Parameter Correlations in the ECLOUD Simulation for the Cloud Lifetime Study Using SPU Witness Bunch Data, First Results for Carbon-coated Vacuum Chambers
and
First Results Using SYNRAD3D Azimuthal Photoelectron Distributions

All material for this talk may be obtained at www.lepp.cornell.edu/~critten/cesrta/ecloud/24nov10

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, and 11/3/2010

A primary purpose of the shielded pickup project (time-resolved measurements) is to measure the cloud lifetime.
This lifetime is sensitive to the secondary yield for low-energy cloud particles hitting the vacuum chamber wall.

First results on the sensitivity to the parameter δ_0 using witness bunch data were shown on 9/22/2010 and at ECLOUD10.

In the meantime, the ECLOUD SPU acceptance model has been improved and hole secondaries introduced (3 Nov).

Today we address the systematic sensitivity of the δ_0 determination to other model parameters.

Motivated by Joe Calvey's RFA studies of model parameters shown last week, we use the data for carbon-coated vacuum chambers for this purpose. We also show the first use of the SYNRAD3D fits for photoelectron azimuthal distributions.

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Cornell Laboratory for Accelerator-Based Sciences and Education

Electron Cloud Meeting
24 November 2010

Status as of ECLOUD10 for the cloud lifetime study using 3/27 5 mA/bunch e+ data at 15E (TiN)

