Time-Resolved Measurements and Modeling of Electron Trapping in a Quadrupole Magnet

-- See also the talks in the Electron Cloud Meetings on 7/3/2013 and 8/7/2013 --

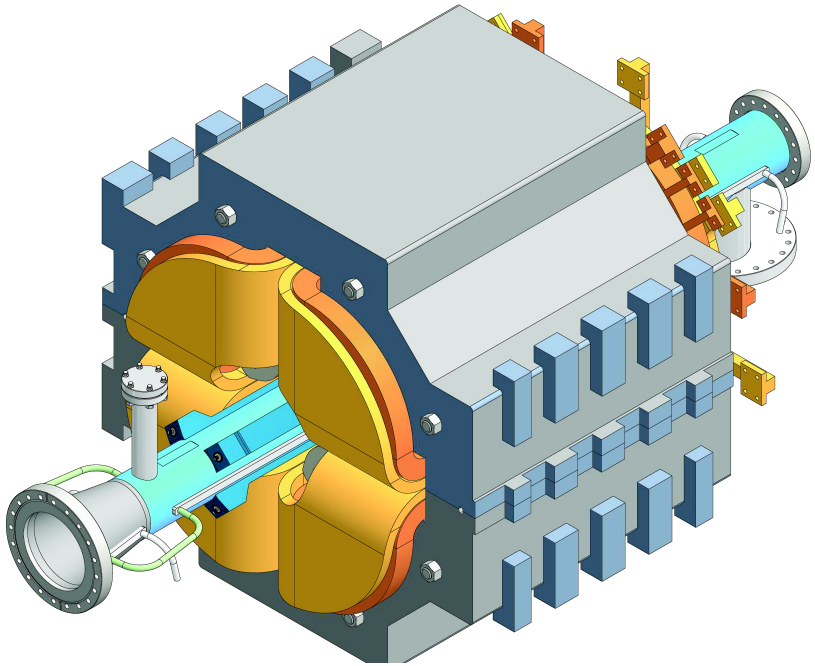
Jim Crittenden

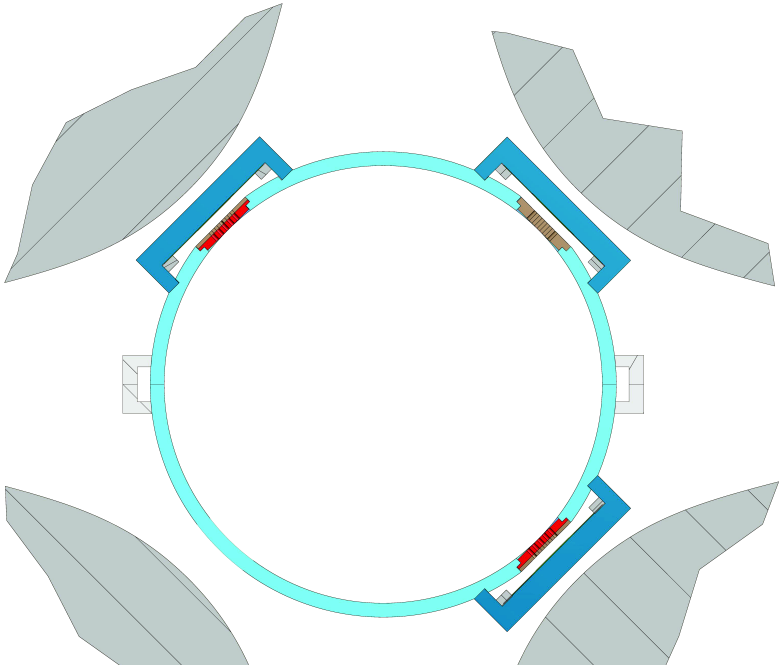
Cornell Laboratory for Accelerator-Based Sciences and Education

