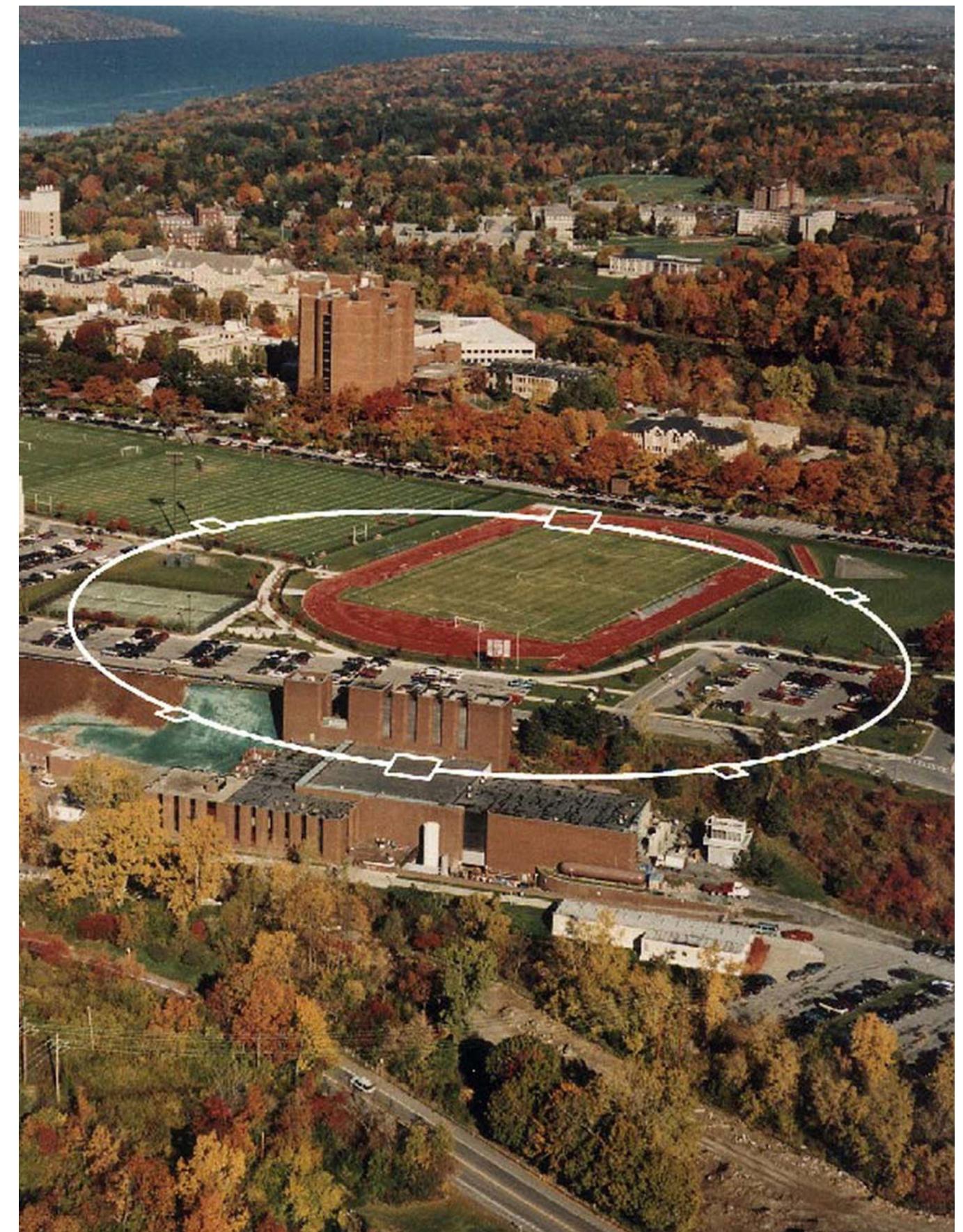


# Studies of the Effects of Electron Cloud Formation on Beam Dynamics at CesrTA

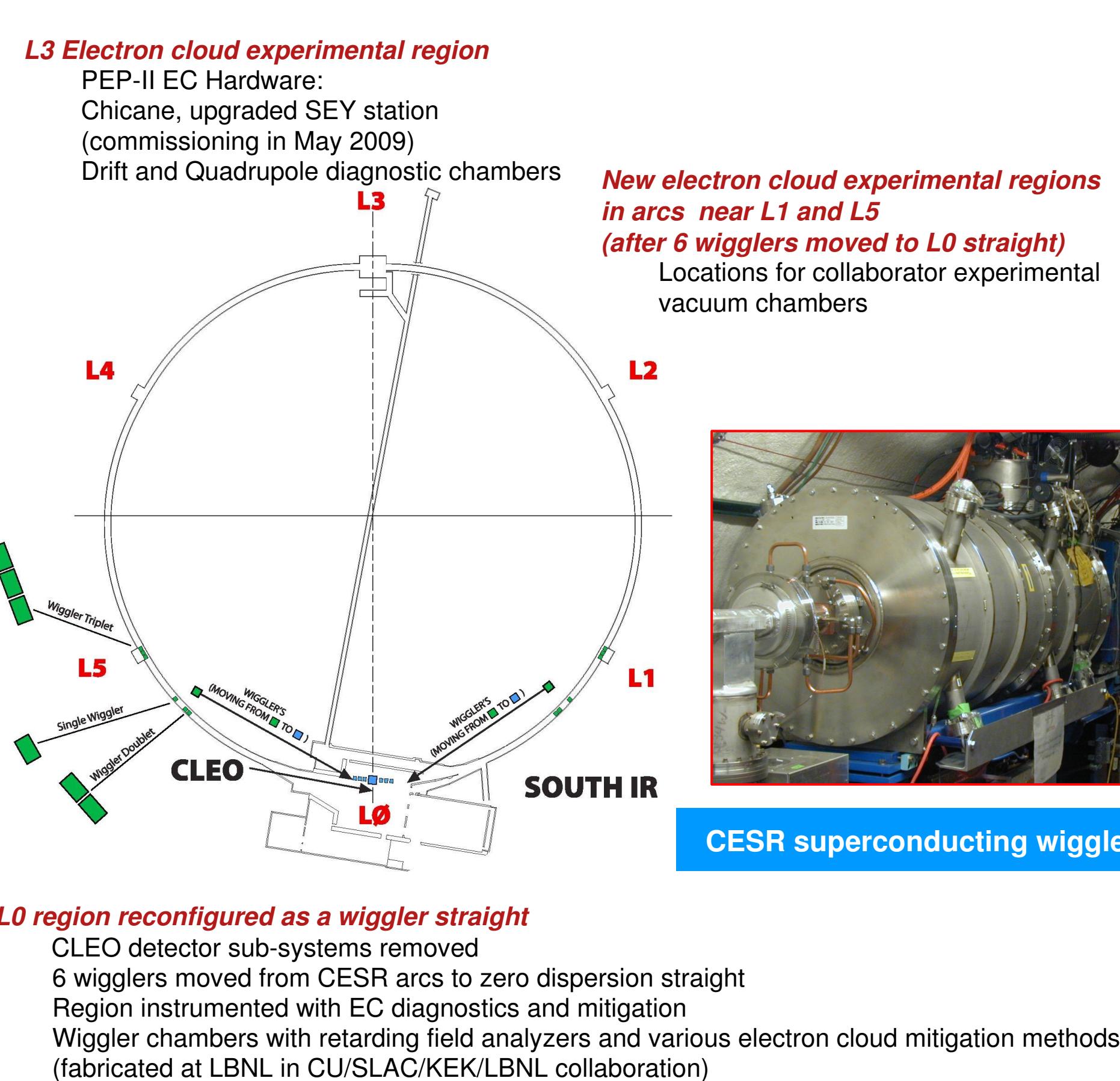
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The Cornell Electron Storage Ring Test Accelerator (CesrTA) has commenced operation as a linear collider damping ring test bed following its conversion from an  $e^+e^-$ -collider in 2008. A core component of the research program is the measurement of effects of synchrotron-radiation-induced electron cloud formation on beam dynamics. We have studied the interaction of the beam with the cloud in various bunch train configurations, bunch currents, beam energies, and bunch lengths, for both  $e^+$  and  $e^-$  beams. This paper compares a subset of these measurements to modeling results from the two-dimensional cloud simulation packages ECLOUD and POSINST. These codes each model most of the tune shift measurements with remarkable accuracy, while some comparisons merit further investigation.

