Cornell University
Laboratory for Elementary-Particle Physics

Comparison of ECLOUD Calculations in Dipole and Quadrupole Fields

I. Beam-pipe-averaged cloud density & lifetime

II. Beam-averaged cloud density & lifetime

III. Contributions to coherent tune shifts

-- Includes additional plots of cloud profiles with offset beams and horizontal tune shifts as discussed during the meeting --
26 Feb 2010: Corrected slide 6. Quad strength for 2.1 GeV is 2.76 T/m, not 9.2 T/m.

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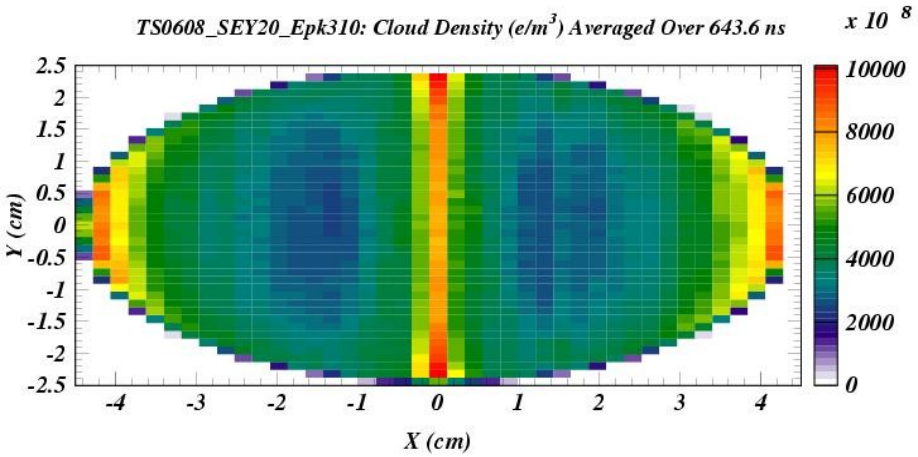
Electron Cloud Meeting

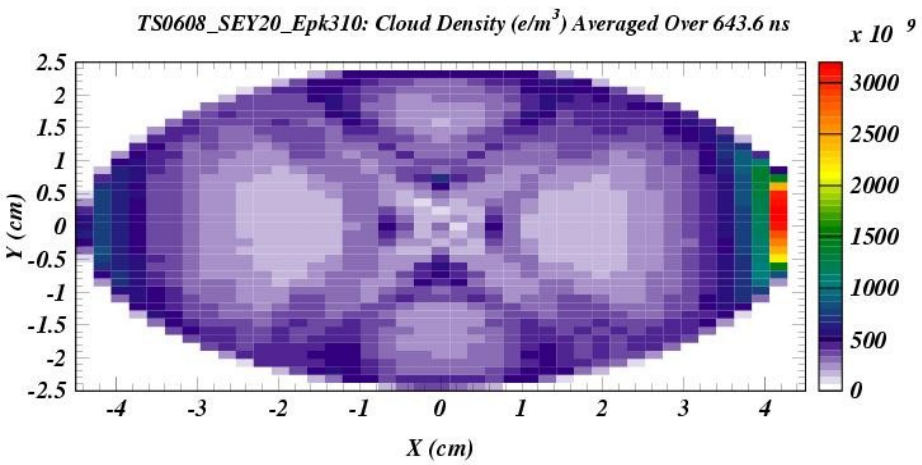
9 December 2009

Conditions of June, 2008 tune shift measurements 5.3 GeV 11 bunches 14-ns spacing 1.2e10 e+/bunch Figure 2 of our PAC2009 paper

Dipole (0.2 T)



