Cornell Laboratory for Accelerator-based Sciences and Education (CLASSE)

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Electron Cloud Modeling Results for Time-Resolved Shielded Pickup Measurements at CesrTA

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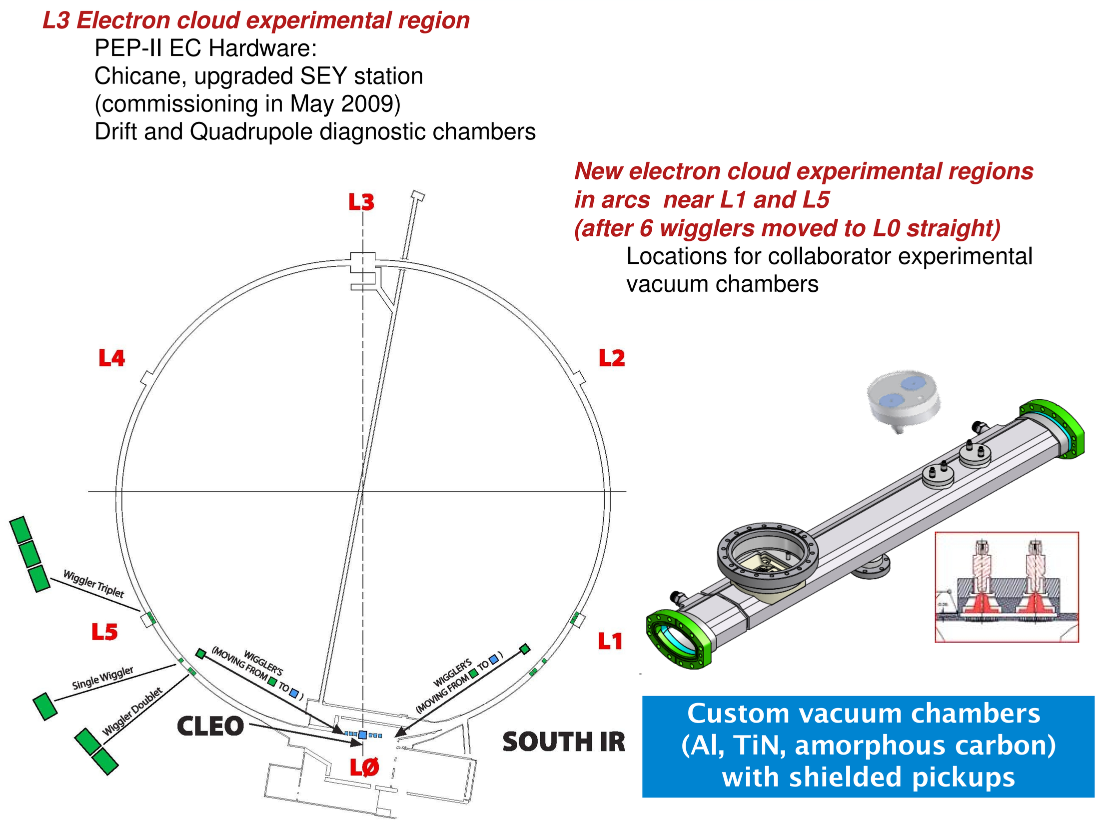
The Cornell Electron Storage Ring Test Accelerator program includes investigations into electron cloud buildup, applying various mitigation techniques in custom vacuum chambers. Among these are two 1.1-m-long sections located symmetrically in the east and west arc regions. These chambers are equipped with pickup detectors shielded against the direct beam-induced signal. Here we report on results from the ECLOUD modeling code which highlight the sensitivity of these measurements to model parameters such as the photoelectron energy distributions, and the secondary elastic yield value.

