



International Linear Collider R&D on electron cloud (SLAC)

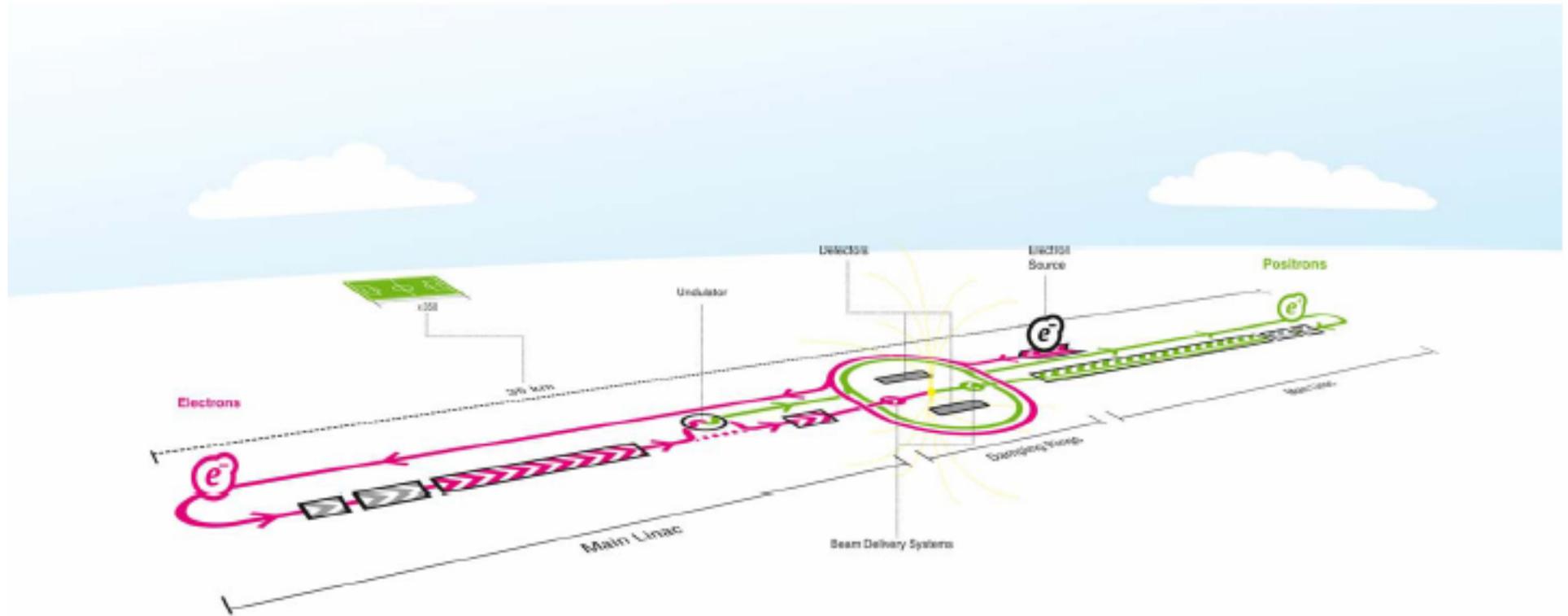
M. Pivi, T. Raubenheimer, J. Seeman, T. Markiewicz,
R. Kirby, F. King, B. McKee, M. Munro, D. Hoffman, G. Collet,
L. Wang, A. Krasnykh, D. Arnett, (SLAC) M. Venturini,
M. Furman, D. Plate (LBNL), D. Alesini (LNF Frascati)
R. Macek (LANL)

Electron Cloud Clearing ECL2

CERN



The International Linear Collider



draft (still missing sections) Reference Design Report (RDR) including **preliminary** Value and Explicit Labor Estimates was made public in Beijing, Thursday, February 8, 2007



<http://www.linearcollider.org>

ilc international linear collider

FOR COLLABORATORS | FOR THE PRESS | FOR COMMUNICATORS | FOR STUDENTS AND EDUCATORS | SEARCH [input] GO

What is the ILC?
 Global Design Effort
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 Talks
 Reports and Statements
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Beijing ILC Workshop 2007, 4-7 February [Image Courtesy IHEP]

Current News

From *iWire* | 11 February 2007
International Linear Collider proposed to explore origins of universe
 "An international high-energy physics research project was proposed on Thursday, February 8, 2007, at a meeting in Beijing, China. The project intends to design and build the International Linear Collider that is proposed to consist of a 30-kilometer (20-mile) linear particle accelerator..."

From *Zeit online* | 10 February 2007
Wer soll das bezahlen?
 "5,5 Milliarden kostet ein neuer Bericht zufolge der moderne Teilchenbeschleuniger der Welt. Deutsche Physiker würden ihn gerne nahe Hamburg aufbauen. Von Björn Schwentker..."

From *Le Figaro* | 10 February 2007
Un accélérateur pour éclairer le big bang
 "Le schéma technique du futur accélérateur de particules international a été présenté à Pékin. Coût estimé : 5,5 milliards d'euros."

Features

Draft Reference Design Report Released

- [Report](#) (10MB pdf)
- [Report](#) (10MB pdf) (Mirror-Asia)
- [RDR Summary](#) (1.6MB pdf)
- [Companion Document](#) (1.6MB pdf)
- [The Estimate Explained](#) (pdf)
- [ILC by the Numbers](#) (pdf)
- [More materials and images](#)

For the Press
 Get additional information about the ILC at our [Media Advisory](#) page.

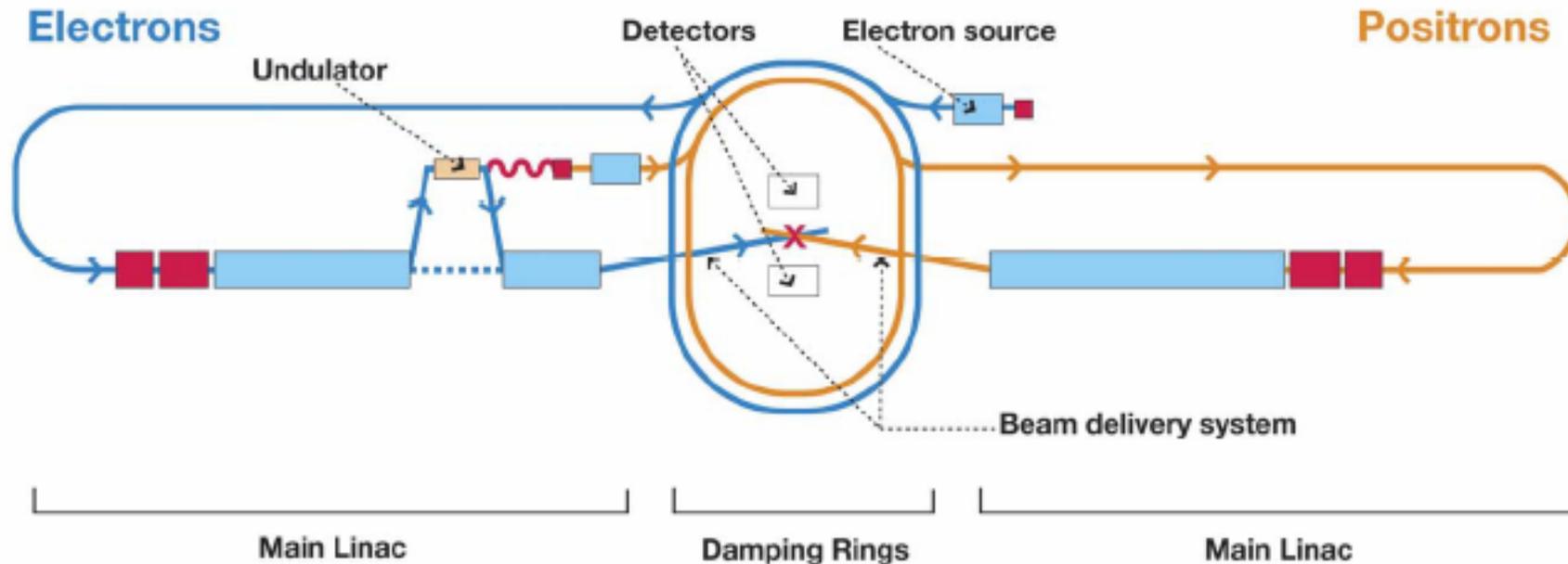
ILC NewsLine | 8 February 2007

 Ni Hao! View some highlights from the Beijing ILC Workshop.

Report,
Companion
Document,
Graphics,
and more...



ILCSC Parameters Reports (R. Heuer)



E_{cm} adjustable (scan) from 200 – 500 GeV

Peak Luminosity $2 \times 10^{34} \text{ cm}^{-2}\text{sec}^{-1}$

→ $\int L dt = 500 \text{ fb}^{-1}$ in 4 years

Energy stability and precision below 0.1%

Electron polarization of at least 80%

The machine must be upgradeable to 1 TeV

Removing safety margins in the energy reach is acceptable but should be recoverable without extra construction. The max luminosity is not needed at the top energy (500 GeV), however

The interaction region (IR) should allow for two experiments the two experiments could share a common IR, provided that the detector changeover can be accomplished in approximately 1 week.



