Cornell University
Laboratory for Elementary-Particle Physics

Developments in Modeling the Shielded Stripline Measurements of Electron Trapping in Q48W

-- Statistical Uncertainties --
-- Dependence on Bunch Current --
-- Effectiveness of Clearing Bunch --
-- Field Gradients During Bunch Passage --
-- ILC Damping Ring --

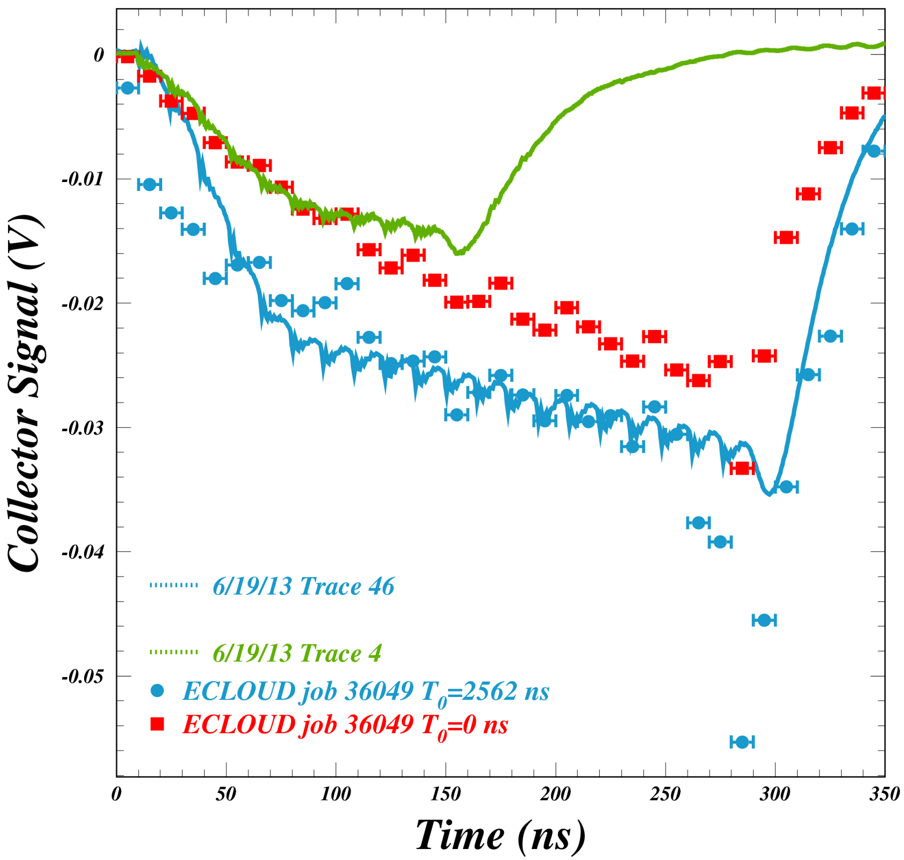
Jim Crittenden

Electron Cloud Meeting

