CESRTA Overview: Status and Plans

Mark Palmer for the CESRTA Collaboration

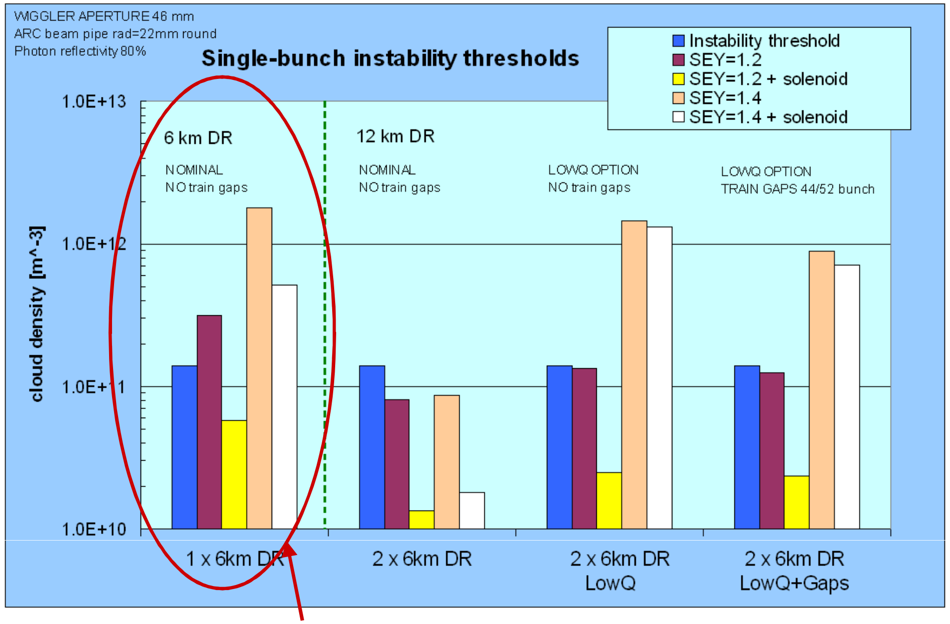
March 28, 2010

ILC2010 – Beijing

Outline

- Project Overview
  - Why CESRTA?
  - Project Goals
  - Reconfiguration
  - Status
- Damping Ring Hardware and Diagnostics
  - Damping Wigglers
  - Electron Cloud Instrumentation
  - Low Emittance Instrumentation
- R&D Effort: EC Build-Up and Mitigation
- Conclusion

Why CESRTA?



- ILCDR06 Evaluation
  - M. Pivi, K. Ohmi, *etal.*
  - Single ~6km positron DR
    - Nominal ~2625 bunches with 6ns bunch spacing and $N_b=2\times10^{10}$
    - Requires SEY values of vacuum chamber surfaces with $\delta_{max}\leq1.2$ (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

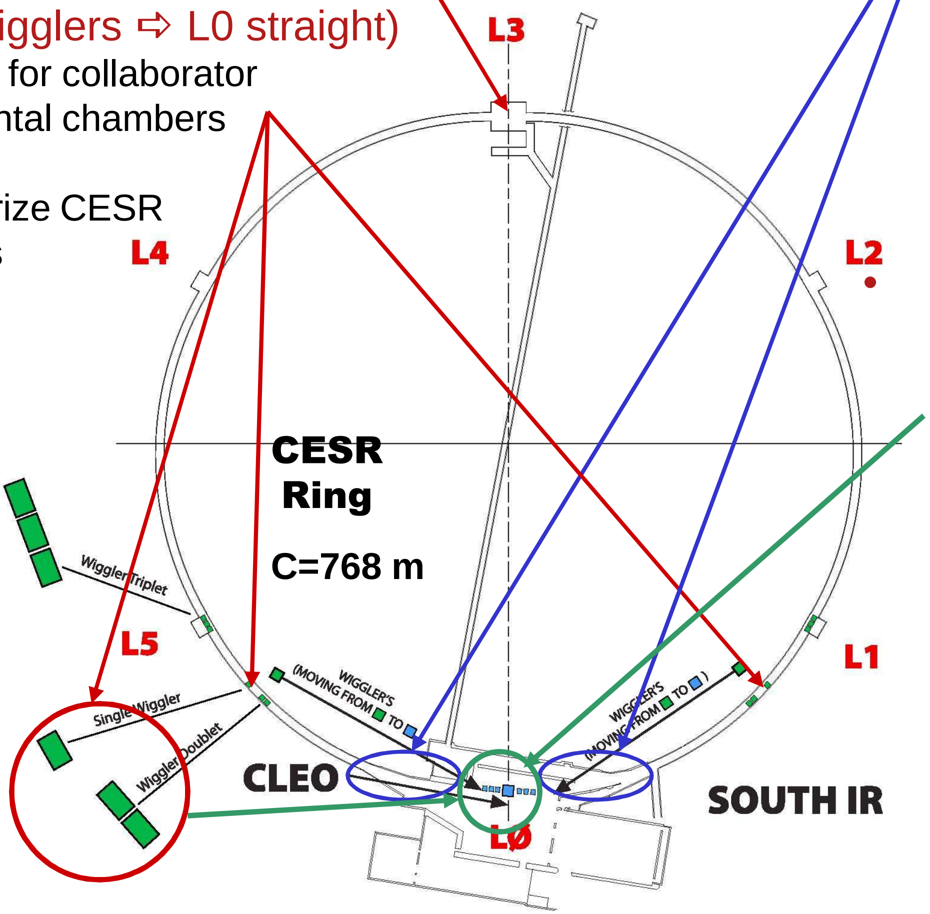
- Studies of Electron Cloud Growth and Mitigation
  - Study EC growth and methods to mitigate it, particularly in the wigglers and dipoles which are of greatest concern in the ILC DR design.
  - Use these studies to benchmark and expand existing simulation codes and to validate our projections for the ILC DR design.
- Studies of EC Induced Instability Thresholds and Emittance Dilution
  - Measure instability thresholds and emittance growth due to the EC in a low emittance regime approaching that of the ILC DR.
  - Validate EC simulations in the low emittance parameter regime.
  - Confirm the projected impact of the EC on ILC DR performance.
- Low Emittance Operations
  - Support EC studies with beam emittances approaching those specified for the ILC DR (CesrTA vertical emittance target: ε_v<20 pm-rad).
  - Implement beam instrumentation needed to achieve and characterize ultra low emittance beams
    - x-Ray Beam Size Monitor targeting bunch-by-bunch readout capability
    - Beam Position Monitor upgrade
  - Develop tuning tools to achieve and maintain ultra low emittance operation in coordination with the ILC DR LET effort
- 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, Shielded Pickups
    - 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
  - Experimental Program
    - Provide sufficient running time to commission hardware, carry out planned experiments, and explore surprises
      ⇨ ~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

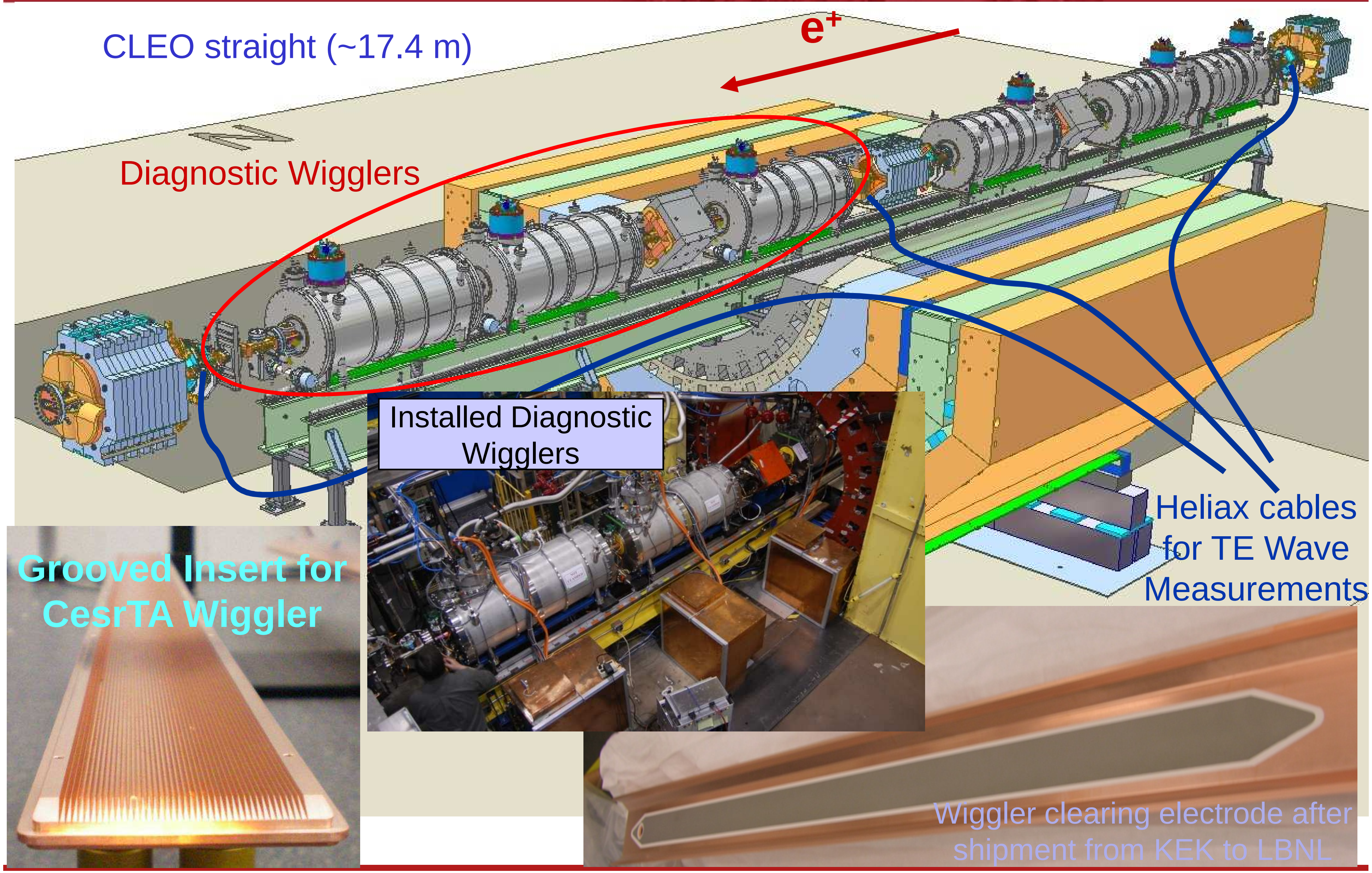
CESR Reconfiguration

- L3 EC experimental region
  - 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



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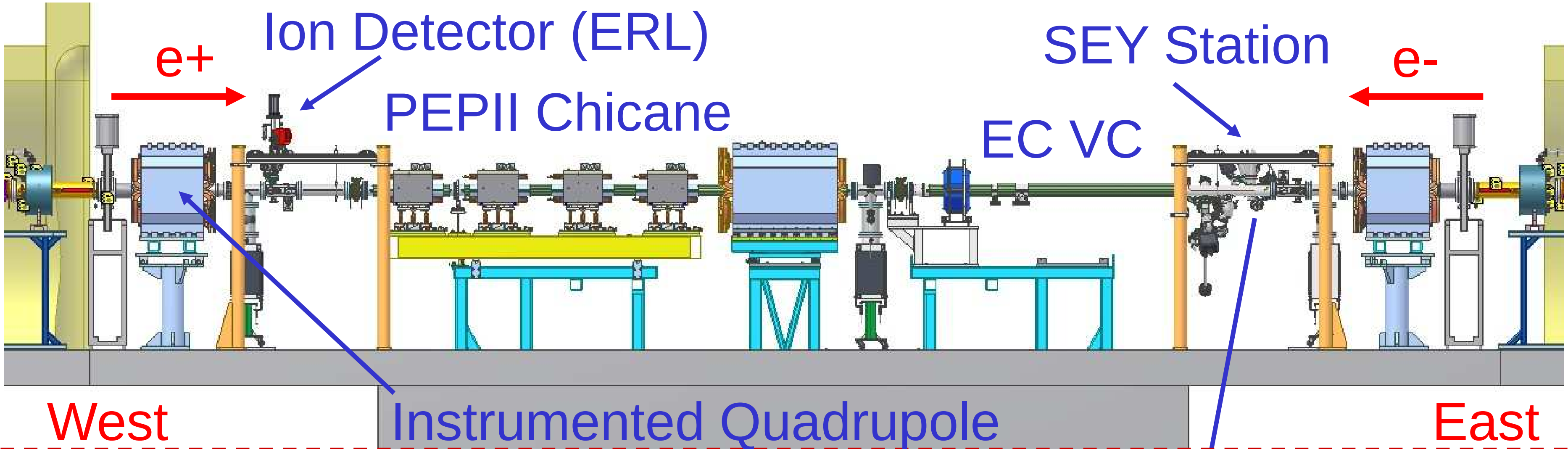
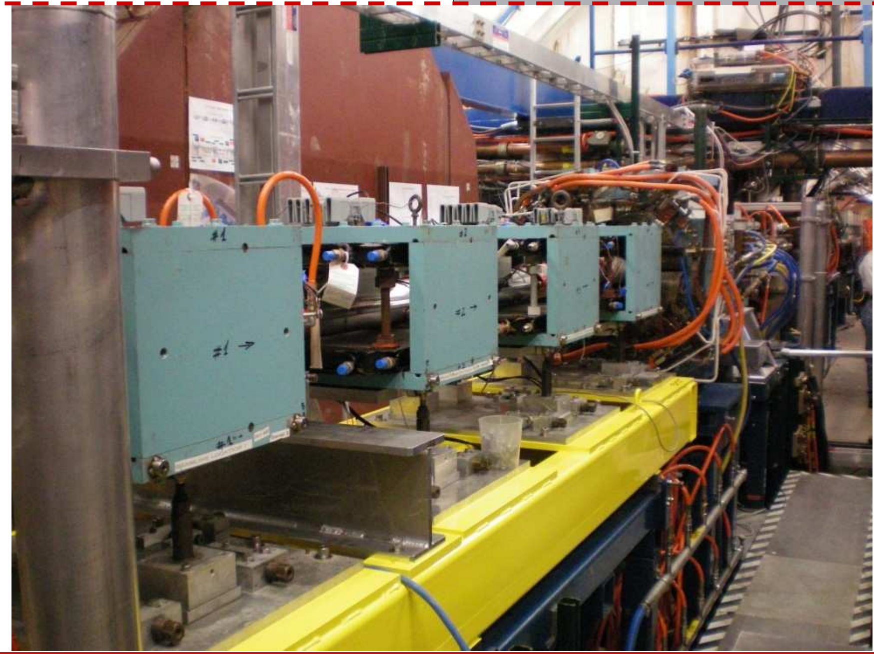
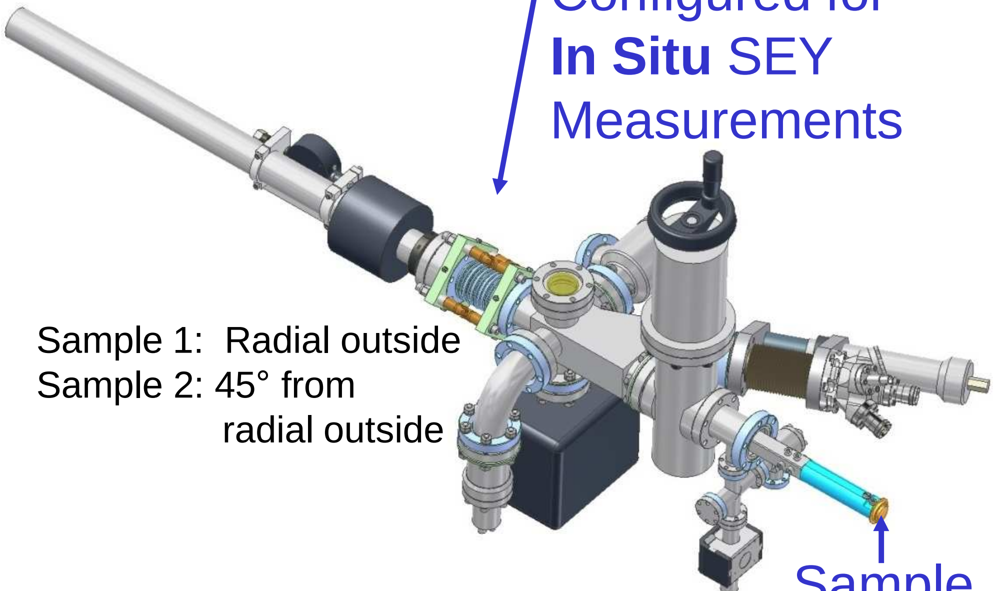
CESR Reconfiguration: L3 Experimental Region

