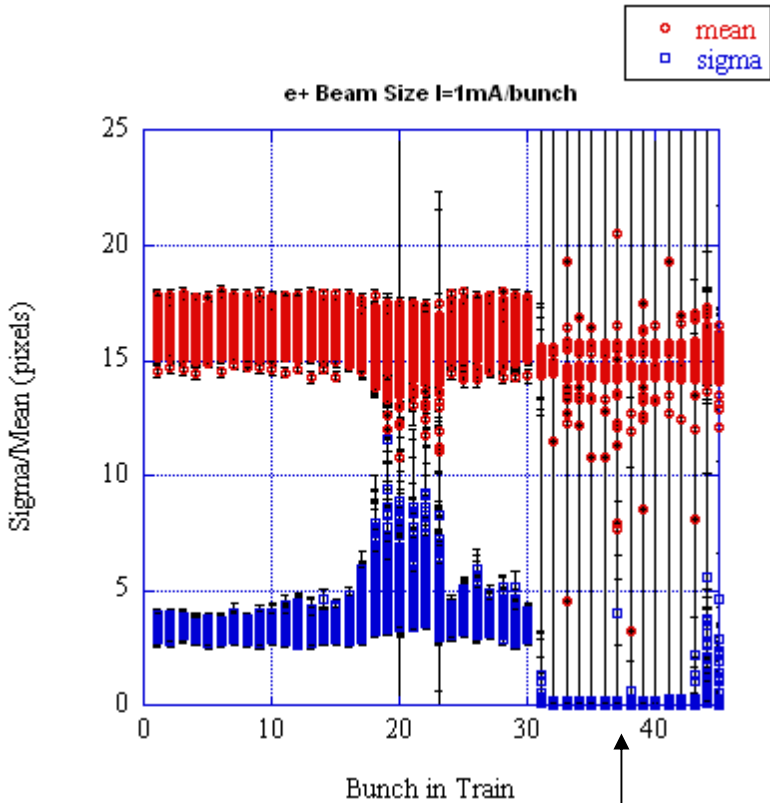
Click to run movie



Bunch 20 Distribution

Click to run movie





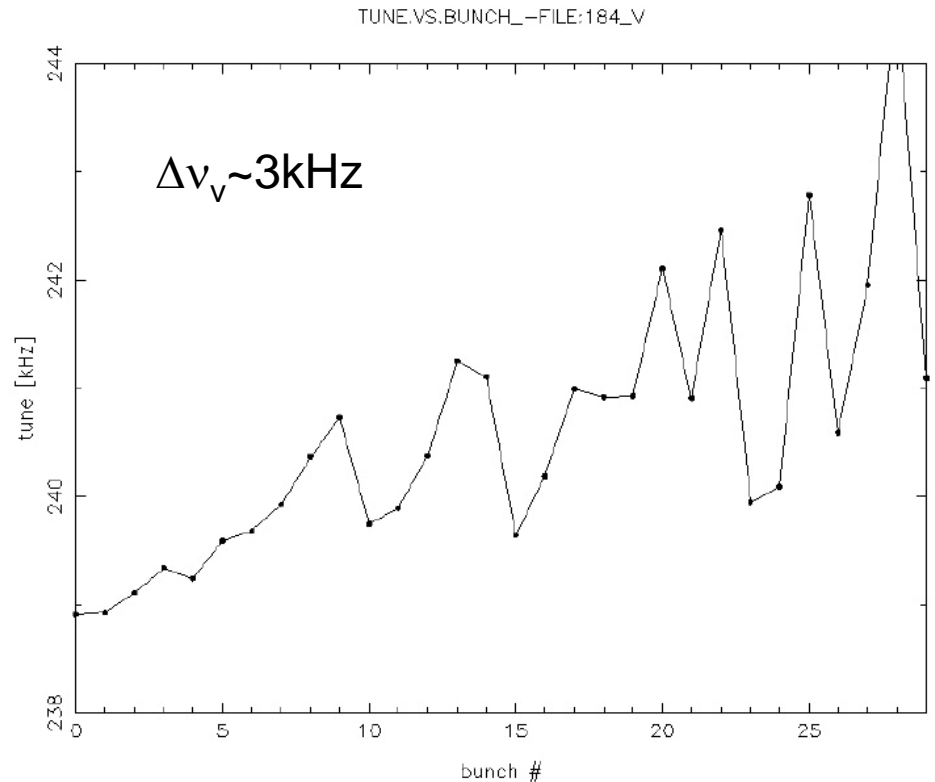
Bunches 31-45 are dumped

$e^+$   $I=1\text{mA/bunch}$

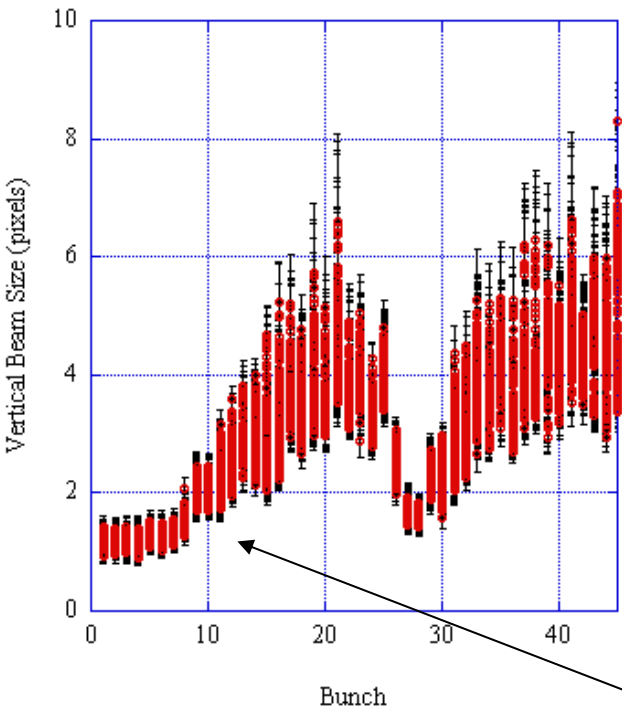
$\sigma_v$  growth and beam oscillation at  $\sim$ bunch 17.