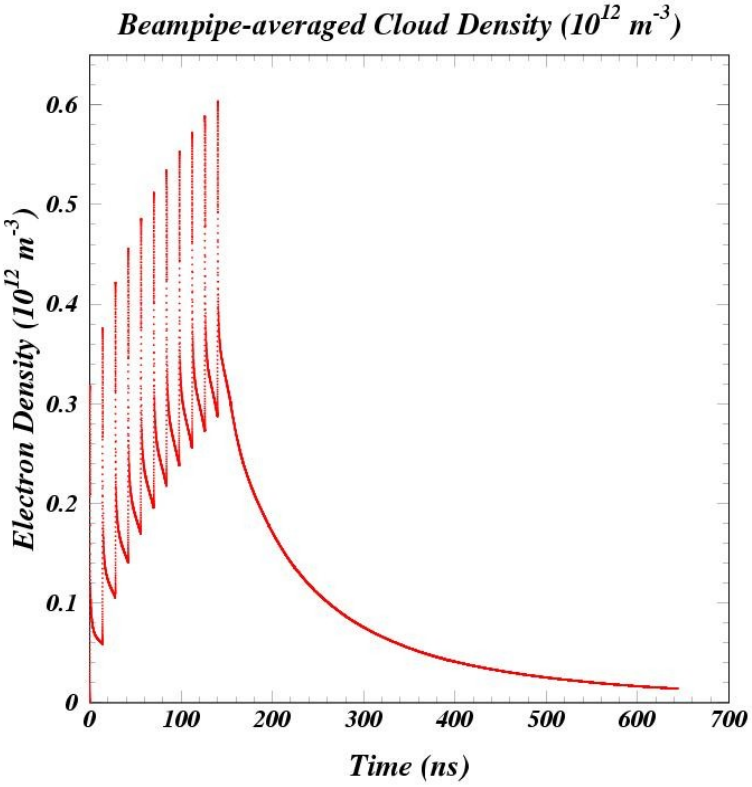
Quadrupole (9.2 T/m)



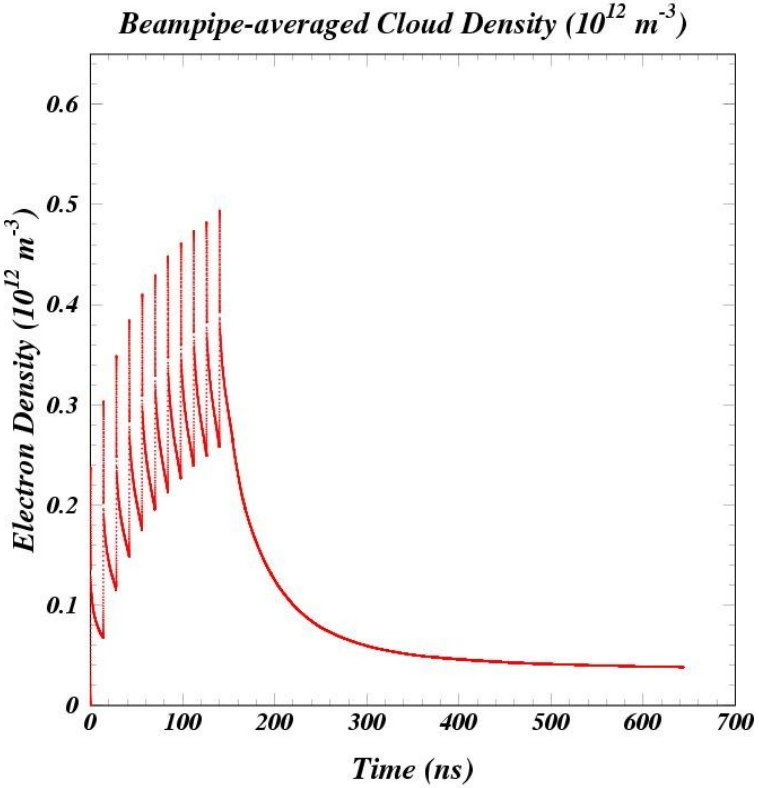
These conditions were chosen to give an estimate of the quadrupole contribution to the coherent tune shifts and to estimate the cloud persistence in quadrupoles relative to dipoles. 11 filled bunches followed by 34 empty ones. Assumed 1.1 photons/m/e (the ring-average for dipoles) and 15% reflectivity in both simulations. The SEY model parameters are the PAC2009 values, whereby ECLOUD now includes the rediffused eomponent.