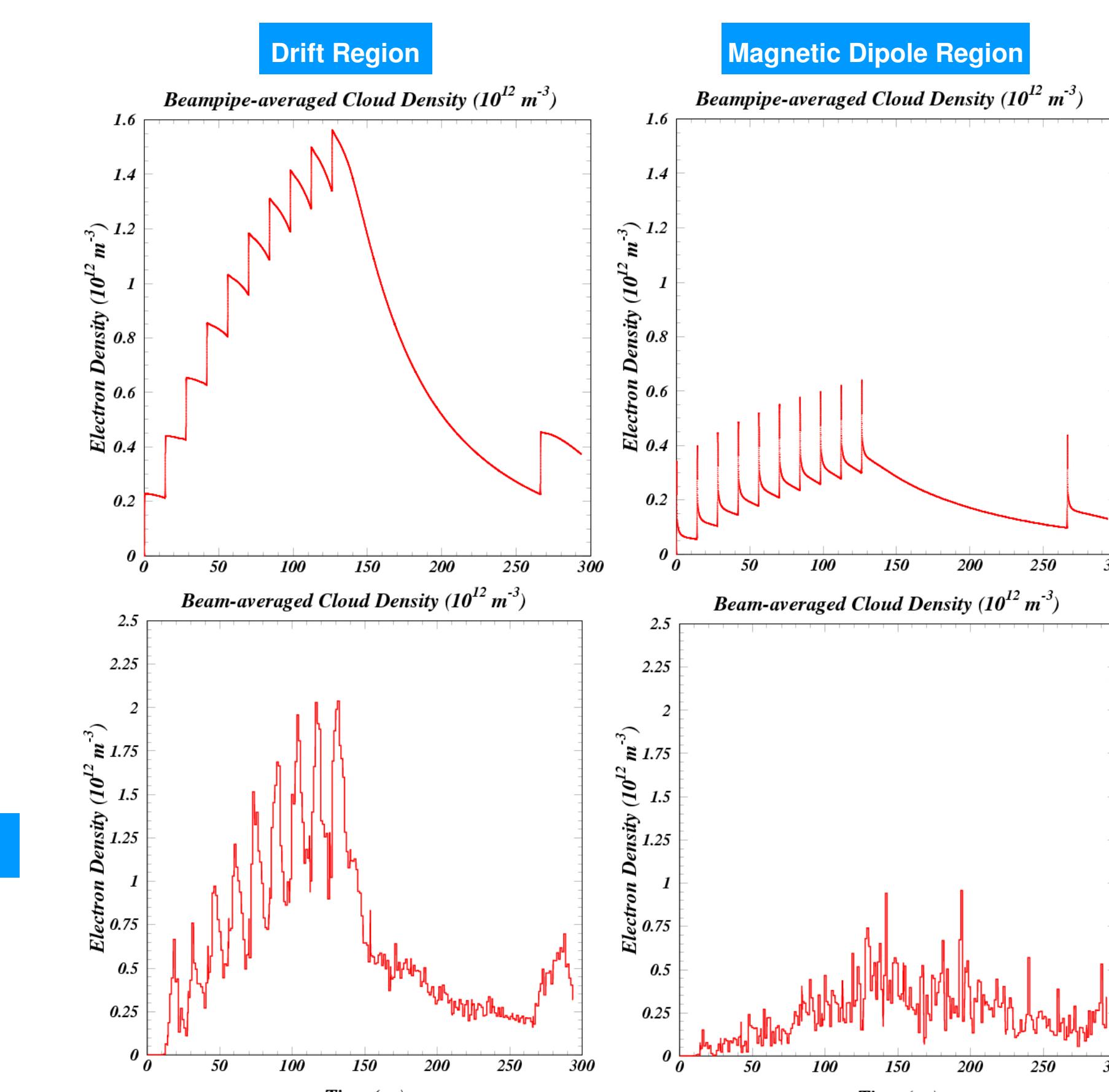
The CESR Tunnel under the Cornell Campus