The CesrTA Reconfiguration July - October 2008



Electron cloud simulation package ECLOUD

- Originated at CERN in the late 1990's
- Widespread application for LHC, KEK, RHIC, ILC ...
- Under active development at Cornell since 2008
- Successful modeling of CESRTA tune shift measurements
- Interactive shielded pickup model implemented in 2010

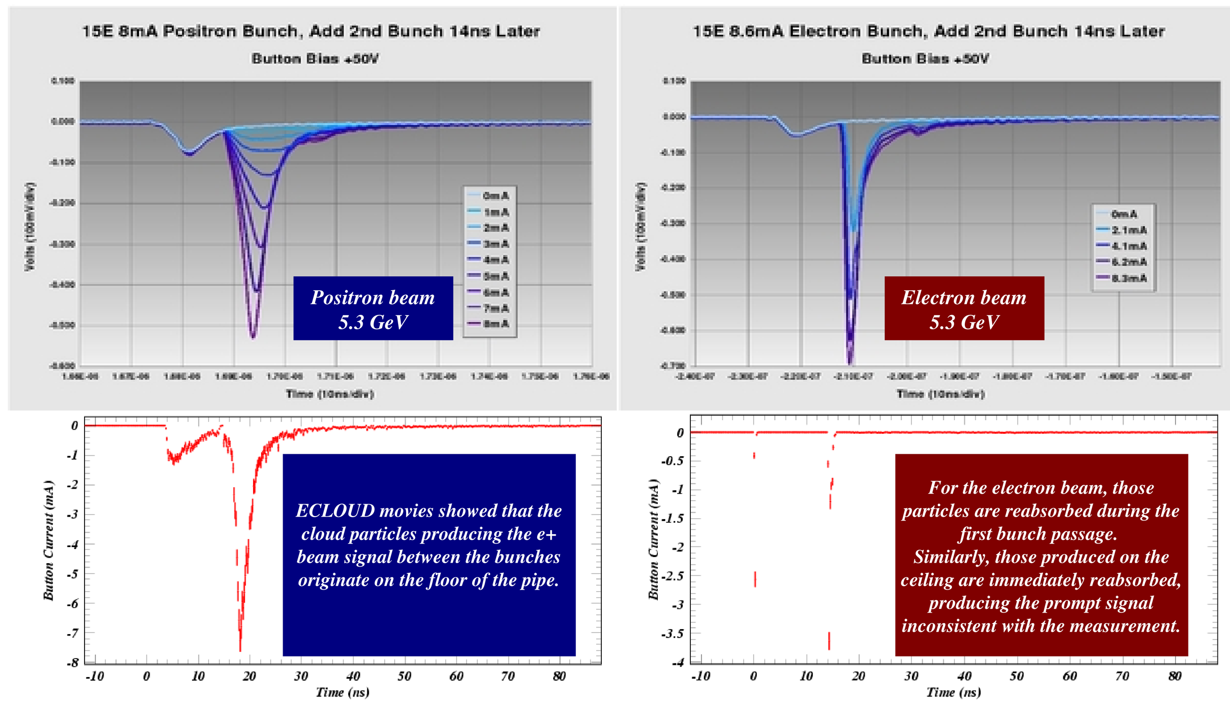
I. Generation of photoelectrons
  A) Production energy, angle
  B) Azimuthal distribution (v.c. reflectivity)

II. Time-sliced cloud dynamics
  A) Cloud space charge force
  B) Beam kick
  C) Magnetic fields

III. Secondary yield model
  A) True secondaries (yields > 1!)
  B) Rediffused secondaries (high energy)
  C) Elastic reflection (dominates at low energy)

IV. Shielded pickup model
  A) Acceptance vs incident angle, energy
  B) Signal charge removed from cloud
  C) Non-signal charge creates secondaries