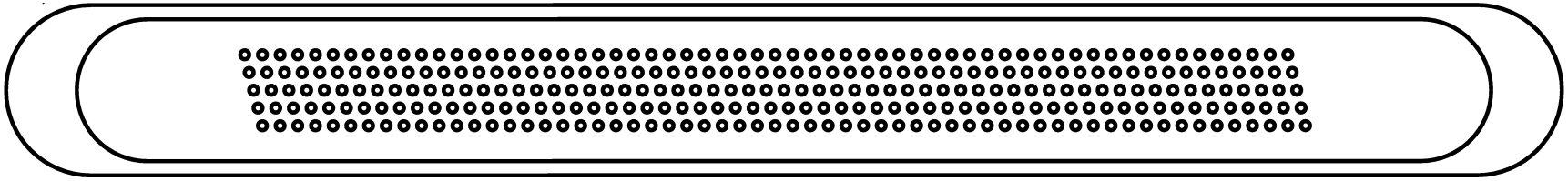
CESRTA Collaboration Meeting

10 September 2013

Shielded Pickup Detector in Quadrupole Q48W

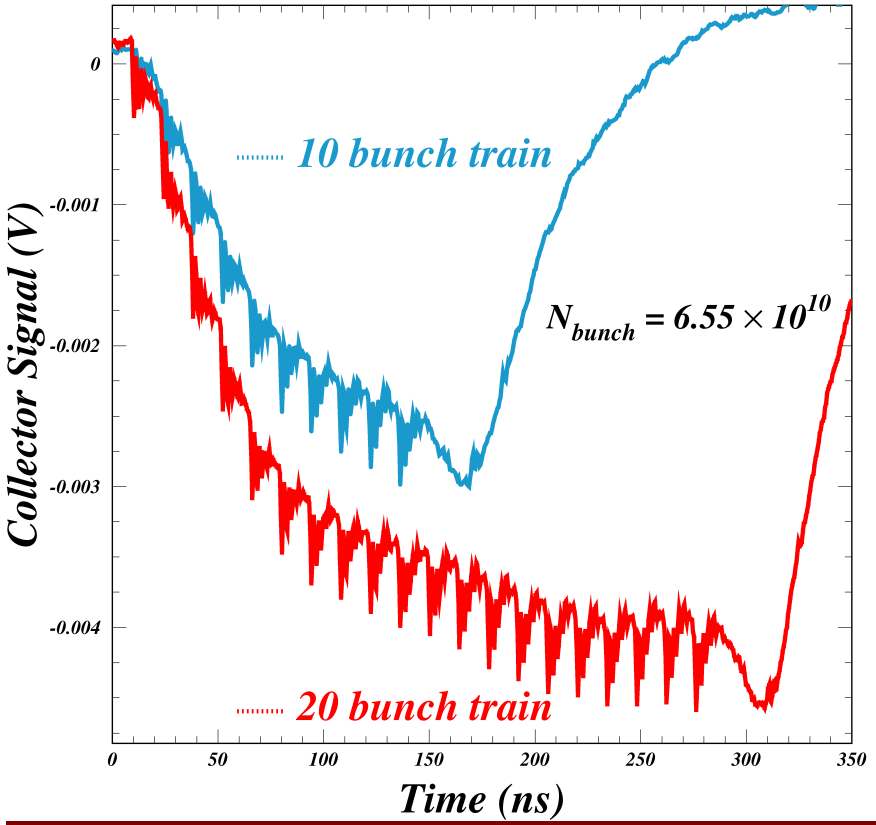




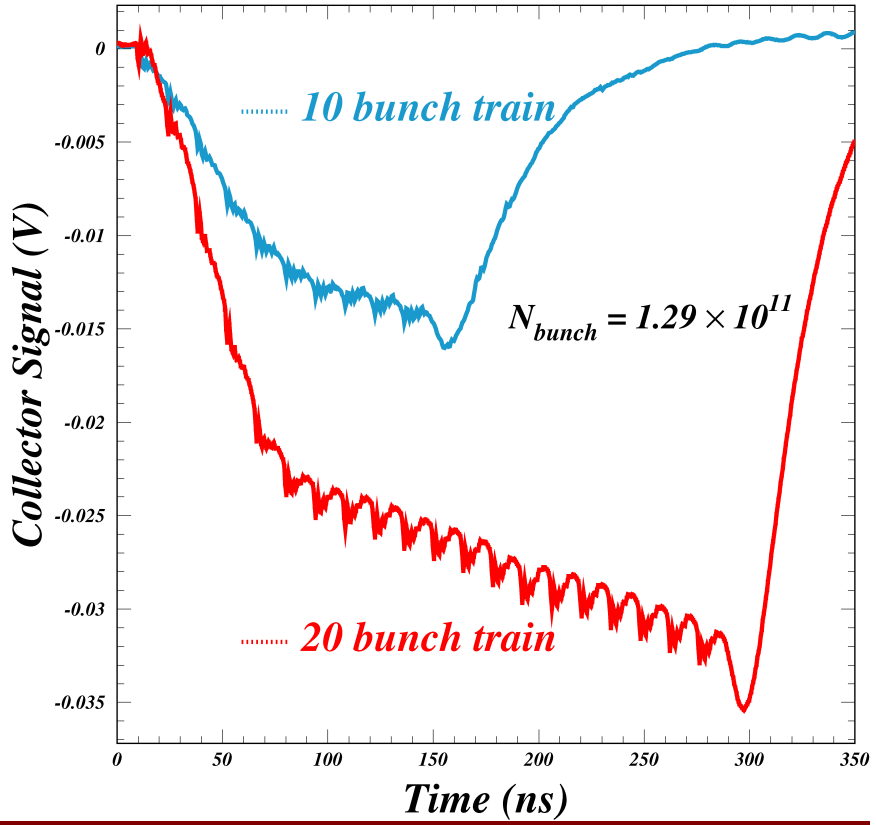


Compare QSPU signals from 10 and 20-bunch e+ trains

