Shielded Button Measurement/ECLOUD Simulation Comparison for 5.3 GeV e+/e- Beams at 15E/W

All material for this talk may be obtained at www.lepp.cornell.edu/~critten/cesrta/ecloud/8sep10

The measurements of 5/17/2010 are described here: https ://webdb.lepp.cornell.edu/elog/CTA+MS/629
See also previous talks on simulations for the shielded button data on 4/21, 4/28, 5/12, 7/7, 7/14, 8/4//2010

Context

The talk on 4 Aug 2010 showed using the 3/16 data how the shielded button signals at 15E are sensitive to the photon energy spectrum and reflectivity for 5.3 GeV e+ and e- beams.

Now we investigate using the 3/27 data how the signals at 15W differ. Since the photon energies and rates at 15W are similar for the opposite-sign beam, we should be able to use the photoelectron energy spectra derived for the 15E data.

Also, by comparing the magnitudes of the e+ and e- signals, we can determine if the reflectivity depends on the direction or species of the beam.

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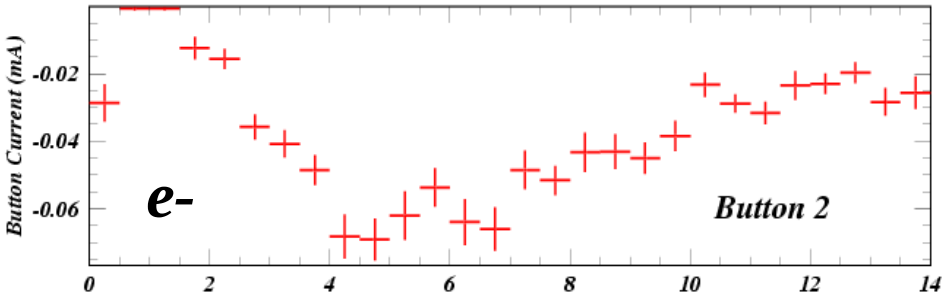
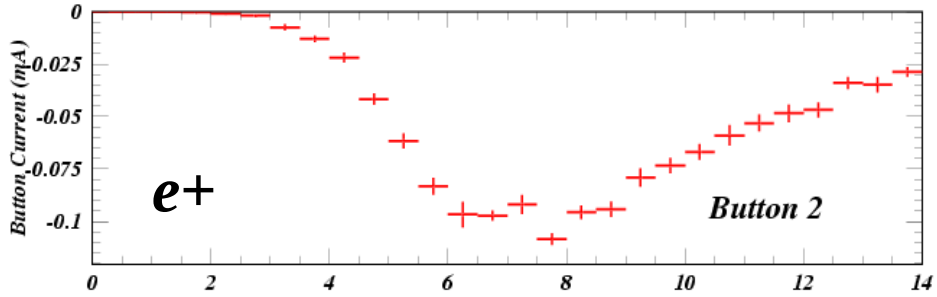
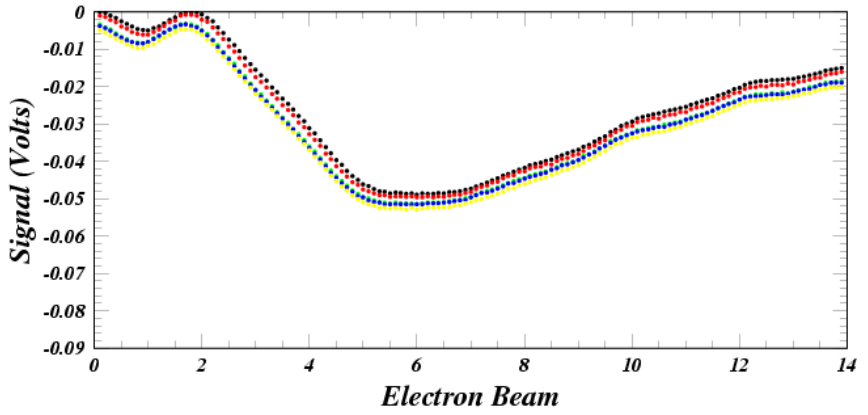
Electron Cloud Meeting

