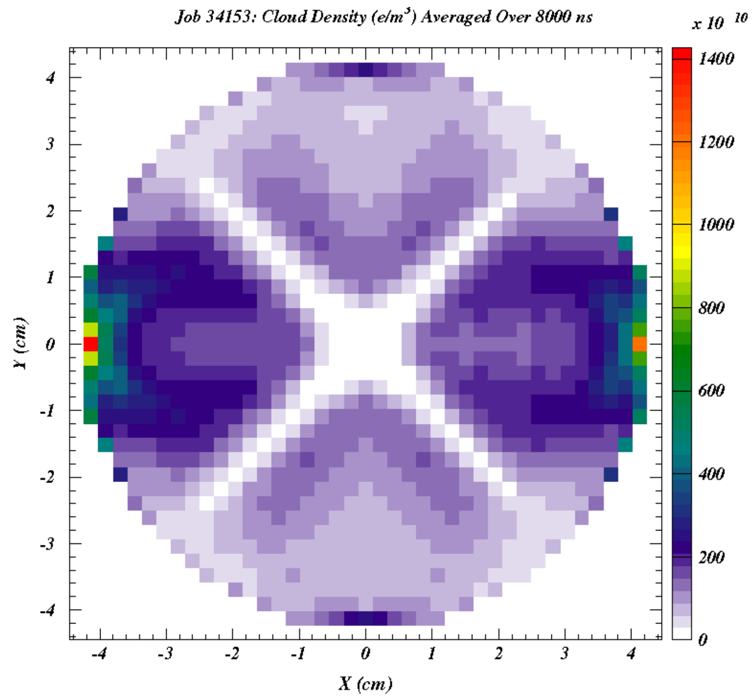
ECLOUD Simulation of Electron Cloud Buildup in the Q48W Quadrupole Magnet for 30-Bunch Trains of 2.1 GeV Positrons With and Without a Precursor Bunch



Plus bonus slide on optimal hole orientation for proposed time-resolved RFA in Q48W

After meeting:
-corrected last slide for RFA collector geometry
-added comparison of 3rd trains in slides 9&10

Jim Crittenden

Cornell Laboratory for Accelerator-Based Sciences and Education

Electron Cloud Meeting

17 October 2012

Kiran's table of cloud dynamics measurements

	Train bunch current (mA)	Lead Bunch current (mA)	Energy (GeV)	Bunch spacing (ns)	Nr of bunches	1st bunch blow up	2nd bunch blowup	Date	Precursor bunch test
1	0.75	0.75	2	4	30	yes	yes	Apr 12	no
2	0.75	0.75	2	8	30	yes	yes	Apr 12 June 11	yes
3	0.75	0.75	2	12	30	yes	no	Apr 12	yes
4	0.75	0.75	2	14	30	no	no	Apr 12 June 11	N/A
5	0.75	0.75	2	16	30	no	no	Apr 12	N/A
6	0.75	0.75	2	20	30	no	no	Apr 12	N/A
7	0.75	0.75	2	24	30	no (?)	no	Apr 12	N/A
8	0.75	0.75	2	28	30	no(?)	yes(?)	Apr 12	no
9	0.75	0.75	4	4	30	no	no	June 11	N/A
10	0.75	0.75	4	4	45	yes	no	June 11	yes
11	0.50	0.50	2	8	45	no	no	June 11	N/A
12	0.50	0.75	2	8	45	yes	no	June 11	no
13	0.75	0.50	2	8	30	yes	yes (bigger than 2)	June 11	no

Can the model account for bunch blowup for 8-ns spacing, the effect of the precursor, and for no blowup with 14-ns spacing?

