Observation of Electron Trapping  

at the CESR Test Accelerator  

Jim Crittenden  

Accelerator Physics Seminar  

Wilson Lab  

8 November 2013
Phases I and II: 2008-2014

Low-emittance tuning development (s.c. wigglers)
Electron cloud buildup/mitigation techniques
Beam dynamics/instabilities
Innovative instrumentation (SPU, RFA, xBSM, vBSM, ...)
3 recent PhD dissertations (Joe Calvey, Mike Ehrlichman, Jim Shanks)
Several dozen articles published, about 30 in preparation


Analysis of huge data sets from Phases I and II
Lower emittance allowing study of new electron cloud phenomena
Fast-ion instability studies
Novel instrumentation R&D

ILC Damping Rings R&D at CESRTA, G. F. Dugan, M. A. Palmer and D. L. Rubin
The CESR Test Accelerator Electron Cloud Research Program Phase I Report


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Shielded Pickup Detector in Quadrupole Q48W

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Observation of Electron Trapping at the CESR Test Accelerator / J.A. Crittenden
Observation of Electron Trapping in a Positron Storage Ring
ArXiv: 1309.2625v2, submitted 9/10/2013

Comparison of shielded-pickup signals for 10-bunch and 20-bunch trains

No magnetic field (15E)

Quadrupole magnetic field (Q48W)

How do the first ten bunches of a 20-bunch train know that they are in a 20-bunch train?

\[ N_{\text{bunch}} = 1.29 \times 10^{11} \]
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

* Originated at CERN in the late 1990's
* Widespread application for PS, SPS, 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
* Full POSINST SEY functions added as option 2010-2012
* Flexible photoelectron energy distributions added 2011
* Synrad3D photon absorption distribution added 2011
Is electron trapping expected under these beam conditions? Ask the model.

Yes.

About 9% of the cloud built up by the train survives until the next passage of the train.
Where is the cloud trapped?

Modeled electron cloud transverse distribution
Immediately prior to the return of the bunch train
Clearing trapped electrons by means of an intermediate train of bunches

(JPS measurements from last Tuesday 11/5 !)
Is the clearing effect expected under these beam conditions? Ask the model.

- Without witness train: $1.14 \times 10^{10}$
- With witness train: $0.94 \times 10^{10}$

Yes