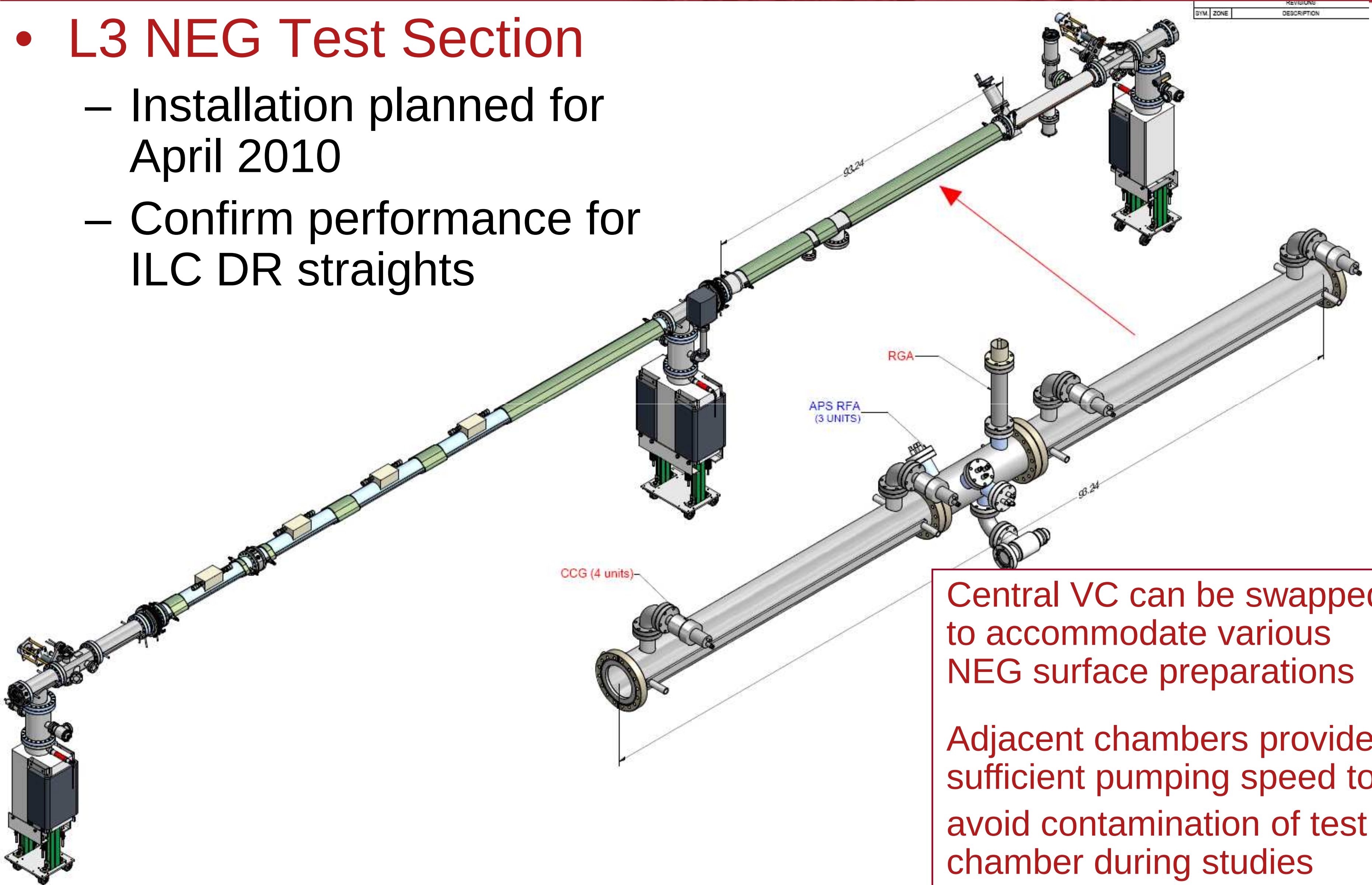






CESR Reconfiguration: L3 Experimental Region

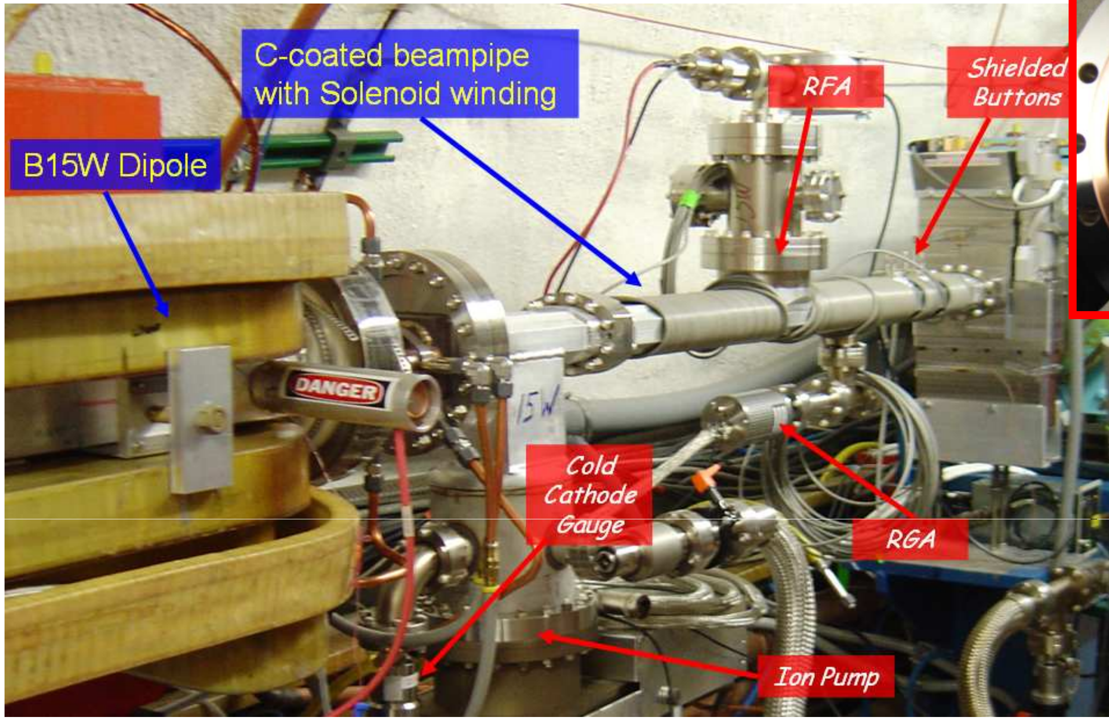
- L3 NEG Test Section
  - Installation planned for April 2010
  - Confirm performance for ILC DR straights

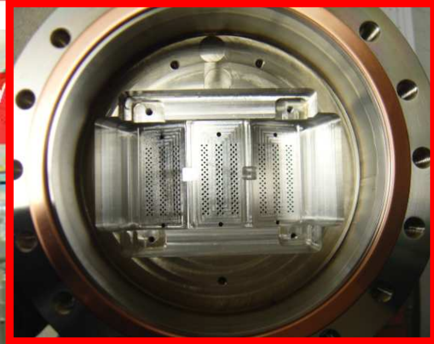


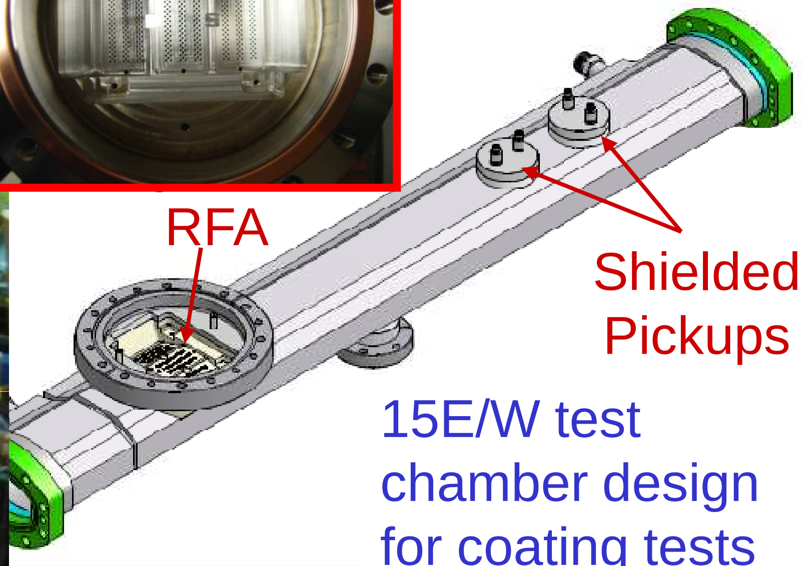
Central VC can be swapped to accommodate various NEG surface preparations

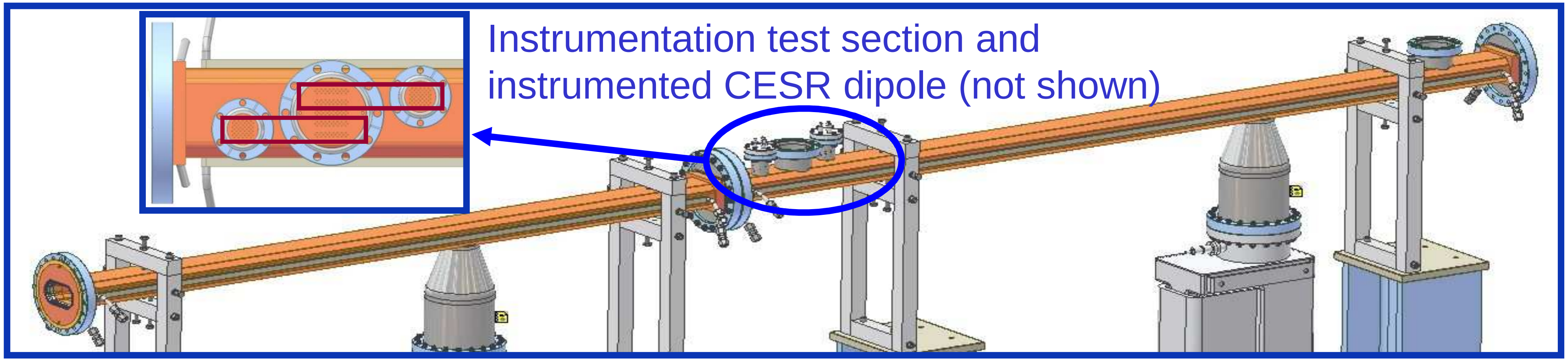
Adjacent chambers provide sufficient pumping speed to avoid contamination of test chamber during studies

CESR Reconfiguration: CESR Arcs





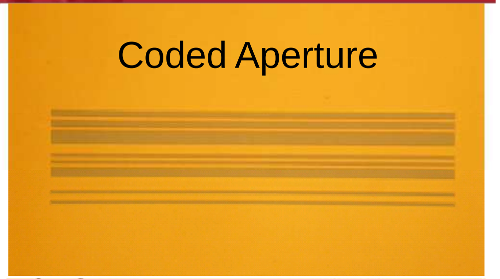


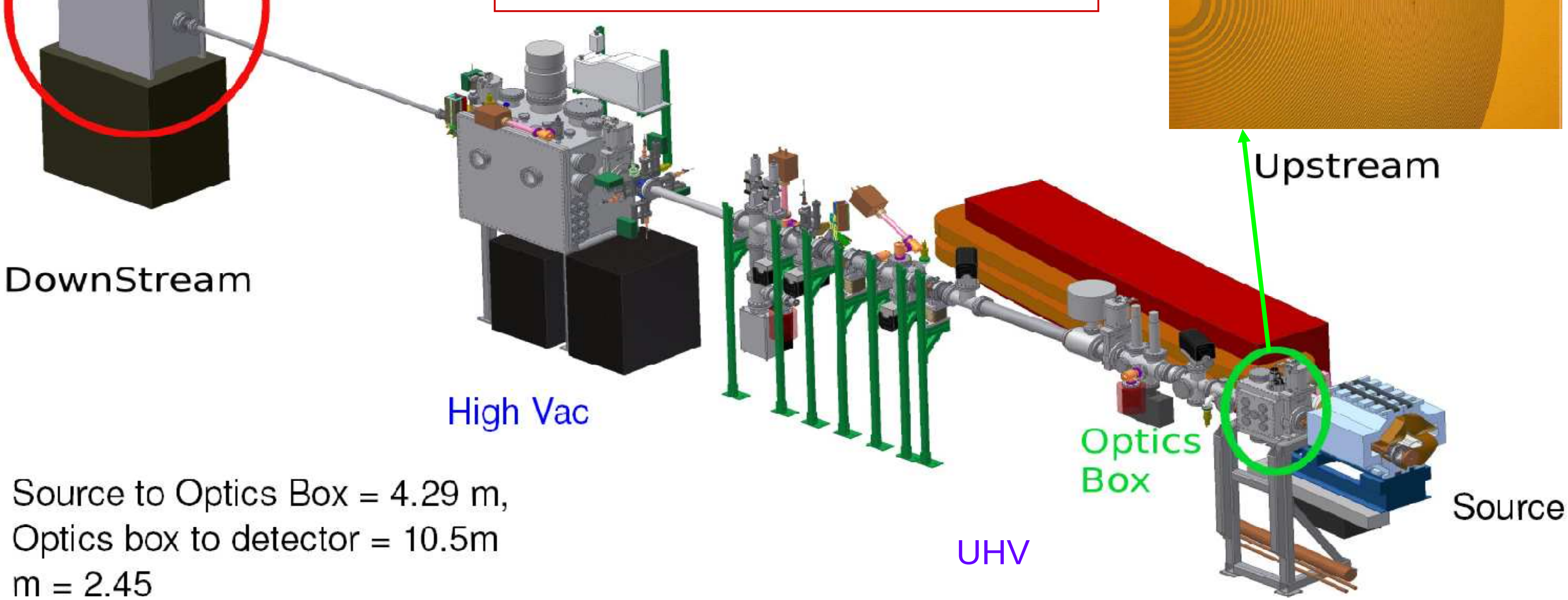


CESR Reconfiguration: X-Ray Lines

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

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

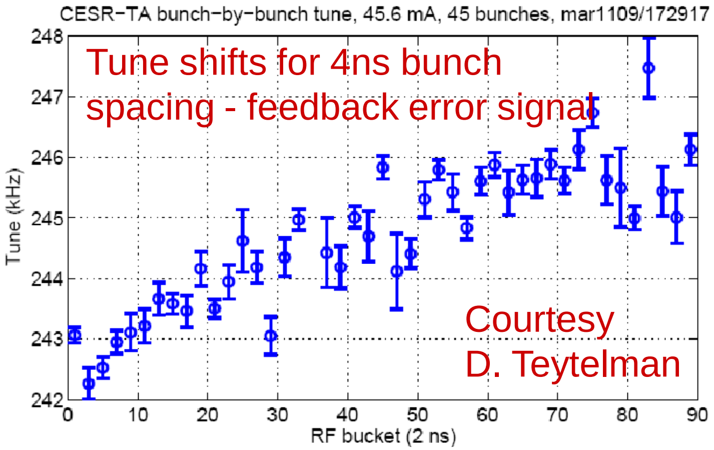
E[GeV]	Wigglers (1.9T/PM)	ε_x[nm]
1.8*	12/0	2.3
2.085	12/0	2.5
2.3	12/0	3.3
3.0	6/0	10
4.0	6 /0	23
4.0	0 /0	42
5.0	6/0	40
5.0	0/0	60
5.0	0/2	90

IBS Studies (rows 1.8, 2.085, 2.3)

* 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

Status and Ongoing Effort

- 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 have just been installed
  - 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
  - Mitigation tests are ongoing
- Low Emittance Tuning and Beam Dynamics Studies
  - Most recently measured emittance with xBSM ~31pm – aiming for 20pm by next September
  - Continuing effort to take advantage of new instrumentation
  - Continuing to work towards providing low emittance conditions for beam dynamics studies

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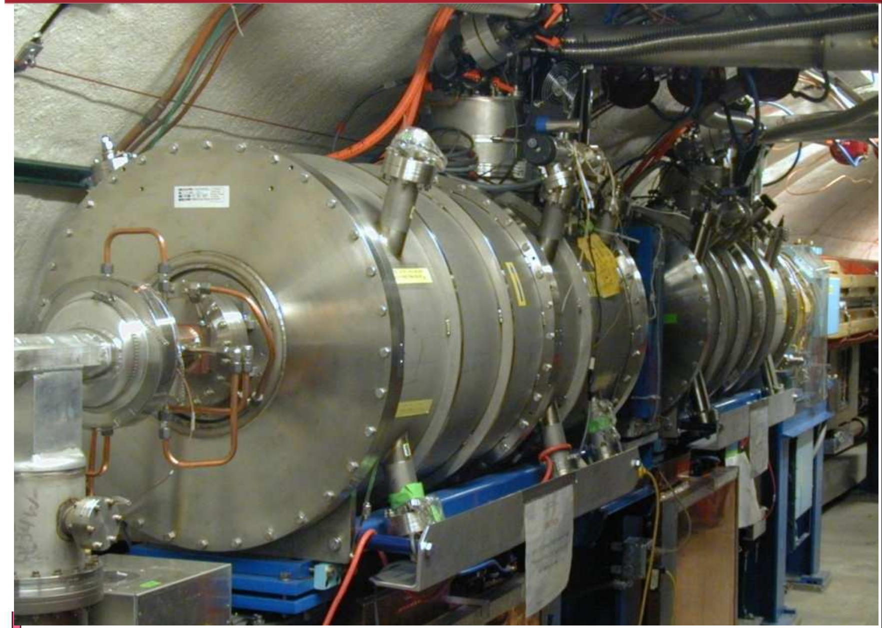
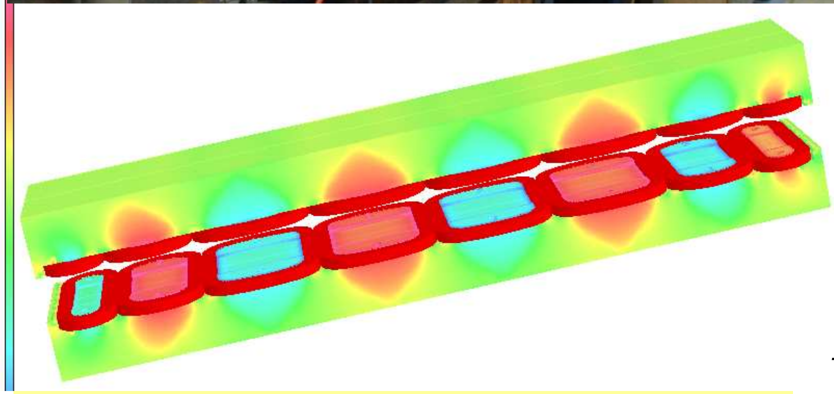
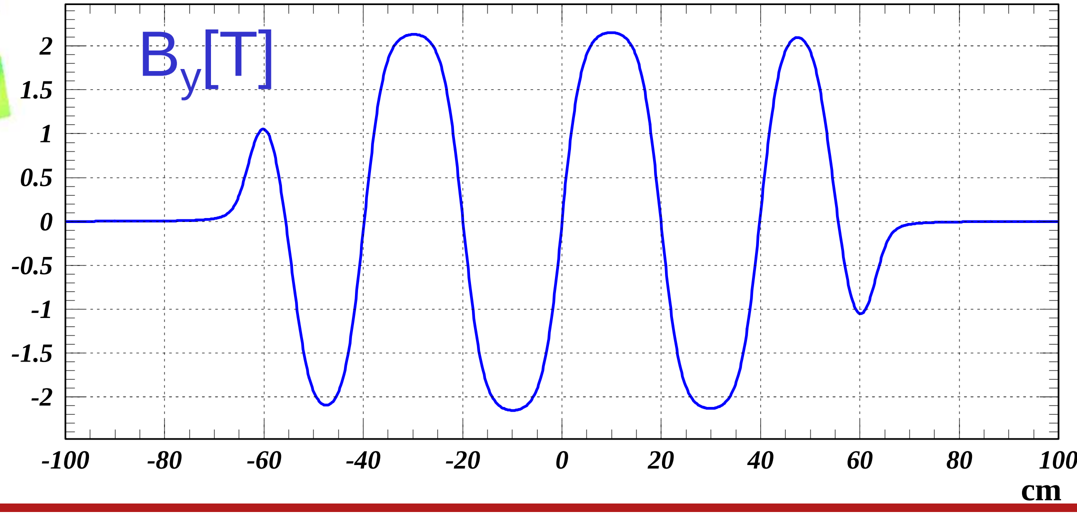
CESR-c Damping Wigglers



B_{peak} [T]	2.1
Period [cm]	40
Pole gap [cm]	7.65
Beam Stay Clear [cm]	5.0
No. Poles	8
ΔQ_y	~0.1/wiggler
Magnetic Length [m]	1.3
Transverse Field Roll-Off	+0.0, -0.3% @ ±20mm
Static Heat Load @ 4K [W]	~1.3W
Static Heat Load @77K [W]	~40W





Further details:

PAC03 Paper (D. Rice *etal)*

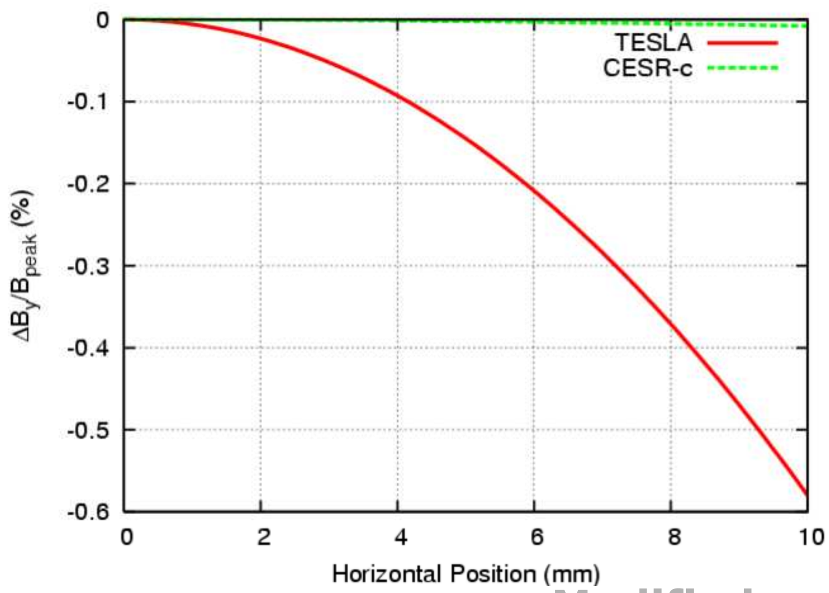
http://accelconf.web.cern.ch/accelconf/p03/PAPERS/TOAB007.PDF