The GDE Plan and Schedule

2005

2006

2007

2008

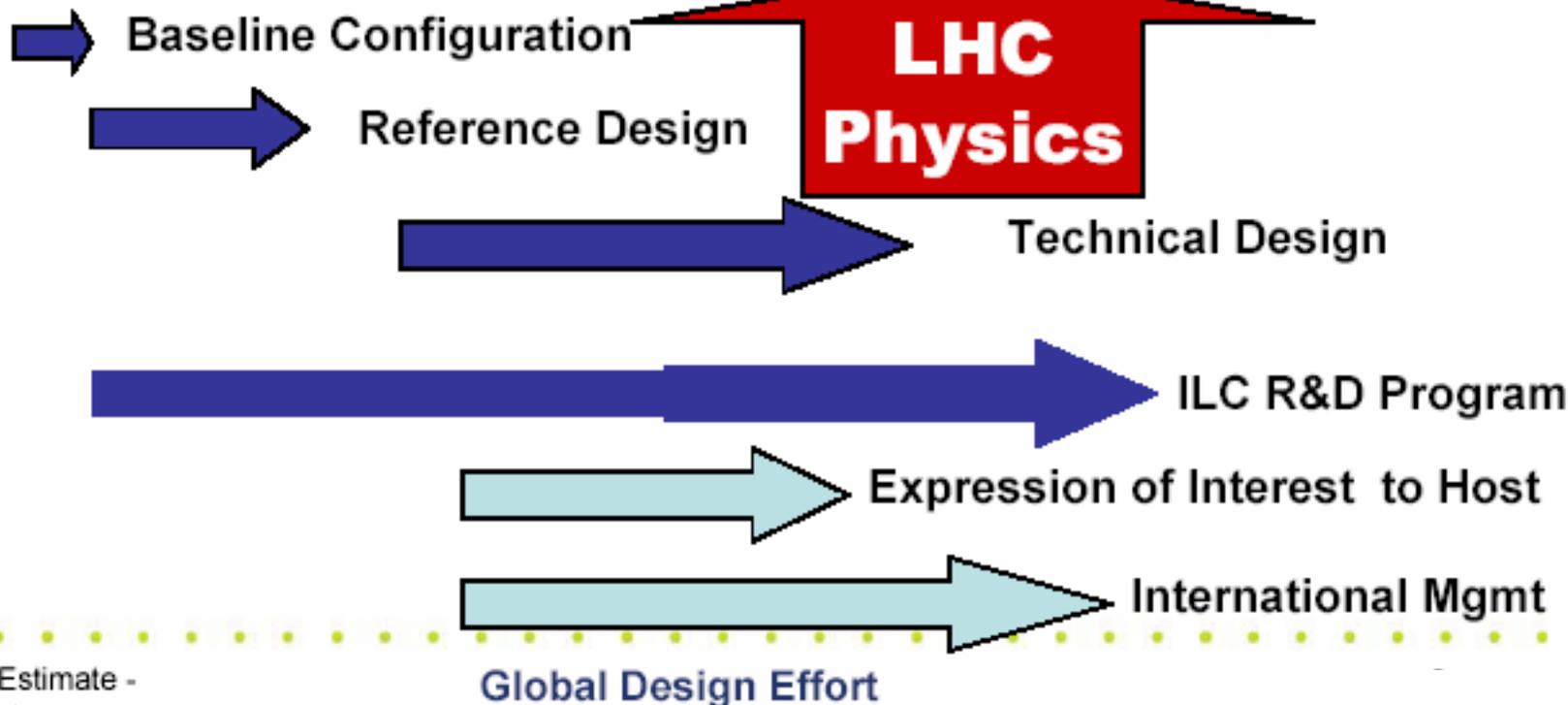
2009

2010

CLIC

Global Design Effort

Project

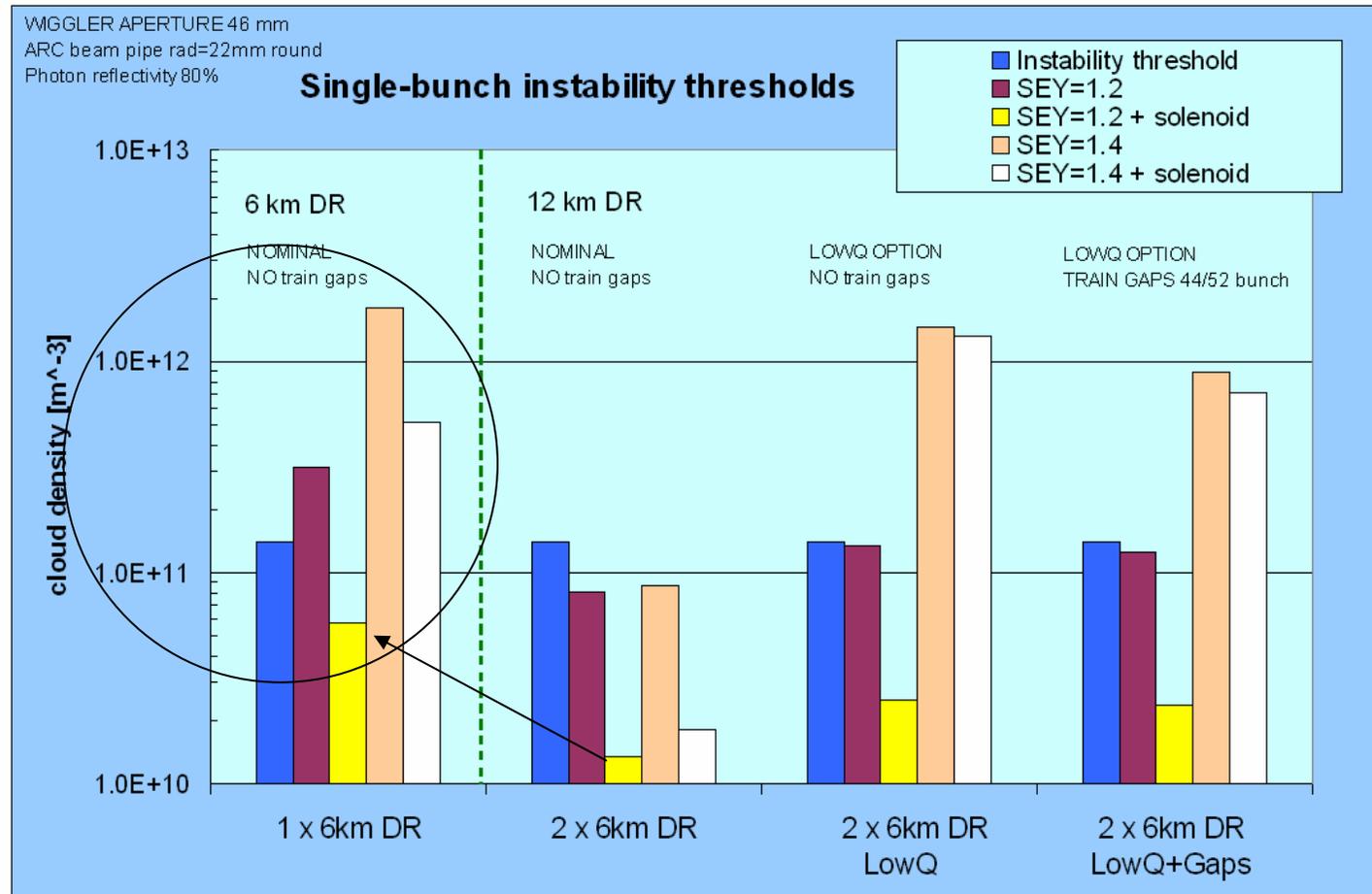




- International collaboration R&D effort: 2006 simulation campaign culminating in the recommendation for the damping ring circumference reduced from 17 km to 12km [electron cloud safe] and then further reduced to 6km [red flag].
 - An electron cloud expected in the 6km positron Damping Ring, but simulations give increased confidence on possible remedies as clearing electrodes and grooves.
 - Substantial R&D is needed to confirm possible mitigation techniques.
-
- A horizontal line of small yellow dots runs across the bottom of the slide, mirroring the one at the top.



Compare options: simulations recent history

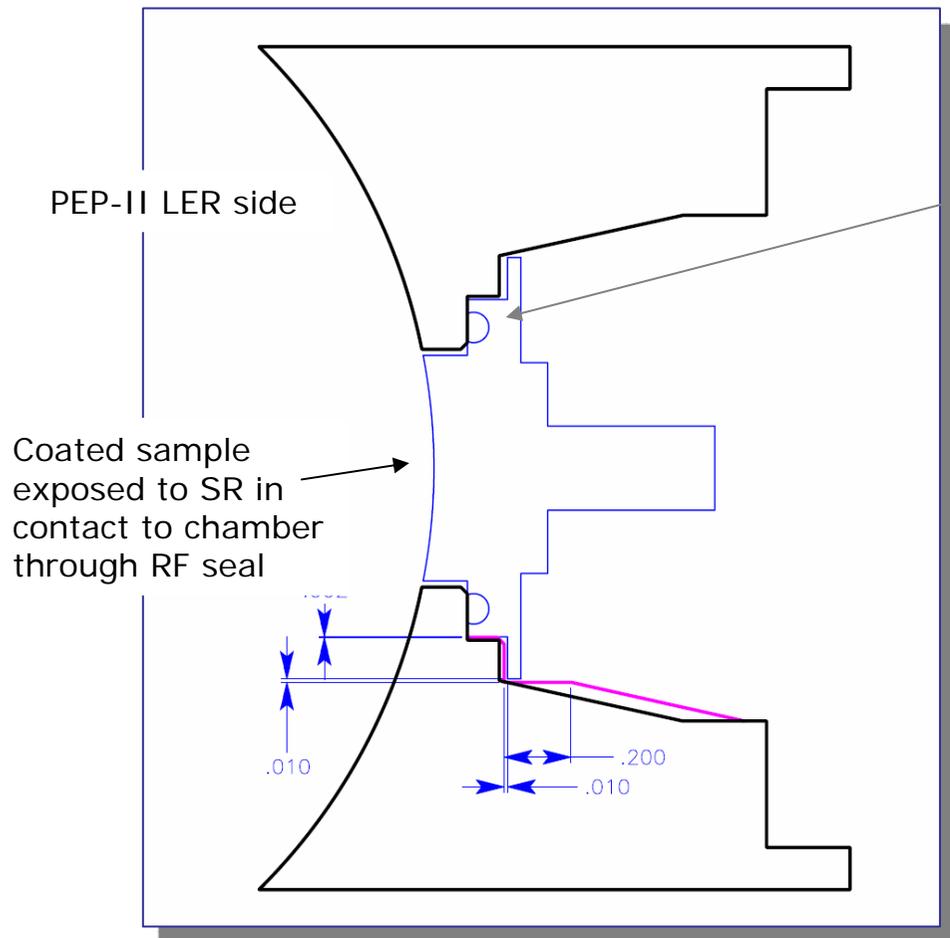


Cloud density near ($r=1\text{mm}$) beam (m^{-3}) before bunch passage, values are taken at a cloud equilibrium density. Solenoids decrease the cloud density in DRIFT regions, where they are only effective. Compare options LowQ and LowQ+train gaps. All cases wiggler aperture 46mm.

SEY TESTS TiN and NEG



Expose samples to PEP-II LER synchrotron radiation and electron conditioning. Then, measure Secondary Electron Yield (SEY) in laboratory. Samples transferred under vacuum.



RF seal location



RF seal provide both RF sealing and thermal contact (Synch radiation load = 1W/cm at 4.7A)