Time development of cloud density averaged over the 4.5 x 2.5 cm elliptical vacuum chamber

Dipole (0.2 T)



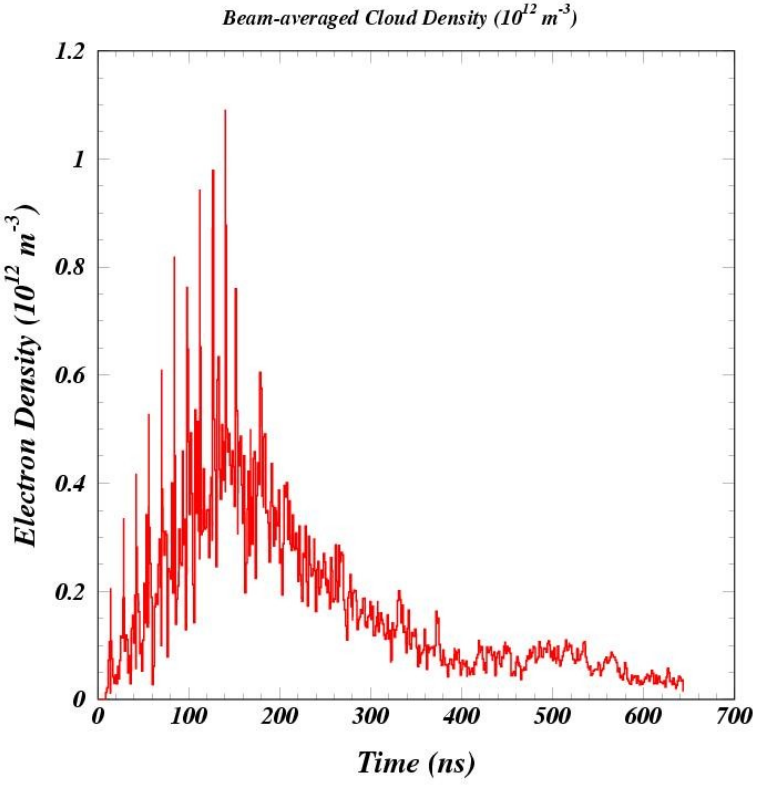
Quadrupole (9.2 T/m)



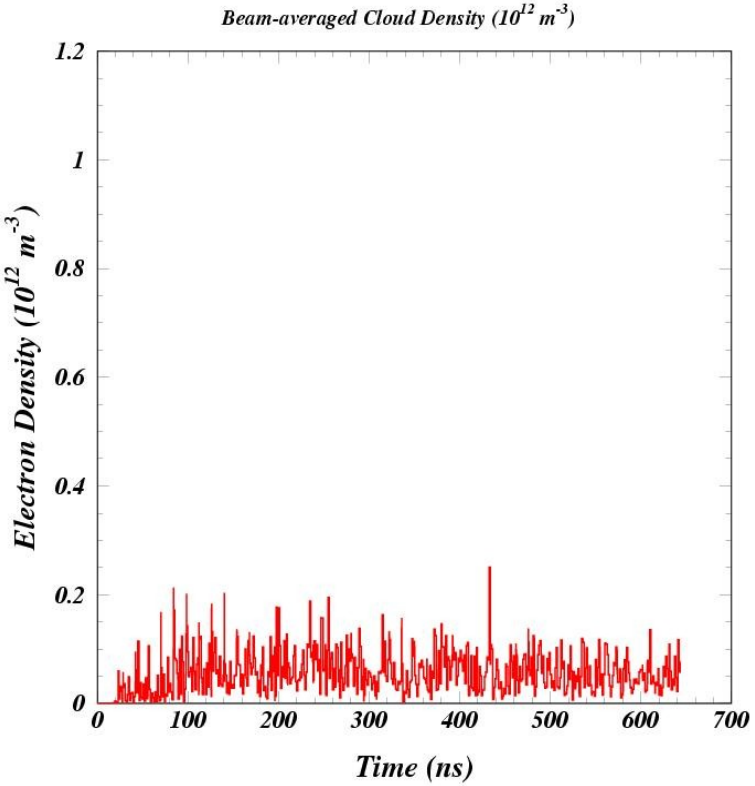
The beam-pipe-averaged density indeed shows a longer lifetime in quadrupoles.

