ECLOUD Calculations of Field Gradients During Bunch Passage

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Electron Cloud Simulations Meeting

Wilson Lab

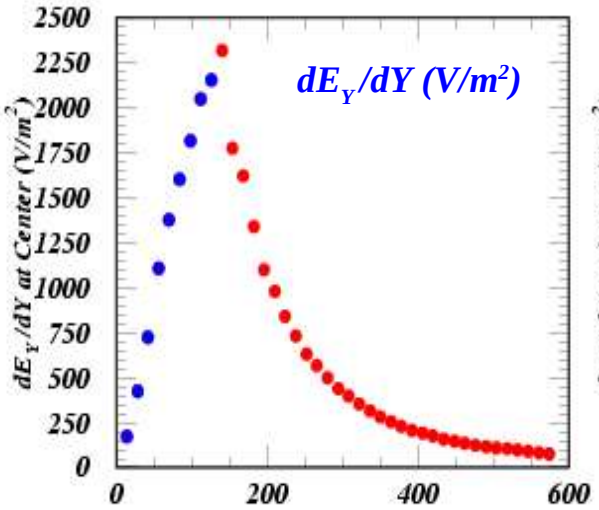
16 July 2008

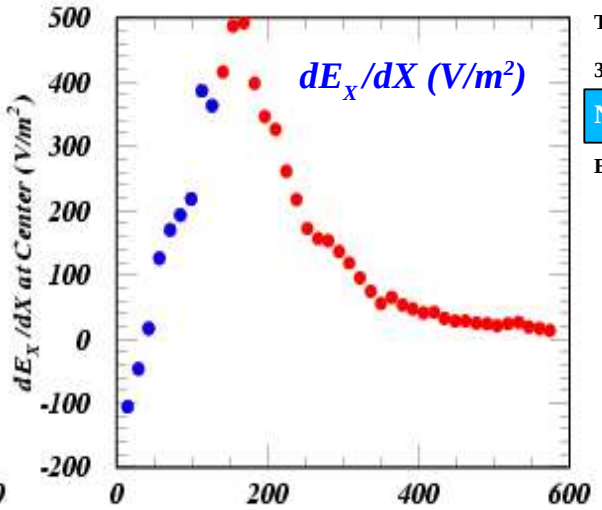
This version includes some corrections and annotations resulting from discussion during the meeting.

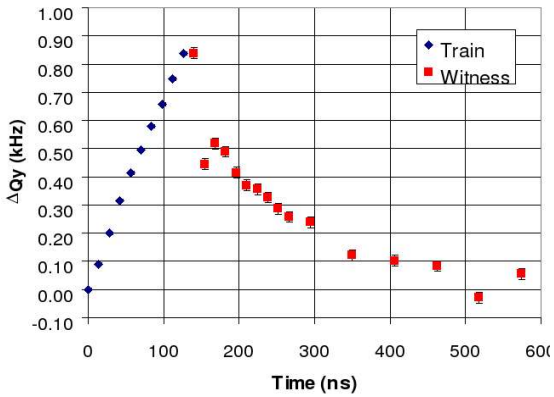
In particular, plots of central density were added on 24 July.