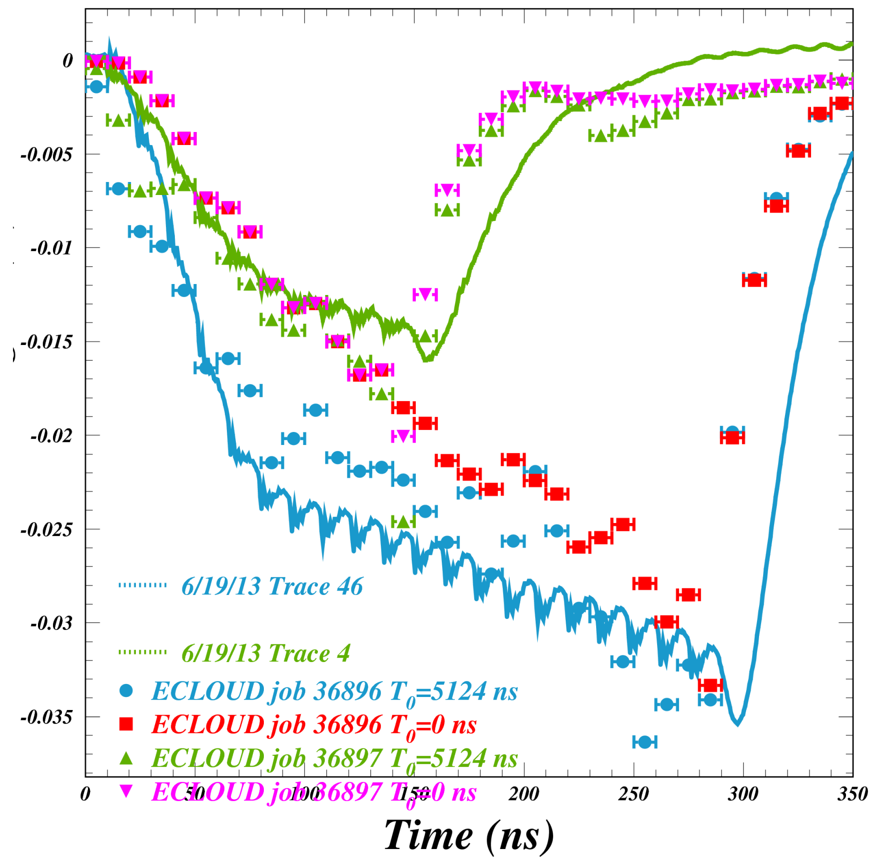
21 May 2014

Recall "Cursory Update" of 26 March 2014: slide 2

4 December 2013
20-bunch train only
Compared only first turn and second turn



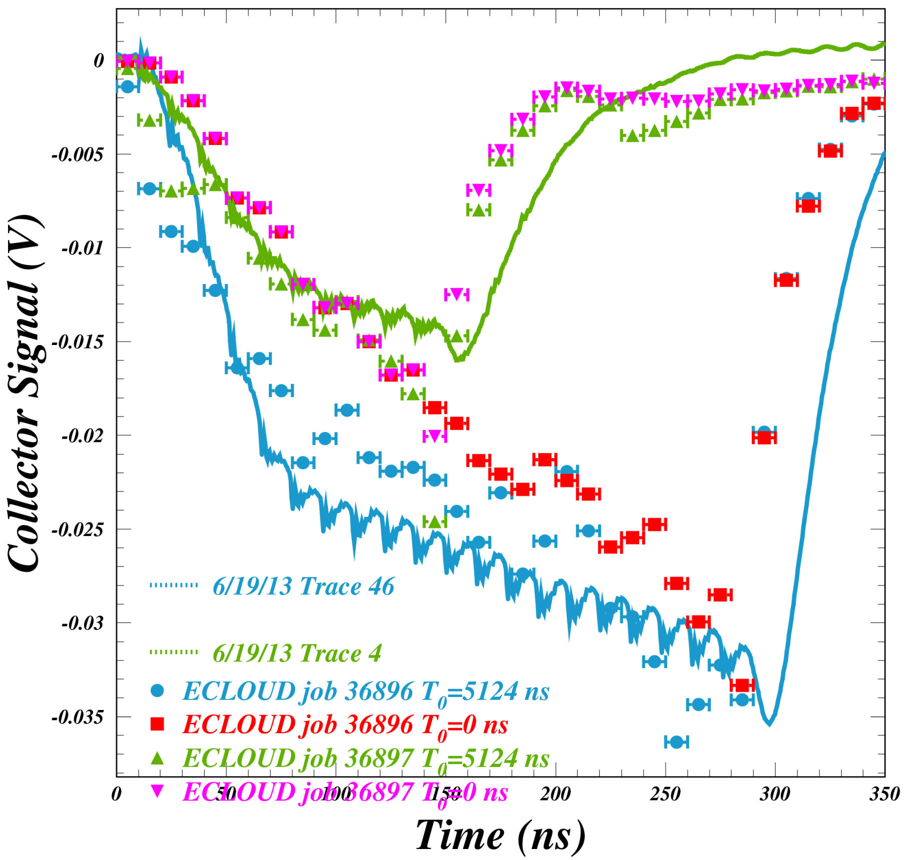
Now compare 10-bunch and 20-bunch trains on first and third turns



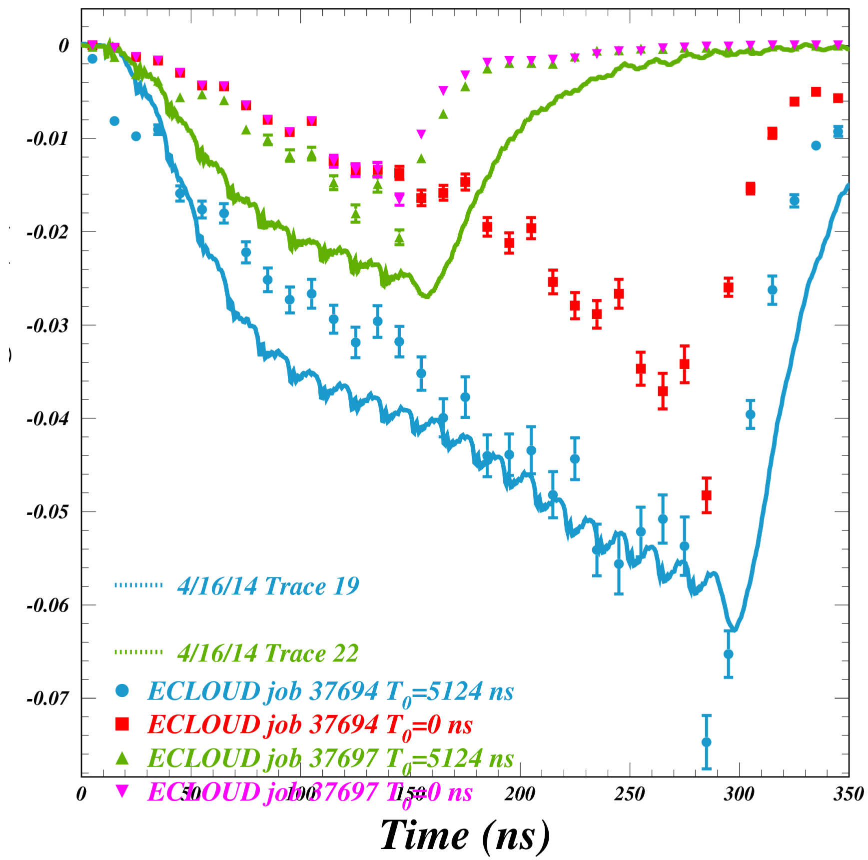
The model is *extremely* sensitive to the SEY parameters.