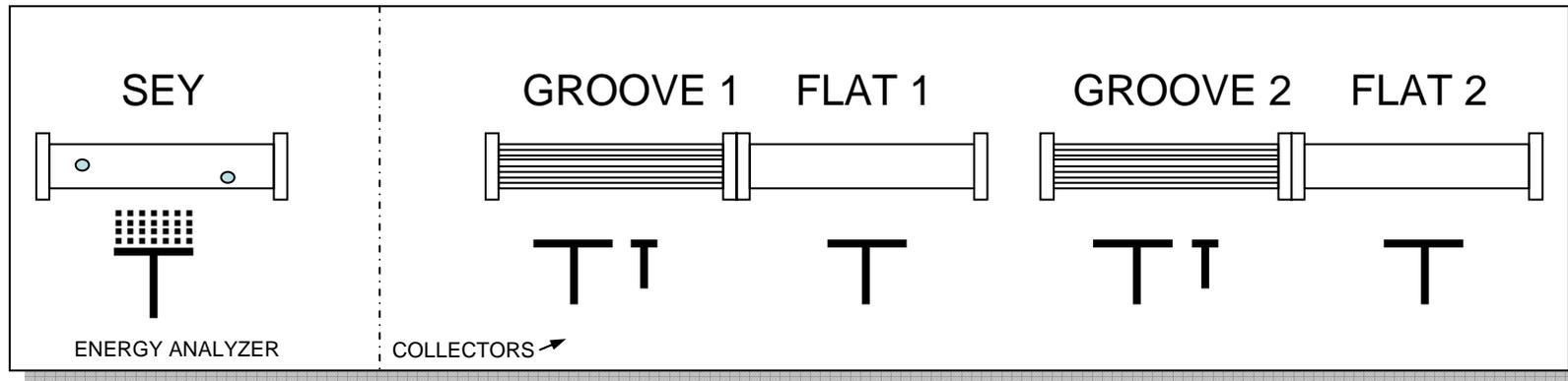
Complementary to SPS and KEK studies



PEP-II test chambers installation

SEY TEST STATION

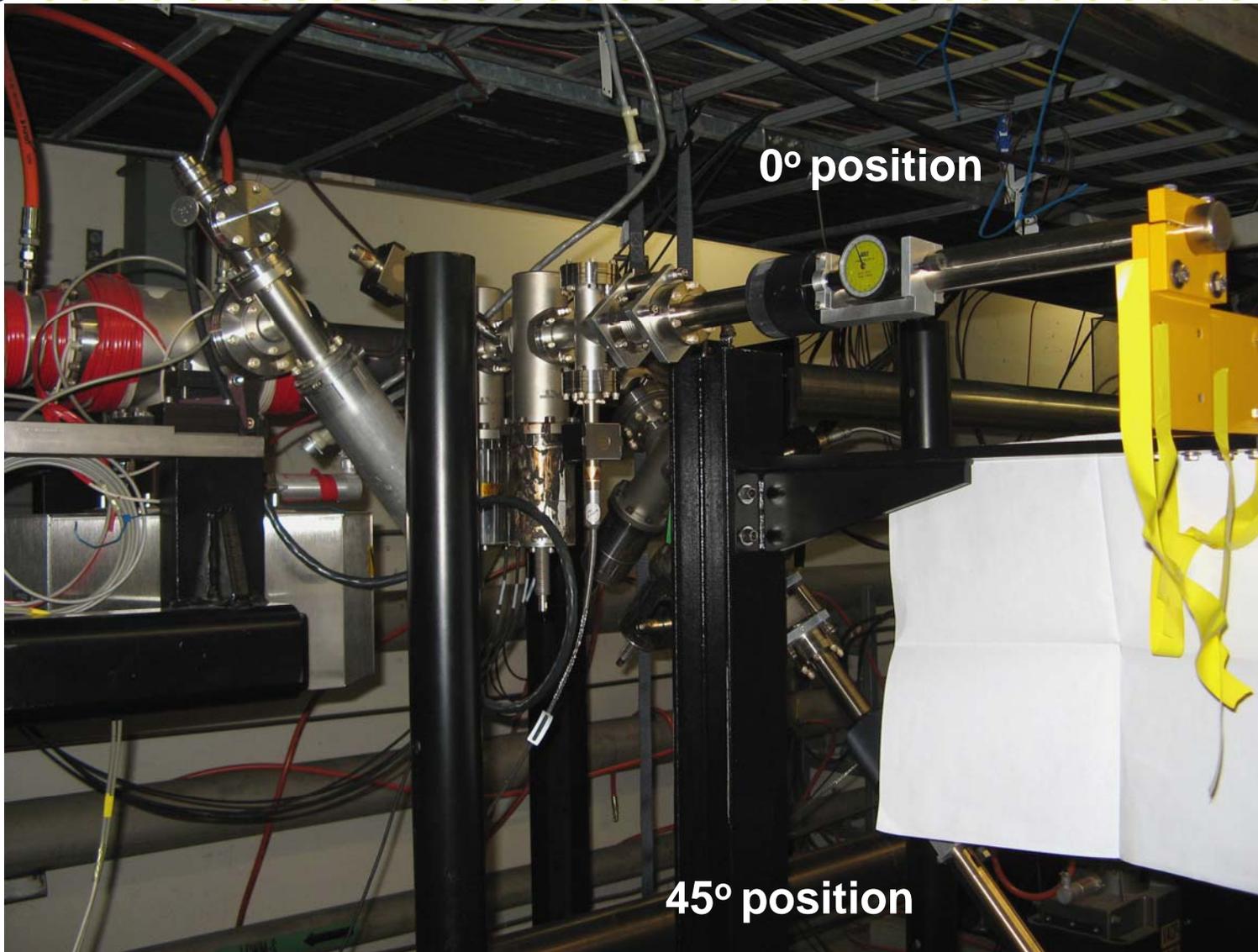
GROOVE CHAMBERS EXPERIMENT



○ THERMOCOUPLES

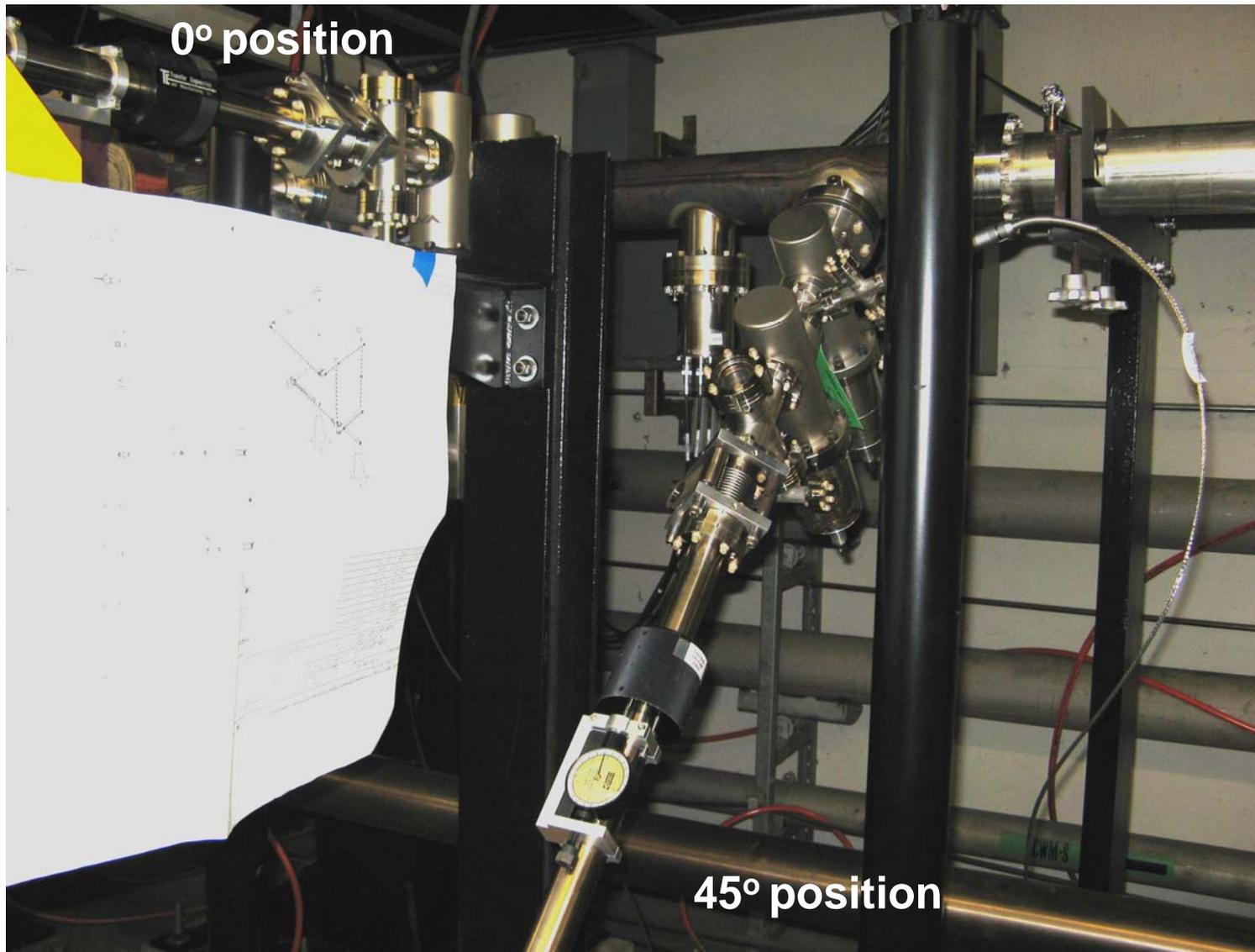


SEY test station in PEP-II LER



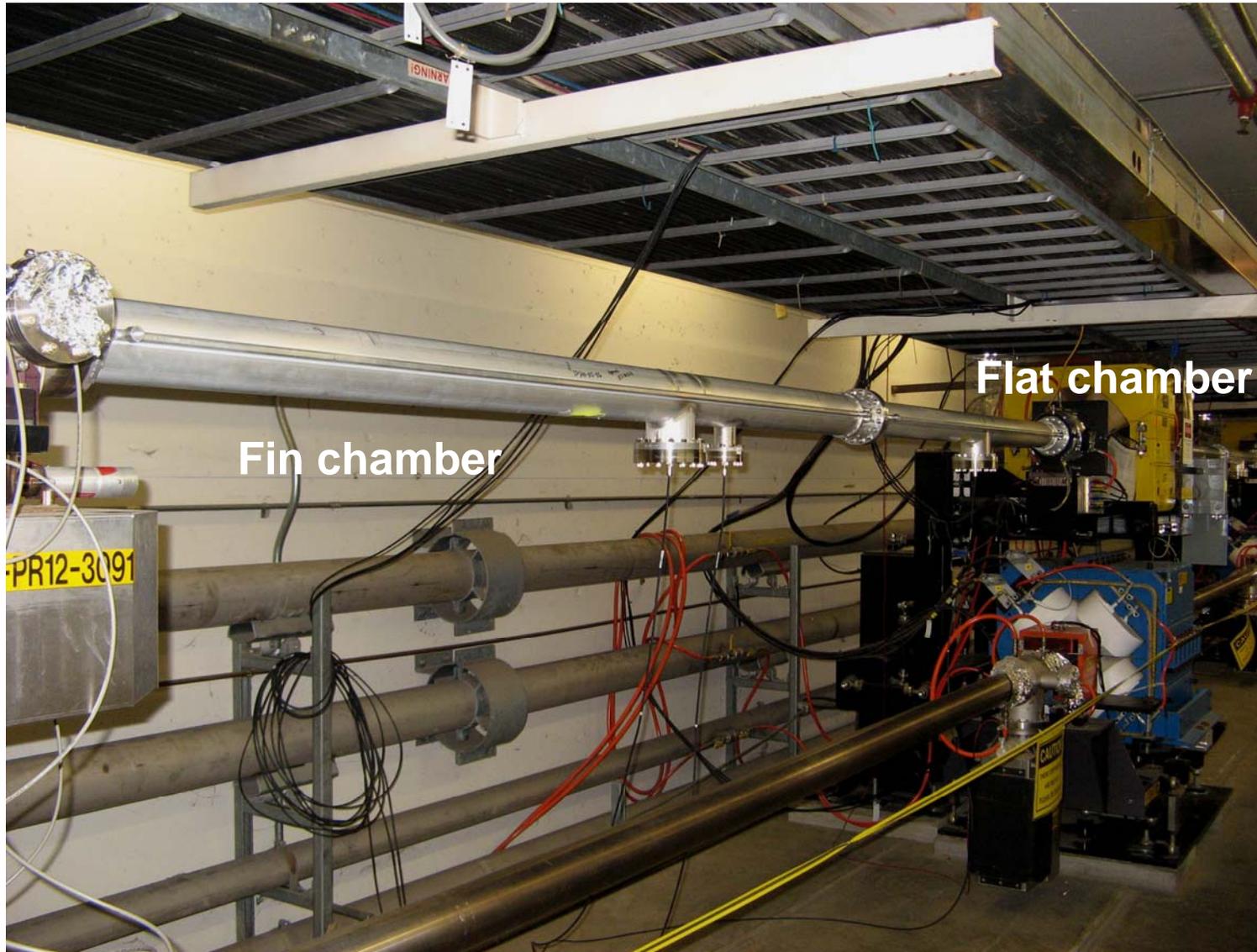


SEY test station in PEP-II LER



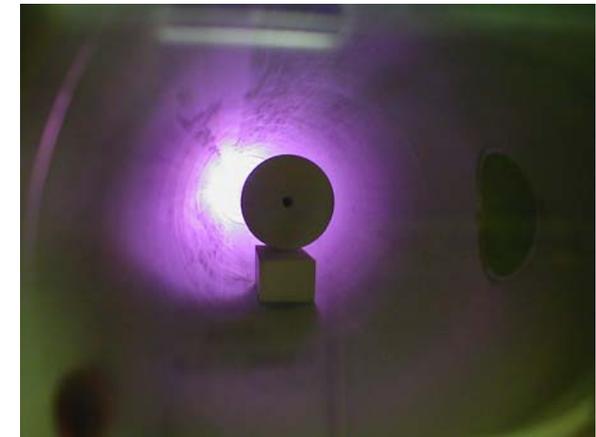
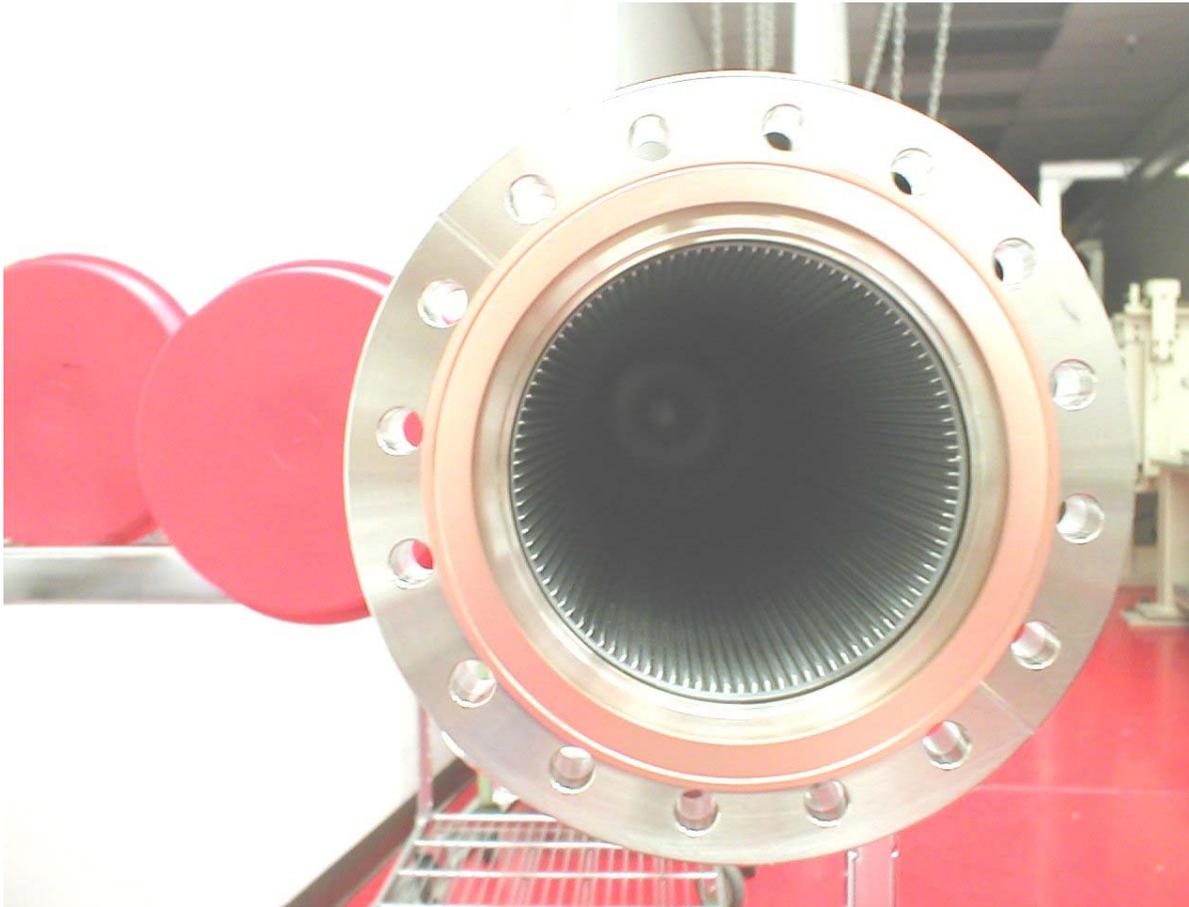