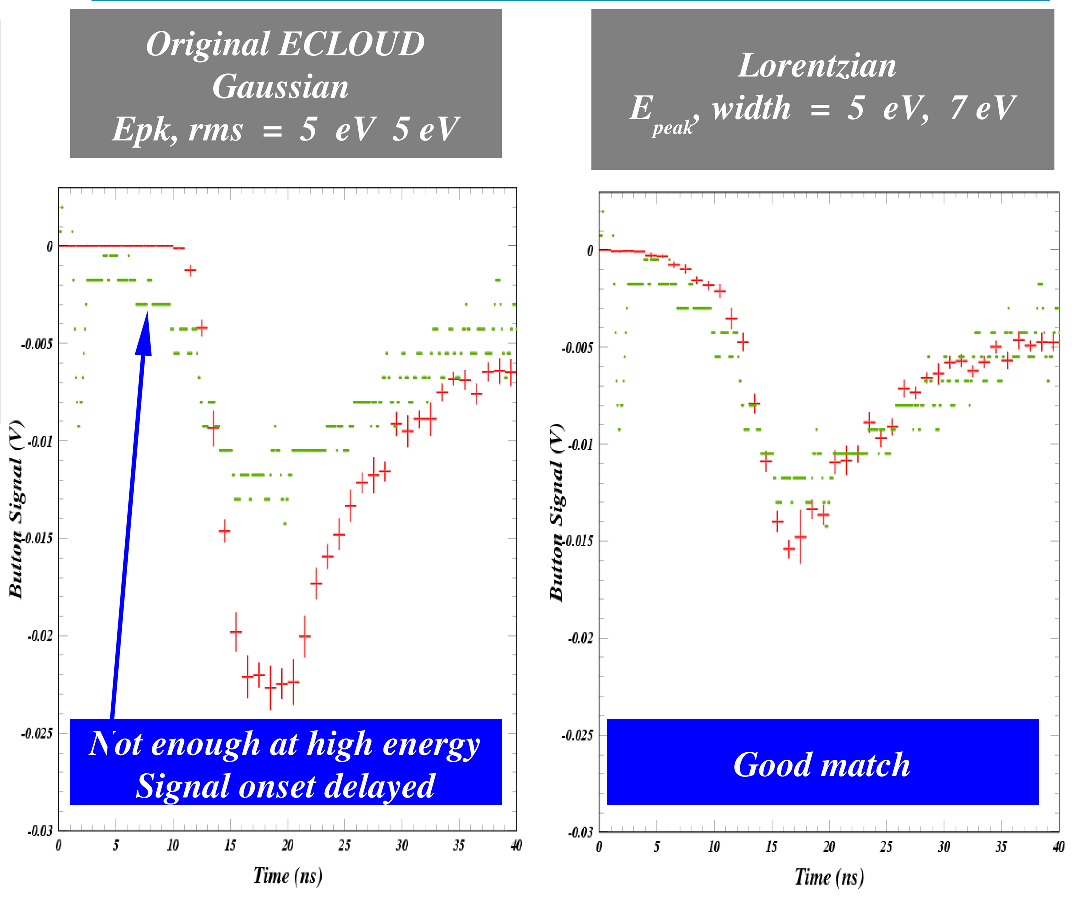
Initial attempt to model the SPU signals with ECLOUD



