Cornell University
Laboratory for Elementary-Particle Physics

Status of Simulations for the April 2014 Shielded Button Electrode Measurements at 15E

-- 20-bunch trains of positrons, 2, 4, 6, 8 mA/bunch --

Presented by John Sikora at IBIC'14 for purposes of intercalibrating the SBE, RFA and microwave measurements

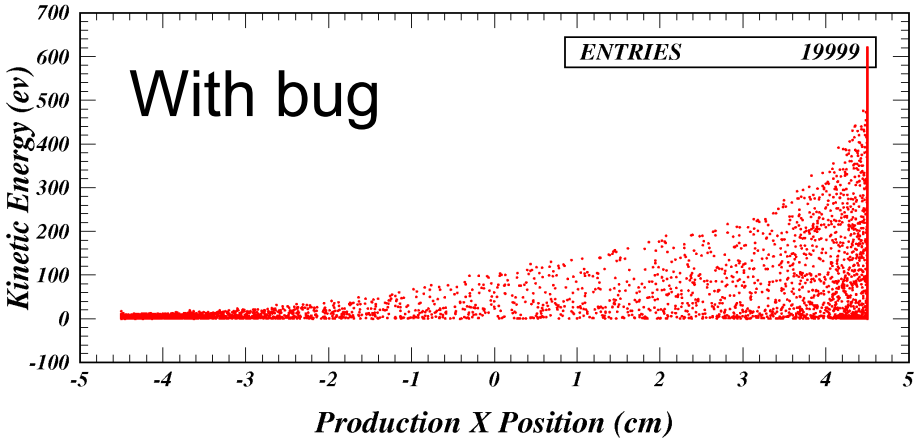
-- 14Dec14: Augmented with slides 5 and 6 in response to questions from JRC --

