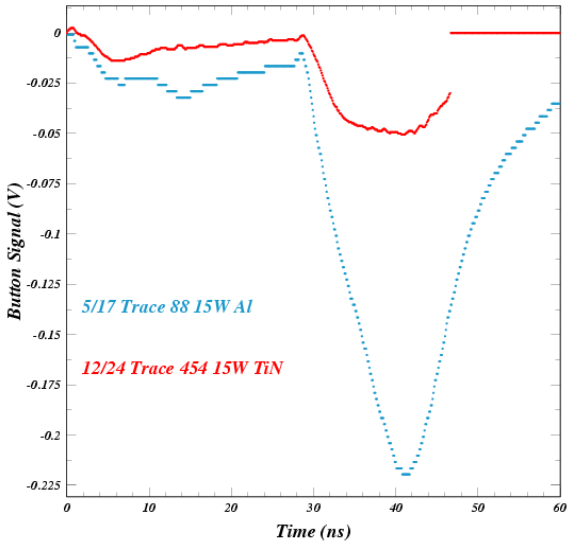
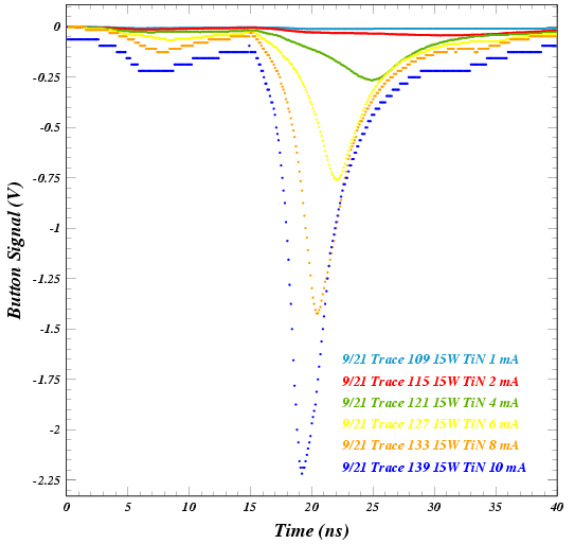
# *Comparison of Electronic Cloud Abatement Techniques Under Same Beam Conditions and Constraining Photoelectron Energy Distributions Using Bunch-Current Scans*

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*Cornell Laboratory for Accelerator-Based Sciences and Education*
*CesrTA Electron Cloud Meeting*
*16 March 2011*

# Witness Bunch Study Data Sets 2010

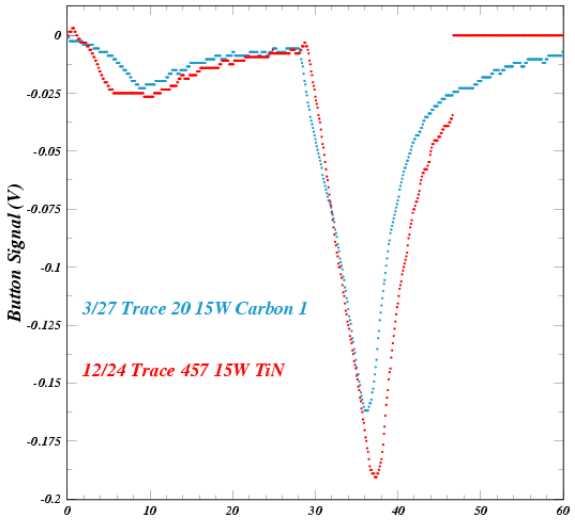
| Date | Species | (GeV) | Bunch Current (mA) | 15E/W | Vacuum Chamber | Spacing | Data Sets | ECLOUD |
|---|---|---|---|---|---|---|---|---|
| 03/27/10 | Positrons | 5.3 | 5 | W | Carbon (1) | 14-84 | 11-74 | 19271-19306 |
| | | | | E | TiN | | 11-74 | 18404-18439 |
| 03/27/10 | Electrons | 5.3 | 5 | W | Carbon (1) | 14-70 | 110-146 | |
| | | | | E | TiN | | 110-146 | |
| 05/09/10 | Positrons | 2.1 | 3 | W | Al | 4-140 | 43-85 | |
| | | | | E | Carbon (2) | | 73-199 | |
| 05/09/10 | Electrons | 2.1 | 3 | W | Al | 4-20 | 91-103 | |
| | | | | E | Carbon (2) | | 217-253 | |
| 05/17/10 | Positrons | 5.3 | 3 | W | Al | 4-100 | 70-109 | 17781-17858 |
| | | | | E | Carbon (2) | | 139-211 | 19793-19870 |
| 05/17/10 | Electrons | 5.3 | 3 | W | Al | 4-100 | 166-199 | |
| | | | | E | Carbon (2) | | 325-391 | |
| 05/19/10 | Electrons | 2.1 | 3 | W | Al | 4-120 | 91-139 | |
| | | | | E | Carbon (2) | | 181-277 | |
| 12/24/10 | Positrons | 5.3 | 3,5 | W | TiN | 14-84 | 436-491 | |
| | | | | E | Carbon (2) | | 436-491 | |
| 12/24/10 | Electrons | 5.3 | 3,5 | W | TiN | 14-84 | 496-551 | |

