Vertex Detector Working Group

Sunday, July 13, 3:30-5:30 p.m.

3:30-4:00	LCFI Status Report	Chris Damerell, Rutherford Laboratory
4:00-4:30	CCD Radiation Damage Studies	Olya Igonkina, Oregon
4:30-5:00	Status of LC R&D at Oklahoma	Patrick Skubic, Oklahoma
5:00-5:30	Technology Options	Chris Damerell, Rutherford Laboratory

Tuesday, July 15, 8:30-10:30 a.m.

9:00-10:30 Discussion

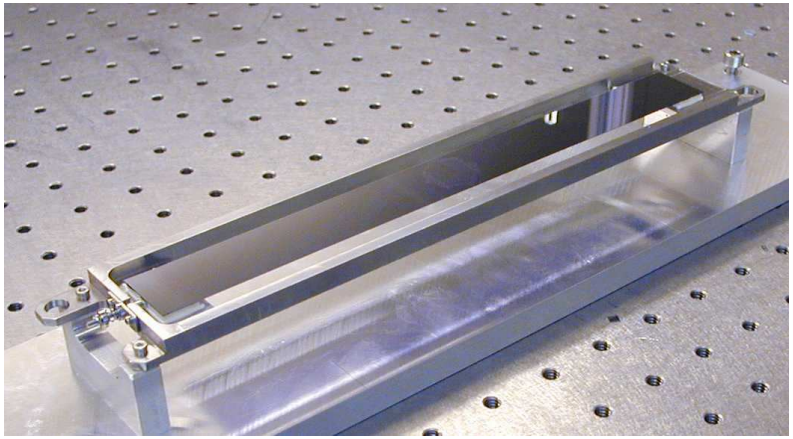
Session convenors: Jim Brau & Marco Battaglia

A CCD-based vertex detector ,

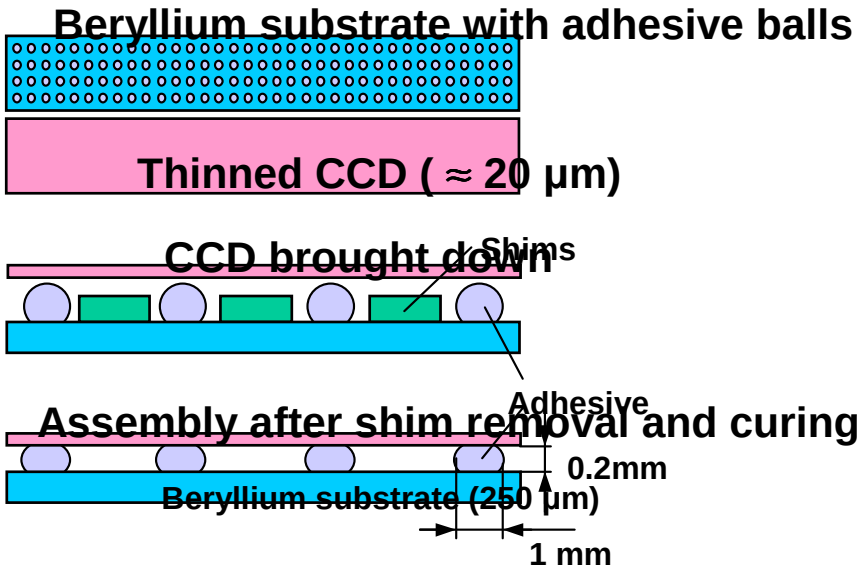
Chris Damerell on behalf of the LCFI Collaboration

R&D programme

- **Development of novel CCDs and readout electronics**
- **Development of thinnest possible detector layers**
- **Physics studies**



Tests of unsupported silicon



Tests of semi-supported silicon
glue issues caused unexpected results

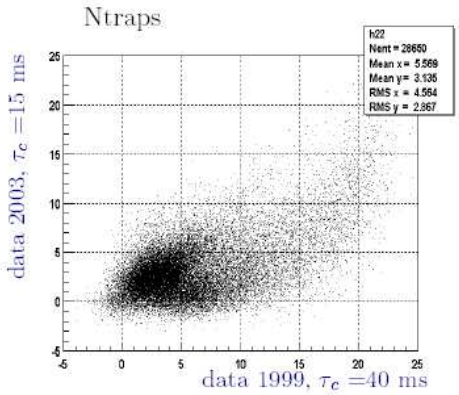
Vertexing and Tracking Summaries, D. Peterson, ALC Workshop, Cornell, July 2003

CCD Radiation Damage Studies, Olya Igonkina

Changing the delay between signal injection and start of read out from 40 ms to 15 ms showed that the

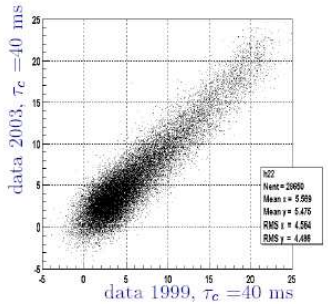
filling time τ_c is of the order of tens ms!