Model Parameters for 2.1 GeV Q48W

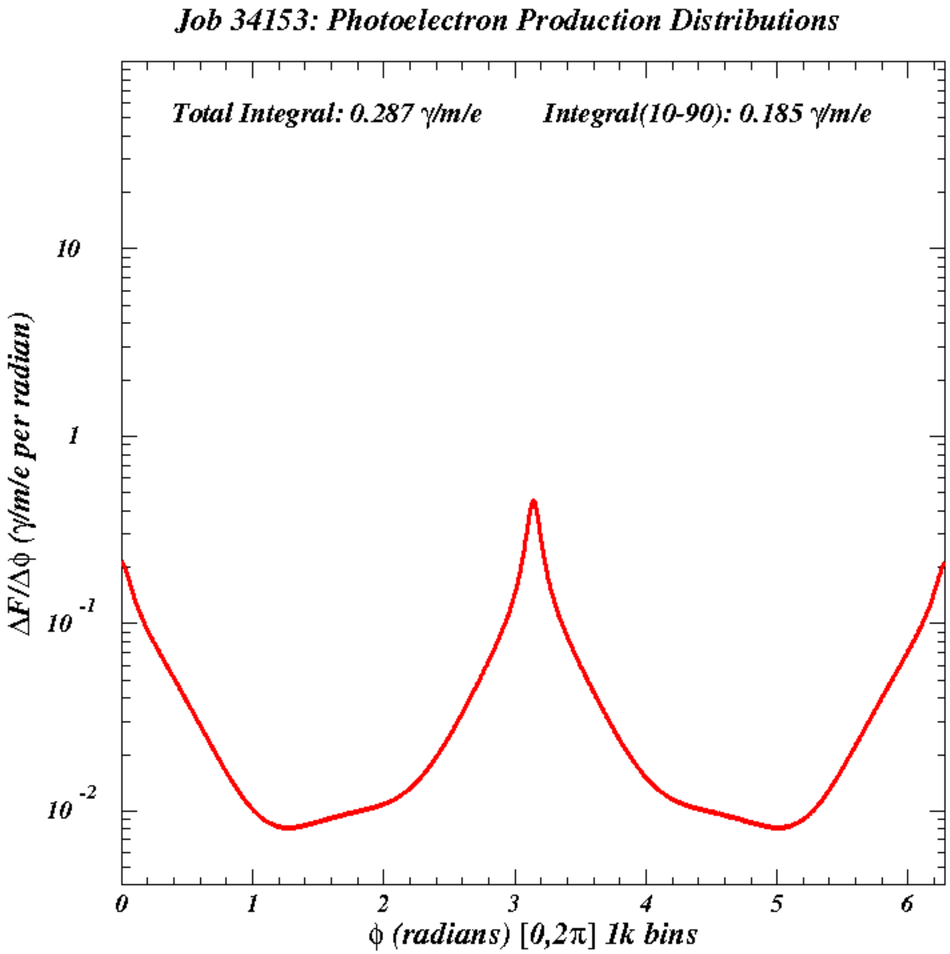
30-bunch trains, 0.75 mA/bunch

$\sigma_x = 350\ \mu$, $\sigma_y = 18\ \mu$, $\sigma_z = 9.2$ mm

Round aluminum v.c., diameter 89 mm

Field gradient 3.7 T/m

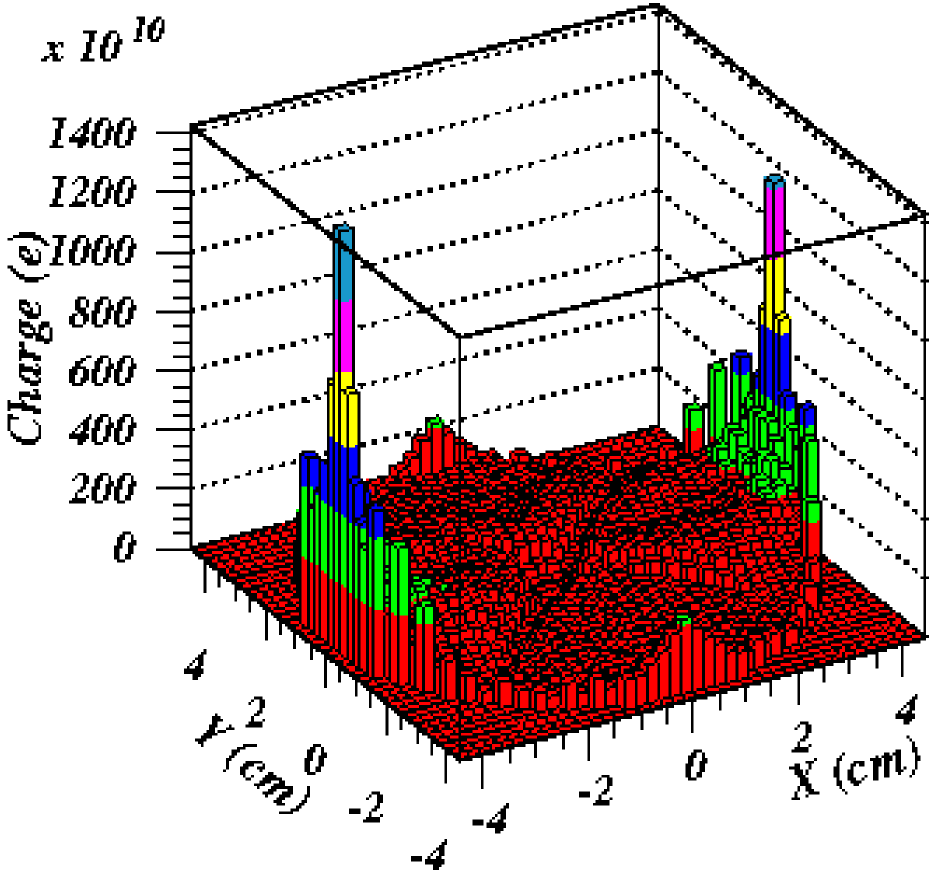
QE=14% (direct γ's), 20% (reflected γ's)