Present status of 14-ns 8 mA/bunch

Status of March 26
Modeling data of June 19, 2013

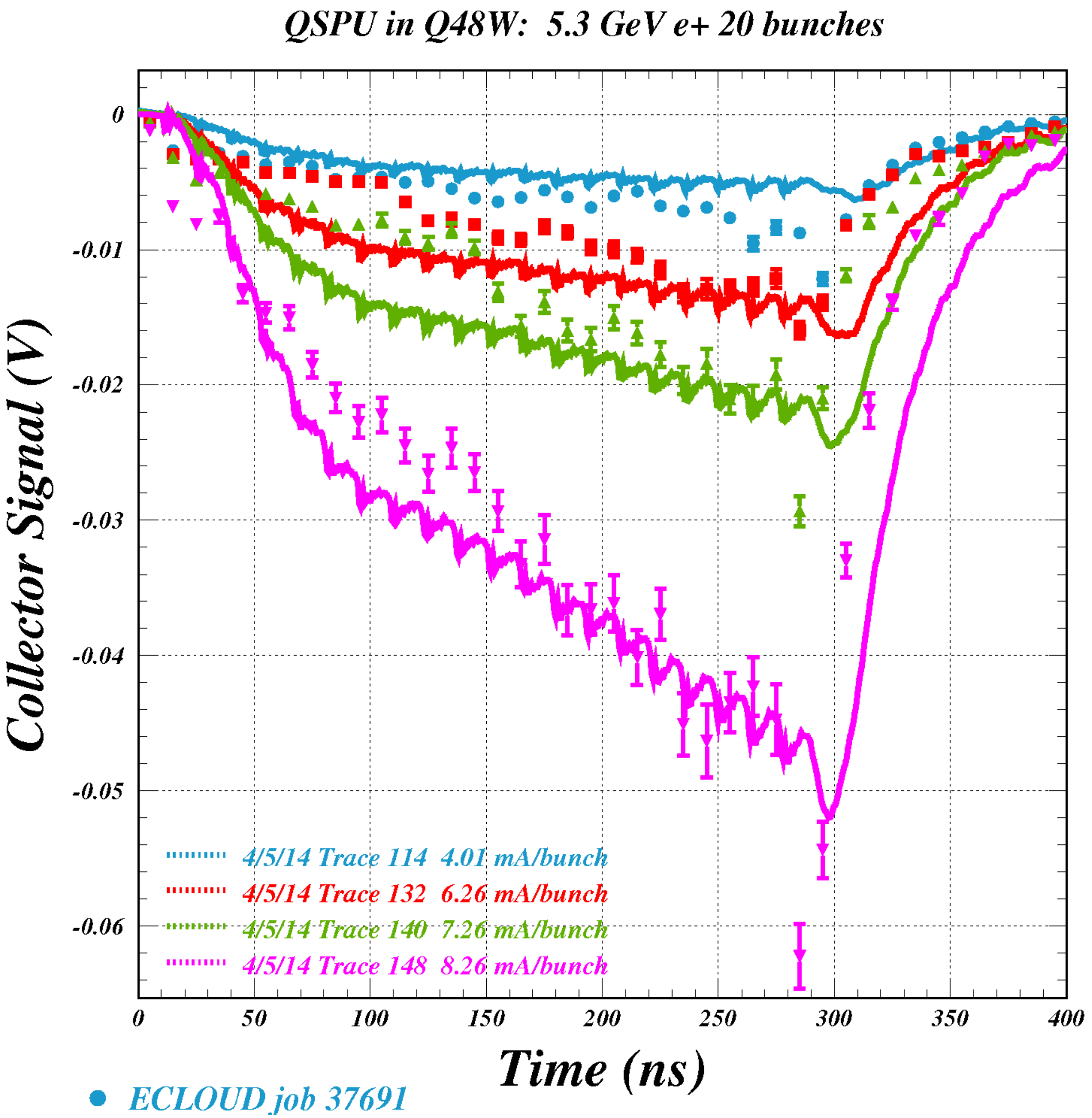


Model for data of April 16



The recent models were tuned for the bunch current study to be shown next.
Trapped signal for 10-bunch train is low.

Calculation of Statistical Uncertainties
-- Example of Bunch Current Dependence --