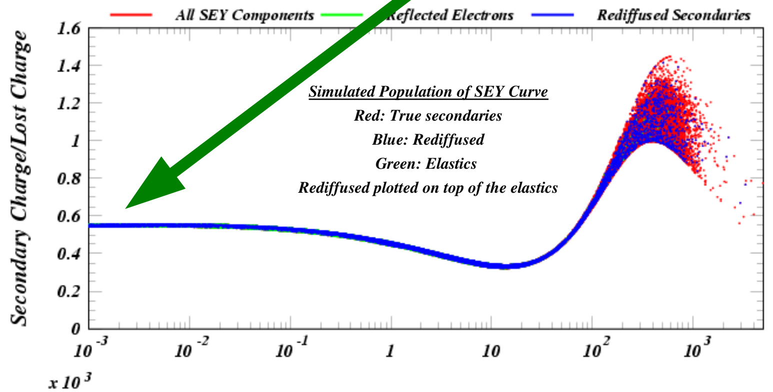
Secondary Yield Model

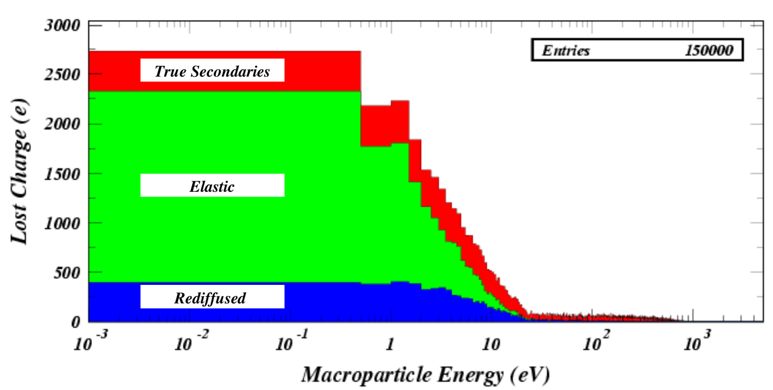
True secondary yield: 0.9

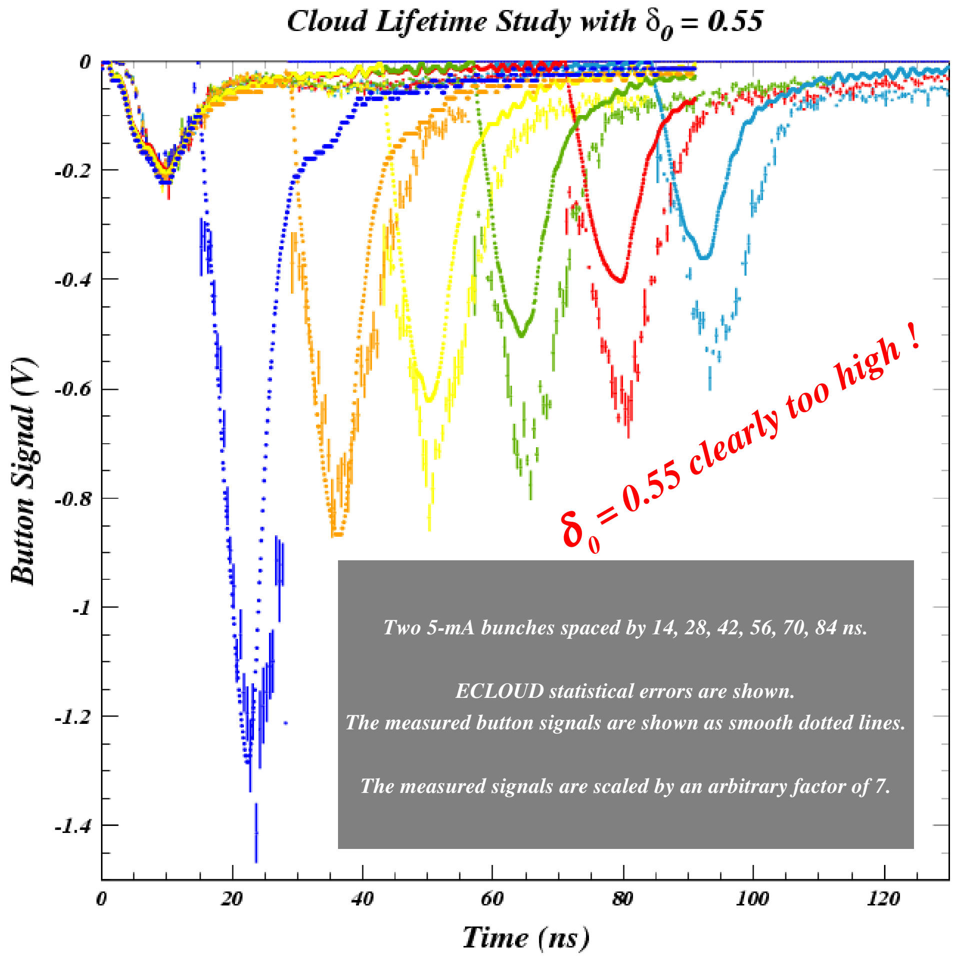
True secondary peak energy: 400 eV

Rediffused yield: 0.1

Elastic yield δ_0: 0.55



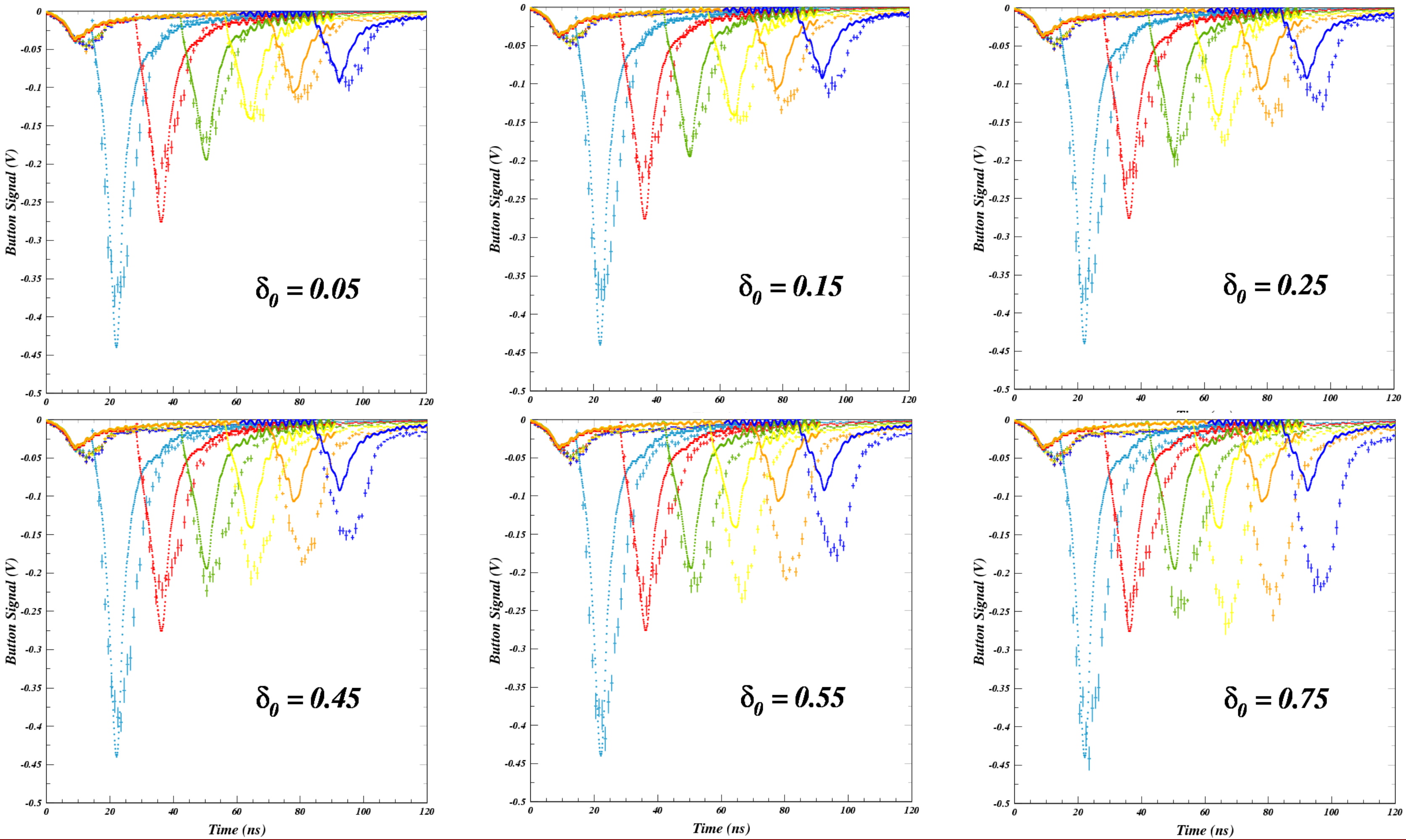




Simulated cloud lifetime found to be sensitive to δ_0

TiN (3/27 15E 14-ns) : δ_0 = 0.05 Al(5/17 15W 4-ns): δ_0 = 0.75

ECLOUD cloud lifetime sensitivity to elastic yield δ_0
-- Present status for 3/27 5 mA/bunch data for 15W carbon-coated v.c.

