ECLOUD Implementation of SYNRAD3D Photon Rates and Azimuthal Distributions

-- Application to Shielded Pickup Measurements at 15E and 15W --

All material for this talk may be obtained at www.lepp.cornell.edu/~critten/cesrta/ecloud/1dec10

See also previous talks on simulations for the shielded pickup data on 4/21, 4/28, 5/12, 7/7, 7/14, 8/4, 9/8, 9/22, 11/3 and 11/24/2010

Last week we showed that the SYNRAD3D photon rates and azimuthal distributions can improve the data/simulation comparison for the SPU witness bunch measurements relative to the uniform azimuthal distributions used previously.

Today we describe the ECLOUD implementation of the SYNRAD3D parameterizations and show them for 15E and 15W.

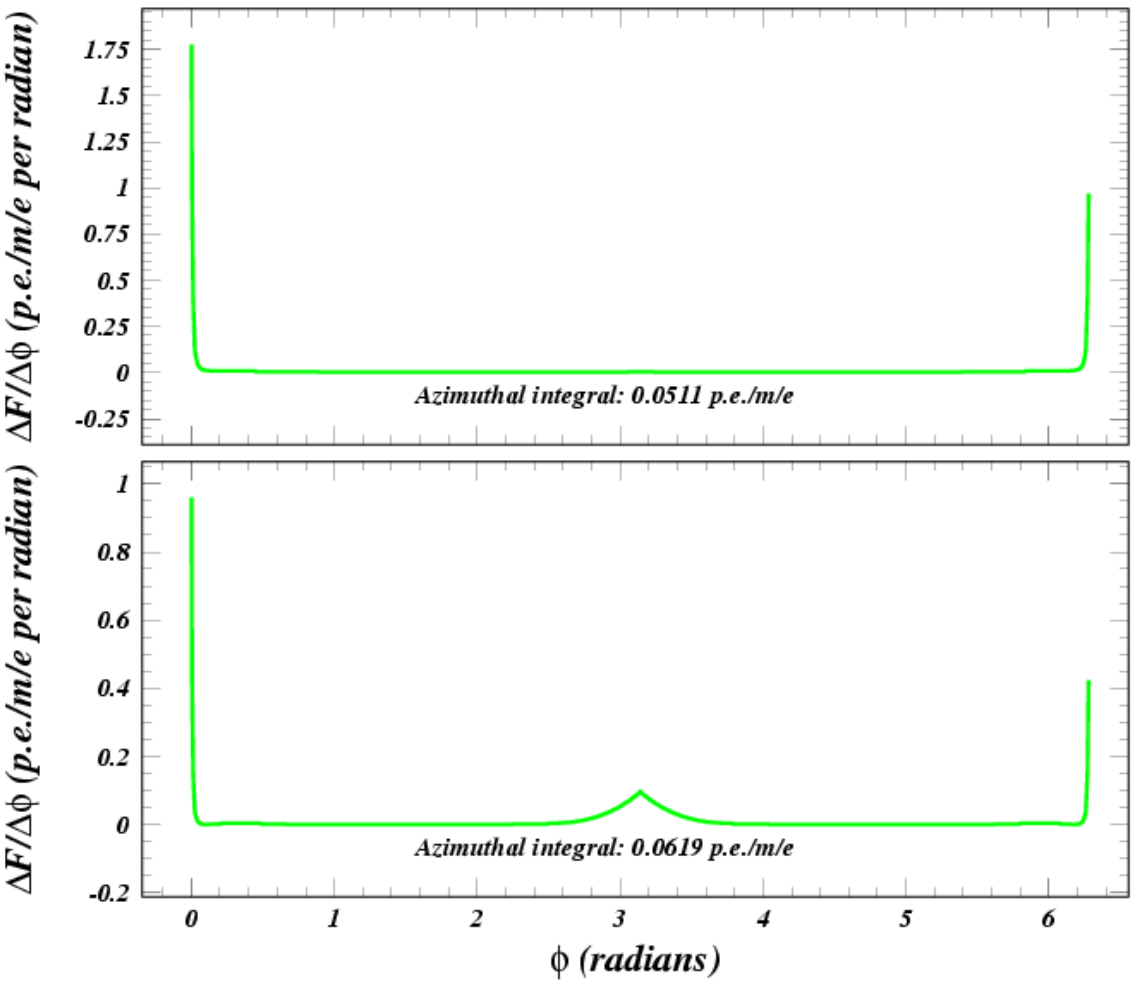
Also, an answer to Joe's question last week concerning the SPU signal width dependence on bunch current is answered.

(Yes, the width depends on bunch current. So the different signal shapes for the carbon chambers at 15W (3/27, 5 mA/bunch) & 15E (5/17, 3 mA/bunch) does not mean they have different secondary yield qualities.)

