CESRTA R&D Program & U.S. DR Activities

Mark Palmer for the CESRTA Collaboration

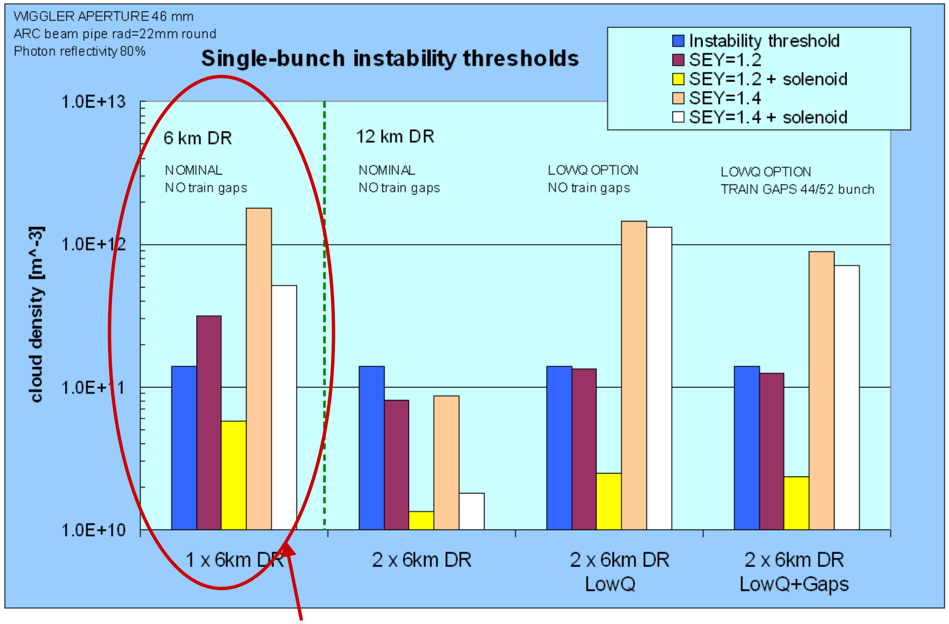
June 9, 2010

ILC ART Review - FNAL

Outline

- CESRTA Project Overview
  - Motivation
  - Project Goals
  - CESR Reconfiguration
  - Status
- CESRTA R&D Effort
  - Low Emittance Correction and Tuning
  - EC Studies: Experimental and Simulation
    - Build-Up and Mitigation
    - EC Beam Dynamics
- DR Activities
  - EC Working Group
  - Fast Kicker Development
- Conclusion and Future Plans

Motivation for CESRTA



- ILCDR06 Evaluation
  - M. Pivi, K. Ohmi, *etal.*
  - Single ~6km positron DR
    - Nominal ~2625 bunches with 6ns bunch spacing and $N_b=2\ \ 10^{10}$
    - Requires SEY values of vacuum chamber surfaces with $\delta_{max}\leq 1.2$ (assuming solenoid windings in drift regions) in order to operate below EC instability thresholds
    - Dipole and wiggler regions of greatest concern for EC build-up

- In 2007, the ILC R&D Board's S3 Task Force identified a set of critical research tasks for the ILC DR, including:
  - Characterize EC build-up
  - Develop EC suppression techniques
  - Develop modelling tools for EC instabilities
  - Determine EC instability thresholds
- CesrTA program targets:
  - Measurements with positron beams at ultra low emittance to validate projections to the ILC DR operating regime
  - Validation of EC mitigation methods that will allow safe operation of the baseline DR design and the possibility of performance improvements and/or cost reductions

R&D Goals

- Studies of Electron Cloud Growth and Mitigation
  - Study EC growth and methods to mitigate it (particularly wigglers and dipoles).
  - Benchmark and expand existing simulation codes
    ⇨ validate projections to the ILC DR.

- Low Emittance Operations
  - EC beam dynamics studies at ultra low emittance
    (CesrTA vertical emittance target: ε_V<20 pm-rad).
  - Beam instrumentation for ultra low emittance beams
    - x-Ray Beam Size Monitor targeting bunch-by-bunch (single pass) readout
    - Beam Position Monitor upgrade
  - Develop LET tuning tools

- Studies of EC Induced Instability Thresholds and Emittance Dilution
  - Measure instability thresholds and emittance growth at ultra low emittance
  - Validate EC simulations in the low emittance parameter regime.
  - Confirm the projected impact of the EC on ILC DR performance.

- Inputs for the ILC DR Technical Design
  - Support an experimental program to provide key results on the 2010 timescale

Project Elements

- 4 Major Thrusts:
  - Ring Reconfiguration: Vacuum/Magnets/Controls Modifications
  - Low Emittance R&D Support
    - Instrumentation: BPM system and high resolution x-ray Beam Size Monitors
    - Survey and Alignment Upgrade
  - Electron Cloud R&D Support
    - Local EC Measurement Capability: RFAs, TE Wave Measurements, and develop Time-resolved Measurement Capability
    - Feedback System upgrade for 4ns bunch trains
    - Photon stop for wiggler tests over a range of energies (1.8 to 5 GeV)
    - Local SEY measurement capability

Large parameter range – see next slide

  - Experimental Program
    - Provide ~240 running days over a 2+ year period
    - Early results to feed into final stages of program
- Schedule coordinated with Cornell High Energy Synchrotron Source (CHESS) operations

CESR Reconfiguration: CesrTA Parameters

Lattice Parameters

Ultra low emittance baseline lattice

Energy [GeV]	2.085	5.0	5.0
No. Wigglers	12	0	6
Wiggler Field [T]	1.9	—	1.9
Q_x	14.57		
Q_y	9.62		
Q_z	0.075	0.043	0.043
V_{RF} [MV]	8.1	8	8
ε_x [nm-rad]	2.5	60	40
$\tau_{x,y}$ [ms]	57	30	20
α_p	6.76 10^{-3}	6.23 10^{-3}	6.23 10^{-3}
σ_l [mm]	9	9.4	15.6
σ_E/E [%]	0.81	0.58	0.93
t_b [ns]	≥4, steps of 2		

Range of optics implemented

Beam dynamics studies

Control photon flux in EC experimental regions

E[GeV]	Wigglers (1.9T/PM)	ε_x[nm]
1.8*	12/0	2.3
2.085	12/0	2.5
2.3	12/0	3.3
3.0	6/0	10
4.0	6 /0	23
4.0	0 /0	42
5.0	6/0	40
5.0	0/0	60
5.0	0/2	90

IBS Studies

* Orbit/phase/coupling correction and injection but no ramp and recovery. In all other optics there has been at least one ramp and iteration on injection tuning and phase/coupling correction

CESR Reconfiguration

- L3 EC experimental region

  SLAC PEP-II EC Hardware: Chicane, upgraded SEY station

  Drift and Quadrupole diagnostic chambers

- New EC experimental regions in arcs (wigglers ⇨ L0 straight)

  Locations for collaborator experimental chambers

  Characterize CESR chambers

- CHESS C-line & D-line Upgrades

  Windowless (all vacuum) x-ray line upgrade

  Dedicated x-ray optics box at start of each line

  CesrTA xBSM detectors share space in CHESS experimental hutches

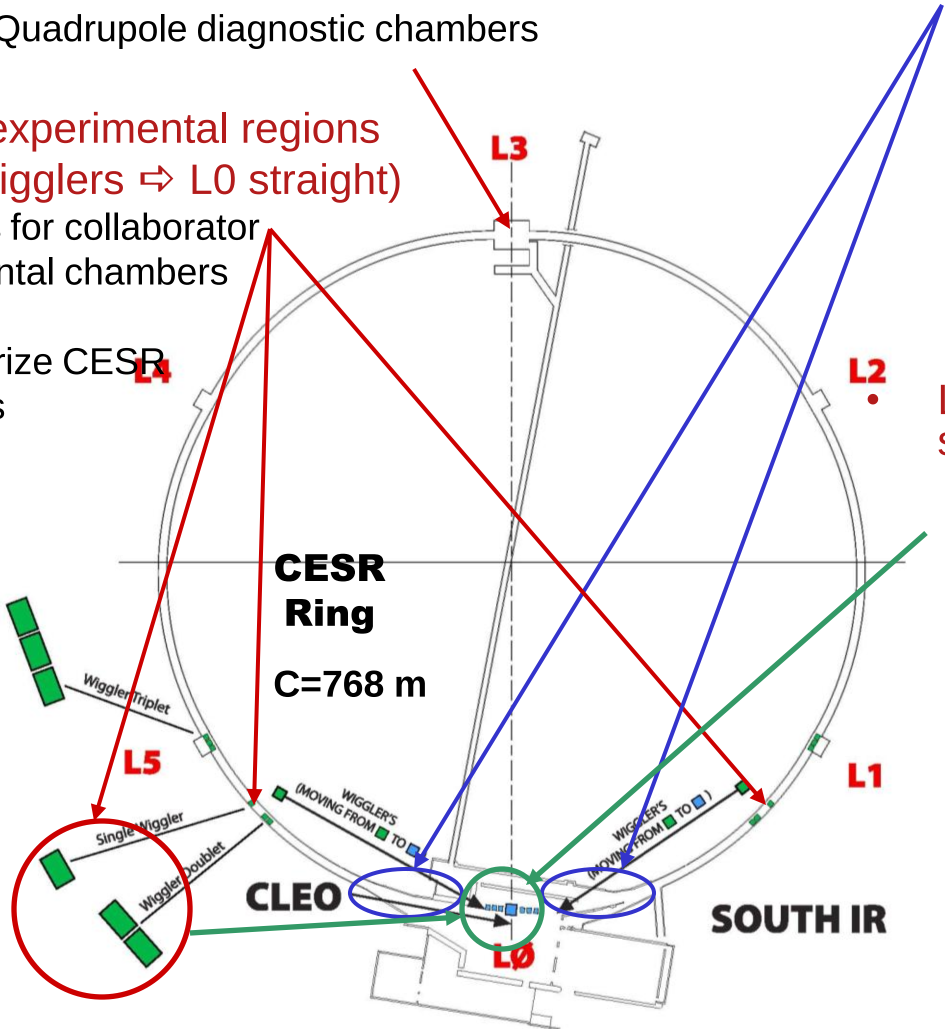
- L0 region reconfigured as a wiggler straight

  CLEO detector sub-systems removed

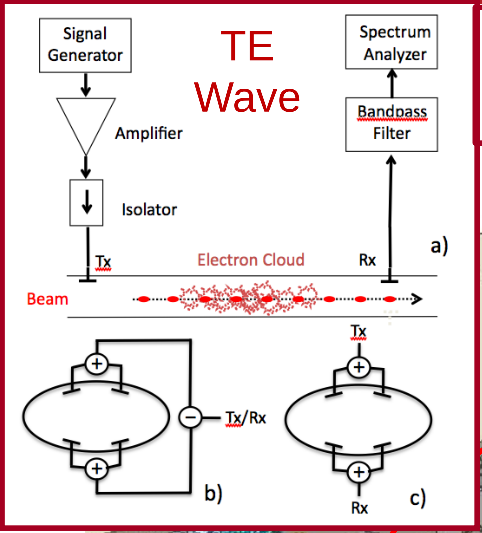
  6 wigglers moved from CESR arcs to zero dispersion straight

  Region instrumented with EC diagnostics and mitigation

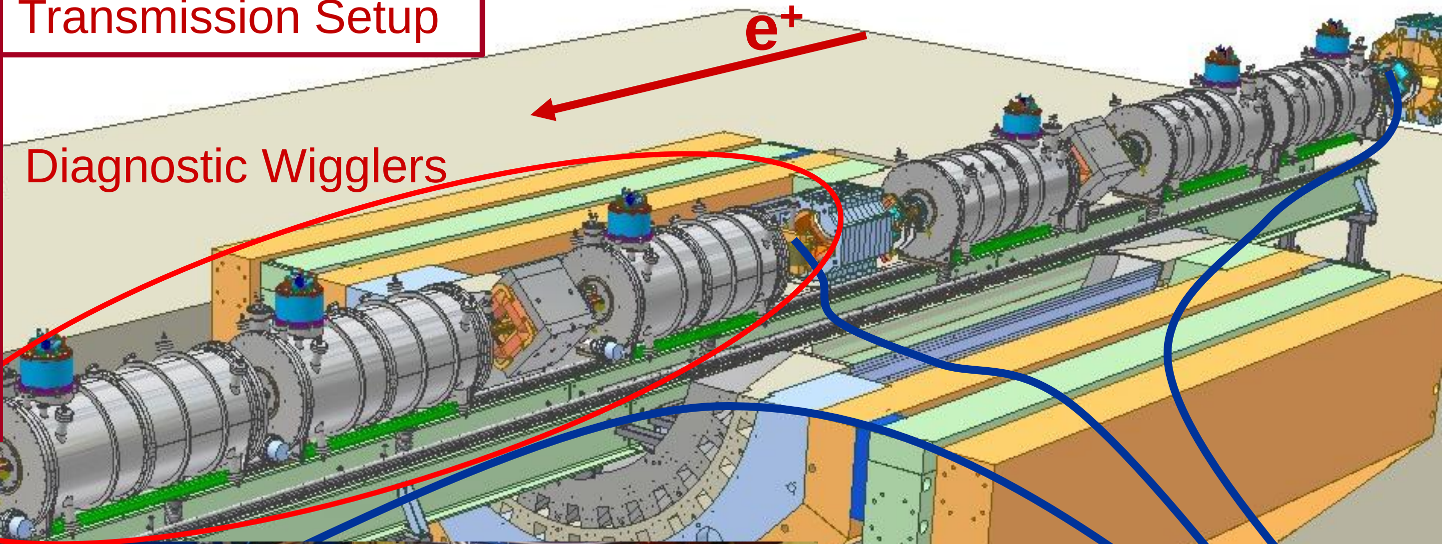
  Wiggler chambers with retarding field analyzers and various EC mitigation methods (fabricated at LBNL in CU/SLAC/KEK/LBNL collaboration)



CESR Reconfiguration: L0 Modifications

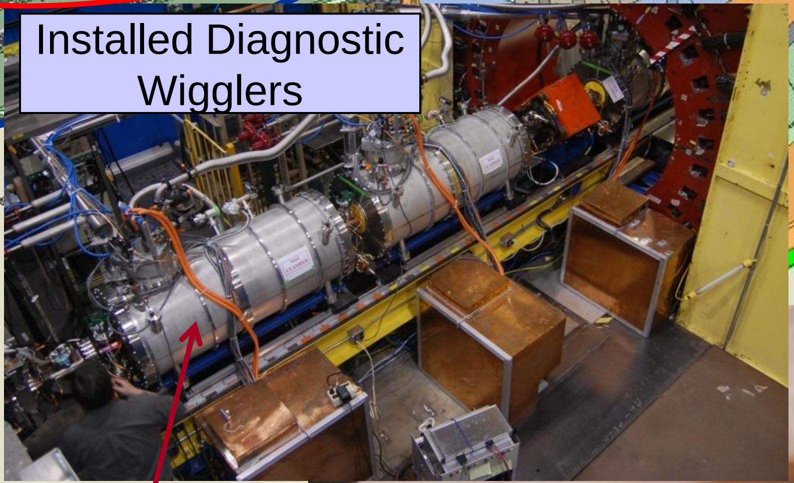


‘Resonant BPM’ and Transmission Setup

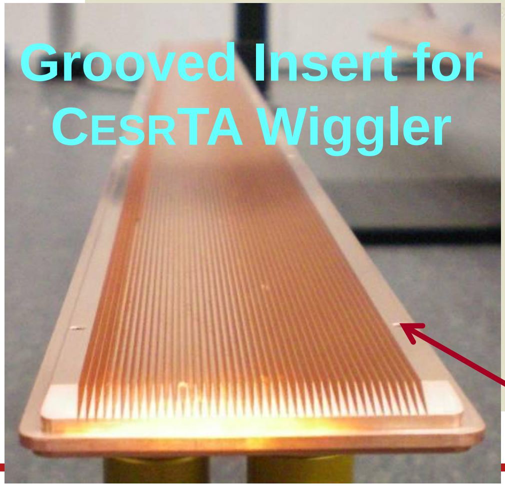


Diagnostic Wigglers

Heliax cables for TE Wave Measurements



Installed Diagnostic Wigglers

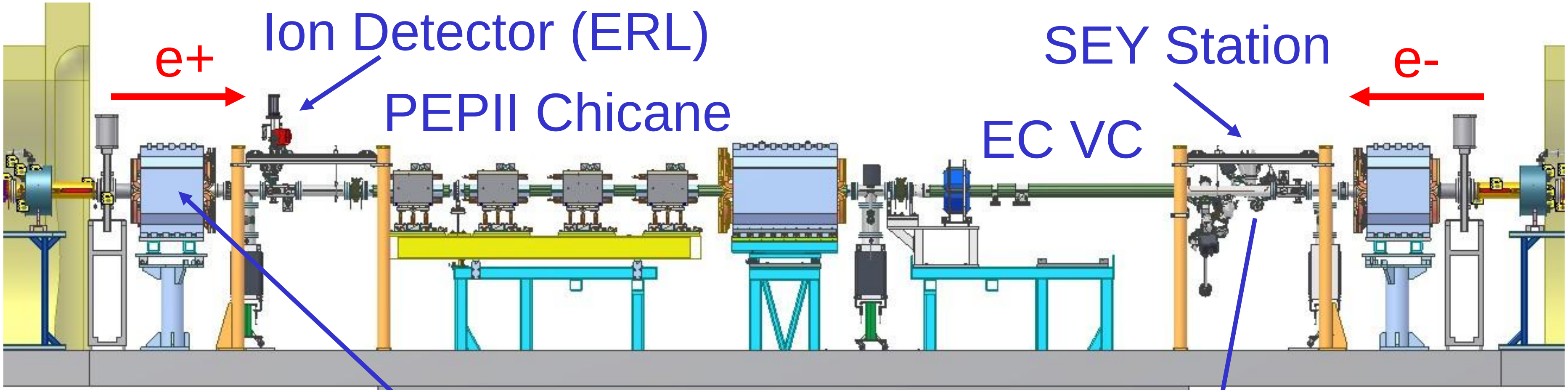


Grooved Insert for CESRTA Wiggler

CU, LBNL
KEK, SLAC

CESRTA Wiggler Electrode

CESR Reconfiguration: L3 Experimental Region



e+

Ion Detector (ERL)