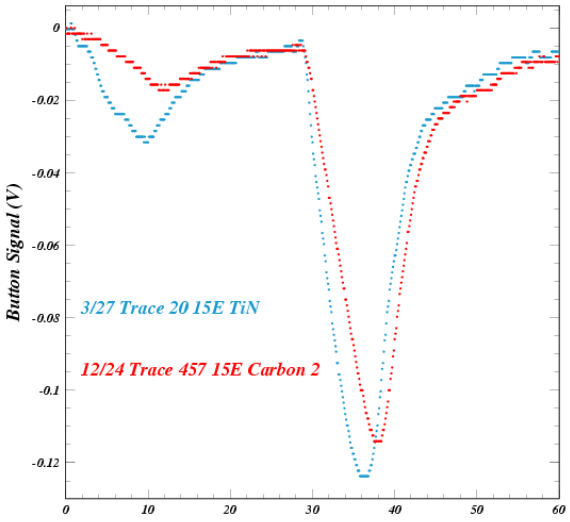
*The December data sets were designed to study the dependence of the witness bunch studies on bunch current. They provide an opportunity to address Mark's request for vacuum chamber comparisons for the same beam energy, species, bunch current and spacing, and reflected photon contribution (15E/W).*

*For TiN and Carbon we can increase the sample of comparisons at 2 GeV in the 2011 data-taking periods. We have not yet submitted the Task Overview sheets for these measurements.*

# Vacuum Chamber Comparison Under Same Beam Conditions
## 5.3 GeV Positron Beam
## Witness bunch with 28-ns spacing

**15W** | **15E**

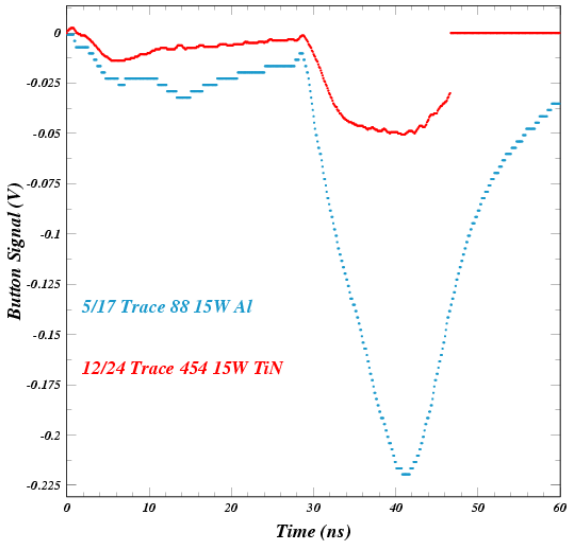


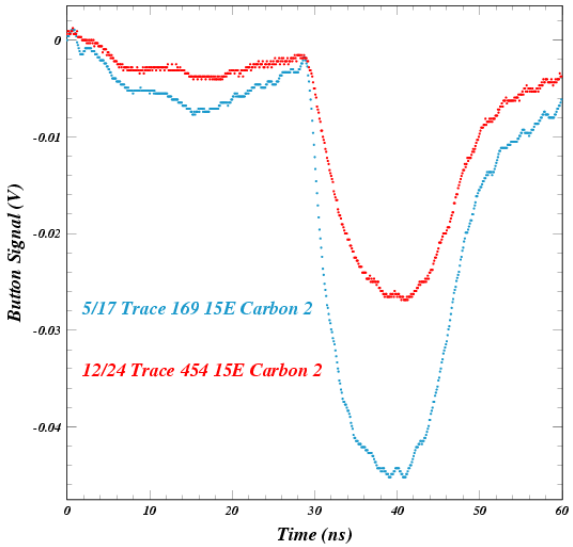




**5 mA/bunch**

*The carbon coating suppresses high-energy photoelectrons compared to the TiN coating.*

*The results for the second carbon-coated chamber corroborate the high-energy photoelectron suppression relative to TiN observed with the first carbon chamber.*




**3 mA/bunch**

*The q.e. for reflected photons and the SEY are both much smaller for TiN compared to Al.*