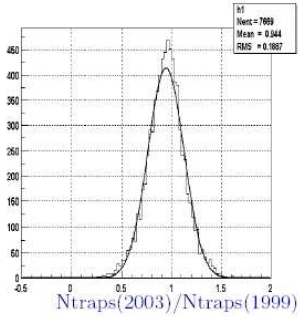
which contradicts to the expectation that τ_c is of the order of ns (C. Damerrel, RAL-P-95-008)



Comparison of the 1999 and 2003 data before irradiation with electrons (collected under exactly the same conditions) shows same amount of traps in the same pixels.

The expectation that traps will anneal during 1 year at room temperature is not confirmed.





Conclusions

After 4 years the CCD still had the same traps –

no signicant annealing at room temperature is observed.

Traps filling with signal charge takes noticeable time –

much larger than the time signal spend in each pixel.

We expect that the increased readout speed will lead to decrease of charge transfer ineciency.

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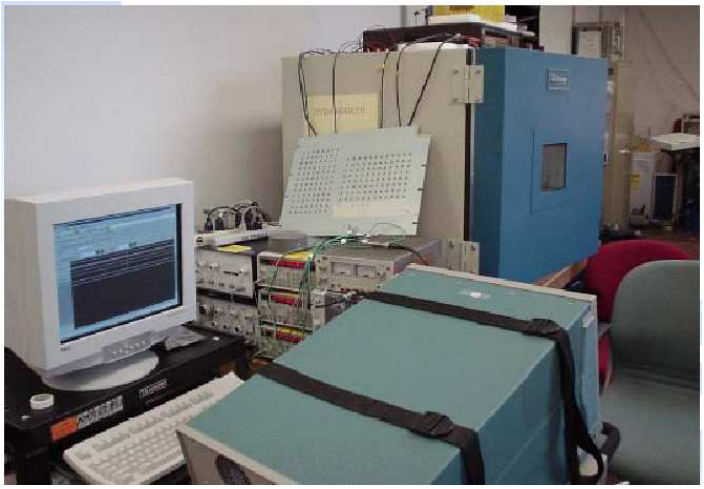
Status of LC R&D Proposals at Oklahoma, Patrick Skubic

NSF Proposal

- UCLC proposal: "Development and design of an LC ASIC for CCD readout and data reduction"
  - » Three year project
  - » Collaboration between OU, Boston U. (Ulrich Heintz), and Fermilab (William Wester)
  - » Previous experience on ATLAS pixel detector which uses IBM deep-submicron process