PEPII Chicane

SEY Station

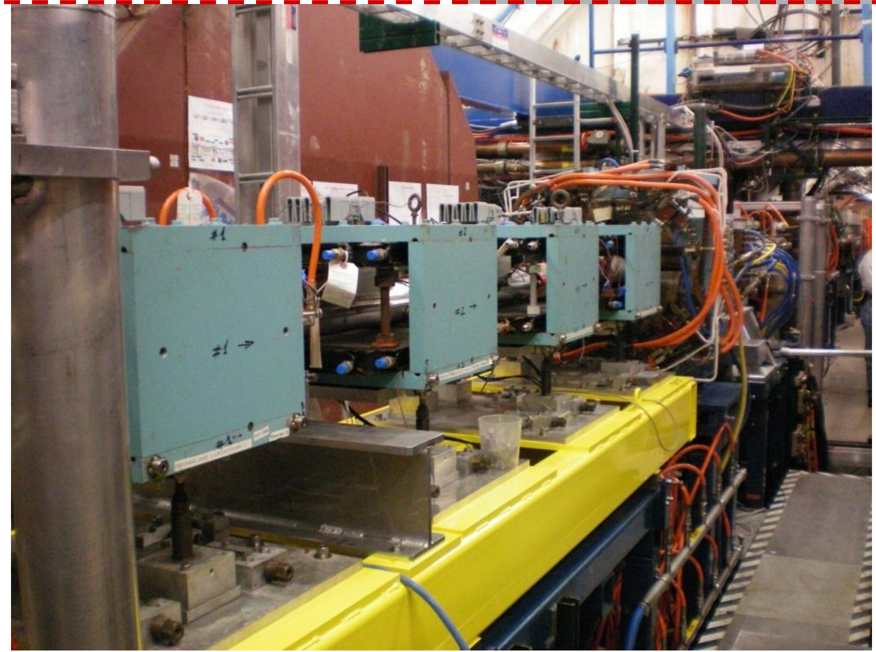
EC VC

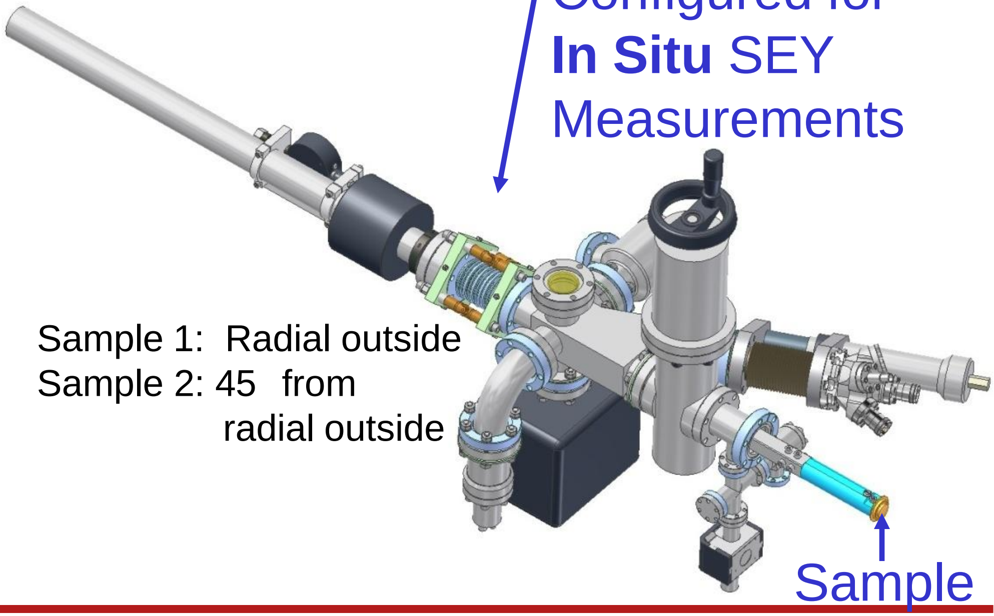
e-

West

Instrumented Quadrupole

East



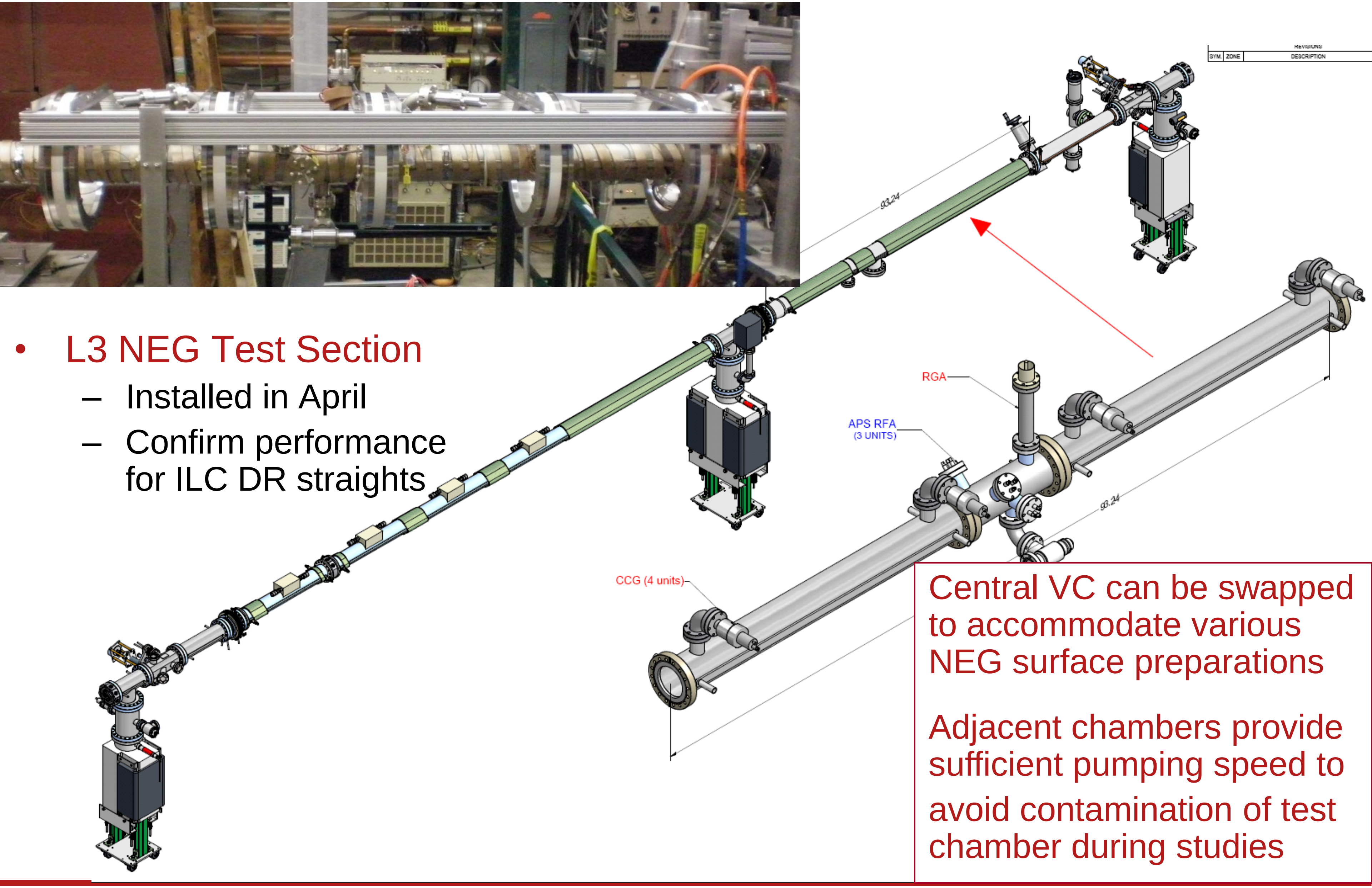


Configured for
In Situ SEY
Measurements

Sample 1: Radial outside
Sample 2: 45 from
radial outside

Sample

CESR Reconfiguration: L3 Experimental Region

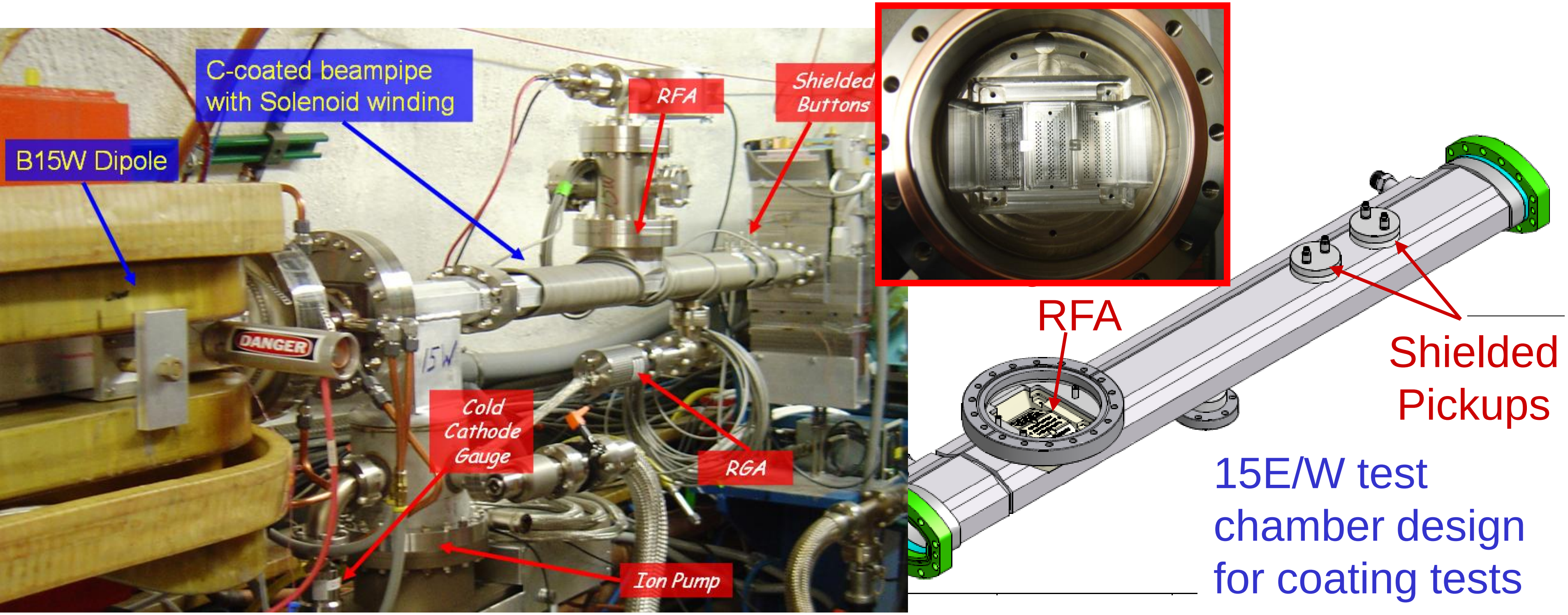


- L3 NEG Test Section
  - Installed in April
  - Confirm performance for ILC DR straights

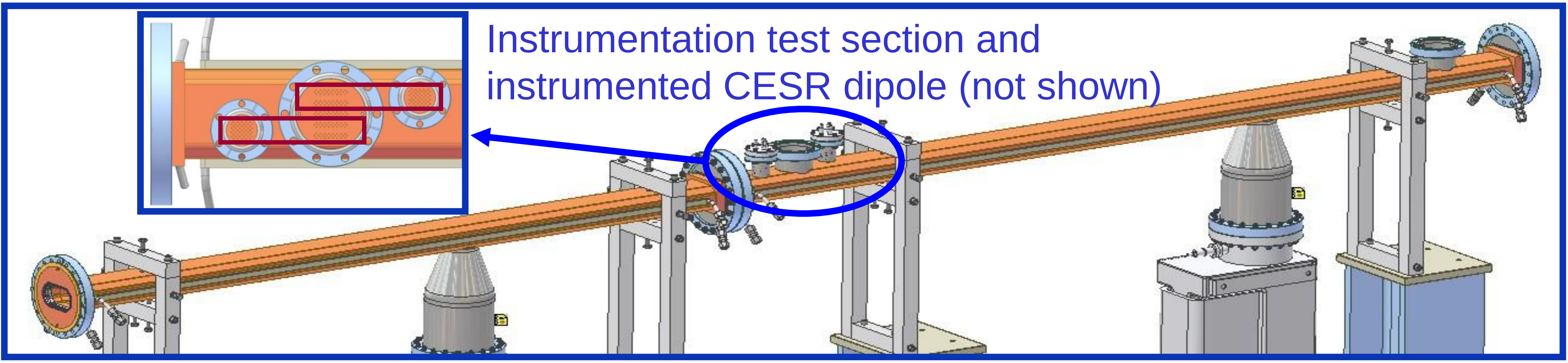
Central VC can be swapped to accommodate various NEG surface preparations

Adjacent chambers provide sufficient pumping speed to avoid contamination of test chamber during studies

CESR Reconfiguration: CESR Arcs



15E/W test chamber design for coating tests



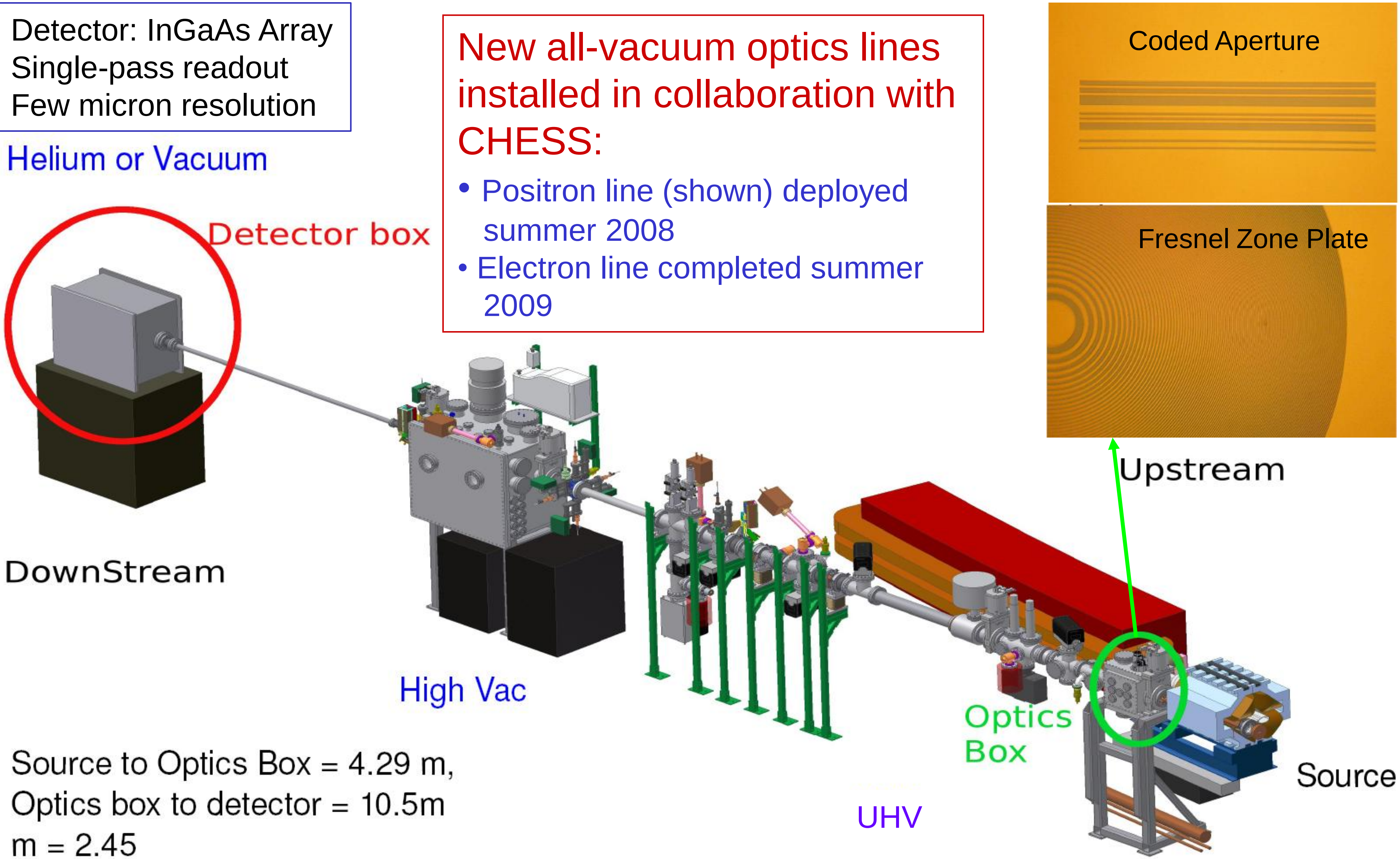
Instrumentation test section and instrumented CESR dipole (not shown)

CESR Reconfiguration: X-Ray Lines

Detector: InGaAs Array
Single-pass readout
Few micron resolution

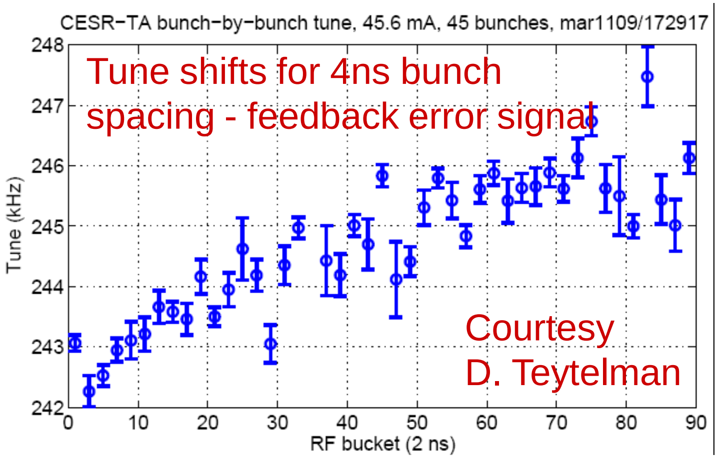
New all-vacuum optics lines installed in collaboration with CHESS:

- Positron line (shown) deployed summer 2008
- Electron line completed summer 2009



Source to Optics Box = 4.29 m,
Optics box to detector = 10.5m
m = 2.45

Status and Ongoing Effort



Tune shifts for 4ns bunch spacing - feedback error signal

Courtesy D. Teytelman

- Ring Reconfiguration **Complete**
  - Damping ring layout
  - 4 dedicated EC experimental regions
  - Upgraded vacuum/EC instrumentation
- Beam Instrumentation
  - xBSM positron and electron lines operational
    - Continued optics and detector development
  - Digital BPM system operational
    - Continued effort on data acquisition and experimental data modes
  - vBSM
    - Significant progress has been made on vertical polarization measurements which can provide a useful cross-check with the xBSM in the ultra low emittance regime
    - New optics line for transverse and longitudinal measurements in L3 are now in use
  - Feedback system upgrade for 4ns bunch spacing is operational