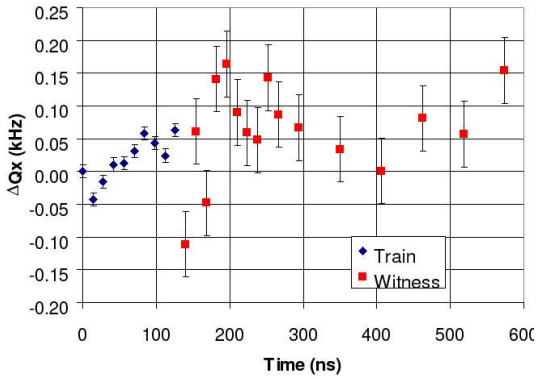
Comparison shown at ILCDR08

Positron Beam









Input Parameter Set

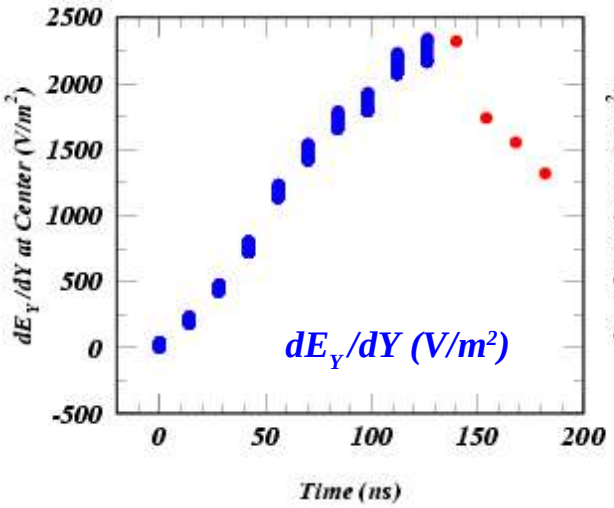
Ten 0.75 mA bunches 1.9 GeV	0.1 s.r. photon per beam particle per m
30 empty witness bunches	20% reflected s.r. photons
No magnetic field	10% photoelectron per s.r. photon
Elliptical chamber 4.5x2.5 cm	Peak secondary yield of 2.0
	Peak SEY energy of 310 eV

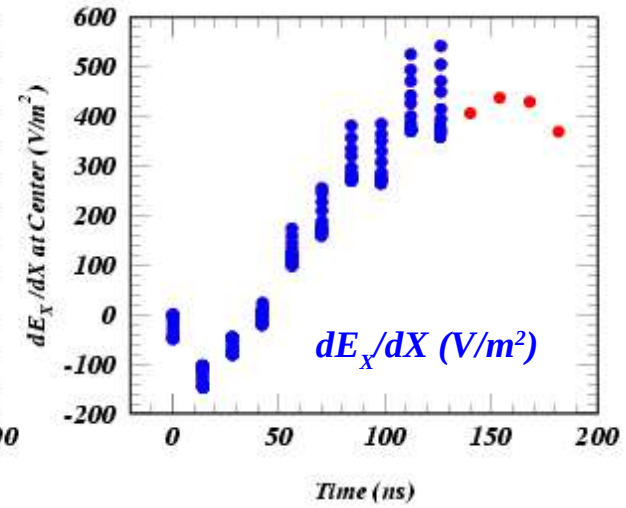
Field gradients averaged over a 9 mm x 5 mm region at the center of the beam pipe

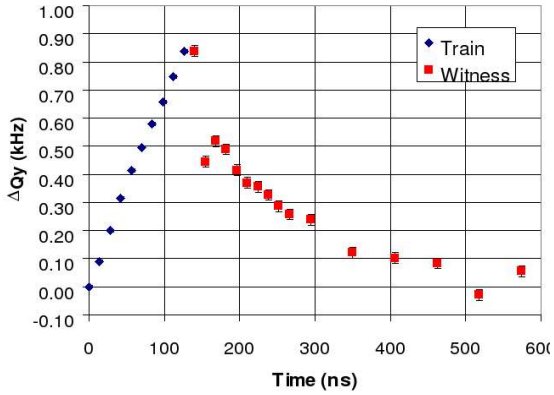
- *Impressively similar time structure*
- *Vertical gradient factor 5 higher*
- *Horizontal gradient bipolar*
- *Predicted vertical tune shift 50% lower than measured even if the entire ring were B-field-free*