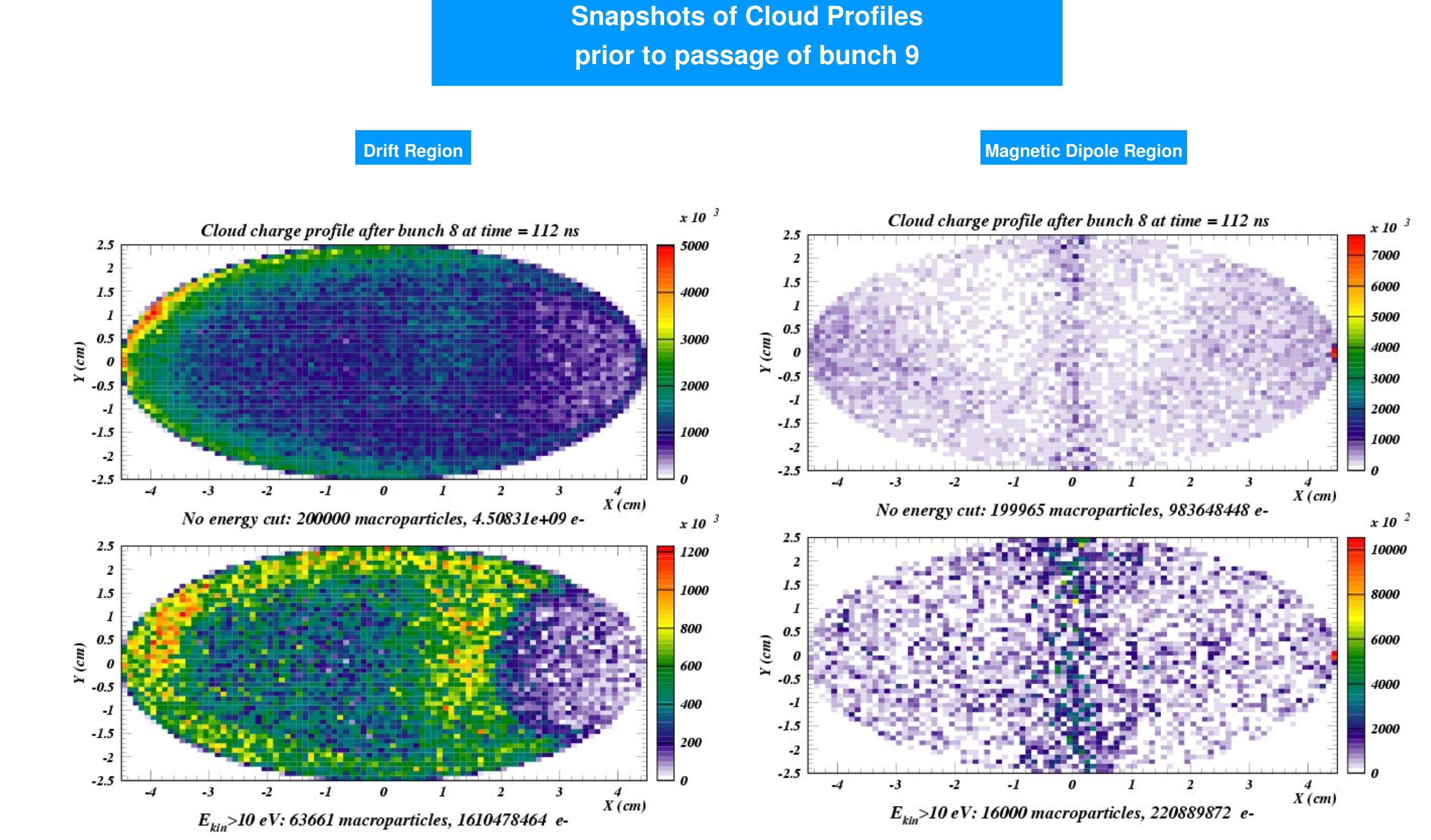
The CesrTA Reconfiguration  
July – October 2008



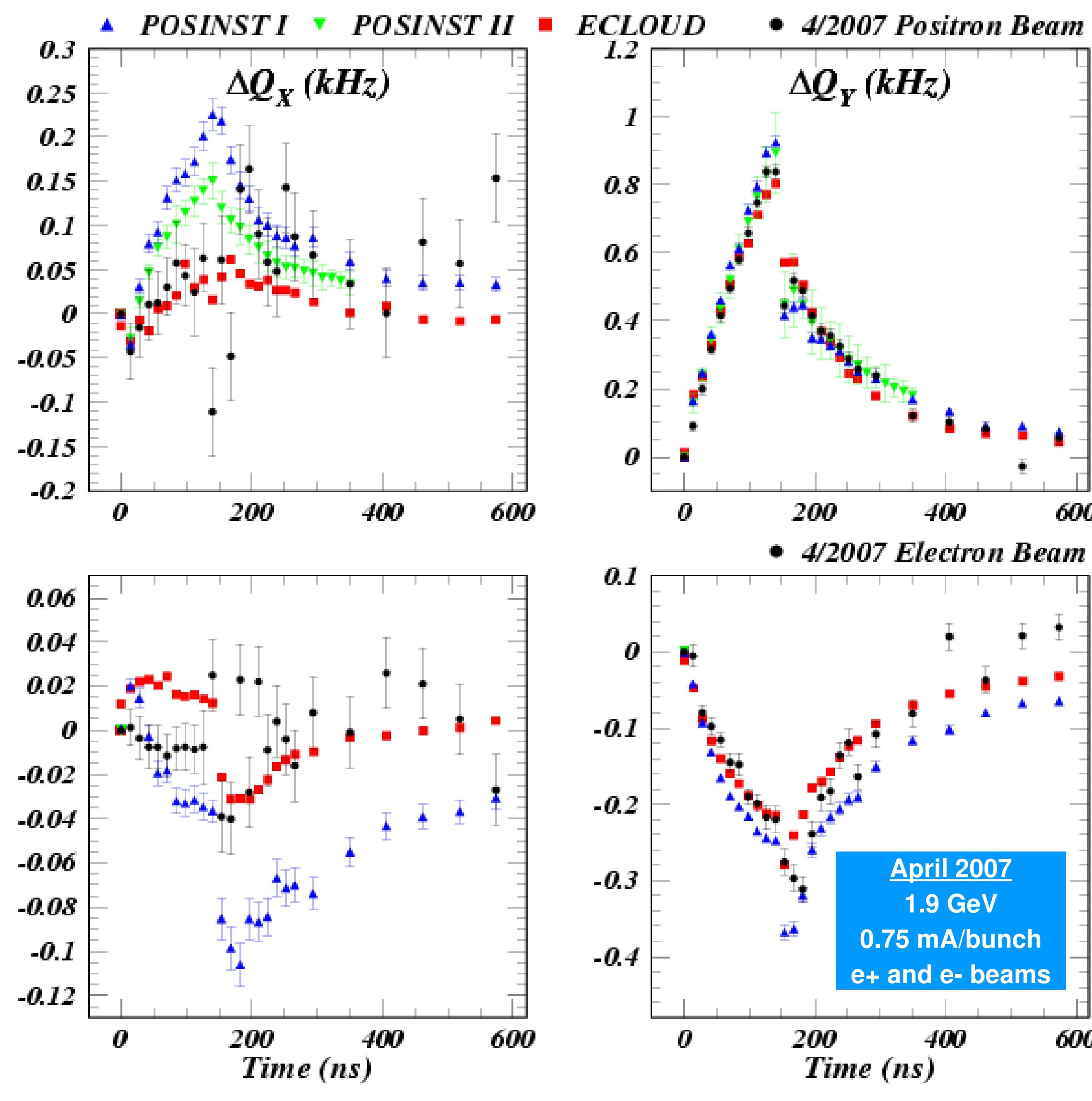
Electron Cloud Buildup  
10 filled bunches and bunch 20 filled as witness bunch  
Bunch spacing 14 ns RMS bunch length 13 mm