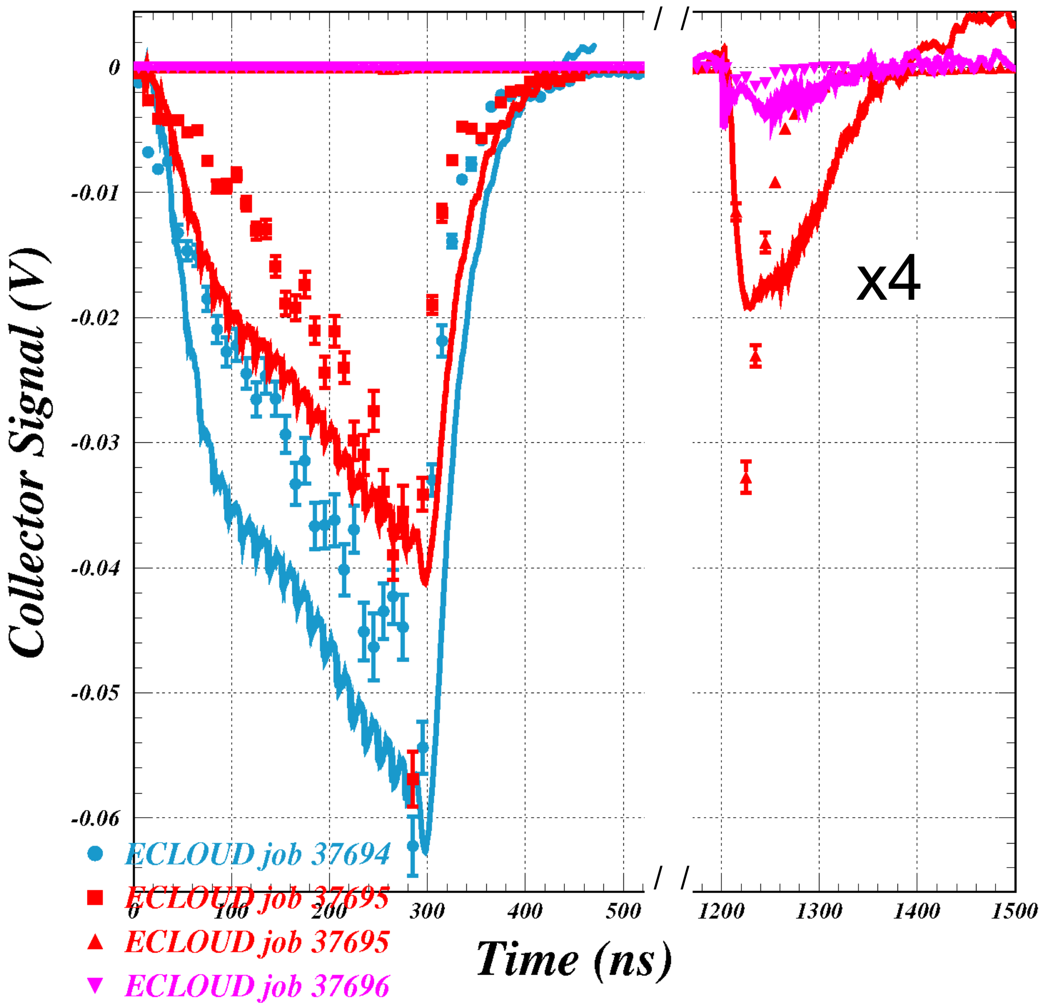


The filtered signal calculation uses exponential weighting of the preceding time bins over a 5-time-constant interval (60 ns).

So the error bars are very correlated.

Model improved by lowering QE and raising SEY, providing necessary increase in dependence on bunch current.
The modeled signal during the third train passage is shown.

Modeled effectiveness of clearing bunch



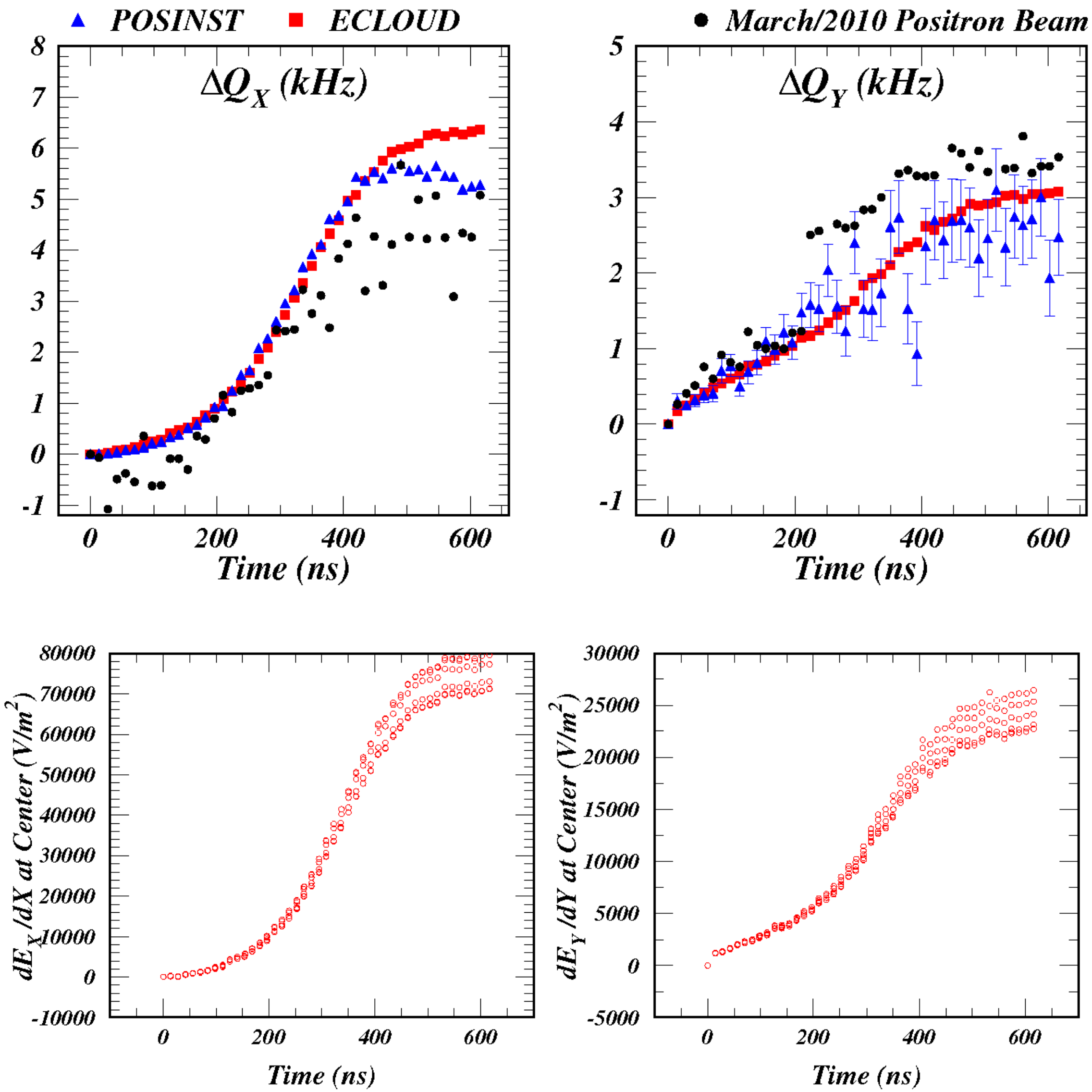
Data of April 16
20-bunch e+ 14-ns spacing

Model optimized for bunch current study of April 5

Reduction of 20-bunch signal and signal from clearing bunch reasonably well modeled.

Long duration of single bunch and clearing bunch signals not well understood.