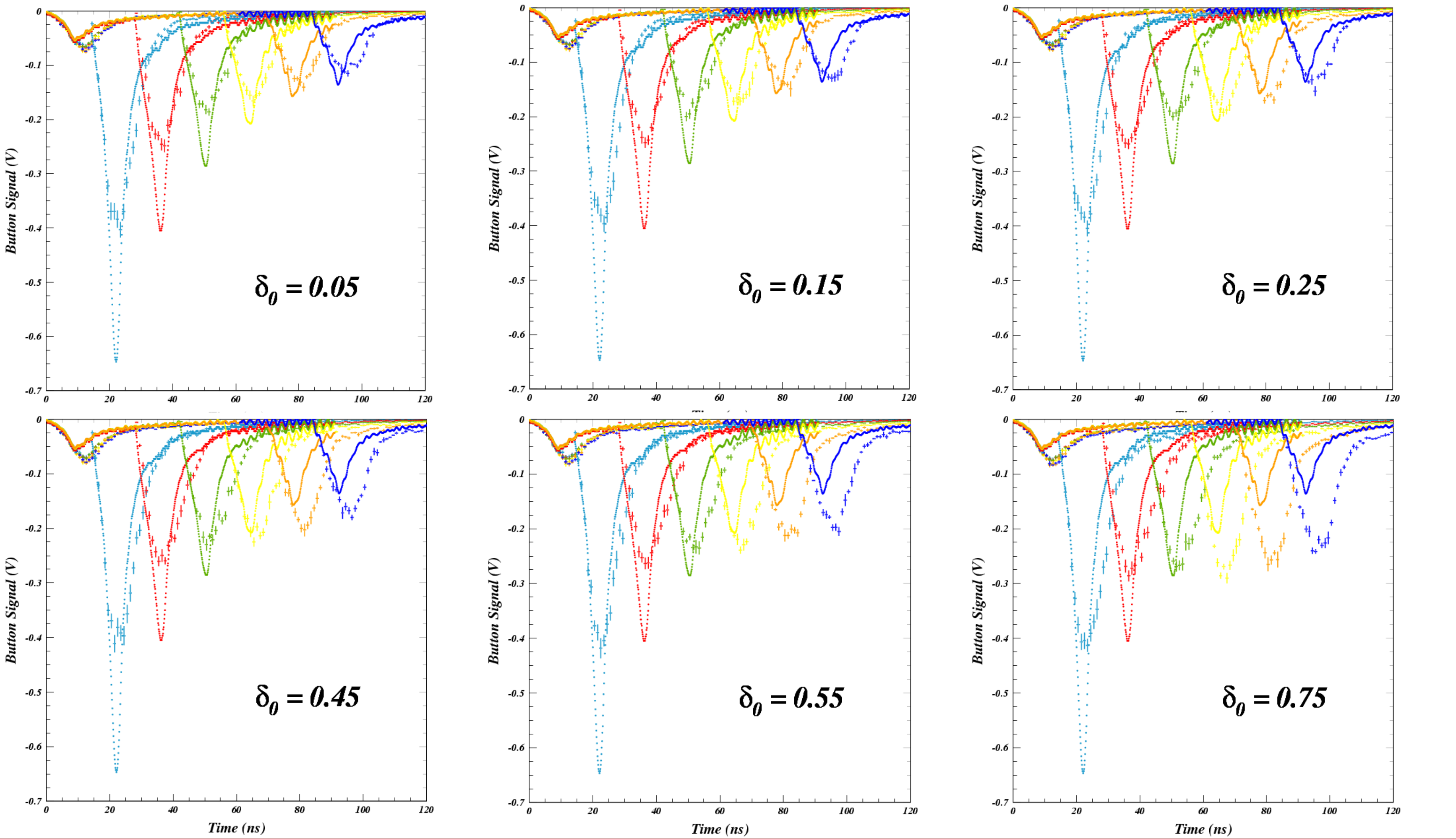


Baseline parameters: 0.9 γ/m/s, q.e. 5%, reflectivity 20%, $\delta_{ts} = 0.7$, $E_{pk} = 400$ eV, $\delta_{red} = 0.1$.

SPU signal scaled by factor 1.7. Elastic yield parameter $\delta_0 = 0.05$ is the best match.

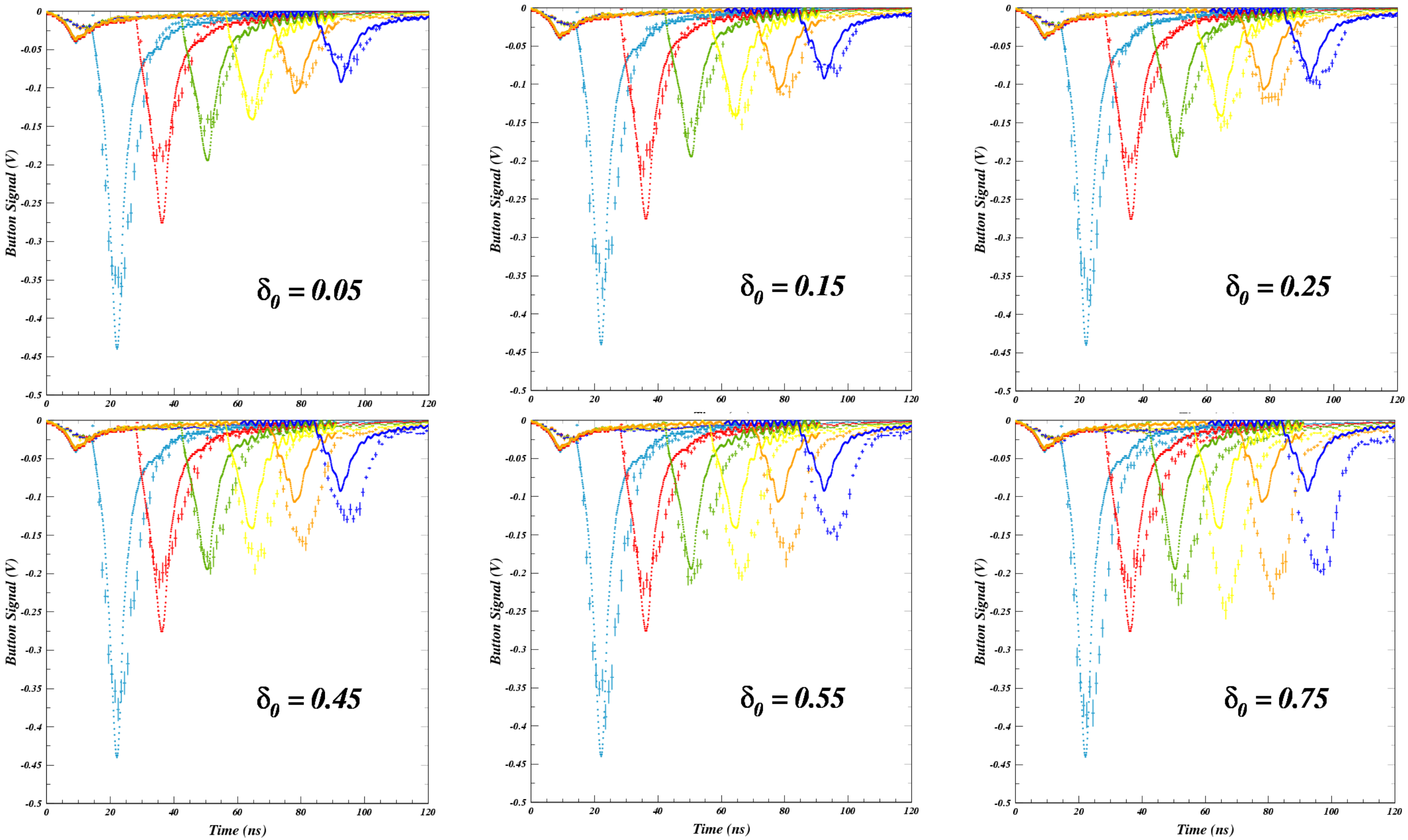
Sensitivity to Reflectivity: 20% --> 30%