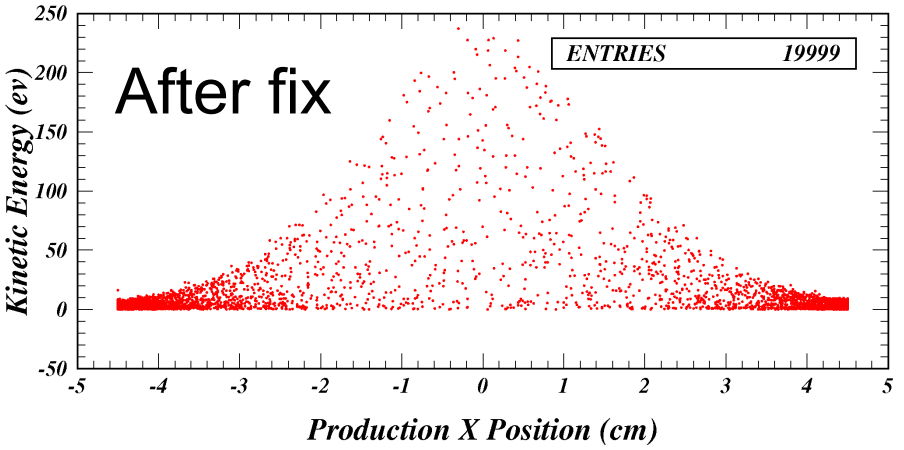
Jim Crittenden

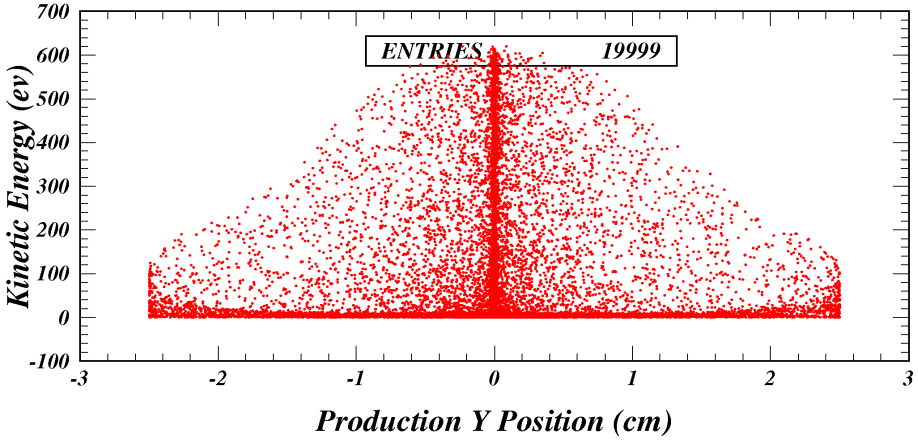
Electron Cloud Meeting

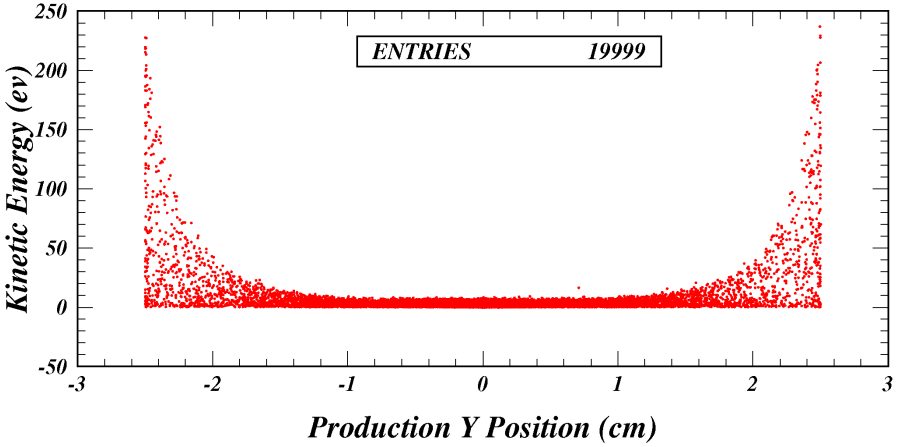
10 December 2014

Discovered incorrect calculation of elliptical coordinates in ECLOUD in October





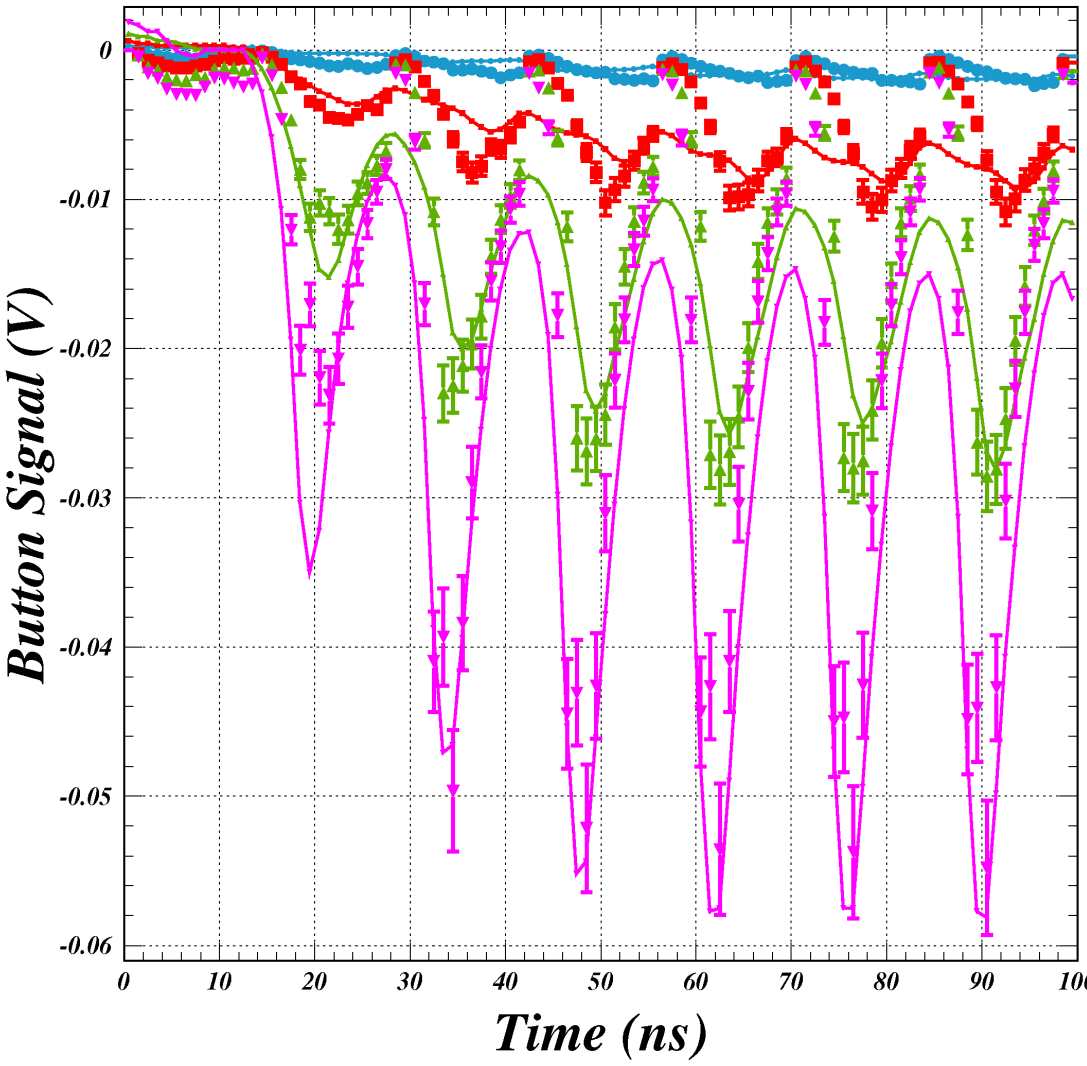




The effect of the bug was to transfer vertical beam kicks to horizontal. The above example shows the effect for a 6-mA bunch of positrons. The correct calculation gives a kick of 240 eV to an