Recall modeled field gradients from IPAC10 tune shift measurements



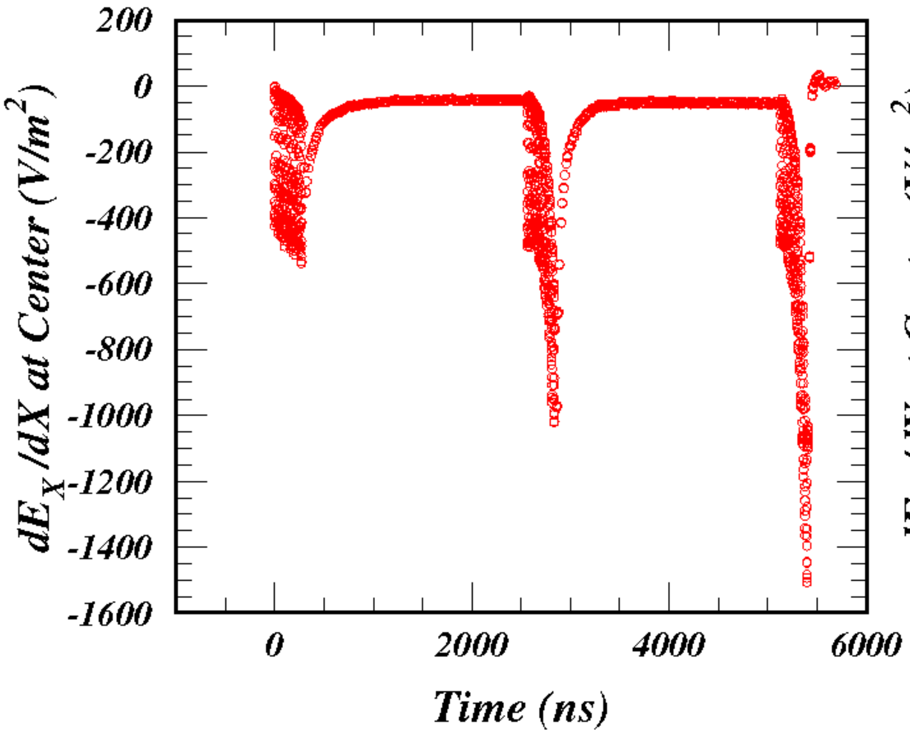
4.0 GeV e+
14-ns, 45 bunches
1.3 mA/bunch

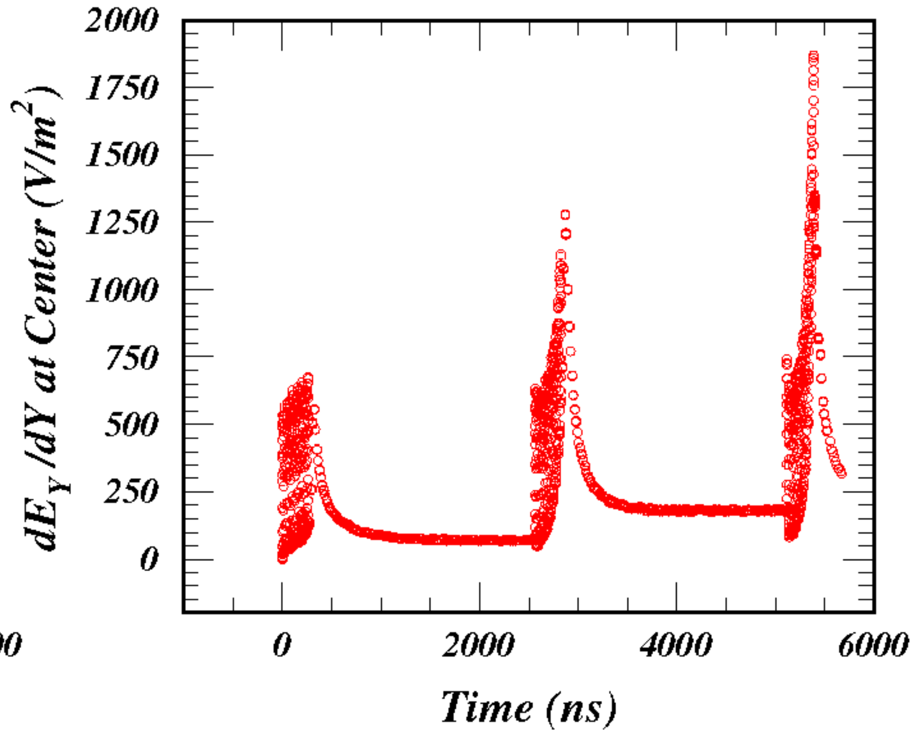
Self-excitation measurement method provided both Qx and Qy.

Modeled tune shifts derived from field gradient at beam.

Tune shifts of 6 and 3 kHz resulted from field gradients of 80k and 25k V/m^2 in the dipoles, which dominated the tune shift (61% of ring).

