The Cornell Electron Storage Ring Test Accelerator (CESRTA) program includes investigations into the mitigation of electron cloud buildup using a variety of techniques in custom vacuum chambers. The CESR ring accommodates two such chambers equipped with BPM-style pickup detectors shielded against the direct beam-induced signal. The signals recorded by a digitizing oscilloscope provide time-resolved information on cloud development. Results for diamond-like carbon, amorphous carbon, and titanium-nitride coatings have been obtained and compared to those for an uncoated aluminum chamber. Here we report on extensions to the ECloud modeling code which refine its description of a variety of new types of in situ vacuum chamber comparisons. Our results highlight the sensitivity afforded by these measurements to model parameters such as the quantum efficiency for producing photoelectrons, their production location and energy distributions, as well as to the secondary yield and production kinematics. We use this sensitivity to draw conclusions comparing the photoelectron and secondary yield properties of the various vacuum chamber coatings, including conditioning effects as a function of synchrotron radiation dose. We find substantial conditioning effects in both the quantum efficiency for producing photoelectrons and for the secondary yield.

### Recent Developments in Modeling

**Time-Resolved Shielded-Pickup Measurements of Electron Cloud Buildup at CESRTA**

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### Time-Resolved Shielded-Pickup Measurements

The CESRTA Reconfiguration

July – October 2009

New electron cloud experimental region

Drift and Quadrupole diagnostic chambers

Chicane, upgraded SEY station

PEP-II EC Hardware:

- Field of view (FOV)
- Position, energy, angle
- Azimuthal distribution (v.c. reflectivity)
- Beam kick
- Production energy, angle
- Elastoplasticity (deformation at low energy)
- True secondaries (yields > 1!)
- Elastic reflection (dominates at low energy)
- Acceptance vs incident angle, energy
- Signal charge removed from cloud
- Non-signal charge creates secondaries

### Conditioning Effects in TiN- and Diamond-like Carbon Coatings

- The quantum efficiency for reflected photons and the SEY change by less than a few percent over this range of radiation dose for the TiN coating.
- The diamond-like carbon coating exhibits an increase in quantum efficiency for reflected photons while the secondary yield decreases significantly.

### 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

**A challenge for the modeling**

- 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 4.5 x 10^11 and 4.7 x 10^11 protons is depicted. The suppression ratio decreases by a factor of 10 due to the conditioning change 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 photodetector production. A reduction in the secondary yield of 25% is consistent with the observed effect, since the leading bunch signal is unchanged.

### Comparisons of Cloud Mitigation Coatings

- The carbon coating suppresses photoelectron production relative to the TiN coating, especially at high photoelectron energy.
- The quantum efficiency for reflected photons and the secondary yield are both much smaller for conditioned TiN than for uncoated aluminum.