Jim Crittenden
Cornell Laboratory for Accelerator-Based Sciences and Education
Electron Cloud Meeting
1 December 2010

SYNRAD3D photon azimuthal distribution

RFA_tab_fits_Lorentz_chess_20090225_positron.csv



15W

15E

A quantum efficiency must also be assumed:
10% in these simulations.

No photon energy information from SYNRAD3D is used.

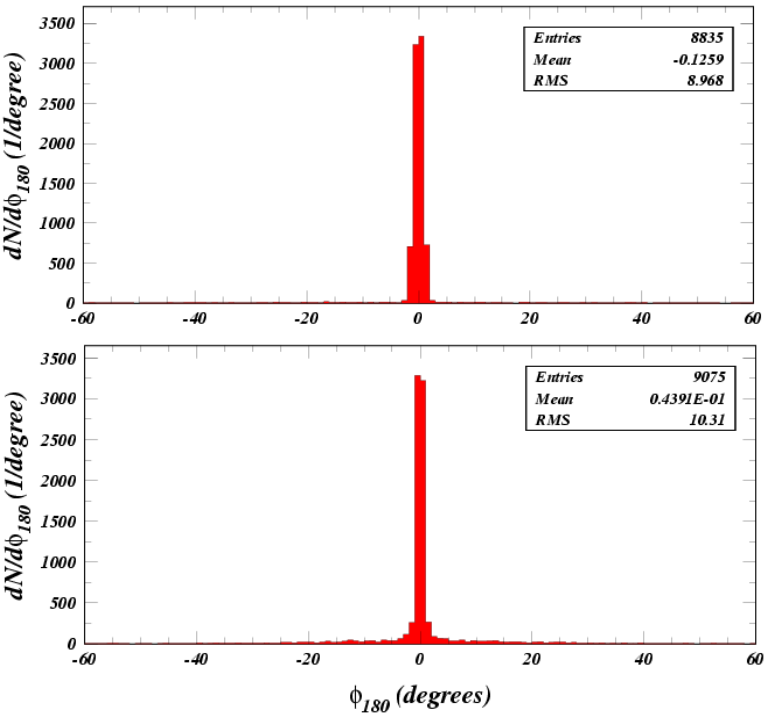
SYNRAD3D provides absolute photon rates as a function of scaled v.c. perimeter in the form of two Lorentzian fits plus a 6th order polynomial.

https: //wiki.lepp.cornell.edu/ilc/pub/Public/CesrTA/EcloudParams/Synrad3d_RFA_fits.pdf

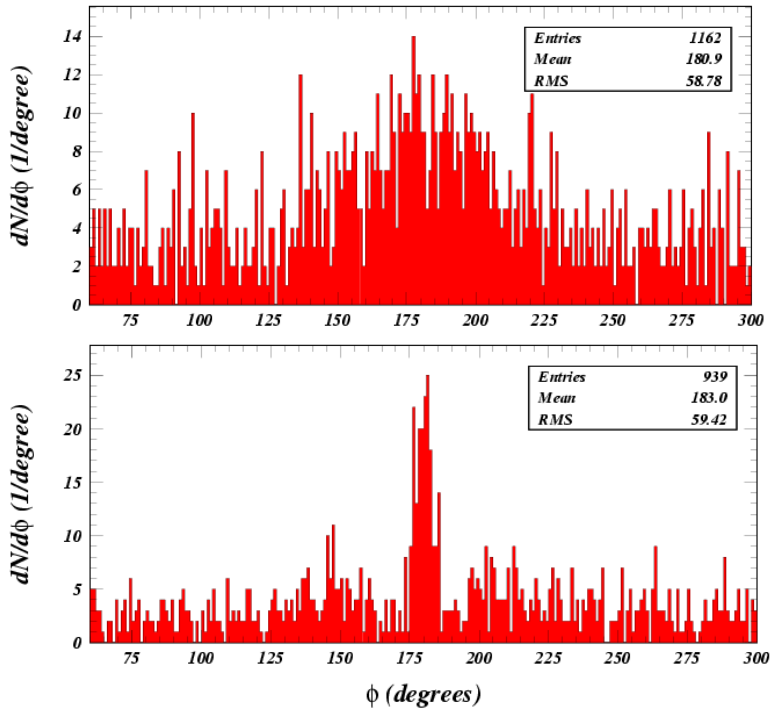
ECLOUD reads the csv file and generates the azimuthal distribution using Miguel's ellipse functions and my Monte Carlo utilities.

Compare 15W uniform and SYNRAD3D generated photoelectron azimuthal distributions (10k sample)

Primary Source Point Region



Outside Primary Source Point Region



Uniform

SYNRAD3D

The variable $\phi_{180} = \phi$ for $\phi < 180$ and $360-\phi$ for $\phi > 180$ degrees.