electron on the bottom or top of the beam-pipe, resulting from equal contributions from the direct and image charge. On the sides of the beam-pipe, the two contributions nearly cancel, leaving a kick of 4 eV.
For photo-electron-dominated simulations, the bug can be partially compensated with the p.e. energy distribution.

Present status of simulation for the space-charge-limited cloud measurements of April 2014

Bunch current dependence: 5.3 GeV 15E Al e+



Outstanding Issues

-Source of the signal immediately following a bunch passage

- The simulated signal is a factor of 50 too high

- The measurement does not allow for low-energy photo-electrons, nor for photo-electrons from the bottom or top of the beampipe.

- The trailing edge of the signals requires a large contribution from low-energy electrons with glancing arrival angle (hole secondaries?)

Good News

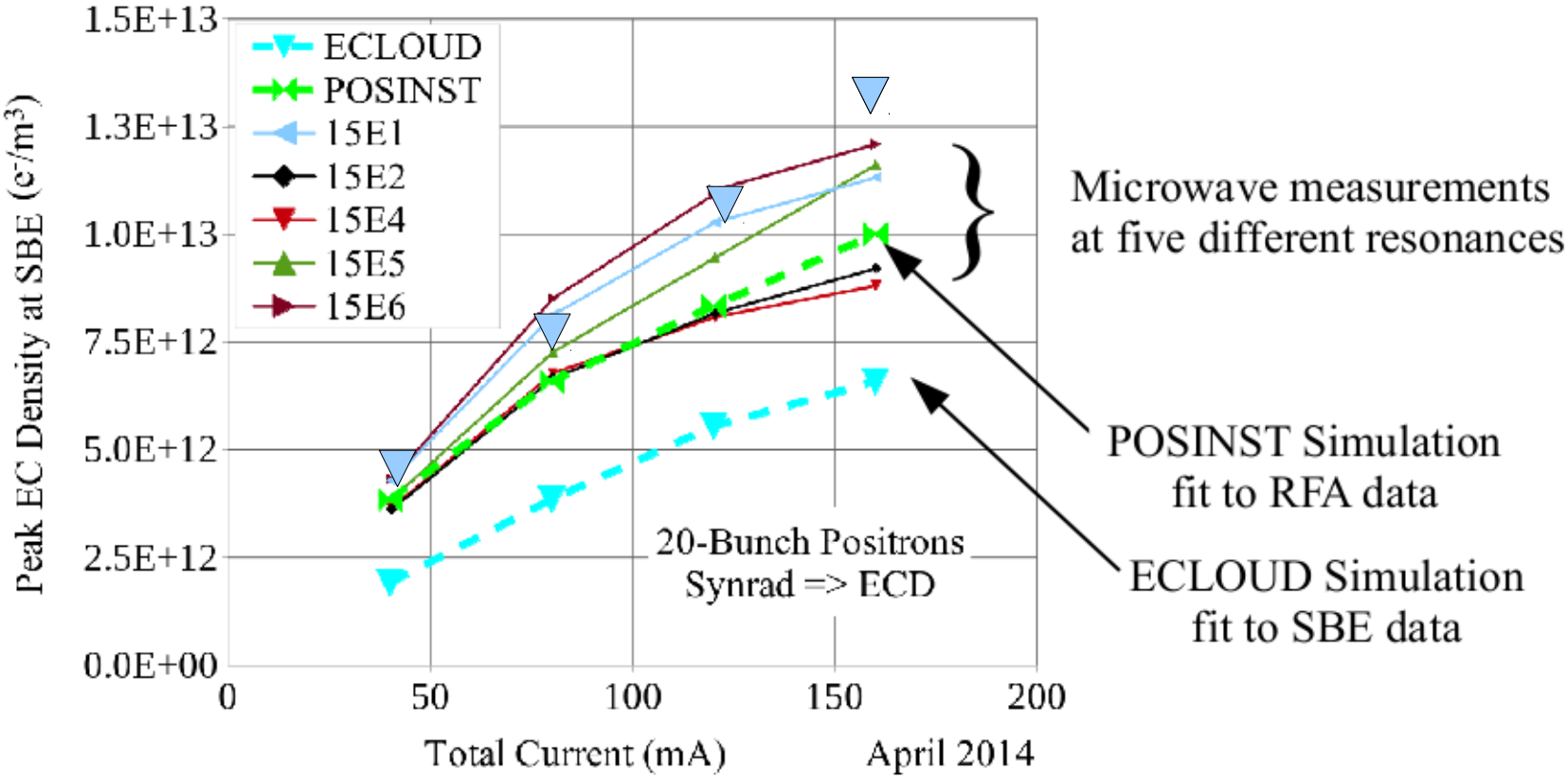
- The timing of the lower bunch current signals is about right without extra tuning.