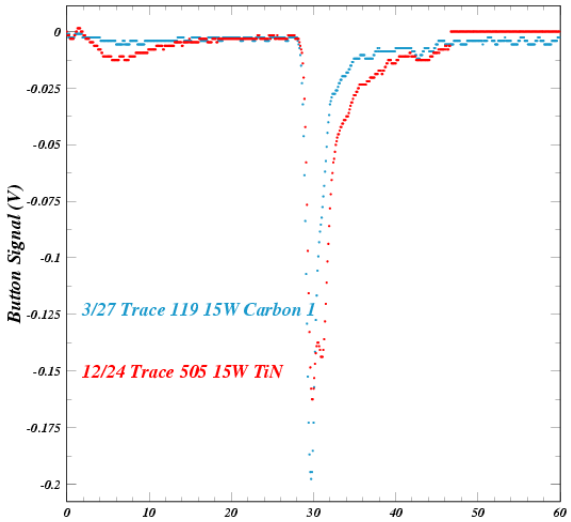
*The 3-mA TiN witness signal is a factor of 5 smaller than for 5 mA/bunch. (see slide 5)*

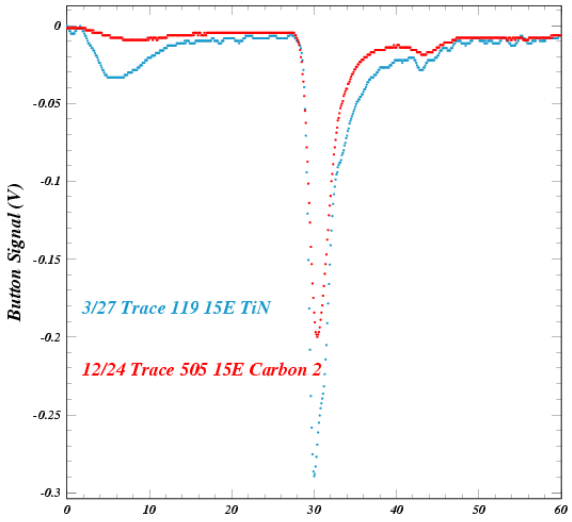
*The second carbon-coated chamber shows conditioning effects between 5/17 and 12/24, primarily for the quantum efficiency.*

# Vacuum Chamber Comparison Under Same Beam Conditions
## 5.3 GeV Electron Beam
## Witness bunch with 28-ns spacing

**15W** | **15E**

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

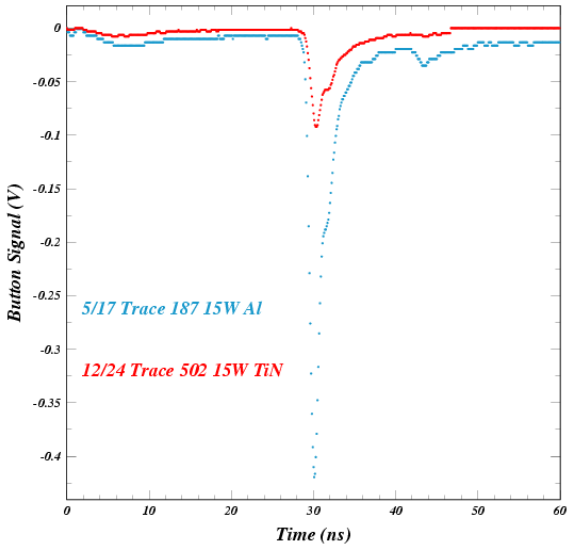


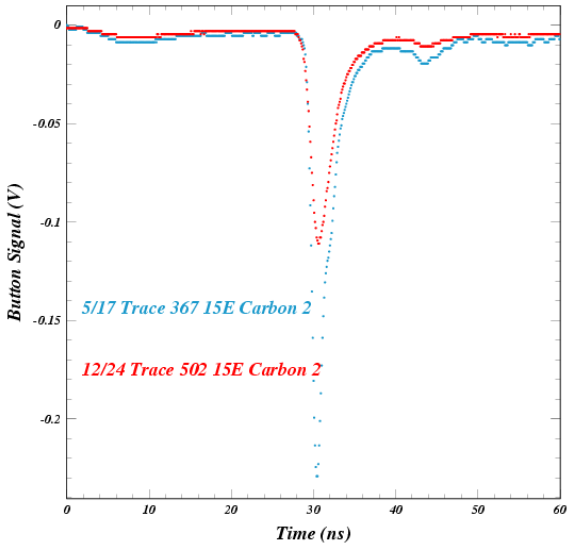




**5 mA/bunch**

Similar conclusions as for the first carbon-coated vacuum chamber.

The measurements with the electron beam confirm the much smaller q.e. for reflected photons and SEY for TiN compared to Al found with the positron beam.