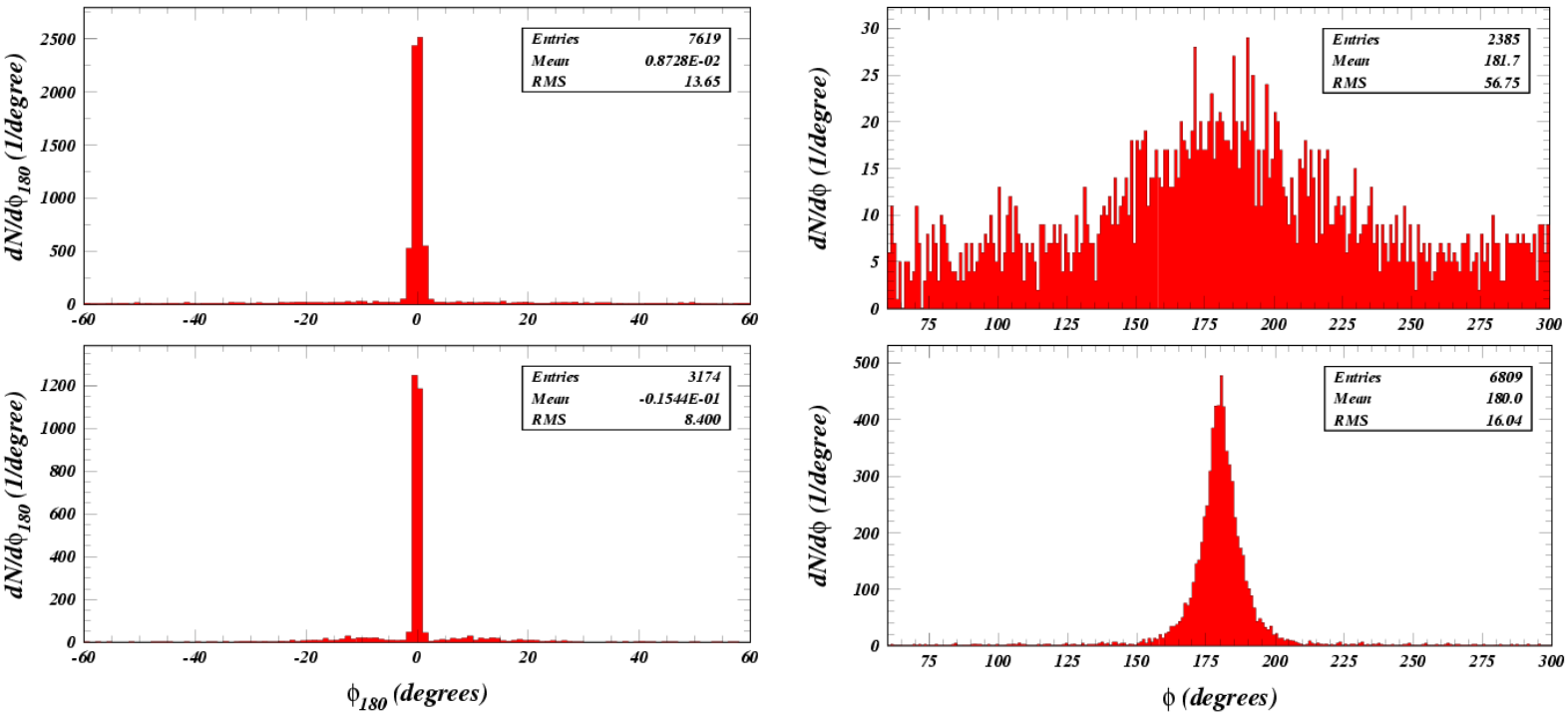
The enhancement at $\phi = 180$ degrees in the uniform case is due to the elliptical geometry.

In the SYNRAD3D case, it is due to reflected photons.

Compare 15E uniform and SYNRAD3D generated photoelectron azimuthal distributions (10k sample)