- EC Diagnostics and Mitigation
  - ~30 RFAs presently deployed
  - TE wave measurement capability in each experimental region
  - Time-resolved shielded pickup detectors in 3 experimental locations (2 with transverse information)
  - Mitigation tests are ongoing

- Low Emittance Tuning and Beam Dynamics Studies
  - Approaching target vertical emittance of 20pm (see following slides)
  - Continuing effort to take advantage of new instrumentation
  - Continuing to work towards providing low emittance conditions for beam dynamics studies

R&D Effort

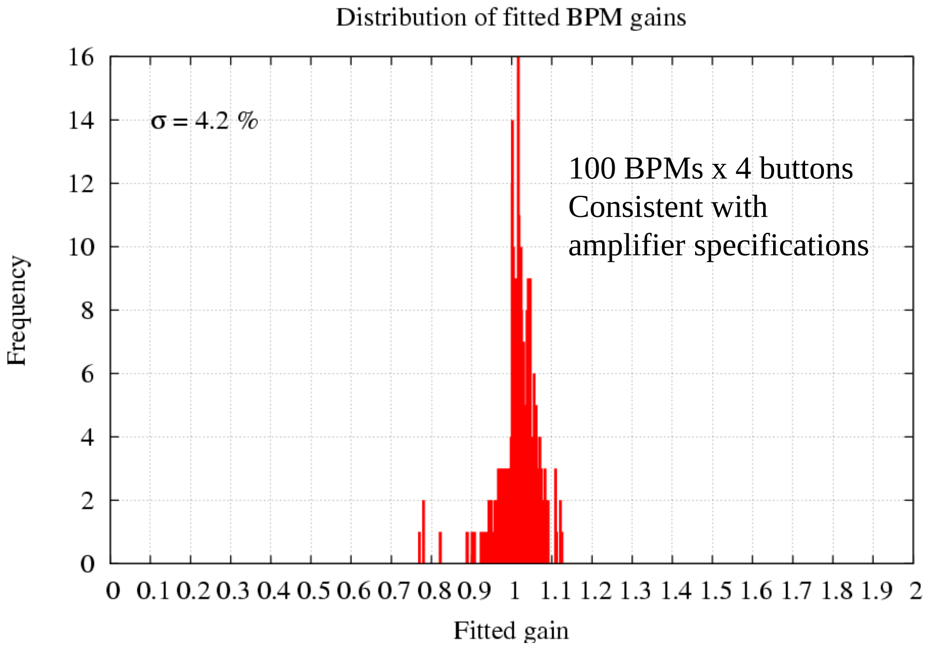
- Will Highlight A Few Items
- Low Emittance Correction and Tuning
- EC Studies
  - Build-Up and Mitigation
  - EC Beam Dynamics
  - Associated Simulation Efforts

Collaboration

- The productivity of the program is determined by the range of collaboration involved:
  - Vacuum chambers with EC mitigation:
    - CERN, KEK, LBNL, SLAC
  - Low Emittance Tuning and Associated Instrumentation
    - CalPoly, CERN, Cockcroft, KEK, SLAC
  - EC Instrumentation
    - FNAL, KEK, LBNL, SLAC
  - *In Situ* SEY Station
    - Carleton, FNAL, SLAC
  - Simulation
    - CERN, KEK, INFN-Frascati, LBNL, Postech, Purdue, SLAC
  - Technical Systems Checks
    - BNL, CERN, KEK

Low Emittance Tuning

- LET Procedure
  1. Collect turn by turn data with resonant excitation of horizontal and vertical motion
  2. Fit BPM gains
  3. Measure and correct
     - Orbit, with steerings
     - Betatron phase and coupling, with quads and skew quads
  4. Measure dispersion by resonant excitation of synch tune
  5. Fit simultaneously – coupling,vertical dispersion and orbit using vertical steerings and skew quads and load corrections



December Run – Measured ε_y =31pm-rad with xBSM.

Low Emittance Working Point

Vertical beam size, measured with x-ray beam size monitor vs tune

- Pinhole x-ray optic:
  β_y=17m at source limits $\sigma_y \geq 16\mu m$
- $Q_s = 0.066$

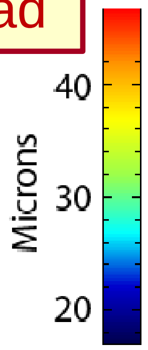
$\sigma_y = 20\ \mu m$

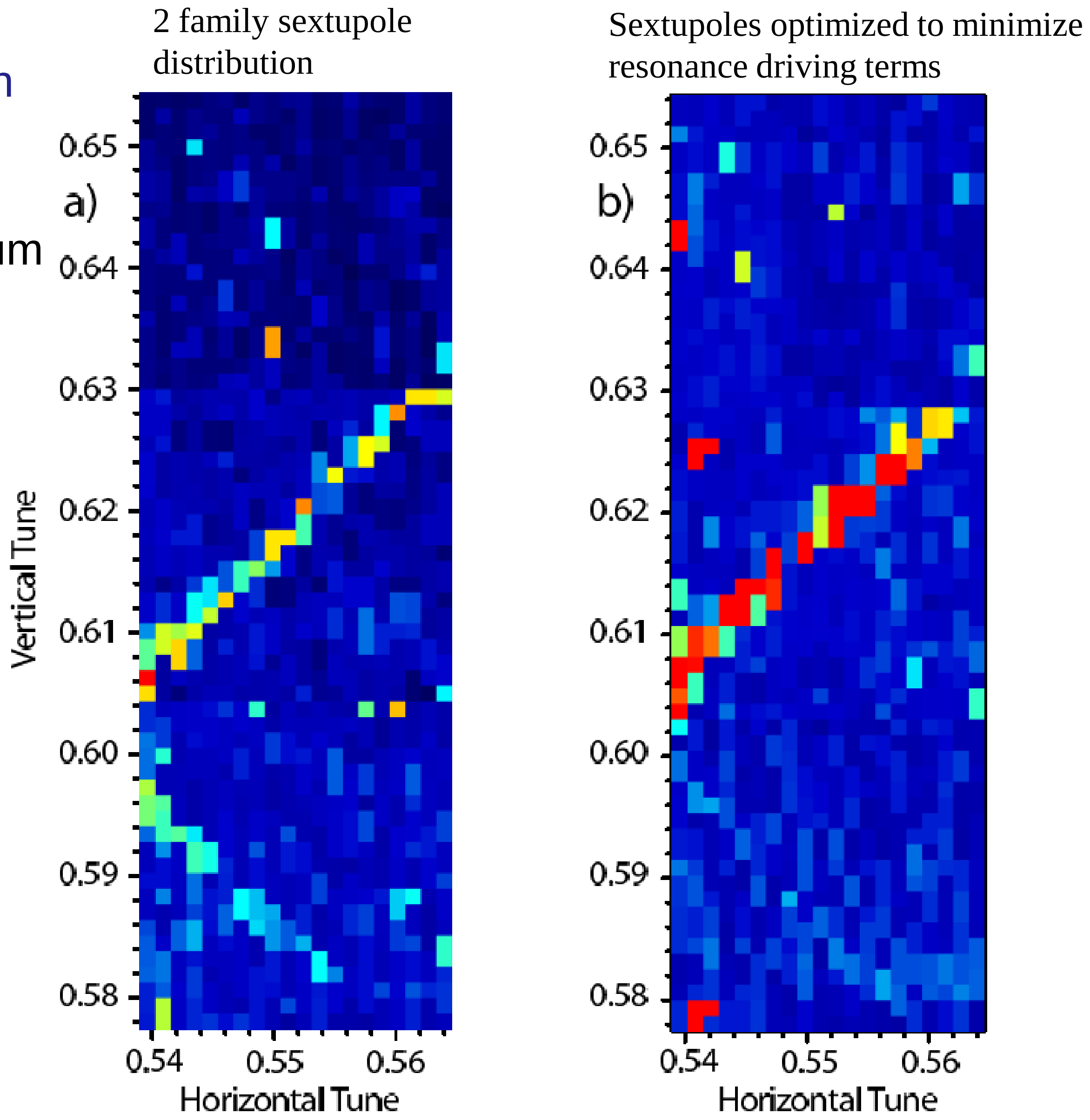
⇨ $\varepsilon_y = 23$ pm-rad

May Run:

$\sigma_y = 18 \pm 5\ \mu m$

⇨ $\varepsilon_y \sim 19$ pm-rad




2 family sextupole distribution

Sextupoles optimized to minimize resonance driving terms

Status of EC Studies

Simulations:

- Code Benchmarking → CLOUDLAND, ECLOUD, POSINST
- Modeling EC Build-up
  - RFA Modeling: Local data ⇨ EC model parameters of surface
  - TE Wave Modeling: probe regions not accessible to RFA measurements (eg, through length of wiggler)
- Coherent tune shifts
  - Characterize integrated EC contributions around ring
  - Constrain EC model parameters
  - Confirm inputs for instability studies
- Time-resolved Build-up
  - Characterize the EC model parameters in instrumented regions
- Improvements to EC Simulations
  - 3D simulations in wigglers
  - Simulations of SR photon production and scattering
- Instabilities and emittance growth
  - Detailed comparisons with data in the ultra low emittance regime
  - Validate projections for the ILC DR

Measurements:

- RFA and TE Wave studies to characterize local EC growth
  - Wigglers, dipoles, drifts, quadrupoles
  - 2 GeV to 5 GeV studies
  - Variety of bunch train lengths, spacing and intensities
  - Studies with electron and positron beams
- Mitigation Comparisons
  - Drift, Quadrupole, Dipole and Wiggler
  - See table on next slide
- Tune shift measurements and systematic checks
- Time-resolved measurements
  - Important cross-checks of EC models
- Instability and emittance growth (w/xBSM) measurements

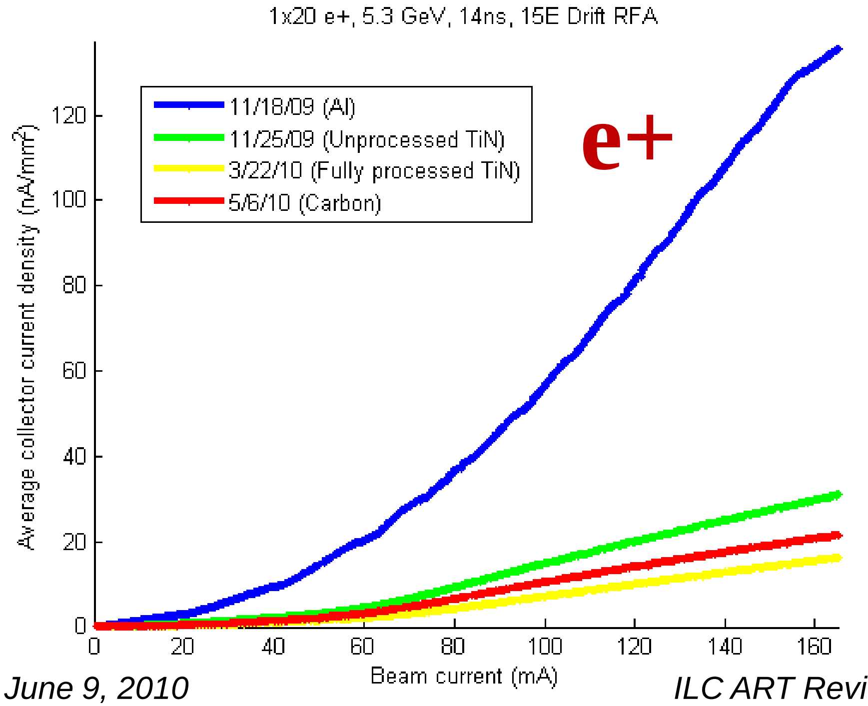
Surface Characterization & Mitigation Tests

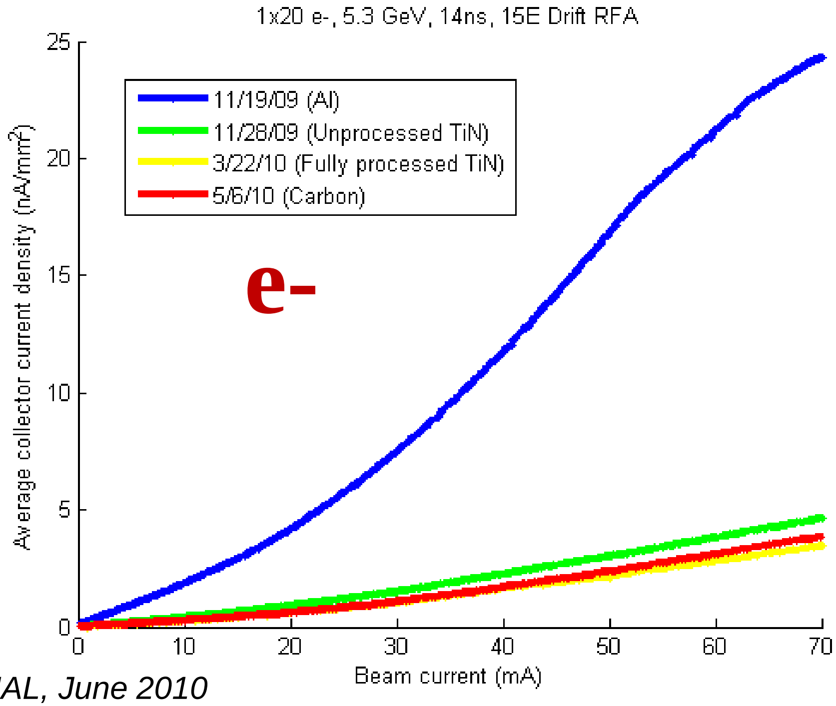
	Drift	Quad	Dipole	Wiggler	VC Fab
Al	✓	✓	✓		CU, SLAC
Cu	✓			✓	CU, KEK, LBNL, SLAC
TiN on Al	✓	✓	✓		CU, SLAC
TiN on Cu	✓			✓	CU, KEK, LBNL, SLAC
Amorphous C on Al	✓				CERN, CU
NEG on SS	✓				CU
Solenoid Windings	✓				CU
Fins w/TiN on Al	✓				SLAC
Triangular Grooves on Cu				✓	CU, KEK, LBNL, SLAC
Triangular Grooves w/TiN on Al			✓		CU, SLAC
Triangular Grooves w/TiN on Cu				✓	CU, KEK, LBNL, SLAC
Clearing Electrode				✓	CU, KEK, LBNL, SLAC

✓ = chamber(s) deployed ✓ = planned

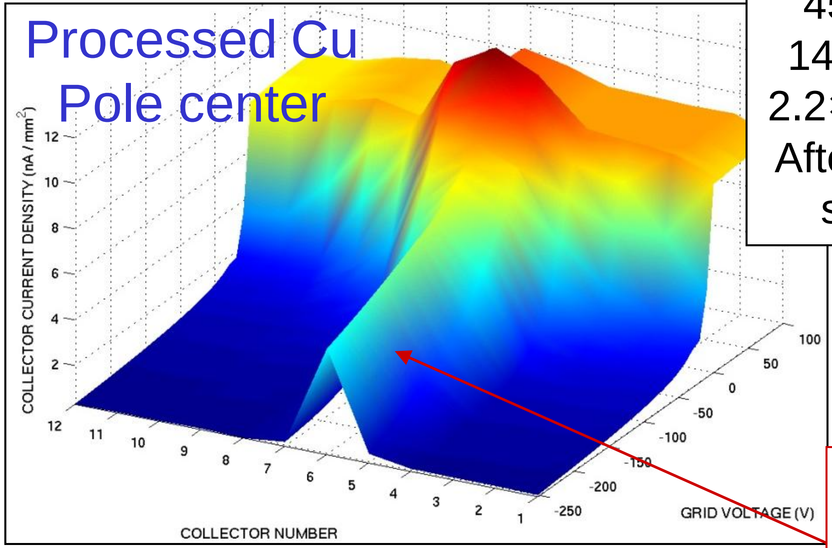
15E Drift RFAs

- April 2010 Down
  - Install amorphous C chamber (CERN) in location first occupied by Al chamber and then by TiN chamber
- 1x20, 5.3 GeV, 14ns
  - Compare three different chambers (Al – blue, TiN – green, Carbon – red) that were installed in 15E test location at different times
  - Both coatings show similar performance, much better than Al – Carbon (early in scrubbing process) currently lies in between processed and unprocessed TiN.
  - Will make final comparisons for scrubbed chambers (July 2010 run)