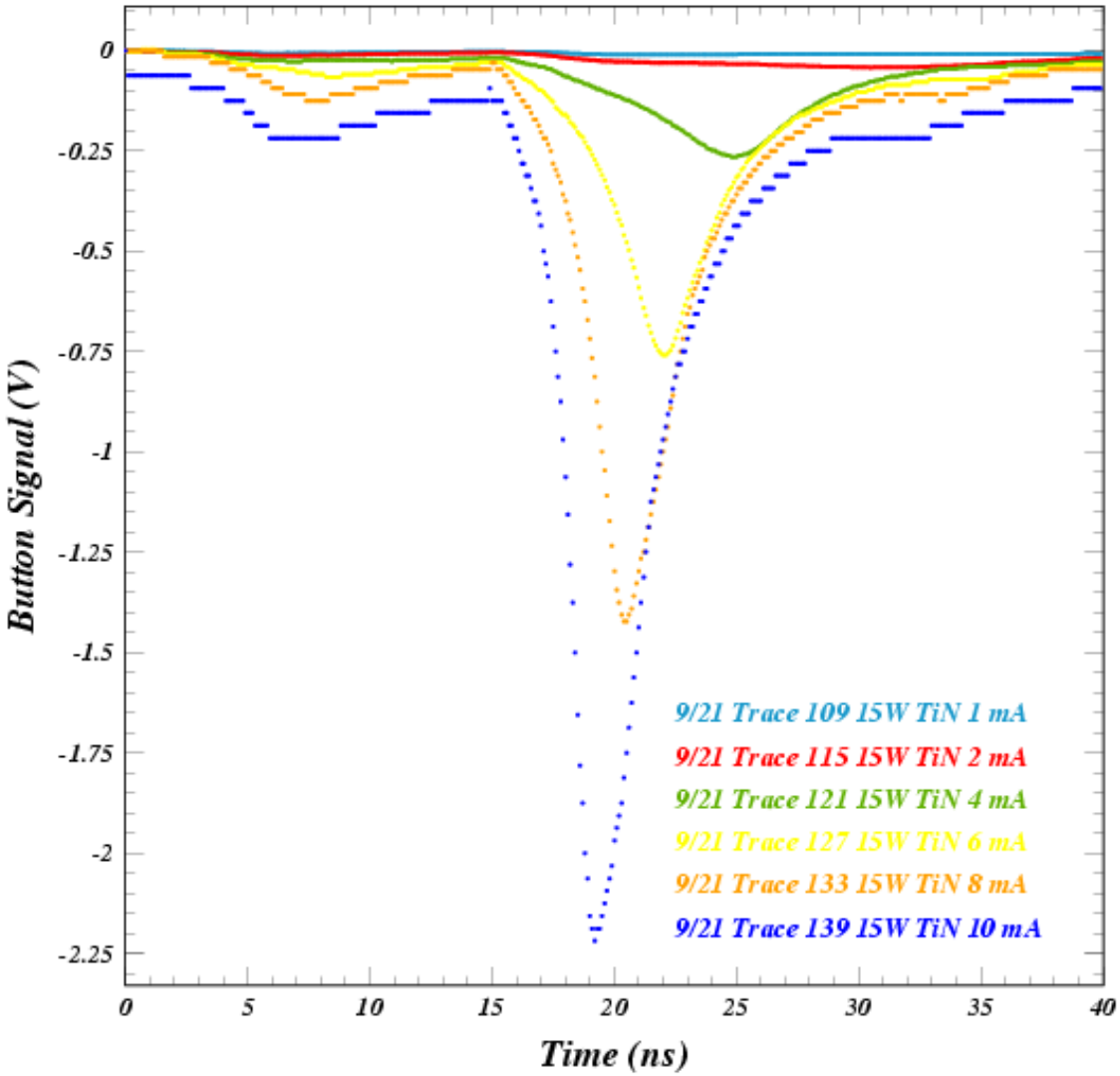

**3 mA/bunch**

The electron beam measurements confirm the processing effect for the second carbon vacuum chamber observed with the positron beam.