Snapshots of Cloud Profiles  
prior to passage of bunch 9



$$\Delta f_x = f_{rev} \frac{e}{4\pi E_{beam}} \oint \beta_x \left\langle \frac{dE_x}{dx} \right\rangle_{beam} ds \approx f_{rev} \frac{e}{4\pi E_{beam}} C \langle \beta_x \rangle_{ring} \left\langle \left\langle \frac{dE_x}{dx} \right\rangle_{beam} \right\rangle_{ring}$$



Modeling Coherent Tune Shift Measurements Using ECLOUD and POSINST Cloud Simulation Packages

## I. ECLOUD and POSINST cloud simulation input parameters

1. Sync rad photon rate per meter per beam particle at primary source point (2007: Drift R=0.23  $\gamma/m/e$ , Dipole R=0.53  $\gamma/m/e$ )
2. Quantum efficiency for producing photo-electrons on the vacuum chamber wall (12%)
3. Beam particles per bunch (0.75 mA/bunch  $\rightarrow$  1.2e10 e/bunch).
4. Contribution of reflected sync rad photons distributed uniformly in azimuth around the beampipe wall (15%).

\*This contribution is also subtracted from the primary source point.

## 5. Secondary emission peak yield (SEY=2.0) at peak energy ( $E_{peak} = 310$ eV)

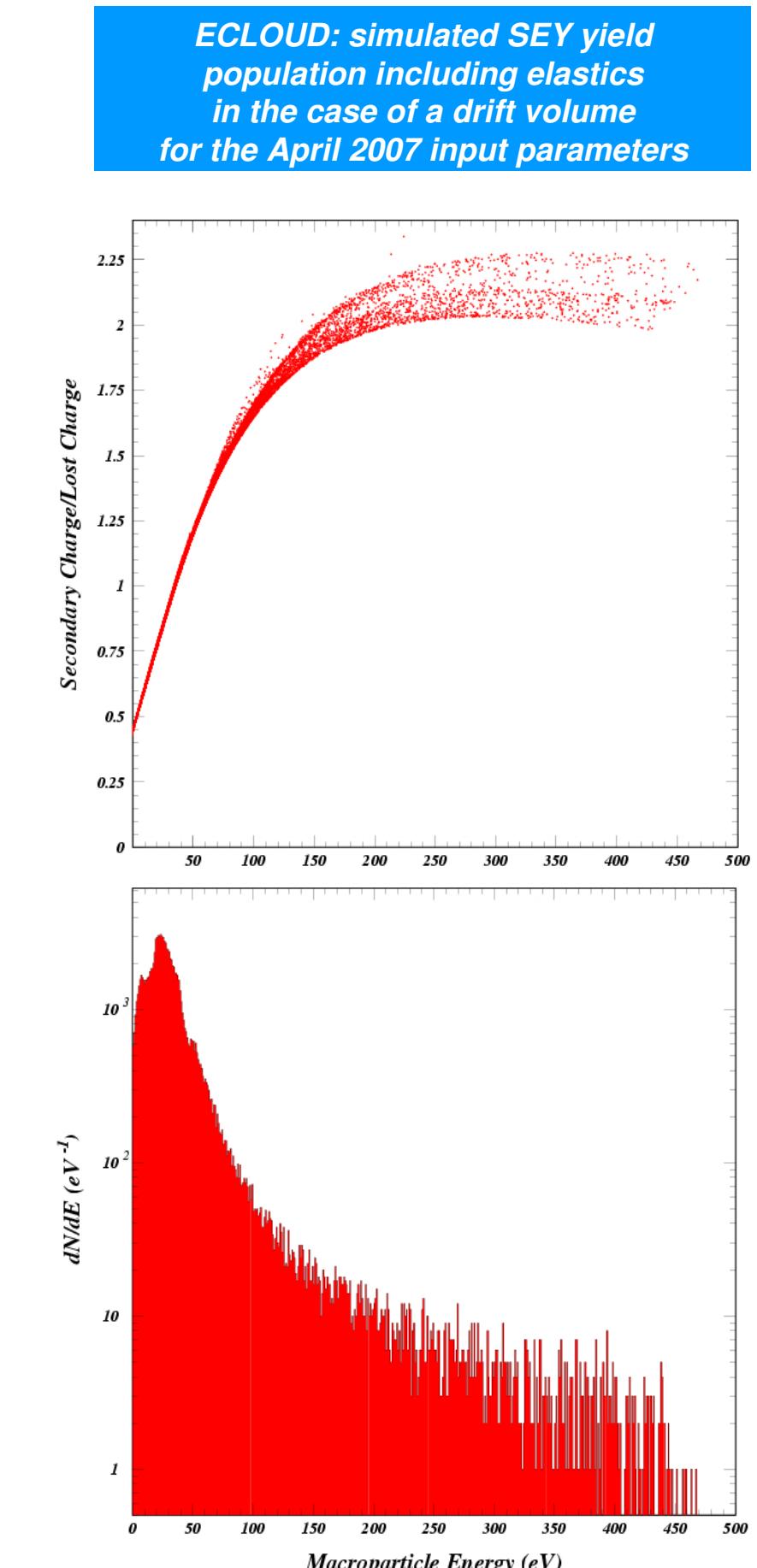
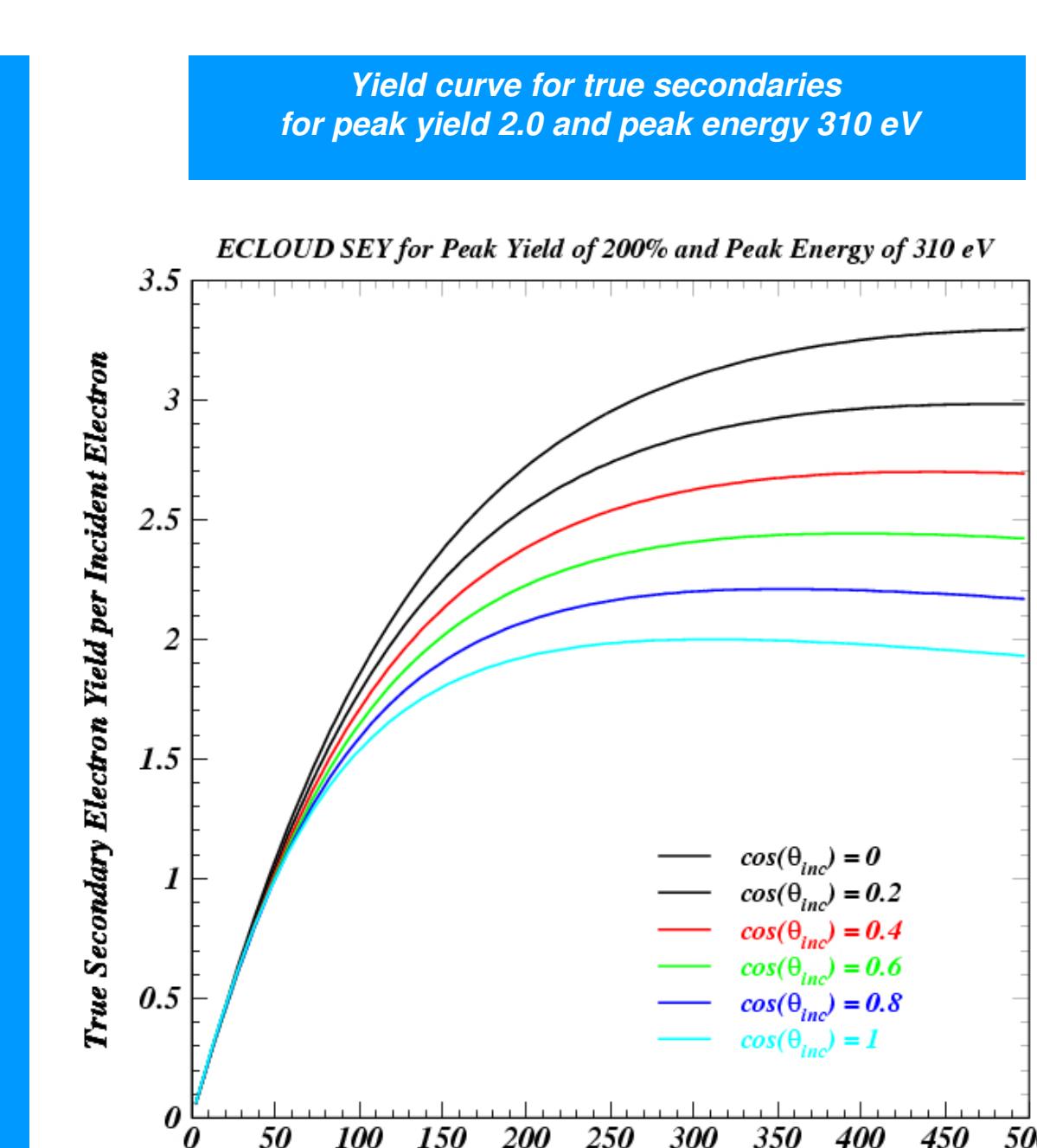
\*These values are also used by POSINST, but the POSINST SEY model is quite different from ECLOUD's.