SYNRAD3D value is 27% (dipole method, GD 14 July 2010, JAC 8 Sep 2010)



The source of the rising edge of the first-bunch signal is photoelectrons from the bottom of the beampipe, so the SPU scale factor must be raised from 1.7 to 2.5. No value for δ_0 reproduces the measured witness bunch signals.

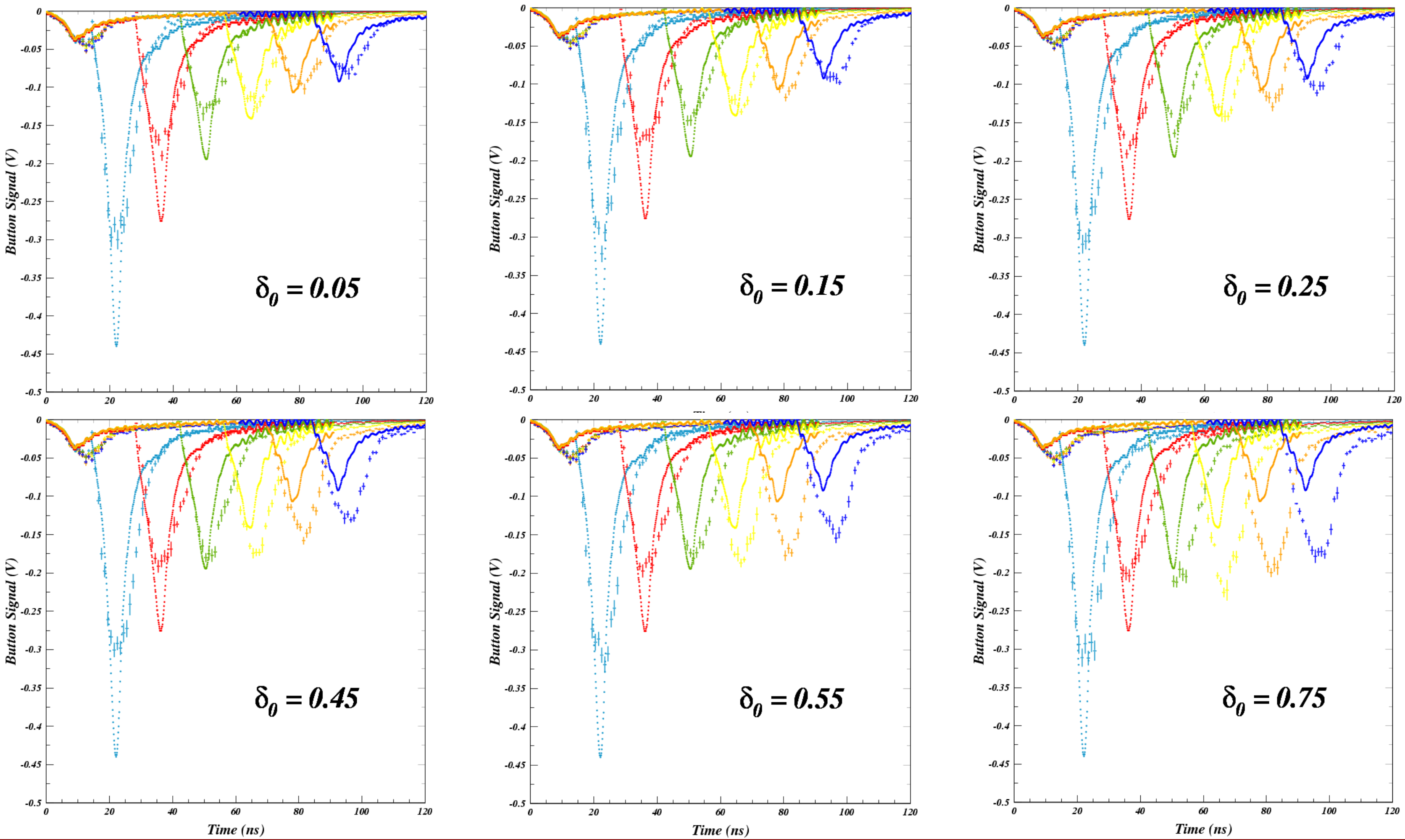
Sensitivity to Reflectivity: 20% --> 10%



For this comparison, the SPU scale factor has been left unchanged at 1.7, rather than reducing it to 0.85. The simulated ratio of the 4-ns-bunch signal to that of the first-bunch is clearly wrong. If this were corrected, again, no value for δ_0 would reproduce the measured witness bunch signals, because the direct signal contributes a substantial fraction of the 84-ns-bunch signal.