# Bunch Current Scans in September (TiN, Carbon 2)
## 5.3 GeV Positron Beam
## Witness bunch with 14-ns spacing

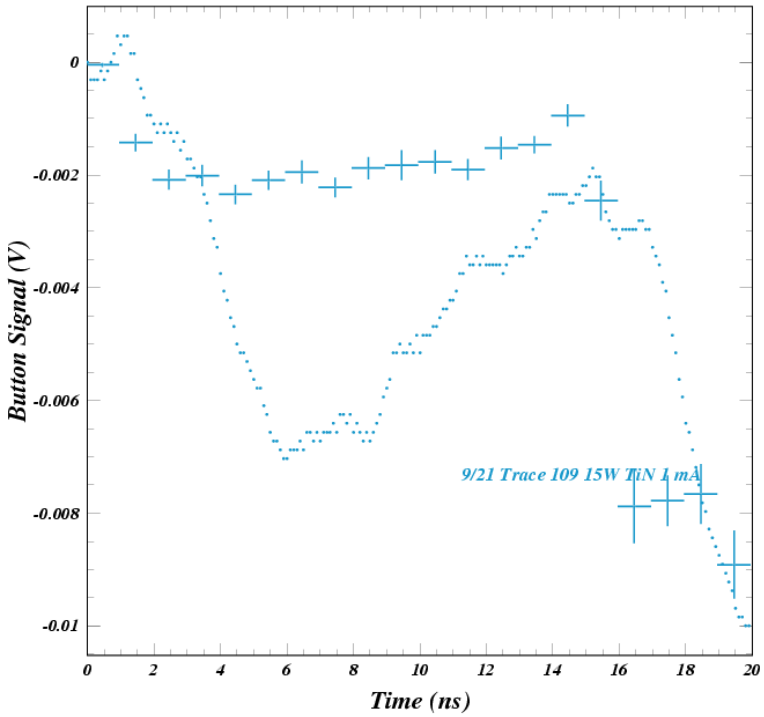
*The bunch current scan of 9/21 confirms the nonlinearity in the TiN signal peak height observed in the vacuum chamber comparisons.*

*Remark from MAP: The AREAS of the signals are linear with bunch current at To better than 15%, as would be expected if primary photoelectrons dominated the signal, in which case the SEY curve will not affect it much. Simulations will tell.*