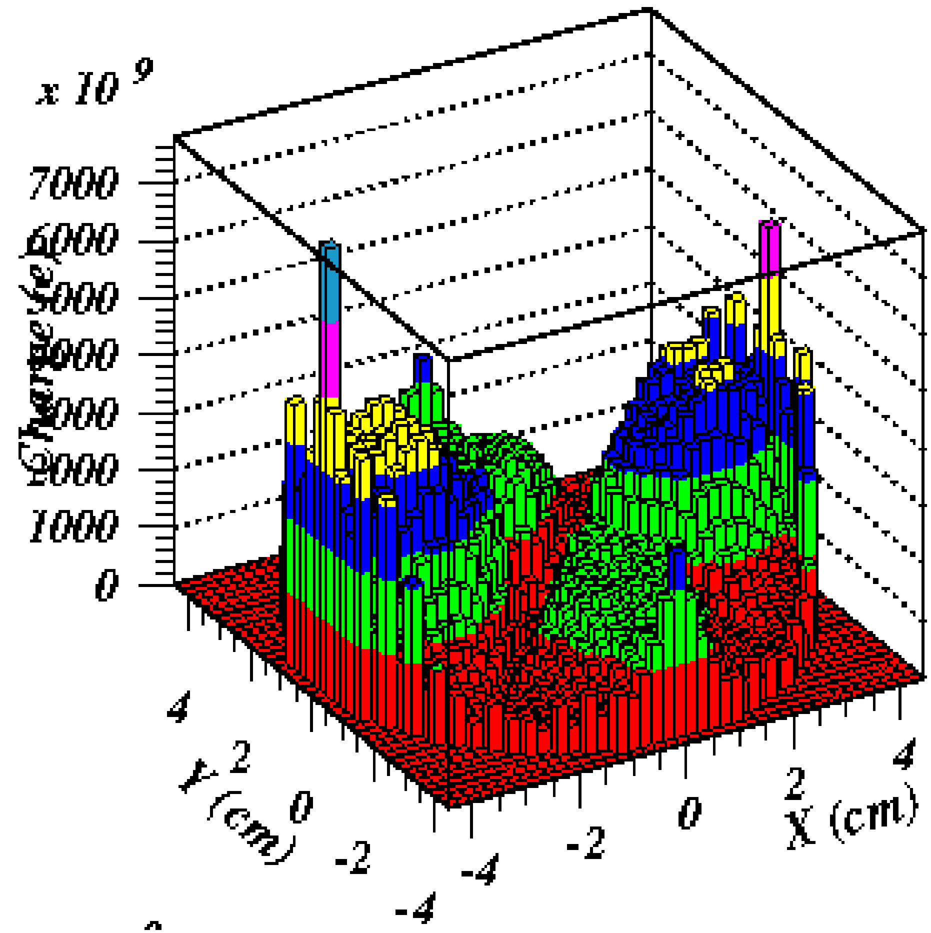
**NB: the quantum efficiency is poorly known.
The critical energy is only 140 eV (!), so photoelectron energies of a few eV were assumed.**

Cloud profiles integrated over several turns for 8 and 14-ns spacing

8-ns spacing



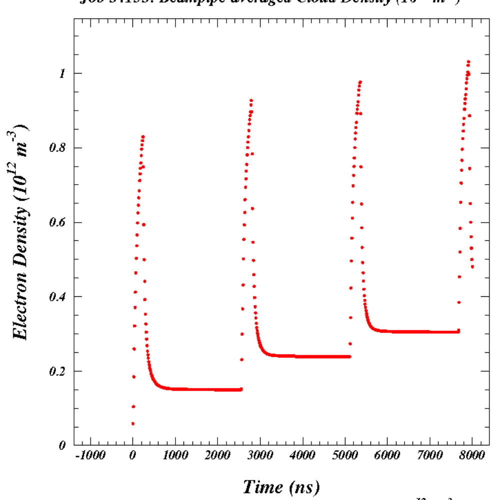
14-ns spacing

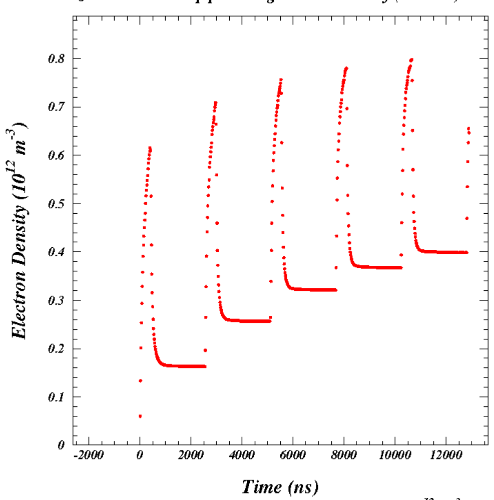


Clouds quite different. Integrated profiles do not depend on presence of precursor bunch.