Fin/Flat TiN chambers in PEP-II LER





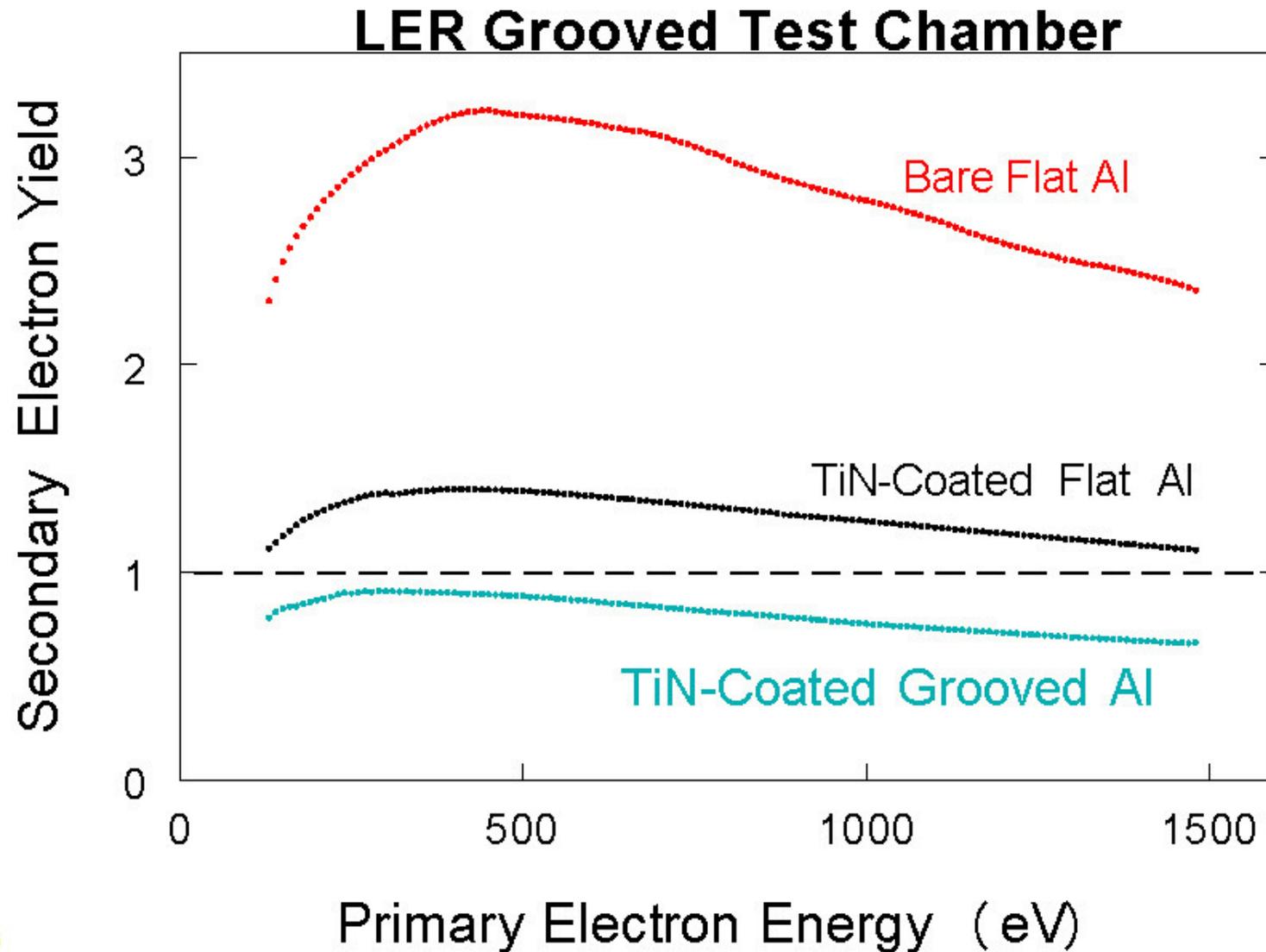
Rectangular groove chamber



Rectangular fin aluminum chambers (extrusion) and TiN coating

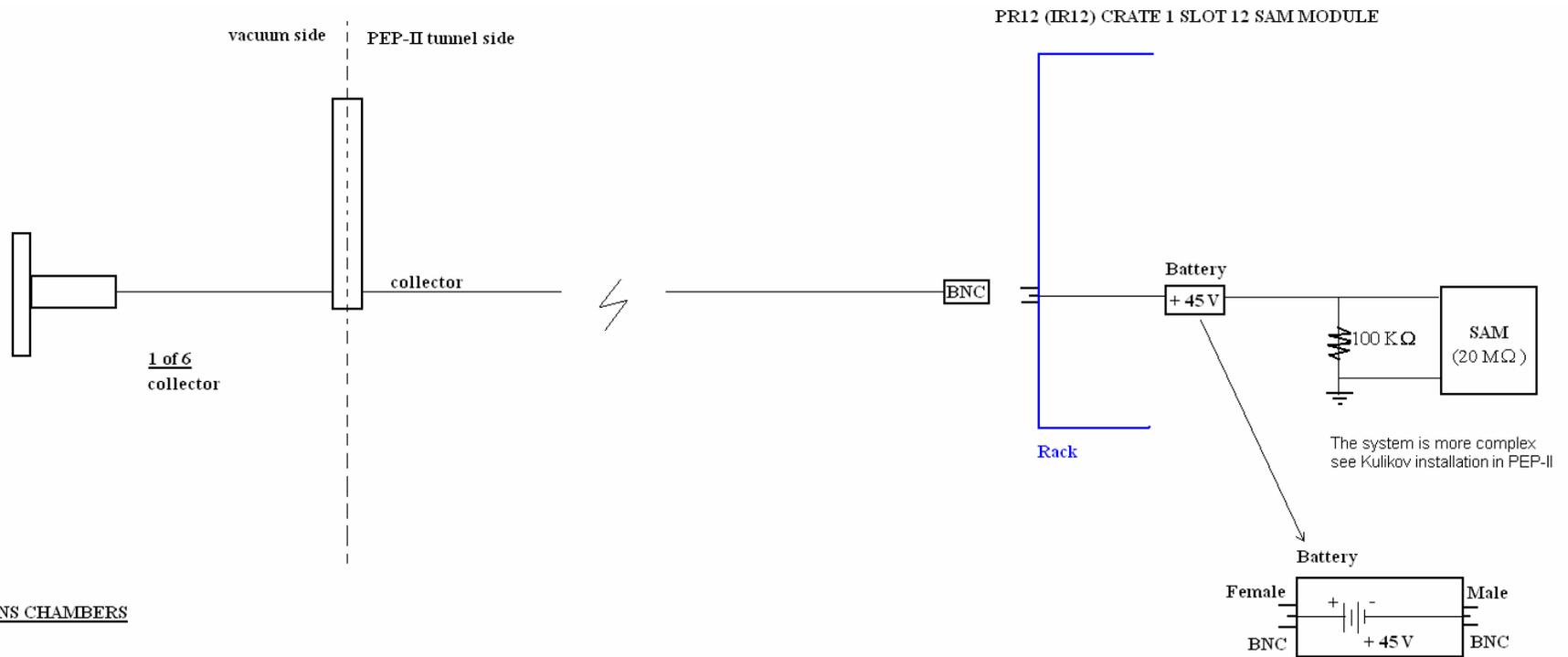


Secondary Electron Yield Measurements at SLAC





Grooved chambers

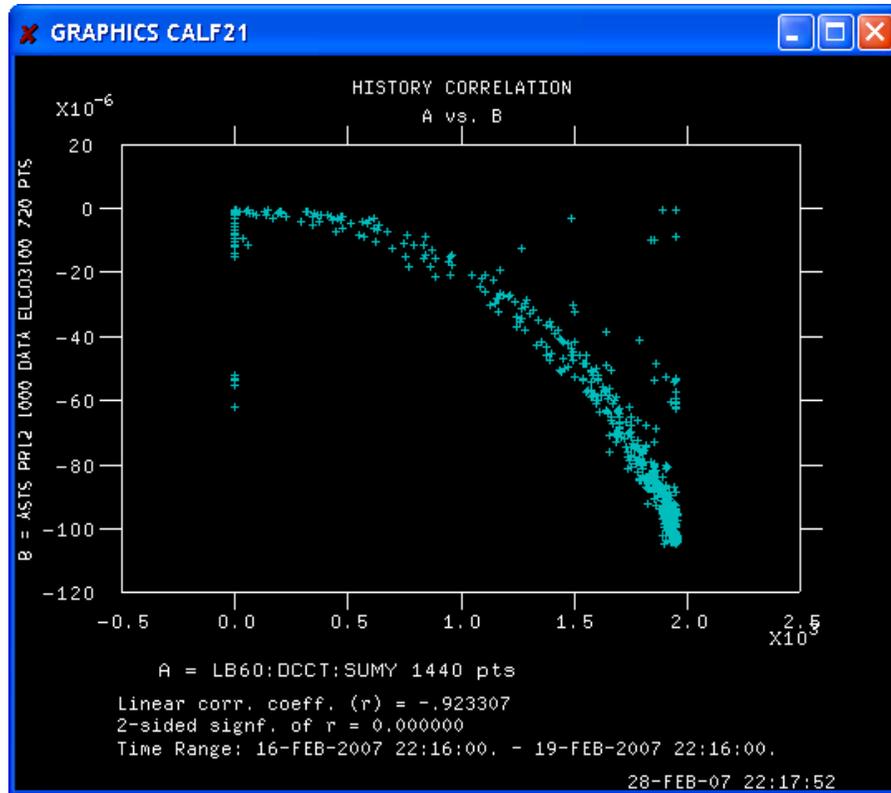


FINS AND NO-FINS CHAMBERS

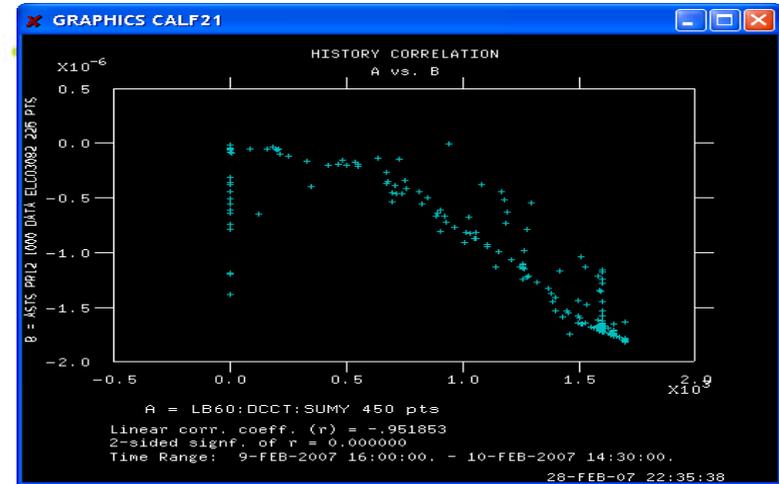


Collector signals vs PEP-II LER current

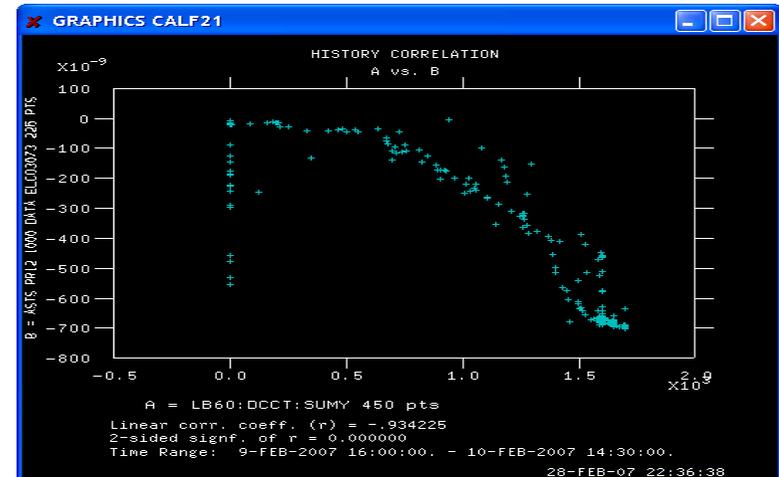
Collector signals vs PEP-II LER current



Stainless steel chamber



Groove TiN chamber

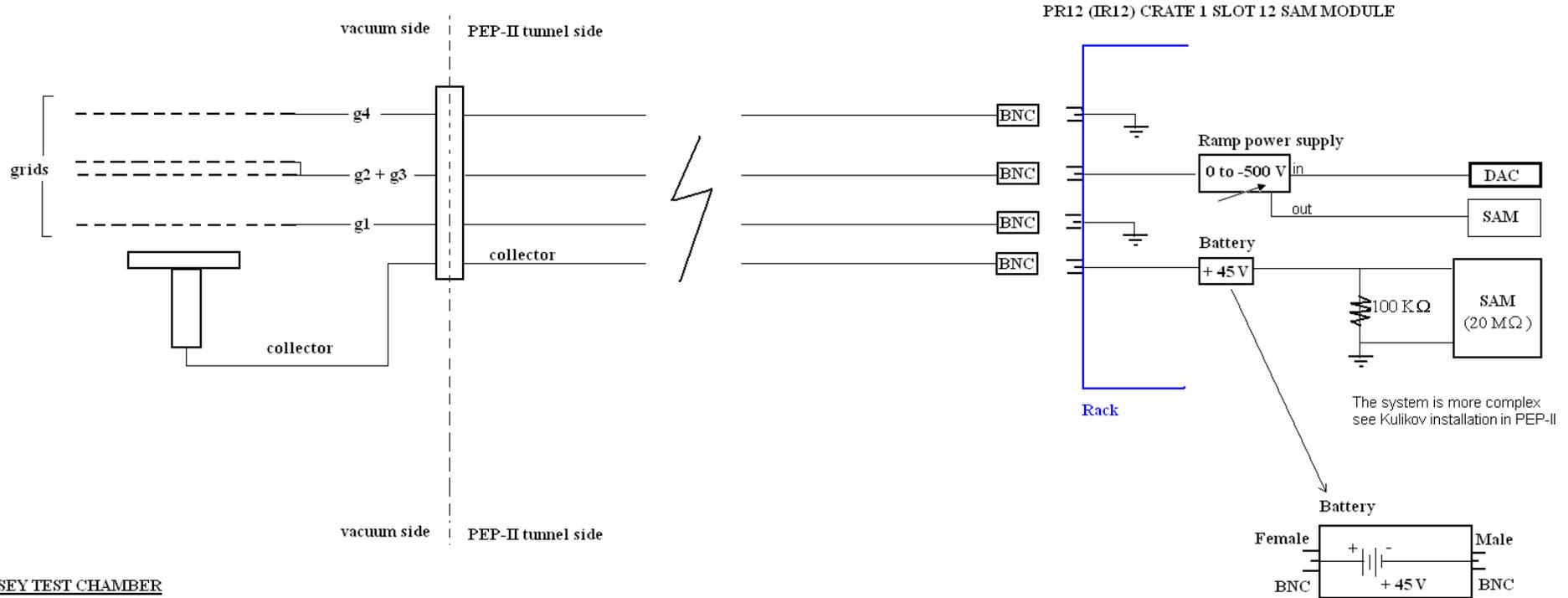


Flat TiN chamber

- electron detector signal in stainless steel SEY test chamber is a factor 50-100 larger than in grooves and flat TiN chambers. Photoelectrons signal in flat is lower than grooves due to surface ratio..?! LER current is .. still raising up to 4A