Primary Source Point Region

Outside Primary Source Point Region



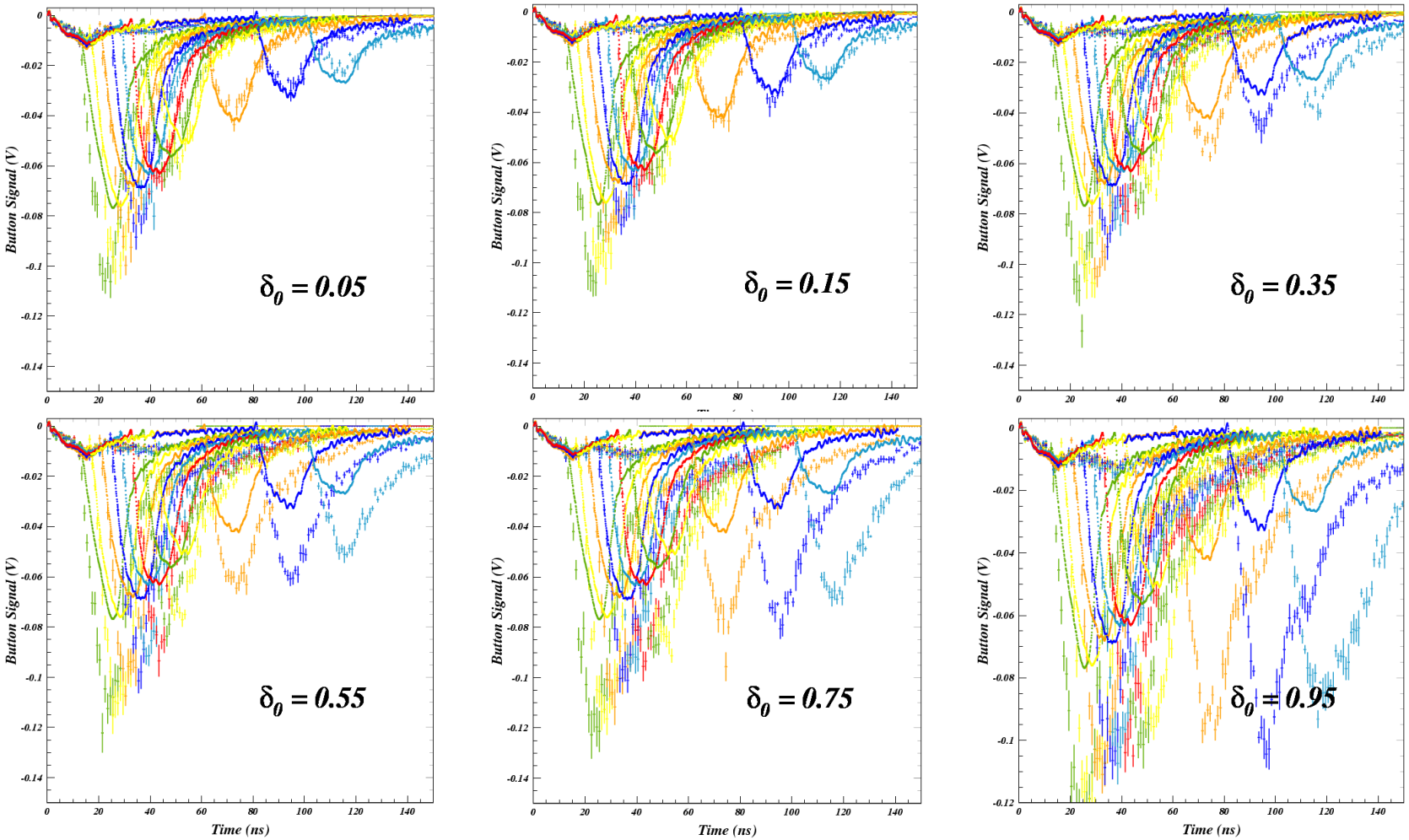
Uniform

SYNRAD3D

The enhancement at ϕ = 180 degrees is very strong at 15E.
This resulted in the dramatically improved comparison with the measurement shown last week and repeated in the following three slides.