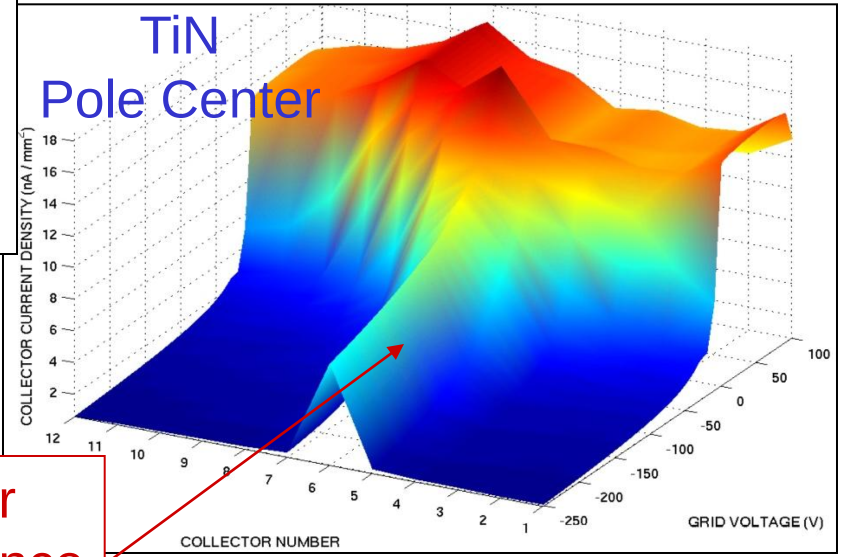

1x20 e+, 5.3 GeV, 14ns, 15E Drift RFA


1x20 e-, 5.3 GeV, 14ns, 15E Drift RFA

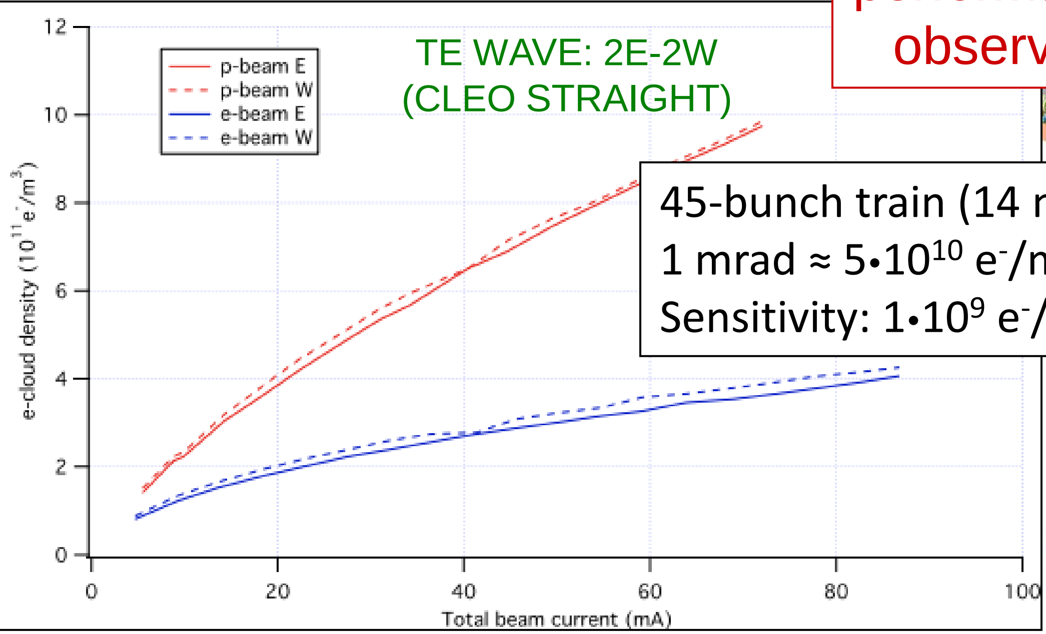
TE Wave & RFA Measurements in L0


Processed Cu
Pole center

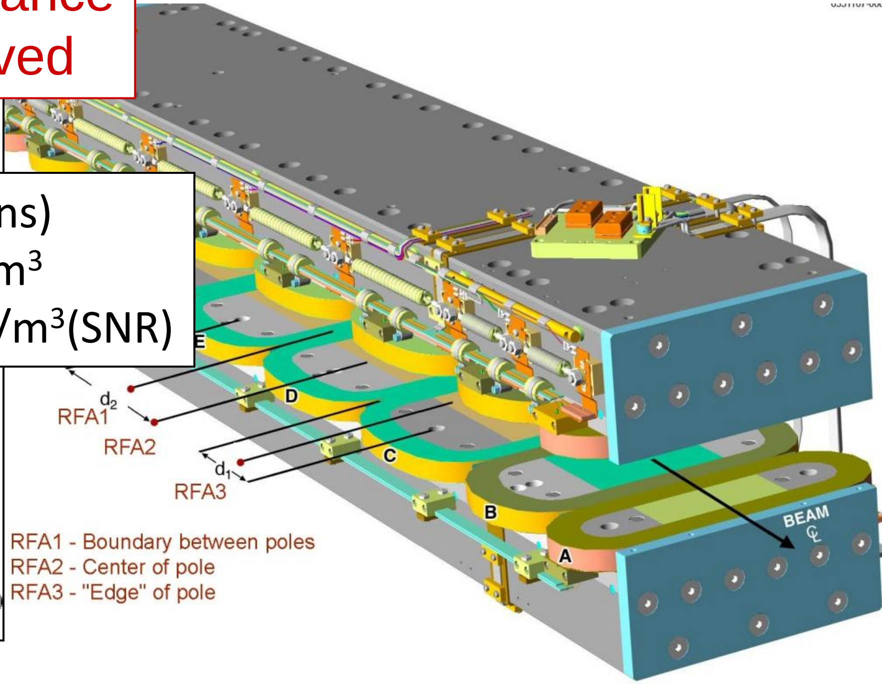
45 bunches
14ns spacing
$2.2{\times}10^{10}$/bunch
After extended scrubbing


TiN
Pole Center

Similar performance observed


TE WAVE: 2E-2W
(CLEO STRAIGHT)

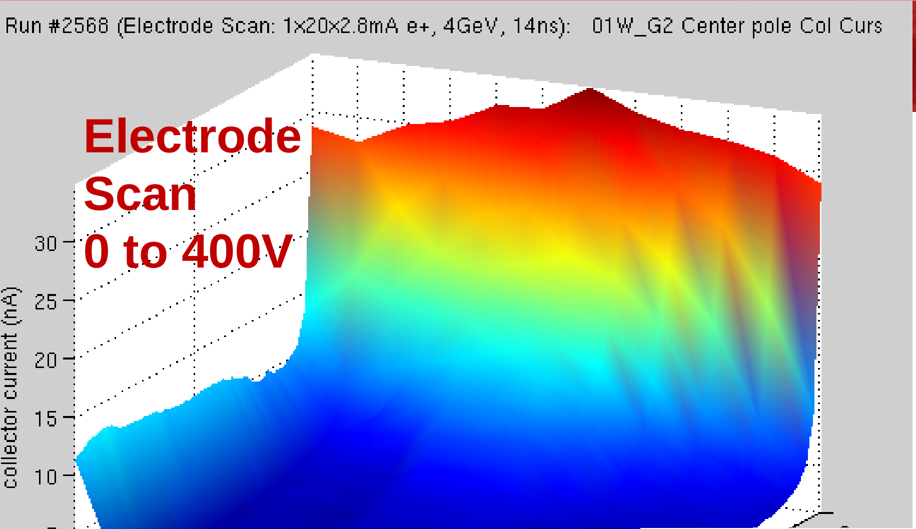
45-bunch train (14 ns)
1 mrad ≈ $5{\bullet}10^{10}$ e^-/m^3
Sensitivity: $1{\bullet}10^9$ e^-/m^3(SNR)

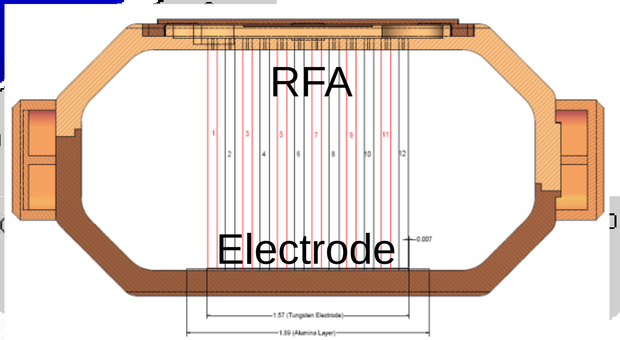


RFA1 - Boundary between poles
RFA2 - Center of pole
RFA3 - "Edge" of pole

Wiggler Clearing Electrode

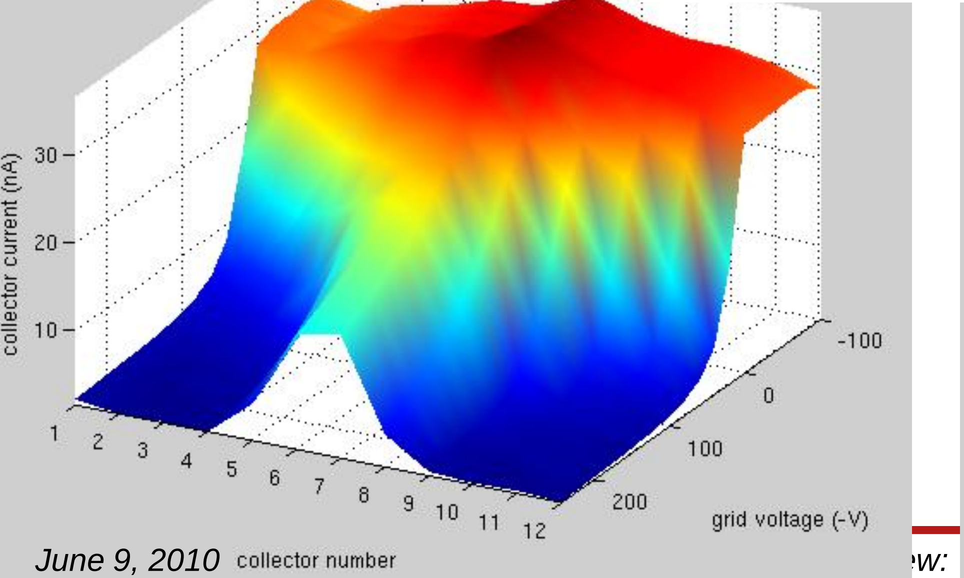
- 20 bunch train, 2.8 mA/bunch
  - 14ns bunch spacing
  - E_{beam} = 4 GeV with wigglers ON
- Effective cloud suppression
  - Less effective for collector 1 which is not fully covered by electrode





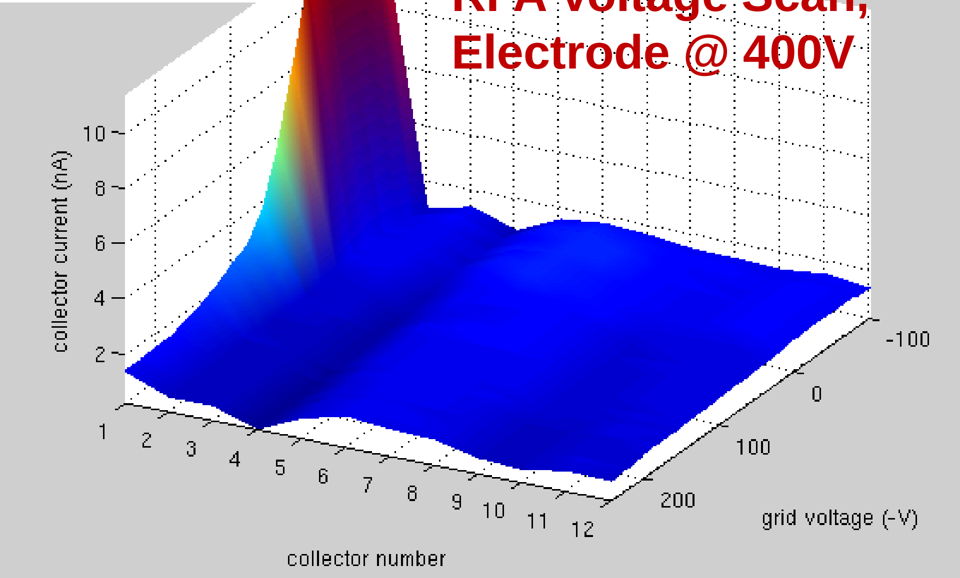
Run #2567 (Electrode:0V, 1x20x2.8mA e+, 4GeV, 14ns): 01W_

RFA Voltage Scan, Electrode @ 0V

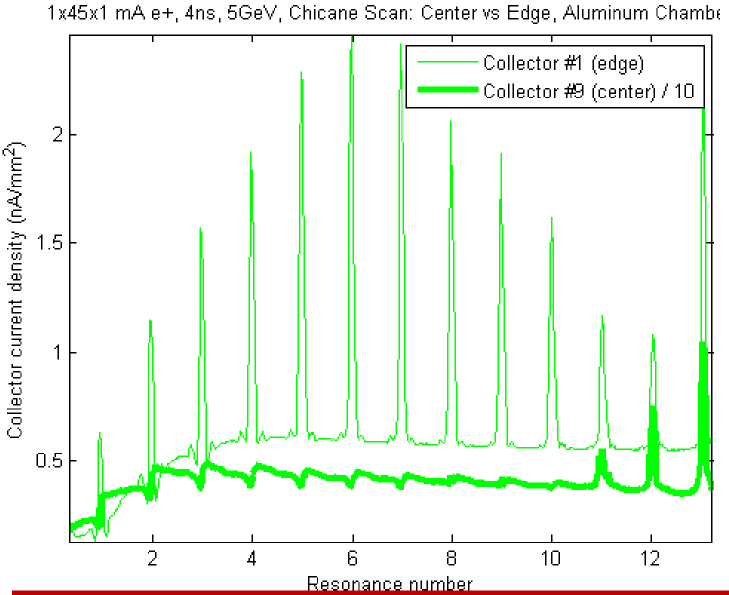


00V, 1x20x2.8mA e+, 4GeV, 14ns): 01W_G2 Center pole Col Curs

RFA Voltage Scan, Electrode @ 400V

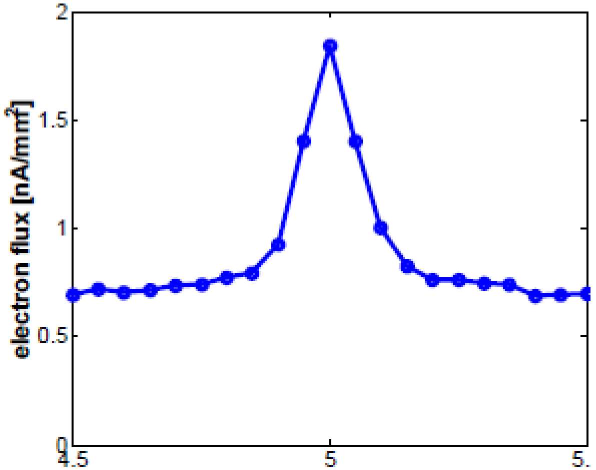


L3 Chicane (SLAC): Measurements & Simulations

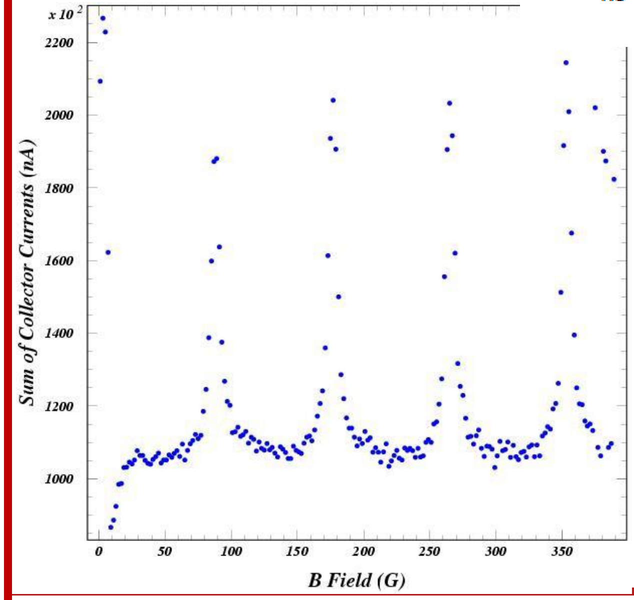


Cyclotron resonances can be reproduced in both ECLOUD and CLOUDLAND

- Plots are of the sum of all collectors for 45 bunches, positrons, 4ns spacing, $\delta_{max} = 2.0$
- Dips are harder to reproduce



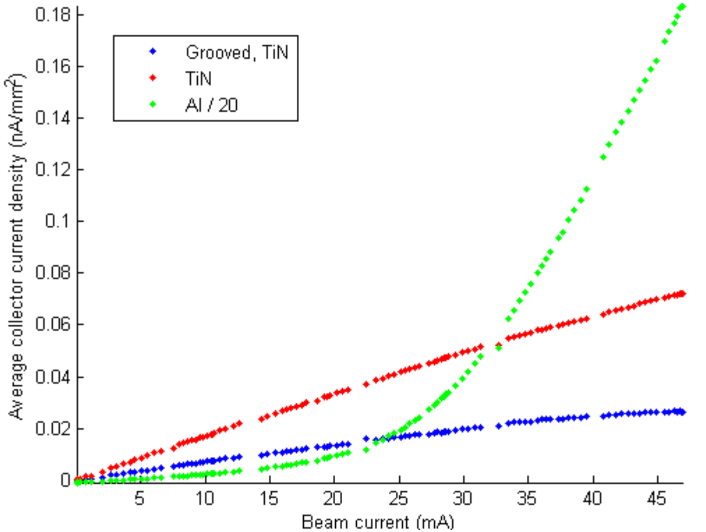
CLOUDLAND (L.Wang)



ECLOUD (J. Crittenden)

Mitigation Comparisons

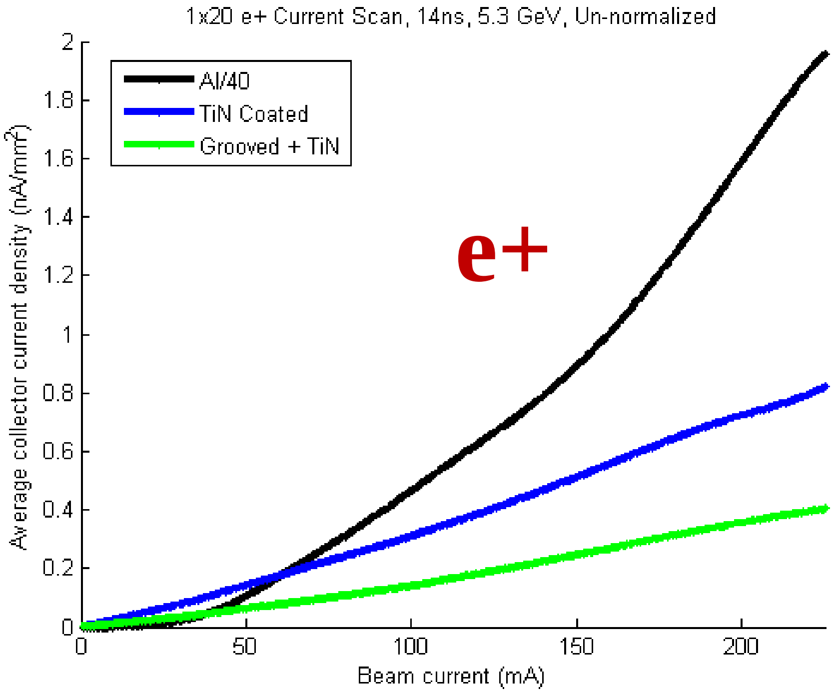
Al (20) vs TiN vs TiN+Grooves

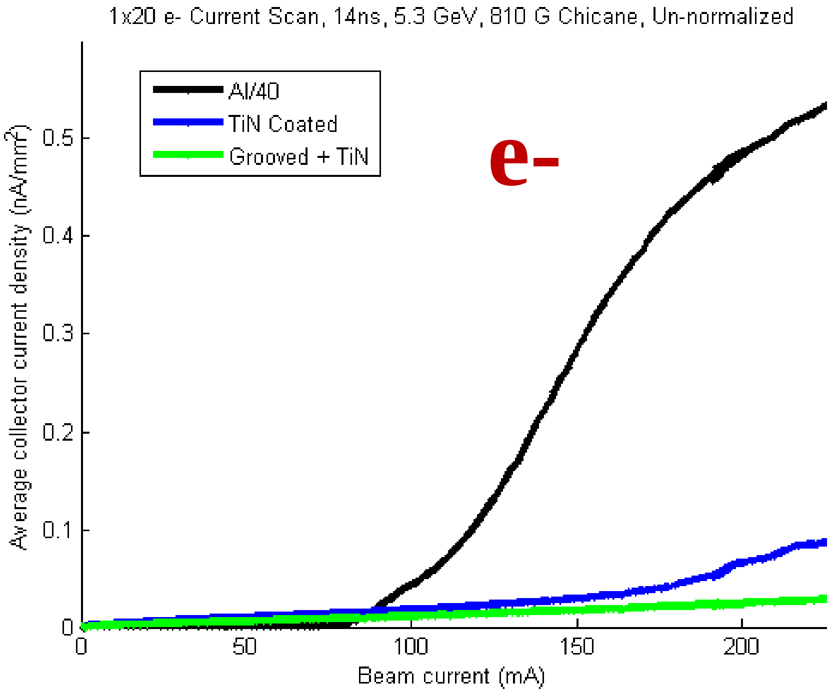


Mitigation Performance in Dipoles (e+ & e-)