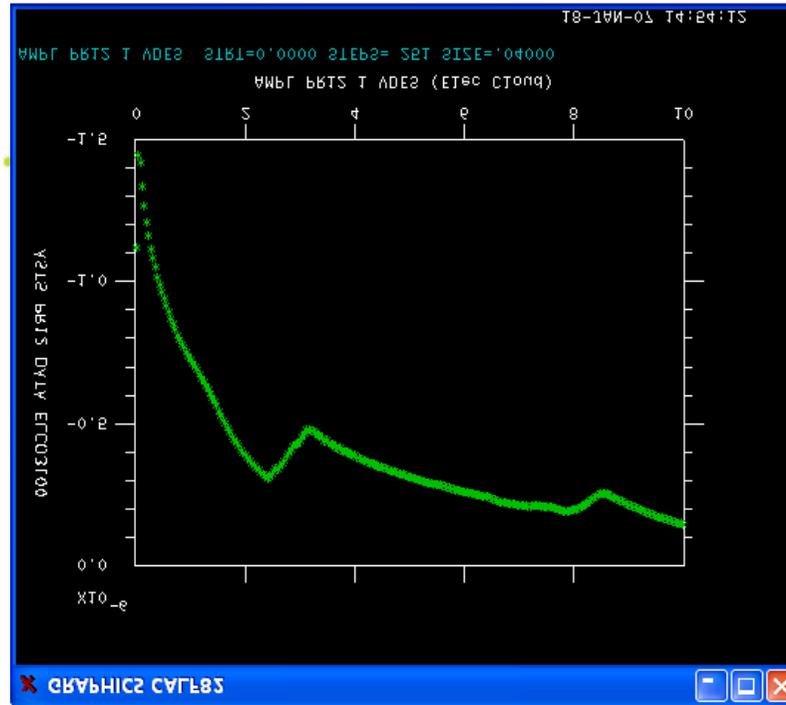
SEY test chamber



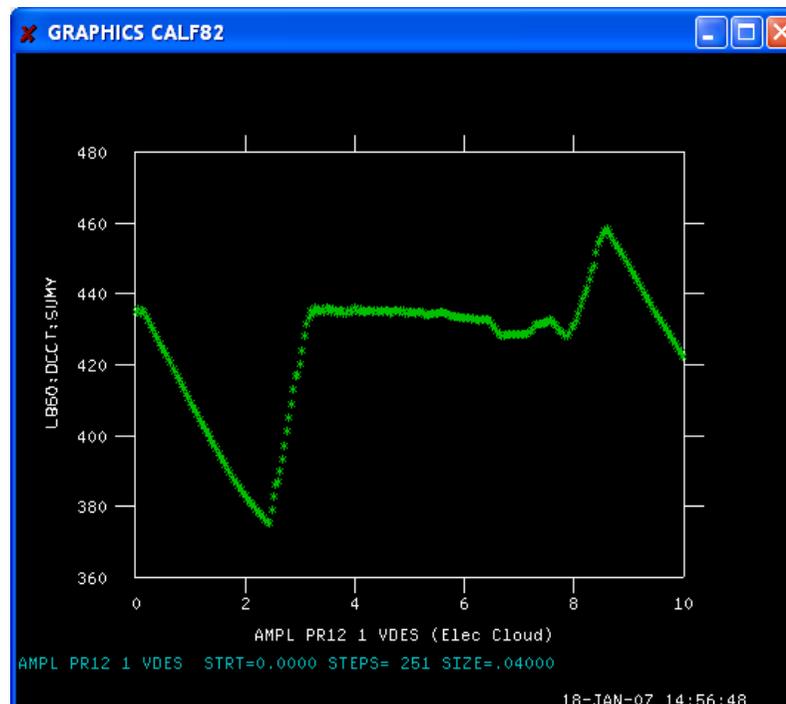
SEY TEST CHAMBER

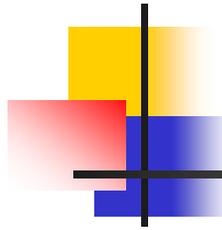


Analyzer Current vs. Retard V (15 minutes or so)



Ring Current





Projects

ONGOING TESTS AT SLAC:

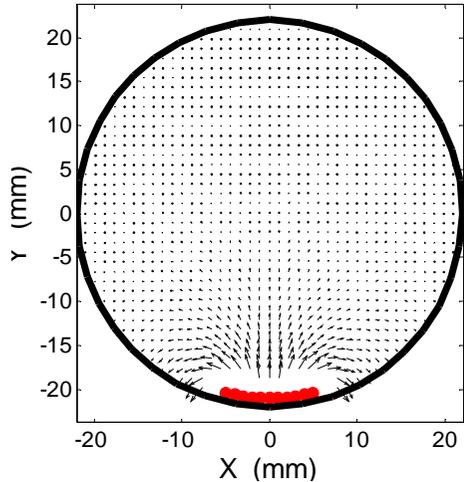
	TEST in	LOCATION	Ready for INSTALLATION	Status
SEY TESTS	STRAIGHT	PEP-II LER PR12	November 2006	Ready
FINS RECTANG.	STRAIGHT	PEP-II LER PR12	November 2006	Coating of extruded Al chambers

ONGOING PROJECTS:

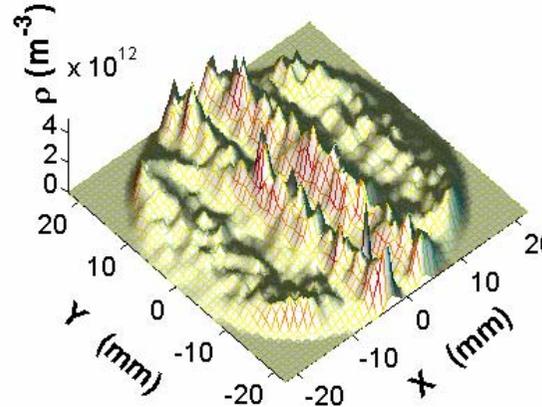
CLEARING ELECTRODES	BEND	PEP-II LER PR12	2008	Design
FINS TRIANG.	BEND	PEP-II LER PR12	2008	Design



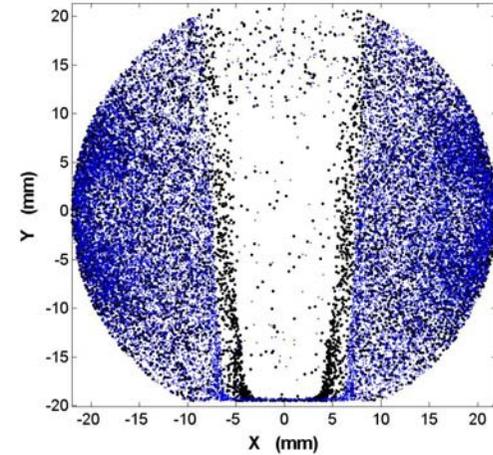
Remedies against ecloud: clearing electrodes