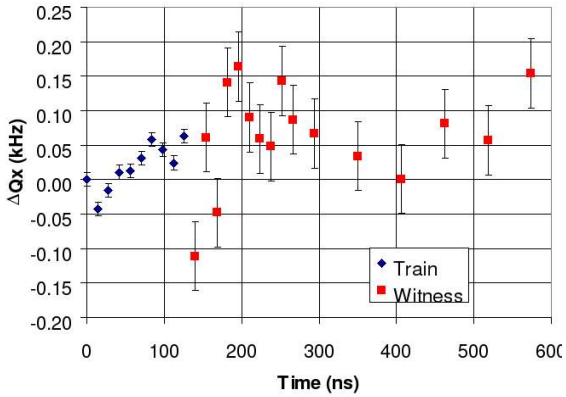
Gradients along bunch length

Positron Beam









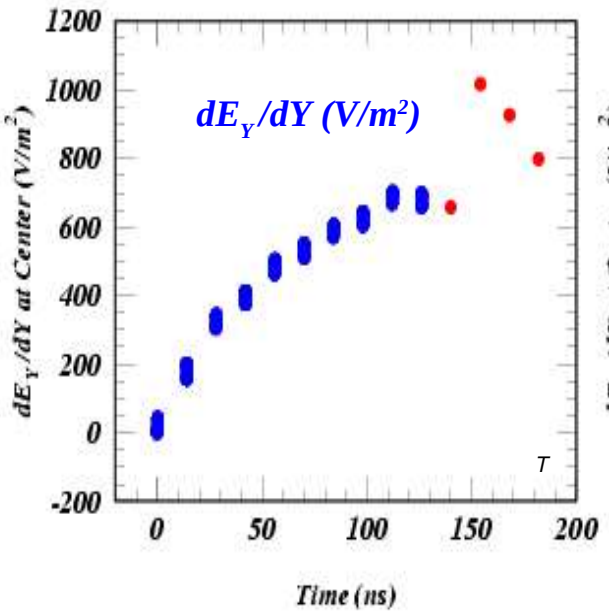
Input Parameter Set

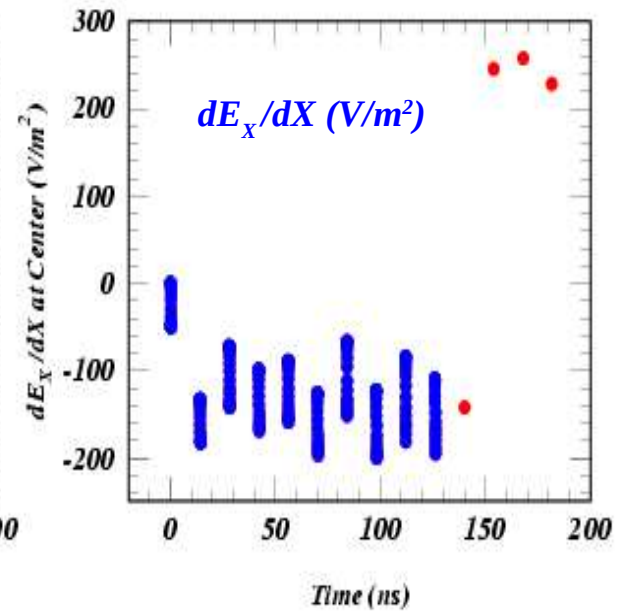
Same as previous slide

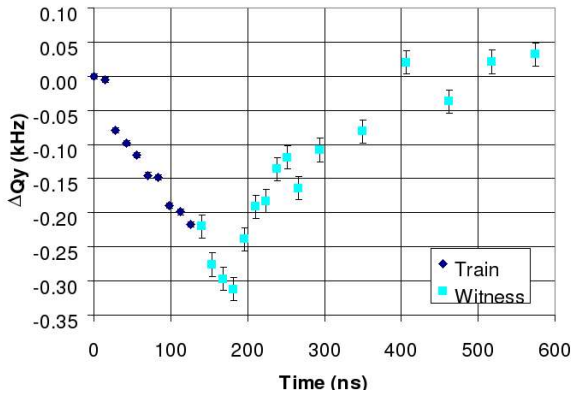
- ***Appreciable gradient change during bunch passage***

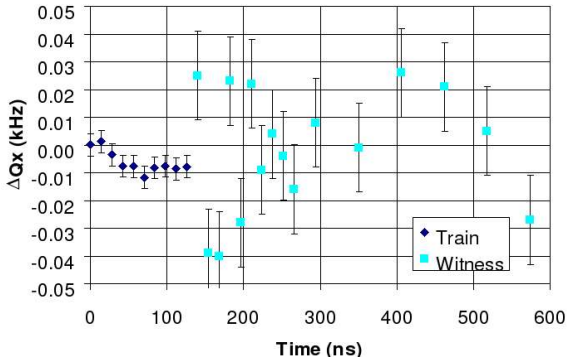
Gradients along bunch length for electron beam

