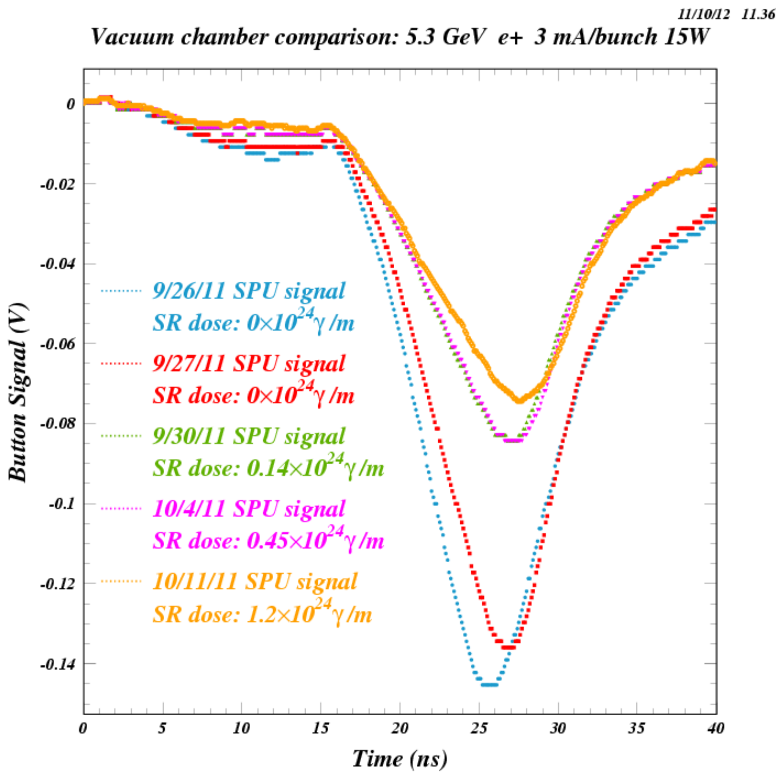
Early Conditioning Information on the Amorphous Carbon Coating from the Shielded Pickup Measurements



Conditioning has not yet finished.

The quantum effiency continues to decrease, particularly for the lower-energy photoelectrons.

NB: RFA data was taken on 9/30 and 10/10.

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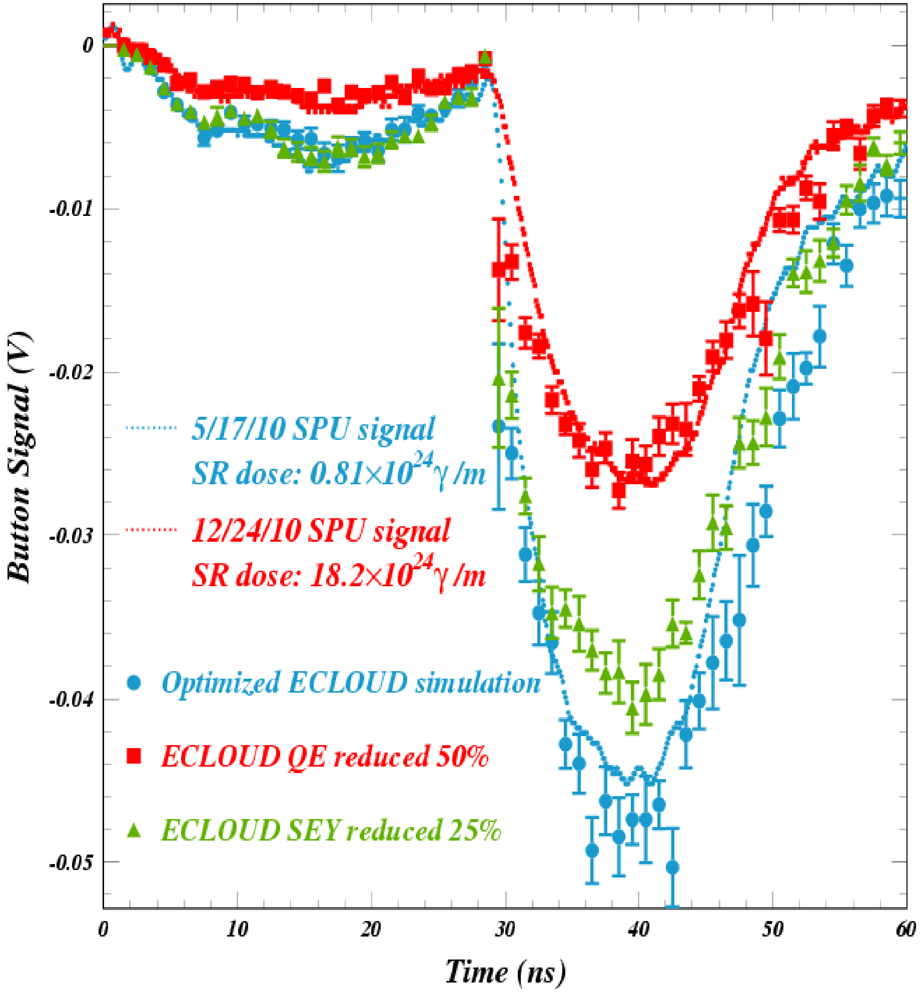
Electron Cloud Meeting
12 October 2011

