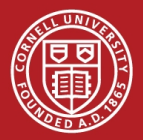

Cornell University
Laboratory for Elementary-Particle Physics

# Observation of Electron Trapping at the CESR Test Accelerator

Jim Crittenden

*Accelerator Physics Seminar*

*Wilson Lab*

*8 November 2013*


# The CESR Test Accelerator Project Highlights

## 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**

## Phase III: 2014-2017 (proposal 12/2013)

**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**
**ICFA Beam Dynamics Newsletter Nr 50, Ed J. Urakawa (2009)**

# The CESRTA Phase I Report
# December/2012, 428 pages

## The CESR Test Accelerator Electron Cloud Research Program Phase I Report

*Editors:* *M. A. Palmer, M. G. Billing, G. F. Dugan, M. A. Furman and D. L. Rubin*

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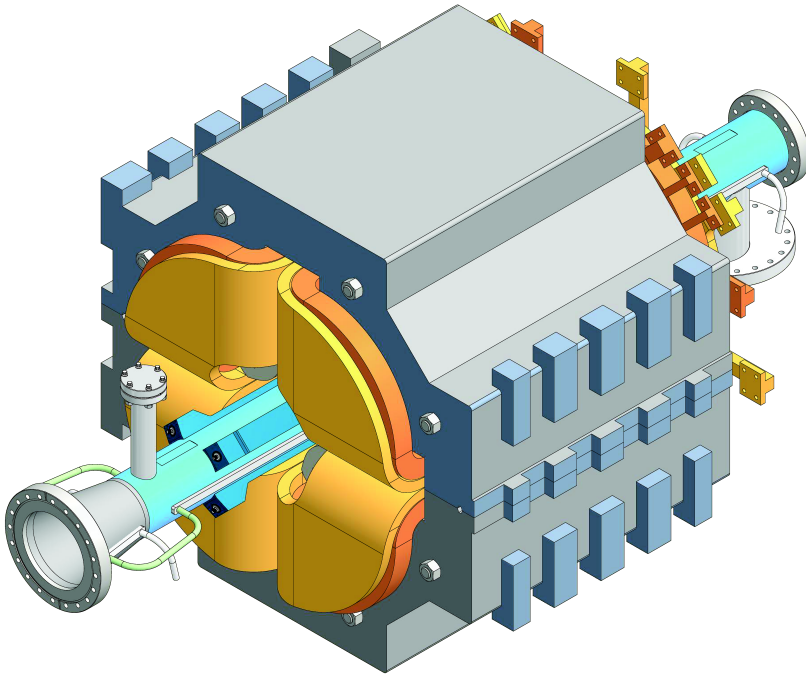
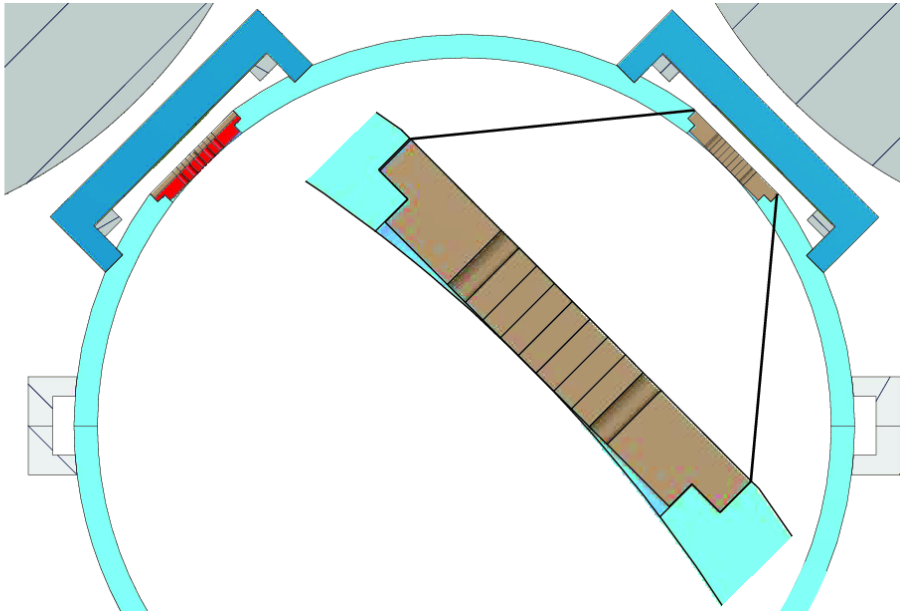
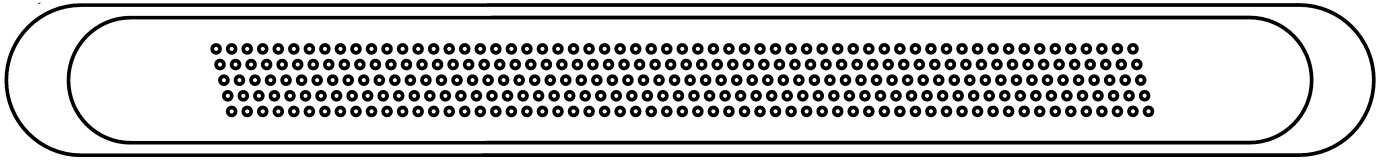
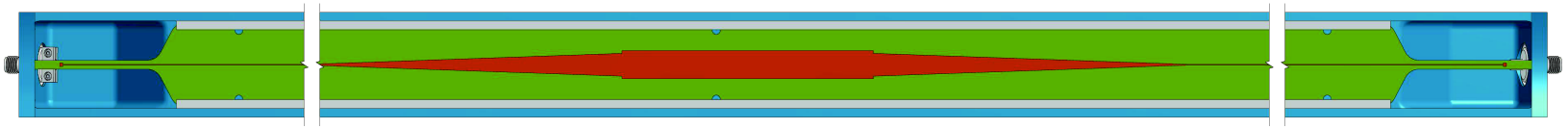
# Shielded Pickup Detector in Quadrupole Q48W