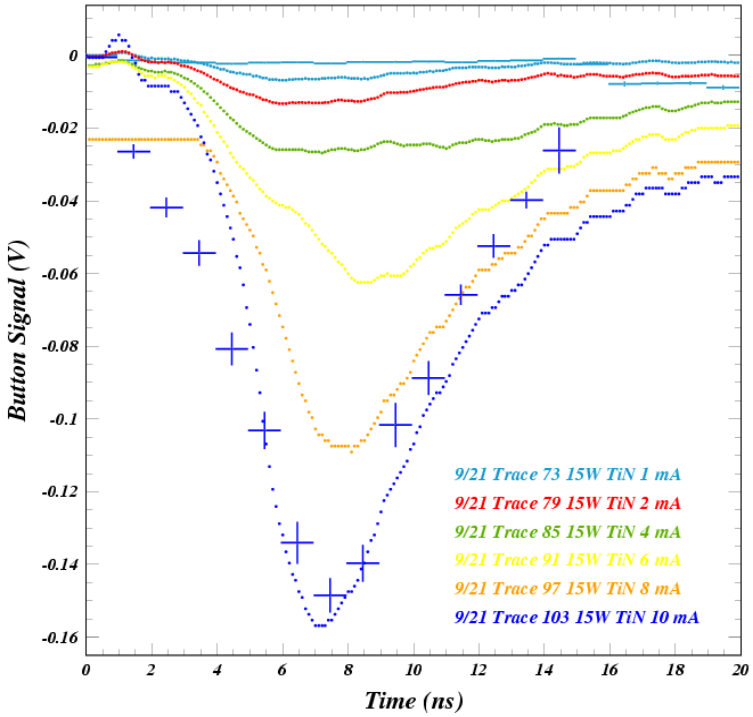


# ECLOUD Simulations for the Bunch Current Scan
## 5.3 GeV Positron Beam
## Witness bunch with 14-ns spacing

**1 mA / bunch**




**1 -10 mA / bunch**

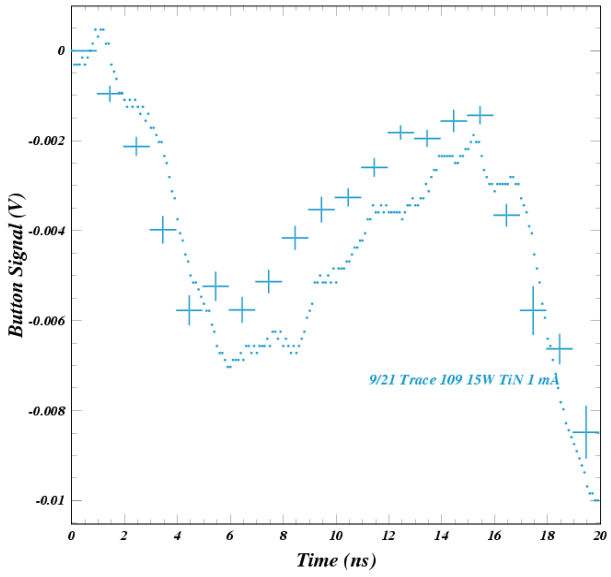


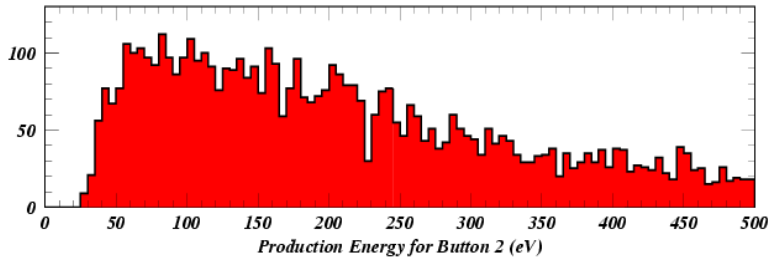

***The bunch current scans provide a much more stringent test of the photoelectron energy distributions used in the simulation.***

***This example shows that the function used for the 3-mA witness bunch studies is a poor match for the 1-mA single-bunch signal, because the beam kick is not strong enough.***

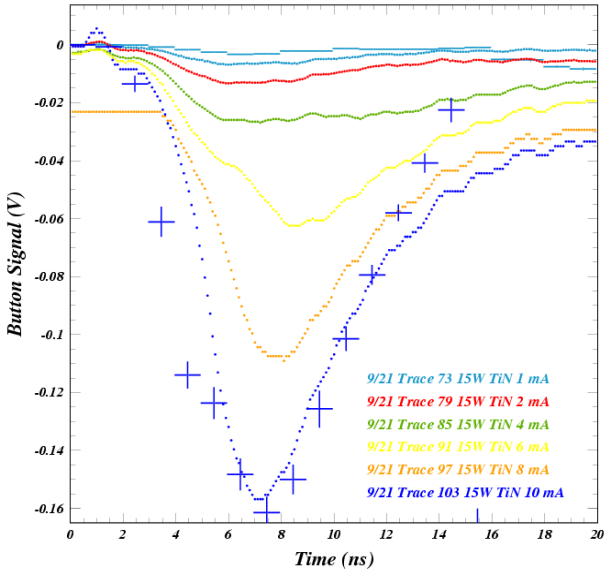
# ECLOUD Simulations for the Bunch Current Scan: Tuning the Photoelectron Energy Distribution