In situ comparison of vacuum chamber surface mitigation techniques for identical conditions of beam energy, species, bunch current and position in the ring, i.e. same radiation environment

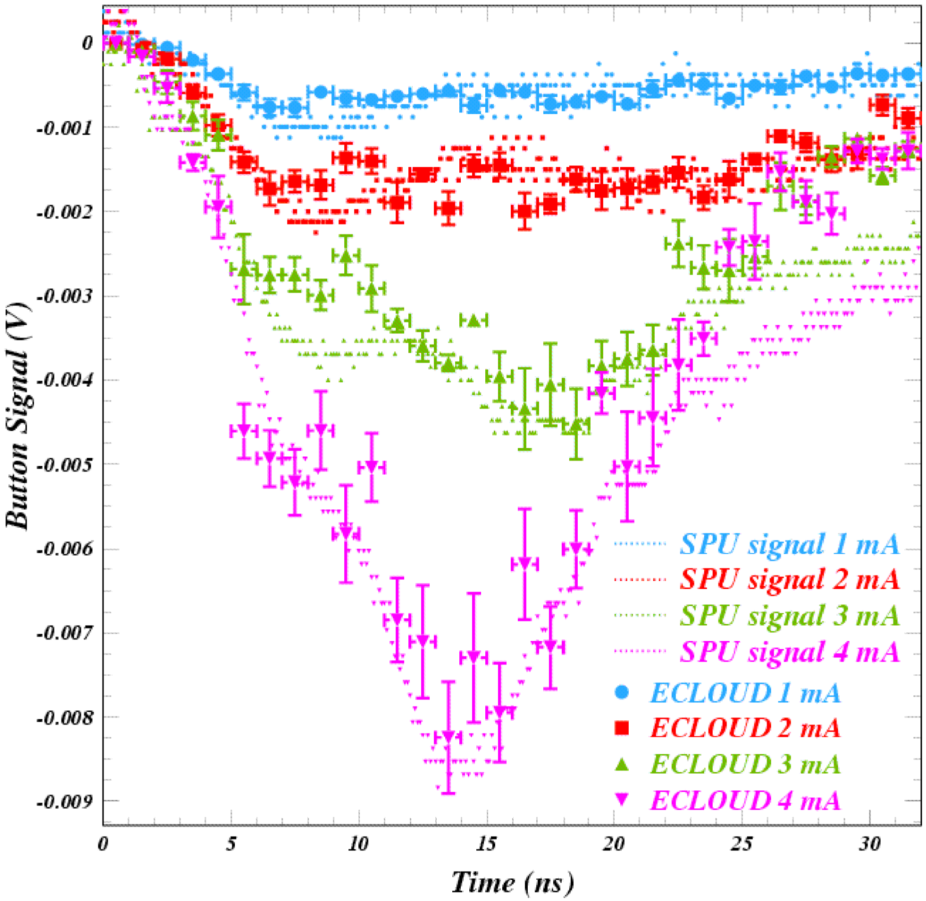


Shielded pickup signals measured in an amorphous-carbon-coated chamber in May (blue dotted line) and December (red dotted line) of 2010 for two bunches carrying 4.8×10^{10} 5.3 GeV positrons 28 ns apart. The synchrotron radiation dose increased by a factor of twenty during this time interval. The ECLOUD model optimized for the May data is shown as blue circles, the error bars showing the model statistical uncertainties.

The leading bunch arises from photoelectrons produced on the bottom of the vacuum chamber. Careful tuning of the energy distribution and quantum efficiency for photoelectrons produced by reflected photons is required to reproduce its size and shape. The signal from the witness bunch includes additionally the contribution from secondary cloud electrons accelerated into the SPU detector by the witness bunch kick and is therefore crucially dependent on the secondary yield and production kinematics. Since the conditioning affects both signals similarly, we can conclude that the conditioning change is in the quantum efficiency rather than in the secondary yield.

The December measurement is reproduced by a 50% decrease in the modeled quantum efficiency for photoelectron production. A reduction in the secondary yield of 25% is inconsistent with the observed effect, since the leading bunch signal is unchanged.