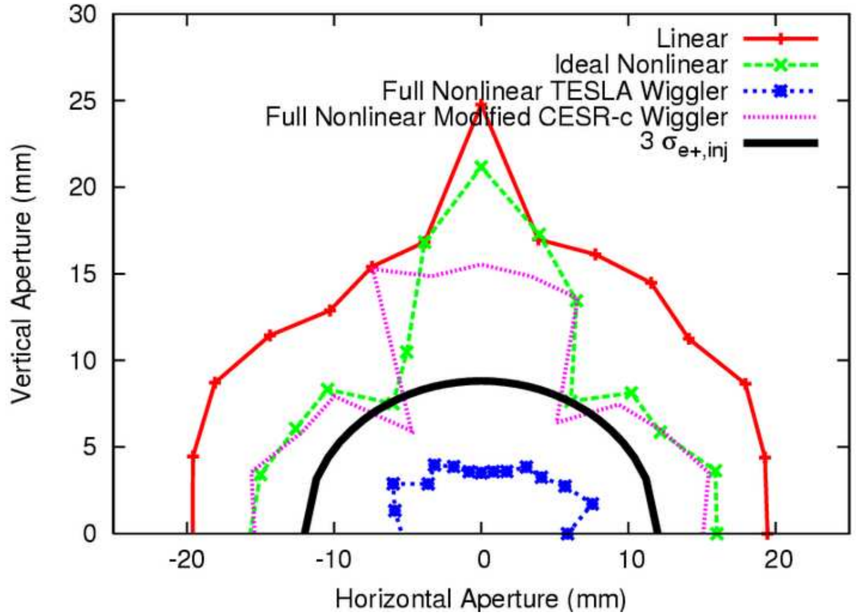
WIGGLE05 talk (A. Temnykh)

http://www.lnf.infn.it/conference/wiggle2005/talks/Temnyk.pdf

ILC DR Wiggler Choice

- Basic Requirements
  - Large Physical Aperture
    - Acceptance for injected e+ beam
    - Improved thresholds for collective effects
      - Electron cloud
      - Resistive wall coupled bunch instability
  - Dynamic Aperture
    - Field quality
    - Wiggler nonlinearities





	TESLA	CESR-c	Modified CESR-c
Period	400 mm	400 mm	400 mm
$B_{y,peak}$	1.67 T	2.1 T	**1.67 T**
Gap	25 mm	76 mm	76 mm
Width	60 mm	238 mm	238 mm
Poles	14	8	**14**
Periods	7	4	**7**
Length	2.5 m	1.3 m	2.5 m

Optimized Wiggler

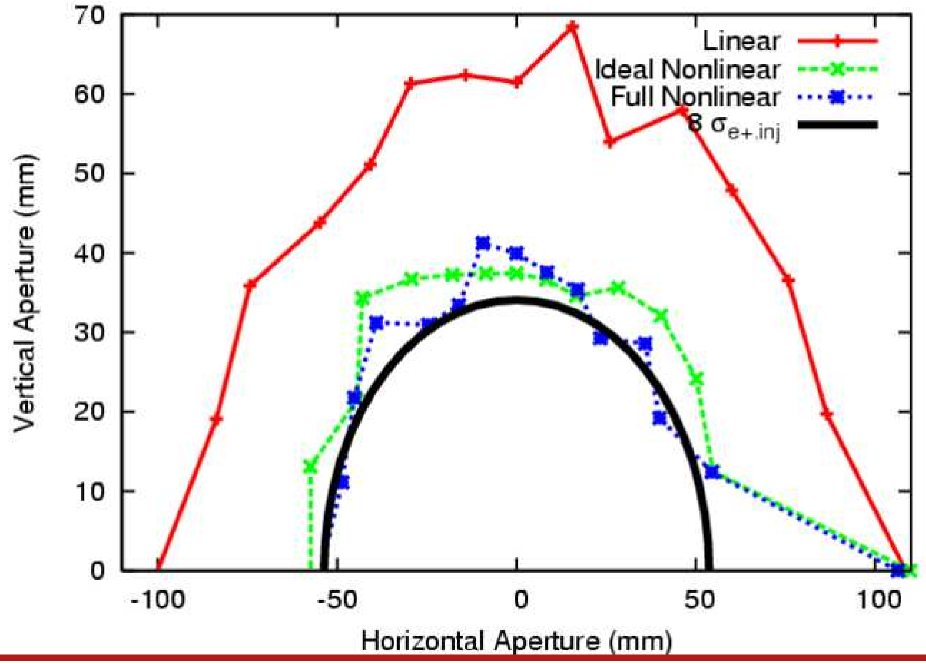
- Superferric ILC Optimized Wiggler
  - 12 poles
  - Period = 32 cm
  - Length = 1.68 m
  - $B_{y,peak}$ = 1.95 T
  - Gap = 86 mm
  - Width = 238 mm
  - I = 141 A

  τ_{damp} = 26.4 ms

  $\varepsilon_{x,rad}$ = 0.56 nm·rad

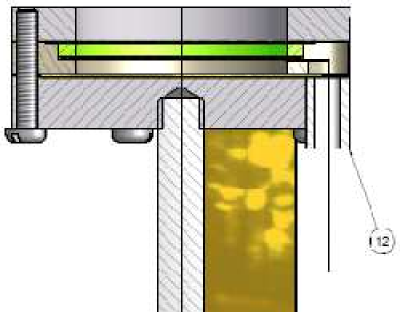
  σ_{δ} = 0.13 %

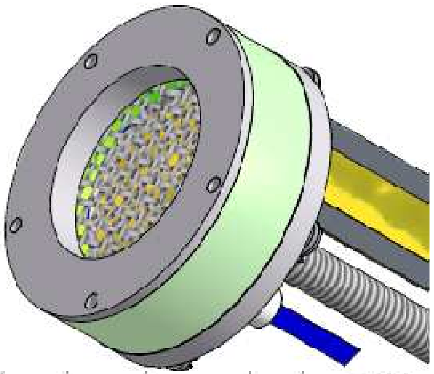
Engineering Design and Cost Optimization using RDR lattice design (J. Urban, etal):
- No. Poles
- Period
- Gap
- Width
- Peak Field

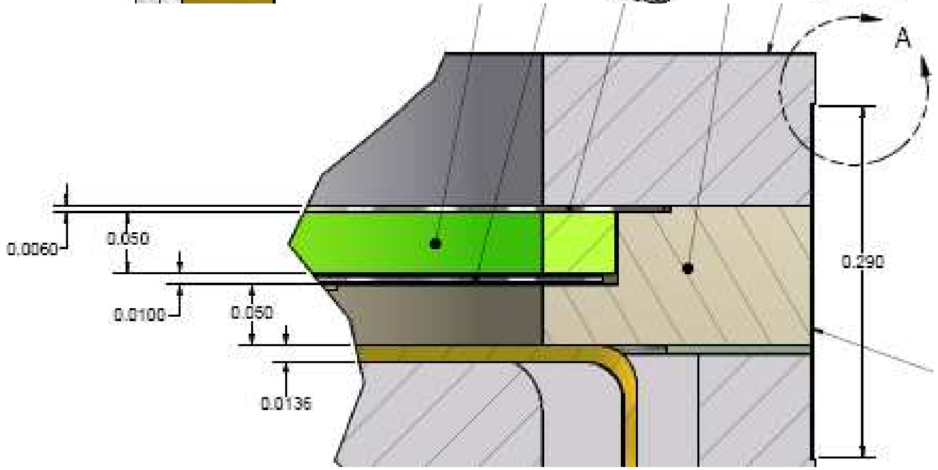


Electron Cloud Instrumentation: Thin RFA Design

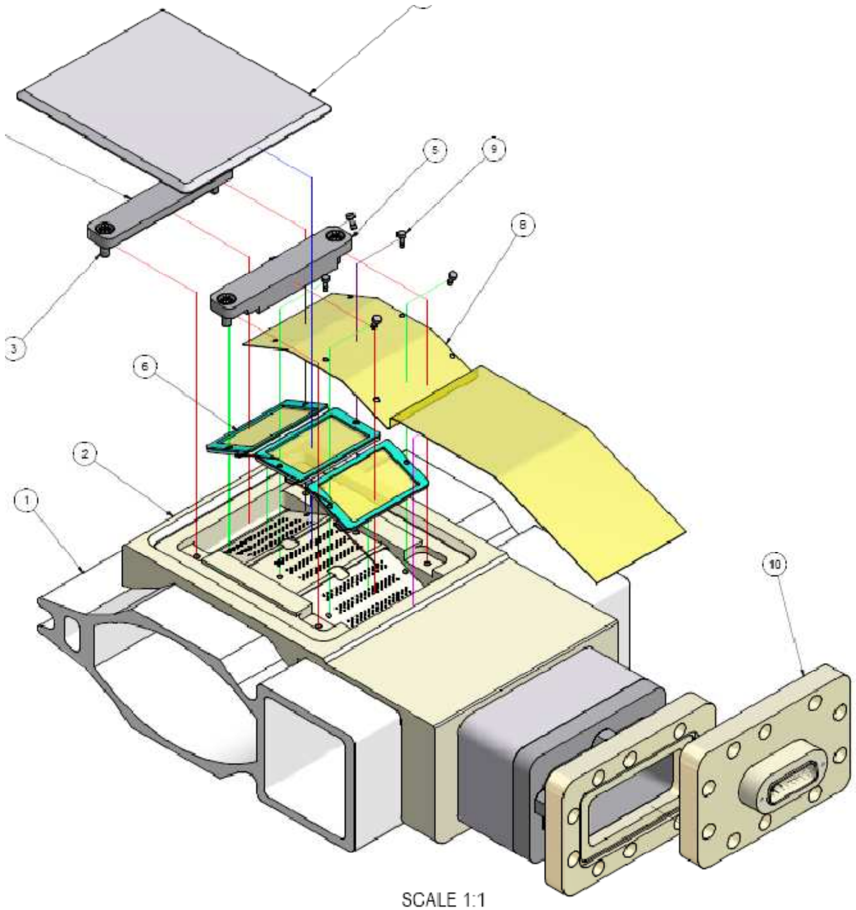
- Thin structure developed for use in limited aperture locations
  - CESR dipoles
  - CESR-c wigglers
- Custom readout system with sensitivity of <50pA/channel



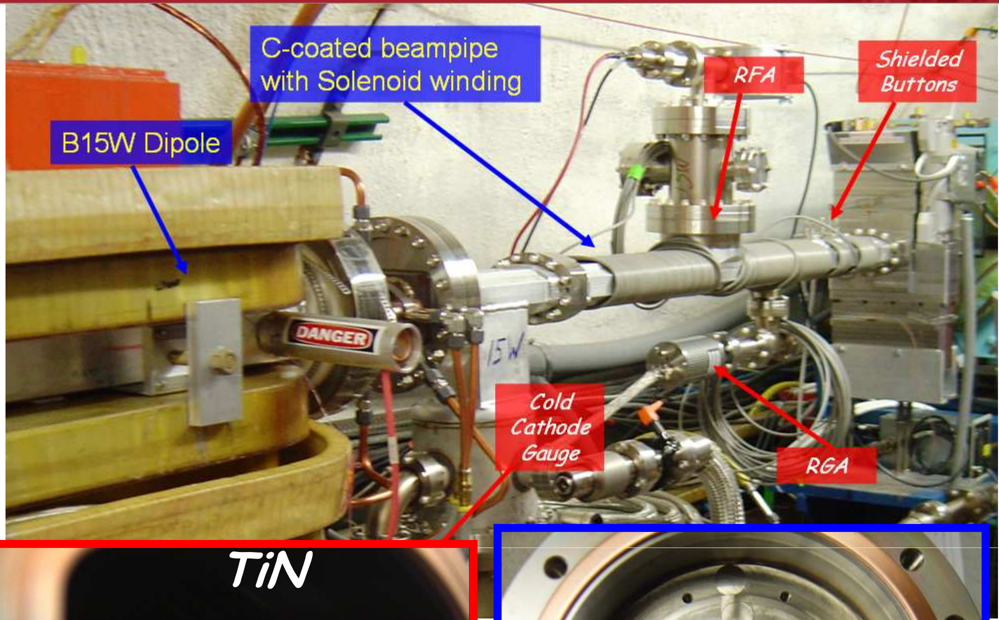


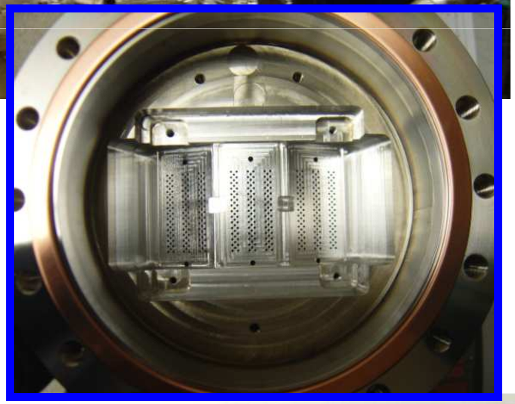


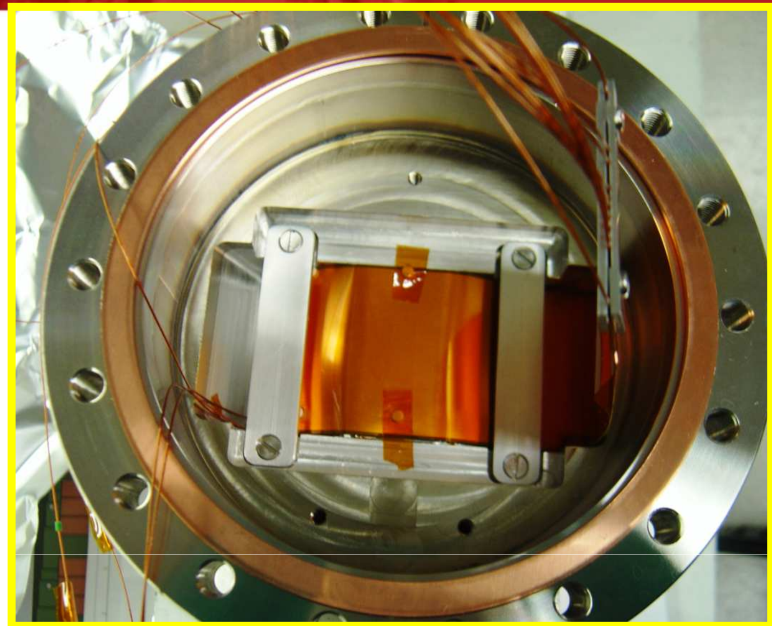
- Application to CESR Dipole

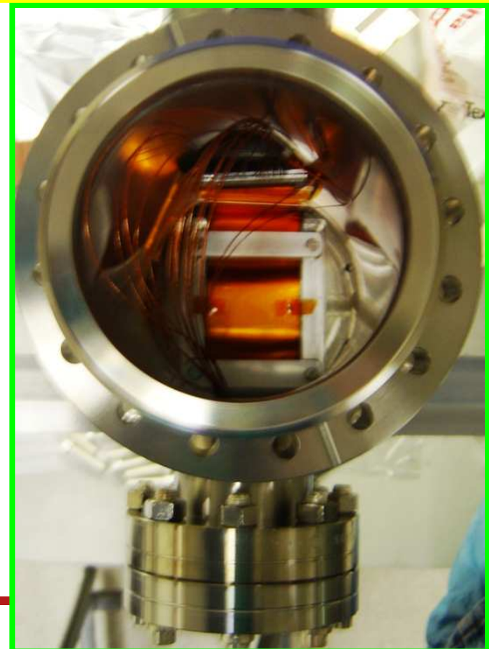


Electron Cloud Instrumentation: 15E/W Test Chambers



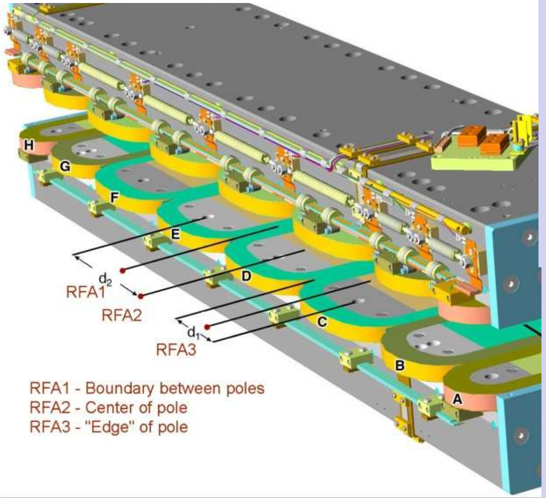


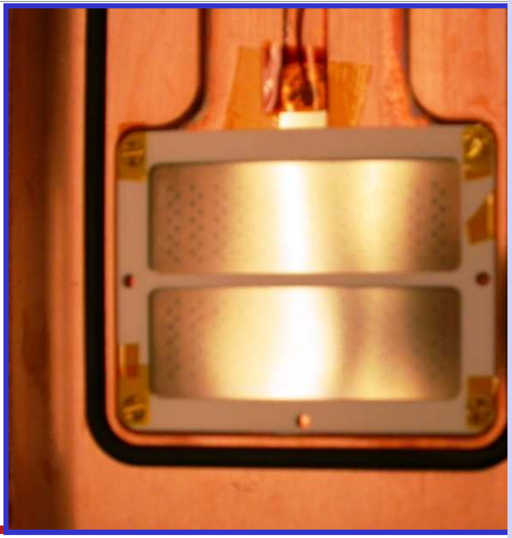




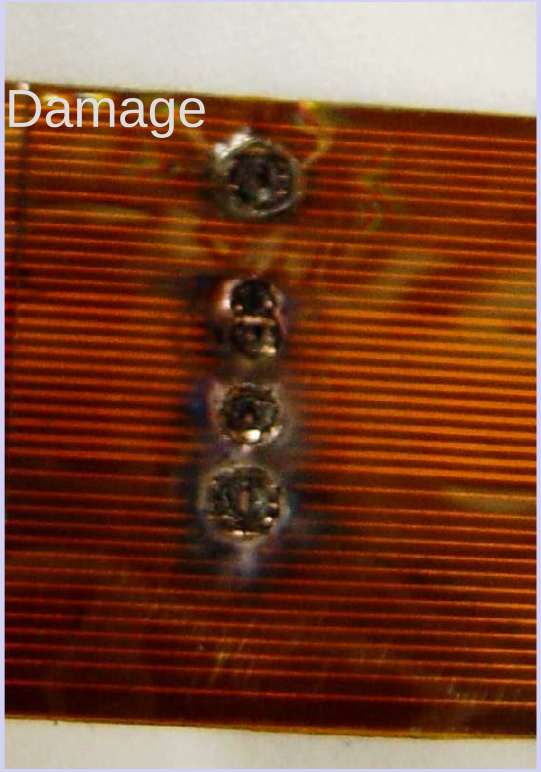
Electron Cloud Instrumentation: …s

Cu & TiN-coated VCs – Oct
Grooved VC – Jul `09
Electrode VC – Apr `09



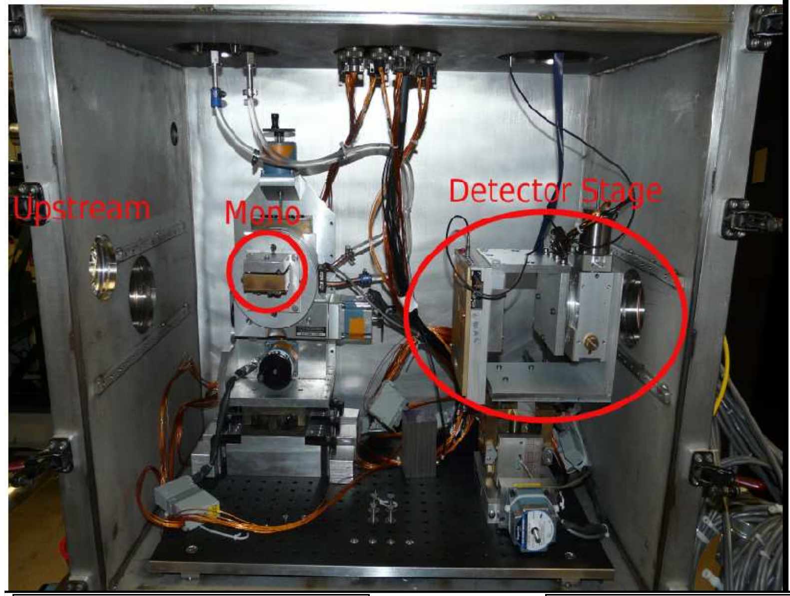


We have had an accident with the latest wiggler chamber – an e-beam weld burn-through at the end of the RFA assembly. The RFA cover has been removed, The damage has been assessed and we expect to be able to re-weld the chamber by the middle of this week. Some CESRTA schedule adjustments will be necessary…