SYNRAD3D photoelectron azimuthal distribution

RFA_tab_fits_Lorentz_chess_20090225_positron.csv RFA: SP15E2



3/17 15E 3 mA 4-ns spacing

q.e. 10% spu scale 1.4 unchanged

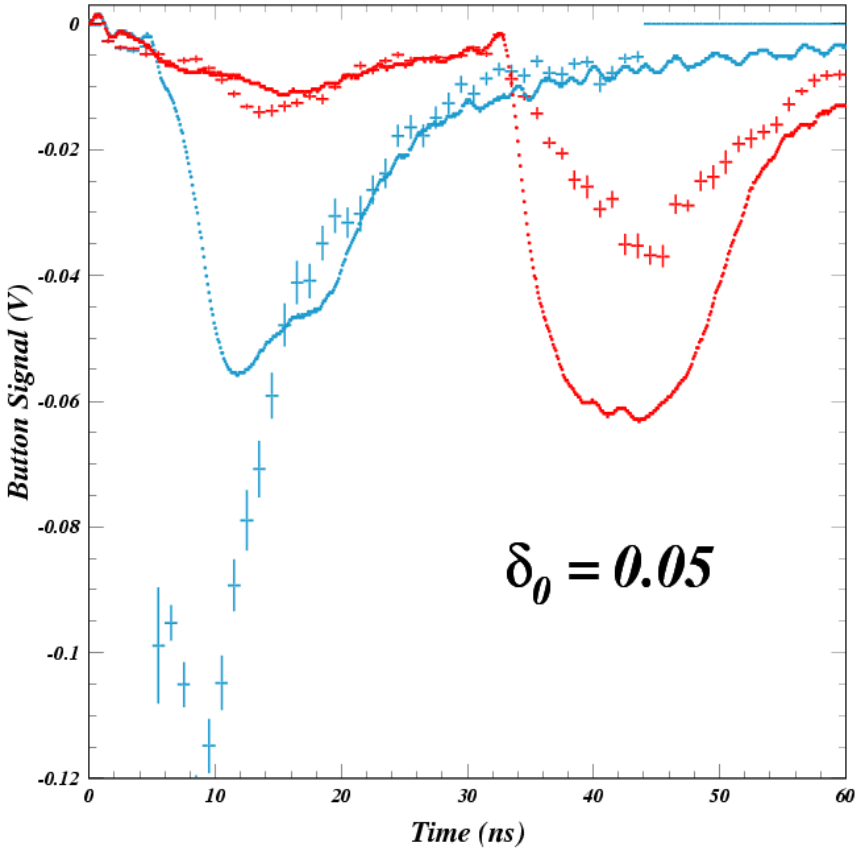
Remarkable agreement again!

Lowering the true secondary yield below 0.7 may help.

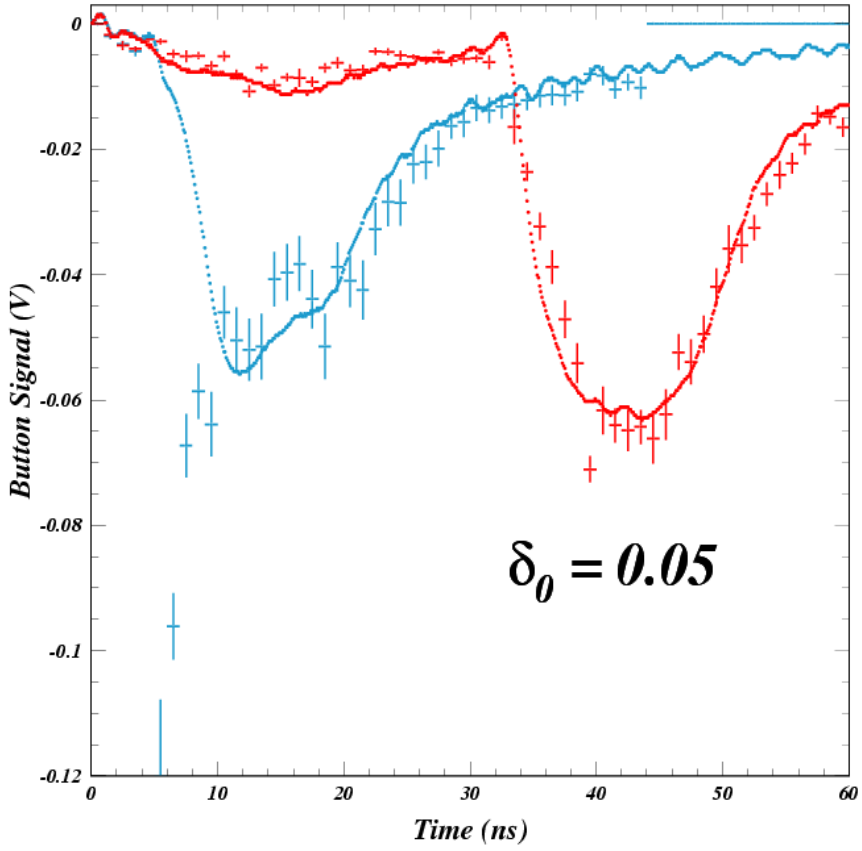
SYNRAD3D reproduces the WIDTH of the SPU signals better than the assumption of uniform azimuthal distribution of reflected photons. I continue to work on the excess early peak for closely spaced witness bunches, which is so bad that I omitted the 4-ns and 8-ns bunches here.

Compare uniform and SYNRAD3D photoelectron azimuthal distributions

Uniform



SYNRAD3D



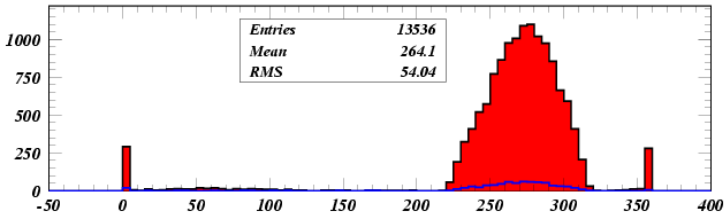
The SYNRAD3D azimuthal distribution is a remarkable improvement, both for the shape of the single-bunch signal and for the shapes and relative sizes of the witness bunches at 4 and 32 ns.