- The ratio of signals from buttons 1 and 3 are now approximately correct.

- The cloud densities are similar to those found for the RFA and microwave measurements: 4.6e12, 7.8e12, 11.1e12, 13.5e12.

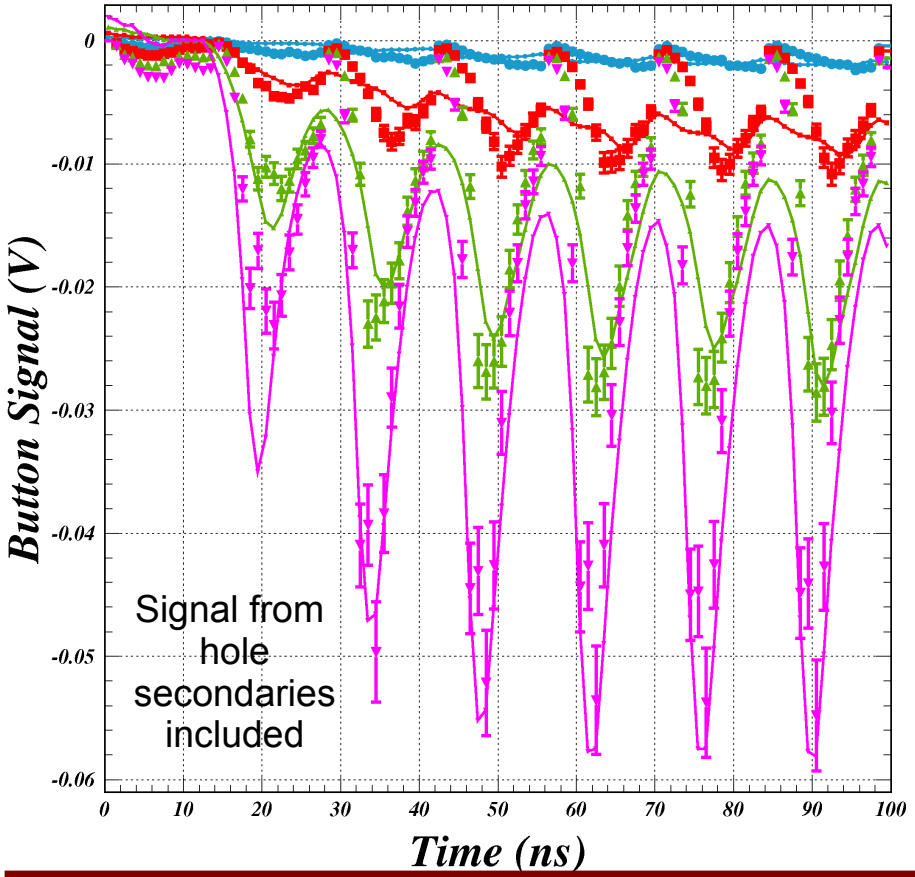
Updated ECLOUD Simulation Densities

Results with a 20-bunch train of Positrons at 5.3 GeV

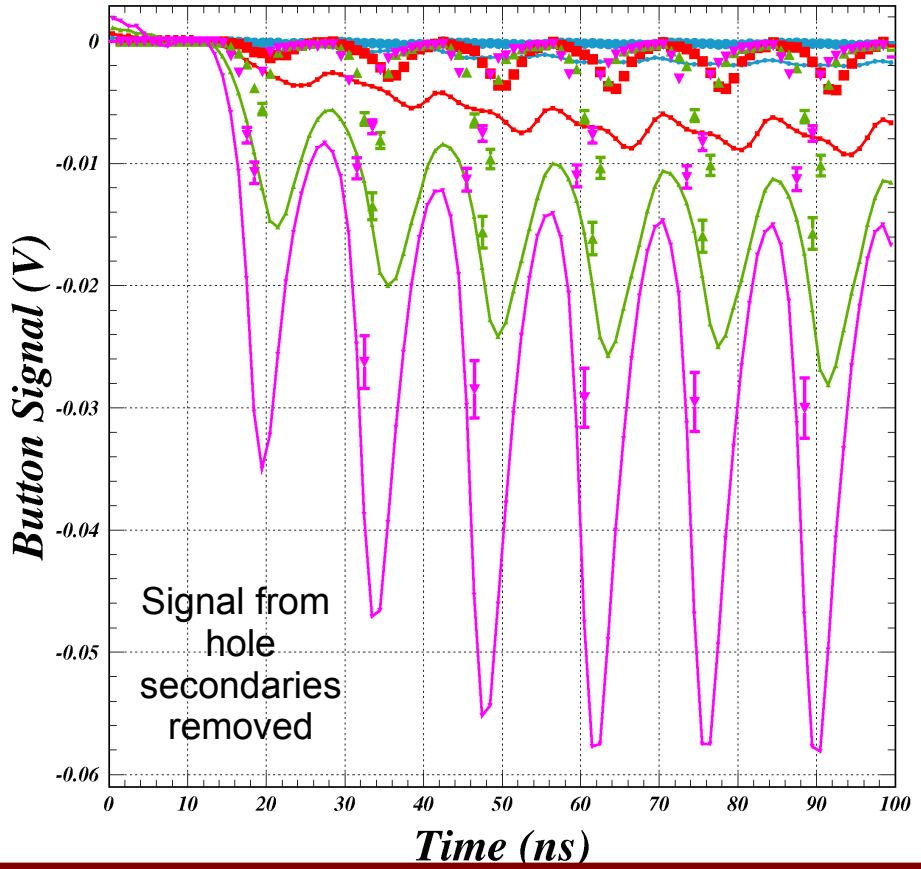


Effect of removing SBE accptance for electrons arriving at large (> 20 degrees) incident angle