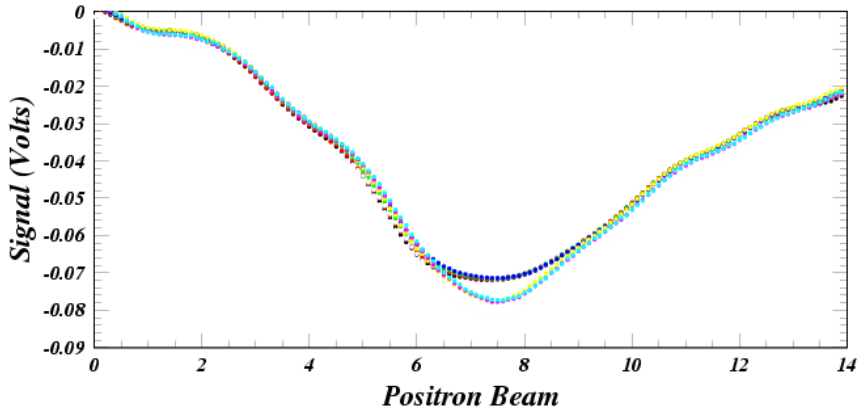
8 September 2010

Recall Addendum 2 to talk on 7/14/2010
Updated ECLOUD simulation
for 3/16 5.3 GeVe+/e- 8 mA/bunch data at 15E







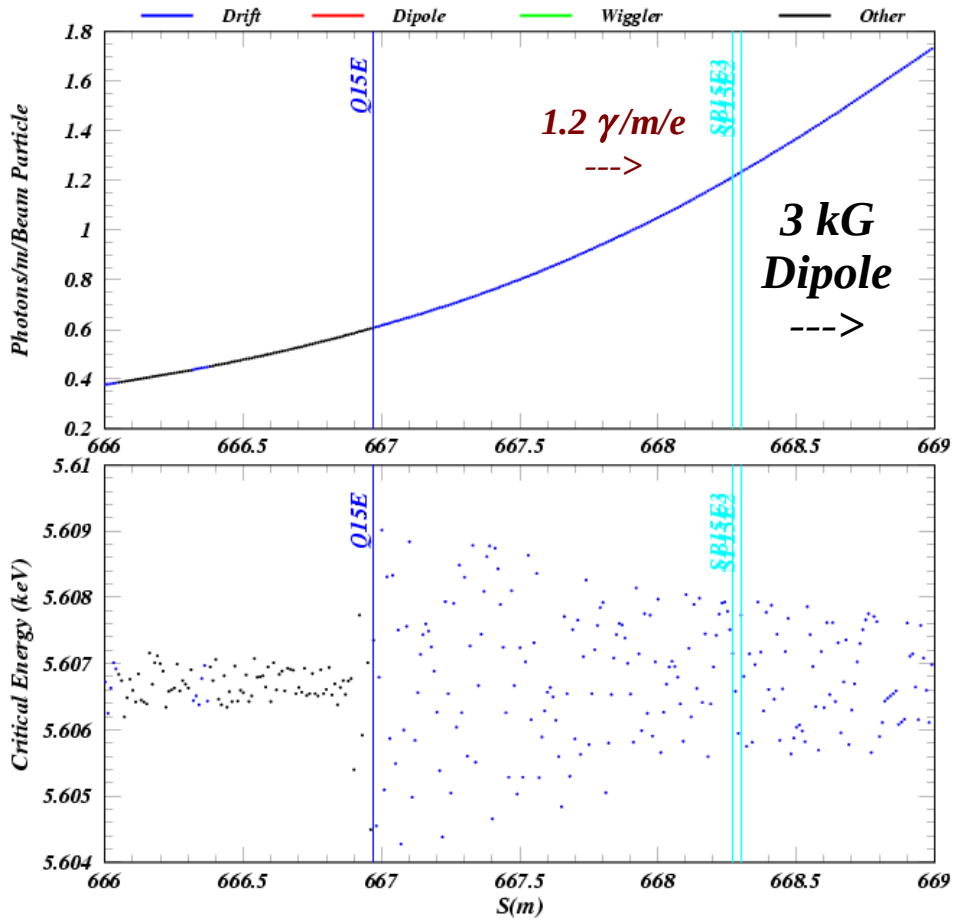


The parameterizations of the ECLOUD photoelectron energy distributions have been adapted to reproduce the signal shapes. It was found that the risetime of the signal was dominated by primaries from the bottom of the vacuum chamber and that a higher-energy spectrum was required for e- relative to e+ in order to overcome the beam kick.