The field gradients in Q48W are not large, but they remember the trapping and increase

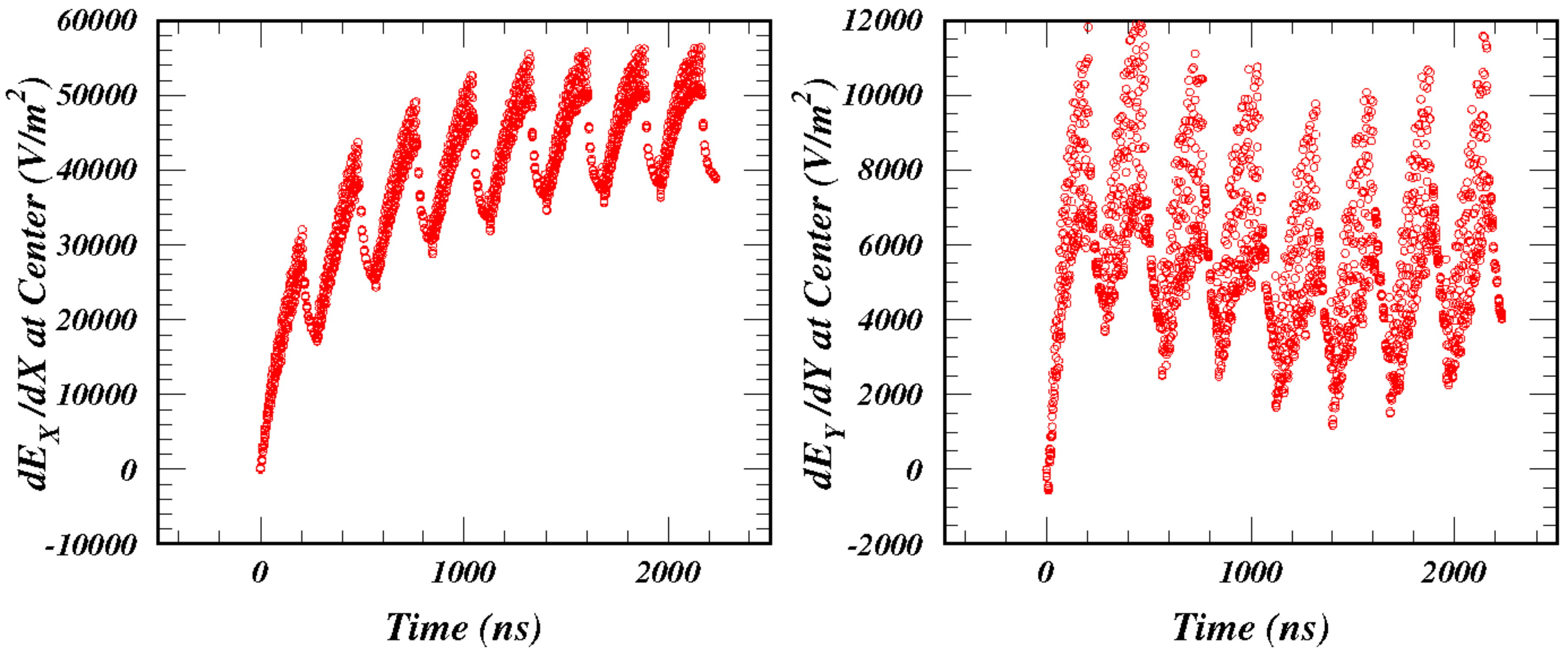




5.3 GeV e+ 14-ns, 20 bunches, 8 mA/bunch

The field gradients remember the trapped cloud!

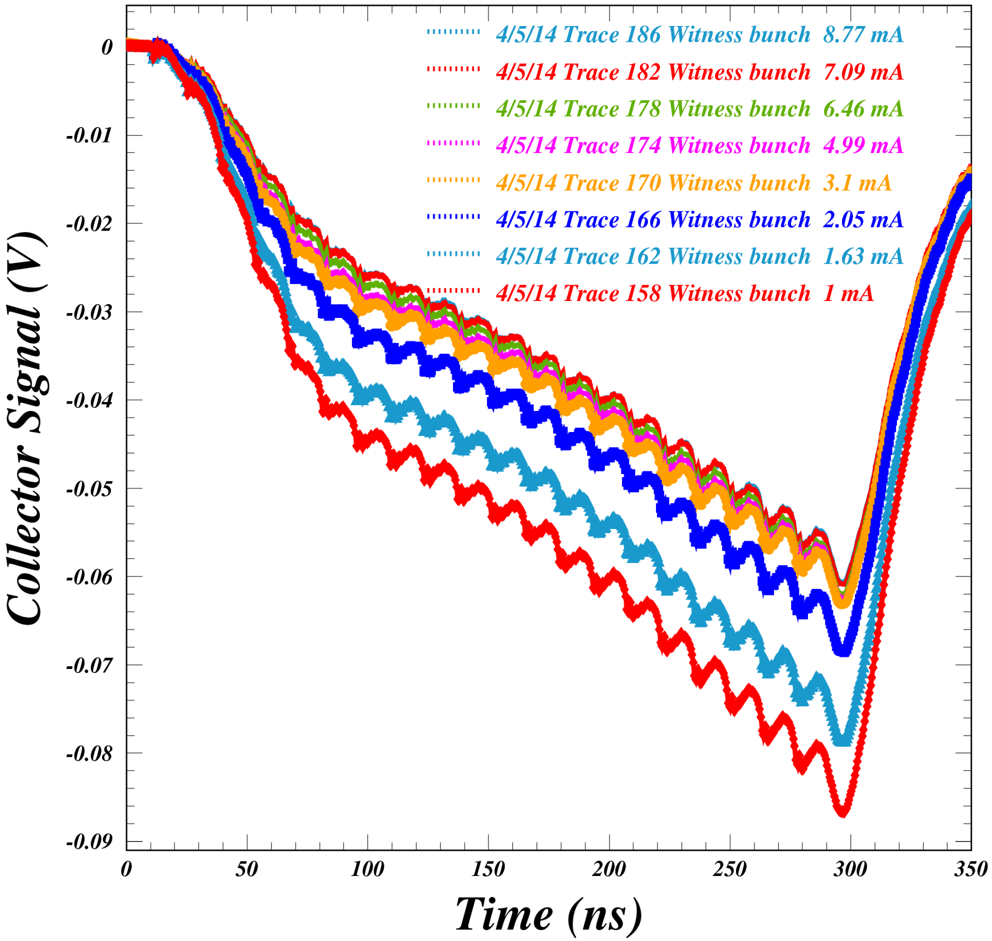
The ILC DR gradients are large !
H: 50k V/m^2 V: 12k V/m^2



5.0 GeV e+   6.15-ns, 34 bunches, 12-bunch intervals, 1.25 mA/bunch

Cloud is trapped near, but not in the beam. So it is more likely to be attracted into the beam during the bunch passage than is the case for either dipoles or field-free regions.
Quadrupoles occupy 10.3% of ring, dipoles 15.1%, 66% is field-free.
For the PRST-AB we used only densities prior to the bunch passage.
Question: Will the quadrupoles dominate the field gradients/peak densities over the dipoles?