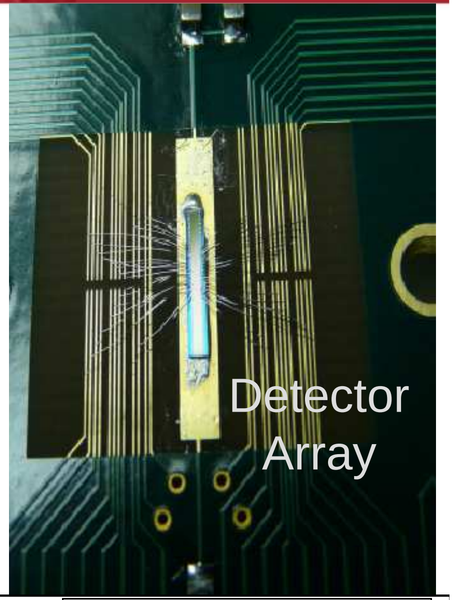
RFA Flex Circuit Damage

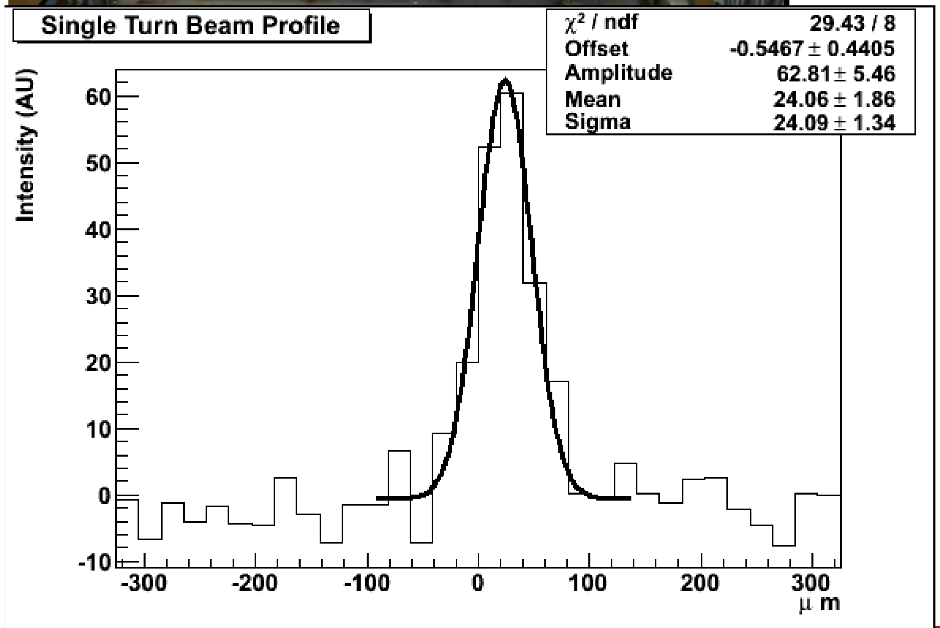
Low Emittance Instrumentation: xBSM Detector

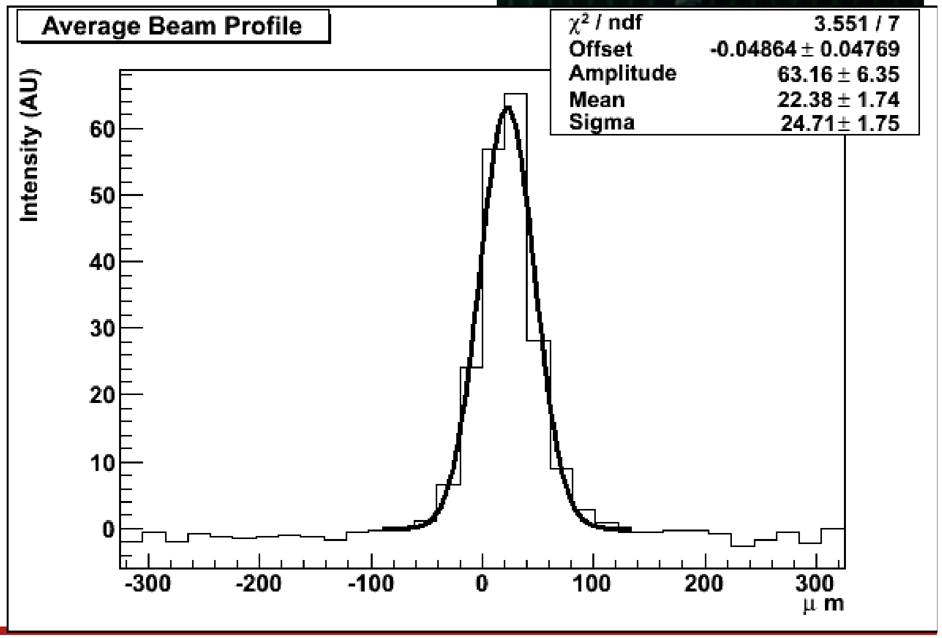


Fast InGaAs Diode Array:

- Single-pass readout
- Few micron resolution with coded aperture and Fresnel imaging optics







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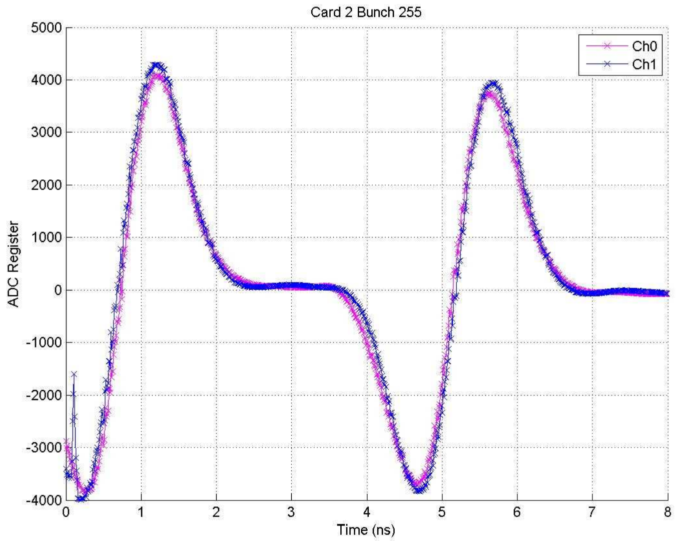
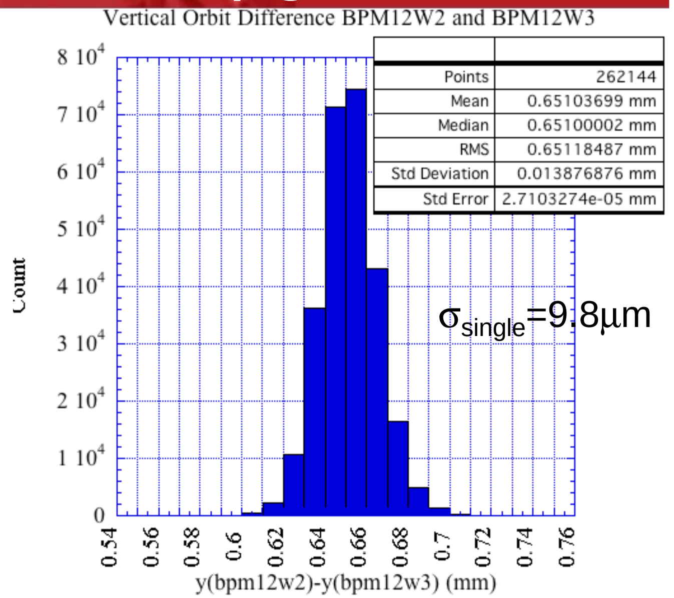
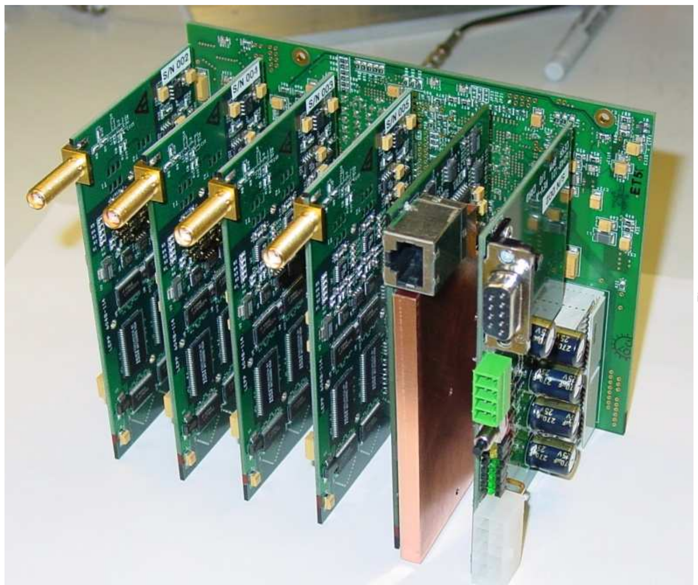
Low Emittance Instrumentation: BPM System Upgrade

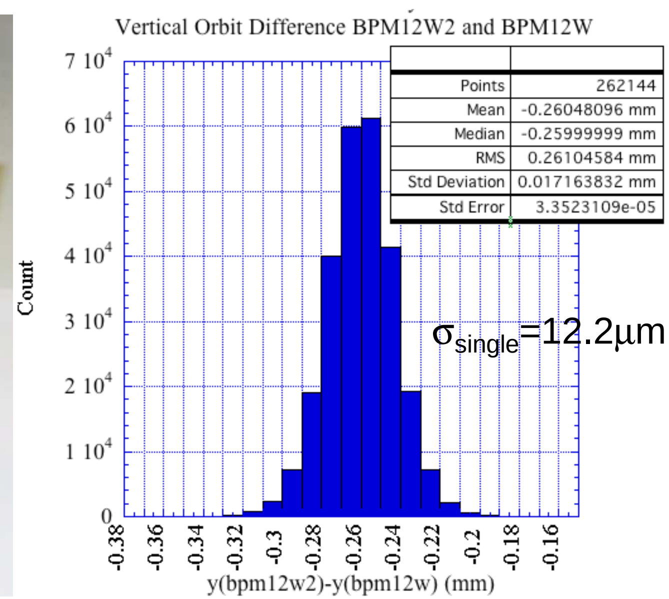
- Ring upgraded to new multi-bunch turn-by-turn electronics
  - 12% Generation 1
  - 88% Generation 2
- Full integration into operational data acquisition in progress





Front End Bandwidth for 4ns Bunch-Train Operation	500 MHz
Single Shot Resolution Target	<10 μm
Timing Resolution Target	<10 ps
Short-Term Repeatability Target	<10 μm
Long-Term Repeatability Target	<50 μm





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R&D Effort

- Optics and LET
  - More details during the talk by Jim Shanks
- Electron Cloud R&D
  - Broad range of studies underway
  - Gerry Dugan will discuss the simulation effort and comparisons with data
  - Will use the remainder of this talk to focus on the study of EC mitigations…

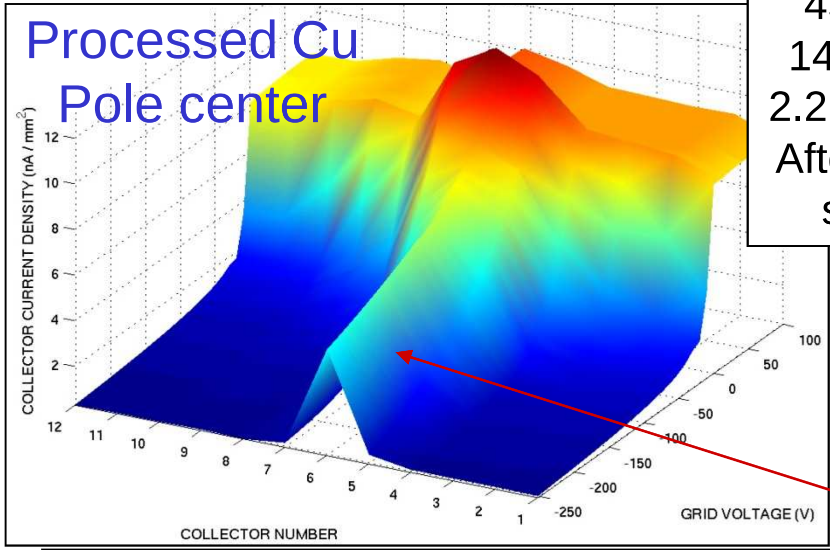
Status of EC Studies

- Simulations:
  - Code Benchmarking (CLOUDLAND, ECLOUD, POSINST)
  - Modeling for RFA and TE Wave measurements
  - Tune shift calculations
    - Characterize the integrated SEY contributions around the ring
    - Now calculated for coherent oscillations of the beam
  - Inst... grow...
- 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
  - New time-resolved measurements

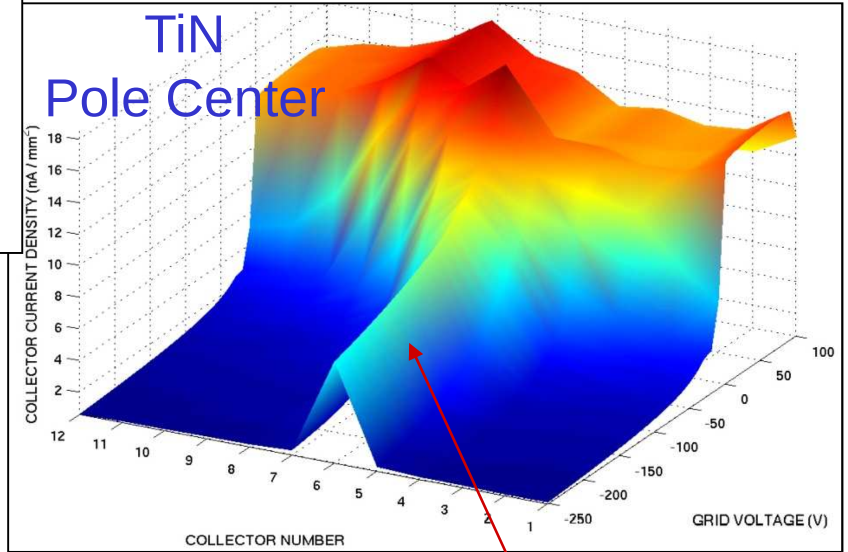
- Mitigation Comparisons
  - SC Wigglers:
    - Presently installed: Cu, TiN-coated Cu, Grooves (Cu, 2mm/20°)
    - Clearing Electrode in preparation
  - Drifts:
    - Presently installed: Al, Cu, TiN-coated Cu, Amorphous C-coated Al, TiN-coated Al
    - NEG chambers for L3 in preparation
  - Dipole:
    - ...ted Al, Grooves ...l
    - ...nstallation
- ...nd systematic checks
  - Pinged beam
  - Feedback system error signal
  - Witness bunch studies for dynamics
- Instability and incoherent emittance growth (w/xBSM) studies will be a major focus of upcoming runs

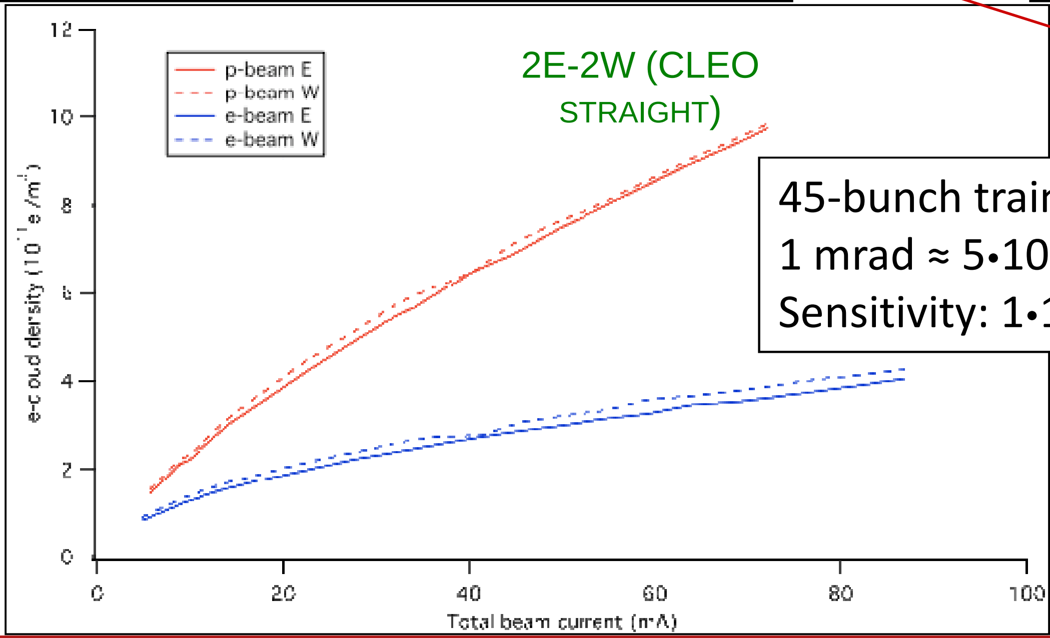
Now will look at 3 topics:
- Mitigation comparisons (Calvey, Livezey, Schwartz, …)
- In Situ SEY measurements (Greenwald, Asner, Kim, …)
- Time-resolved EC measurements (Sikora, De Santis, …)