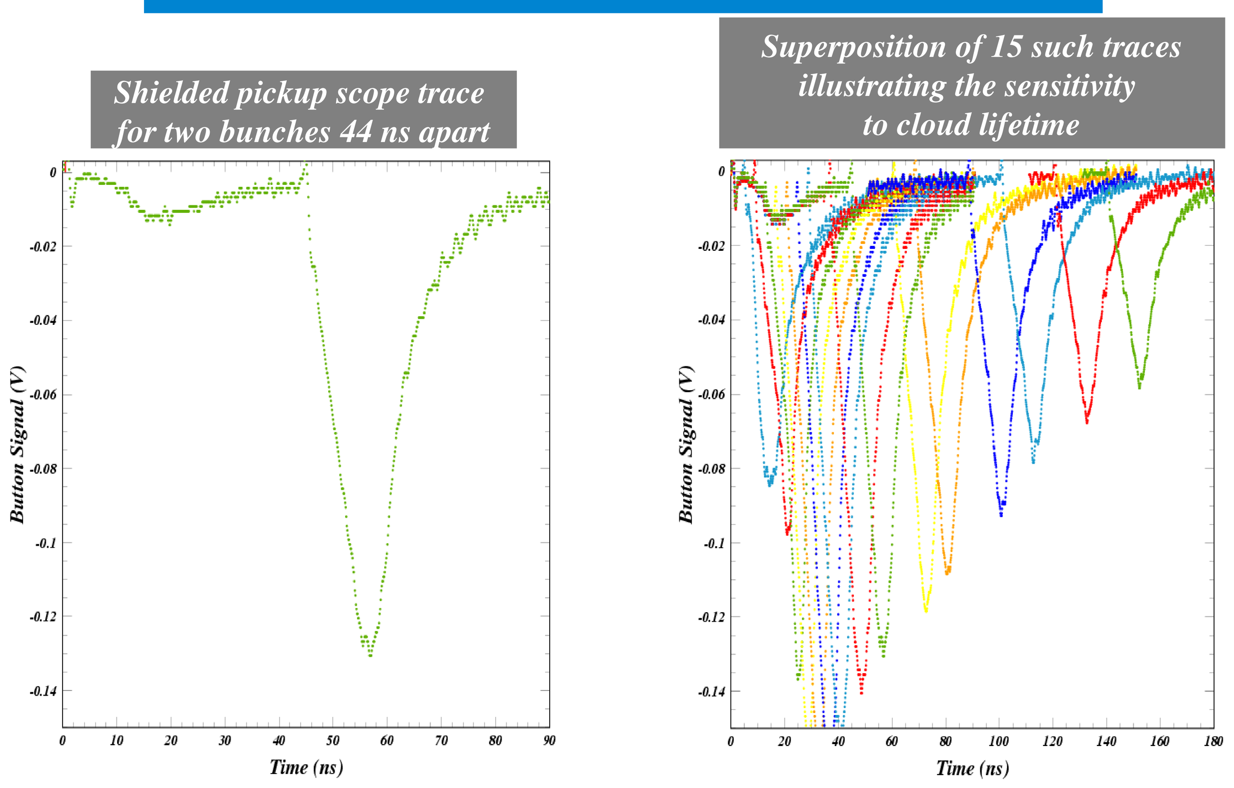
ECLOUD fails to model the signal for an electron beam with high bunch current, because the production energies of the photoelectrons are too low to overcome the repulsion of the beam kick.