4 mA / bunch

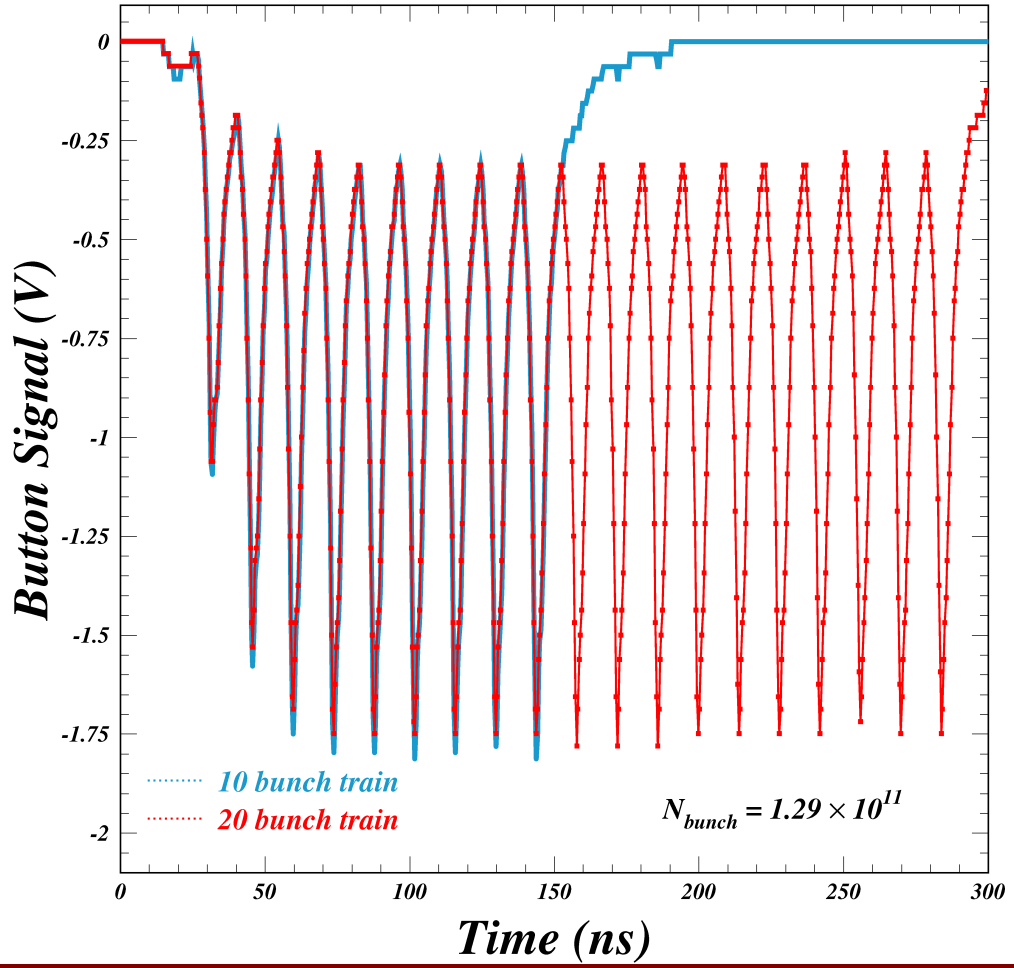


8 mA / bunch



Average over 8k turns after cloud buildup equilibrium reached.
First ten bunches of train larger for 20-bunch train --> Trapping !
Reservoir of charge depleted after seven bunches.