TE Wave & RFA Measurements in L0



45 bunches
14ns spacing
2.2×10^{10}/bunch
After extended scrubbing





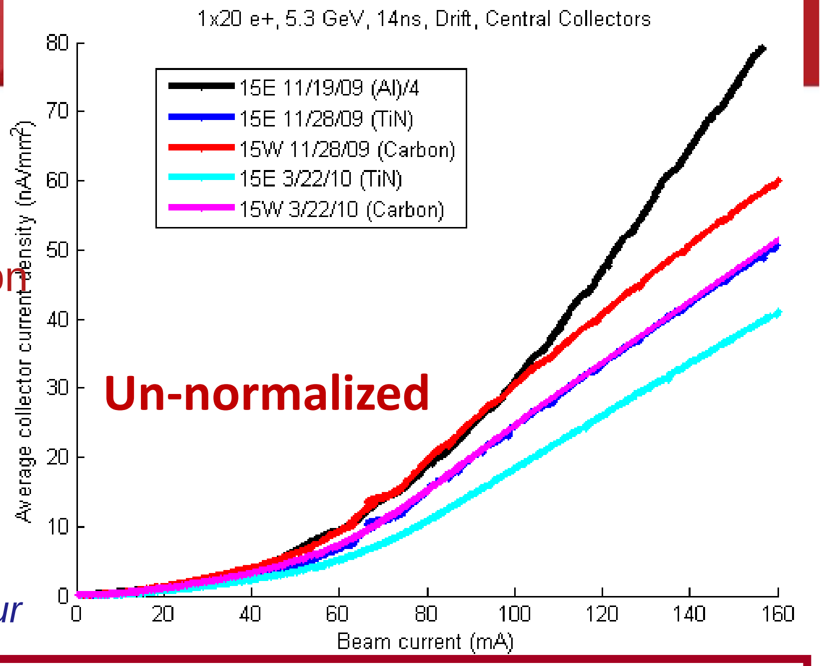
45-bunch train (14 ns)
1 mrad ≈ $5\cdot10^{10}$ e^-/m^3
Sensitivity: $1\cdot10^{9}$ e^-/m^3 (SNR)

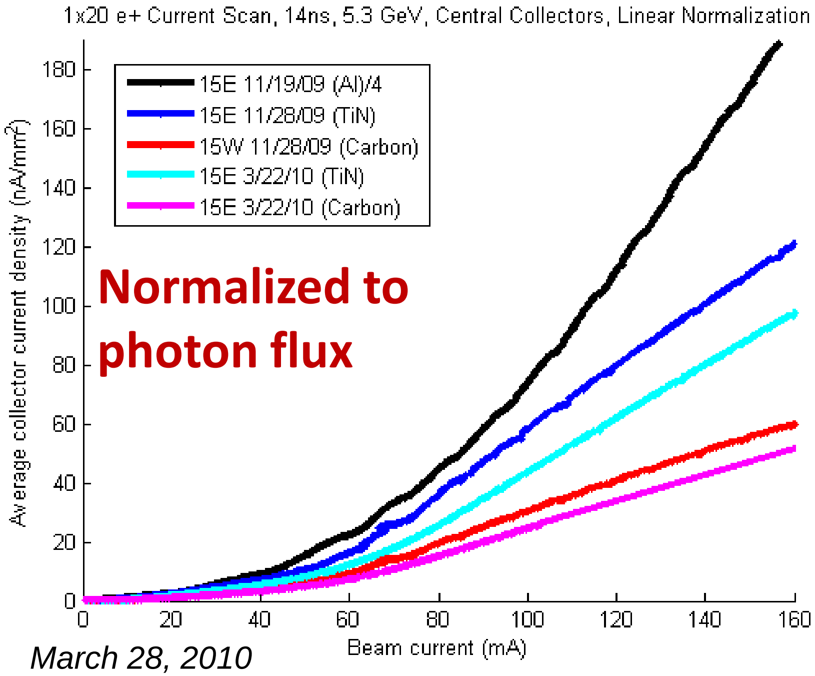
Similar performance observed

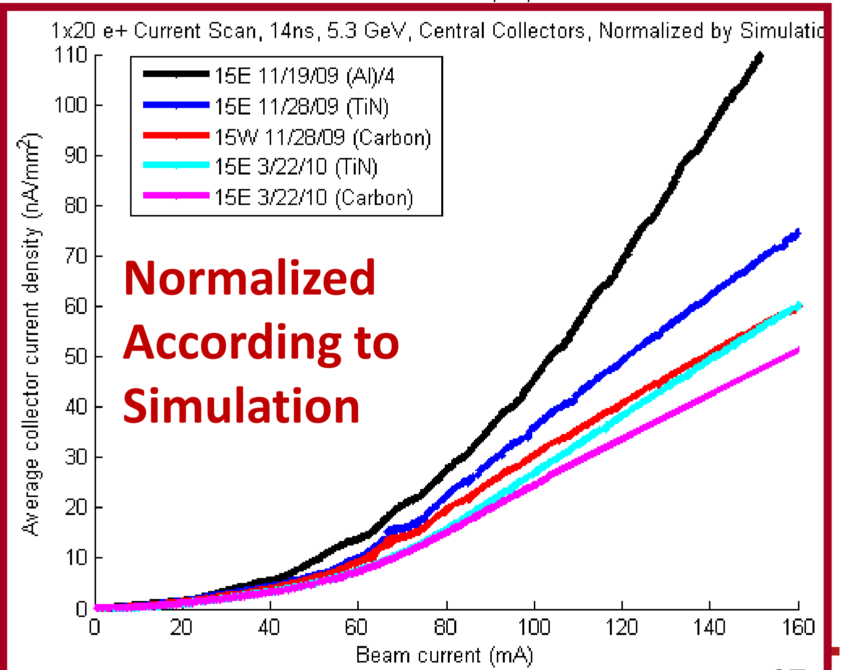
15E/W Comparison – e+

- 1x20 e+, 5.3GeV, 14ns, drift
  - Central collectors (4-6) only
  - Note: Al signal is divided by 4
- 15W location (amorphous C) sees about 2.4× the photon flux of the 15E (TiN) location
- At high bunch charges, normalization to photon flux insufficient ⇨ normalize based on a simulation of the ratio of fluxes
- TiN and a-C are comparable, both much better than Al

Note: Both chambers show a similar dP/dI which is worse than our Al chambers







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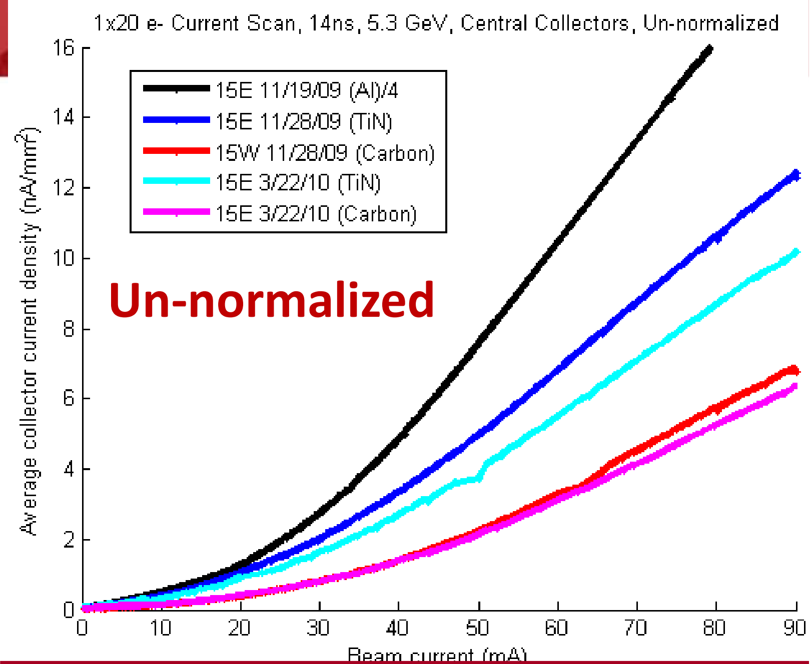
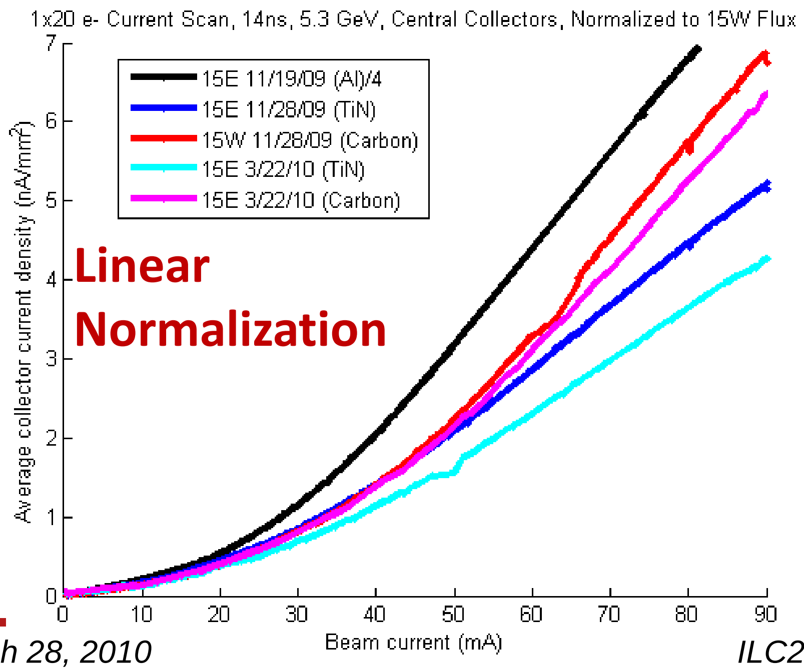
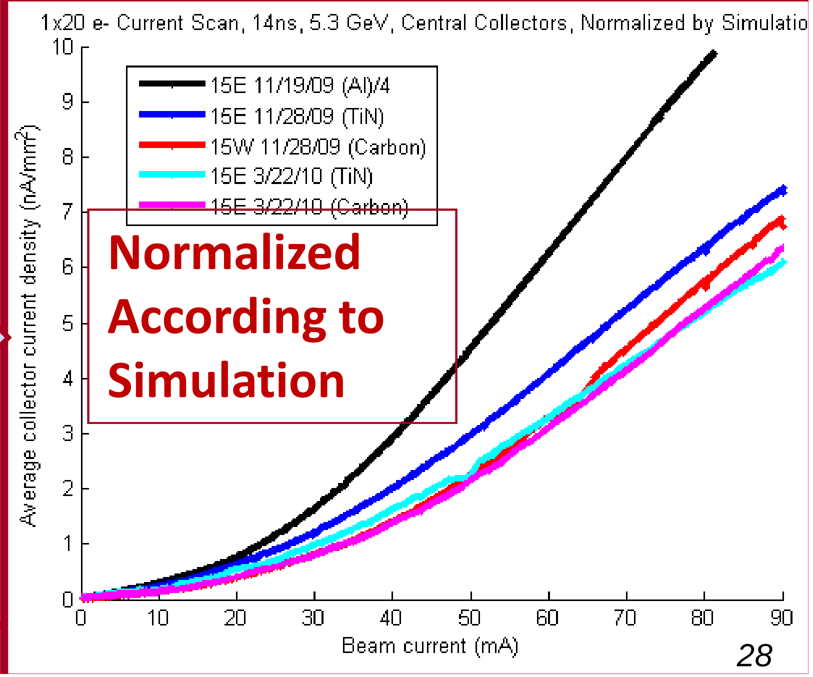
15E/W Comparison – e-

- 1x20 e+, 5.3GeV, 14ns, drift
  - Central collectors (4-6) only
  - Note: Al signal is divided by 4
- 15W location (amorphous C) sees about 2.4× the photon flux of the 15E (TiN) location
- At high bunch charges, normalization to photon flux insufficient ⇨ normalize based on a simulation of the ratio of fluxes
- TiN and Carbon are comparable & much better than Al





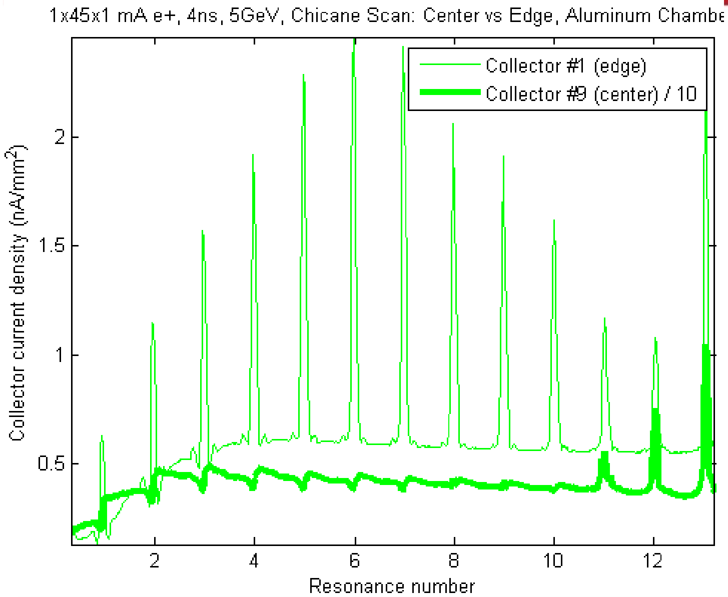


"Normalization Using Simulation"

- Nominal positron photon flux for 15W is 2.38× that of 15E
  - Ratio flips for electron beam
- Simulations over the range of conditions measured indicate that the EC build-up will not scale proportionally to the photon flux
- Table shows the normalization (ratio of time averaged cloud density) for different conditions
  - Done for bunch currents of 2, 4, 6, 8, 10 mA for 1x20
  - Done for bunch currents of .5, 1, 1.5, 2, 2.5 mA for 1x20
- Normalization is closer to direct value for 1x45, and for e-
- It also tends to be slightly higher for low beam current (~10% higher than for high current), values shown are an average of all simulated values

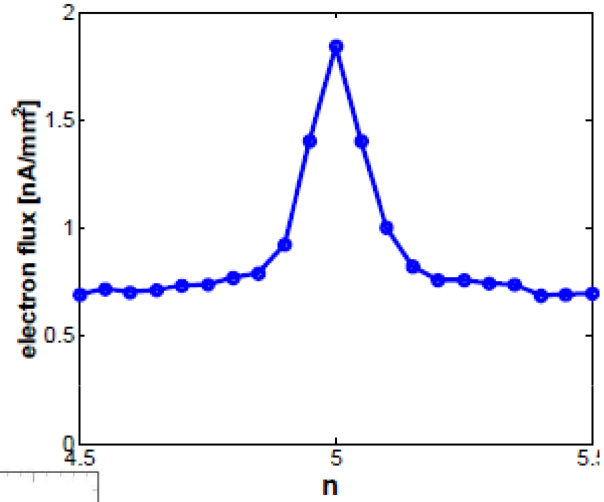
Conditions	Normalization (15W/15E)
1x20 e+	1.47
1x20 e-	.599
1x45 e+	1.67
1x45 e-	.544

L3 Chicane (SLAC): Measurements & Simulations



Cyclotron resonances can be reproduced in both ECLOUD and CLOUDLAND

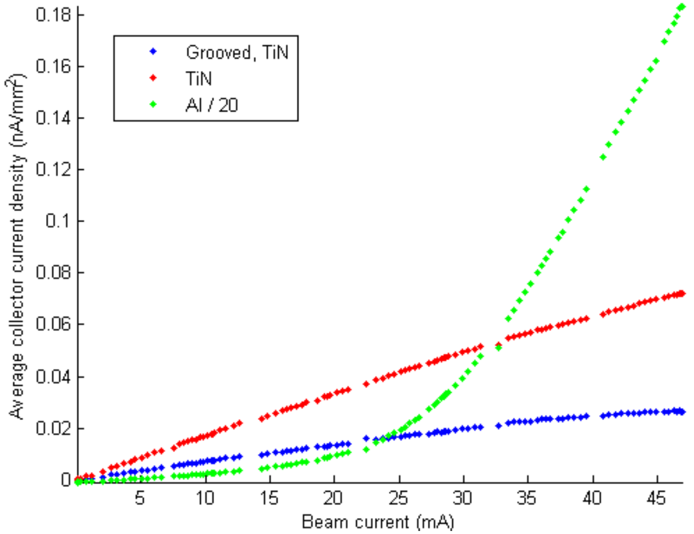
- Plots are of the sum of all collectors for 45 bunches, positrons, 4ns spacing, δ_{max} = 2.0
- Dips are harder to reproduce

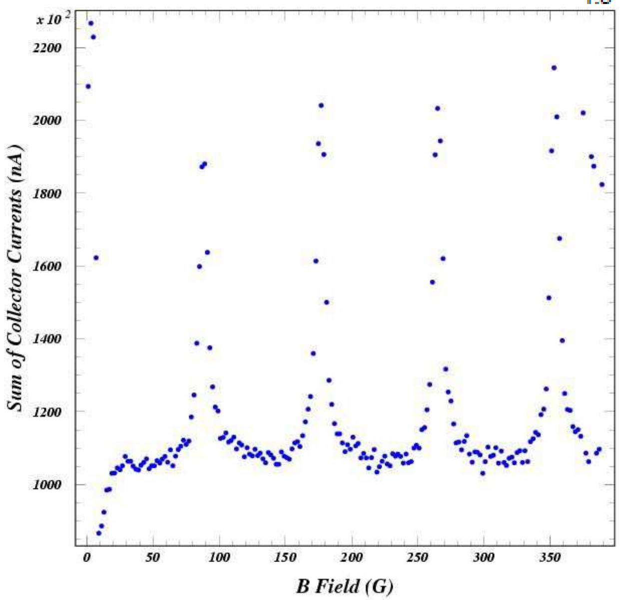


CLOUDLAND (L.Wang)

- Mitigation Comparisons

Al (÷20) vs TiN vs

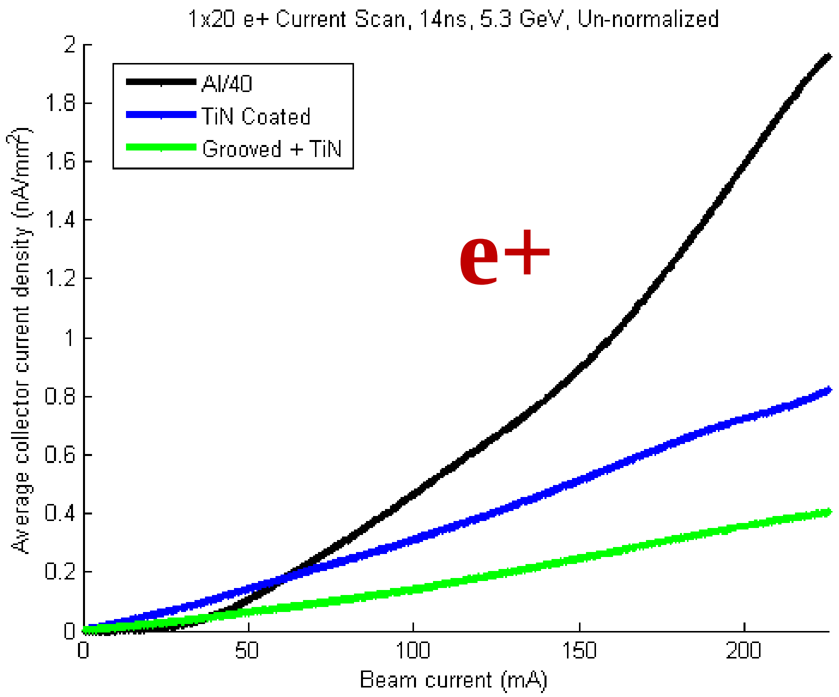


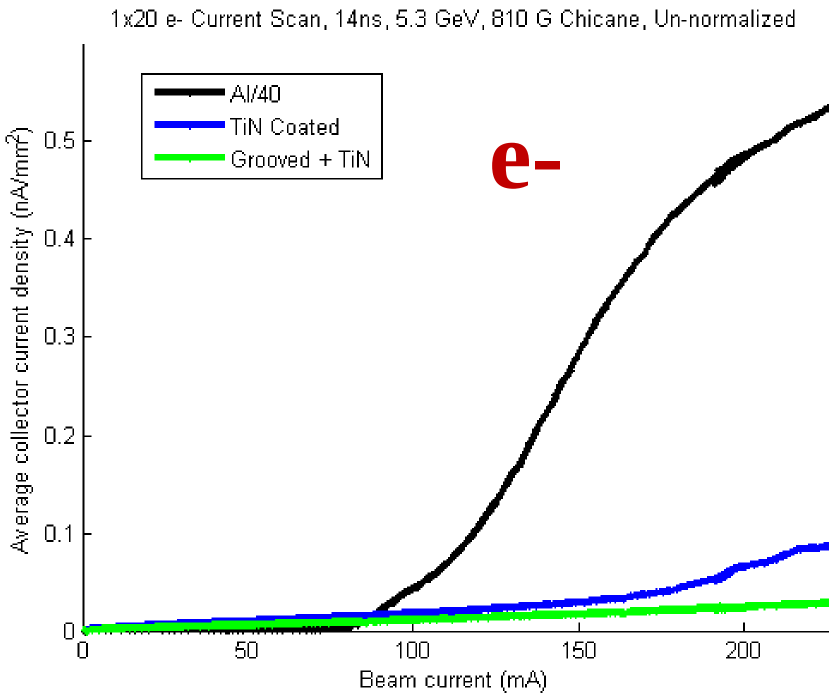


ECLOUD (J. Crittenden)