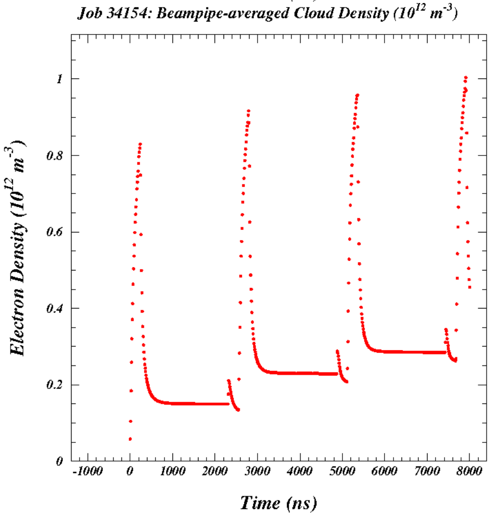
Beampipe-averaged cloud density

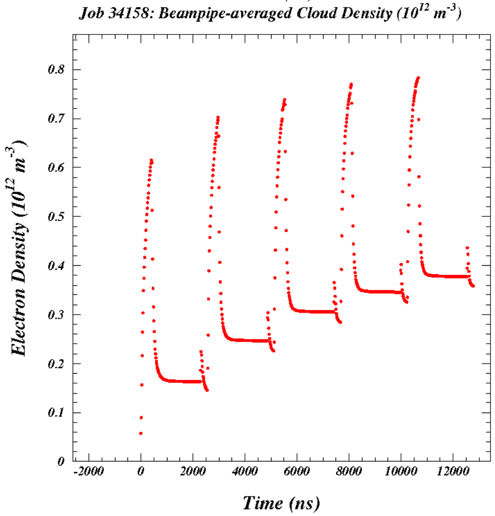
8-ns spacing	14-ns spacing	





Without precursor bunch





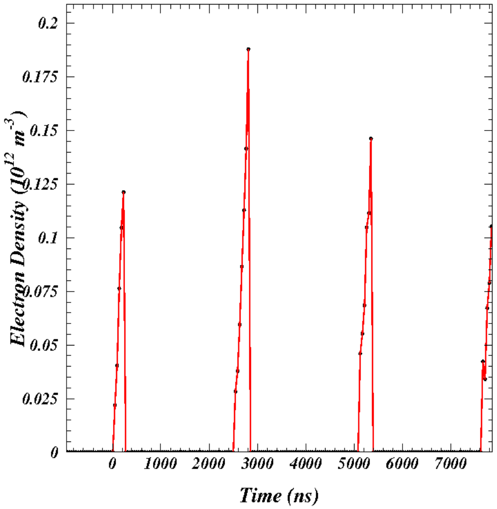
With precursor bunch

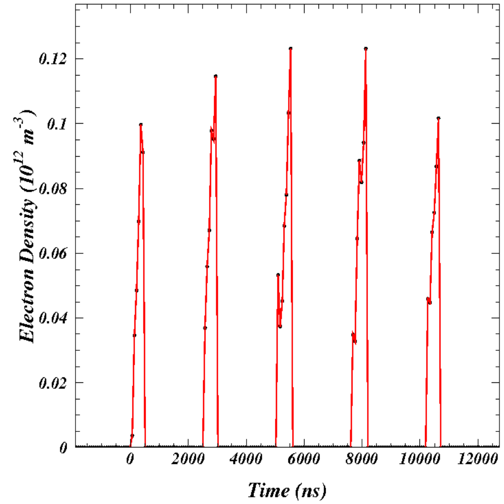
Saturation not reached after four days of computing.