Compare to Shielded Pickup Measurements in Field-free Region 15W

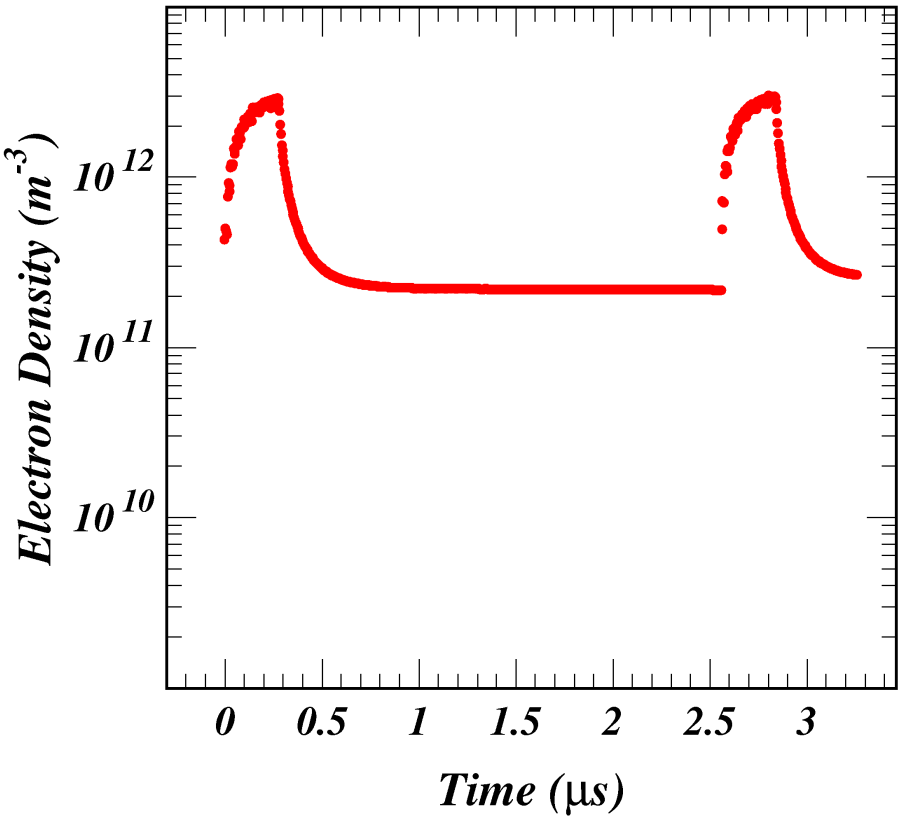


Use SPU measurements simultaneous with 8-mA QSPU measurements

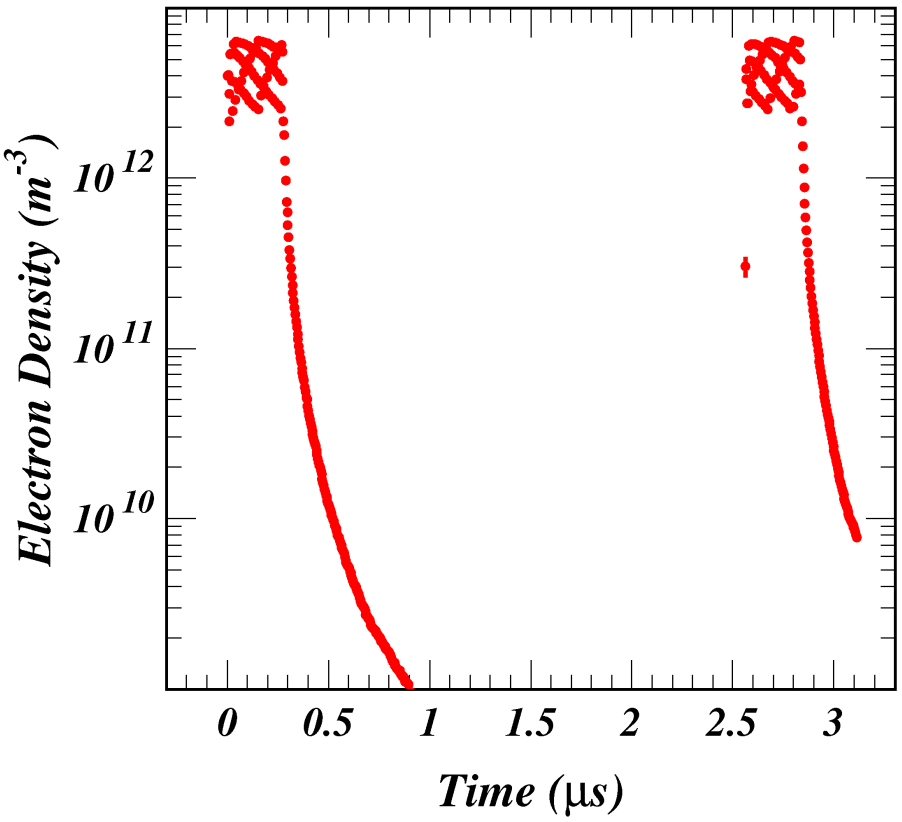
No trapping observed.