Remarkable sensitivity to photoelectron energy

Example: 2.1 GeV positron beam

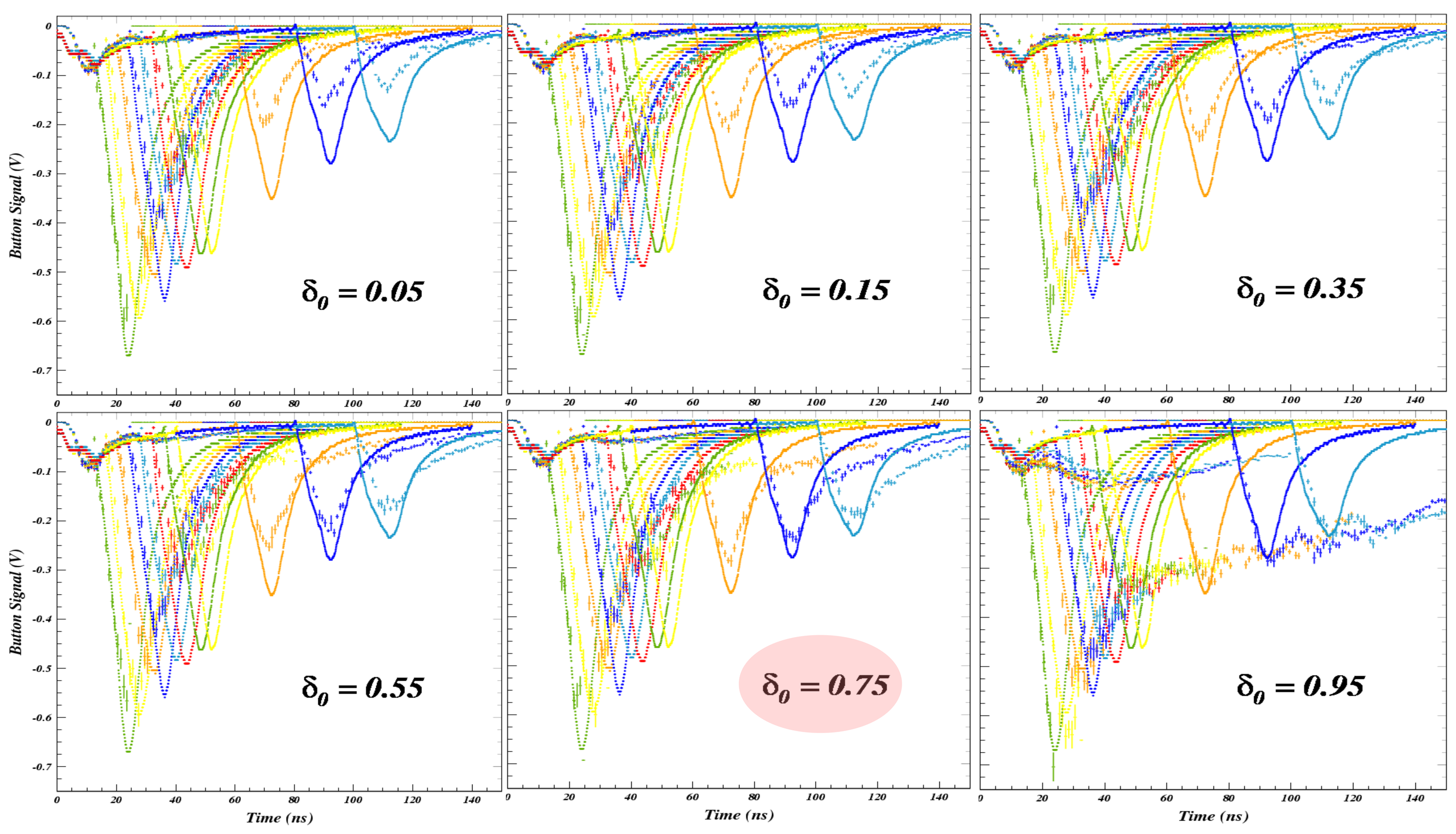


Witnessbunch Method for Estimating Elastic Yield



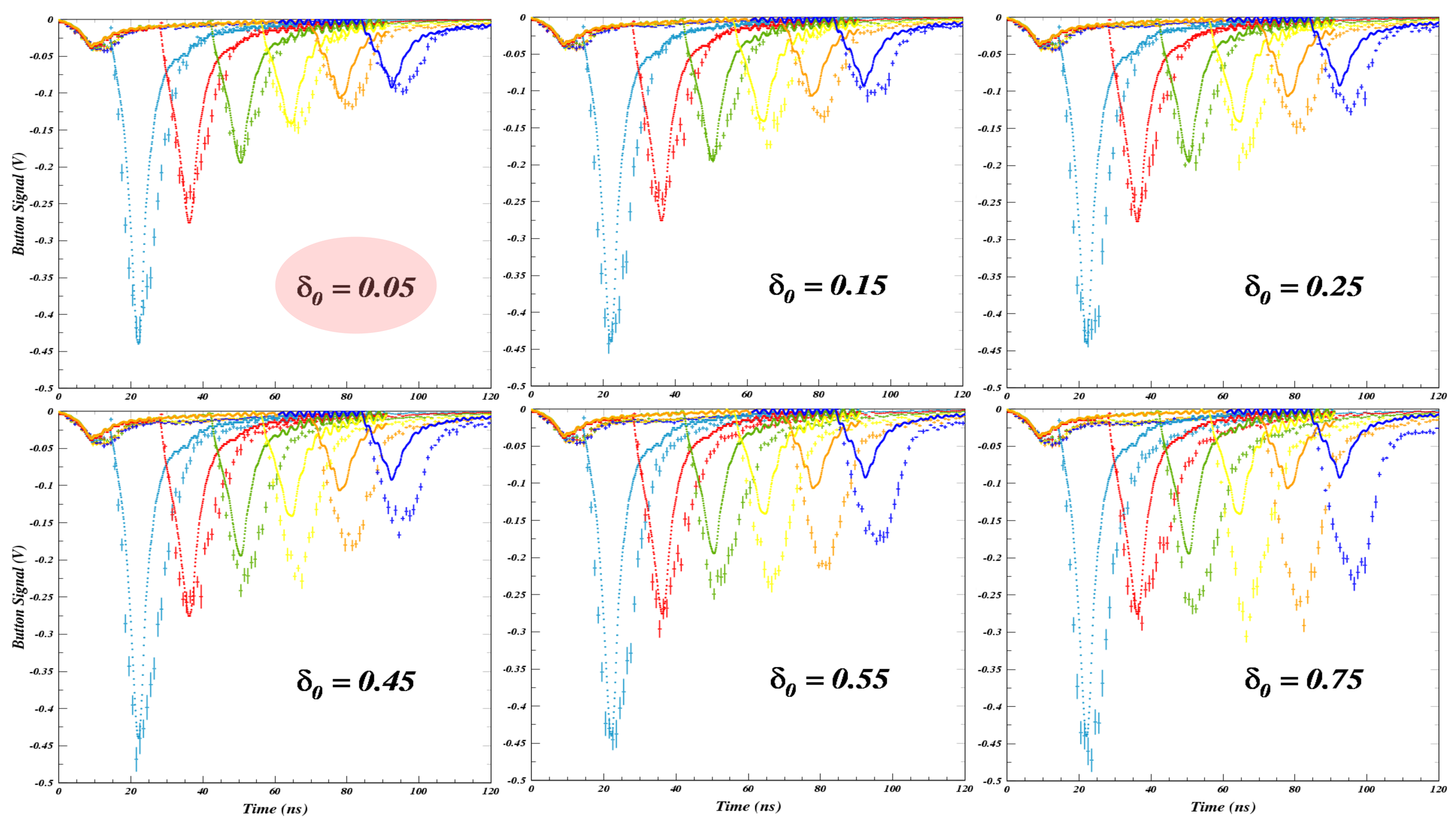
The single bunch signal arises from photoelectrons produced on the bottom of the vacuum chamber. Its shape is thus closely related to the photoelectron kinetic energy distribution modulo the beam kick.
The witness bunch signal includes the single-bunch signal as well as the that produced by cloud particles accelerated into the shielded pickup by the kick from the witness bunch.

Elastic yield estimate for an uncoated Aluminum vacuum chamber



The witness bunch data with bunch spacing in multiples of 4 ns requires accurate modeling during cloud buildup.