Vertical tune shift  $\sim 3\text{kHz}$  from bunch 1-25.

Stable bunches from  $\sim 25-30$  (non uniform  $I$  along train).



e- CESR-c 1x45 I=0.5mA/bunch



## II CESR-c e- Vertical Beam Size

e- 1x45 100 turn average/10K turns

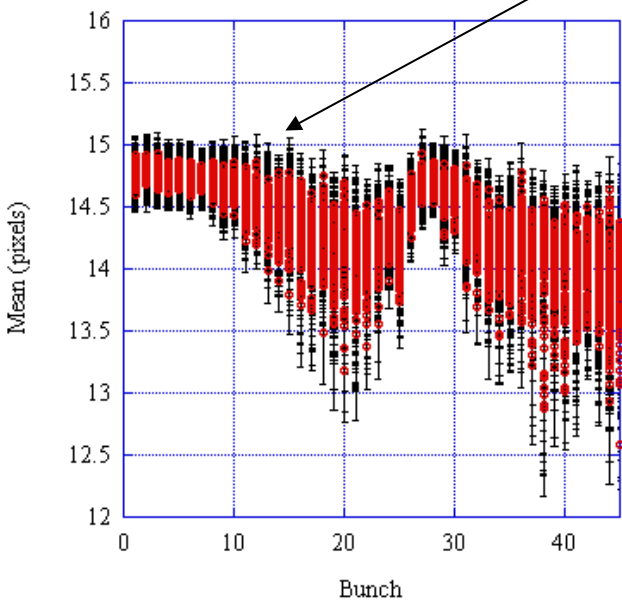
Vertical beam size at I=0.5, 1.0, and 1.5 mA/bunch