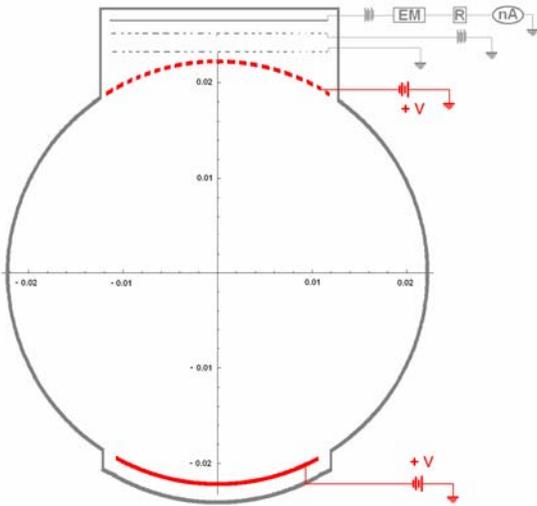
L. Wang CLOUD_LAND code



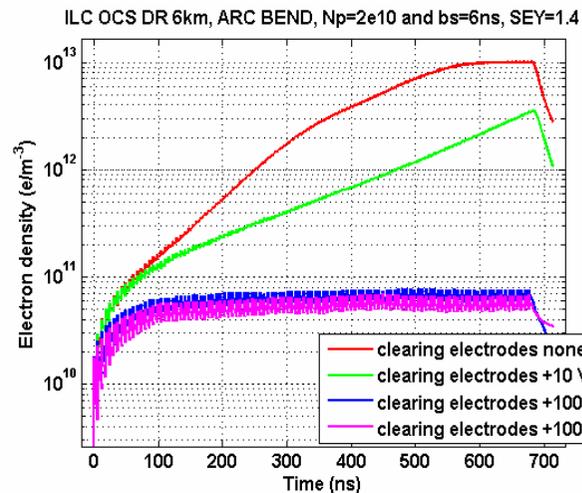
0 Voltage



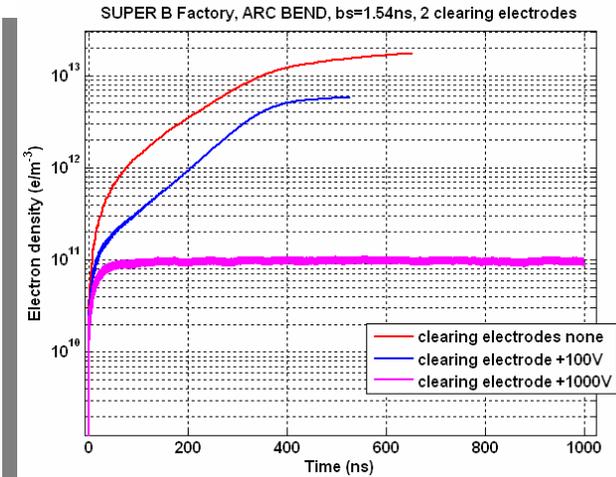
100 Voltage



P. Raimondi, M. Pivi POSINST code

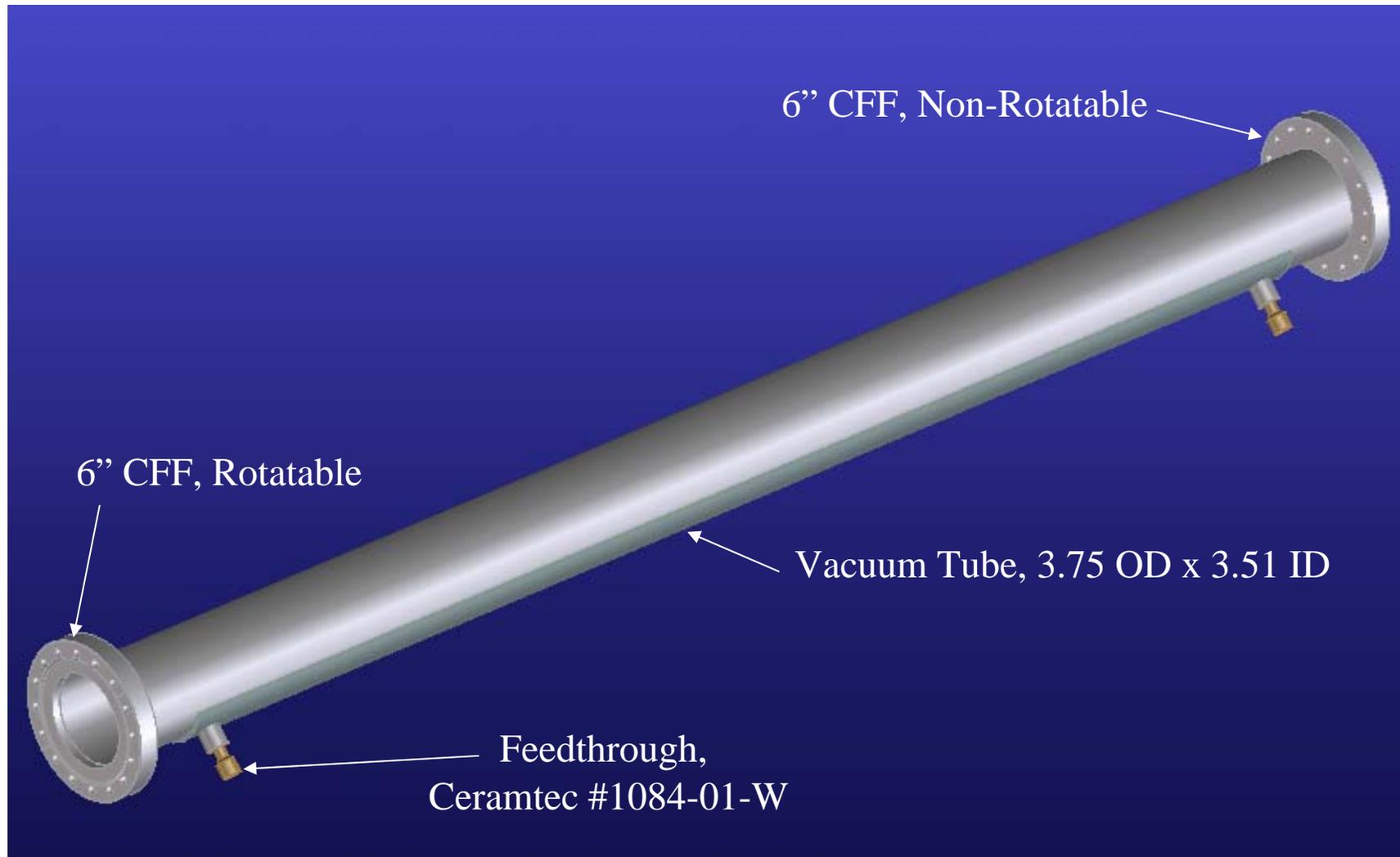


Bunch spacing = 6ns

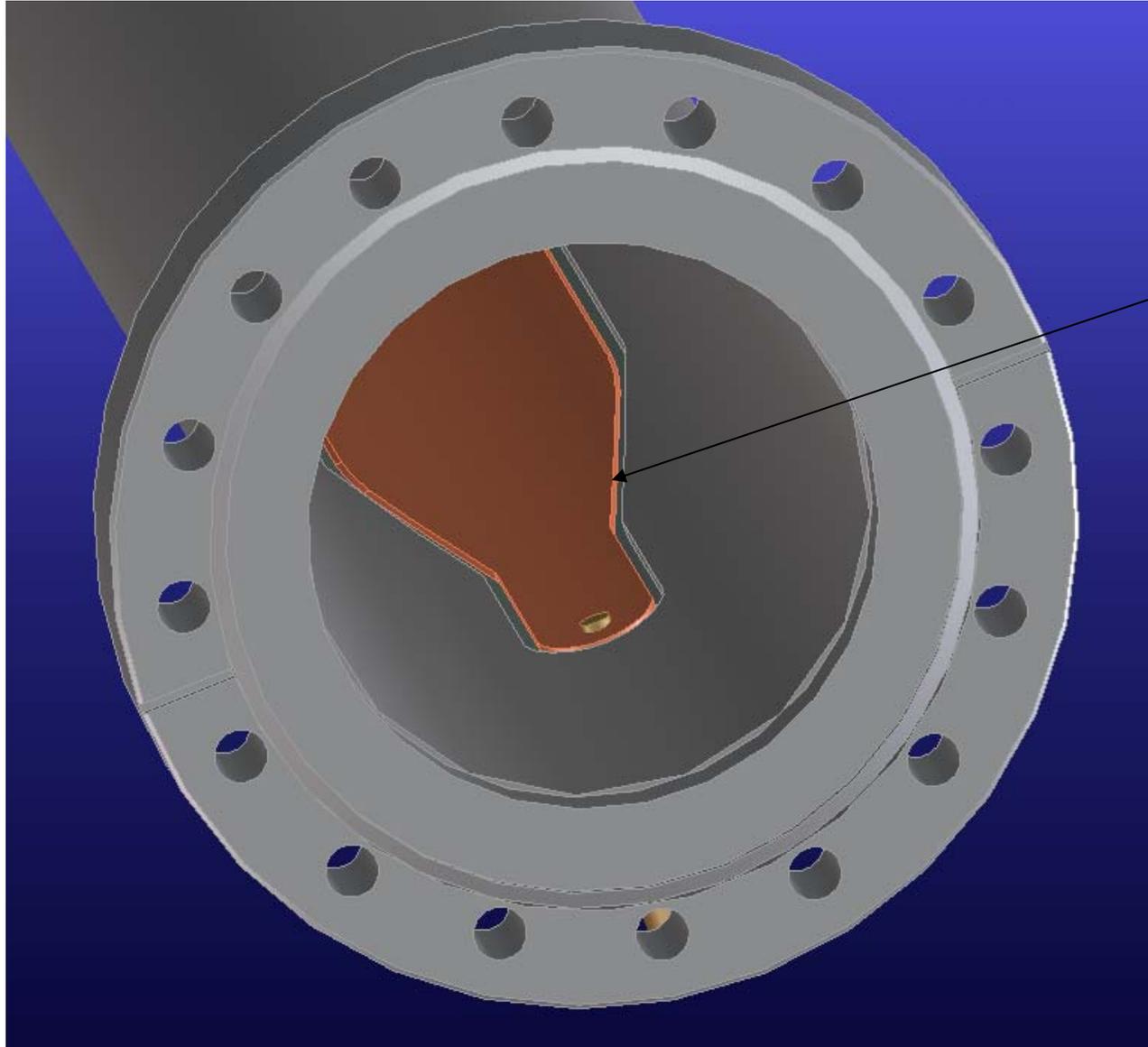


Bunch spacing = 1.5ns !!

Test Chamber Assembly, 1.5M Long (59.00")



Test Chamber with Electrode



Electrode, Copper
0.063" x 2.0" x 50.0"
(49.606" between
feedthrough centers)

Dimensions:

$L_{TOT} \approx 630$ mm

$L_{TAP} \approx 115$ mm

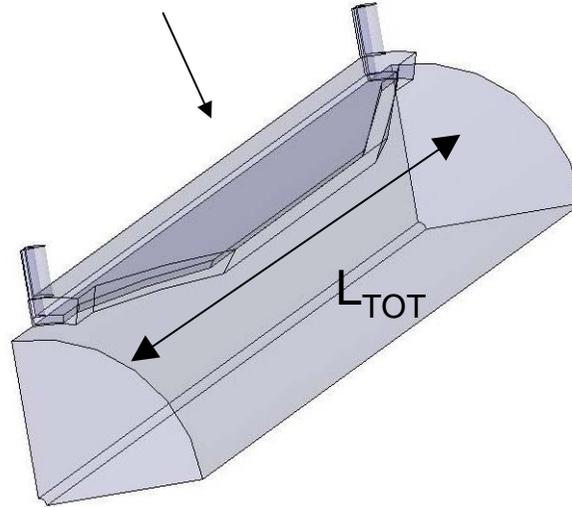
$R_{pipe} = 44$ mm

$\phi = 60$ deg

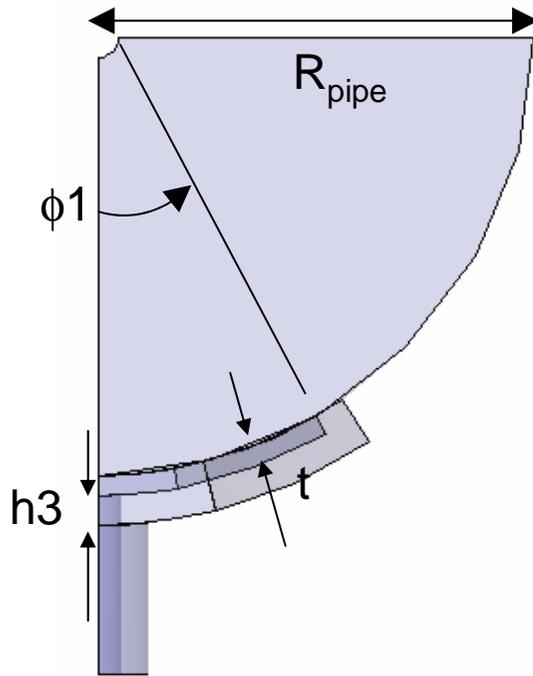
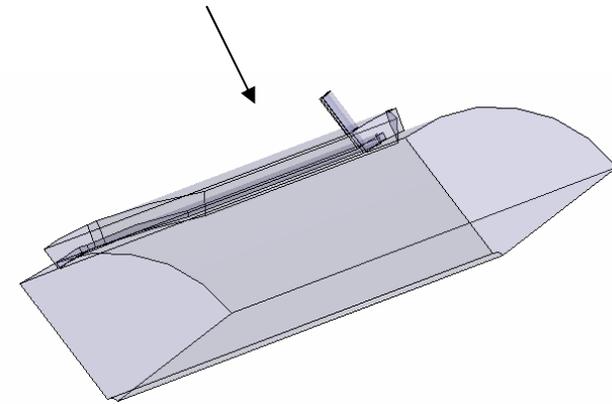
$h1, h3, h3 = 5$ mm