# Observation of Electron Trapping

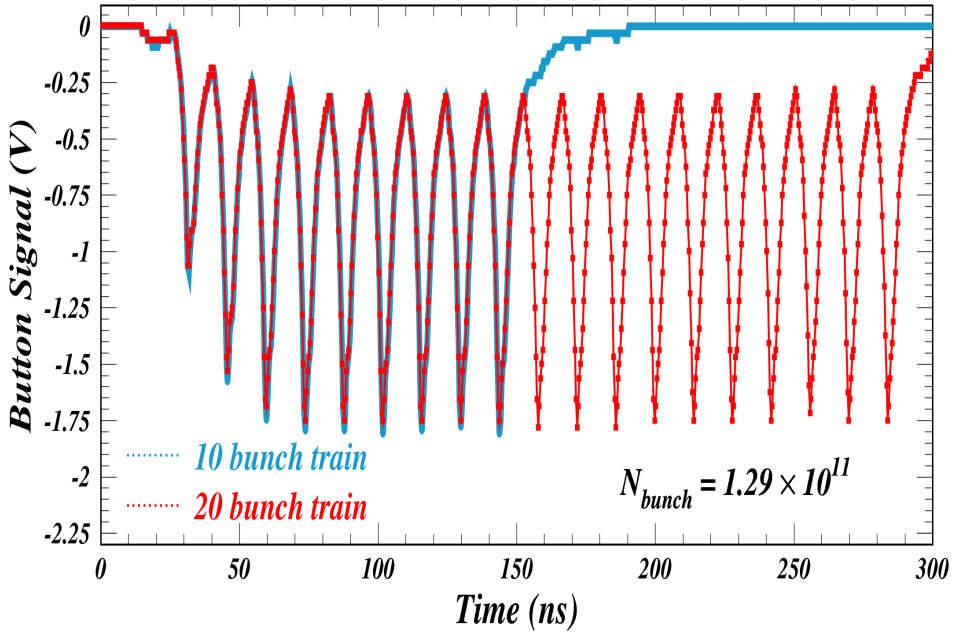
## Observation of Electron Trapping in a Positron Storage Ring

M.G. Billing, J. Conway, E.E. Cowan, J.A. Crittenden, J. Lanzoni, Y. Li, C.S. Shill, J.P. Sikora and K. Sonnad