- 1x20 e+, 5.3 GeV, 14ns
  - 810 Gauss dipole field
  - Signals summed over all collectors
  - Al signals ÷40

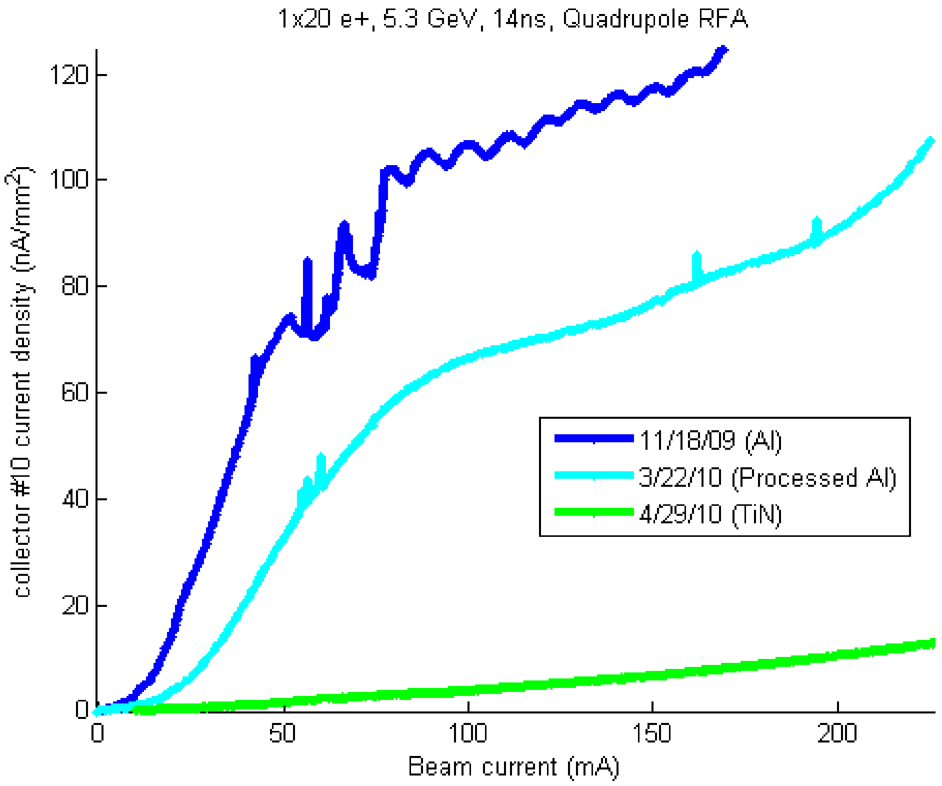
Longitudinally grooved surfaces offer significant promise for EC mitigation in the dipole regions of the damping rings

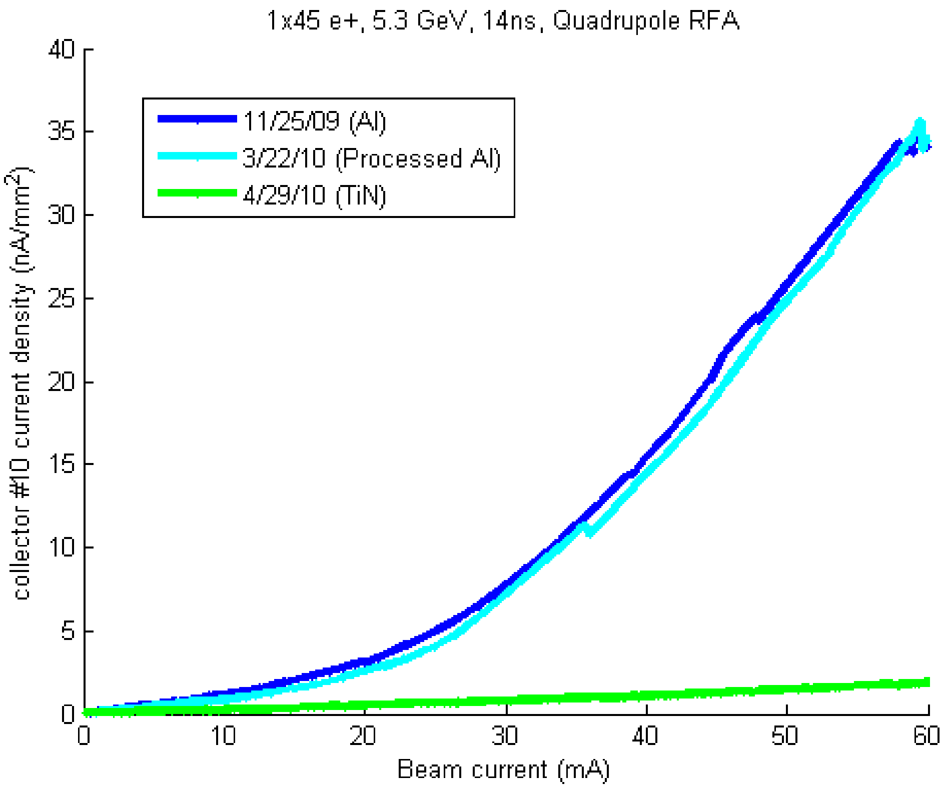




Quadrupole Measurements

- Left: 20 bunch train e+
- Right: 45 bunch train e+ Clear improvement with TiN
- Currents higher than expected from “single turn” simulations
  - Turn-to-turn cloud buildup
  - Issue also being studied in wigglers

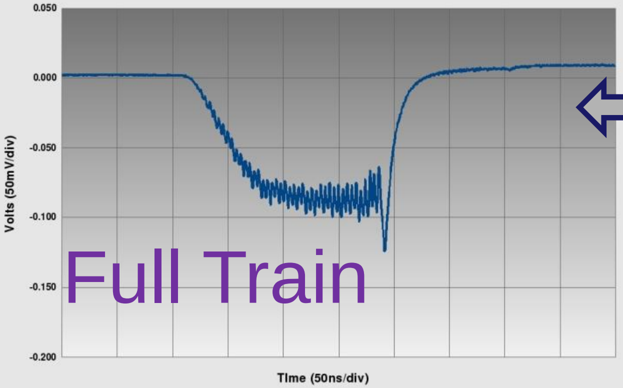




Time Resolved Measurements

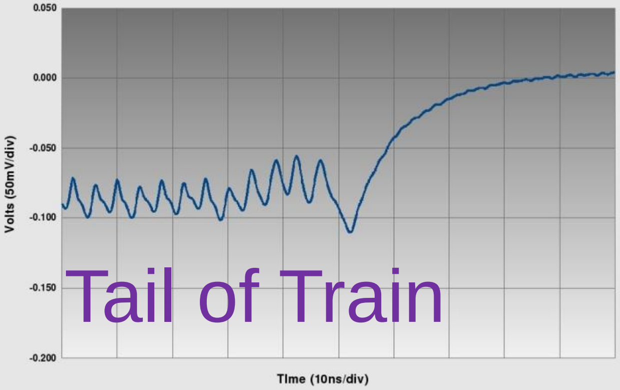
Positron Bunch Train 1x45 4ns 64mA Total Current

4.0 GeV Conditions Button Bias +50V



Positron Bunch Train 1x45 4ns 64mA Total Current

Leading Bunches

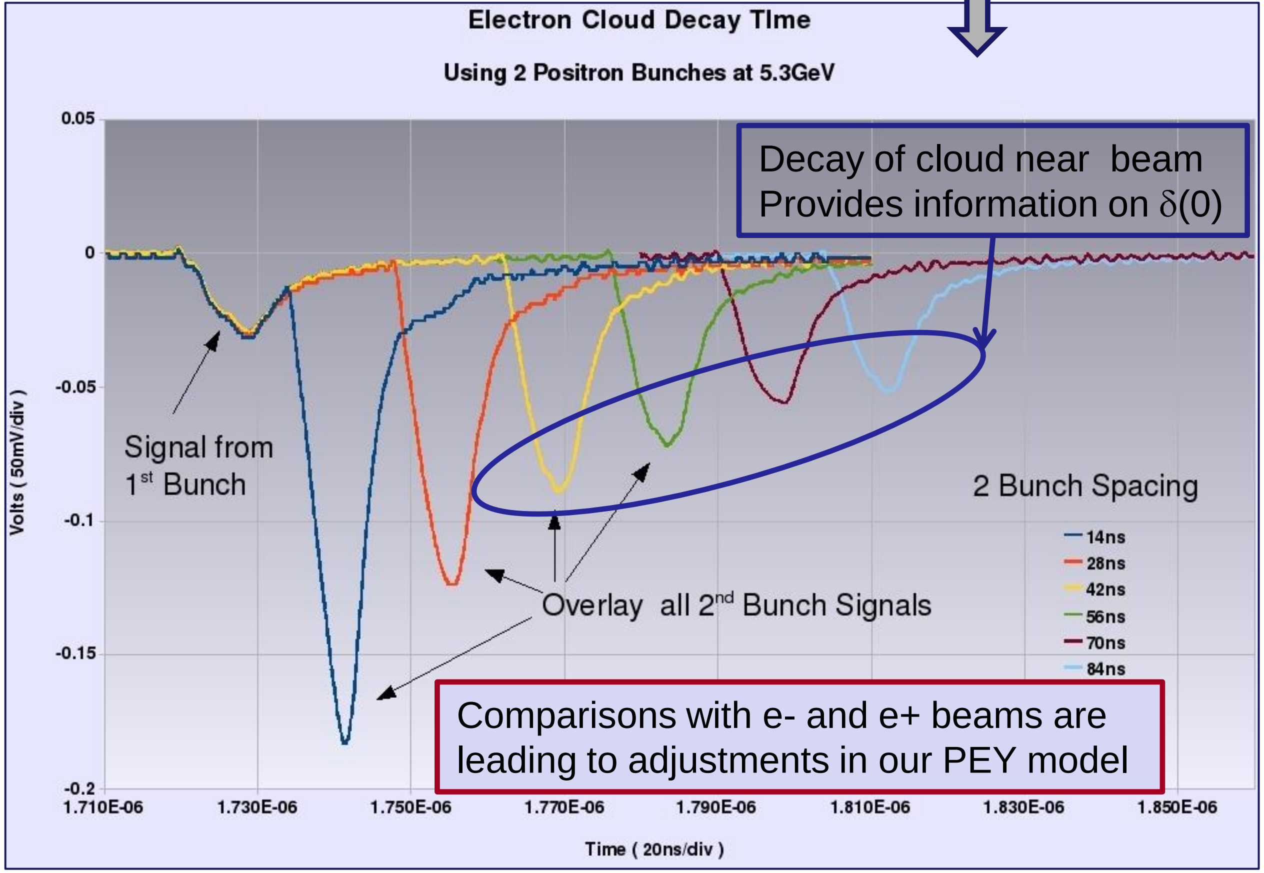


45 bunch train
4ns bunch spacing
$\sim 2.3\ 10^{10}$ e+/bunch

Witness Bunch Studies:
EC-generating Bunch
Trailing Probe Bunch

Electron Cloud Decay TIme

Using 2 Positron Bunches at 5.3GeV



Decay of cloud near beam
Provides information on $\delta(0)$

Comparisons with e- and e+ beams are leading to adjustments in our PEY model

Higher BW Version of CERN Technique
Mahners, *et al.*, PRSTAB 11 094401 (2008)

Coherent Tune Shifts

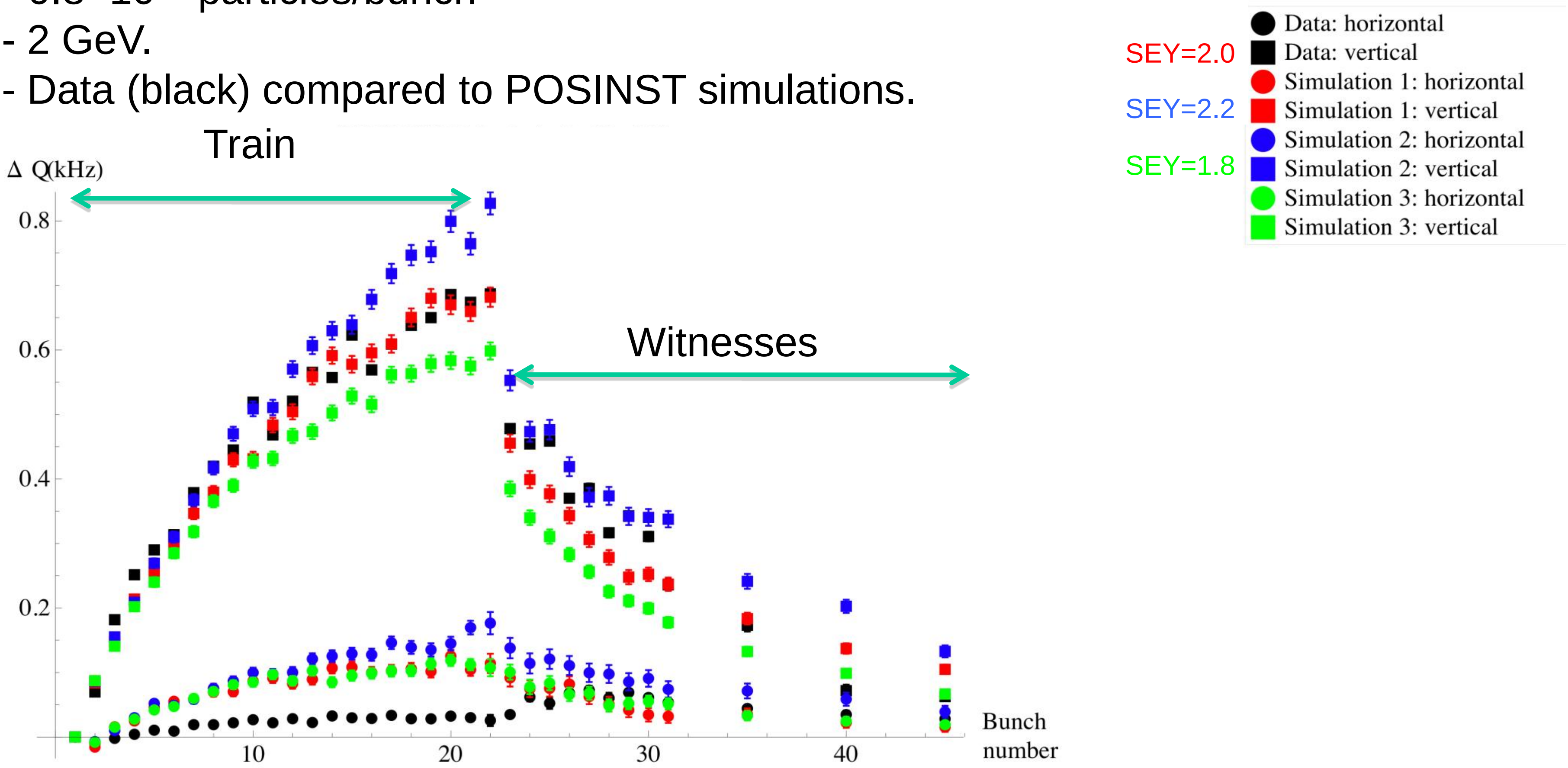
- Measurements of bunch-by-bunch coherent tune shifts:
  - Along bunch trains and with witness bunches
  - Positron and electron beams
  - For a wide range of:
    - Beam energies
    - Emittances
    - Bunch currents
    - Bunch spacings
    - Train lengths
- Methods: Excite coherent oscillations of whole trains using a single-turn pinger
  Observe tune of self-excited bunches (Dimtel system diagnostics)
  Excite individual bunches using a fast kicker
- Comparison with predictions (dipoles & drifts): POSINST
  ECLOUD
- Fit all data ⇨ 6 EC model parameters: Peak SEY
  Photon reflectivity
  Quantum efficiency
  Rediffused yield
  Elastic yield
  Peak secondary energy

Example: Positron Witness Bunch Study at 2GeV

Peak SEY Scan

Coherent Tune Shifts (1 kHz ~ 0.0025), vs. Bunch Number

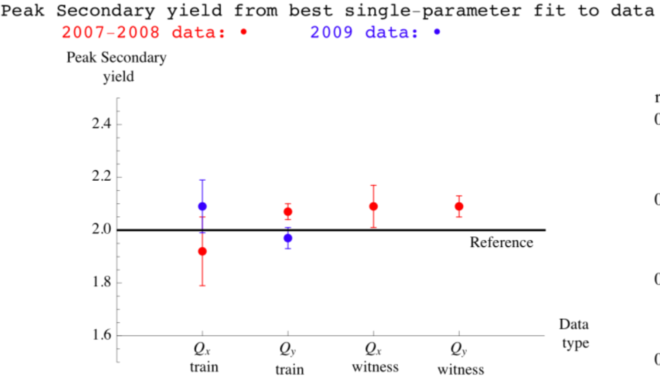
- 21 bunch train, followed by 12 witness bunches
- 0.8 10^{10} particles/bunch
- 2 GeV.
- Data (black) compared to POSINST simulations.