Cloud density calculations from ECLOUD models which reproduce the observed signals

Q48W



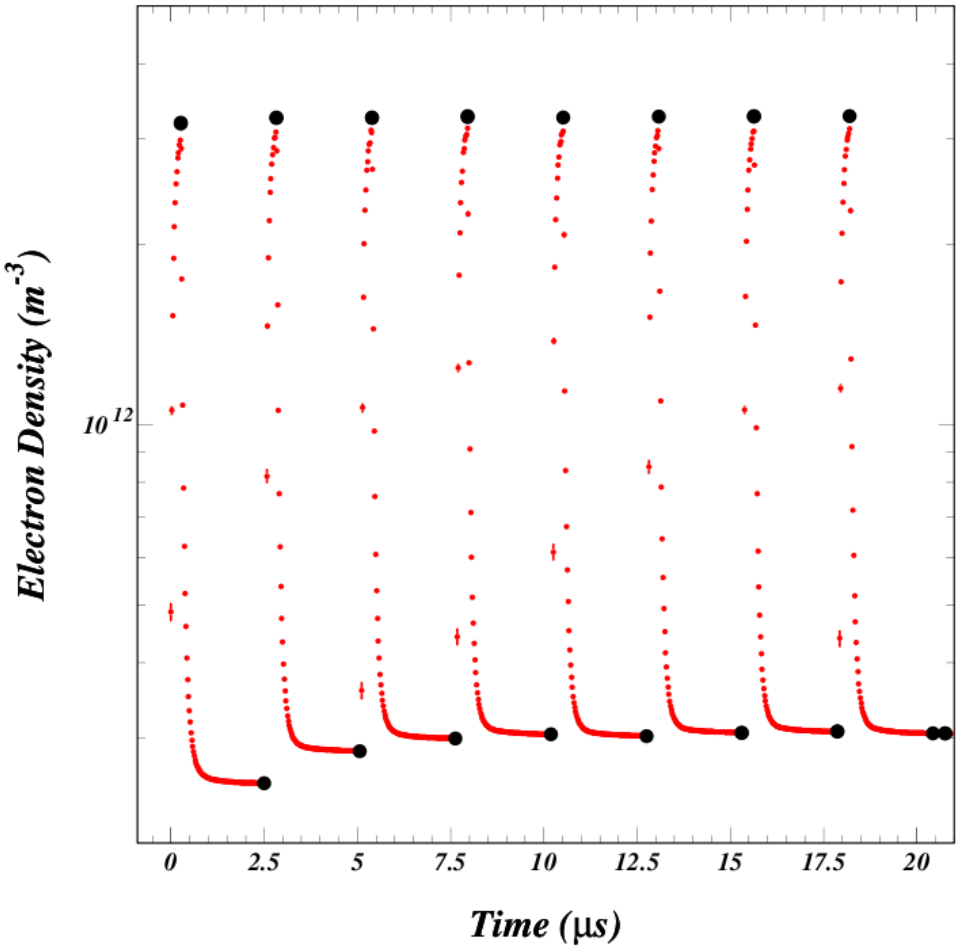
15W



Full ECLOUD model including Synrad3D at Q48W and 15W (TiN) for 20 8-mA e+ bunches.