20-sigma cloud density prior to bunch arrival

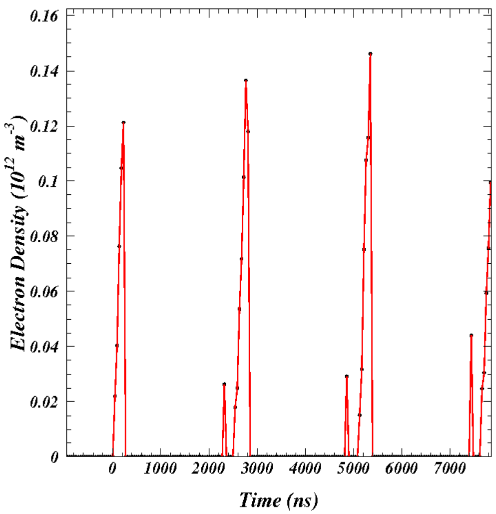
8-ns spacing | **14-ns spacing**

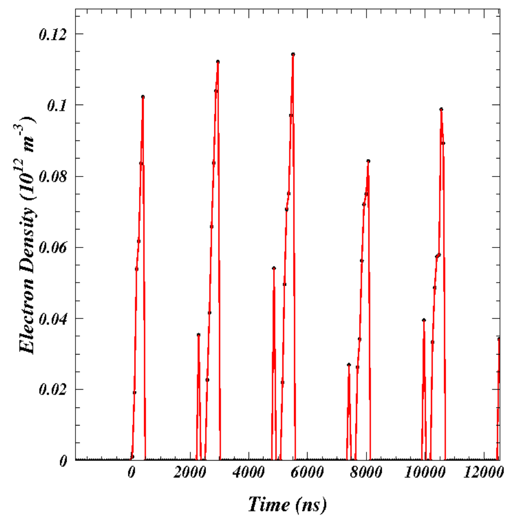
Without precursor bunch





With precursor bunch



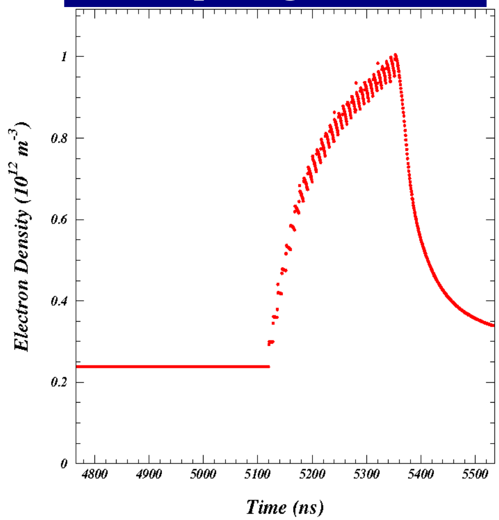


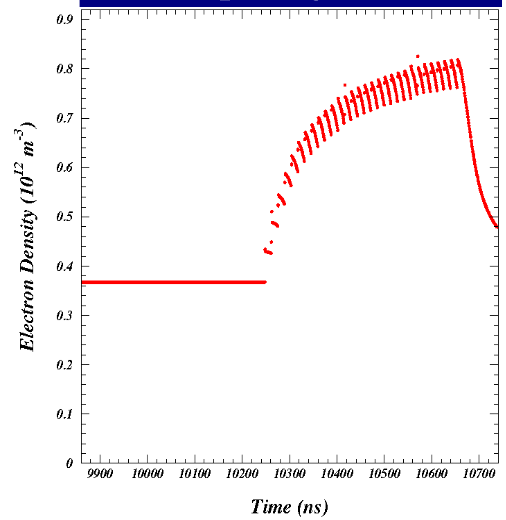
20-sigma density appears to saturate earlier than bp-avg. Now zoom in on the third and fifth trains.

Beampipe-averaged cloud density

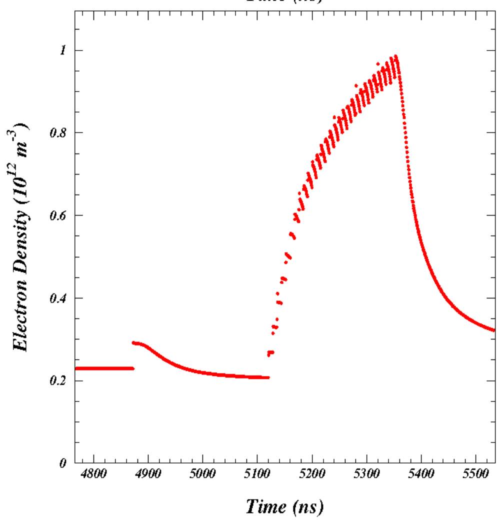
8-ns spacing, 3rd train

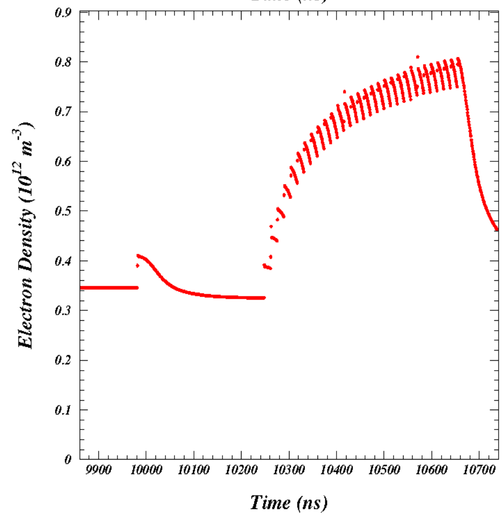
14-ns spacing, 5th train





Without precursor bunch





With precursor bunch

Additional cloud from precursor bunch mostly gone after 250 ns.