I=0.5mA/bunch

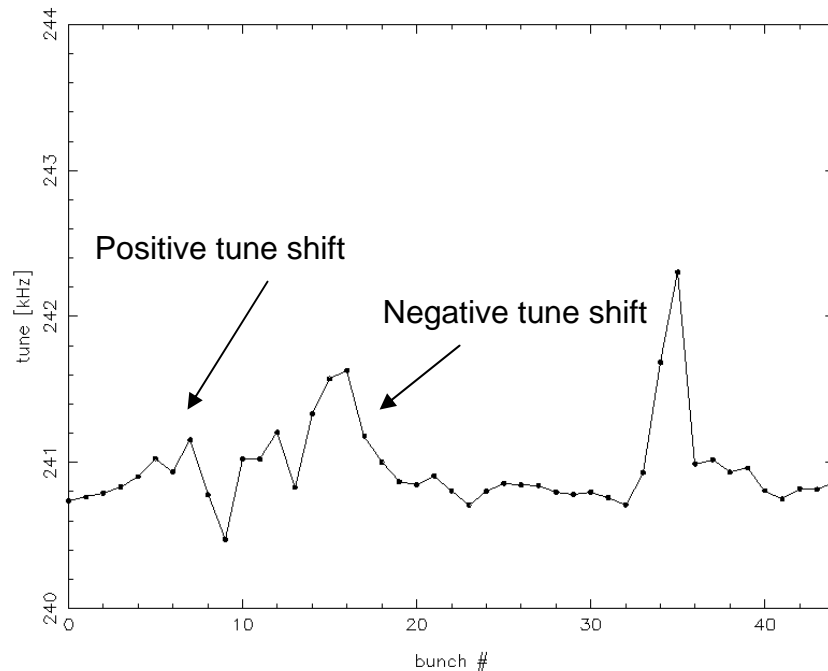
$\sigma_v$  growth/oscillation and centroid motion at ~bunch 10

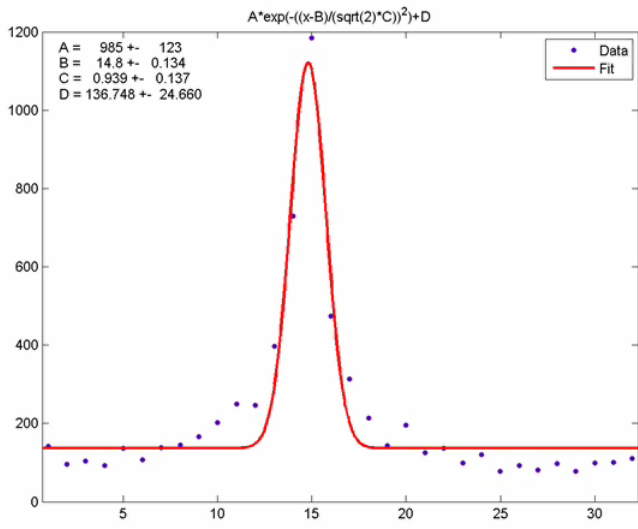
Beam size growth  
centroid oscillation

e- CESR-c 1x45 I=0.5mA/bunch



TUNE.VS.BUNCH\_-FILE:185\_V





### Bunch 1 Distribution

Click to run movie