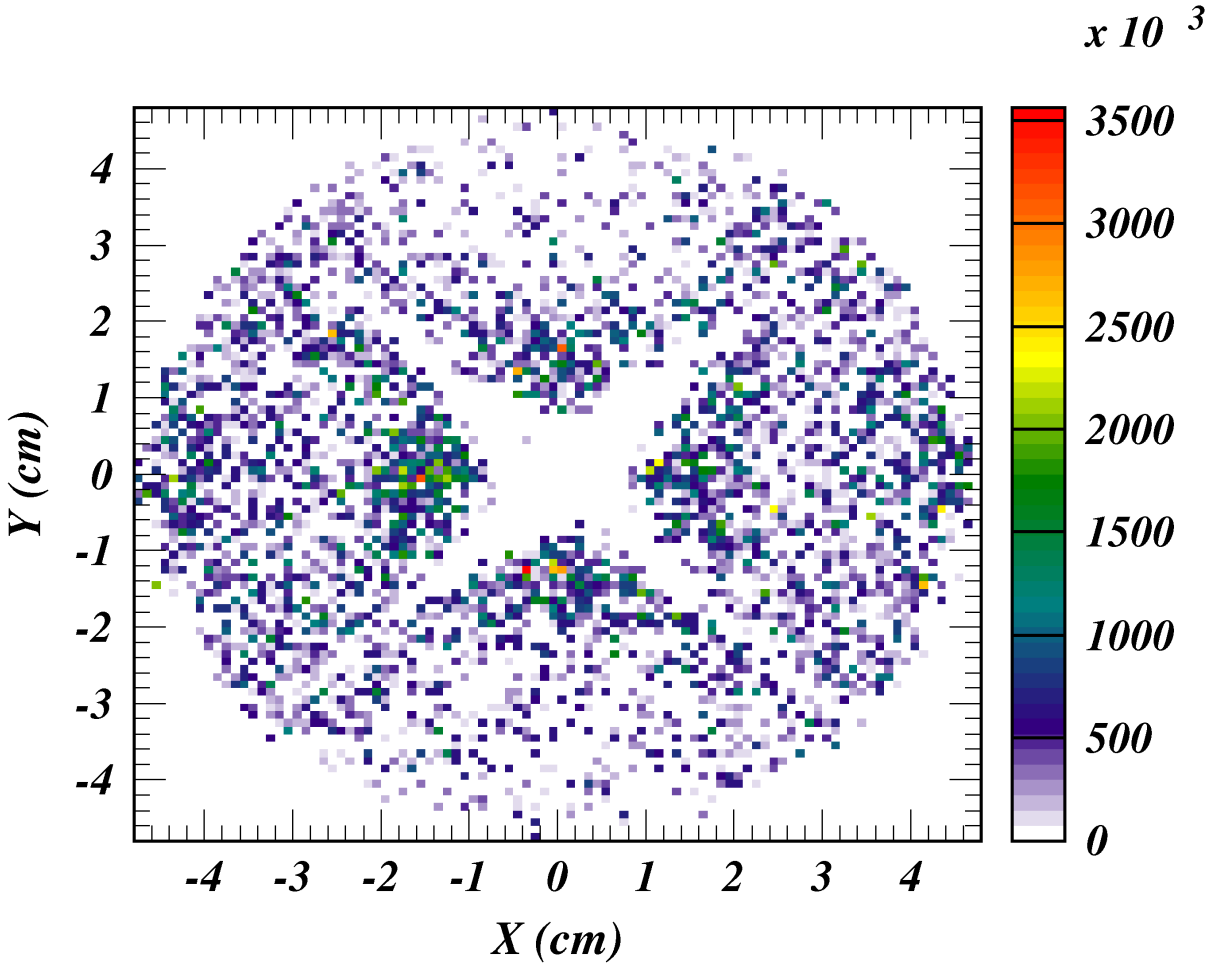
ECLOUD shows trapping is to be expected in the quadrupole and not expected in the field-free region.

ECLOUD prediction for equilibrium trapped cloud



For the 20-bunch 8 mA/bunch train in the 7.4 T/m quadrupole, 7.6% of the cloud is trapped after one train passage.
The trapped cloud reaches equilibrium of 9.4% after just a few turns.

Snapshot of modeled cloud distribution just prior to return of 20-bunch train



Modeled trapping pattern is consistent with Kiran's calculations for field gradient 7.4 T/m.

Median electron energy is 50 eV.