Dependence on Clearing Bunch Current



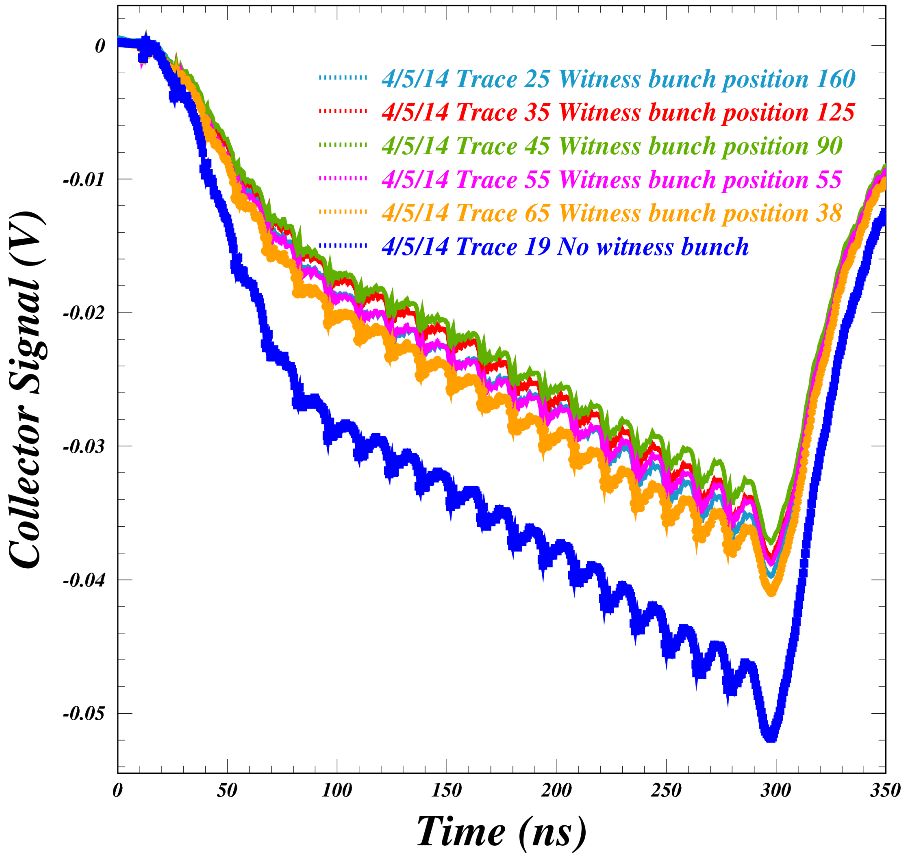
20-bunch e+ train with 8 mA/bunch

Witness bunch injected at position 90 of 183.

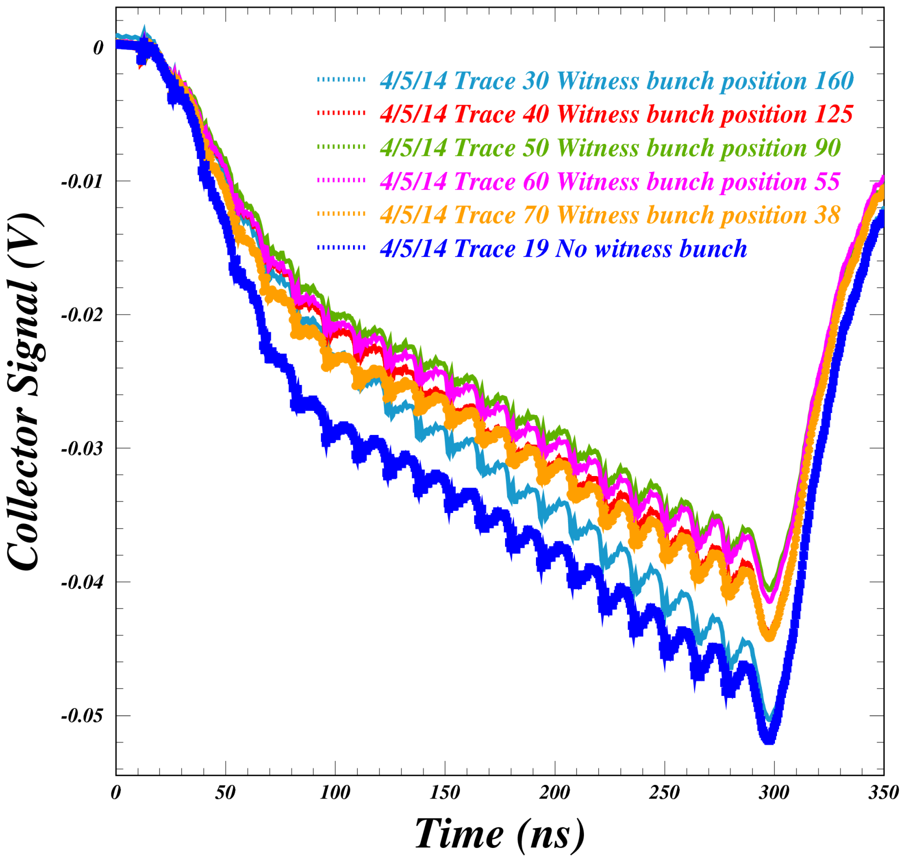
Just a few mA suffice to obtain nearly all the clearing effect.