## II. Field difference or gradient $\rightarrow$ tune shift conversion parameters

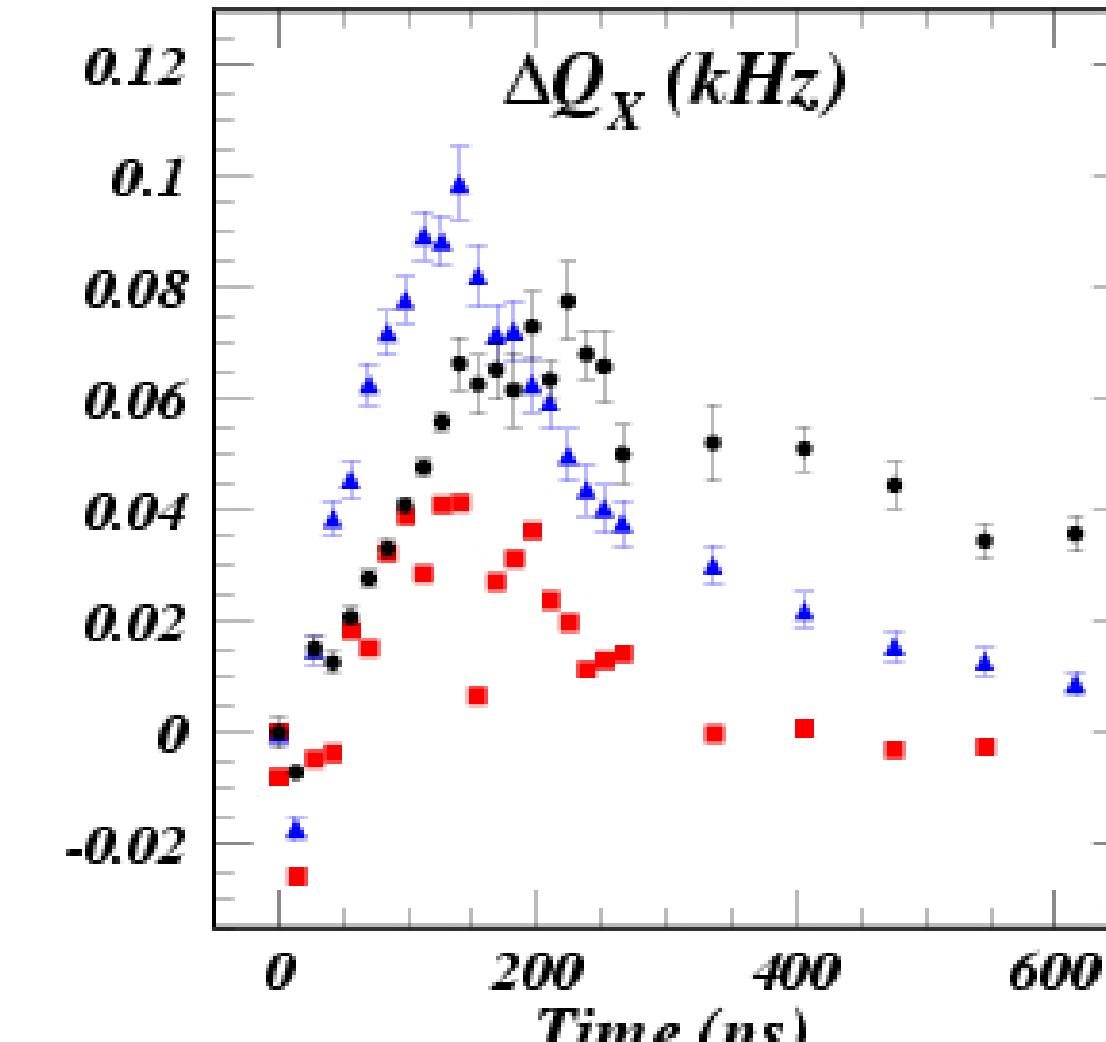
1.  $E_{beam} = 1.885e9$  eV
2.  $f_{rev} = 390$  kHz
3. Ring circumference  $C=768$  m ( $C f_{rev} = c = 2.998e8$  m/s)
4. Ring-averaged  $\beta$  values (from sync rad summary tables derived from lattice model)
  - $\bullet$   $e^+$  beam: Drift  $\beta_x(\beta_y) = 19.6$  m (18.8m), Dipole  $\beta_x(\beta_y) = 15.4$  m (18.8m)
  - $\bullet$   $e^-$  beam: Drift  $\beta_x(\beta_y) = 19.4$  m (19.3m), Dipole  $\beta_x(\beta_y) = 15.3$  m (19.4m)