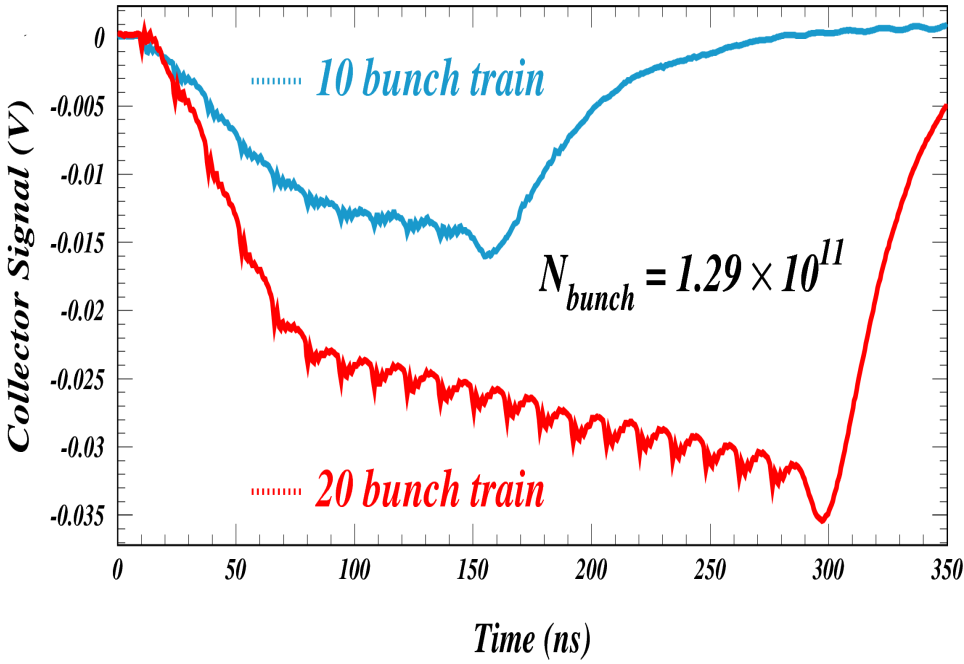
ArXiv: 1309.2625v2, submitted 9/10/2013

**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?**

# Electron cloud buildup modeling code ECLOUD

* 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

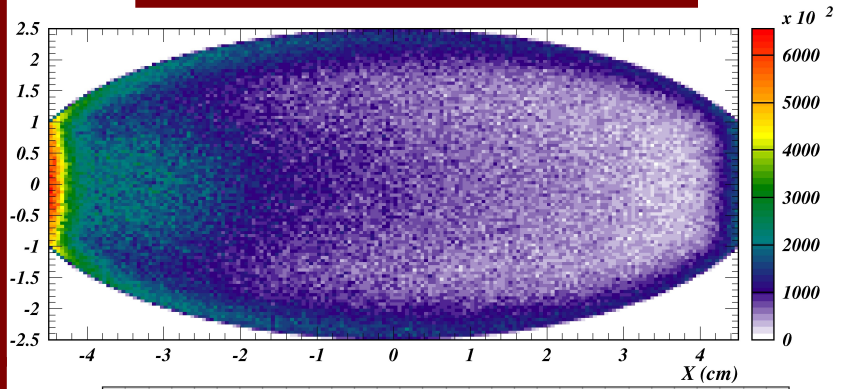
I. Generation of photoelectrons
   - A) Production energy, angle
   - B) Azimuthal distribution (v.c. reflectivity)

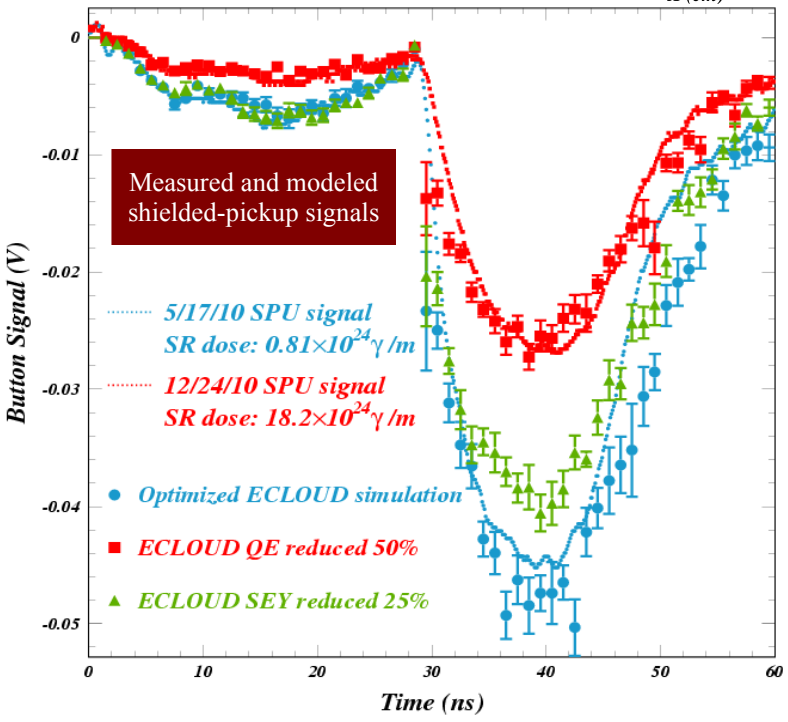
II. Time-sliced cloud dynamics
   - A) Cloud space charge force
   - B) Beam kick
   - C) Magnetic fields