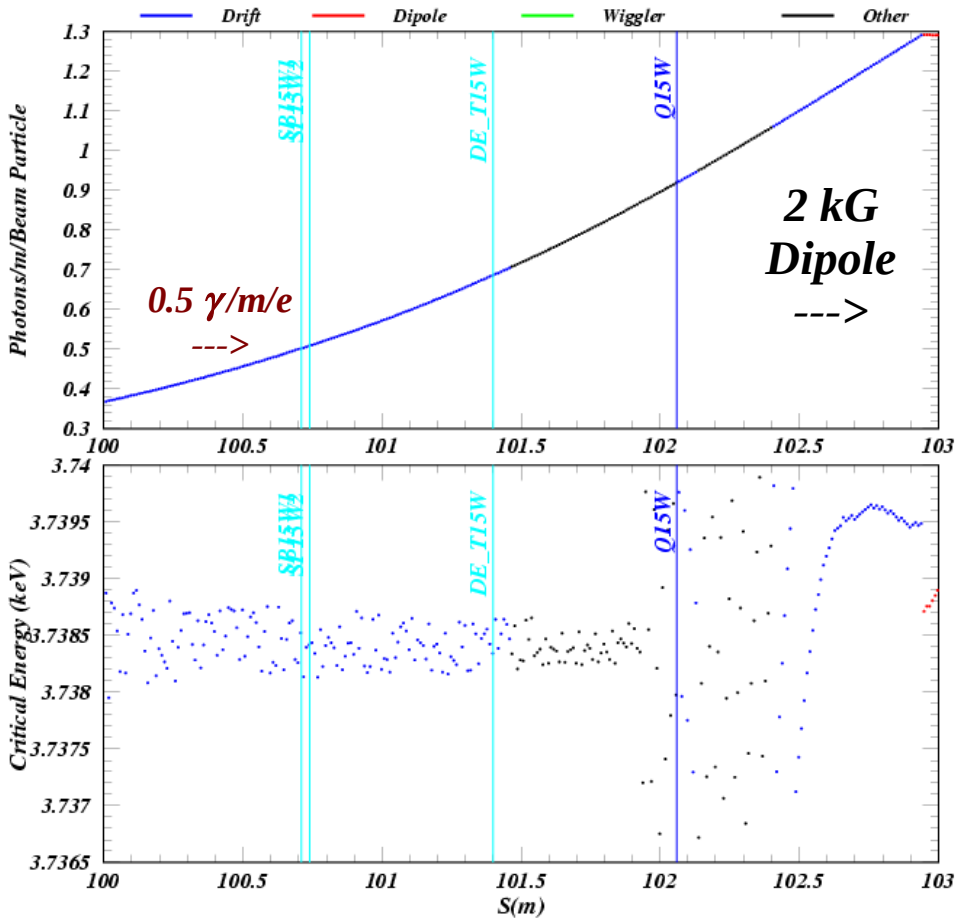
Values for the reflectivity of 20% and 33% for the e+ and e- beams respectively provided the reasonable estimates of the relative e+ and e- shielded button signal magnitudes shown here.