Dependence on clearing bunch/train position

Single clearing bunch

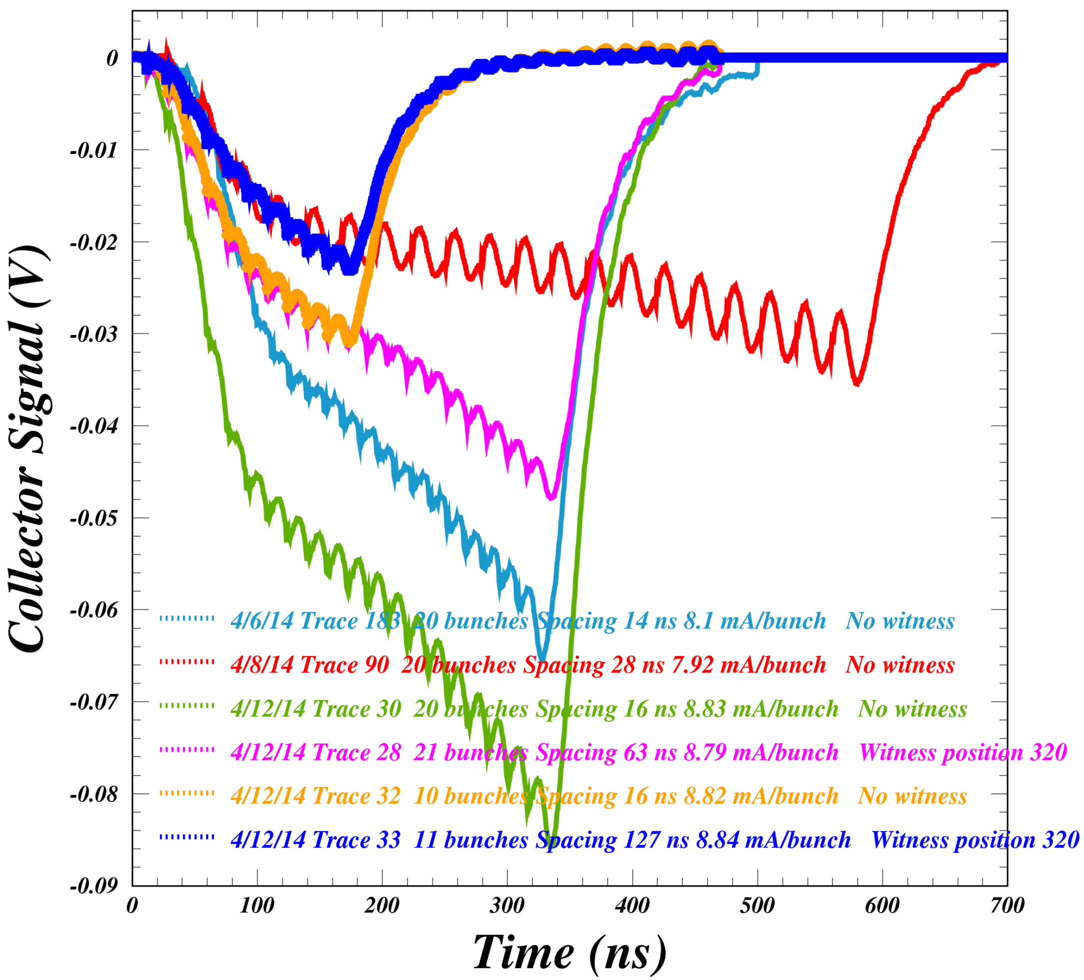


6- bunch clearing train



The clearing effect depends only weakly on position. A single bunch is more effective than a 6-bunch clearing train. The optimal position is about halfway around the ring.

First Look at the Dependence on Bunch Spacing



I) The signal from the 20-bunch train with 28-ns spacing is about half of that of the 14-ns spaced train. The trapped cloud which contributes to the signal is cleared by the first three bunches rather than the first six. Will the trend hold for spacings between 14 and 28 ns?

II) For the 16-ns spacing, comparison of the 10-bunch and 20-bunch train signals indicates significantly more trapping than for the 14-ns spacing. (Aside: the 20-bunch signal is higher than for the 14-ns spacing because the bunch current is higher.)

III) The clearing bunch is much more effective for the 16-ns spacing than for the 14-ns spacing, reducing the signal by nearly a factor of two for the 20-bunch train.

IV) For 16-ns spacing, the signal for the 20-bunch train with a clearing bunch is very similar to that of the 10-bunch train with no clearing bunch. This was NOT the case for the 14-ns spacing, so it may be a red herring/coincidence.

Near-term plans

I) Investigate spacings of 14, 16, 20, 24, 28 ns with 10- and 20- bunch trains with 8 mA/bunch with and without a clearing bunch at position 90/320. Each fill requires 30 minutes. Adding the clearing bunch requires an additional 15 minutes. We already have 14 ns (20 bunch only), 16-ns (complete) and 28-ns (20 bunch only, no witness). Time required: 4x1.5 hrs = 6 hrs.

II) 30 bunch trains

III) Fine current scan for resonances (partly done, no clear sign of resonance)

IV) More ideas

<u>Available time</u>

1) 6 hours tonight

2) 10 hours Friday night

3) 12 hours contingency Saturday night/Sunday owl