Electron Beam









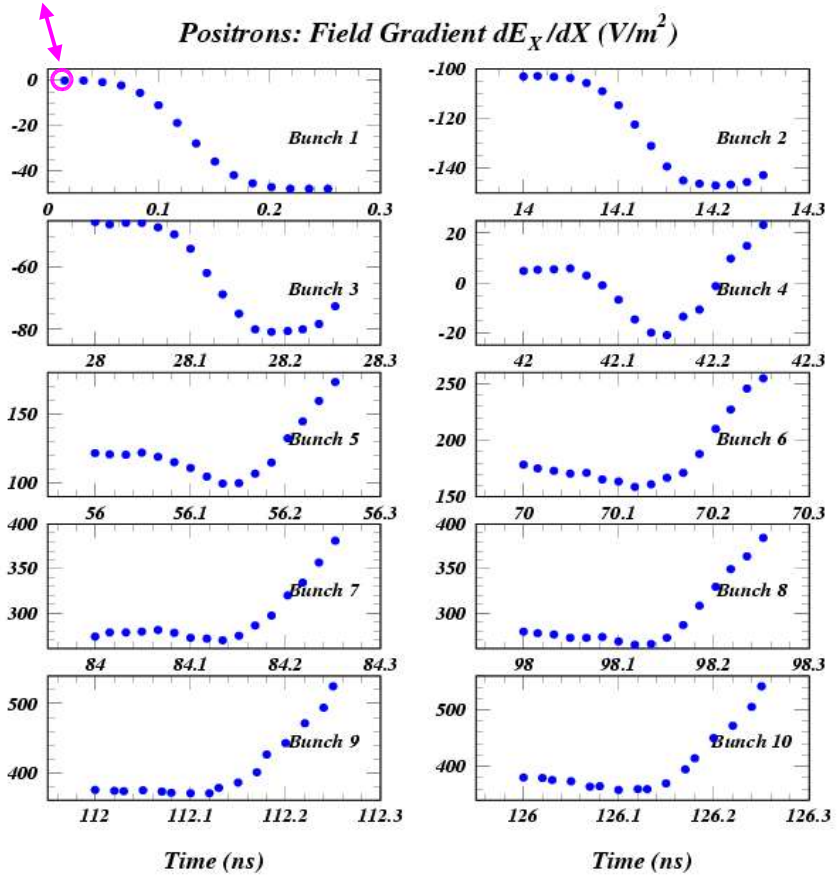
- *Large relative variation for smaller gradients*

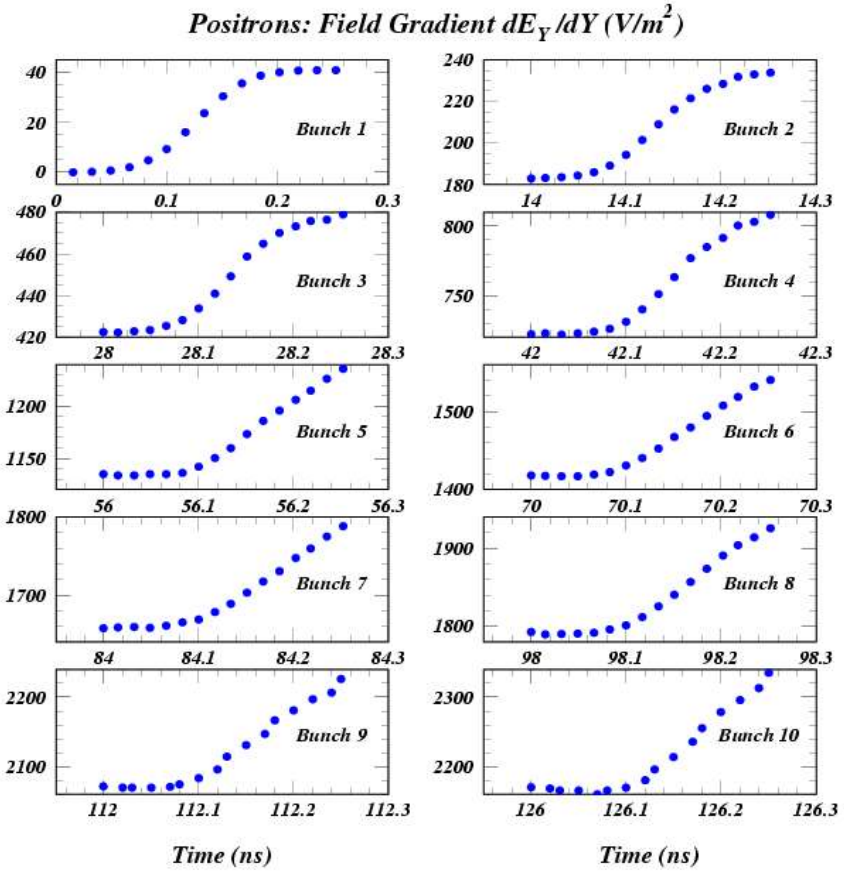
Gradients along bunch length for positron beam