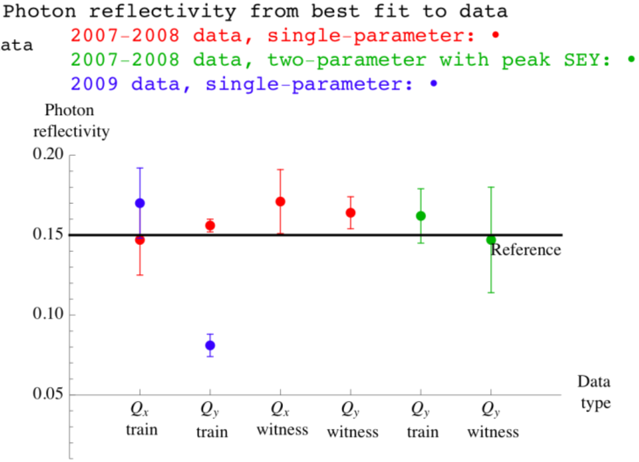


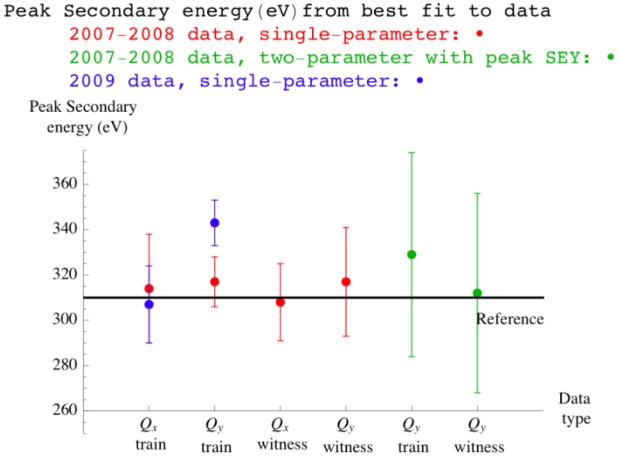
Coherent Tune Shift Comparisons

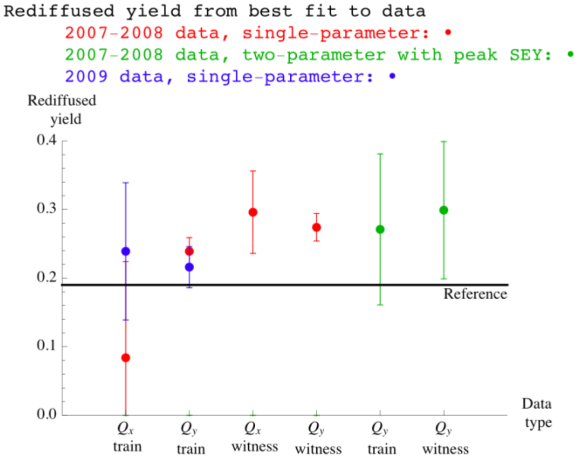
14 ns spacing

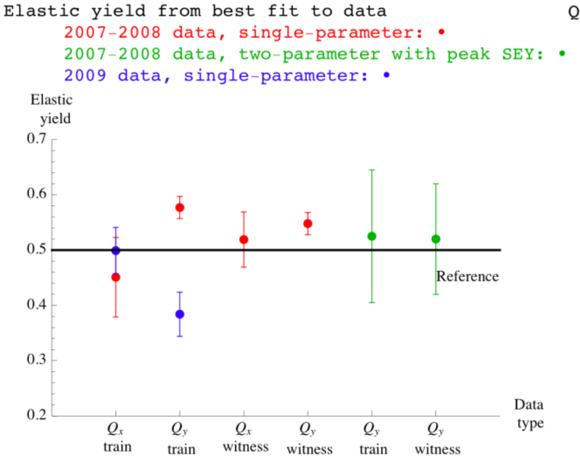
Measure coherent train motion

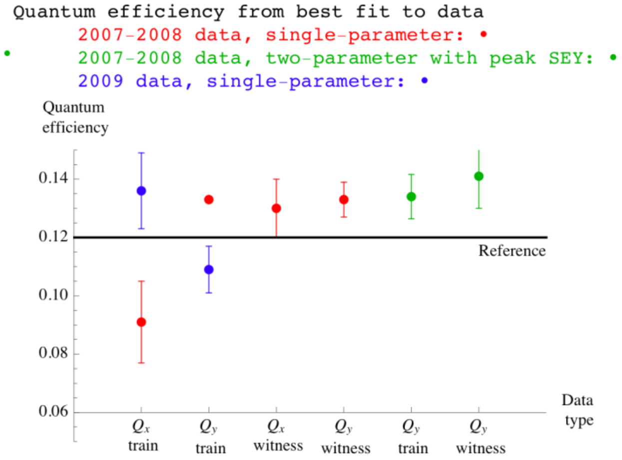








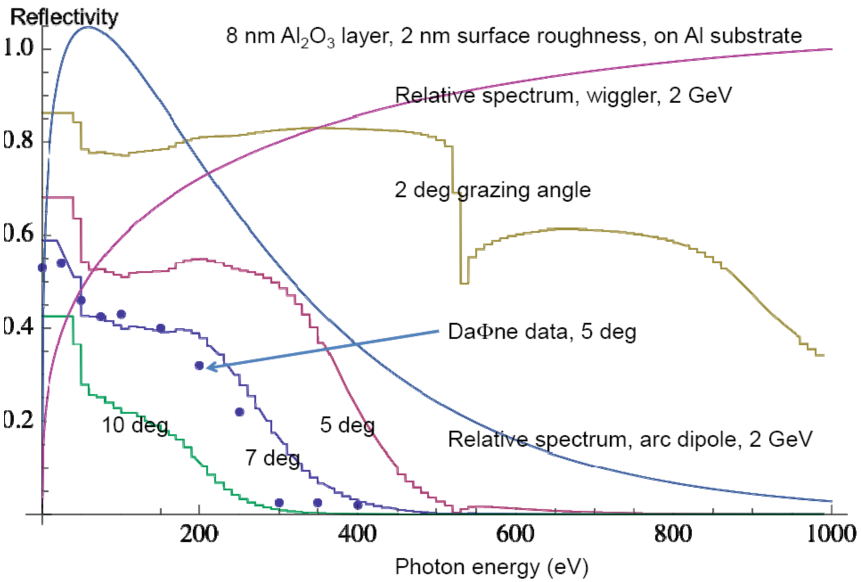


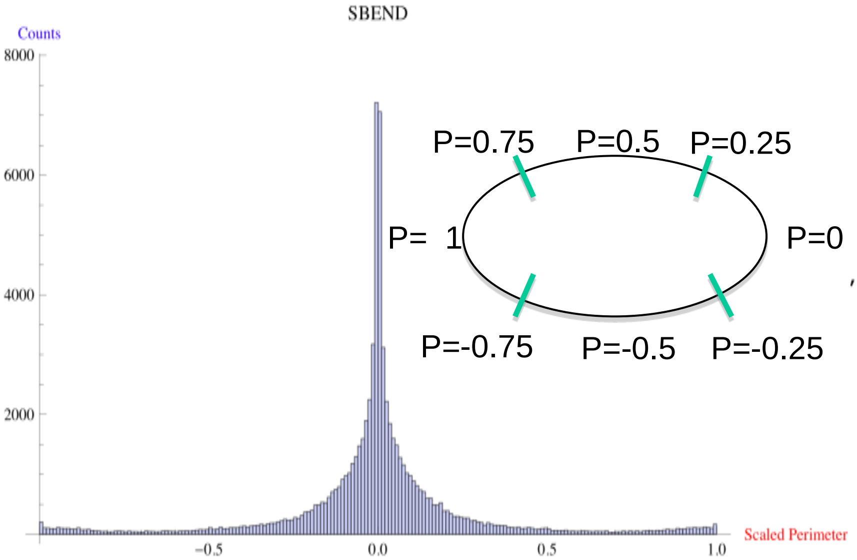


The ability to obtain a set of EC model parameters which works for a wide range of conditions validates the fundamental elements of the cloud model.

Synchrotron Radiation Simulations

- SYNRAD3D (Sagan *et al.*): computes the direct and reflected synchrotron radiation distributions
  - Parameterizes X-ray scattering data from the LBNL online database.
  - Provides azimuthal distributions around the vacuum chamber of photon absorption sites at each ***s*** position around the ring.
- Results needed to understand photon distributions in CESRTA instrumented vacuum chambers
  - Resulting photon distributions show significant differences from typical values obtained from models which ignore reflections – both in azimuthal and in longitudinal distributions
  - For CESRTA simulations, photon rates in key areas can vary by a factor of several
- Work underway to incorporate these results into the RFA and Coherent Tune Shift analyses

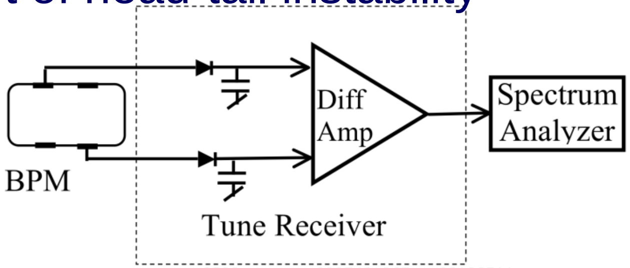




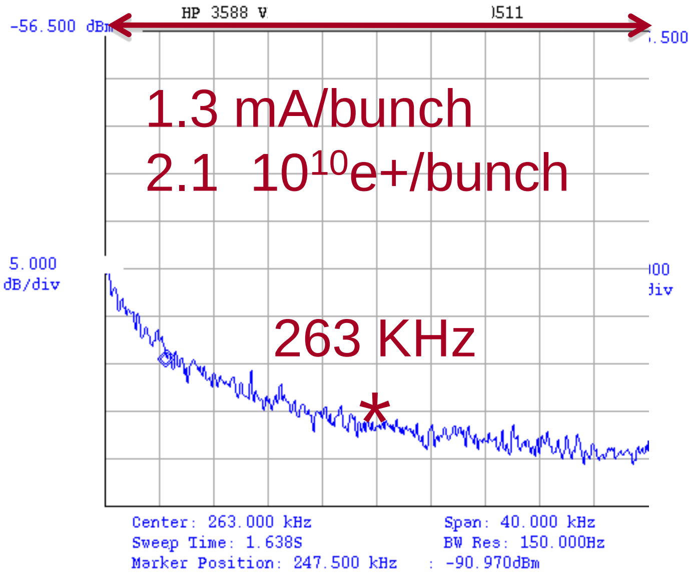
Beam Instabilities & Emittance Growth

- Bunch-by-bunch measurements - xBSM
- Single-bunch (head-tail) – spectral methods and growth rates
- Multi-bunch modes via feedback and BPM system
- Modeling: KEK-Postech (analytical estimates and simulation)
  SLAC-Cornell (CMAD)
  Frascati (multi-bunch instability)

- Current scan in 45 bunch positron train ⇨ Look for onset of head-tail instability
- 2 GeV Low Emittance Lattice, 14ns bunch spacing
  - F_v & Head-Tail Mode spectra (expected at $F_v + F_s$)
  - Synchrotron Tune ~26 kHz



Preliminary



40 kHz

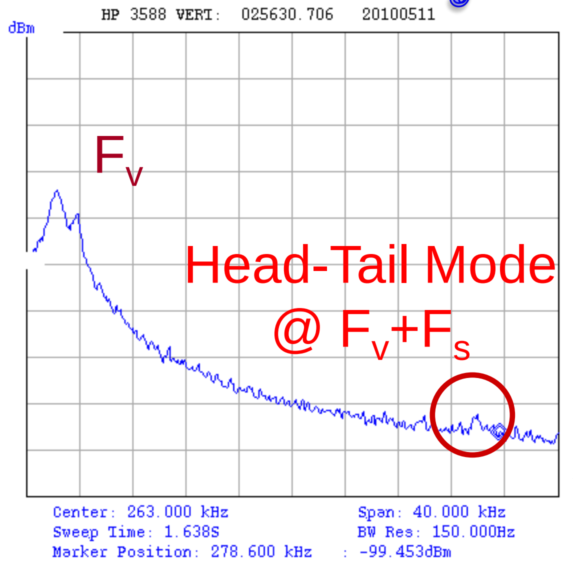
1.3 mA/bunch

2.1 10^{10}e+/bunch

263 KHz

*

Bunch #1

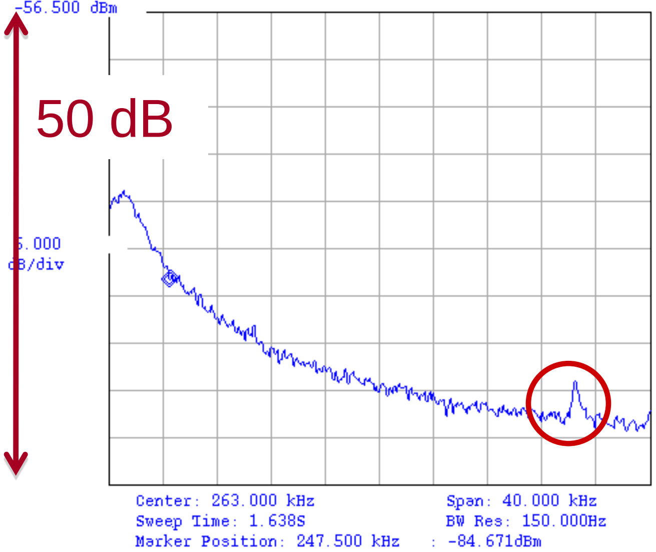


F_v

Head-Tail Mode @ F_v+F_s

Bunch #25

50 dB



Bunch #40

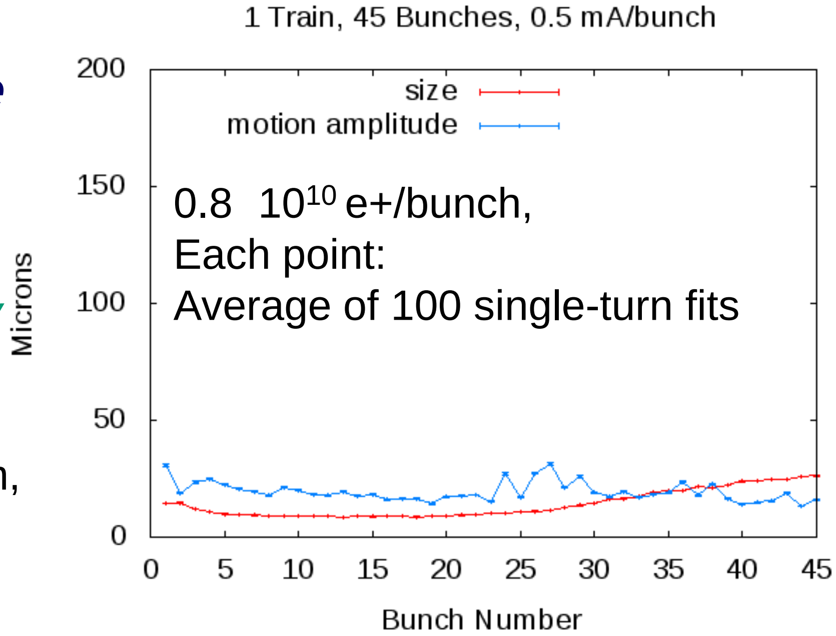
Beam Size

- Measure Bunch-by-Bunch Beam Size

  Same current scan as on preceding page
  - Beam size enhanced at head and tail of train

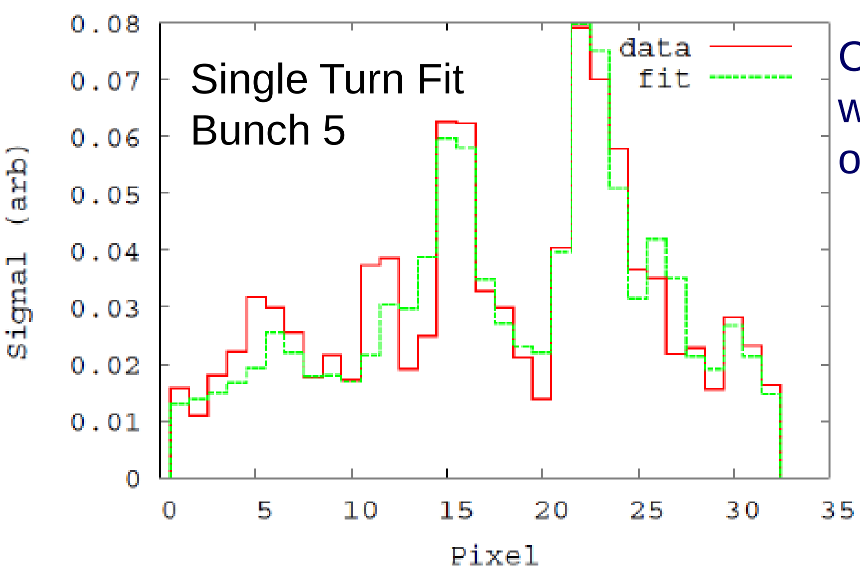
    Source of blow-up at head requires further investigation (resonance? other?).

