Status of ECLoud Simulations for the Shielded Button Measurements

I. Improvement in the simulation of e+ beam measurements
II. Properties of the macroparticles producing the button signal
III. Startling movies
IV. More information on the discrepancy for the e-beam measurements
V. Simulations for the witness bunch measurements

All material for this talk, including full sets of the analysis plots, may be obtained at www.lepp.cornell.edu/~critten/cesrta/ecloud/14apr10

-- 16 April: Added slide 13 showing effect of increasing the primary photoelectron energy from 5 eV to 40 eV --

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Electron Cloud Meeting

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The ratio of the second peak in the button 2 signal to the first was only about a factor of four.
The ratio of the two peaks is much better reproduced when the 12 mm offset of the beam axis is included.
The ratio of the two peaks is sensitive to the azimuthal distribution of primaries. The first bunch gives no button signal if no primaries are produced in the region of the shielded button. A value for the reflectivity of 20% gives a good match to the measured ratio.
Post-processing of 11k cloud macroparticles entering the detector. Averages over 0.11 ns are shown here.

Primaries are generated with the same charge value of about 65k e. The button signal is a convolution of macroparticle number and charge.

The bunch charge of 1.28e11 e (8 mA) is sufficient to generate kinetic energies of 6 keV during passage of the second bunch.
Unexpected result for the cloud snapshot at the arrival time of the second bunch.

A vertical stripe moving horizontally reaches the central button just as the second bunch arrives, as shown in the following movie.

The movie has 10 snapshots during the bunch passage and 40 snapshots between bunch passages.
Today I will be brief on the simulation for the electron beam, because we don't yet understand it. However, I will show some important differences from the positron beam, and can quantitatively exclude one speculative source of the discrepancy in the time structure (mp transit time in the detector).
The reflected-photon contribution accounts for ALL of the signal in the case of an electron beam.
**ECLOUD input parameters**

--- Modified to give equal reflected contributions for e+ and e- ---

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bunch population</td>
<td>( N_b ) 1.28e11 (8 mA)</td>
</tr>
<tr>
<td>Number of bunches</td>
<td>( N_b ) 2</td>
</tr>
<tr>
<td>Bunch gap</td>
<td>( N_{gap} ) n.a.</td>
</tr>
<tr>
<td>Bunch spacing</td>
<td>( L_{sep}[m] ) 4.2 (14 ns)</td>
</tr>
<tr>
<td>Bunch length</td>
<td>( \sigma_z[mm] ) e+: 18.8 e-: 18.8</td>
</tr>
<tr>
<td>Bunch horizontal size</td>
<td>( \sigma_x[mm] ) e+: 0.222 e-: 0.205</td>
</tr>
<tr>
<td>Bunch vertical size</td>
<td>( \sigma_y[mm] ) e+: 0.0185 e-: 0.0191</td>
</tr>
<tr>
<td>Photoelectron Yield</td>
<td>( \gamma ) 0.1</td>
</tr>
<tr>
<td>Photon rate ((\gamma / m / e))</td>
<td>( dn_{\gamma}/ds ) e+: 1.00 e-: 0.3</td>
</tr>
<tr>
<td>Antechamber protection</td>
<td>( \eta ) n.a.</td>
</tr>
<tr>
<td>Photon Reflectivity</td>
<td>( R ) e+: 20% e-: 67%</td>
</tr>
<tr>
<td>Max. Secondary Emission Yeld</td>
<td>( \delta_{max} ) 1.0 (0.9 t.s. &amp; 0.1 rediff)</td>
</tr>
<tr>
<td>Energy at Max. SEY</td>
<td>( E_m[eV] ) 400</td>
</tr>
<tr>
<td>SEY model</td>
<td>Cimino-Collins ((\delta(0)=0.5))</td>
</tr>
</tbody>
</table>

**SEY estimated for processed TiN.**

*Numerical parameters large: 1000 steps, 101 kicks, 250k m.p. per bunch, 4000 steps between bunches.*
The simulated signal is prompt, and very brief, unlike the measurement. In particular, where is the signal between bunches coming from the cloud self-repulsion?
Does the cloud kinetic energy distribution contribute to an arrival time spread at the button?

Postprocessing for 17.4k cloud particles.

The 50 V button bias dominates the contribution to the transit time.

Despite overestimating the distance to the button, the transit time spread cannot account for the signal time structure.
The success of the simulation for a positron beam opens up a broad range of inquiry. Will we be able to derive an estimate for $\delta(E=0)$ from such cloud lifetime measurements?
The energy distribution for primary p.e. is Gaussian with the negative tail omitted.

For higher-energy photoelectrons, the ratio of the two peaks is more consistent with the measurements for the electron beam and less similar for the positron beam.

The discrepancy between bunch passages for the electron beam remains to be resolved.

**NB:** The energy of an electron which travels 5 cm in 14 ns is 36 eV.

\[
E_{\text{peak}} = 5 \text{ eV} \quad \sigma_E = 5 \text{ eV} \\
\text{(ECLOUD default)}
\]

\[
E_{\text{peak}} = 40 \text{ eV} \quad \sigma_E = 20 \text{ eV}
\]