Mitigation Performance in Dipoles for Positrons & Electrons

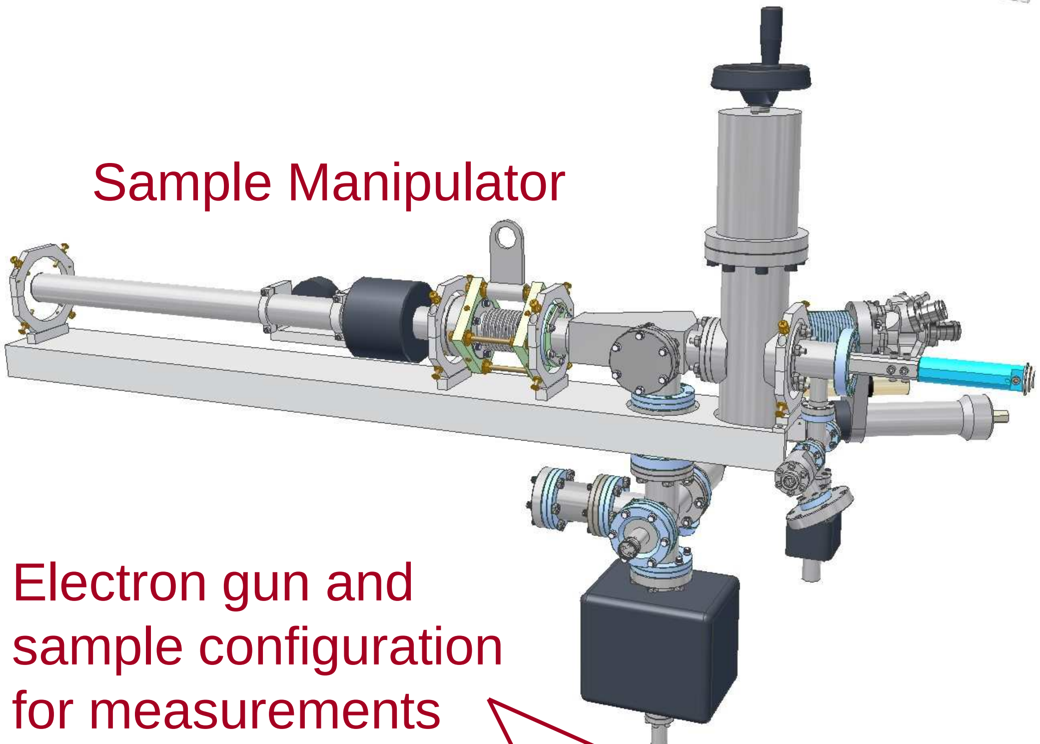
- 1x20 e+, 5.3 GeV, 14ns
  - 810 Gauss dipole field
  - Signals summed over all collectors
  - Al signals ÷40

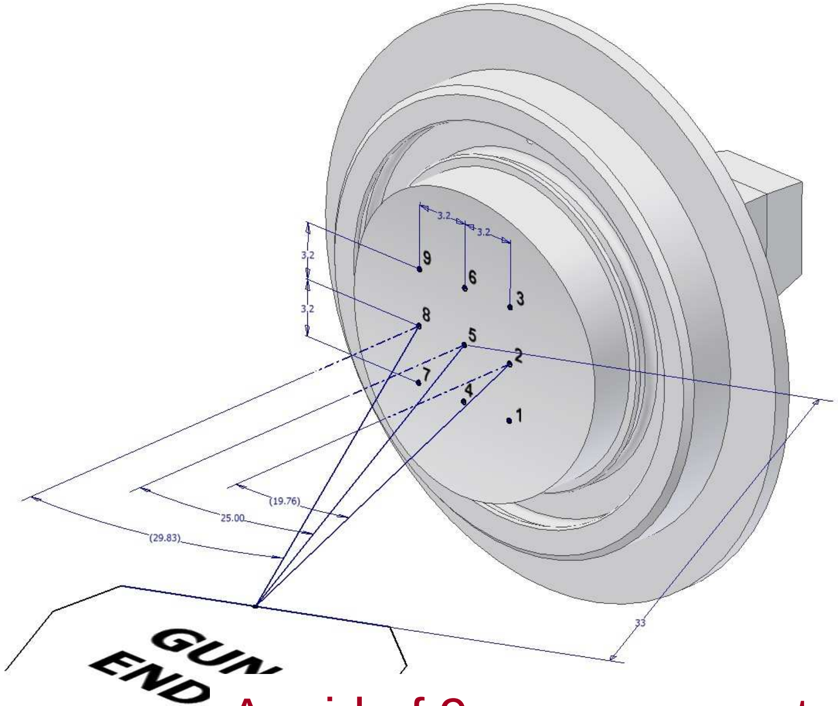




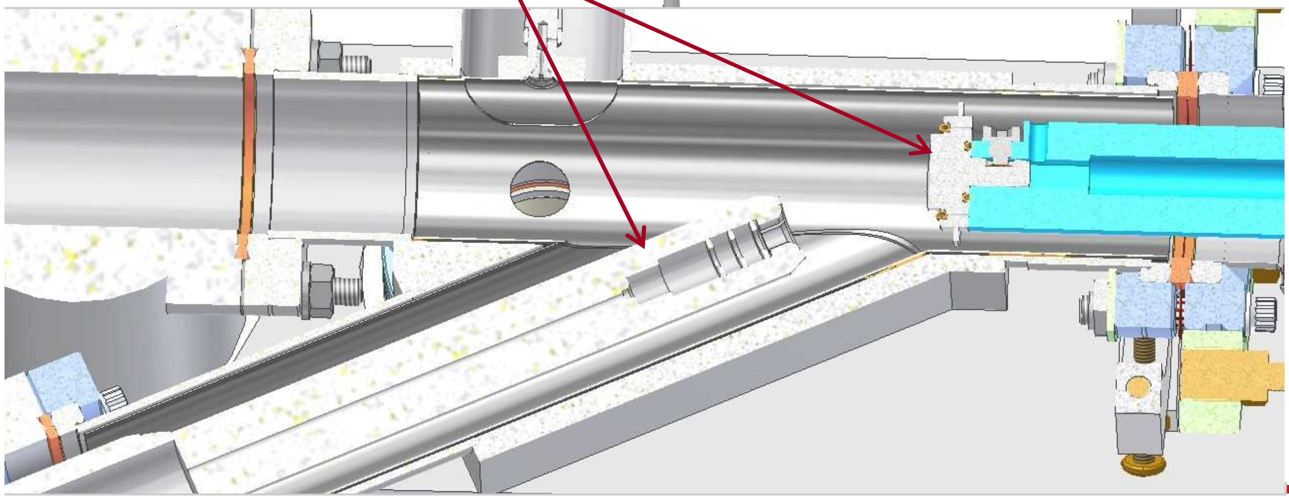
In Situ SEY Measurement System

Sample Manipulator





Electron gun and sample configuration for measurements



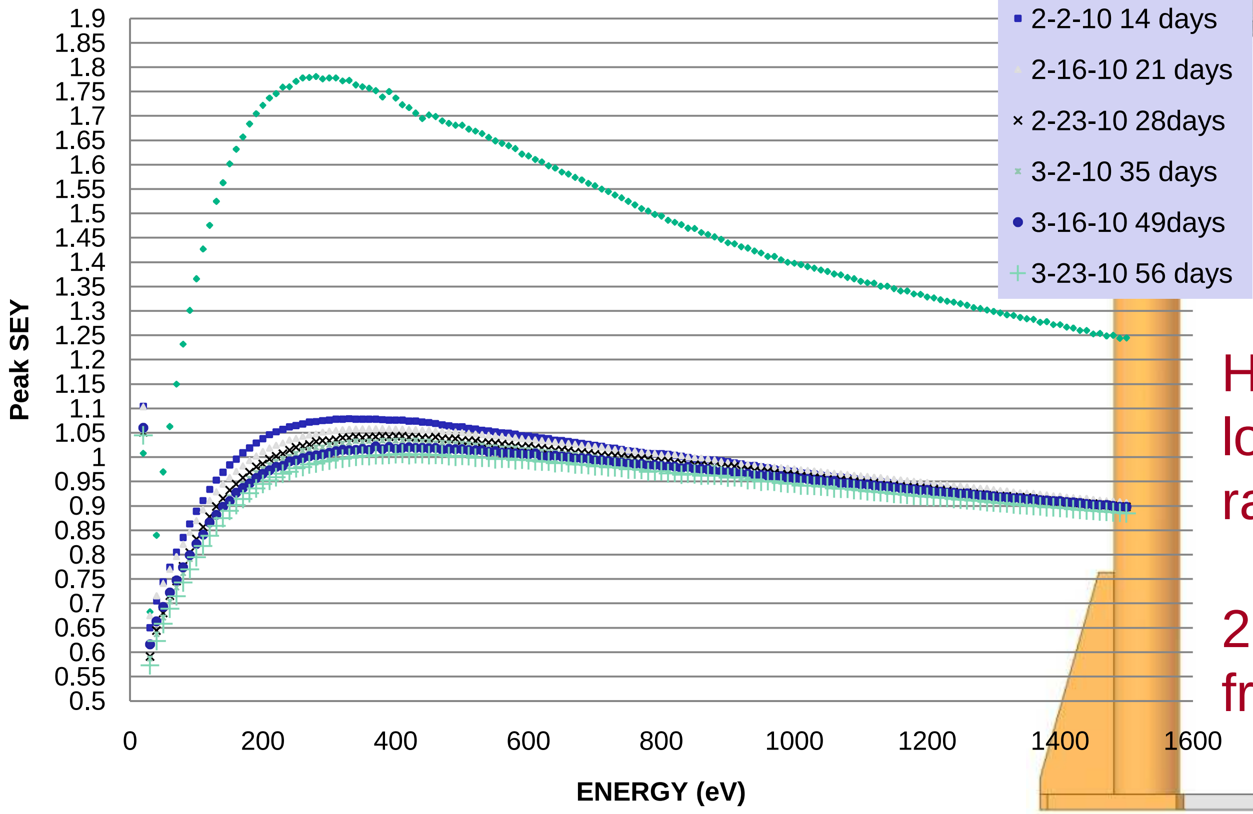
A grid of 9 measurement points is defined on the sample surface and the gun steering electrodes are used to make measurements at each point

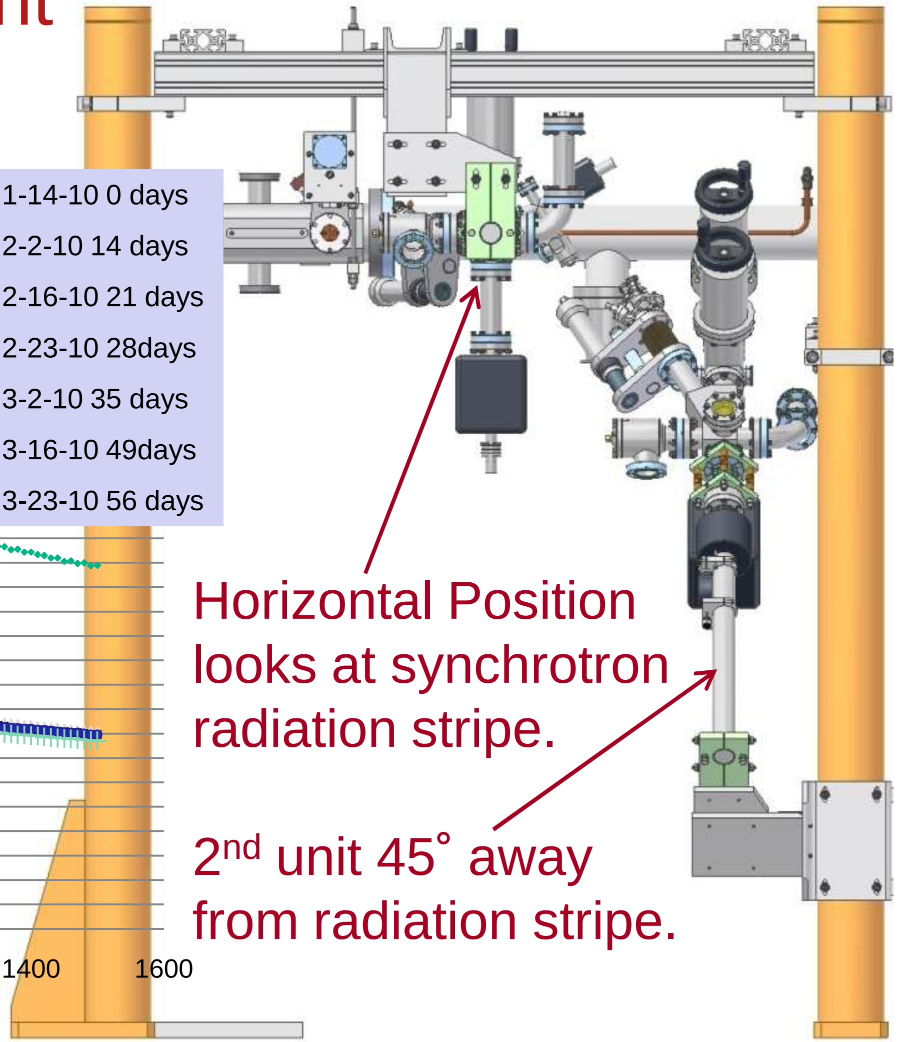
Angles: 20˚, 25˚, 30˚

Horizontal Sample: TiN

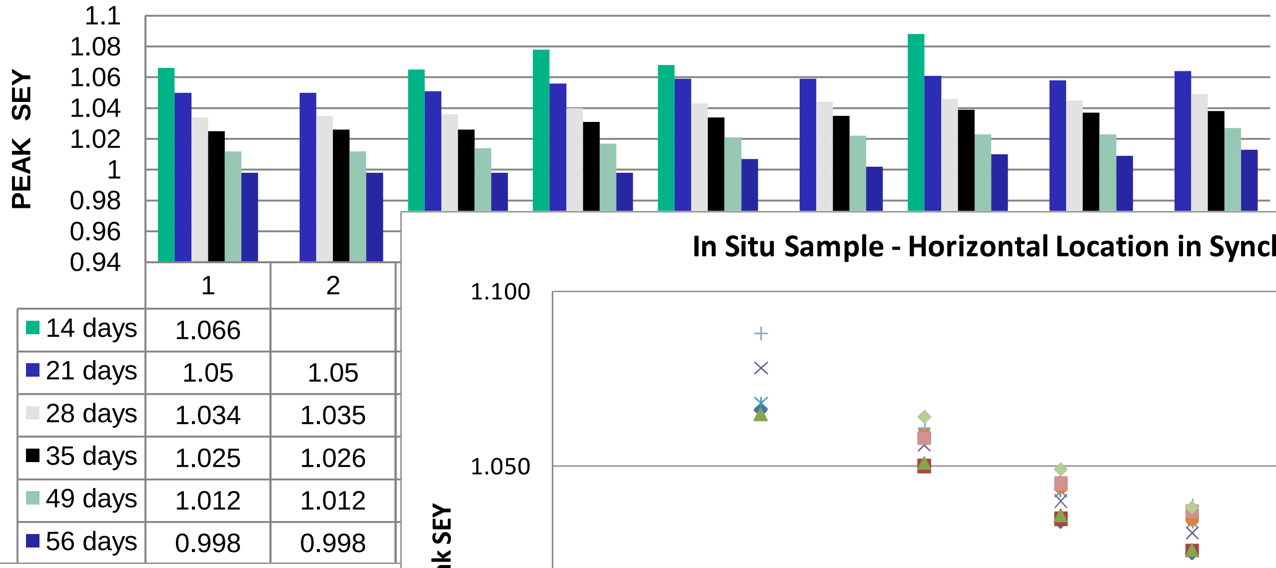
- Rapid initial improvement in SEY followed by a slower processing component