Sensitivity to True secondary yield: 0.7 --> 0.5

Can the elastic yield compensate the true secondary yield?

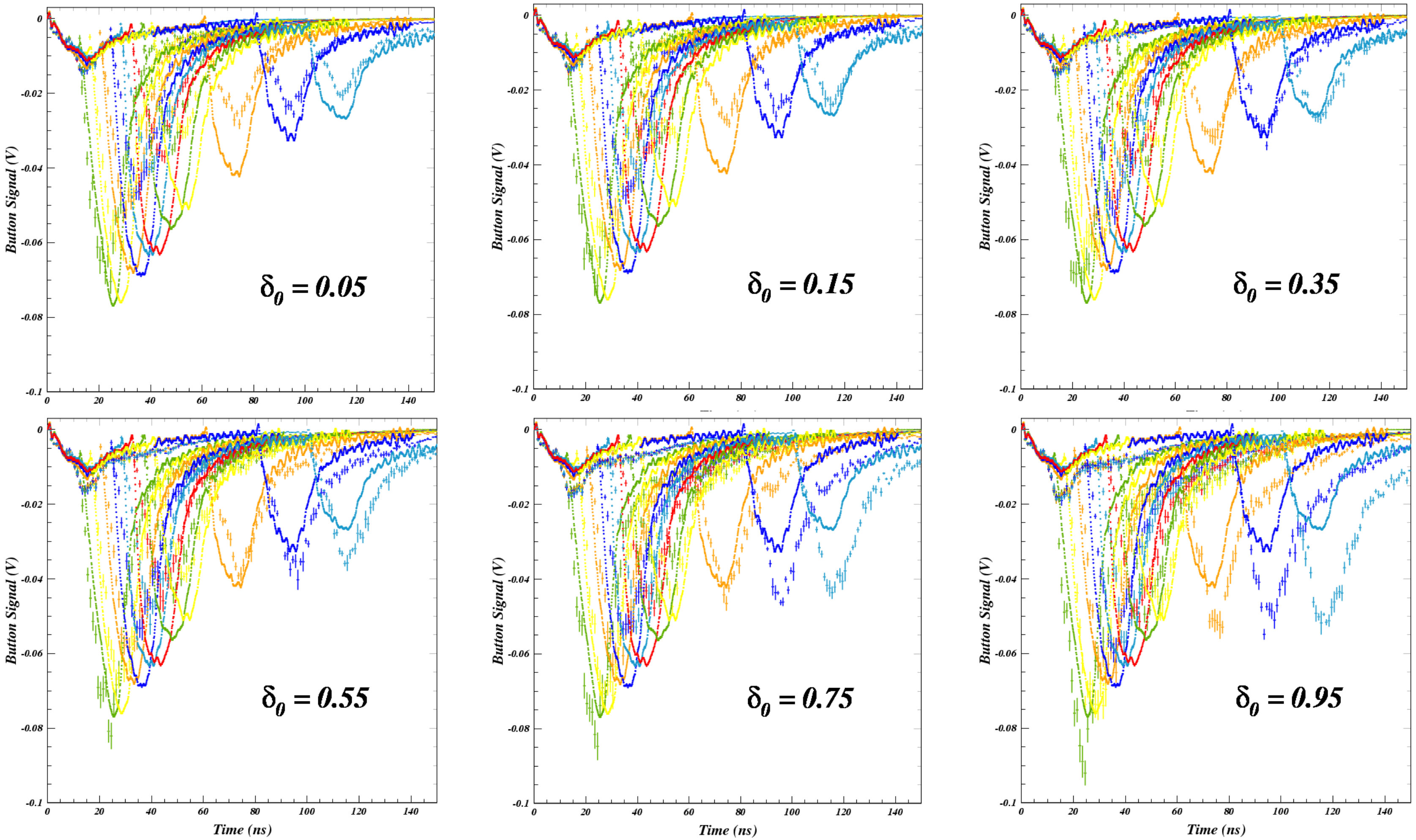


Nope. The elastic component does not contribute enough to the 4-ns-bunch signal to compensate a deficit in the true secondary yield.

Also investigated E_{pk}=250, 400 eV, δ_{ts} = 0.9 , δ_{red} = 0.1, 0.3 and δ_{ts}, δ_{red} correlation. The elastic yield did not budge.

Also, none of these parameters could explain the narrowness of the observed signals. Needs more study.