Movie of e- bunch 1, 20, and 28 at I=0.5mA/bunch

- 100 turn average

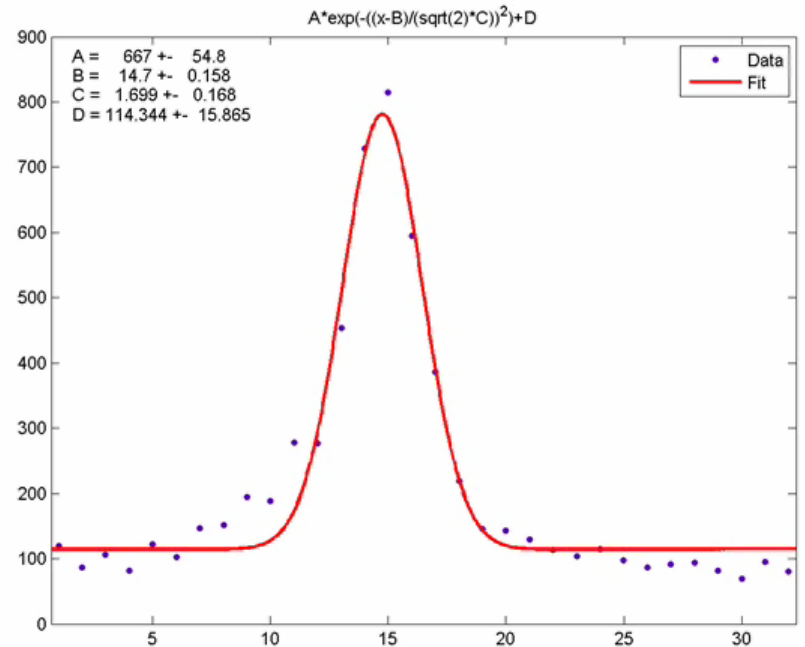
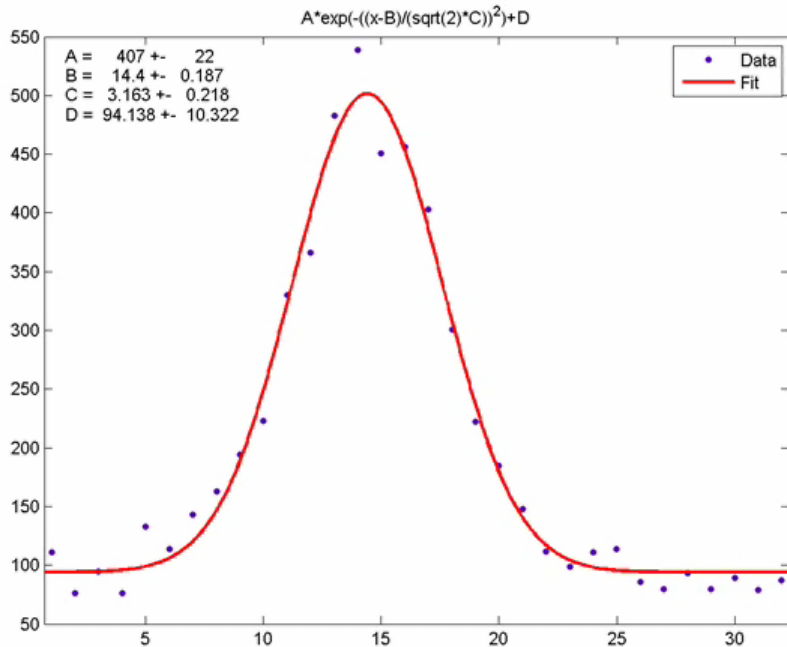
- Beam size growth/oscillation and slight centroid oscillation at ~bunch 20. Beam size oscillation settles down at bunch 28.