Time development of cloud density averaged over the transverse beam profile (1.56 x 0.15 mm)

Dipole (0.2 T)



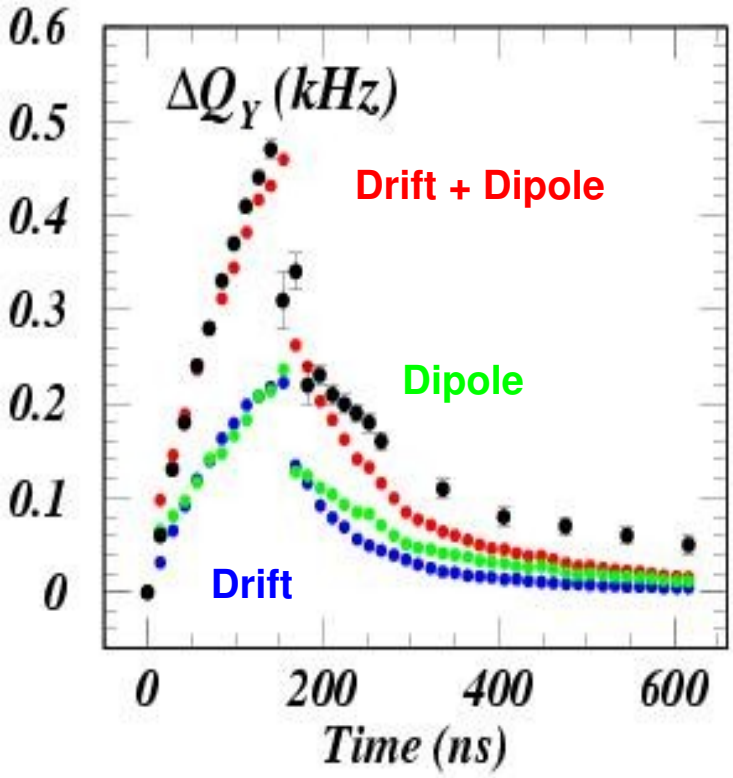
Quadrupole (9.2 T/m)



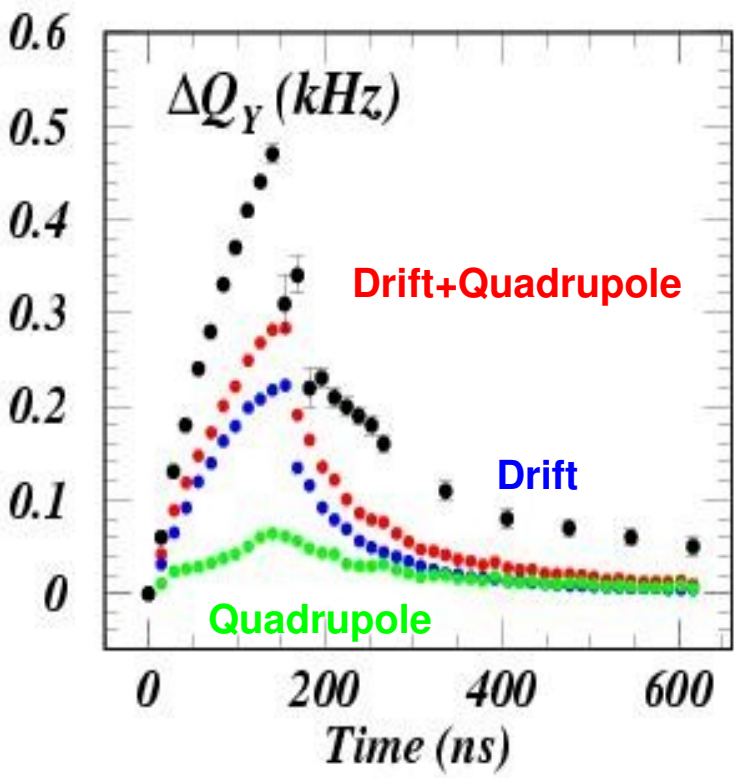
The beam-averaged density shows a longer lifetime in quadrupoles but the dipole cloud is much more concentrated on the beam during the time period covered by these simulations.