Electron Beam Photon Rates and Spectrum at 15E/W

15E



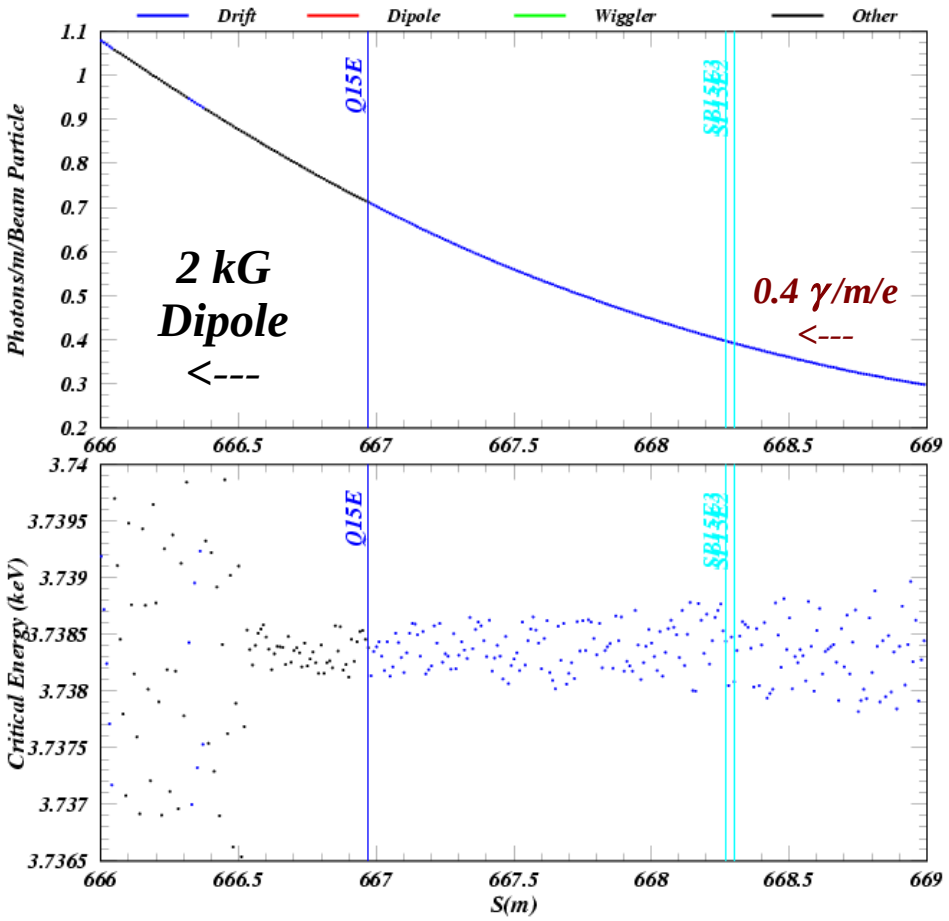
15W



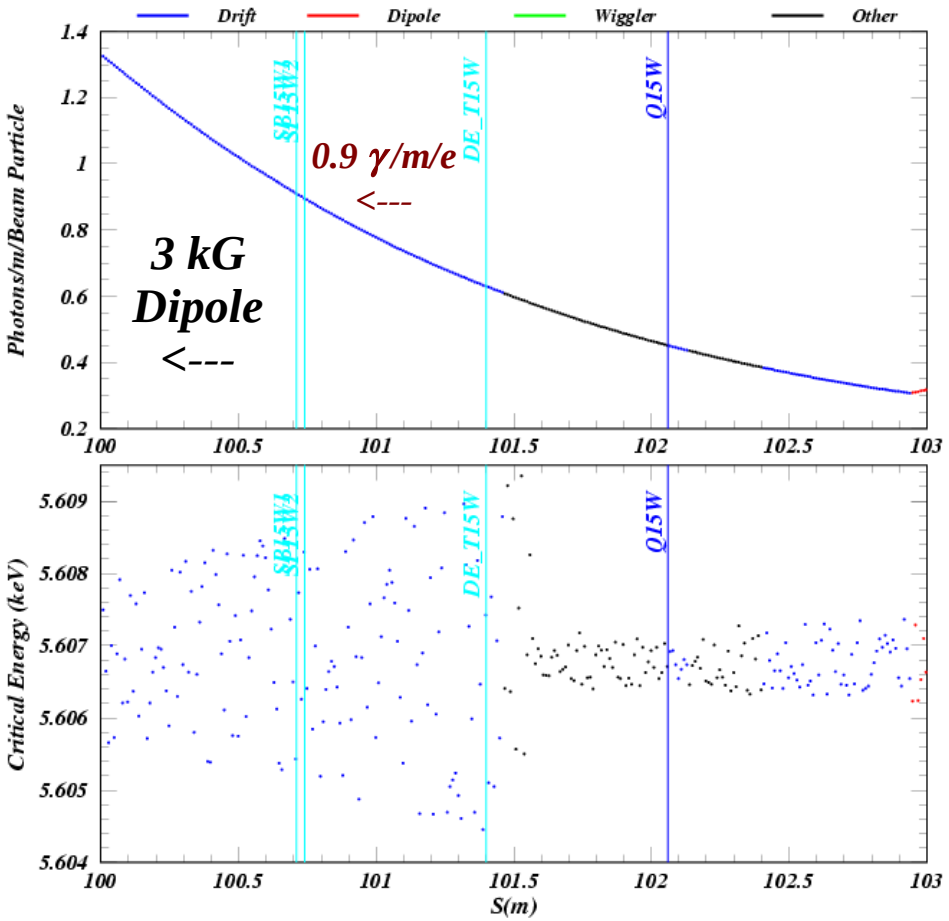
The 3 kG dipole is upstream (downstream) of the shielded button detector at 15E (15W) for the e- beam.
The 2 kG dipole is downstream (upstream) of the shielded button detector at 15E (15W).
So the photon energy spectrum is higher energy for the electron beam at 15E than it is at 15W.