### Bunch 20 Distribution

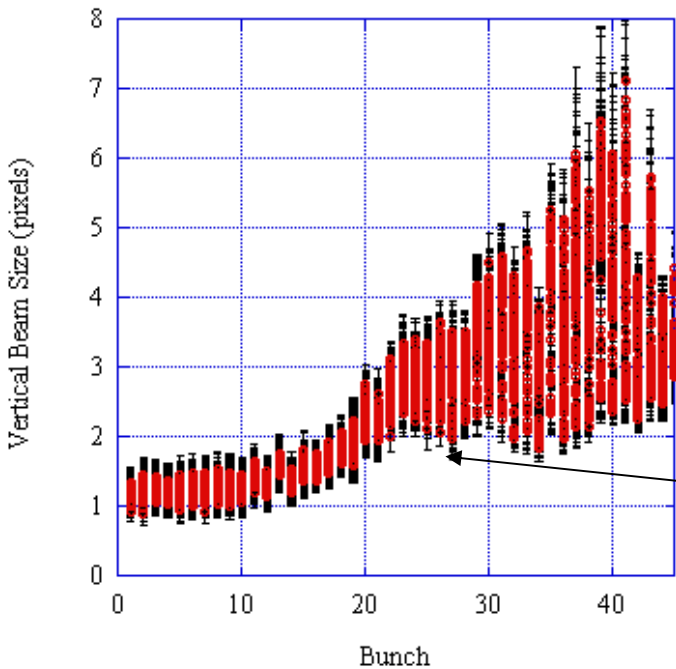
Click to run movie

### Bunch 28 Distribution

Click to run movie



e- CESR-c 1x45 I=1.0mA/bunch

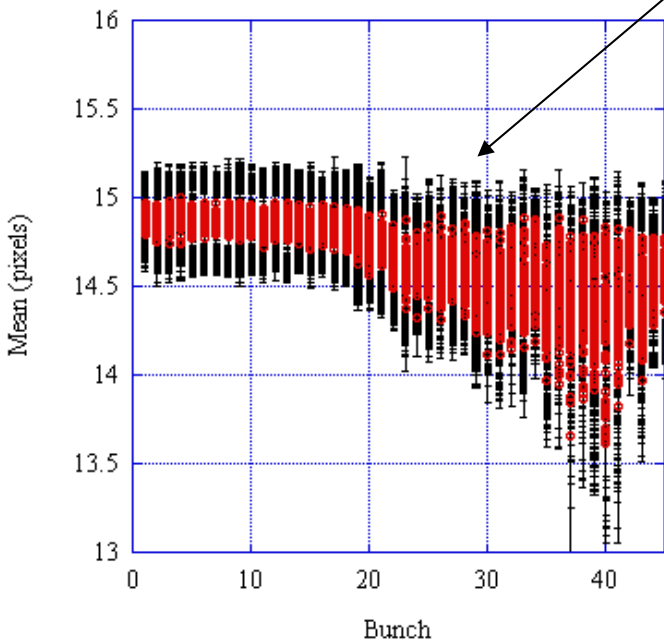


e- I=1mA/bunch

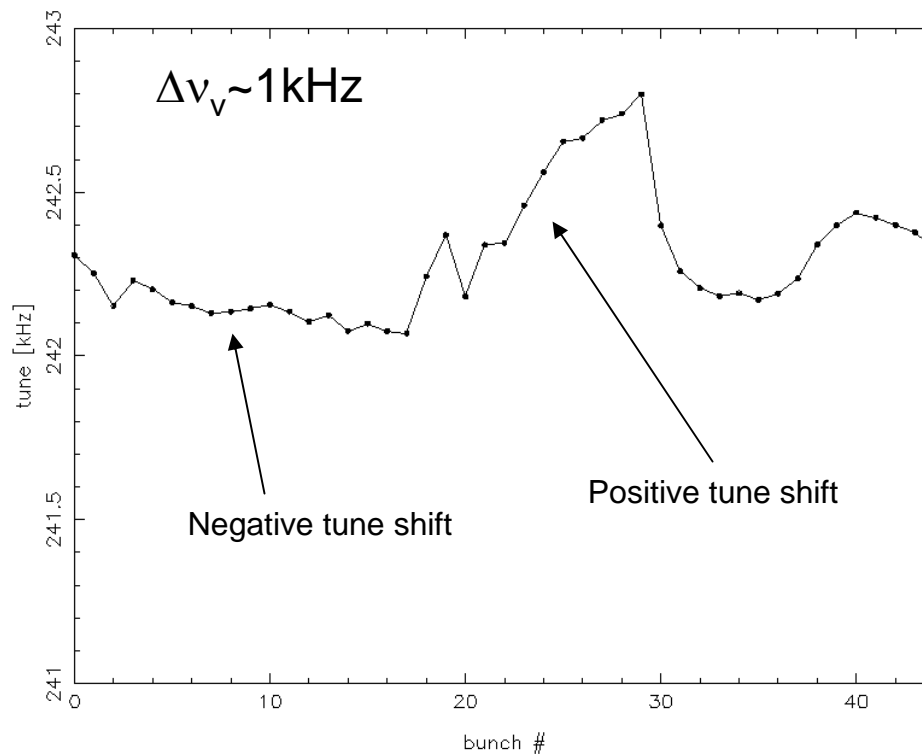
Unstable  $\sigma_v$  and centroid oscillation occurs latter in the train (at ~bunch 20)

Positive vertical tune shift correlates with  $\sigma_v$  growth/oscillation and centroid oscillation.