ECLOUD cloud lifetime study for the 15E carbon-coated v.c.
-- 3 mA/bunch 5/17 data 14-ns spacing --

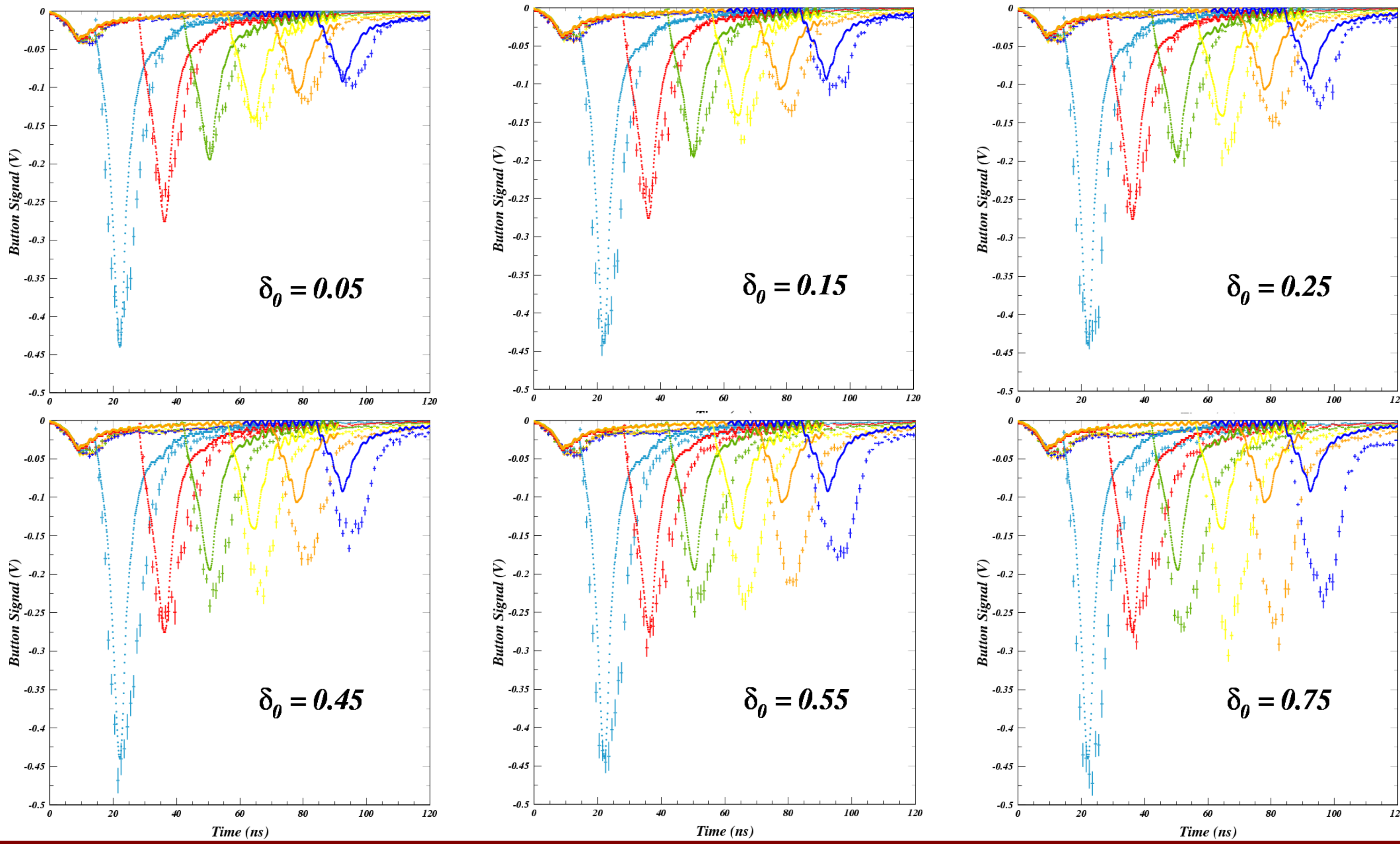


Baseline parameters: 0.4 γ/m/s, q.e. 5%, reflectivity 40%, δ_{ts} = 0.7, E_{pk} = 400 eV, δ_{red} = 0.1.

SPU signal scaled by factor 1.4. ***Elastic yield parameter δ_0 = 0.35 is the best match, but work needed.***

SYNRAD3D photoelectron azimuthal distribution

RFA_tab_fits_Lorentz_chess_20090225_positron.csv   RFA: SP15W2



3/27 15W 5 mA
14-ns spacing

q.e. 10%
spu scale 1.7
unchanged

Remarkable agreement!