Positron Beam Photon Rates and Spectrum at 15E/W

15E

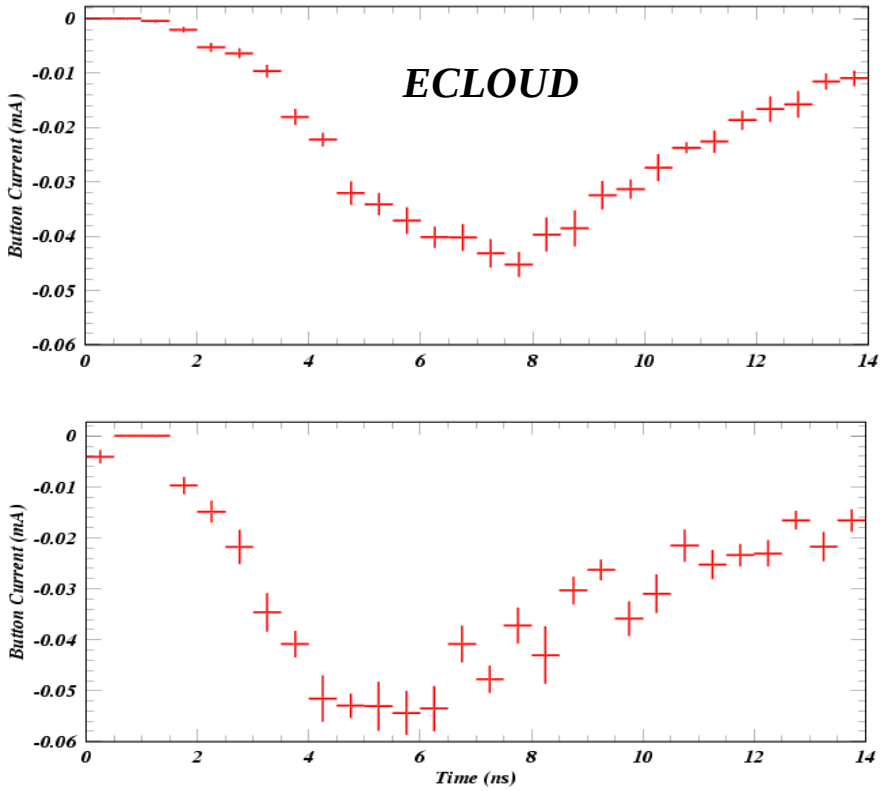


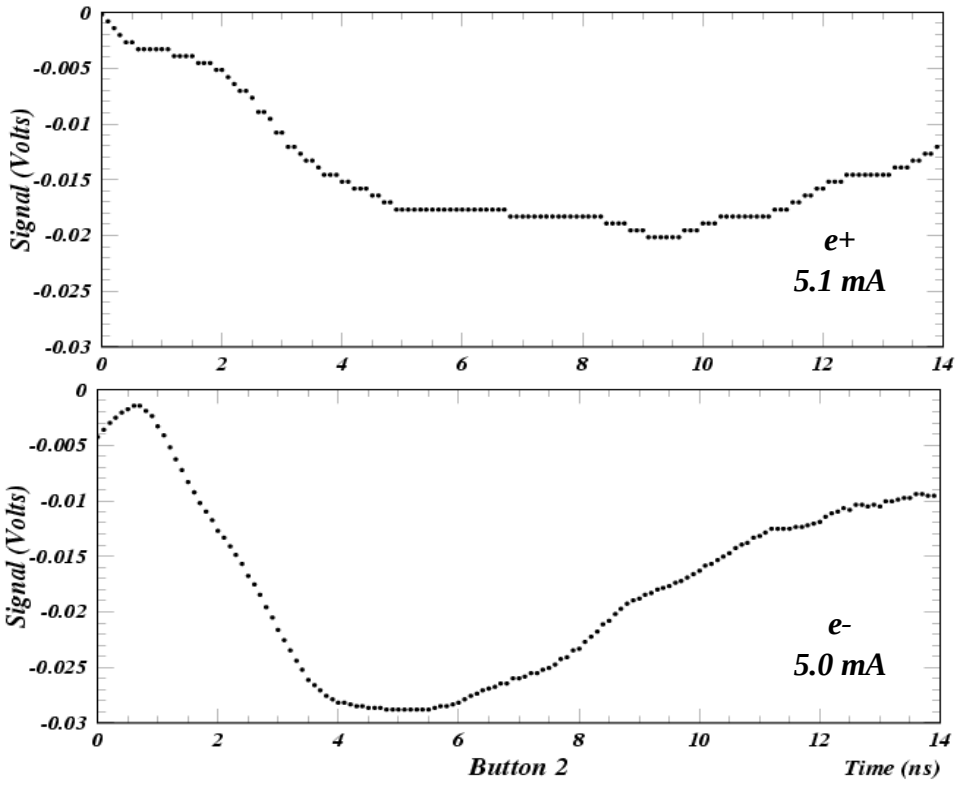
15W



The 3 kG dipole is downstream (upstream) of the shielded button detector at 15E (15W) for the e+ beam.
The 2 kG dipole is upstream (downstream) of the shielded button detector at 15E (15W).
So the photon energy spectrum is higher energy for the positron beam at 15W than it is at 15E.