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

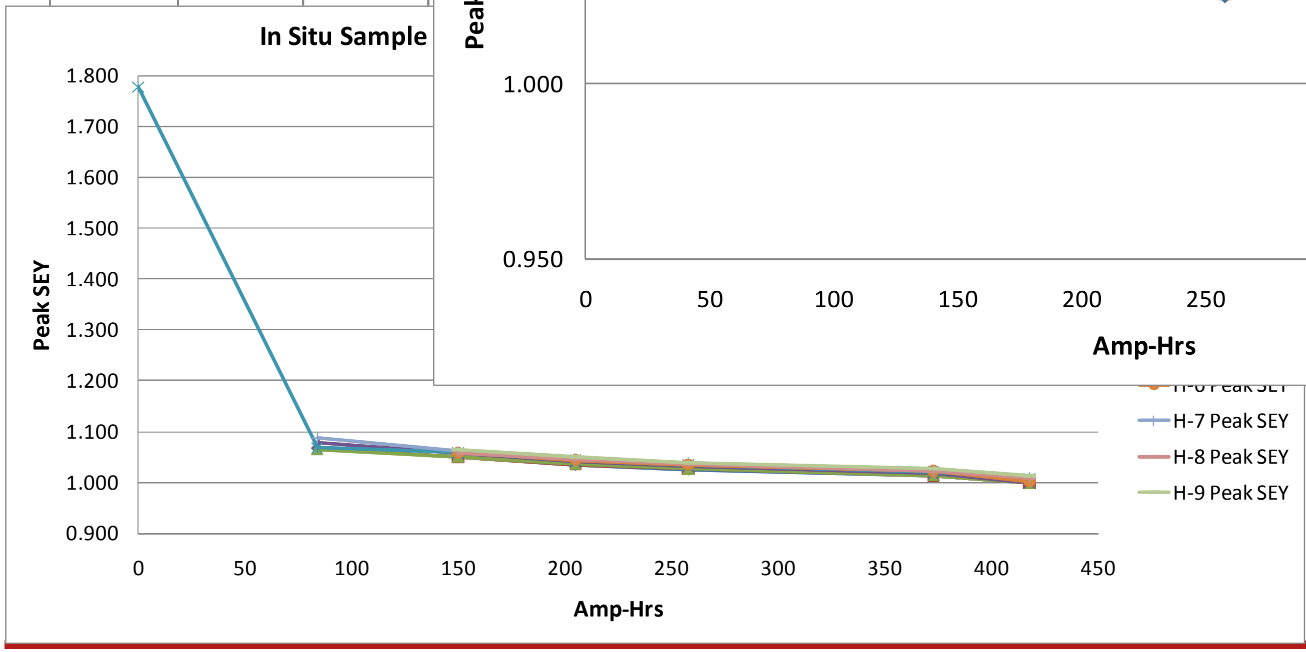


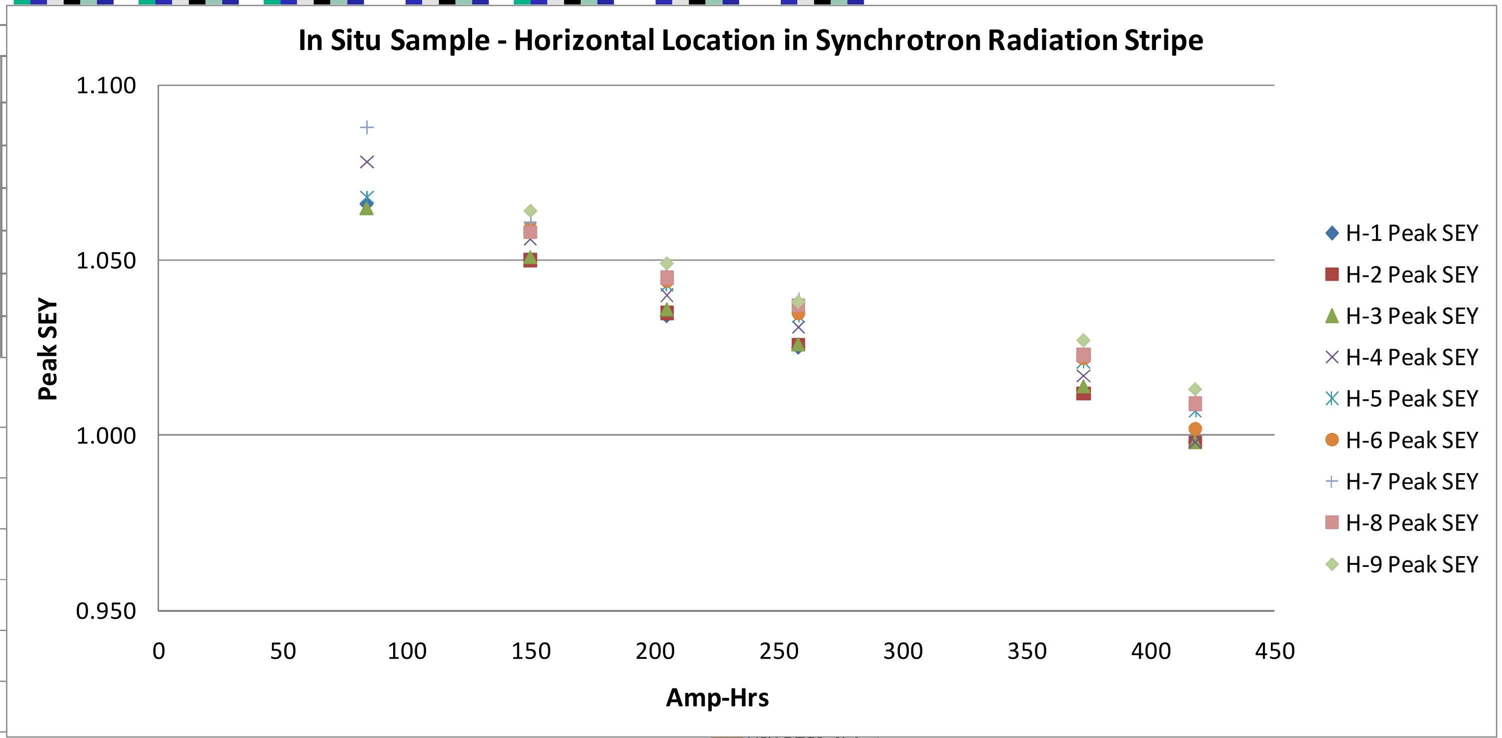


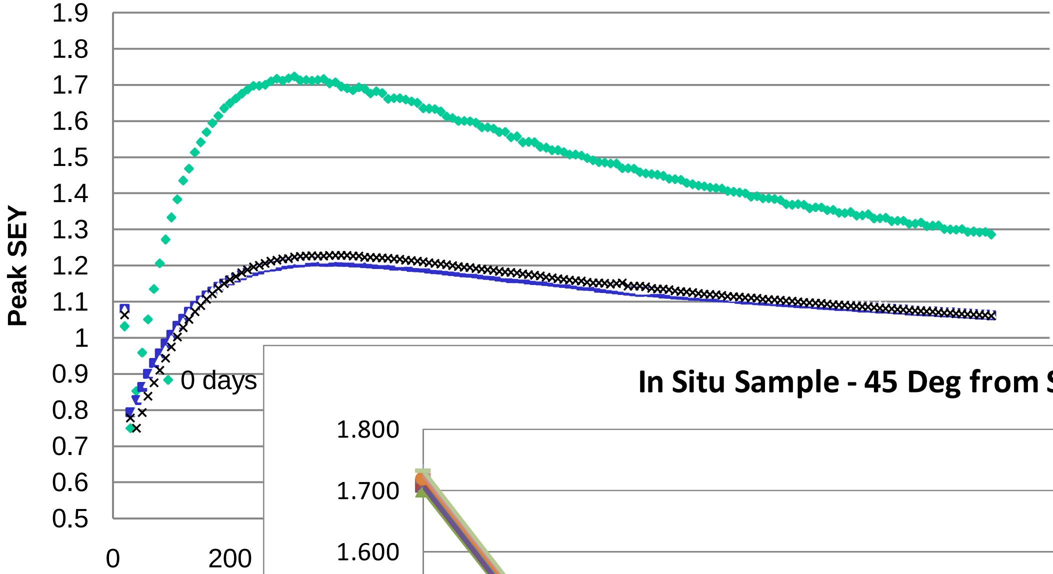
Processing of Horizontal Stripe

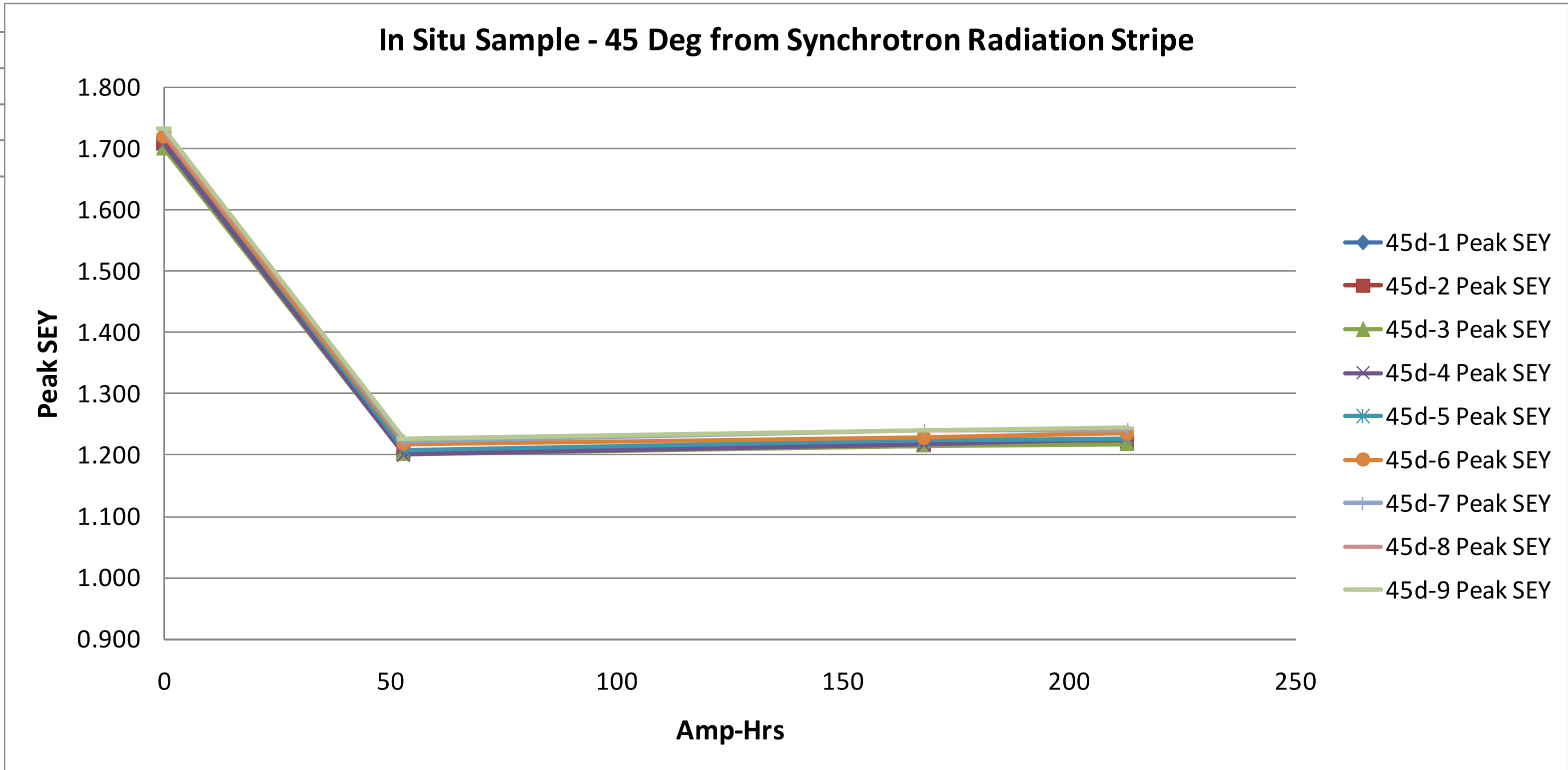


	1	2
14 days	1.066	
21 days	1.05	1.05
28 days	1.034	1.035
35 days	1.025	1.026
49 days	1.012	1.012
56 days	0.998	0.998





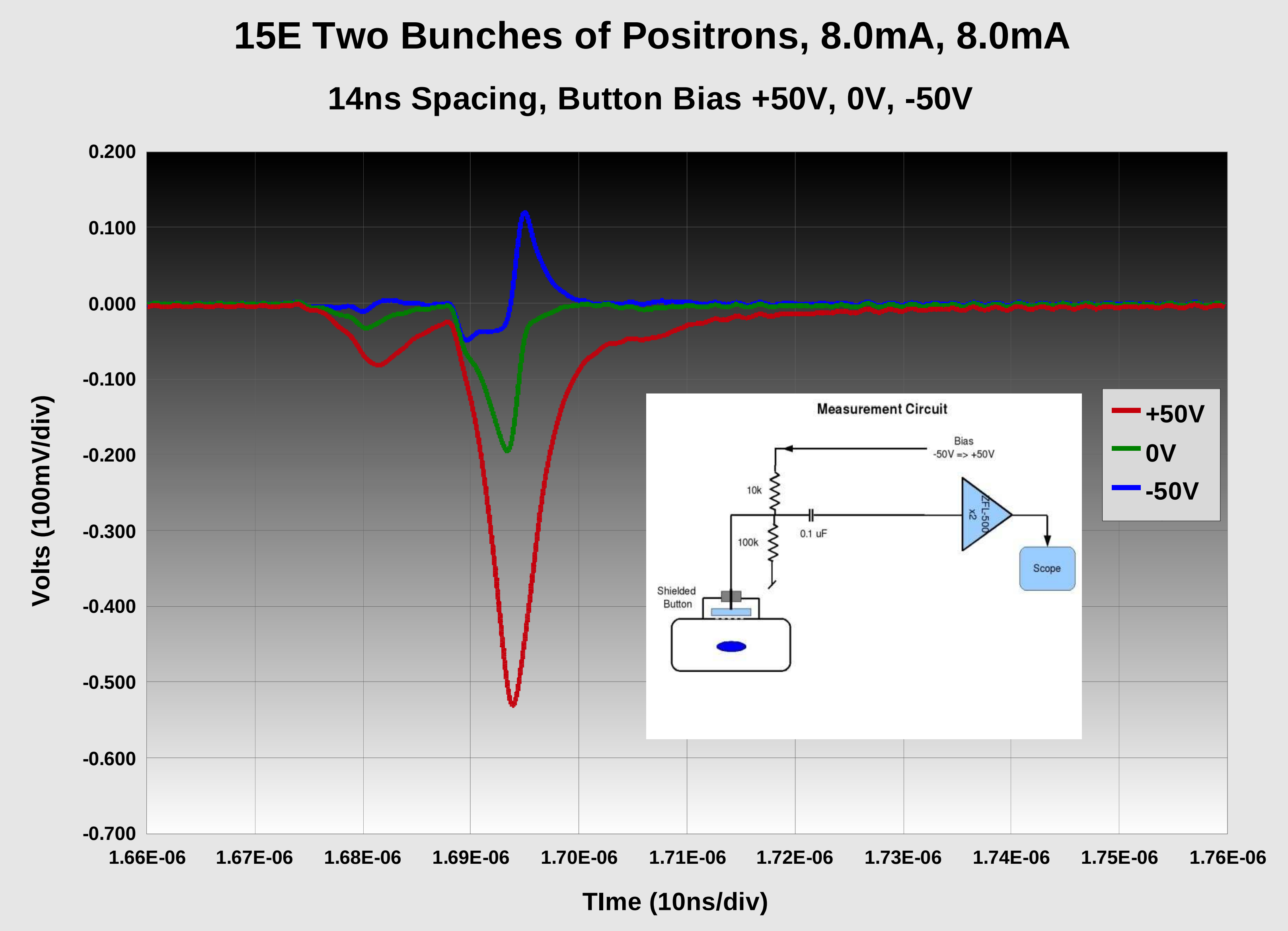




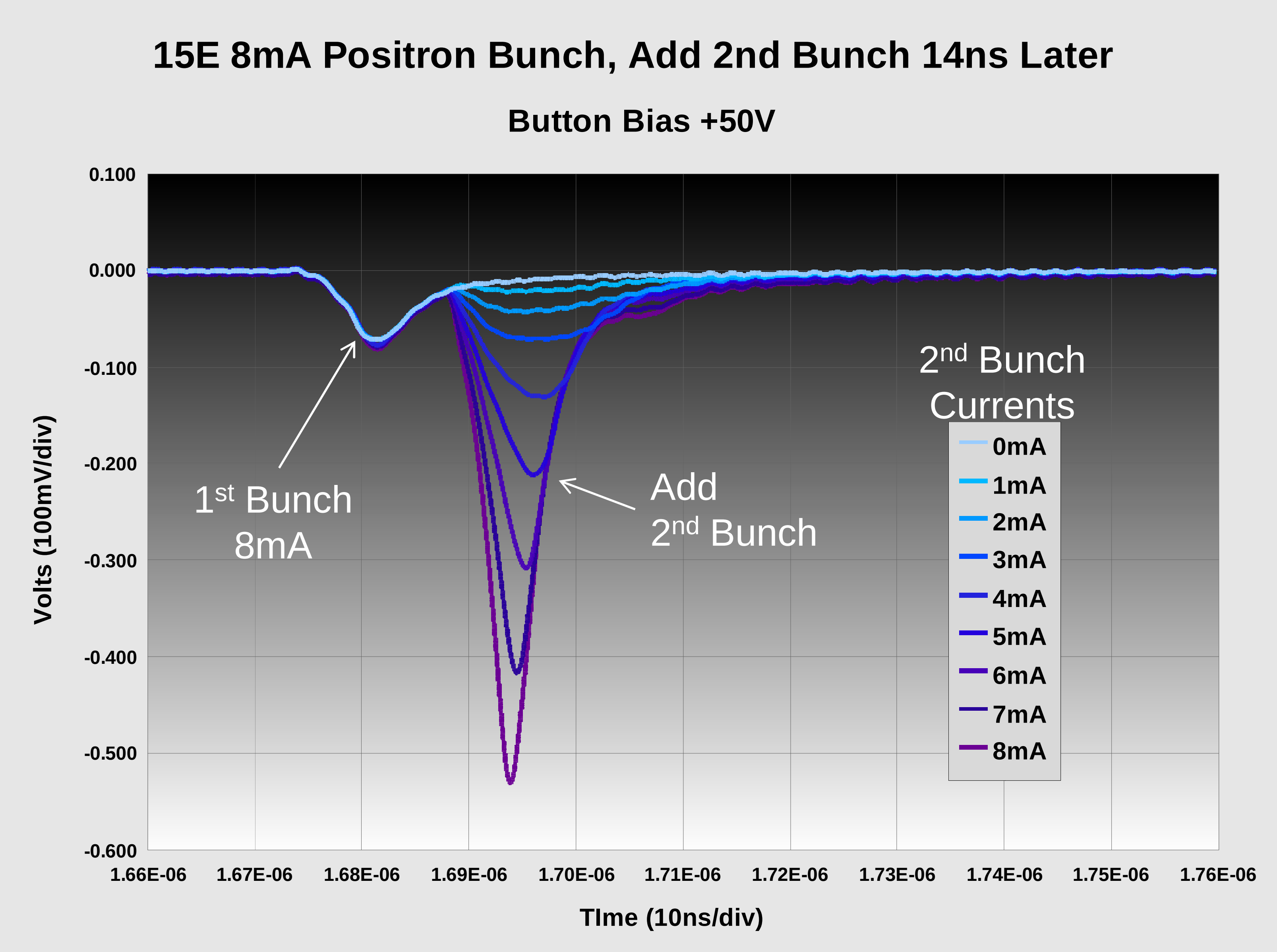
21 days	1.217	1.216	1.216	1.217	1.224	1.229	1.24	1.24	1.24
28 days	1.22	1.219	1.218	1.227	1.227	1.235	1.241	1.243	1.244

- While initial improvement is present, the slower processing component is not observed for the 45° sample