    Bunch lifetimes (Touschek-limited) qualitatively consistent with relative bunch sizes.
  - Beam size measured around bunch 5 is consistent with $\varepsilon_y \sim 20$pm-rad (σ_y=11.0±0.2 μm, β_{source}=5.8m)



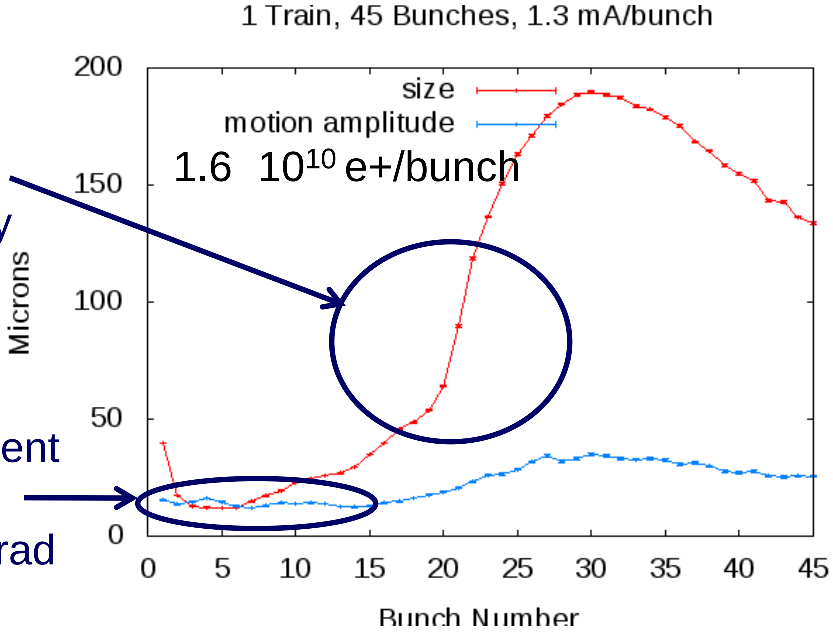
$0.8\ 10^{10}$ e+/bunch,
Each point:
Average of 100 single-turn fits

Preliminary



Single Turn Fit
Bunch 5

Consistent with onset of instability

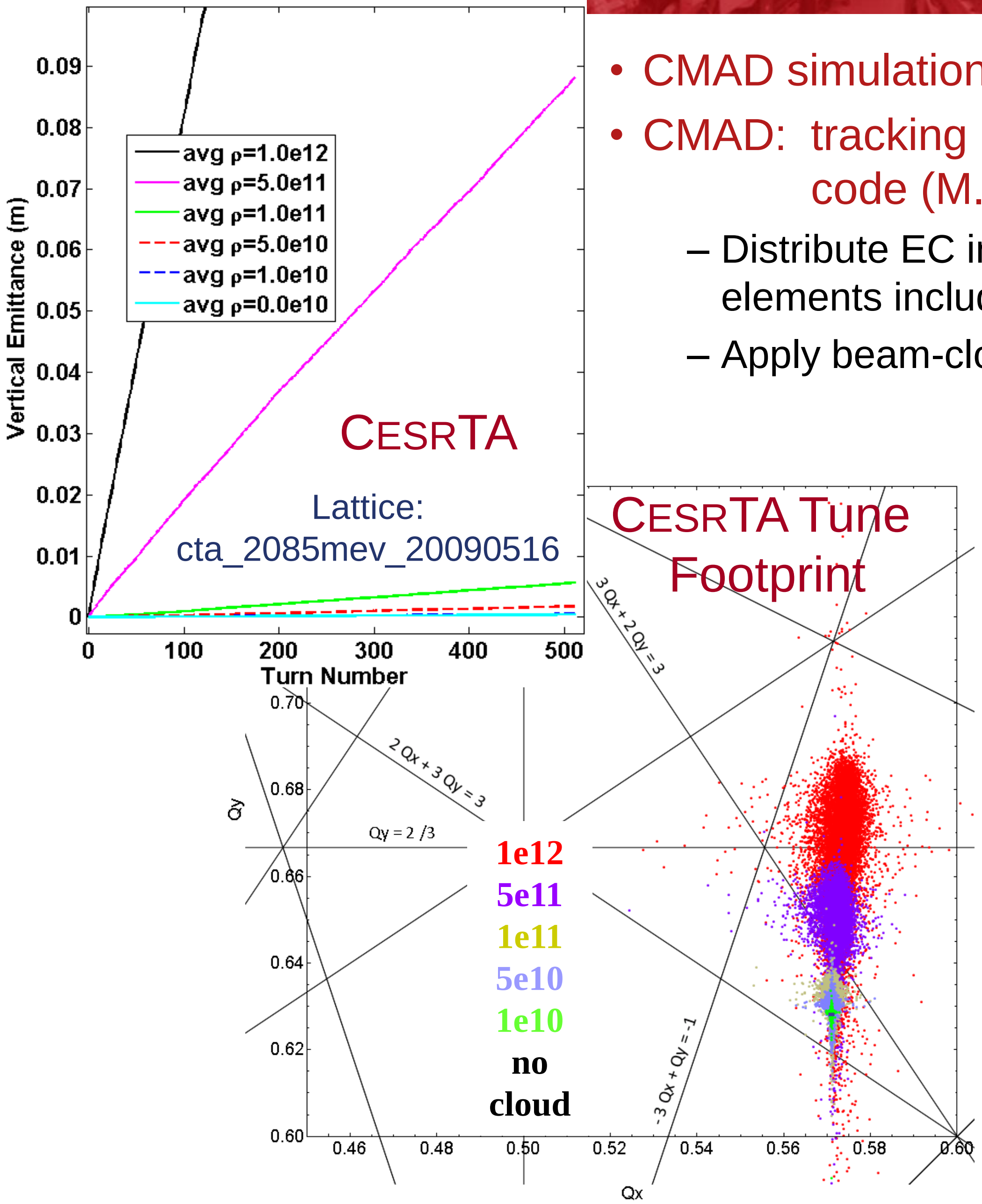


$1.6\ 10^{10}$ e+/bunch

Consistent
with
20 pm-rad

Simulation of Incoherent ε_y Growth & Instabilities

- CMAD simulation (Pivi, Sonnad)
- CMAD: tracking and e-cloud beam instability parallel code (M.Pivi SLAC)
  - Distribute EC in every magnetic element of ring: ~1,000 elements including drift, dipoles, quad, sext, etc.
  - Apply beam-cloud IP in every element

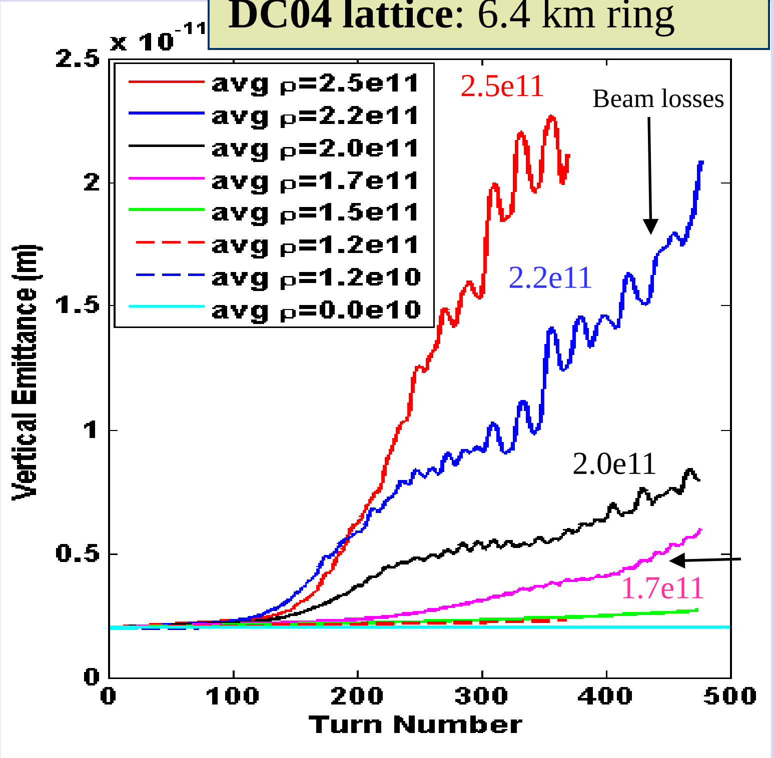


CESRTA

Lattice: cta_2085mev_20090516

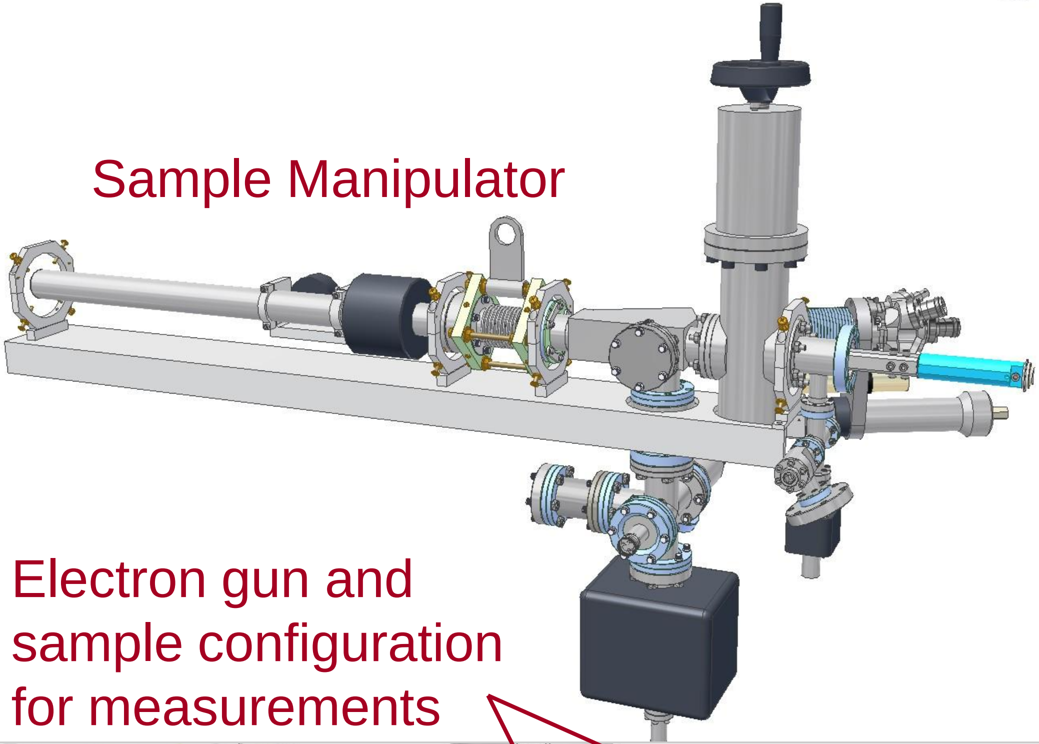
CESRTA Tune Footprint

Application to ILC DR

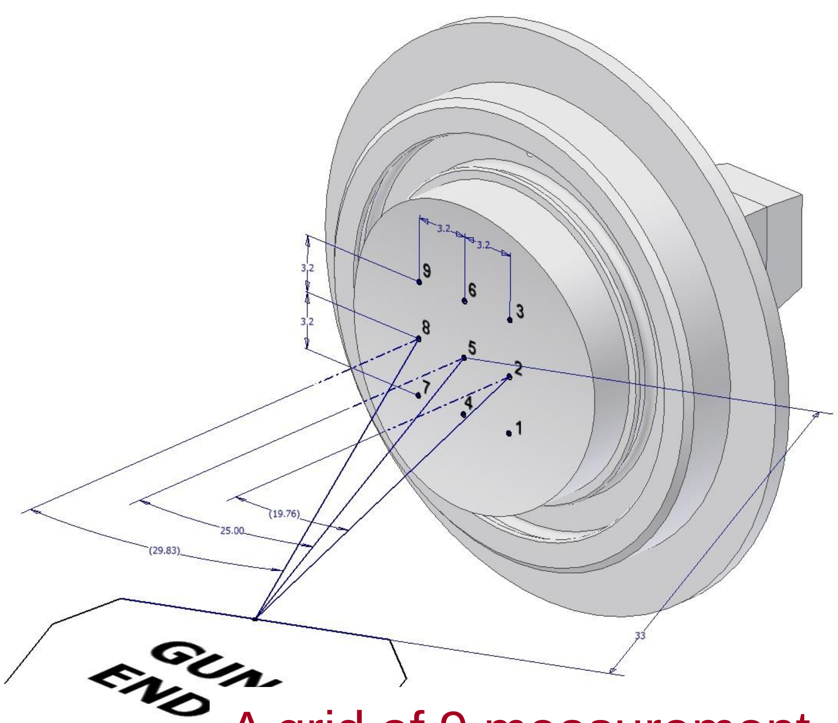


DC04 lattice: 6.4 km ring

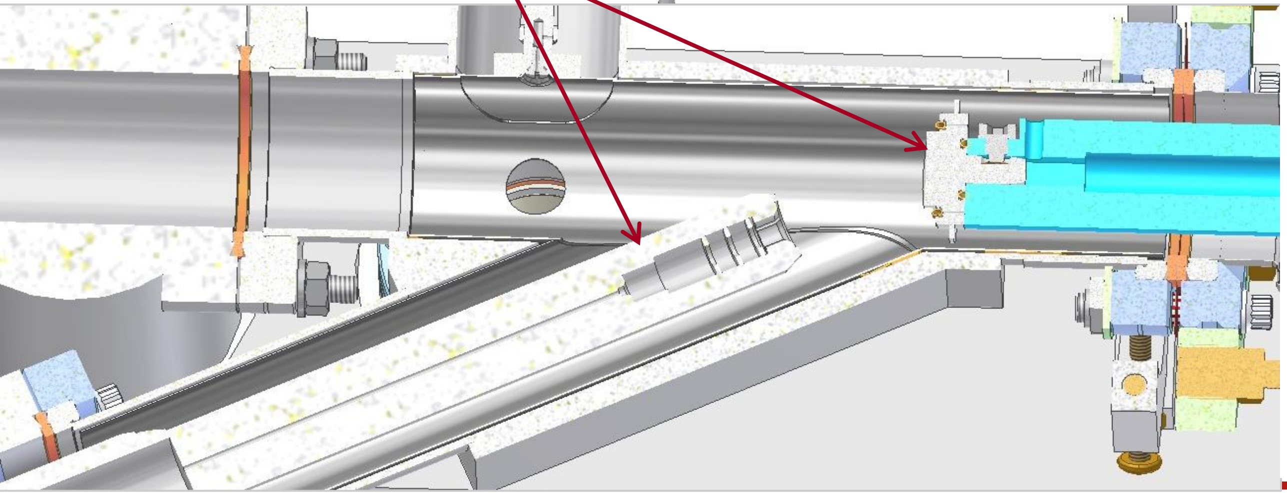
In Situ SEY Measurement System



Sample Manipulator



Electron gun and sample configuration for measurements

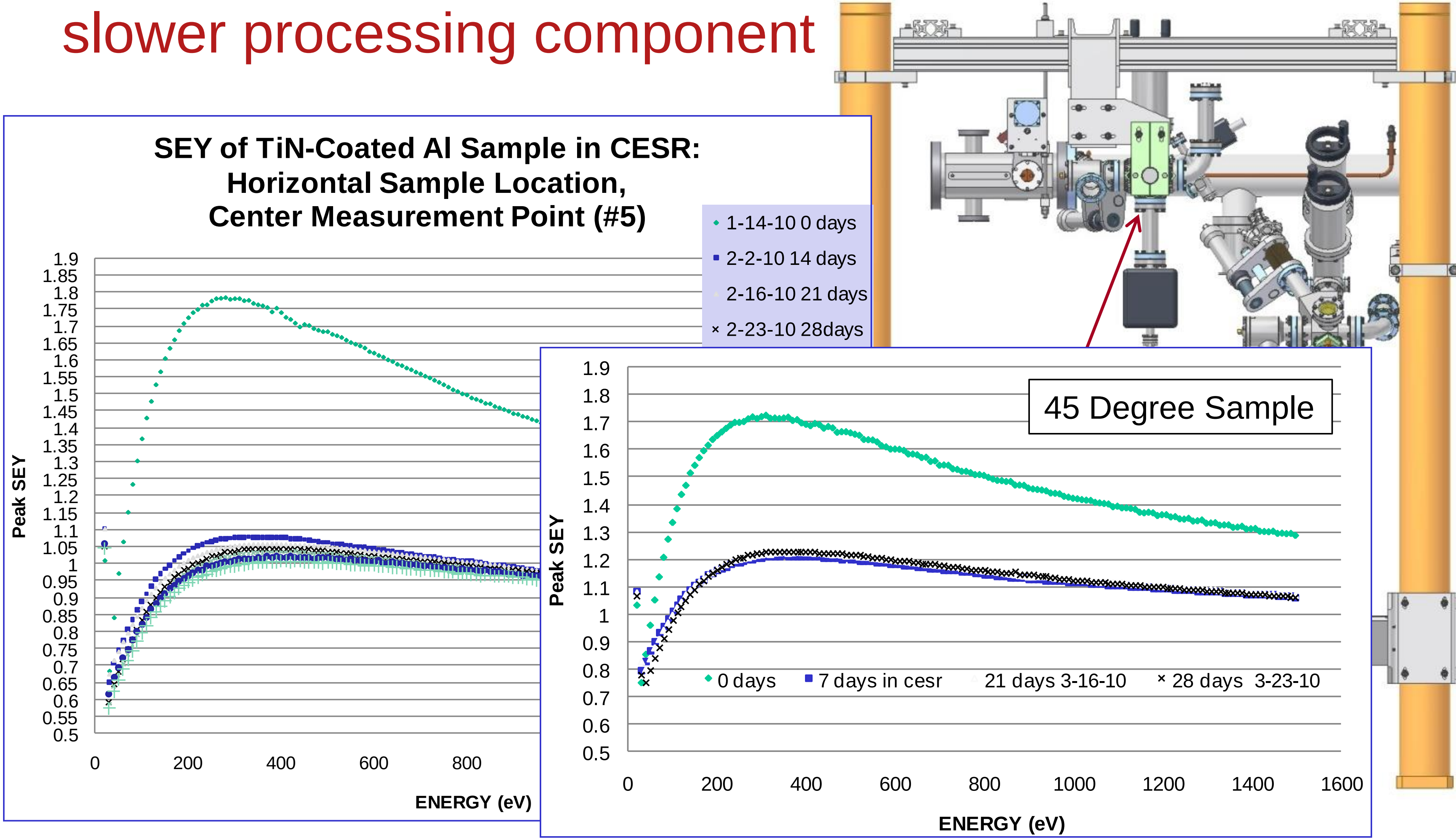


A grid of 9 measurement points is defined on the sample surface and the gun steering electrodes are used to make measurements at each point

Angles: 20°, 25°, 30°

SEY Measurements: TiN

- Rapid initial improvement in SEY followed by a slower processing component



SEY of TiN-Coated Al Sample in CESR:
Horizontal Sample Location,
Center Measurement Point (#5)

Implications for the DR I

- Mitigation performance – a few comments (note that not all measurements have been discussed in this talk)…
  - Grooves are effective in dipole/wiggler fields, *but challenging to make when depth is small*
  - Amorphous C and TiN show similar levels of EC suppression so both coatings can be considered for DR use
    - Both have worse dP/dI than Al chambers at our present level of processing
    - In regions where TiN-coated chambers are struck by wiggler radiation (high intensity and high Ec), we observe significant concentrations of N in the vacuum system
  - EC suppression with the clearing electrode in the wiggler is very good
    - No heating issues have been observed with the wiggler design in either CESRTA or CHESS operating conditions
  - Further work remains to take RFA measurements in chambers with mitigations and convert these to the effective SEY of the chamber surfaces
    - Agreement between data and simulation continues to improve
    - One area that has not been fully resolved is that we see more EC in our quadrupole test chamber than is expected. Possibly due to trapping and build-up of the cloud over the course of multiple turns. Trapping issues in the wigglers are also being studied (Celata, Wang)
  - In situ SEY measurements raise the question of how the SEY varies around the chamber azimuth
  - First measurements in NEG chamber are underway
    - Also want to test new NEG formulations (lower activation temperature) being proposed for DR use
  - Quadrupole chamber measurements continue