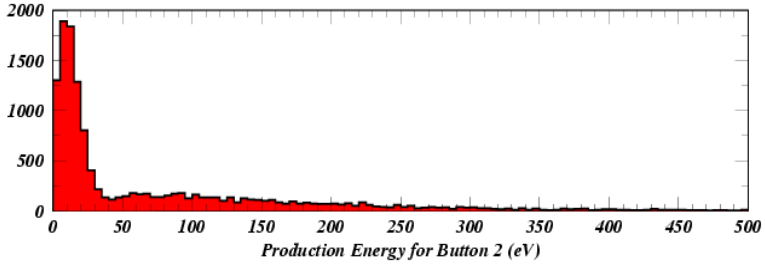
## 1 mA / bunch



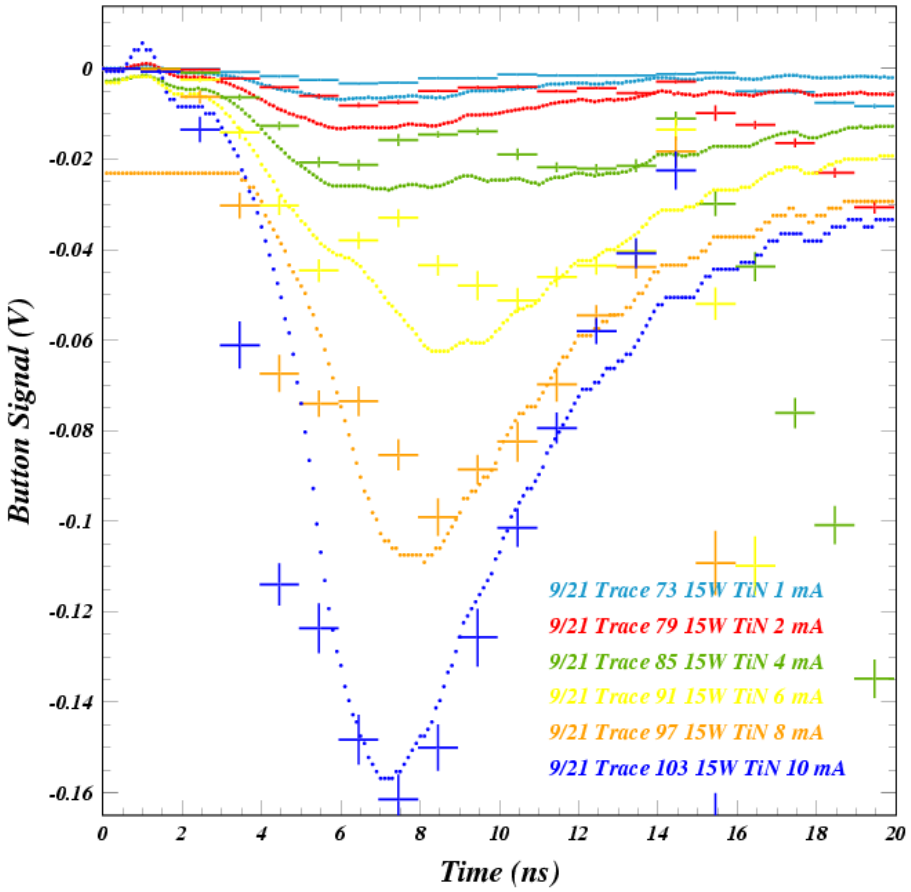

## 1 -10 mA / bunch

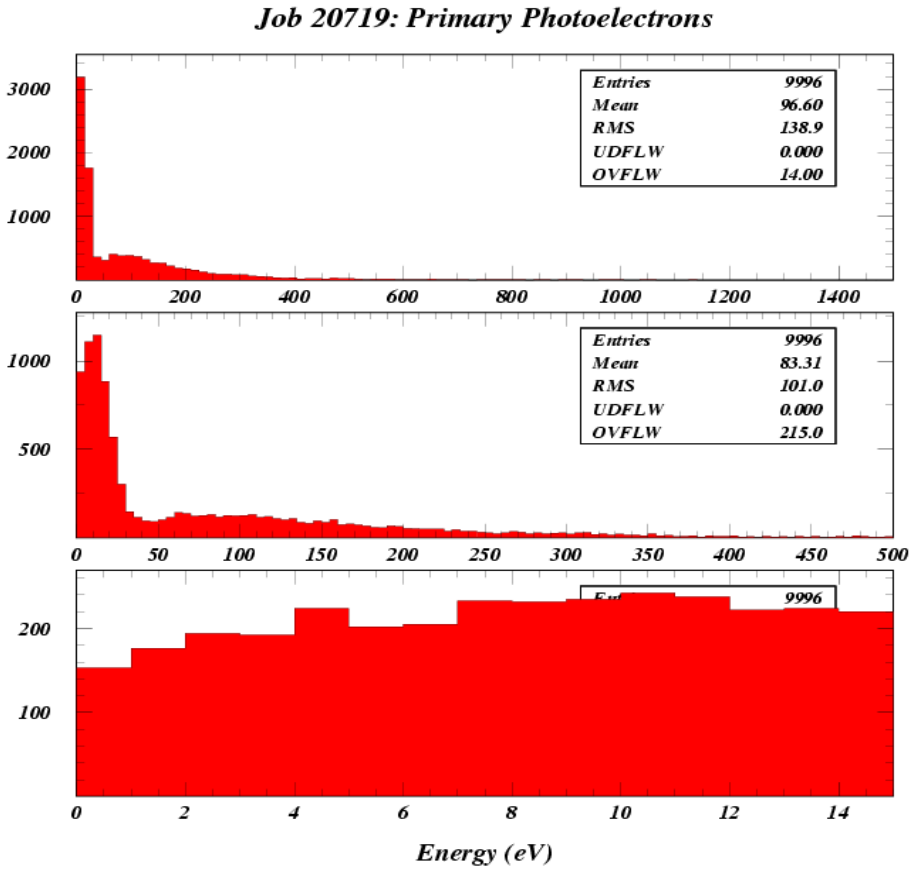



**After MUCH tuning work, the optimal p.e. energy distribution has changed a LOT.**
**These examples show why: the energy acceptance at 1 mA and 10 mA is very different.**
**The 10-mA signal requires a low energy peak to which the 1-mA signal is entirely insensitive.**