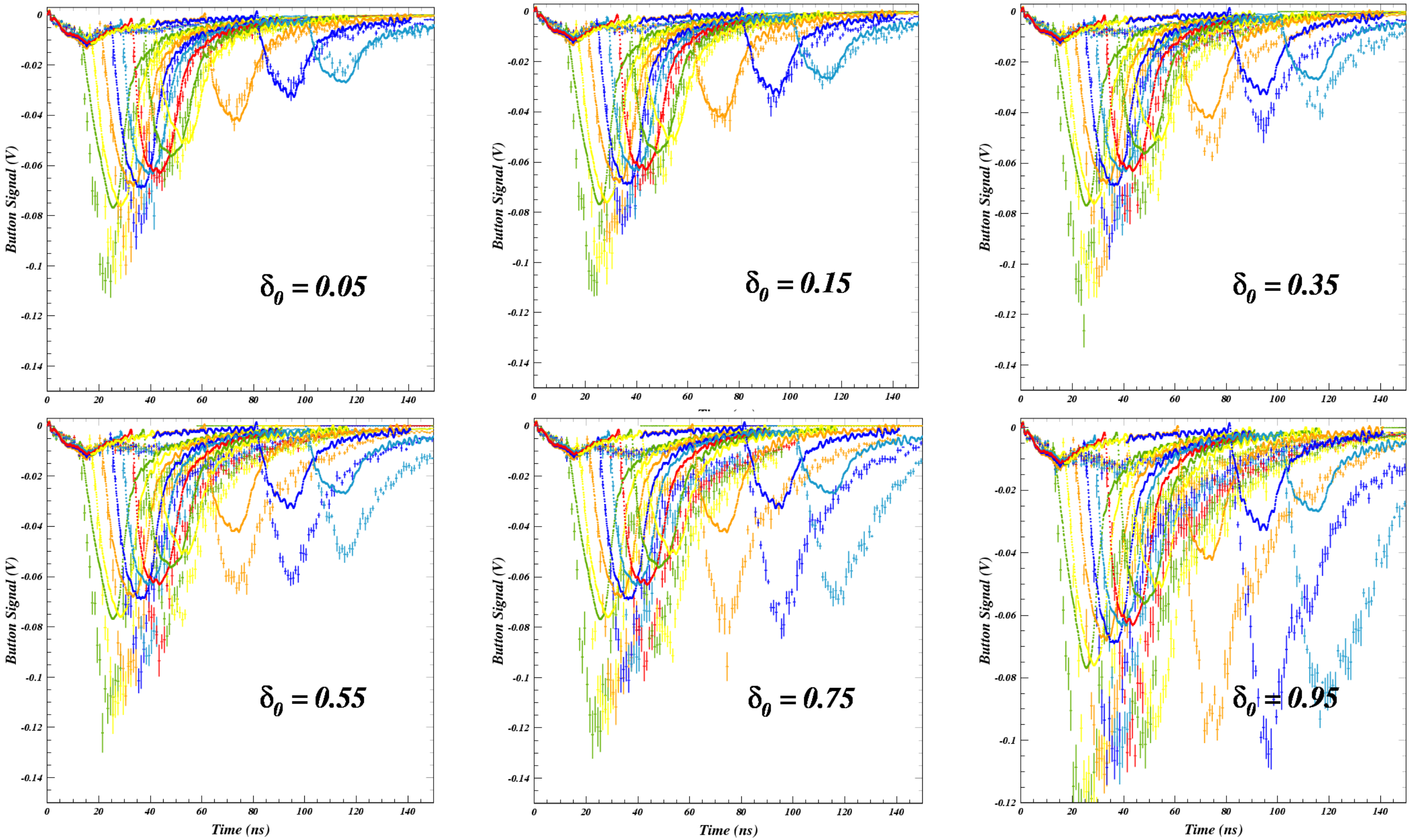
SYNRAD3D provides absolute photon rates as a function of scaled v.c. perimeter in the form of six Lorentzian fit parameters.

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.

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

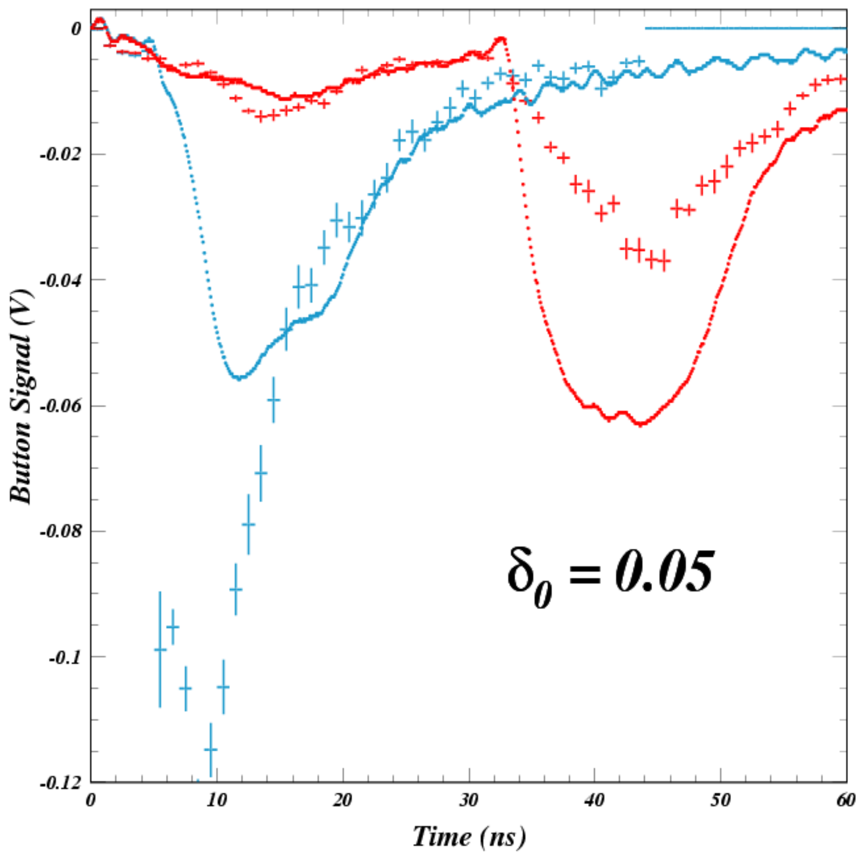
Remarkable agreement again!

Lowering the true secondary yield below 0.7 may help.