Quadrupole tune shift contribution assuming dipole ring averages June, 2008 vertical tune shift measurements

Dipole (0.2 T)



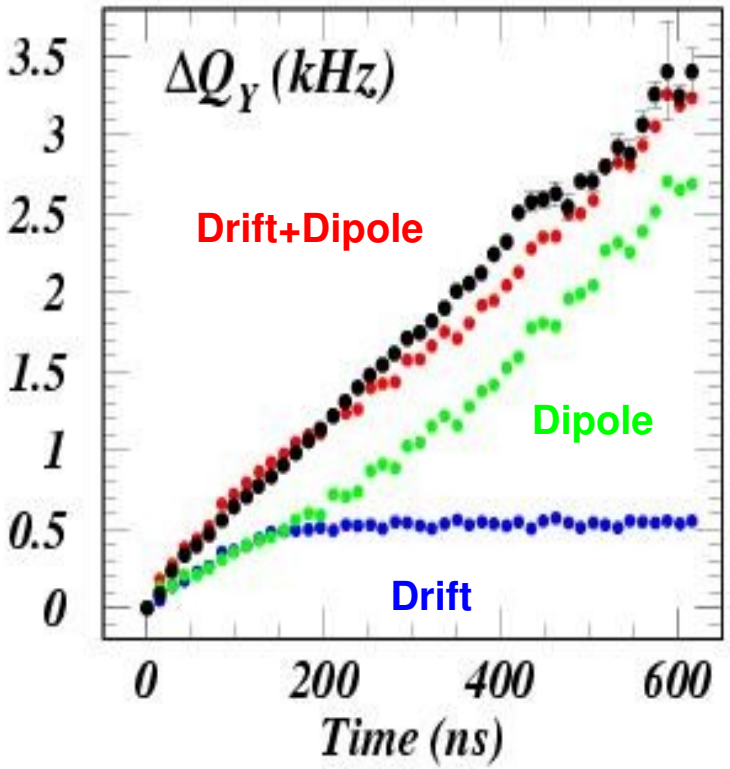
Quadrupole (9.2 T/m)



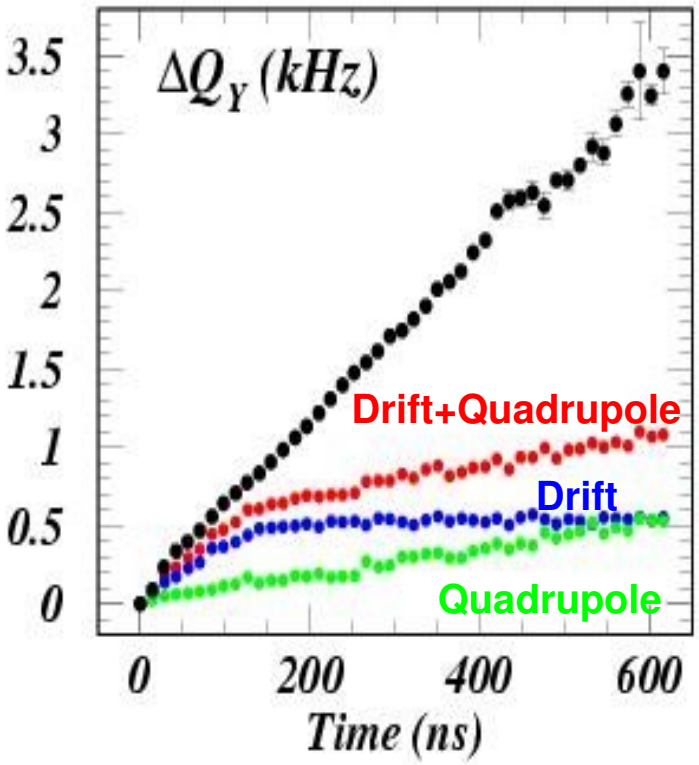
The assumption of dipole ring averages (61.5% occupancy and 1.16 photons/m/e) exaggerates the quadrupole contribution (8.5%, 0.78 photons/m/e) by more than a factor of 10. The quadrupole contribution thus calculated is nonetheless only about 20% of the dipole contribution during the passage of the filled bunches. It can be neglected at the 2% level.