$t = 2$ mm

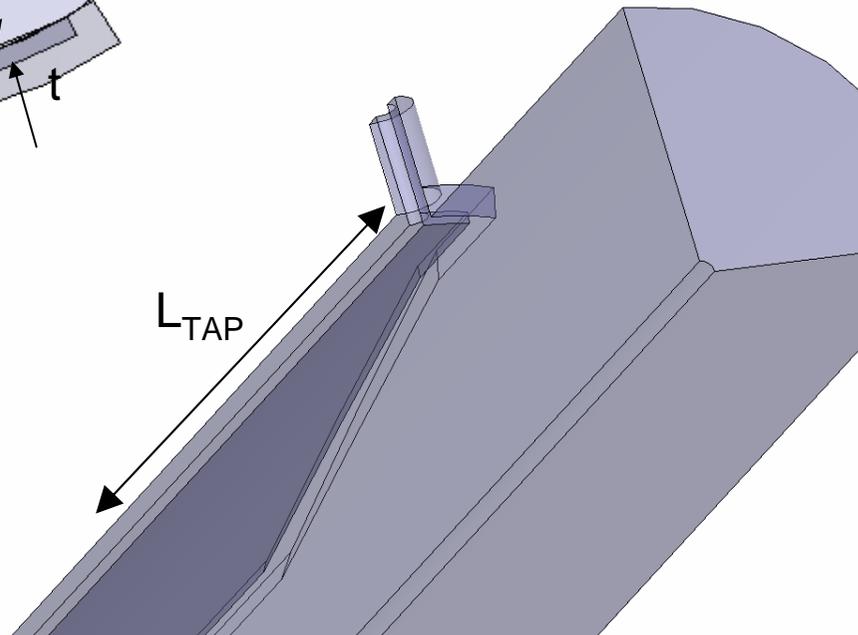
1st Geometry: 2 Ports 50 Ohm



2nd Geometry: 1 Ports 50 Ohm

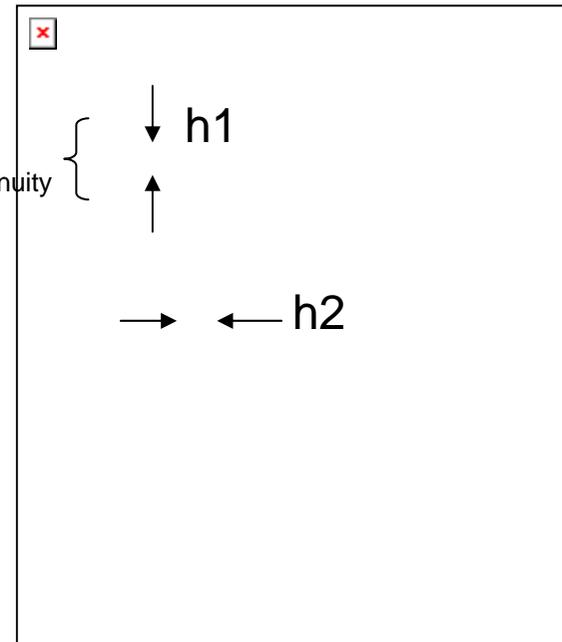


L_{TAP}



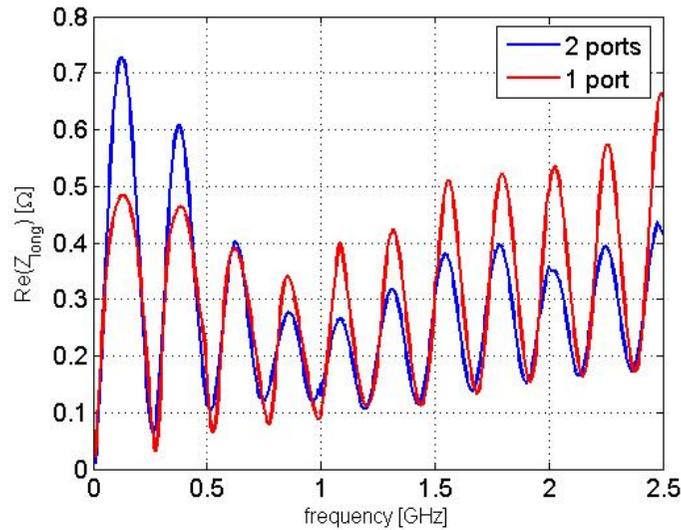
David Alesini, Frascati, Feb 2007

First discontinuity



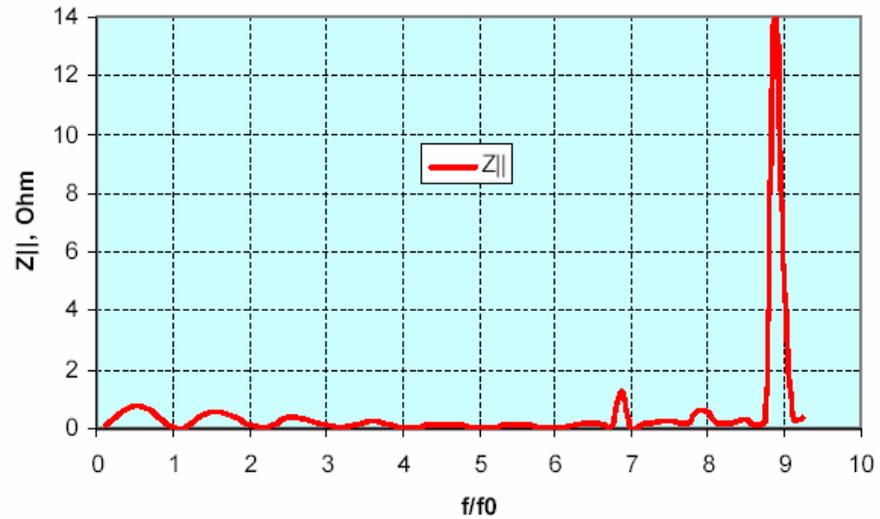


HFSS Results on Copper electrode stainless steel chamber



Frascati results

R=22mm (stainless steel) housing with Cu electrode

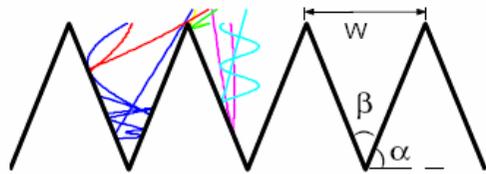


$$\langle Z \rangle \cong 0.48 \text{ Ohm in } (59.5 - 4403) \text{ MHz}$$

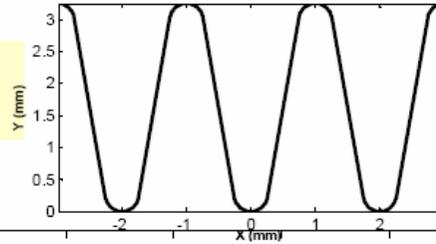
A. Krasnykh, SLAC, February 2007

Long. Impedance: power deposited to electrode $\sim 10\text{W}$ with PEP-II beam, and $\sim 2\text{W}$ for ILC DR beam

SEY of grooved surface



To reduce the impedance & manufacture



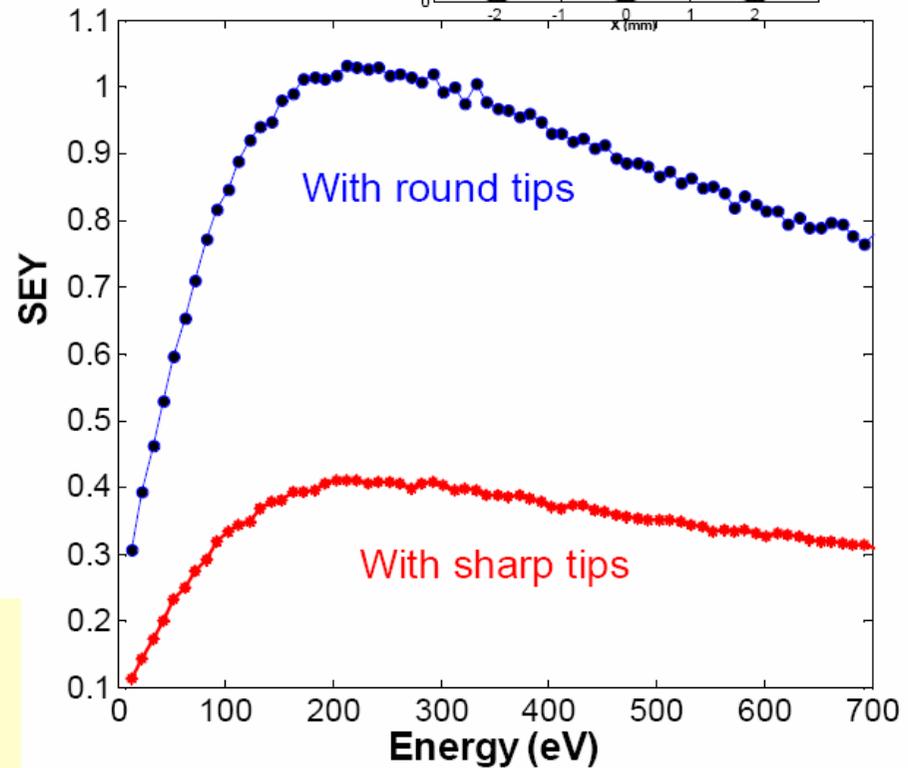
Al with SEY=2.7

Coating to get a SEY~1.74

Grooved surface, SEY ~<1.0

Need more optimization to minimize SEY!

Effective SEY of an isosceles triangular surface with rounded tip. $\delta_{max}=1.74$, $E_{max}=330\text{eV}$, $B_0=0.2\text{Tesla}$, $R_{tip}=0.254\text{mm}$, $W=2\text{mm}$.

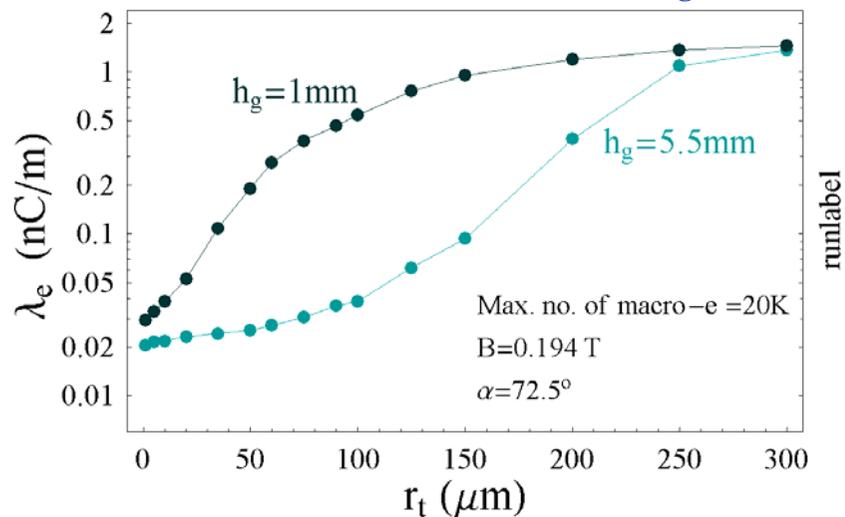


SLAC ILC R&D meeting Nov. 27, 2006

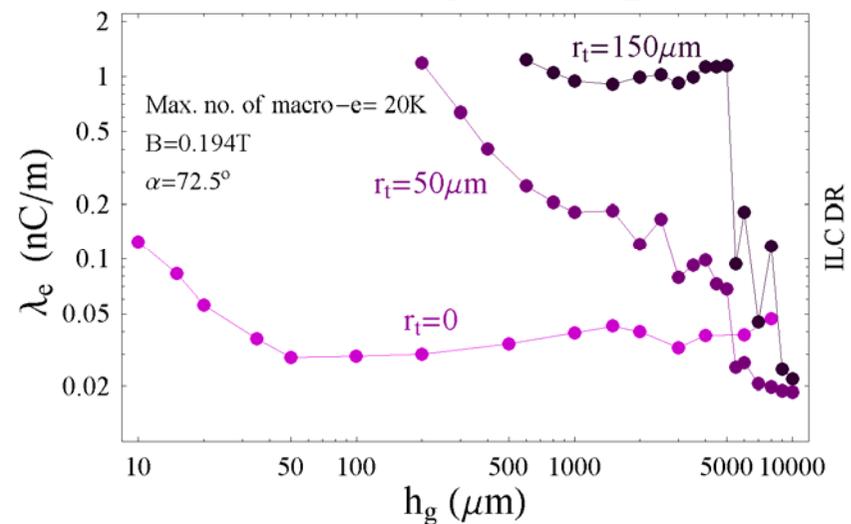
Smoother tips spoil effectiveness of grooves (POSINST)



Max of cloud density vs. groove-tip radius for two groove height h_g

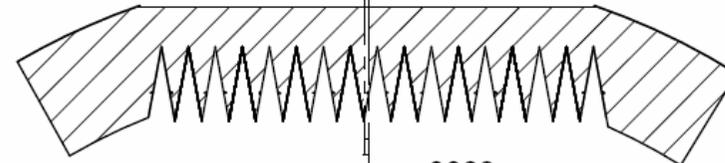
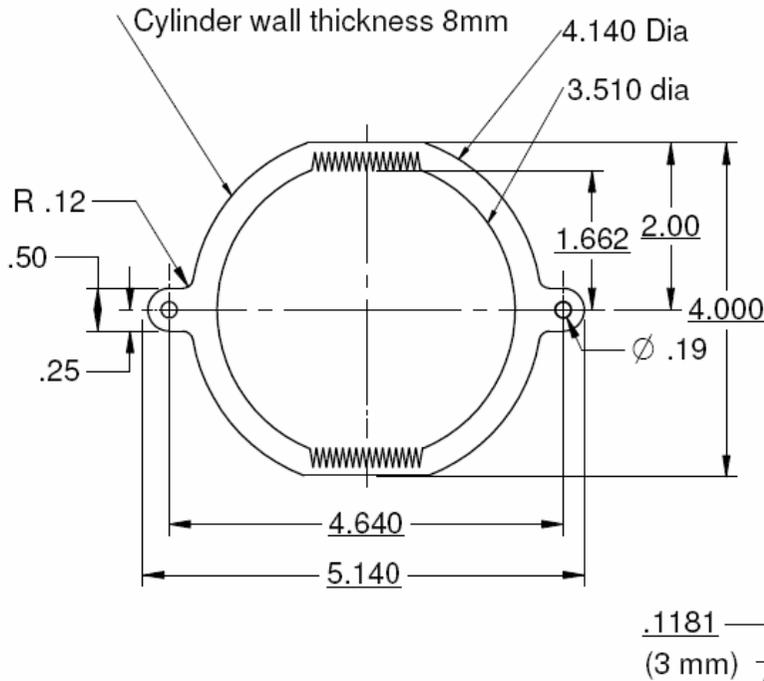


Max of cloud density vs. height h_g for 3 choices of groove-tip radius

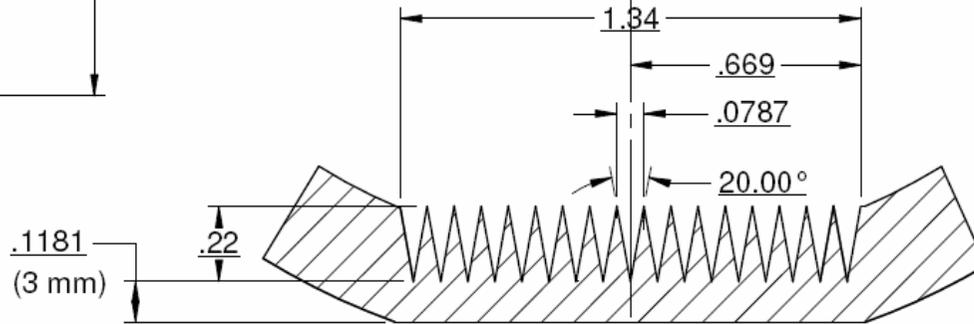


- ↖ Spoiling effect of smooth groove-tips can be compensated by making the grooves deeper.
- ↖ Generally, a finite groove-tip radius enhances dependence of groove effectiveness on groove height

Triangular groove chamber



Note: Peak of serration is offset 0.25 mm (0.0098) to left of center line



Note: Bottom of serration is on center

Serrations are 2mm (.0787) wide by 20 degrees
Total of 17 serrations

CHECK-PRINT
munro
11-20-2006 03:17:07 PM

Material Al 6063

DIMENSIONING AND TOLERANCING IS IN ACCORDANCE WITH ASME Y14.5M-1994.		SCALE:	DO NOT SCALE DRAWING	CAD FILE NAME:
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.		STANFORD LINEAR ACCELERATOR CENTER U.S. DEPARTMENT OF ENERGY STANFORD UNIVERSITY STANFORD, CALIFORNIA		Lamfa Extrusion - Rev 9
TOLERANCES: BREAK EDGES .005-.015 INTERNAL CORNERS R.015 MAX FRACTIONS ± DEC .XX± XXX± XXXX± ANGLE ±		PROPRIETARY DATA OF STANFORD UNIVERSITY AND/OR U. S. DEPARTMENT OF ENERGY. RECIPIENT SHALL NOT PUBLISH THE INFORMATION WITHIN UNLESS GRANTED SPECIFIC PERMISSION OF STANFORD UNIVERSITY.		
NEXT ASSEMBLIES:	ALL SURF ✓	ENGR _____ DWN _____ CHKR _____	DATE _____ APPROVALS _____	DRAWING NUMBER _____ REVISION NUMBER _____