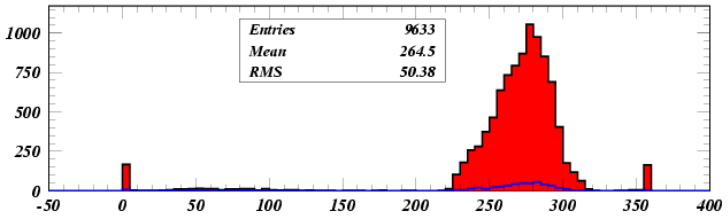
This explains why my weeks-long attempt to fix the 4-ns bunch with the photoelectron energy distribution alone has been so fruitless.

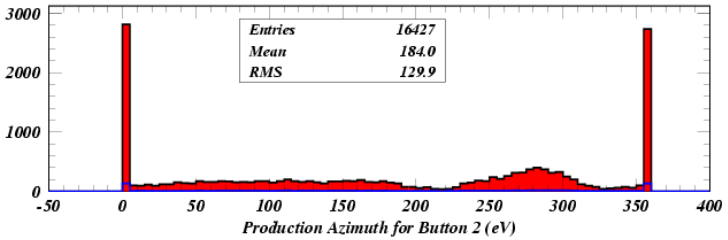
The accuracy of the normalization must be fortuitous, since the assumption of 10% quantum efficiency for SYNRAD3D was arbitrary.