III. Secondary yield model
   - A) True secondaries (yields > 1!)
   - B) Rediffused secondaries (high energy)
   - C) Elastic reflection (dominates at low energy)

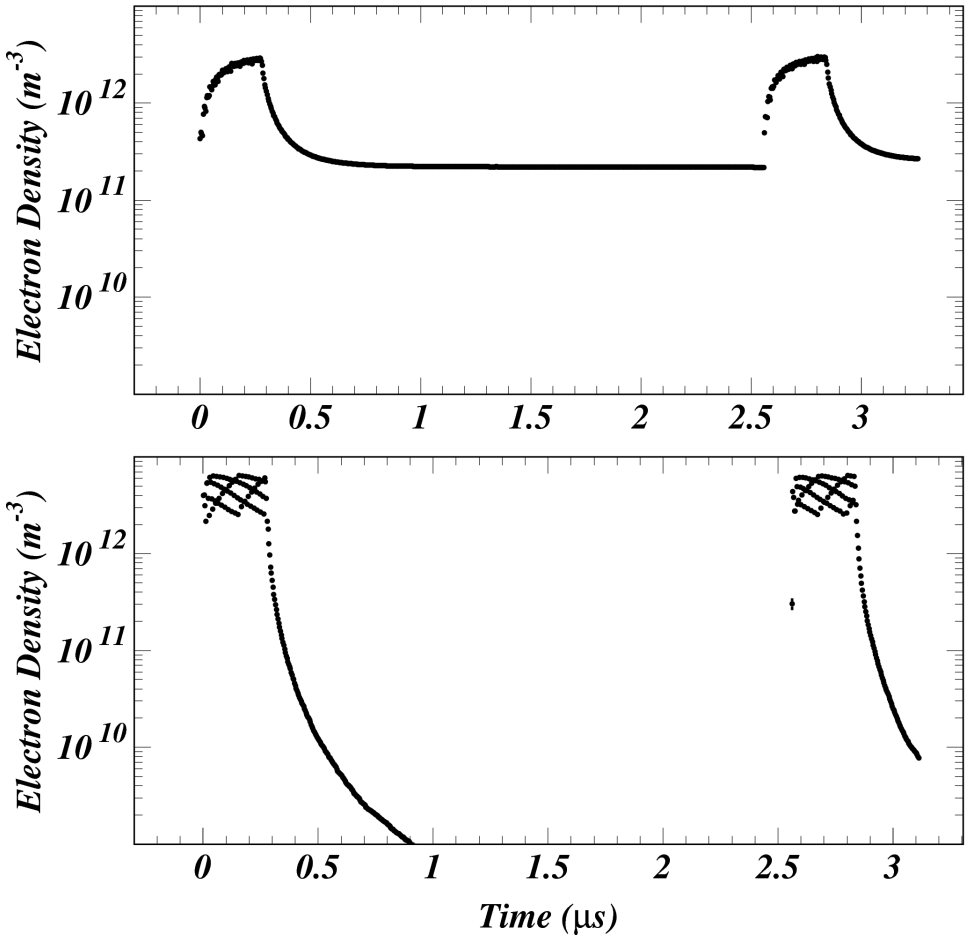
IV. Shielded pickup model
   - A) Acceptance vs incident angle, energy
   - B) Signal charge removed from cloud
   - C) Non-signal charge creates secondaries