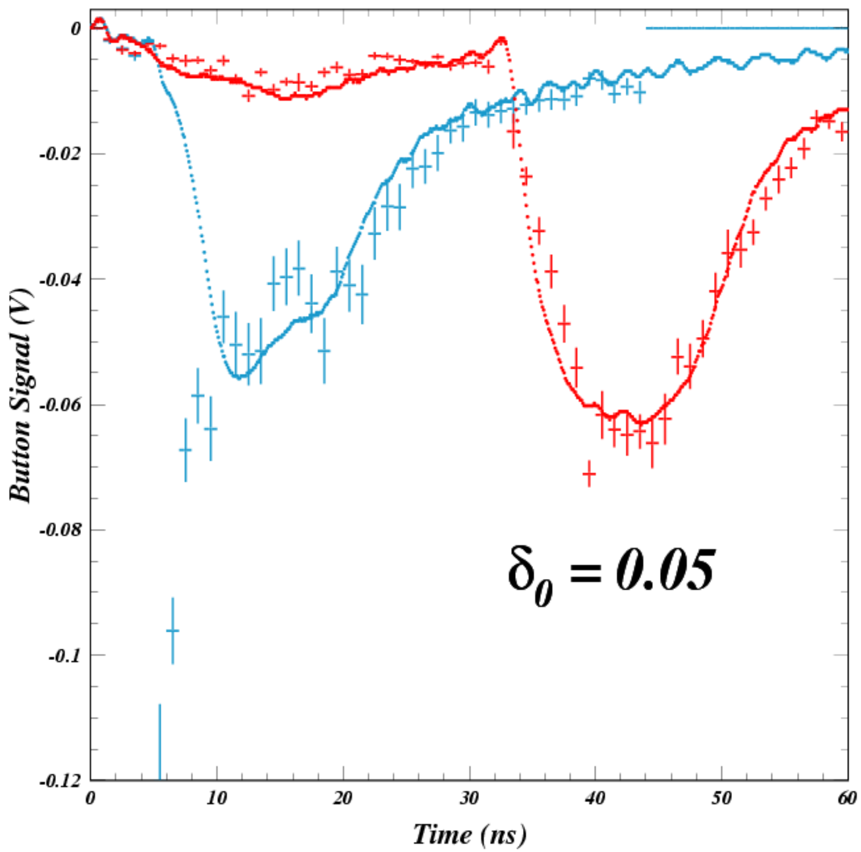
SYNRAD3D reproduces the WIDTH of the SPU signals better than the assumption of uniform azimuthal distribution of reflected photons.
Note that in each of these measurements, the positron beam was displaced 12 mm toward the outside of the vacuum chamber.
I continue to work on the excess early peak for 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.

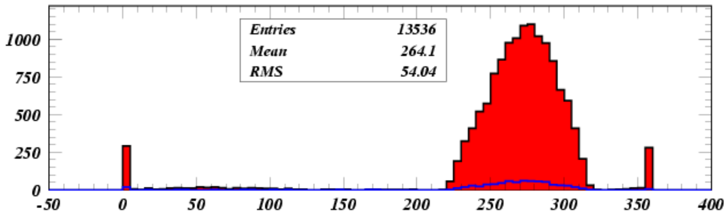
This explains why my weeks-long attempt to fix the 4-ns bunch with the photoelectron energy distribution alone has been so fruitless.

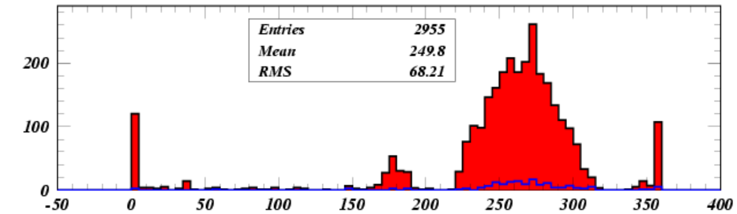
The accuracy of the normalization must be fortuitous, since the assumption of 10% quantum efficiency for SYNRAD3D was arbitrary.

Compare azimuthal origins of SPU signal particles

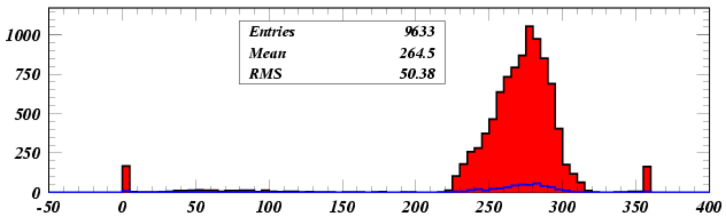
Uniform | *SYNRAD3D*

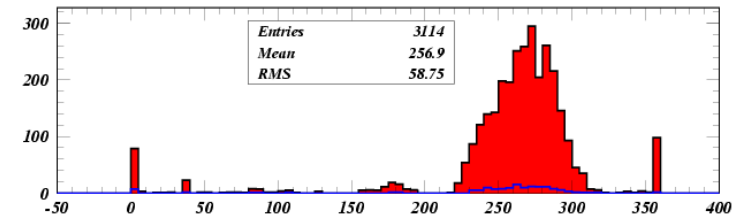
Single Bunch
0 < t < 30 ns



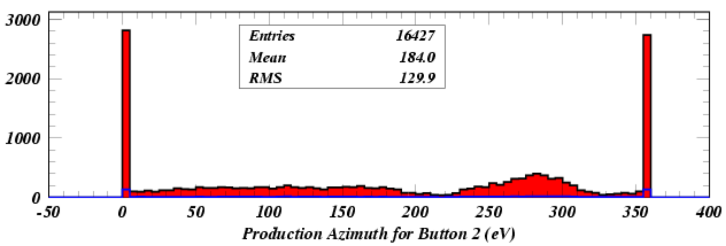


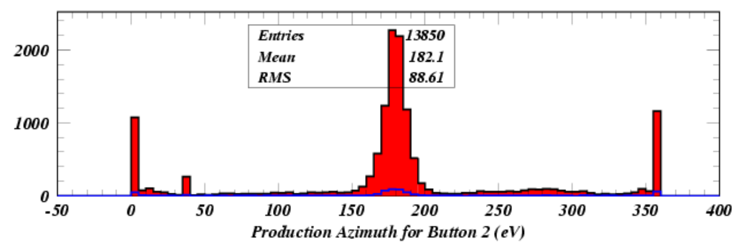
4-ns Bunch
10 < t < 30 ns





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.