Compare azimuthal origins of SPU signal particles

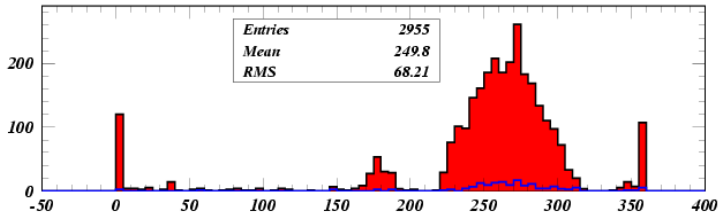
Uniform

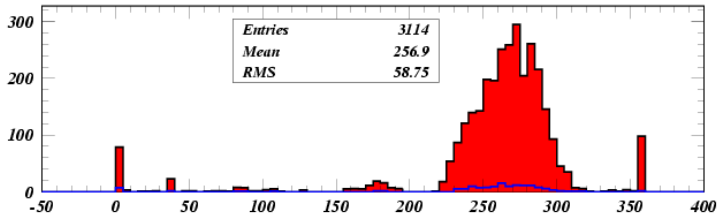


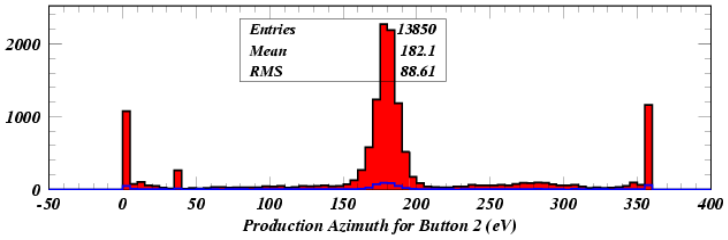




SYNRAD3D







Single Bunch
0 < t < 30 ns

4-ns Bunch
10 < t < 30 ns

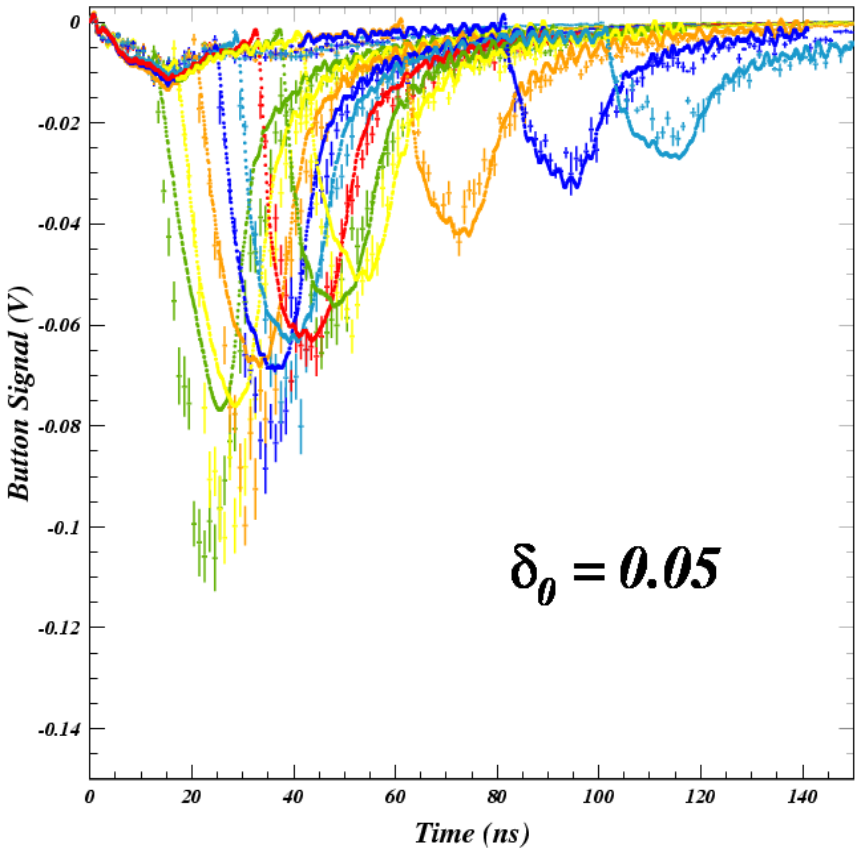
32-ns Bunch
32 < t < 52 ns

Particles contributing to the signal by producing secondaries in the port holes are shown in blue

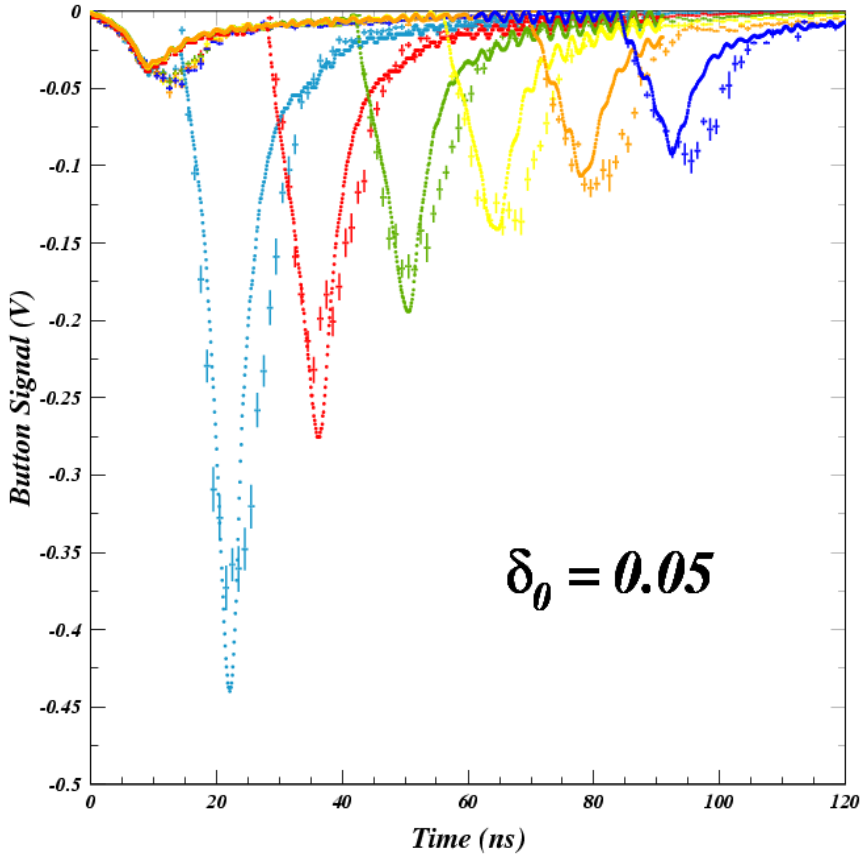
There are many fewer signal particles in SYNRAD3D for the first bunch and the witness bunch at 4-ns. That is, SYNRAD3D produces many more particles at azimuthal positions where they cannot contribute to these signals. Particles produced at the opposite side of the vacuum chamber from the primary source point are important for the signal from the witness bunch at 32-ns. These are absent in the uniform azimuthal distribution.

Dependence of SPU signal widths on bunch current ?