ECLOUD simulation for the 3/27 e+/e- 5 mA/bunch data at 15E (TiN)

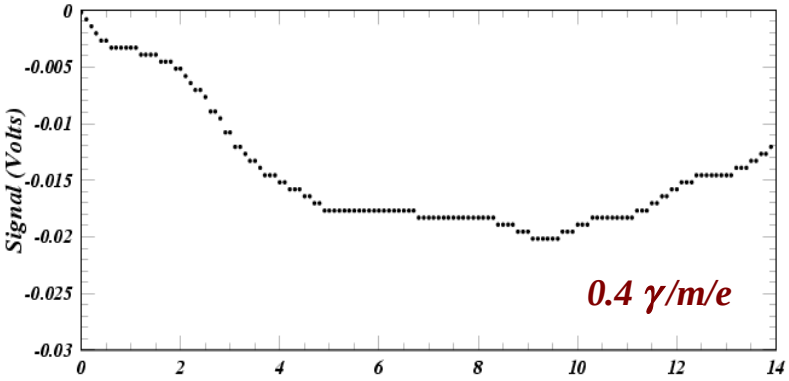
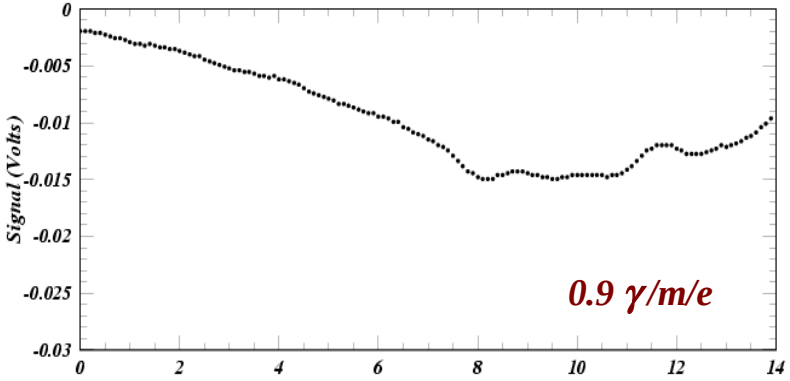
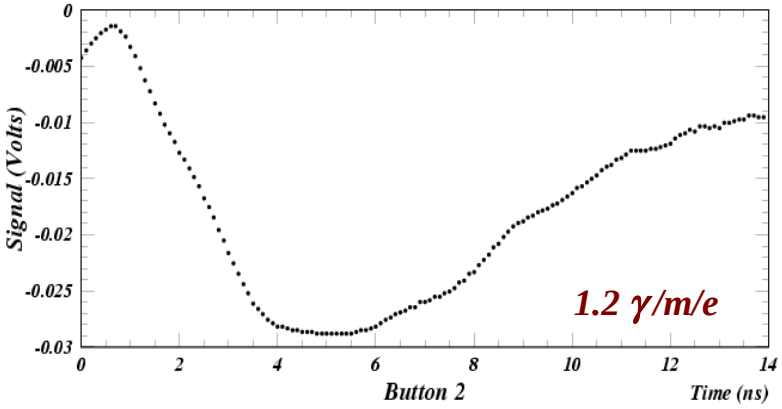
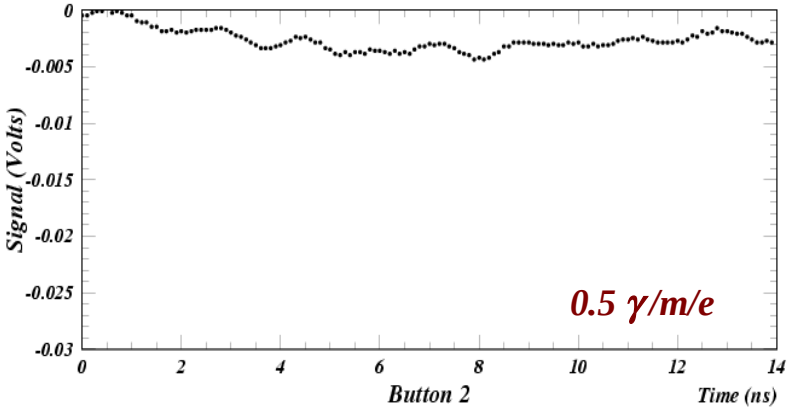