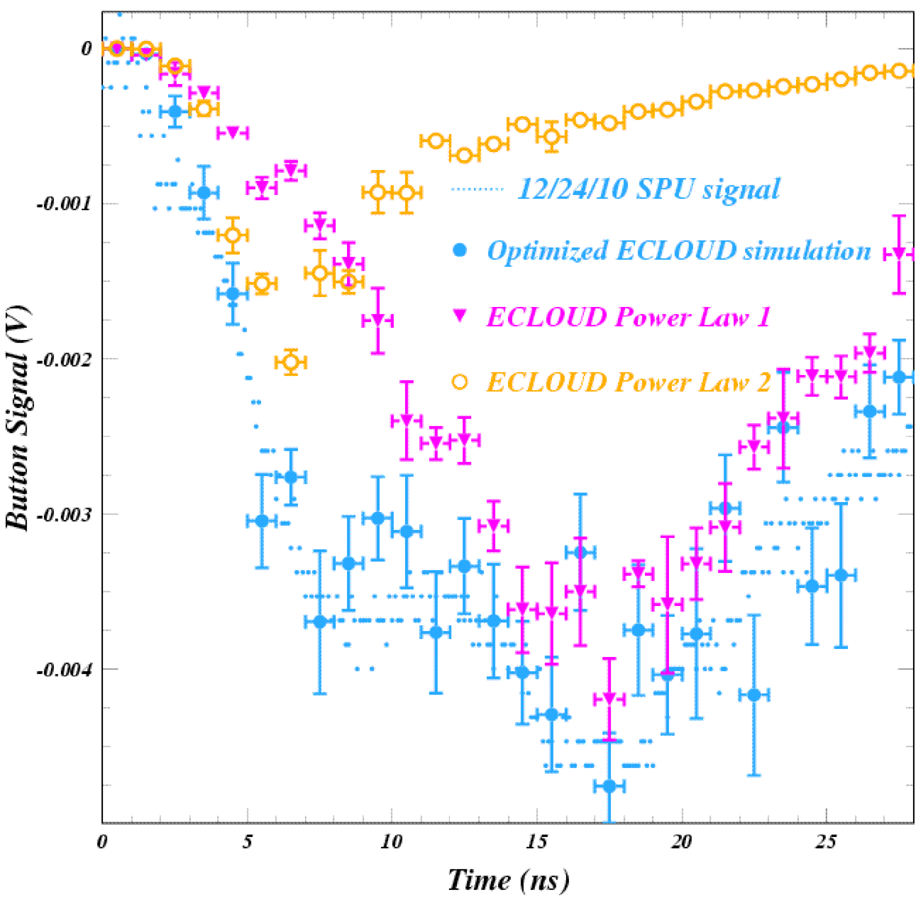
Bunch Current Scan Analysis



Disentangling the Photoelectron Production Kinetic Energy Distribution from the Beam Kick Strengths

The early SPU signal from the leading bunch for a positron beam is largely due to photoelectrons produced on the bottom of the vacuum chamber. This is the closest production point where the beam kick attracts the photoelectrons toward the SPU. Thus the size and shape of the leading bunch signal is determined by the reflected photon rate, azimuthal distribution, the quantum efficiency for producing photoelectrons, and the kinetic energy distribution of the photoelectrons. In particular, the arrival time distribution determines the shape. By modeling the shape for different strengths of beam kick, we can determine the photoelectron energy distribution. An example of such an analysis is shown on the left. Note that the signal begins just a few nanoseconds after bunch passage even for weak beam kicks, indicating that high-energy photoelectrons were produced (hundreds of eV).

Example: 3 mA/bunch 5.3 GeV e+ 15E a-Carbon



Two Power-Law Contributions

$$F(E) = E^{P1} / (1 + E/E_0)^{P2}$$

$$E_0 = E_{peak} (P_2 - P_1)/P_1$$

This level of modeling accuracy was achieved with the photoelectron energy distribution shown below, using a sum of two power law distributions.

$$E_{peak} = 80\ eV \quad P_1 = 4 \quad P_2 = 8.4$$

The high-energy component (22%) has a peak energy of 80 eV and an asymptotic power of 4.4. Its contribution to the signal is shown as yellow circles in the lower left plot.

$$E_{peak} = 4\ eV \quad P_1 = 4 \quad P_2 = 6$$

The low-energy component (78%) has a peak energy of 4 eV and an asymptotic power of 2. It's contribution to the signal is shown as pink triangles.

Photoelectron Energy Distribution
5.3 GeV e+ 15E a-Carbon