Cloud snapshot after 14 ns at 15W



# *Is electron trapping expected under these beam conditions? Ask the model.*



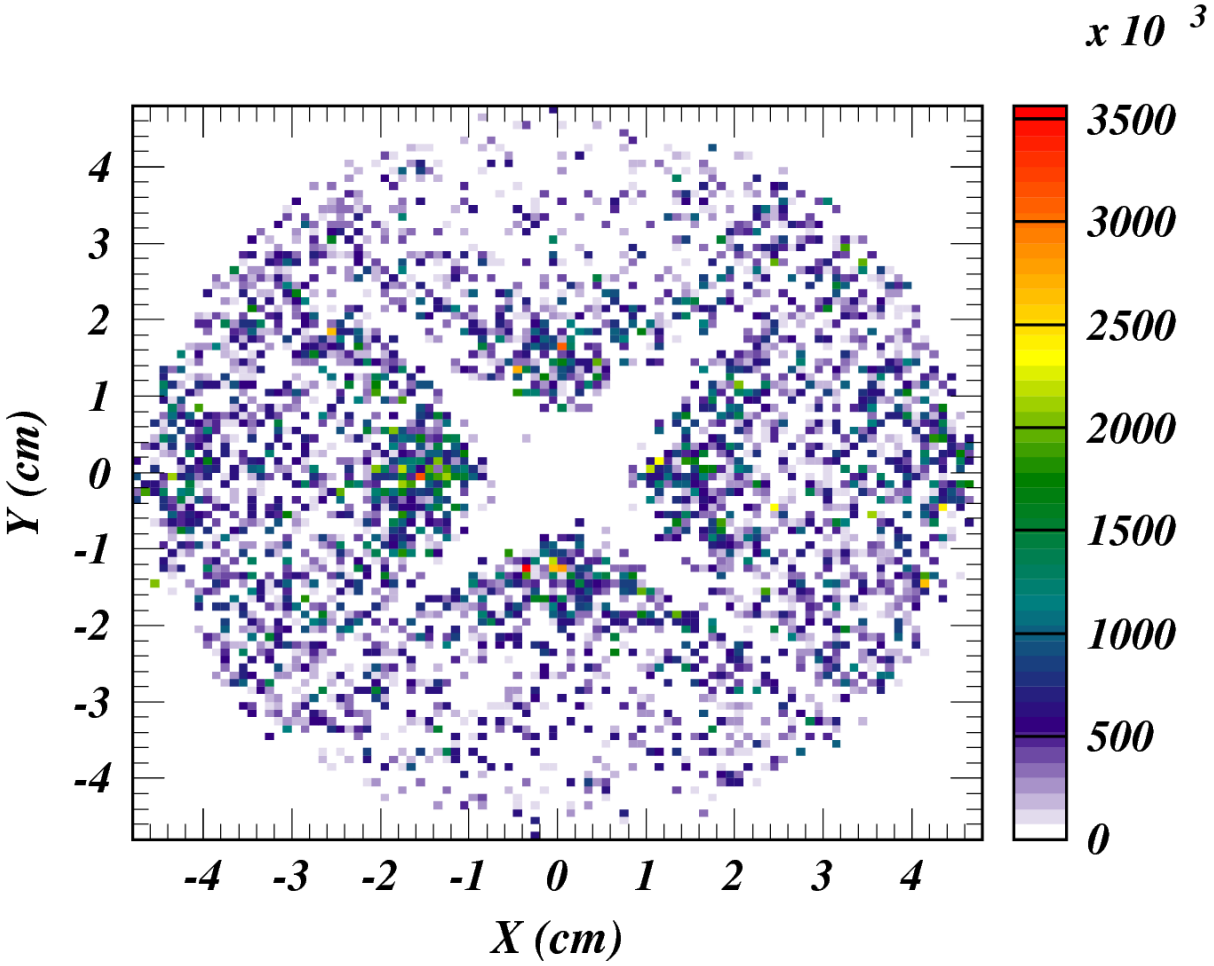

**Quadrupole magnetic field (Q48W)**

**No magnetic field (15E)**

**Yes.**

**About 9% of the cloud built up by the train survives until the next passage of the train.