5/17 data, 15E, 4-ns spacing, 3 mA/bunch



3/27 data, 15W, 14-ns spacing, 5 mA/bunch

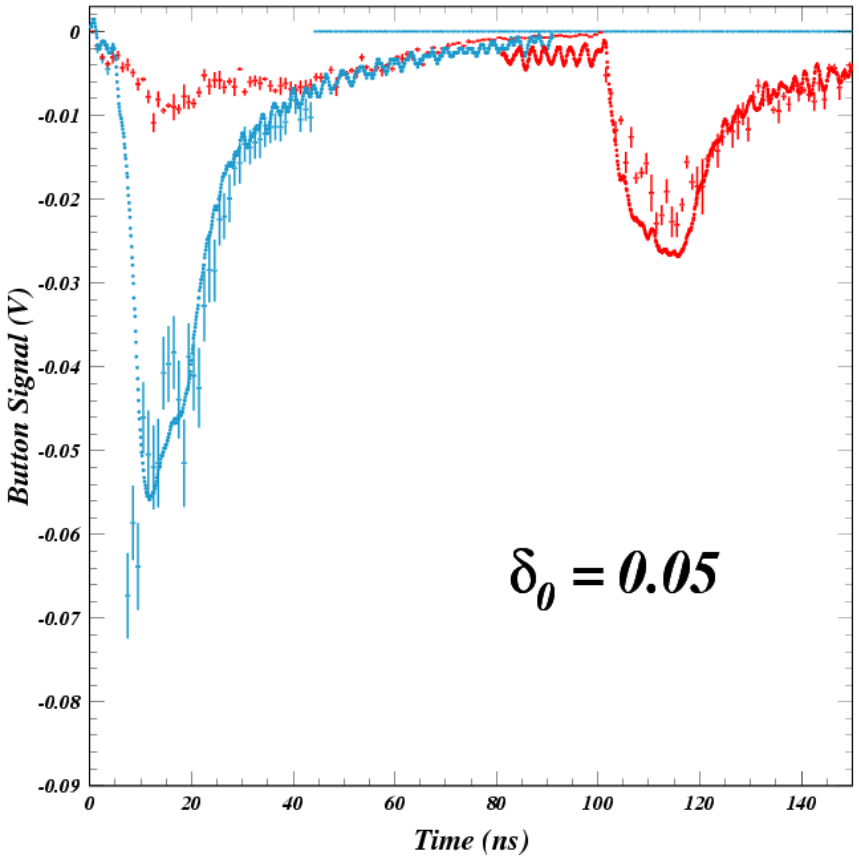


Last week I surmised that the different shapes of the SPU signals for the carbon-coated v.c. at 15E (5/17 4-ns data) and 15W (3/27 14-ns data) might be due to differing SEY characteristics. These are different chambers, but the coating is the same method.

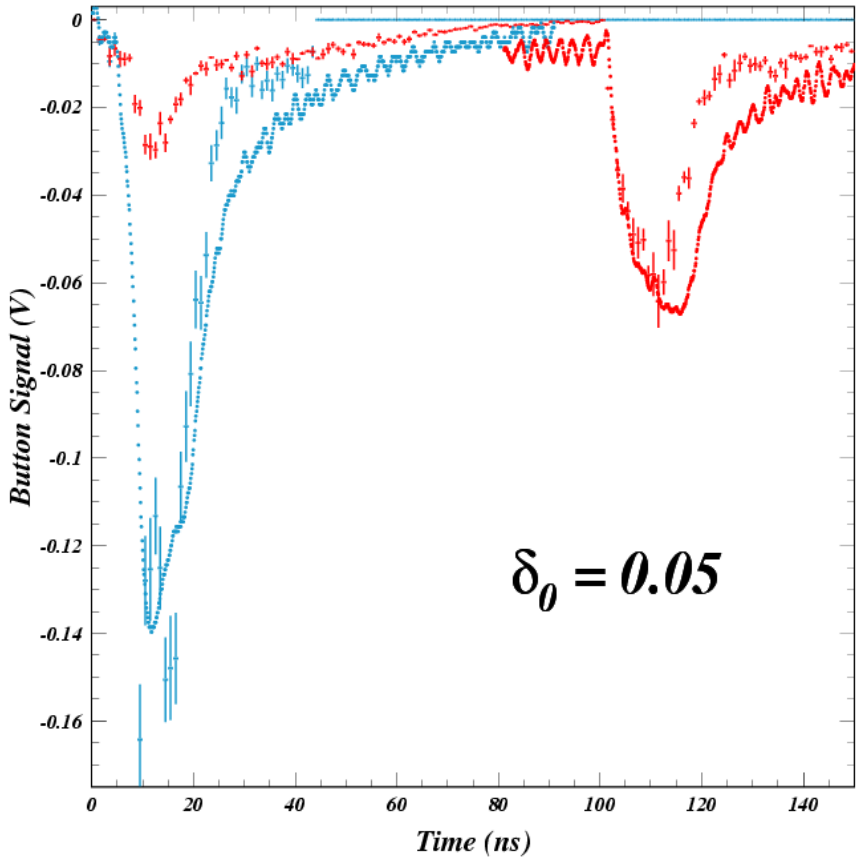
Joe asked if the differing bunch current might be the reason instead.

Dependence of SPU signal widths on bunch current ?

5/17 data, 15E, 4-ns spacing, 3 mA/bunch



Simulation with 3 --> 5 mA/bunch



Sure enough, ECLOUD sez the bunch current is important for the signal widths.

We plan witness bunch studies with 5 mA/bunch for a direct comparison with the 3/27 data during the coming experimental run. We also plan to take advantage of the new bipolar solenoid power supply at 15W.