## III. Relative drift/dipole weighting (from sync rad summary tables)

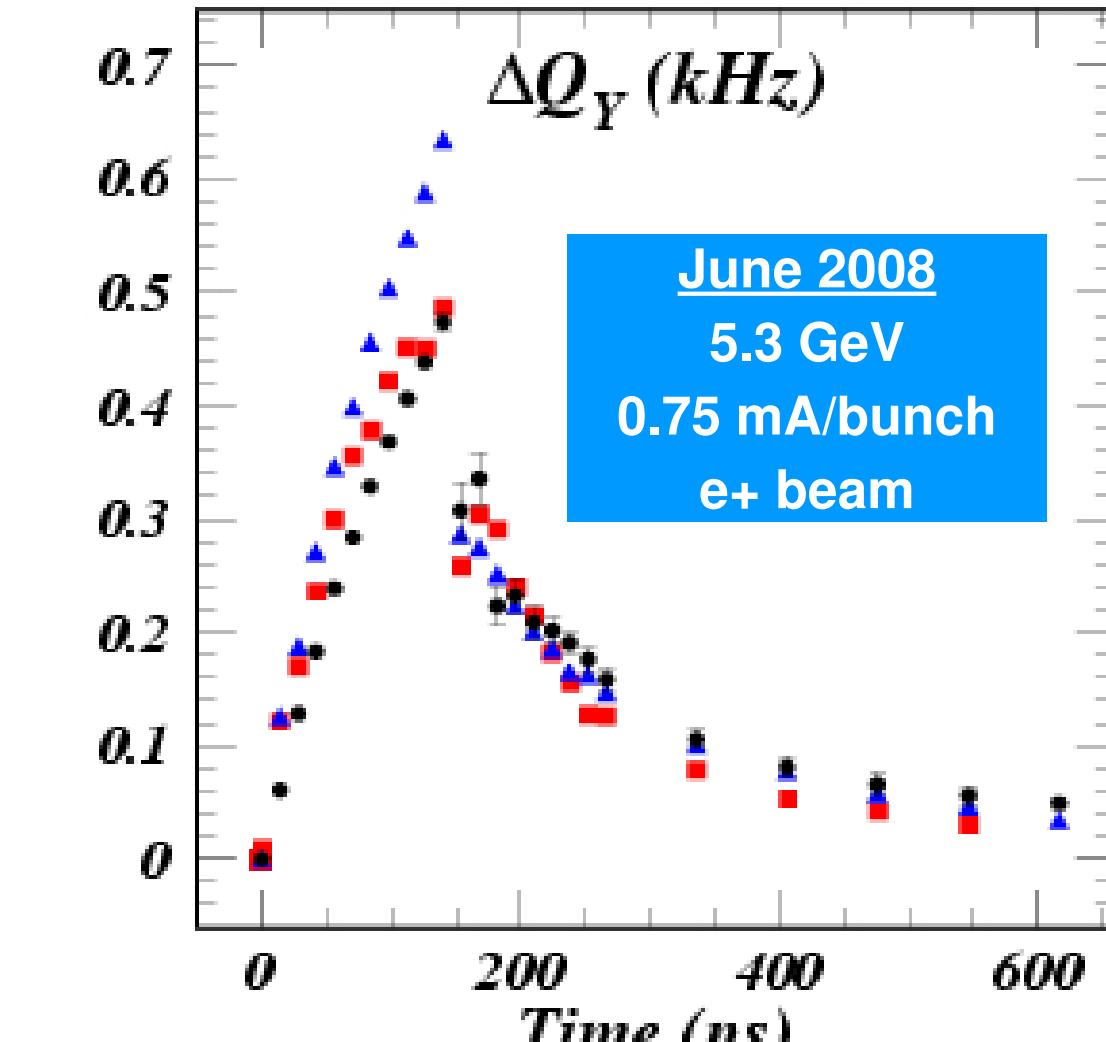
1. Ring length fractions: Drift: (174.9m/768m) = 0.228, Dipole: (473.9m/768m) = 0.617. Remaining 15% of ring ignored.



POSINST I ■ ECLOUD



● 6/2008 Positron Beam



● POSINST I ■ ECLOUD