Simulation for e+ 5 mA/bunch showed a need for more high energy photoelectrons for the e+ beam.
This need was not clear for the 8 mA/bunch data because the beam kick provided the necessary higher energy photoelectrons.
It was found that the arrival time was determined by the photoelectron energy spectrum for the e- beam and by the beam kick for the e+ beam.

The e+/e- relative signal sizes were set with reflectivity (e+:20%, e-:33%) using the 8 mA data.
These values work fairly well for the 5 mA data as well.
Since the relative photon rates differ by a factor of (1.2/0.4)/(0.5/0.9) = 5.4, they predict the ratio of the signals (e-/e+)
to be reduced from 1.5 to 0.27 assuming the reflectivity values are associated with the beam species rather than the beam direction.
Otherwise the ratio will be $0.27*(20/33)^2=0.1$.

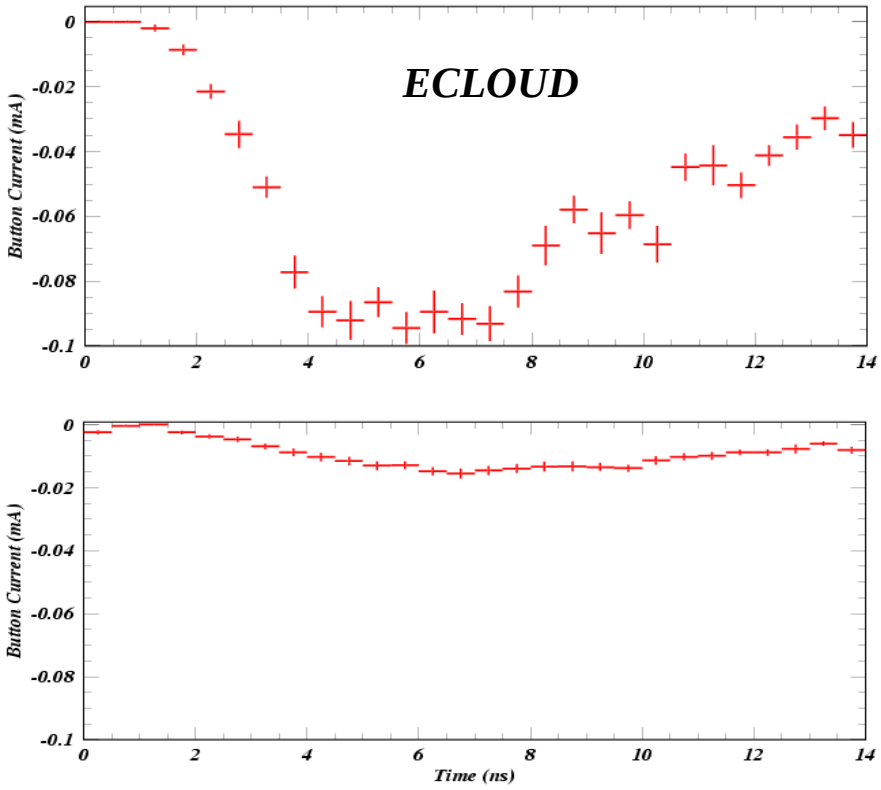
Shielded Button Measurements of 3/27/2010 for 5.3 GeV e+ and e- beams with 5 mA/bunch