These points immediately preceding the bunch passage are the gradient values shown at ILCDR08. Small differences are due to the fact that 15 recalculations per bunch passage are made here, while only 6 were made in the ILCDR08 calculation. No point was shown for bunch 1 at ILCDR08.

Positron Beam

- *The integrated-Gaussian shape in bunch 1 shows the time development expected from a longitudinal Gaussian bunch shape.*

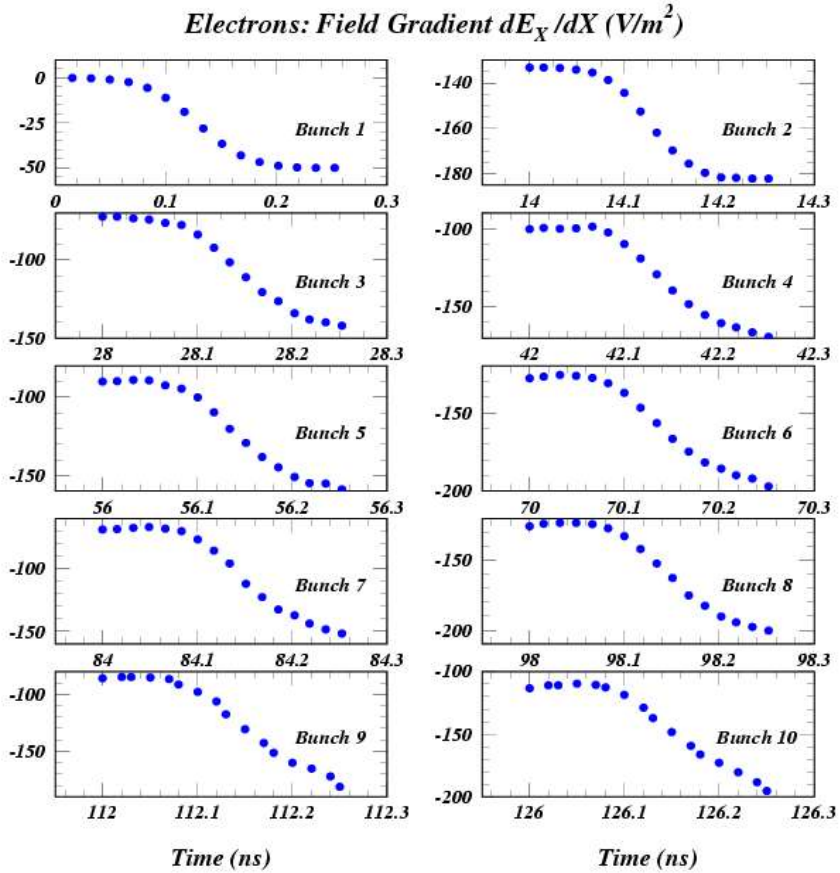


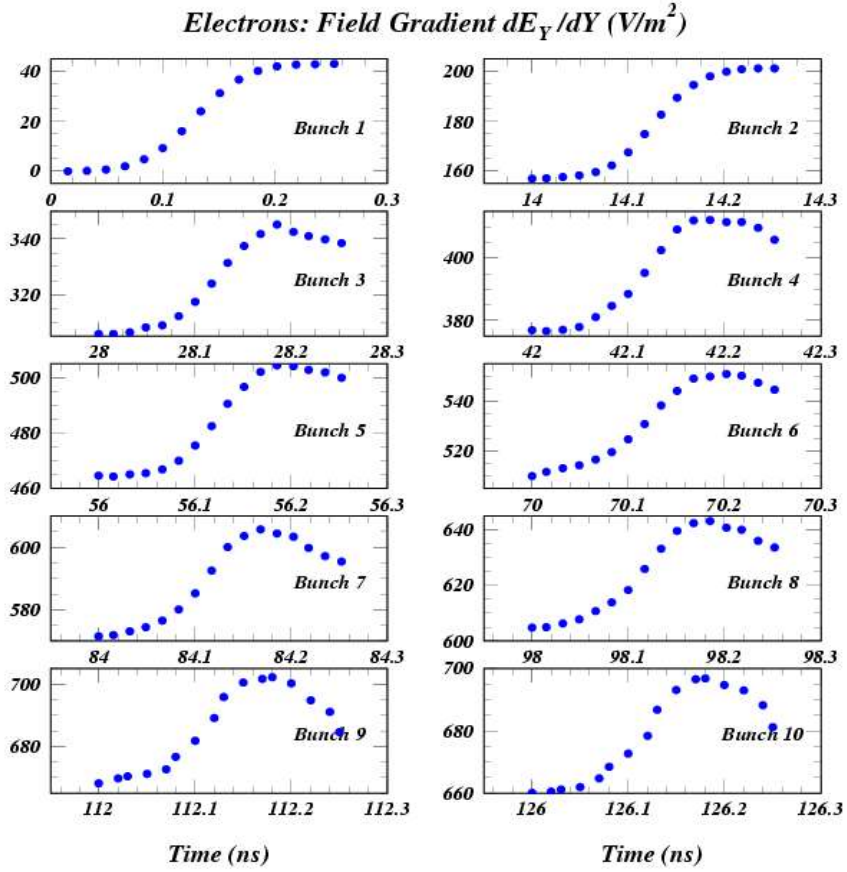


- *Bunch 1 shows the gradient dominated by the charge at the source point with very little cloud migration. Note the equal and opposite vertical and horizontal tune shifts (c.f. Ohmi). Deviations from this sum rule are due to nonzero cloud density in the beam.*
- *The gradient is recalculated 10 time slices into the passage, and a total of 15 times during the 150 time slices during the passage.*