Bunch current dependence: 5.3 GeV 15E Al e+

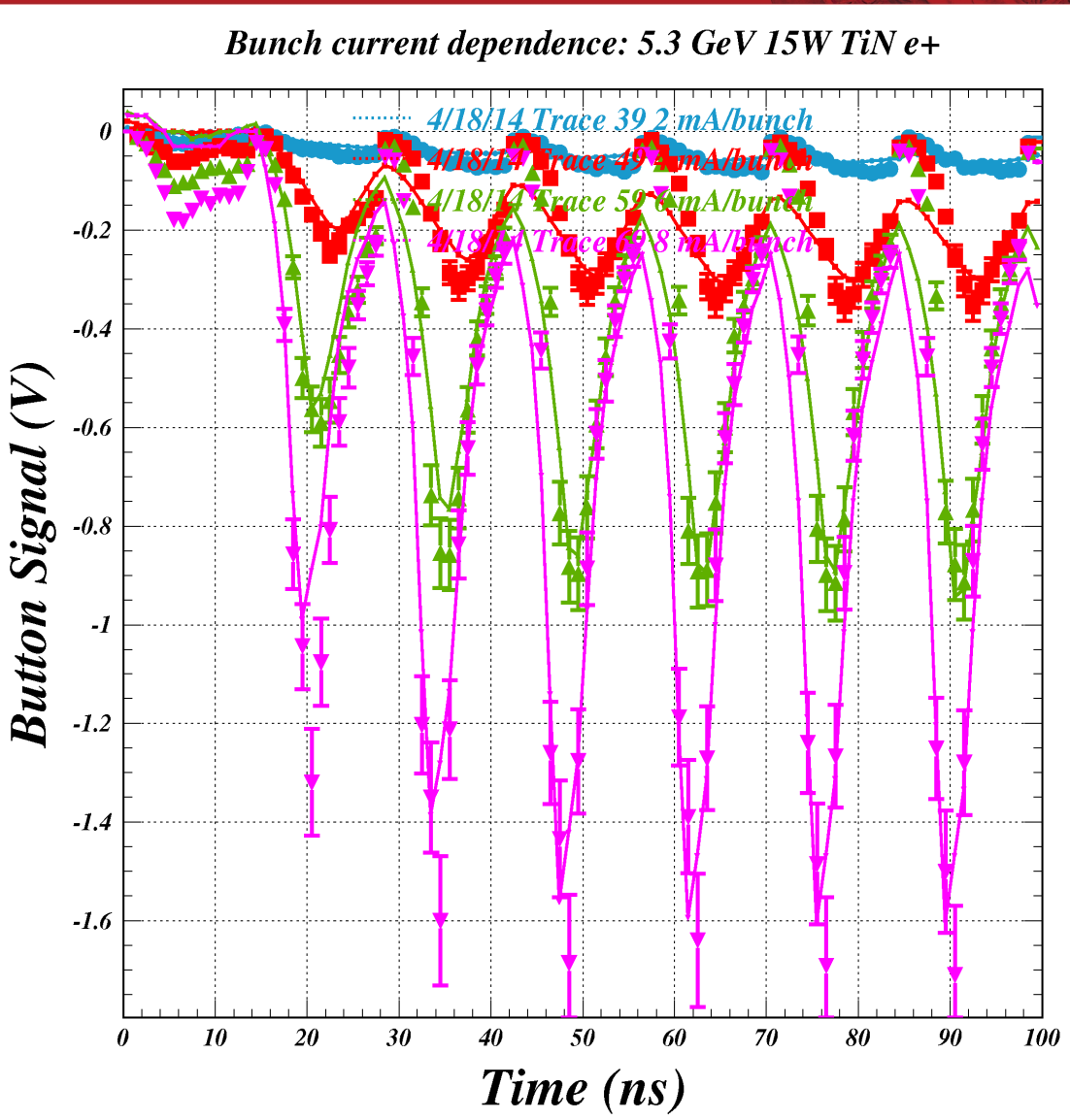


Bunch current dependence: 5.3 GeV 15E Al e+



The modeled signals on the right have no provision for secondaries produced in the holes in the beampipe, i.e. they use only the WHH analytic expression for the acceptance of electrons which do not hit the wall of the hole. The signal is dominated by electrons which gathered near the bottom of the beam-pipe during the 14 ns between bunch passages and are accelerated by the beam bunch toward the detector, arriving 4-5 ns later with trajectories mostly perpendicular to the beampipe-wall.

Result of the model tuned for the 15E (Al) data applied to the measurement at 15W (TiN)



Remarkably good agreement with the size of the signal as a function of bunch number as the cloud reaches the space-charge-limited state – even better than for the 15E data!

The bunch 1 signal is too big.

All signals are about a factor of 300 too large (!)

The zeroing of the signal directly after the bunch passage in the model is still present.

On Friday, JPS and I surmised that the observed signal within a few ns following the bunch passage must come from low-energy electrons already in the holes when the bunch arrives, therefore shielded from the beam kick.

Such few-eV electrons are slow enough that they can take 1-3 ns to arrive at the hole exit, especially when they are reflecting off the hole wall (which also attenuates them). Our hope is that a model which includes this effect will broaden the spike signal from the bottom of the beampipe and explain the factor 50/30 problem in normalization, in addition to solving the mystery of the signal zeroing following the beam passage.