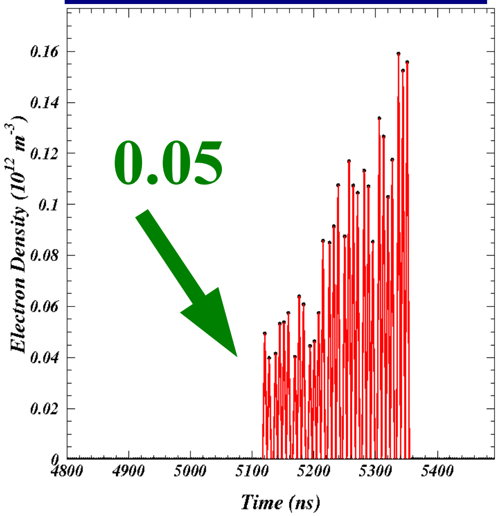
Cornell University
Laboratory for Elementary-Particle Physics

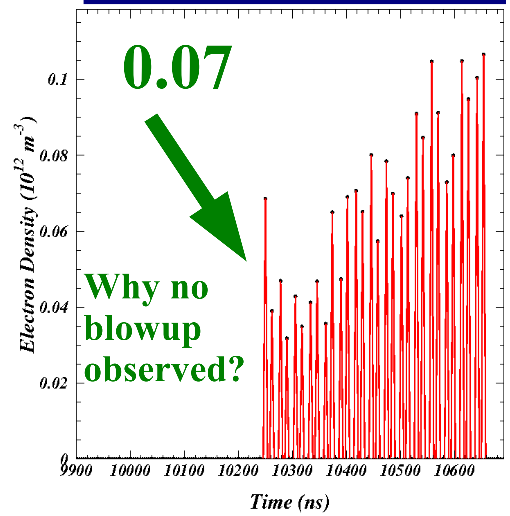
20-sigma cloud density prior to bunch arrival

8-ns spacing third train

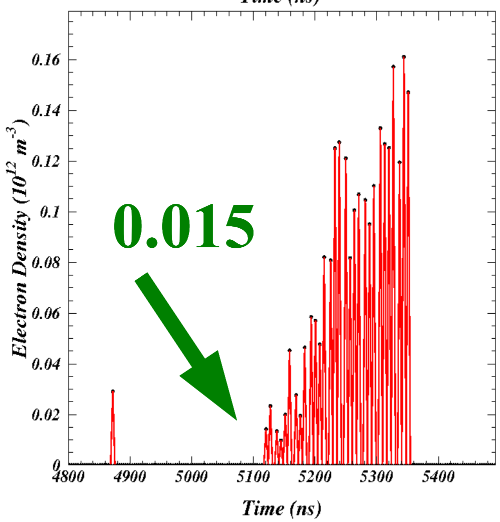
14-ns spacing, fifth train

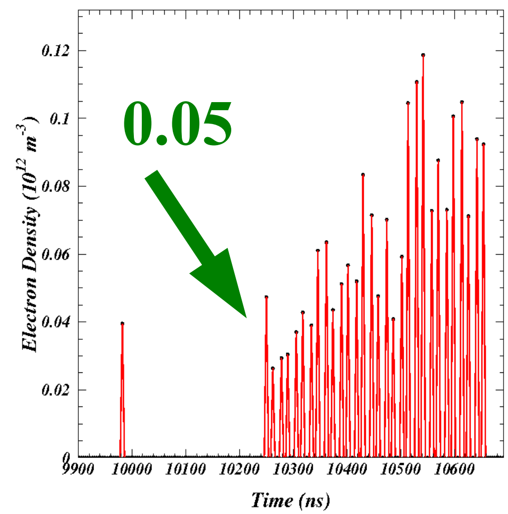
Without precursor bunch





With precursor bunch





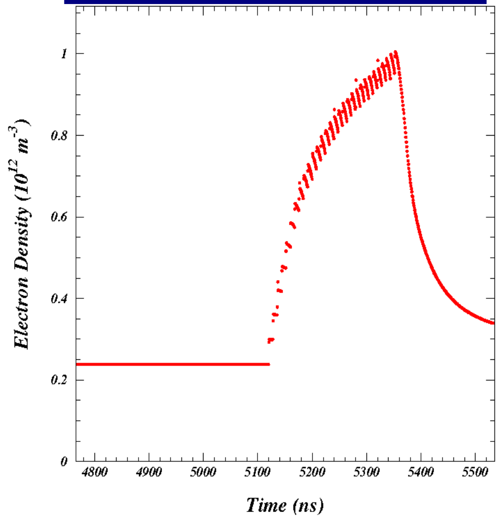
First modeling result showing reduction of cloud density by a precursor bunch!

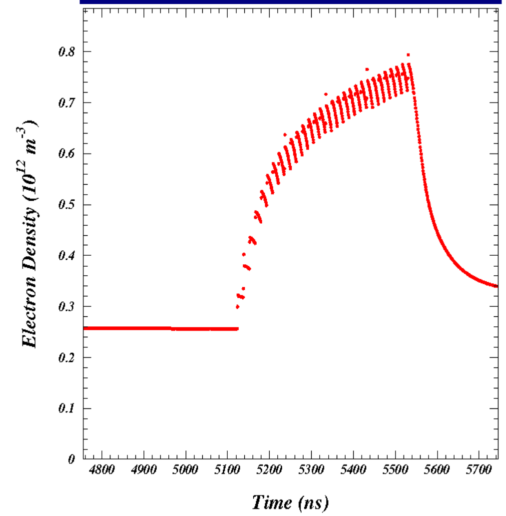
Some indication that the precursor bunch reduces cloud density more for 8-ns spacing than for 14-ns spacing.