e- CESR-c 1x45 I=1.0mA/bunch

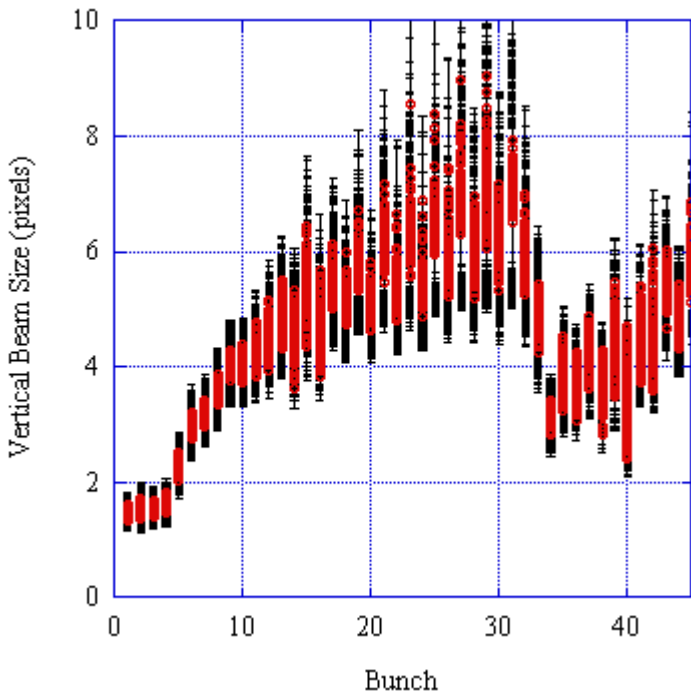


TUNE.VS.BUNCH\_-FILE:186\_V





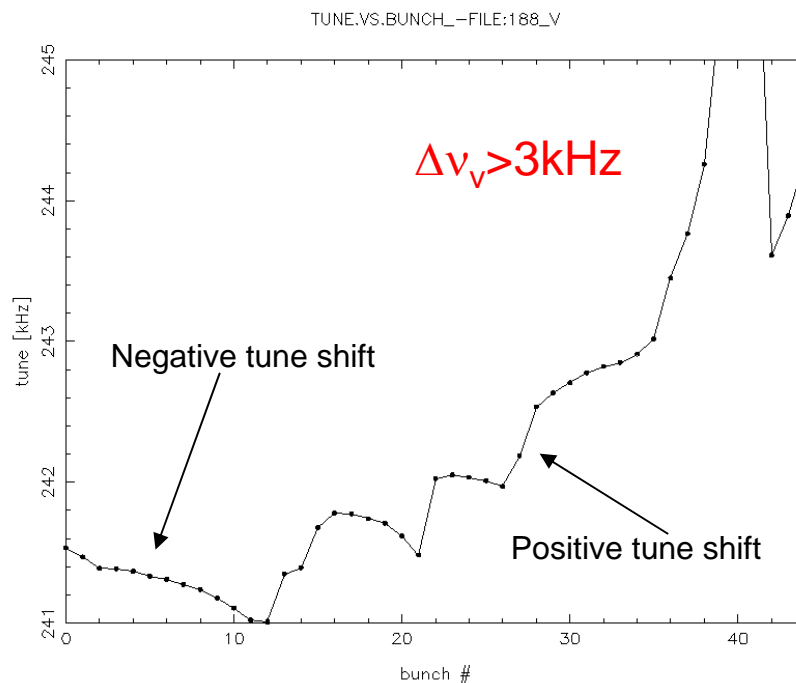
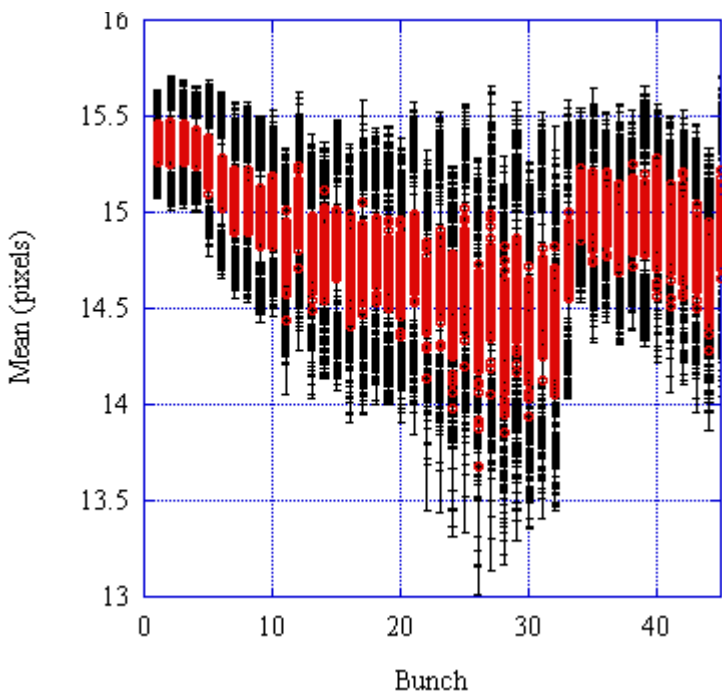
e- CESR-c 1x45 I=1.5mA/bunch



e- I=1.5mA/bunch

Large beam size growth from bunch 5-32.

Vertical tune shift changes slope at bunch 12 which correlates with the  $\sigma_v$  oscillation.



## Summary

### Positrons:

- At 0.5mA/bunch the vertical beam size and centroid is stable along the 45 bunch train. A positive vertical tune shift of 1kHz.
- Between 0.5-0.75mA/bunch the vertical beam size and centroid oscillates after bunch 17. The vertical tune shift along the train is ~2.5kHz.
- At 1mA/bunch the tune shift along the train increased to ~3kHz and bunches 31-45 are dumped.
- Vertical beam size growth/oscillation and tune shift along the train is a signature of the electron cloud instability.

### Electrons:

- Vertical beam size growth and centroid oscillation is present along the train at all currents measured. The vertical tune shift along the train is initially negative but then changes slope at the higher currents. The positive tune shift correlates to beam size oscillations.