D
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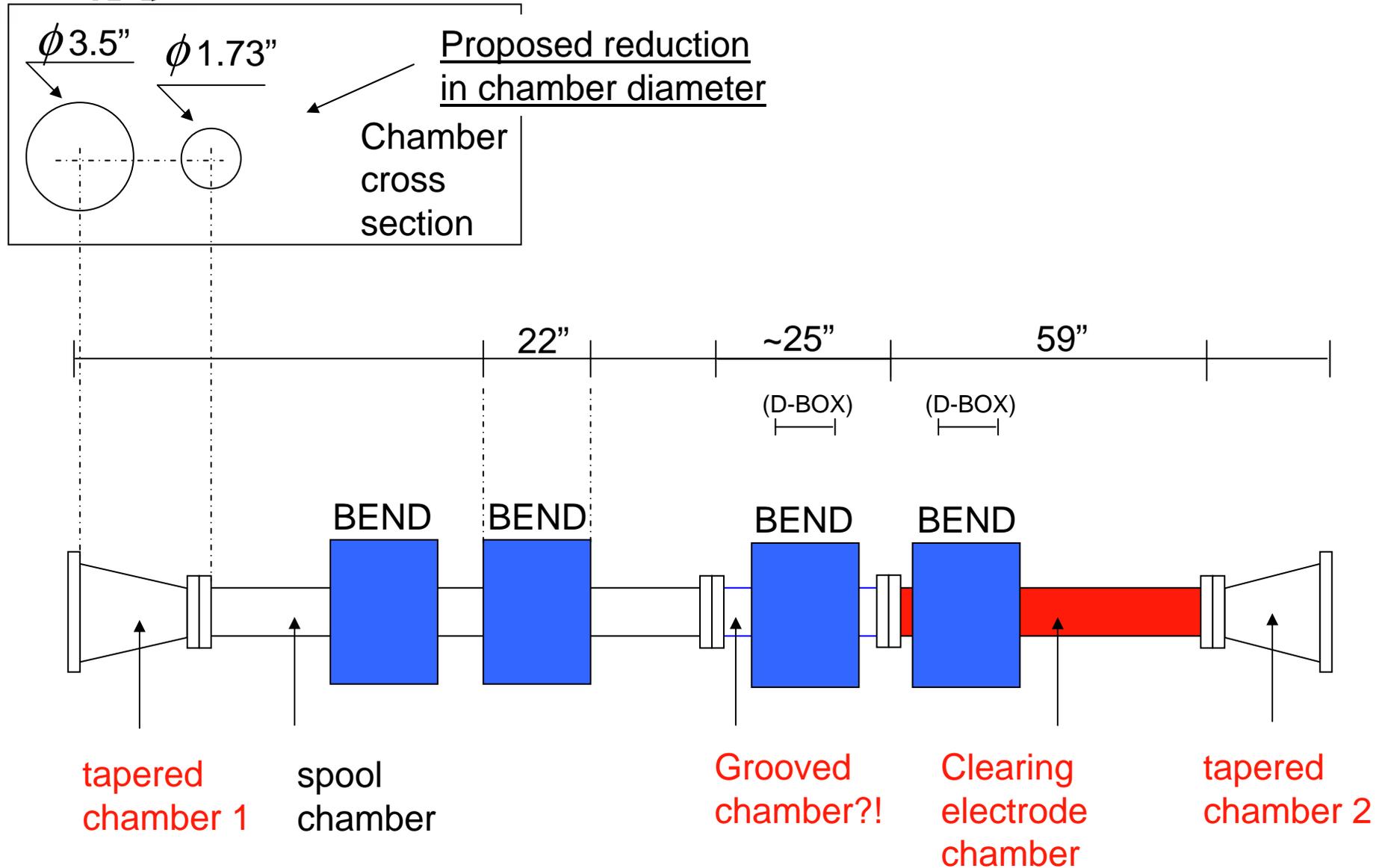
D
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4 3 2 1

4 3 2 1



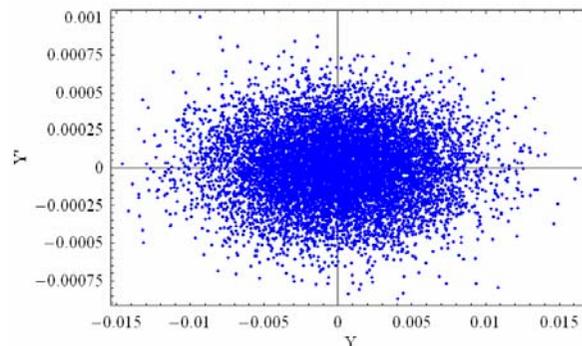
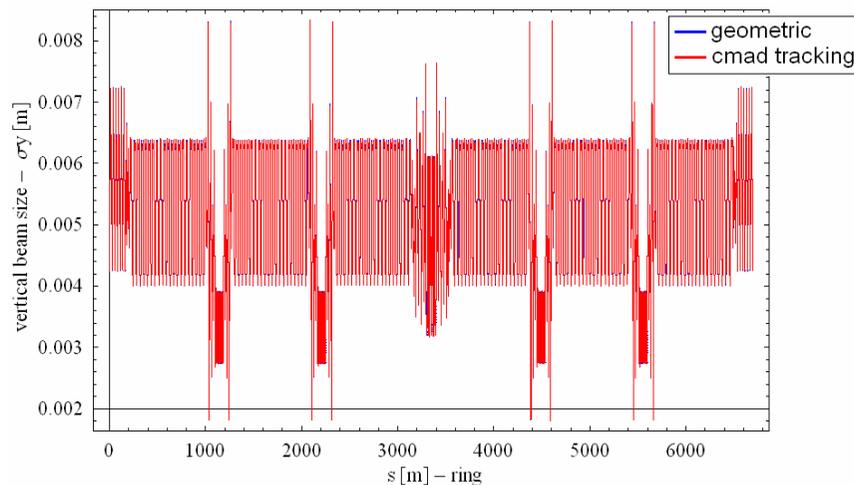
Layout installation – in PEP-II



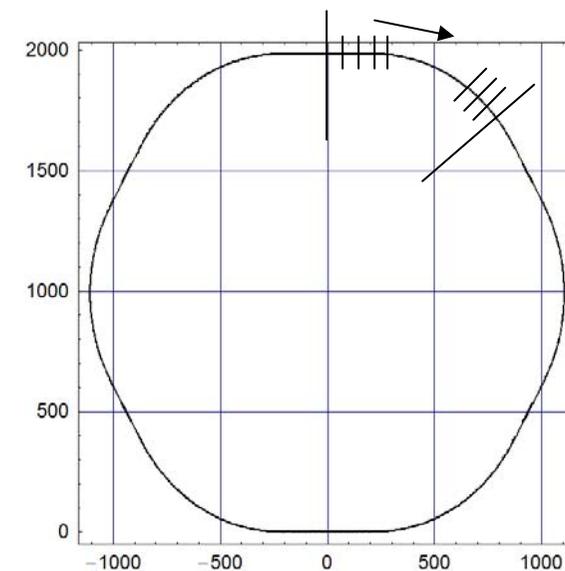


Simulation plans for FY07 /FY08

At SLAC, developing self-consistent simulation code including e-cloud build-up and beam instabilities. It allows: parallel computation (Message Passing Interface - MPI), tracking the beam in a MAD lattice for ILC DR, interaction with cloud at each element in the ring and with different cloud distribution, single- and coupled-bunch instability studies, threshold for SEY, dynamic aperture and frequency map analysis, tune shift ...



Bunch at injection



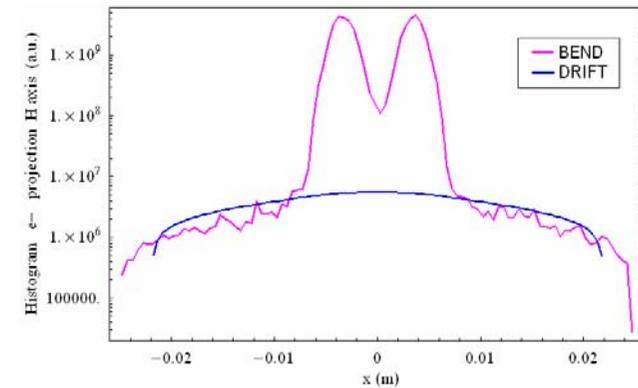
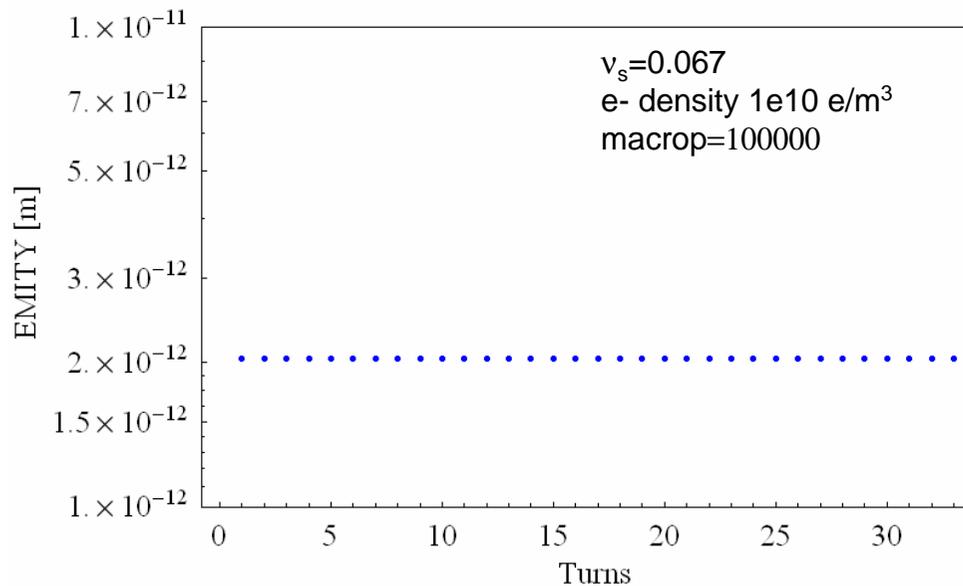
MAD deck to track beam with an electron cloud at each element of the ILC DR.



CMAD status

Beam-cloud interaction: resolve pinching and kick bunch particles at each element in ring, with given electron cloud distributions in different elements (wigglers, bend, quad sext fields). Completed. Single-bunch instability preliminary studies ongoing.

Electron cloud build-up (SEY, vacuum chamber, etc.) to be added soon.



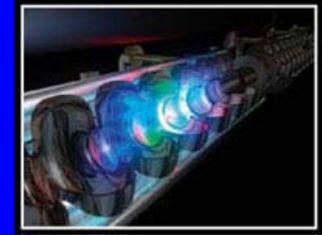
Electron cloud distribution in bends and straights (so far from POSINST)

First results: few synchrotron oscillation periods (9min * 320 CPUs / turn) CMAD tracking, ILC DR beam at extraction, with average cloud density $1e10 \text{ e/m}^3$ (below threshold).

- Bottleneck => in ILC DR, beam aspect ratio reaches $\sigma_x/\sigma_y=200$, demanding Particle in Cell grid ratios num-gridx \gg num-gridy, to correctly simulate Electric field.



International Linear Collider
at Stanford Linear Accelerator Center



Thanks !

To the contributors to this presentation M. Palmer (Cornell), S. De Santis (LBNL) F. Willeke (DESY), K. Suetsugu (KEK), K. Bane, P. Raimondi, L. Wang (SLAC), F. Zimmermann (CERN)

and to DR collaborators

D. Arnett, G. Collet, R. Kirby, N. Kurita, B. Mckee, M. Morrison, P. Raimondi, T. Raubenheimer, J. Seeman, L. Wang, G. Stupakov (SLAC), D. Rubin, D. Rice, L. Schachter, J. Codner, E. Tanke, J. Crittenden (Cornell), J. Gao (HIPEP), A. Markovic et al. (Rostock Univ.), M. Zisman, S. De Santis, C. Celata, M. Furman, J.L. Vay (LBNL), K. Ohmi, Y. Suetsugu (KEK), F. Willeke, R. Wanzenberg (DESY), J.M. Laurent, A. Rossi, E. Benedetto, F. Zimmermann, G. Rumolo, J.M. Jimenez, J-P. Delahaye (CERN), A. Wolski (Cockroft Uniiiv.), B. Macek (LANL), C. Vaccarezza, S. Guiducci, R. Cimino (Frascati), et many other colleagues...