Beampipe-averaged cloud density
Now compare 3rd trains

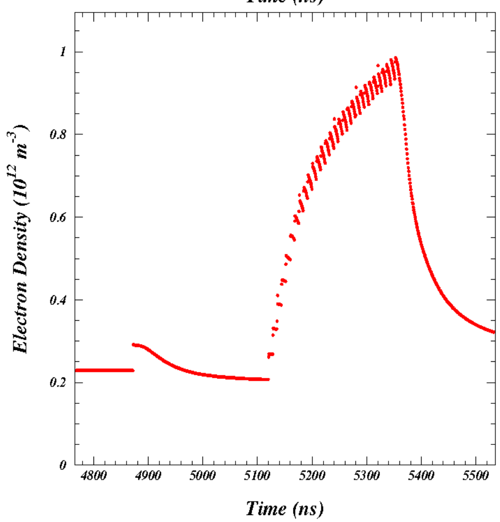
8-ns spacing, 3rd train

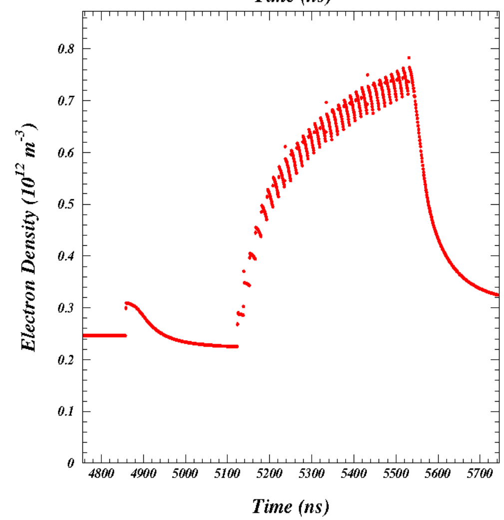
14-ns spacing, 3rd train





Without precursor bunch





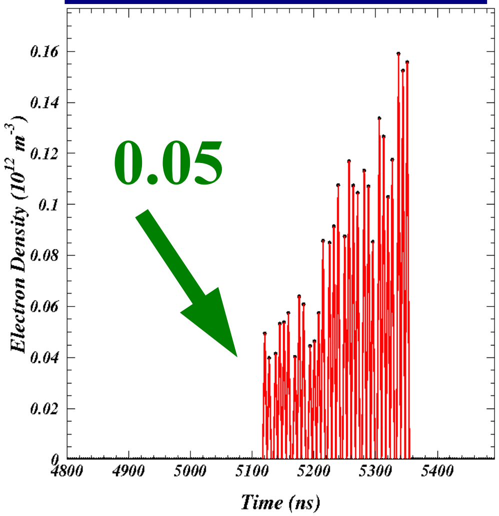
With precursor bunch

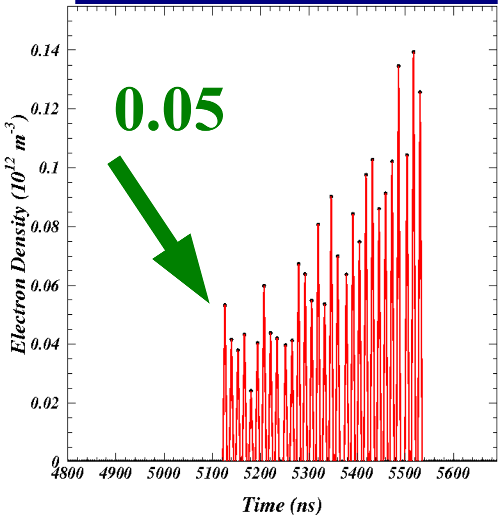
Additional cloud from precursor bunch mostly gone after 250 ns.