Time-resolved Measurements: Shielded Button Signal vs. Bias



Positrons: Shielded Button with 2 Bunches



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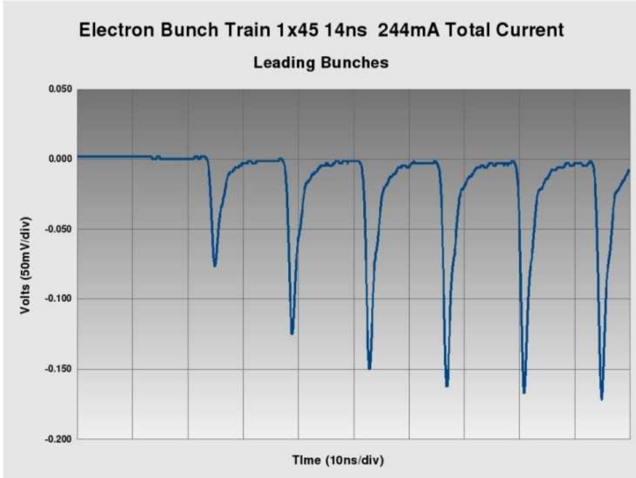
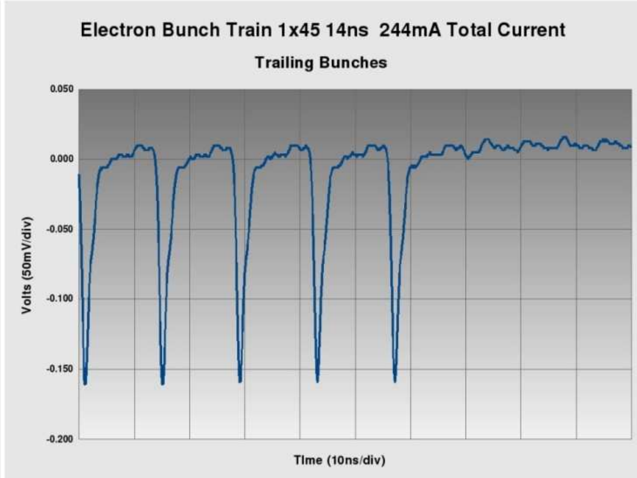
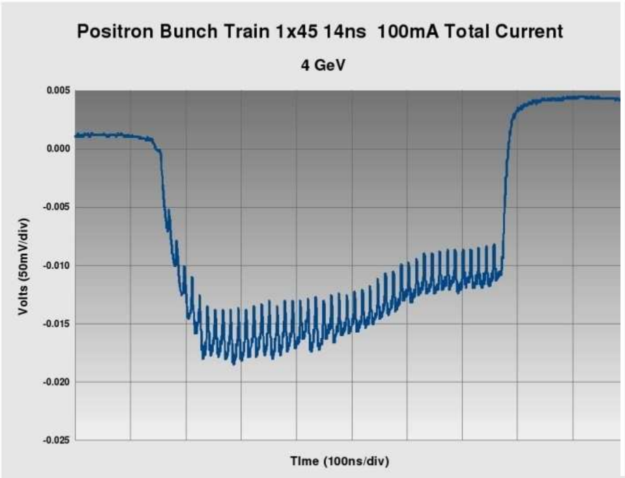
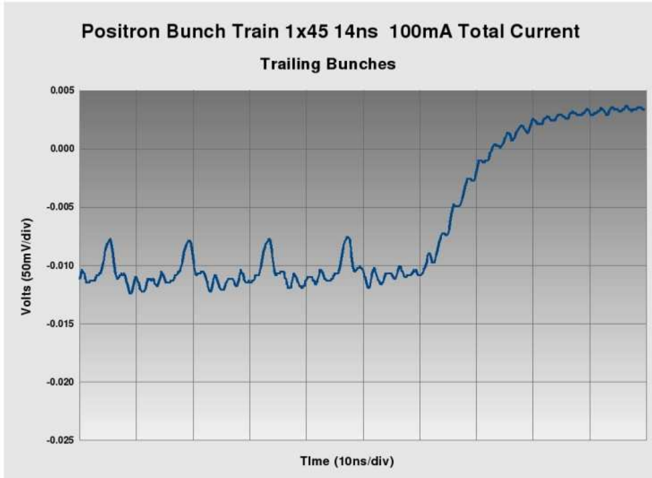
First Look: 14ns Trains
1x45 Electrons and Positrons





Full Train — Head of Train — Tail of Train

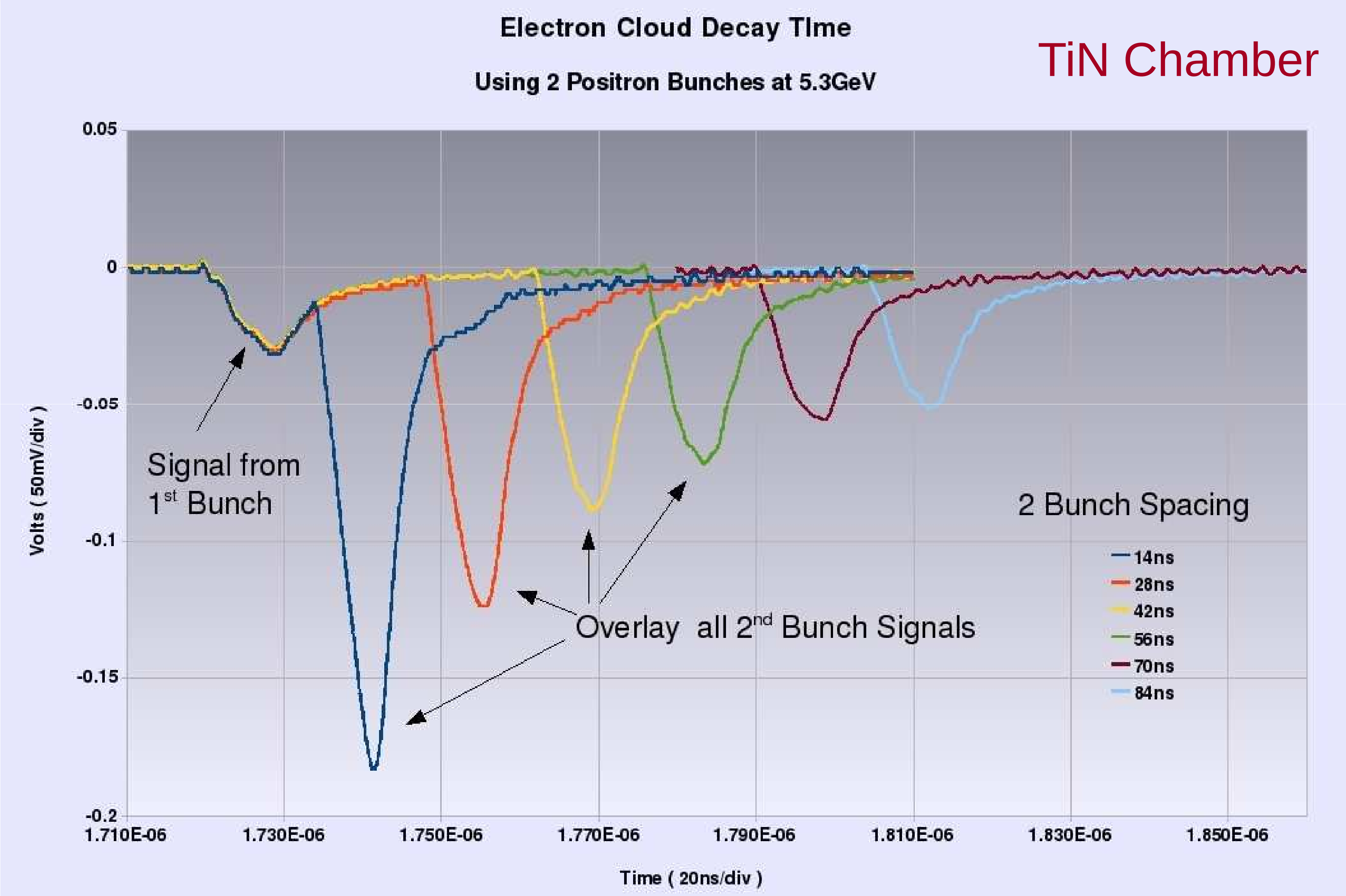




First Look: 4ns Train
1x45 Positrons, 64mA Total

Full Train Head of Train Tail of Train

Cloud Decay Time



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 to ε_y ~ 31pm (within factor of ~1.5 of target)
  – EC mitigation comparisons
  – First single-pass 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:
  – Fully exploiting our new ring instrumentation
  – LET effort to reach a target emittance of $\varepsilon_y \leq$ 20pm
  – Completion of our targeted EC mitigation studies
  – Detailed characterization of instabilities and sources of emittance dilution in the ultra low emittance regime (EC-induced incoherent emittance growth, IBS studies)
  – ***Application of our results to the damping rings design effort***

What Should We Take from These Results???

- Mitigation performance – a few comments…
  - 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
  - Further work is still required 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 resolved (but not discussed today) is that we see more EC in our quadrupole test chamber than is expected. May be 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 a chamber azimuth
  - Additional tests planned:
    - Wiggler with clearing electrode
    - NEG comparisons
    - Tests of surfaces processed by ion bombardment – expected to provide geometric suppression of the cloud similar to grooves
- Time-resolved measurements potentially offer more information with which to validate our PEY and SEY models – important for DR projections

Important Dates & Changes

• **Down Time Preparation Meeting:**		***March 22***
• CesrTA Characterization:		March 22
• **Machine Studies and Down Prep:**		***March 23 – 28 (Δ = 6 days)***
• LCWS10 (CesrTA and EC status reports)		*March 26 – 30*
• CESR Down:	Δ = 0 days	*March 29 – April 22*
• CESR Startup:	Δ = - 2 days	*April 22 (aft/eve) – May 1 (morn)*
• CesrTA Run 6a:	Δ = - 2 days	*May 1 – May 20 (morn)* ← Somewhat Problematic
• CHESS MS:	Δ = - 2 days	*May 20 – May 25*
• IPAC10:		May 23 – May 28
• CHESS Run:		May 26 – July 20 (morn)
• CesrTA Run 6b:		July 20 – August 3 (morn)
• CESR Down:		August 3 – September 2 (morn)
• CESR Startup:		Sept 2 (aft/eve)- Sept 10 (morn)
• CesrTA Run 7a:		Sept 10 – Sept 30
• ECLOUD10 (Cornell)		October 8 – 12
EC Working Group Satellite Meeting		October 13
• Joint CLIC-ILC Workshop		October 18 – 22(?)

Formal conclusion of current CesrTA operations

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 Instrumentation
    - CalPoly, CERN, Cockcroft, KEK, SLAC
  - EC Instrumentation
    - FNAL,KEK, LBNL
  - SEY Station
    - Carleton, FNAL, SLAC
  - Simulation
    - CERN, KEK, INFN-Frascati, LBNL, SLAC
  - Technical System Checks
    - BNL, CERN, KEK

The End

Thank you for your attention!

- Backup Slides Follow

Unique Features of R&D at CESR

CESR offers:

- An operational wiggler-dominated storage ring
- The CESR-c superconducting damping wigglers
  - Technology choice for the ILC DR baseline design
    - Physical aperture: Acceptance for the injected positron beam
    - Field quality: Critical for providing sufficient dynamic aperture in the damping rings
- Flexible operation with ***positrons*** *and* ***electrons***
- Flexible bunch spacing suitable for damping ring tests (≥ 4ns)
- Flexible energy range from 1.5 to 5.5 GeV for EC growth and beam dynamics studies
- Dedicated focus on damping ring R&D for significant running periods
  - Support for collaborator experiments
  - Support for electron cloud hardware (eg, PEP-II experimental hardware has been re-deployed in CESR to complete the SLAC measurement program)
- A useful set of damping ring research opportunities…
  - The ability to operate with positrons and with the CESR-c damping wigglers offers a unique experimental reach in the ultra low emittance regime

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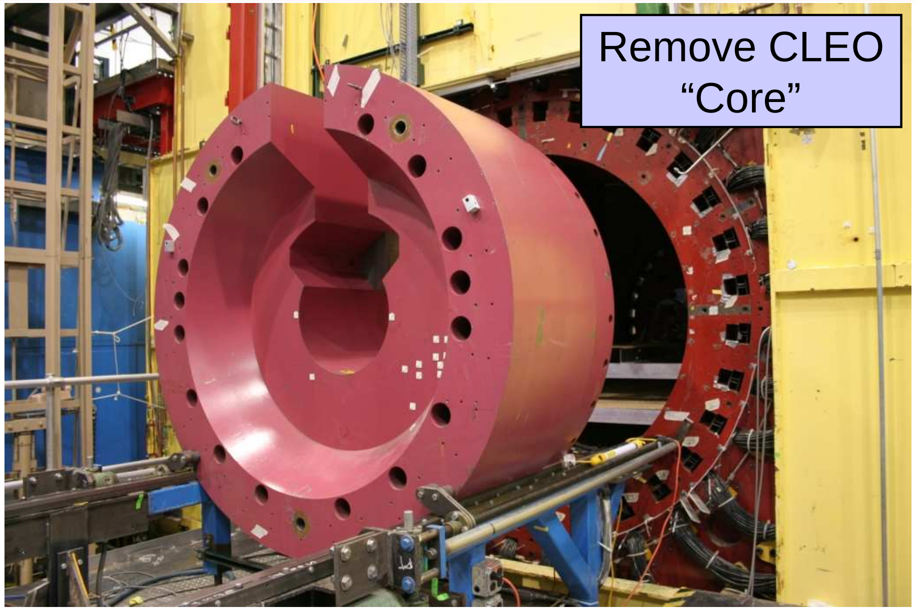
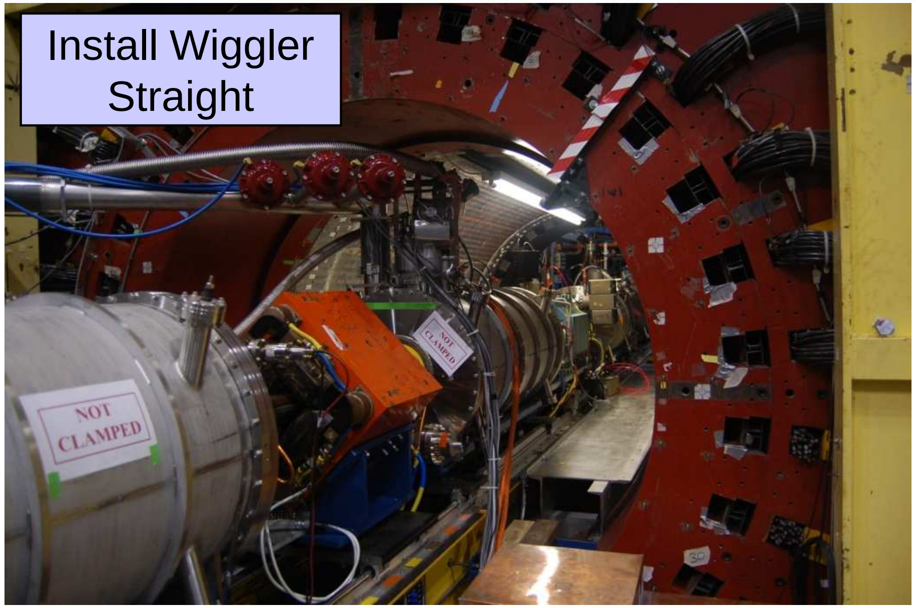
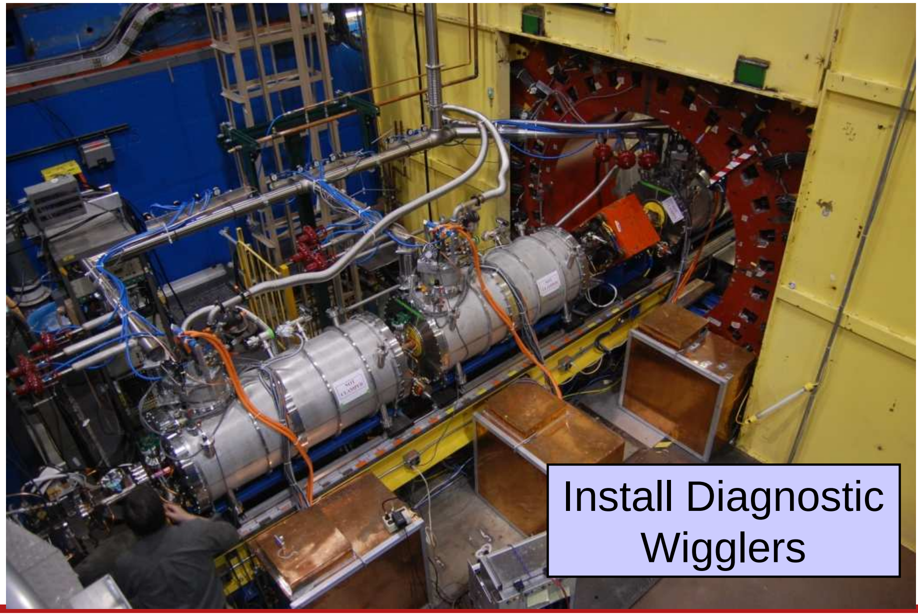
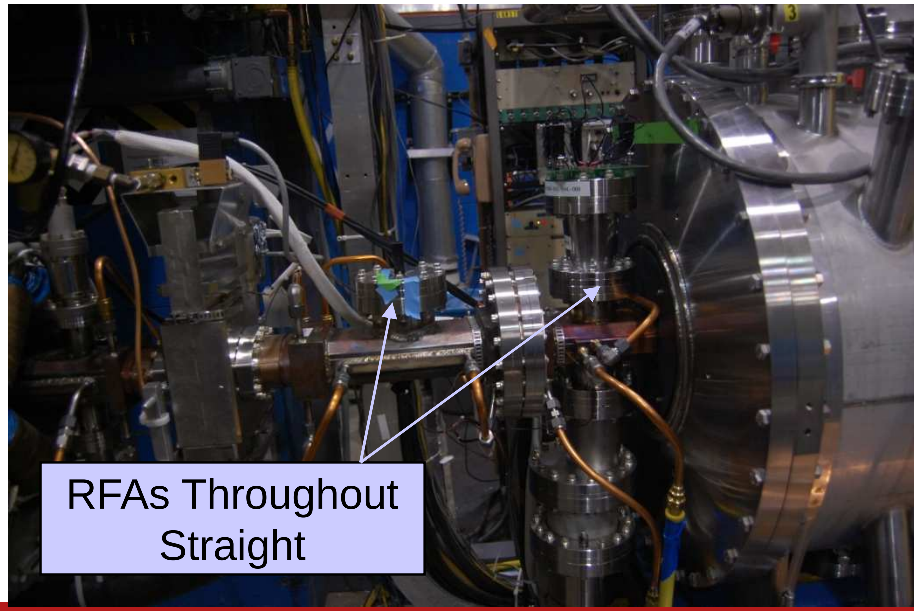
CESR Reconfiguration: L0 Modifications









R&D Effort

- Major components of our remaining R&D effort are:
  - Low emittance tuning and achieving <20pm vertical emittance
  - EC mitigation studies
  - EC instability studies
  - Detailed comparisons with simulation
- Specific priorities were identified at CTA09 (June 25-26)
  https://wiki.lepp.cornell.edu/ilc/bin/view/Public/DampingRings/CTA09/WebHome
  - 3 Working Groups
    - EC Build-Up and Mitigation
      - Conveners: K. Harkay, Y. Suetsugu, R. Zwaska
      - 27 Deliverables with 21+ contributors identified
      - 3 Broad Catgories
        - » EC Build-Up
        - » Instrumentation
        - » Mitigation
    - EC Simulation and Beam Dynamics
      - Conveners: G. Dugan, J. Flanagan
      - 32 Deliverables with 16 contributors identified
      - Divided into beam measurement and simulation categories
    - LET
      - Conveners: M. Billing, S. Guiducci, J. Shanks
      - 16 Deliverables with 19 contributors identified
      - Divided into LET and instrumentation categories
- Detailed discussion in the next two talks, however, will briefly summarize here…

Integration into the ILC DR Design

- We expect by 2010 to have placed the positron damping ring on a more solid foundation by having confirmed and updated our performance projections
  - Detailed comparisons of data and simulation in the low emittance regime will lead to significantly more reliable estimates in our DR simulations
  - Results will confirm, or cause us to re-evaluate, our plans to move to a smaller circumference layout

- Testing of a range of mitigations in operational vacuum chambers will provide the necessary inputs for the technical design
  - Will allow the damping rings group to proceed with detailed design work and costing on an updated baseline vacuum system
  - Fully expect that there will be significant ongoing work to validate the design details
    - Prototyping
    - Some tests such as durability checks of newer coatings may still await final results
  - We anticipate that these inputs can largely be incorporated as incremental changes to the DR design work presently underway