# Present Status

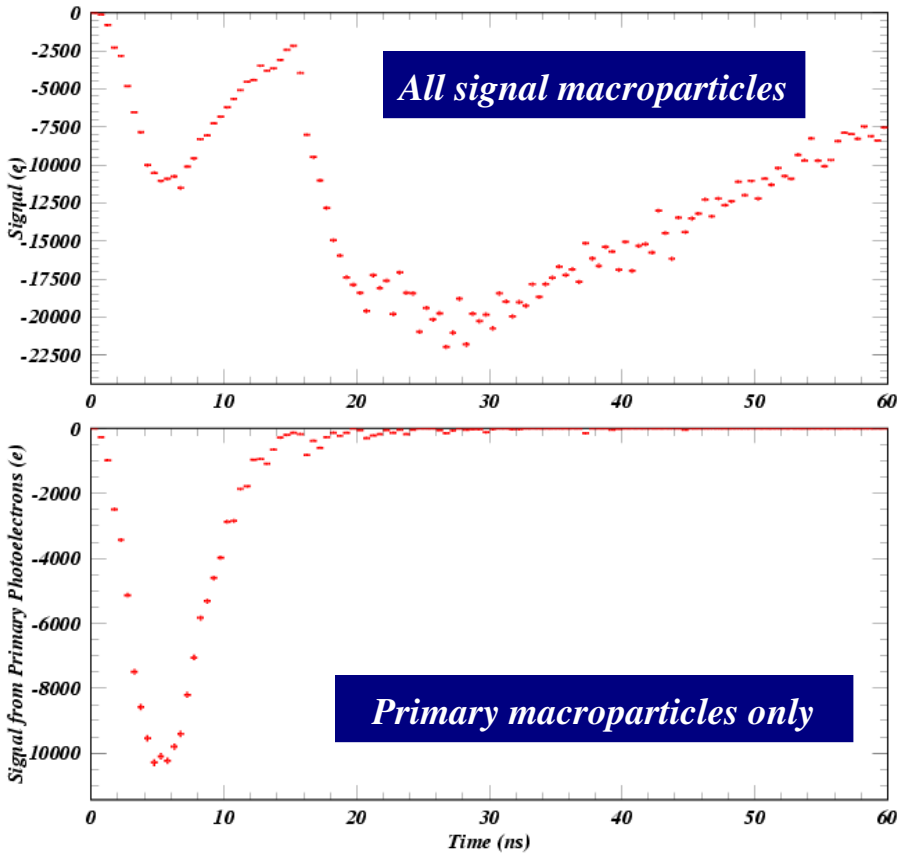


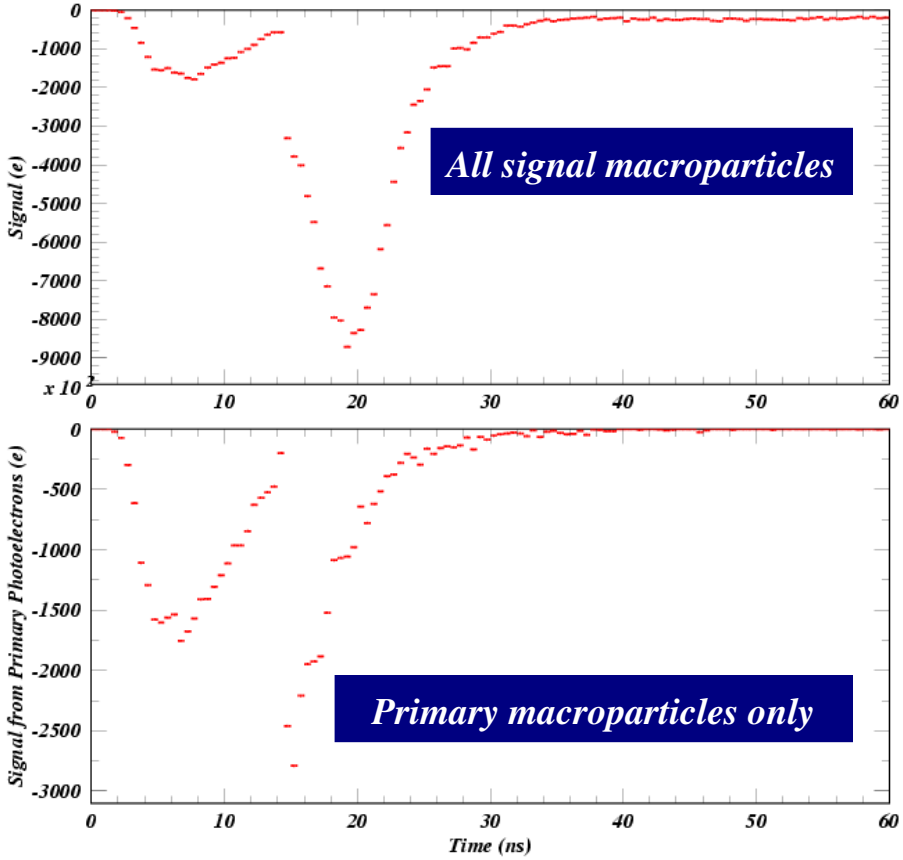

***Still work to do. Dip is wrong.***

# Relative Contribution of Primaries

## 1 mA / bunch




## 10 mA / bunch




**Witness at 14 ns mostly secondaries for 1 and 10-mA bunch currents.**