Quadrupole tune shift contribution
2.1 GeV 45 bunches 1.28e10 e+/bunch
Figure 3 of our PAC2009 paper

Dipole (0.2 T)



Quadrupole (2.76 T/m)

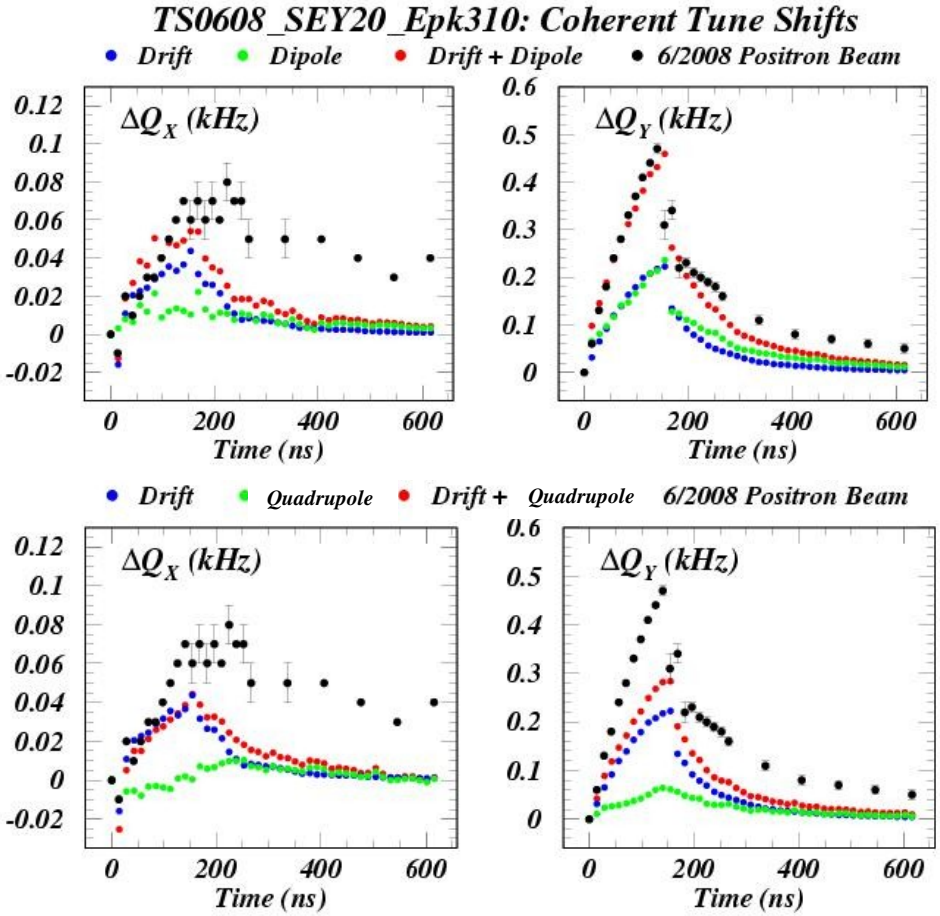


Long bunch trains provide additional information because of the large SEY contribution.
We have previously shown that the rediffused component accounts for about half of the vertical tune shift in bunch 45.
The quadrupole contribution shows a similar time structure, but can be neglected at the 2% level.