Implications for the DR II

- Time-resolved studies (shielded pickups)
  - Being applied to understand SEY at ~0 energy, $\delta(0)$, which determines EC decay rates
  - Have already shown discrepancies in the PEY spectra being used (e- beam data)
- Photon transport models
  - Detailed 3D simulation shows differences from models typically used
  - Potential implications for modeling assumptions in regions with high photon rates (arc and wiggler regions)
  - *High priority to test this in detail using the CesrTA data and then apply to the ILC DR simulations*
- Low emittance and techniques to measure instabilities and sub-threshold emittance growth
  - Measurement tools are rapidly maturing
  - Coordinated simulation effort with a focus on testing predictions
  - *High priority to carry out systematic studies of the instability thresholds in the low emittance regime*
  - *High priority to design experiments and characterize incoherent emittance growth below the instability threshold. Recent simulation results reinforce this concern.*

Underlined items will be major focus of the remaining running time in the current CesrTA Program

Damping Ring Activities

- Highlight 2 additional activities supported by ART:
  - ILC Damping Rings Electron Cloud Working Group

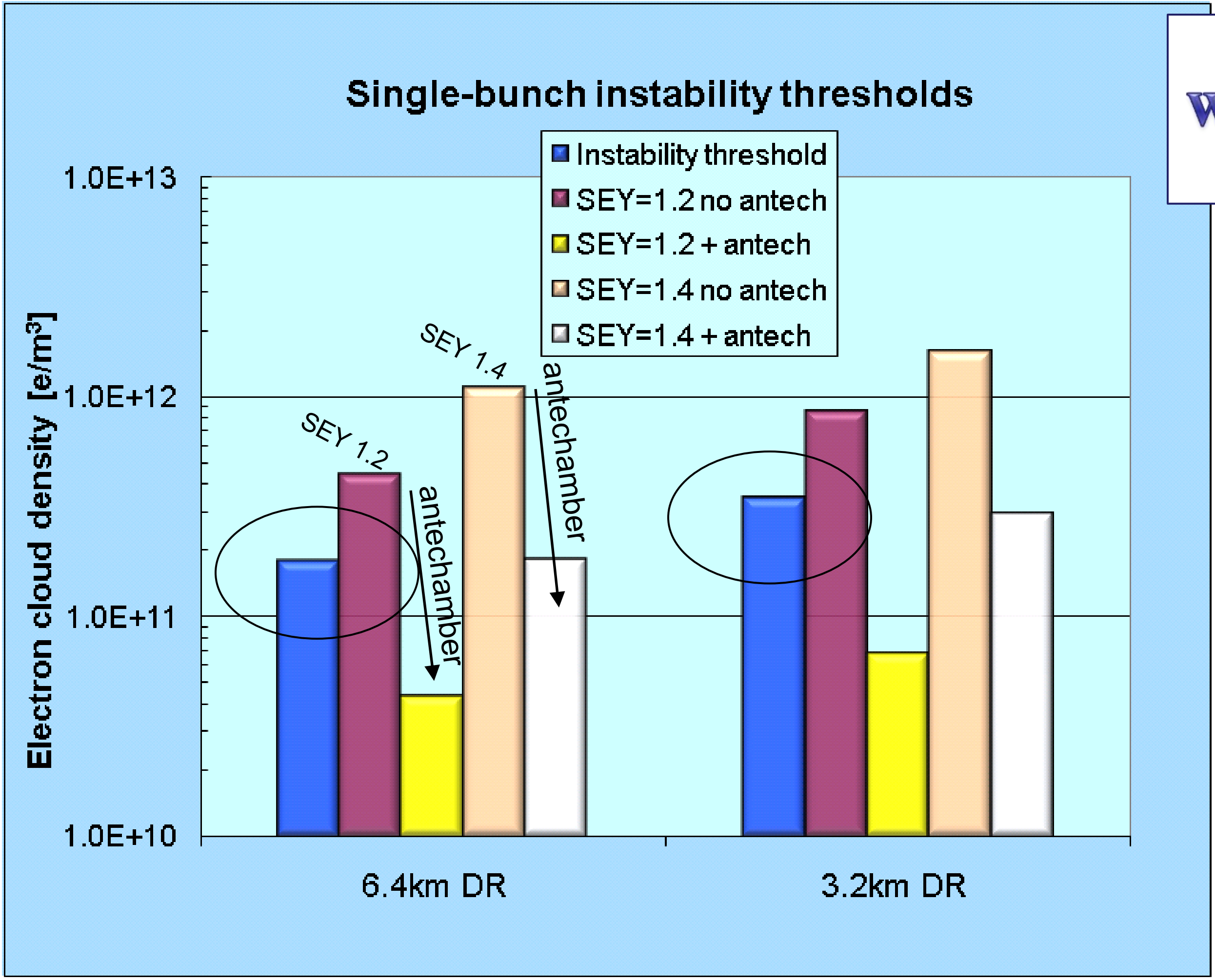
    - M. Pivi (SLAC) – working group coordinator
    - Members: *K. Harkay, L. Boon (ANL/Purdue)*
      I. Papaphilippou (CERN)
      J. Crittenden, G. Dugan, M. Palmer (Cornell)
      T. Demma, S. Guiducci (INFN-LNF)
      K. Ohmi, K. Shibata, Y. Suetsugu (KEK)
      M. Furman, M. Venturini, C. Celata (LBNL)
      O. Malyshev (Liverpool U.)
      L. Wang, (SLAC)

ART Supported

    - ***1st Task: Address the question of whether a 3.2 km DR with 1300 bunches is viable from the EC perspective (SB2009 Proposal)***
  - Fast Kicker Development (SLAC)
    - Fast pulsers with reliability and high availability requirements built into the core of the design
    - C. Burkhart, A. Krasnykh, R. Larsen, & T. Tang
    - DSRD Devices from Diversified Technologies, Inc. (DOE-SBIR funding)

Compare thresholds for 6 km and 3km DR

ILC DR EC
Working Group
M. Pivi



Simulation campaign 2010: compiled data of build-up simulations compared against the simulated beam instability thresholds. Overall ring average cloud densities for the 6 km and 3km rings. The surface Secondary Electron Yield (SEY) determines the cloud build-up and density level.

Base for Recommendation and Risk Assessment

- With respect to the RDR baseline, the risk level to adopt a reduced 3km Damping Ring while maintaining the same bunch spacing is: Low.
- The acceptable surface Secondary Electron Yield (SEY) may strongly depend on issues not yet thoroughly investigated as beam jitter and the slow incoherent emittance growth. Refined estimations of the photoelectron production rate by simulations will better define the SEY.
- Reducing the positron ring circun losing the back up option of 12 n regime) and will reduce the lumir
- In the event that effective EC mit 3km damping ring, an option of last resort would be to add a second positron damping ring.

ILC DR EC Working Group M. Pivi

Now Tasked with a New Question:
What is the limiting current at which we can consider operating the smaller ring? (*ie, can we consider full current operation in the 3.2km design?*)

⇨ Challenges the EC mitigations to allow operation below the predicted instability thresholds.

DSRD Pulser

- Targeting:
  - **Full scale prototype (FY10-Q3)**
  - **Demonstration modulator (FY10-Q4)**
  - **ATF2 Testing of 4ns Pulser (FY11)**

Tek Run Sample 11 Feb 10 09:38:17

Curs1 Pos 0.0V

Curs2 Pos -4.42V

V1: 0.0V
V2: -4.42V
ΔV: -4.42V

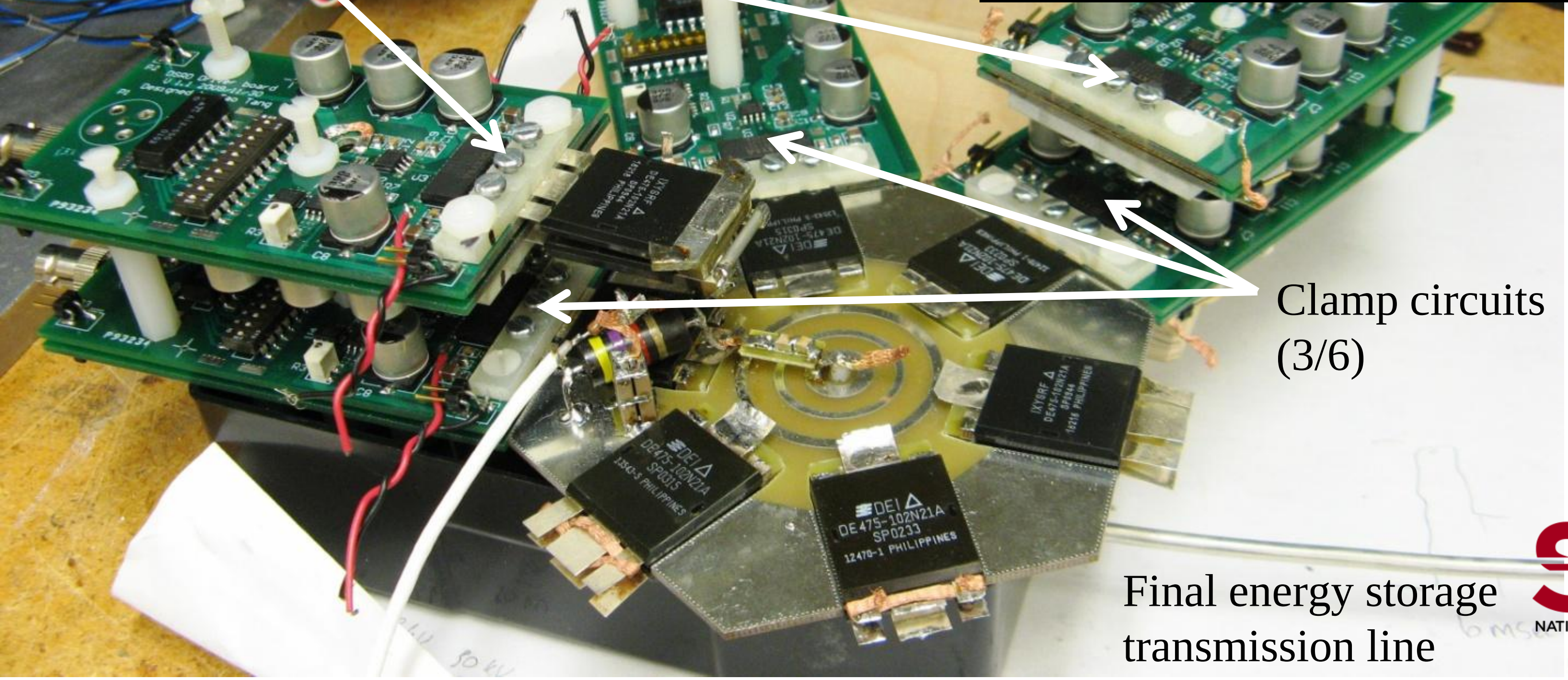
Fall(C1) 1.2ns

Neg Wid(C1) 4.457ns

Ch1 1.0V Ω

M 1.0ns 20.0GS/s IT 20.0ps/pt
A Aux ⁄ 3.0V

Width not yet tuned
~4.5 ns



Pump circuits
(2/3)

Clamp circuits
(3/6)

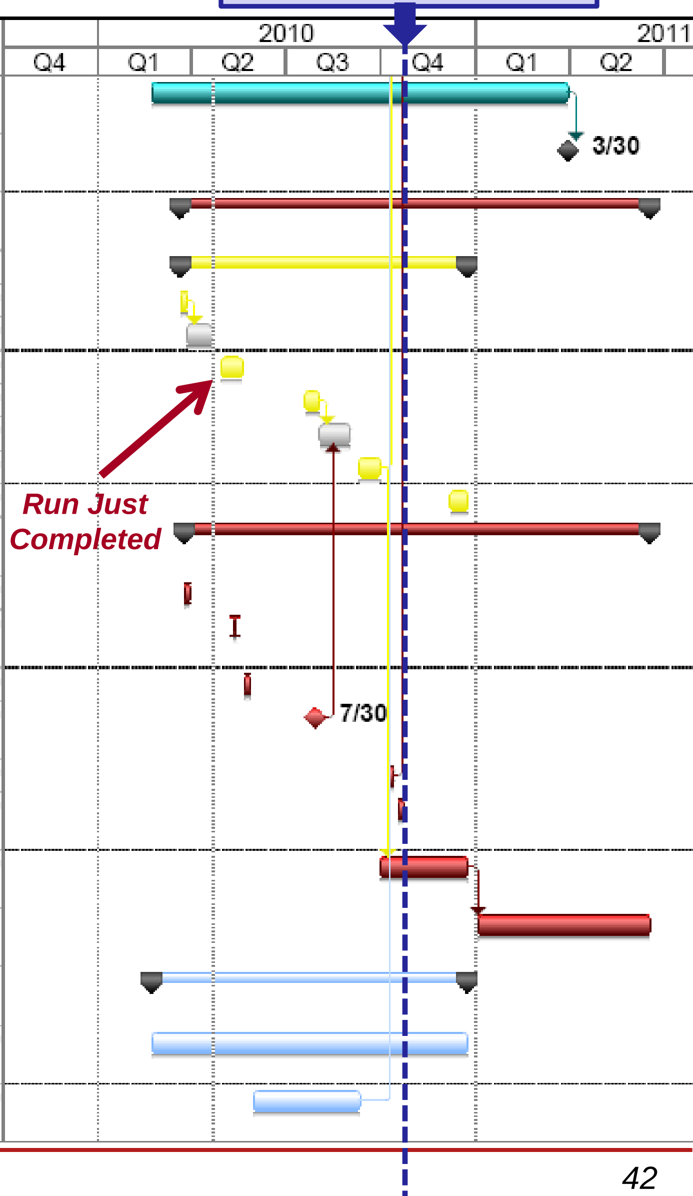
Final energy storage
transmission line

Schedule

Baseline EC WG Recommendation

Taken from ILC DR Planning GANTT Chart

ID		Task Name	Duration	Start	Finish
23		Beam Tuning for Fast Kicker Multi-bunch Extraction	282 days	Mon 2/22/10	Wed 3/30/11
24		Begin Standard Fast Kicker Operations	0 days	Wed 3/30/11	Wed 3/30/11
25		**CesrTA Damping Ring R&D**	**319 days**	**Mon 3/22/10**	**Fri 6/17/11**
26		**CesrTA Operations Schedule**	**277 days**	**Mon 3/22/10**	**Thu 12/23/10**
27		Mixed CesrTA/CHESS Machine Devel	6 days	Mon 3/22/10	Sat 3/27/10
28		March Down	24 days	Sun 3/28/10	Tue 4/20/10
29		CesrTA Run 6a	21 days	Fri 4/30/10	Thu 5/20/10
30		CesrTA Run 6b	14 days	Tue 7/20/10	Mon 8/2/10
31		Summer Down	30 days	Tue 8/3/10	Wed 9/1/10
32		CesrTA Run 7a	21 days	Fri 9/10/10	Thu 9/30/10
33		CesrTA Run 7b	17 days	Tue 12/7/10	Thu 12/23/10
34		**CesrTA Phase I Milestones**	**315 days**	**Fri 3/26/10**	**Fri 6/17/11**
35		ILC10 Status Report	5 days	Fri 3/26/10	Tue 3/30/10
36		ILC PAC Status Report	1 day	Thu 5/13/10	Thu 5/13/10
37		IPAC10 Reports	5 days	Sun 5/23/10	Thu 5/27/10
38		Final CesrTA Experimental Hardware Readiness	0 days	Fri 7/30/10	Fri 7/30/10
39		ECLOUD 10 Reports	6 days	Fri 10/8/10	Wed 10/13/10
40		ILC TDP-I Recommendation - Linear Collider Workshop 2010	5 days	Mon 10/18/10	Fri 10/22/10
41		Prepare Summary of CesrTA EC R&D Program (Phase I)	60 days	Fri 10/1/10	Thu 12/23/10
42		Full R&D Technical Report Writing	120 days	Mon 1/3/11	Fri 6/17/11
43		**DAFNE Damping Ring R&D**	**219 days**	**Mon 2/22/10**	**Thu 12/23/10**
44		Fast Kicker Design and Demonstration (5ns Rise-Time)	219 days	Mon 2/22/10	Thu 12/23/10
45		DR Kicker Impedance Evaluation (INFN)	75 days	Mon 5/31/10	Fri 9/10/10



Run Just Completed

Conclusion

- The CESR reconfiguration for CesrTA is complete
    - Low emittance damping ring layout
    - 4 dedicated experimental regions for EC studies with significant flexibility for collaborator-driven tests
    - Instrumentation and vacuum diagnostics installed (refinements ongoing)
- Recent results include:
    - Machine correction nearing our emittance target $\varepsilon_y \sim 20\text{pm}$
    - EC mitigation comparisons
    - Bunch-by-bunch beam size measurements to characterize emittance diluting effects
    - Extensive progress on EC simulations
- ~70 machine development days scheduled in 2010 – May, July, September and December experimental periods. Will focus on:
    - LET effort to reach a target emittance of $\varepsilon_y \leq 20\text{pm}$
    - Continued EC mitigation studies
    - Detailed characterization of instabilities and sources of emittance dilution in the ultra low emittance regime
    - ***Application of our results to the damping rings design effort***
    - An extension to the R&D program has been proposed…
- ILC DR Electron Cloud Working Group
    - Baseline mitigation recommendation targeted for October 2010

Future Plans

- A 3 year extension to the CESRTA experimental program has been proposed (30-40 machine development days/yr)
  - Experimental operations supported by NSF – enabling:
    - Ongoing studies of EC mitigations and vacuum system design issues (eg, durability and long-term performance of various coatings)
    - Range of experiments at ultra low vertical emittance (5-10 pm): Intrabeam Scattering and Touschek Effect, Fast Ion Instability, emittance dilution issues
    - Instrumentation and Techniques for Low Emittance Tuning
  - Damping ring activities supported via DOE/ART
    - Design Activities: Optics, EC simulations, EC mitigation design,…
    - Experimental program for further refinements/tests of the DR design (vacuum design tests for EC suppression, LET techniques and instrumentation, physics studies in an emittance regime even more closely approaching the ILC DR case)
- Leverages the upgrades made during CESRTA Phase I
- Given the physics and technical challenges (eg, EC, FII, injection & extraction,..), as well as the evolution direction of the overall ILC design, this will support a ***reliable*** damping ring design that can be implemented at the ***lowest possible cost***.

The End

Thank you for your attention!