Gradients along bunch length for electron beam

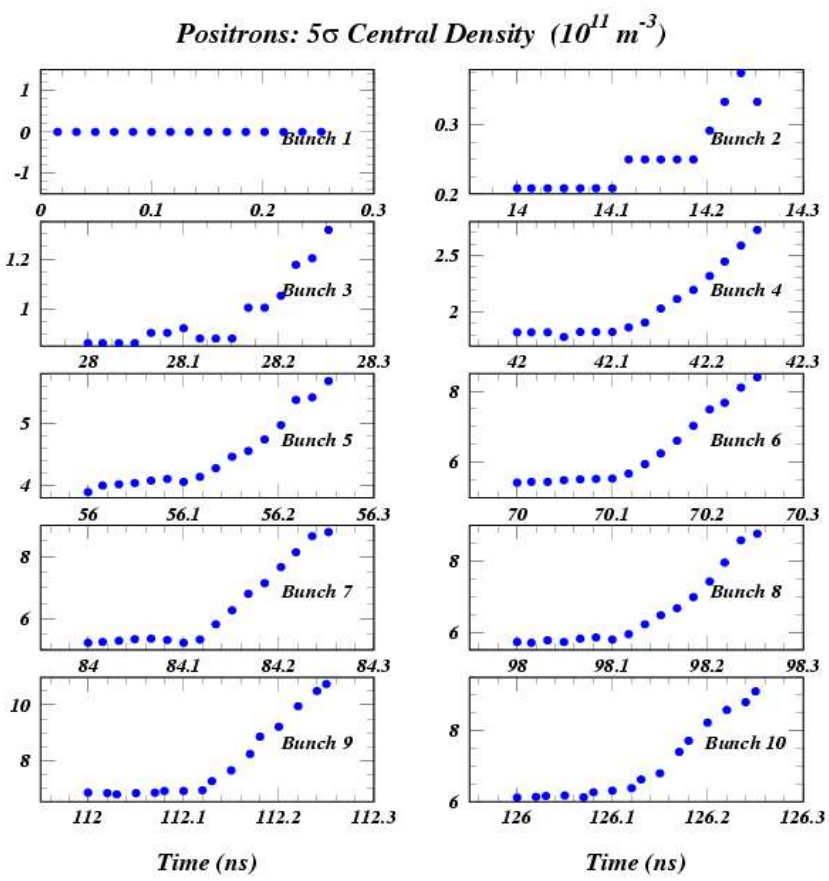
Electron Beam

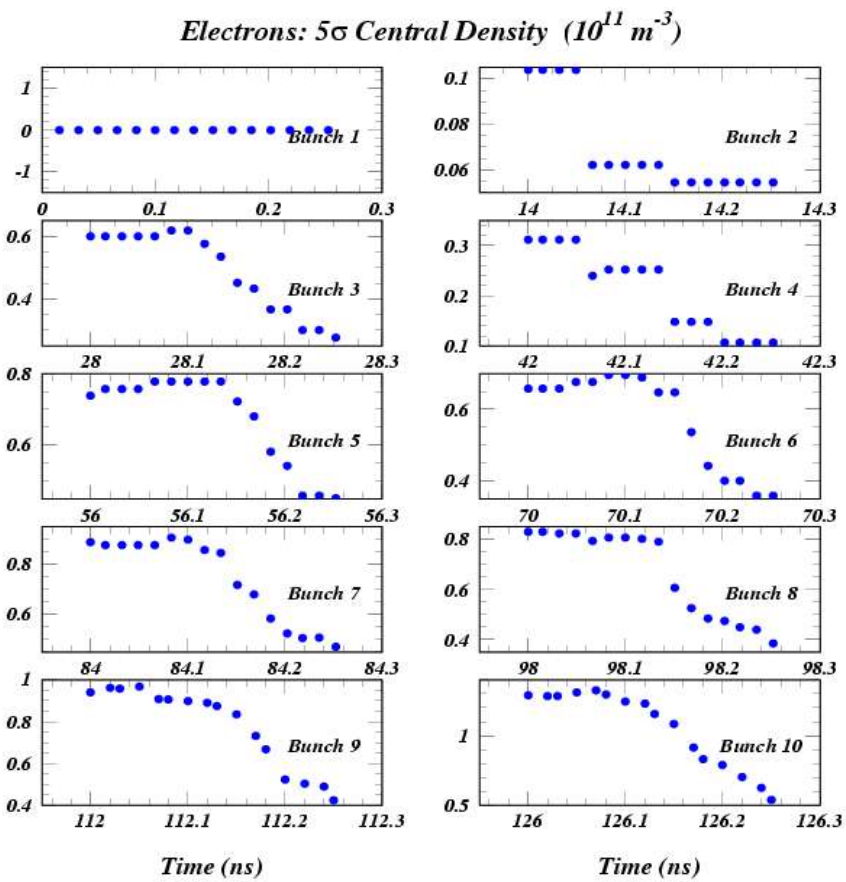




- *For electrons, bunch 1 shows the same source-dominated gradients as calculated for positrons, while the later cloud development is very different, owing to opposite-sign cloud kicks from the beam. If the source point dominated throughout, one would expect horizontal (vertical) gradient after ten bunches of about -(+)500 V/m². All contributions to the gradient which do not produce equal and opposite horizontal and vertical tune shifts must be caused by charge density in the beam region.*

Central Cloud Density During Bunch Passage





- ***These central density values are calculated over a rectangular region extending over ±5 standard deviations of the transverse beam size, which was 1.35 mm horizontally and 0.16 mm vertically. Some discontinuities due to macroparticle statistics are observed. The attractive (repulsive) force of the positron (electron) beam is evident. The result is a central density which changes significantly during the 0.25 ns of the passage of the 11-mm-long (rms) bunch.***