Quadrupole tune shift contribution assuming dipole ring averages June, 2008 tune shift measurements

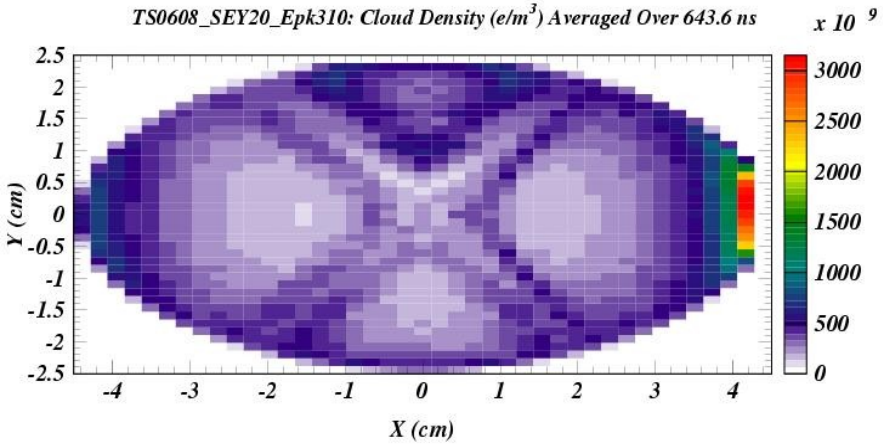
Dipole (0.2 T)

Quadrupole (9.2 T/m)



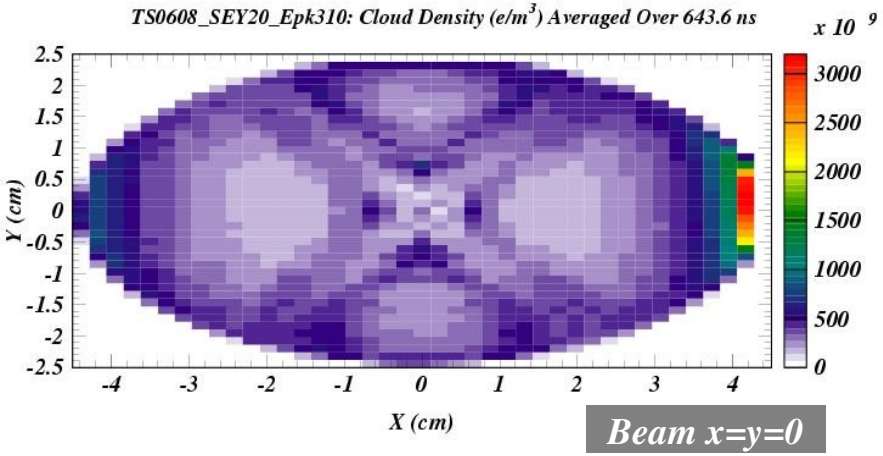
Horizontal and vertical tune shift calculations

Conditions of June, 2008 tune shift measurements
5.3 GeV 11 bunches 14-ns spacing 1.2e10 e+/bunch
Figure 2 of our PAC2009 paper

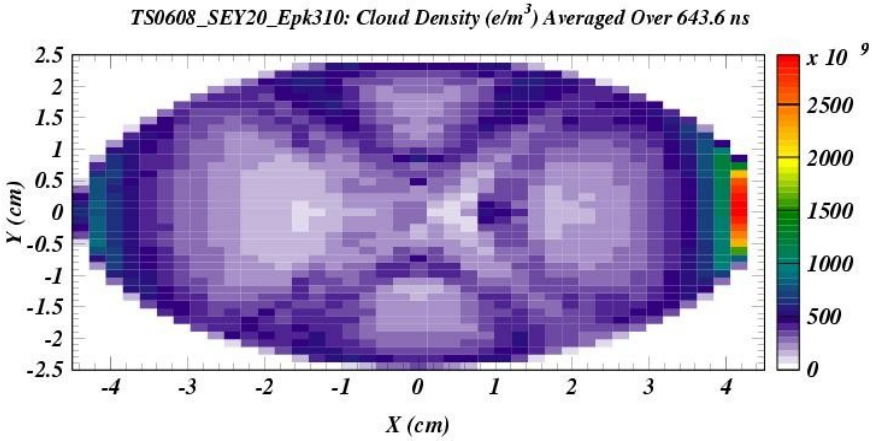


Beam x=0 y=5mm

Beam x= 5mm y=0



Beam x=y=0



Time-averaged cloud profiles with offset beams.
11 filled bunches + 34 empty bunches