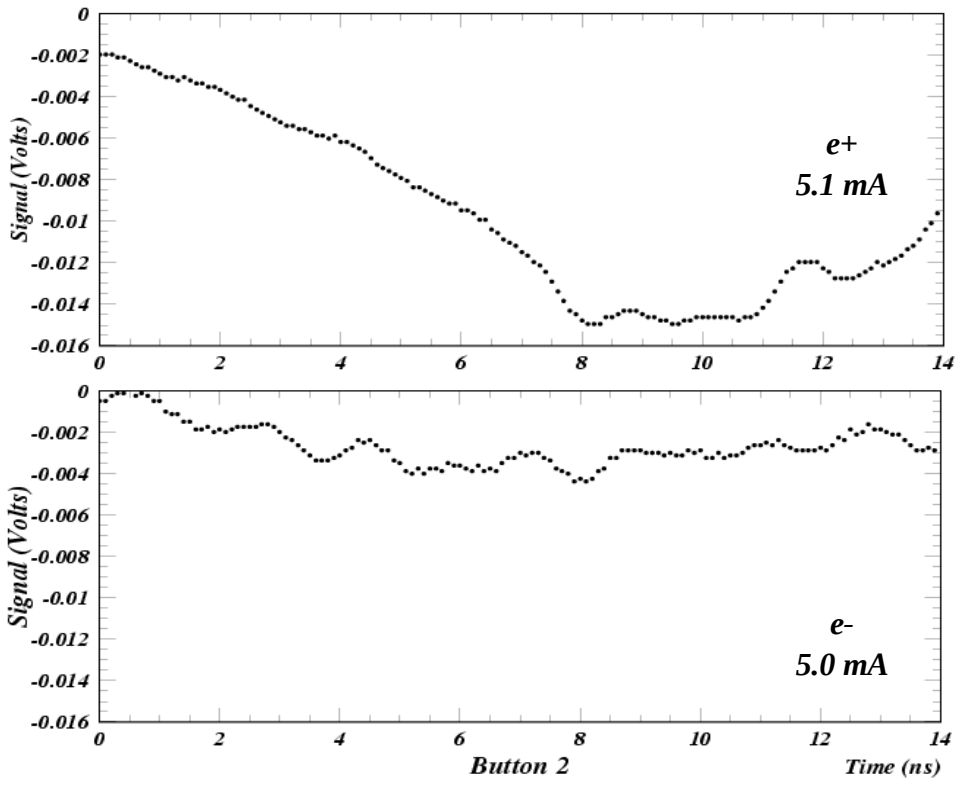
	15E (TiN)	15W (Carbon)
Positron Beam		
Electron Beam		

The 15E e- signal does appear to arrive later at 15W as expected from the weaker B field at the source of the radiation.
However, one might have expected the e+ signal to arrive earlier at 15W. This is not obvious. Need full simulations to check that the apriori prejudice was justified.
Also, the e+ signal at 15W should arrive at least as early as the e- signal at 15E, since it has the harder p.e. energy spectrum as well as the beam kick.
Do these reflected photons have a much lower energy for some reason?

The ratio of the signals (e-/e+) at 15W is about 0.15/0.04 = 0.27, indicating the reflectivity is higher for the e- beam, as it is at 15E.

ECLOUD simulation for the 3/27 e+/e- 5 mA/bunch data at 15W (Carbon)





Using a more appropriate scale to compare the e+ and e- signal magnitudes at 15W shows more clearly that the ratio 0.035/0.15 = 0.23 is consistent with the value 0.27 expected from the assumption that the reflectivity ratio is similar to what was found at 15E, and inconsistent with the value of 0.1 resulting from the assumption that the reflectivity is associated with the direction of the beam rather than the species.

The ECLOUD simulation for e+ 5 mA/bunch at 15W using the photoelectron energy distribution used for the e- beam at 15E clear shows too many high-energy (early) photoelectrons. This distorts the comparison of the magnitudes of the e+ and e- signals. Further work/understanding is needed here.

Summary

The shielded button measurements together with the ECLOUD simulations are providing information on photoelectron production energy distributions and reflectivity which has otherwise been hard to obtain.

For example, it has been shown that the photoelectron energies required to model the signals from an electron beam are much higher than presently modelled in SYNRAD3D. Some work on improving the model has begun.

Today some preliminary information indicating that the reflectivity values are associated with the beam species rather than with the beam direction was presented. Is this credible?

In previous talks, it was also shown how the data with a solenoidal magnetic field can be used to scan through the energy spectrum for photoelectrons produced at the primary source point on the side of the vacuum chamber.

More development work is needed to obtain the photoelectron energy spectrum from the signals shapes in a more systematic manner, since the hunt-and-peck parameter search method is very inefficient.

Both the data and simulations shown here have hidden the comparison of the second bunch passage, since the physics issues are so different. In particular, these signals are very sensitive to the secondary yield model, and hence to the mitigation techniques. Preliminary indications are that secondary e- production in the beampipe holes contribute significantly. An algorithm to update ECLOUD accordingly is in progress.

This work has revealed a number of promising measurements which have not yet been made.
An experimental program which can be performed during the present CesrTA measurement period is under development.