Elastic yield estimate for an a-Carbon coated vacuum chamber

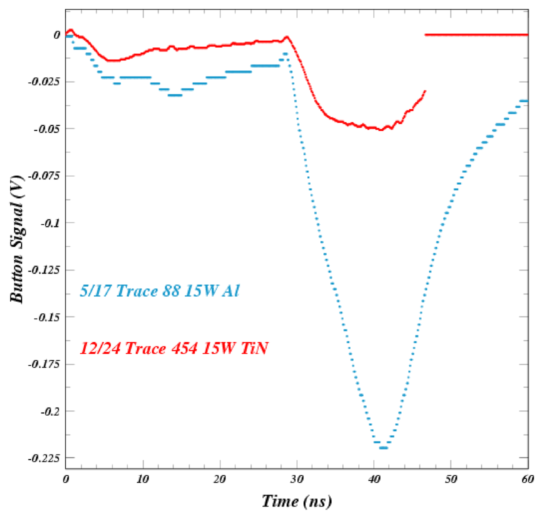


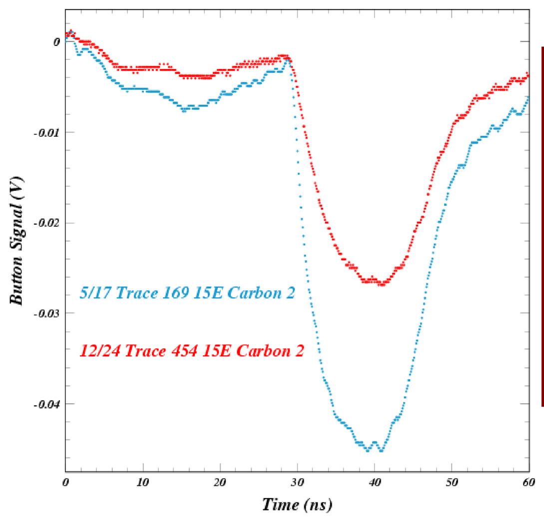
ECLOUD model for the witness bunch data is very sensitive to the elastic yield parameter. Many systematic studies of parameter correlations are underway.

Comparison of vacuum chamber surface mitigation techniques for identical conditions of beam energy, species, bunch current and position in the ring, ie same reflected photon contribution

Positron Beam ----- A challenge for the modeling !! ----- Electron Beam

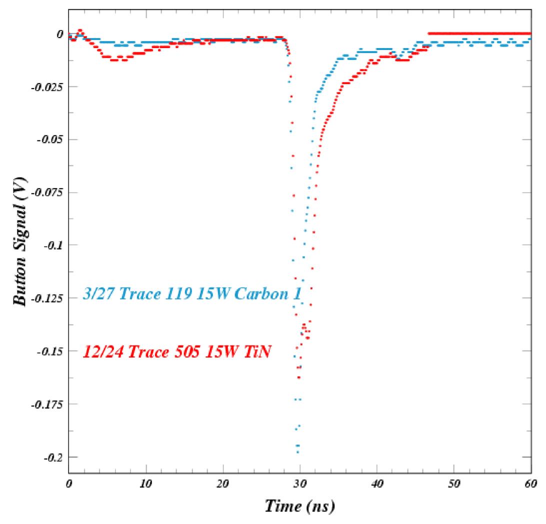
The quantum efficiency for reflected photons and the SEY are both much smaller for TiN than for Al.

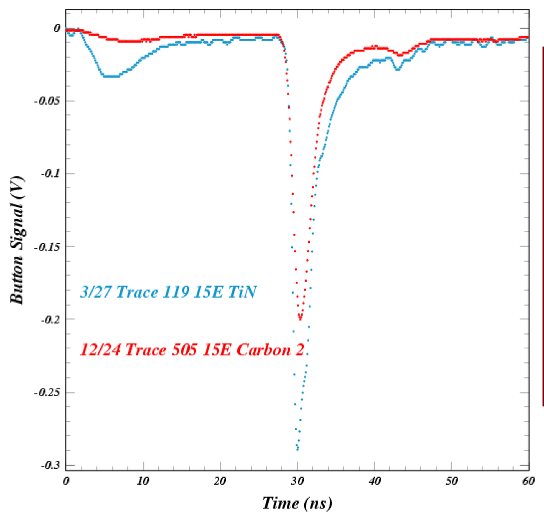




The second carbon-coated chamber shows conditioning effects between 5/17 and 12/24, primarily for the quantum efficiency.

The carbon coating suppresses photoelectron production relative to the TiN coating, but the SEY may be higher.





Conclusions for the second carbon-coated chamber same as for the first carbon-coated vacuum chamber.

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