**

# Where is the cloud trapped ?

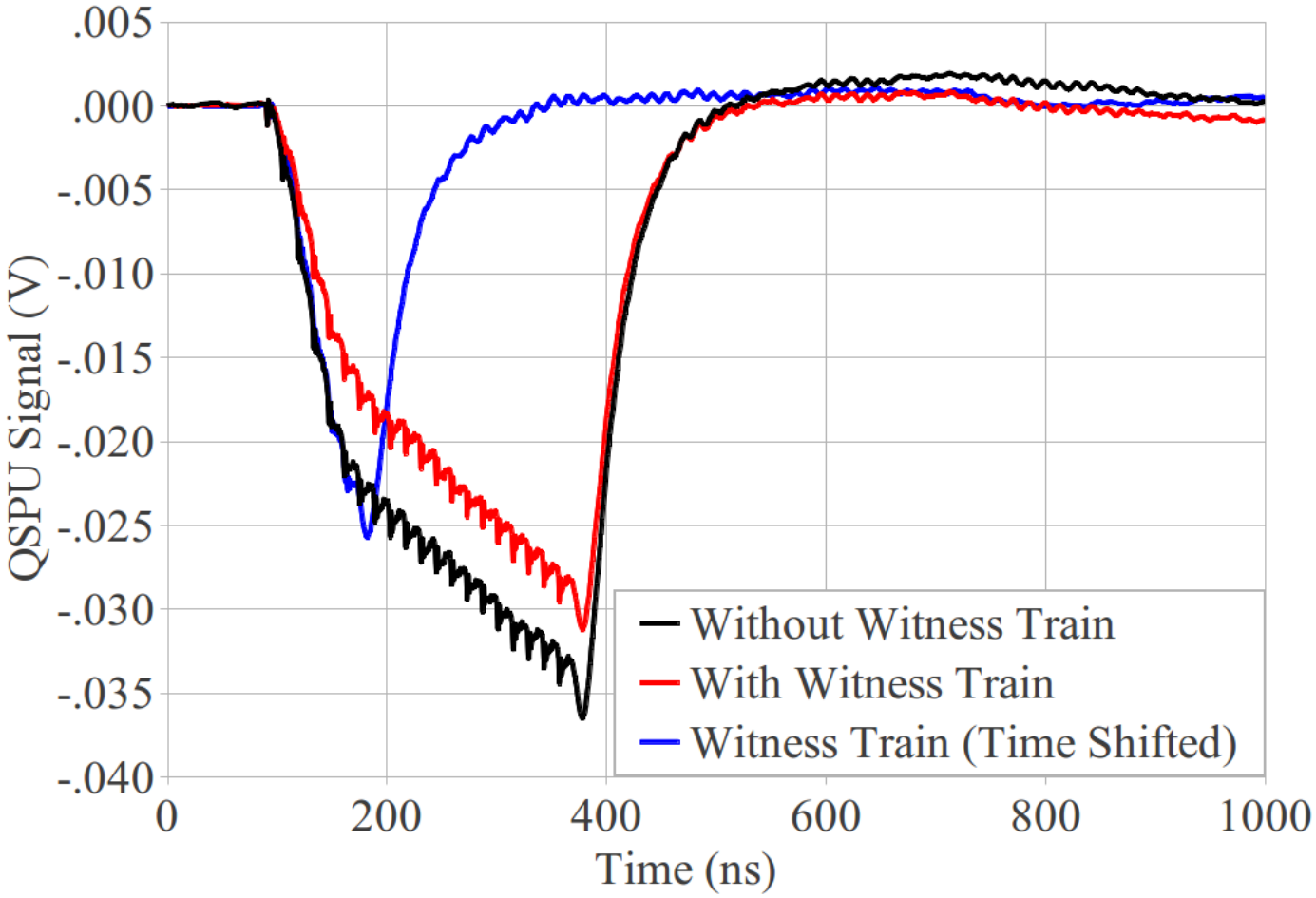



**Modeled electron cloud transverse distribution**
**Immediately prior to the return of the bunch train**

# Rich future measurement program

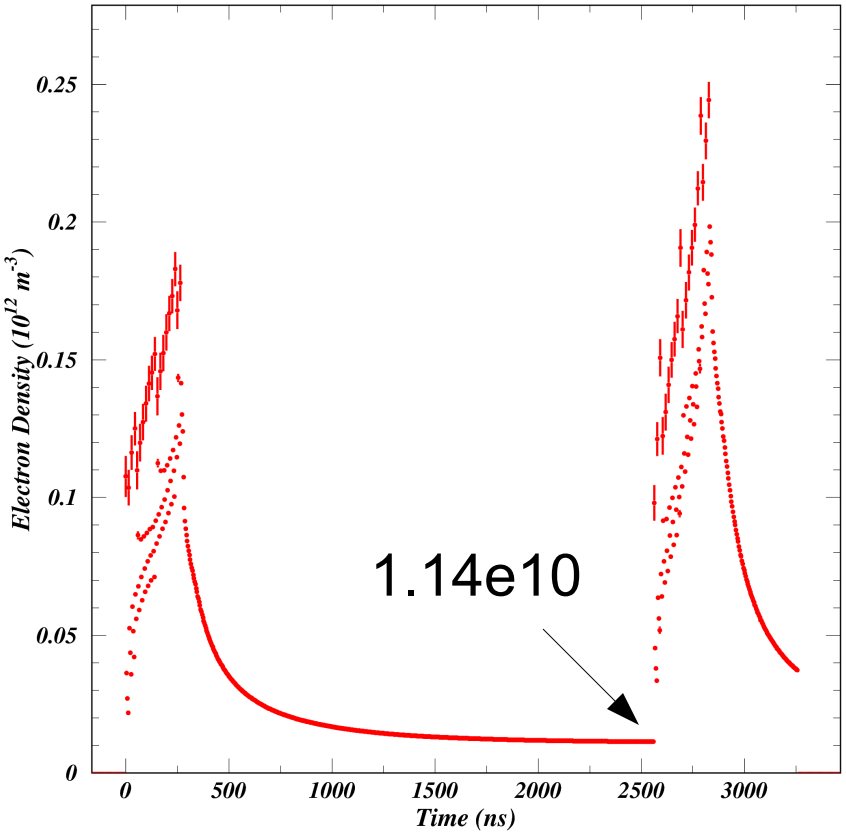