20-sigma cloud density prior to bunch arrival

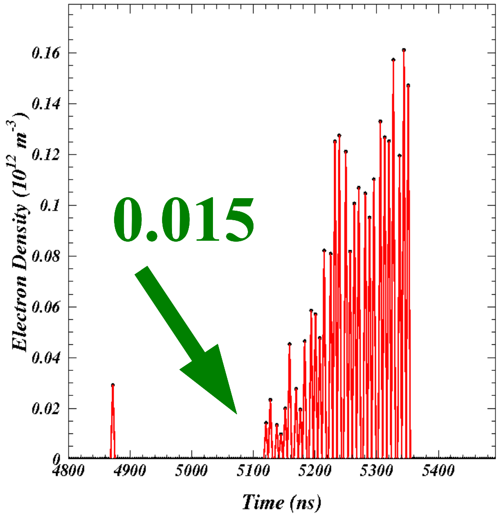
8-ns spacing 3rd train

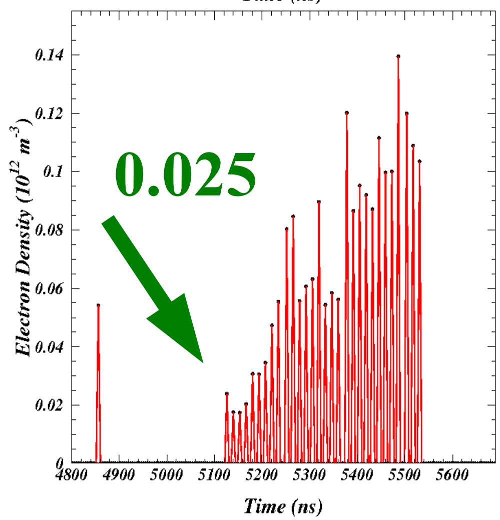
14-ns spacing, 3rd train





Without precursor bunch



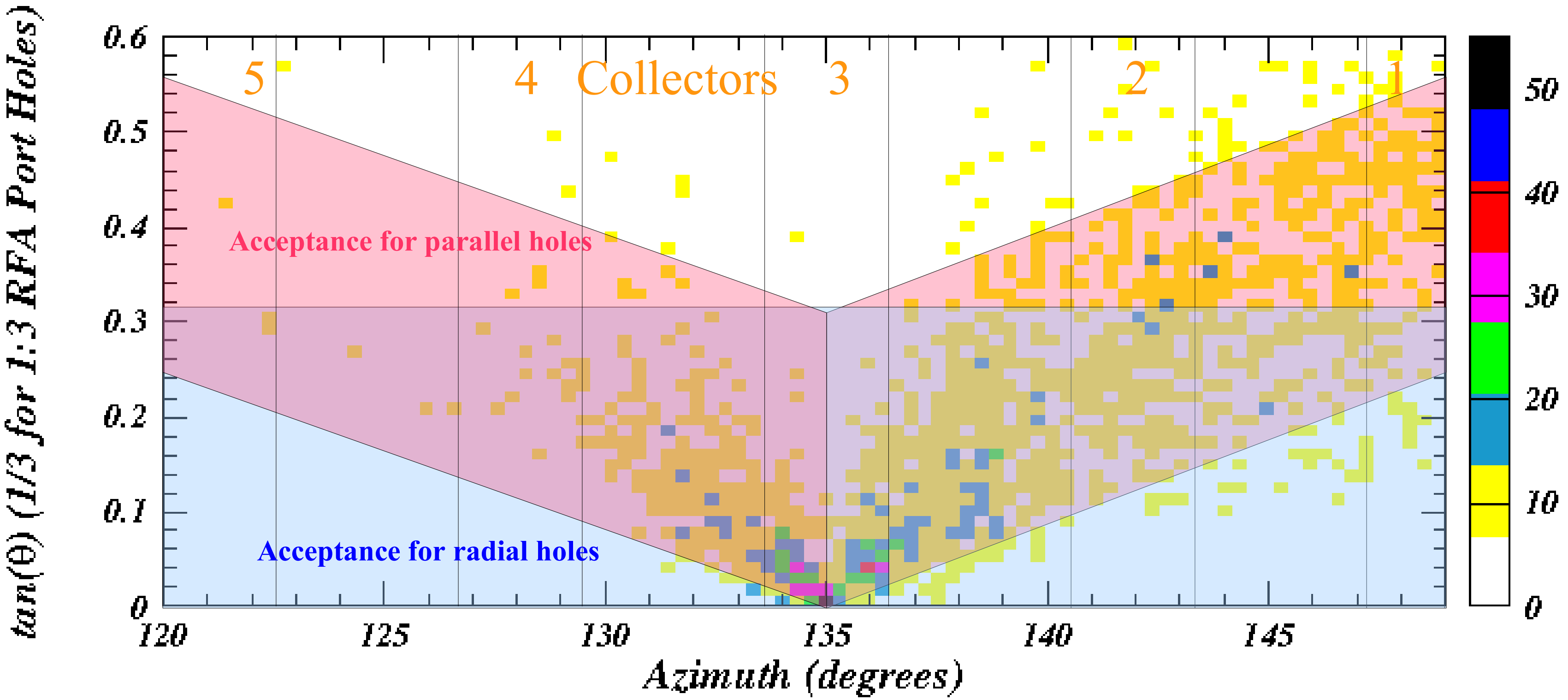


With precursor bunch

Precursor more effective for 3rd train also for 14-ns spacing.

Time -Resolved RFA Design for Q48W
How to orient the holes in the beampipe?

Cloud electron incident angle on wall relative to perpendicular near the pole tip at 45 degrees.
θ = 0 corresponds to perpendicular incidence.



The 12 collectors span 2.8 degrees (2.17 mm) and are separated by 3.9 degrees (3 mm).
Arrival angle along field lines has poor acceptance away from the central collector.
Parallel holes are much better, nearly as good as parallel to the field lines.