## *Clearing trapped electrons by means of an intermediate train of bunches*

## *(JPS measurements from last Tuesday 11/5 !)*

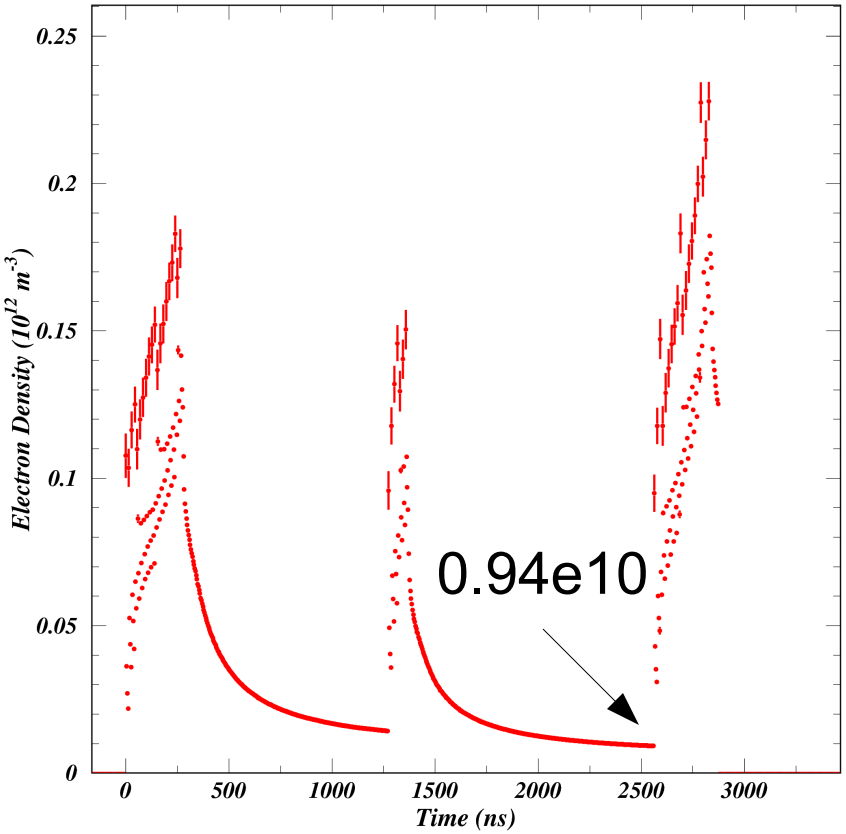


# *Is the clearing effect expected under these beam conditions? Ask the model.*

**Without witness train**




**With witness train**




**Yes**