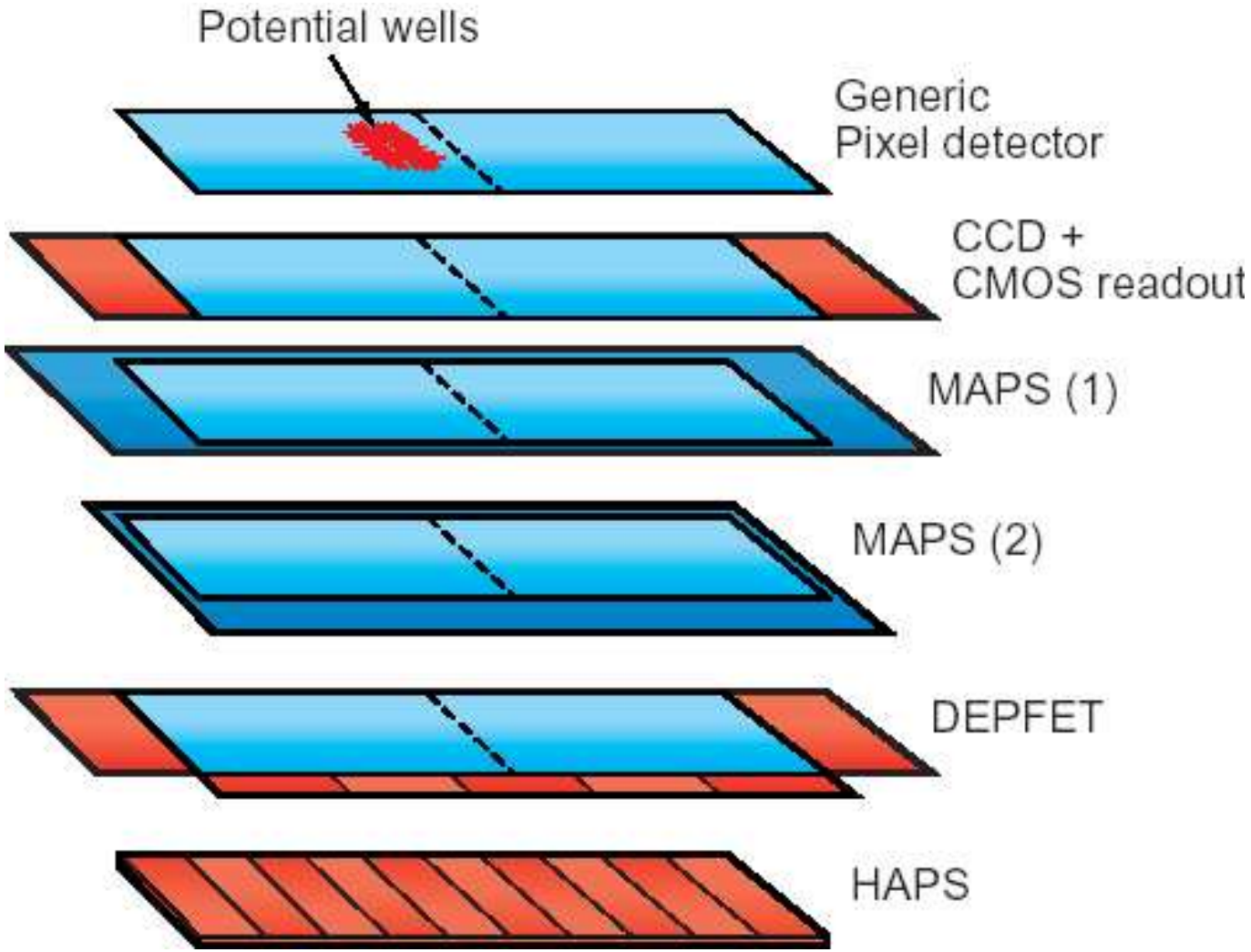


Tests at OU with VXD3 CCD Started
(with help from Jim Brau and Nick Sinev)

Conclusions

- CCD Tests at OU have been Started
- Software Tools for VLSI Design are Installed and Tested
- Contacts with Others Interested in Vertex Detector Readout have been made
  - » Oregon/Yale group
  - » LCFI group
  - » SLAC
  - » Fermilab

LC vertex detector technology options, Chris Damerell



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Detector Working Group: Tracking

13 talks

Sunday, July 13, 1:00-3:00

1:00-1:15	Welcome and Introduction	Bruce Schumm
1:15-1:40	JLC Tracking Report	Norik Khalatyan
1:40-2:05	Status of Linear Collider TPC R&D	Ron Settles
2:05-2:40	Update on TPC R&D In Canada	Dean Karlen
2:40-3:00	Open for discussion	

Monday, July 14, 10:55-12:55

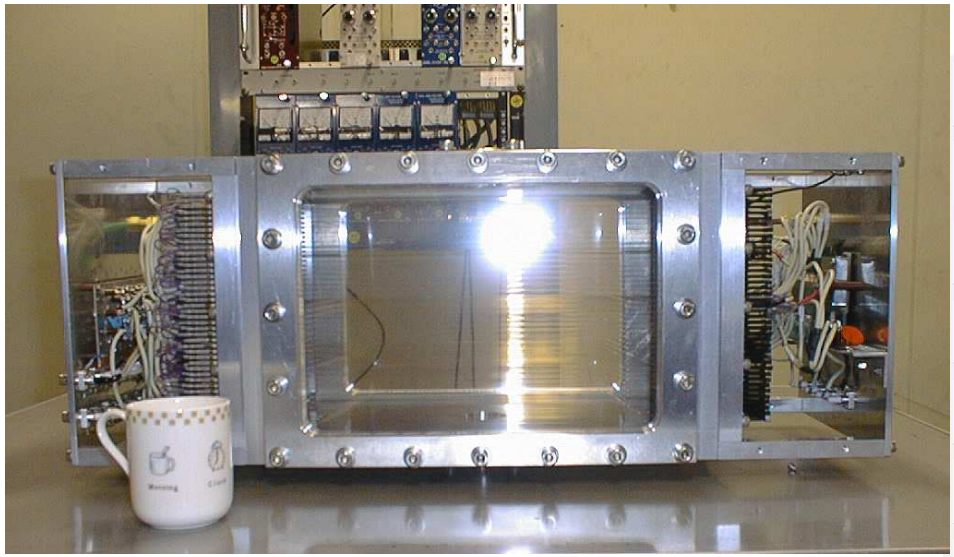
10:55-11:15	Negative Ion TPC for the Linear Collider	Alexander Schreiner
11:15-11:35	Commissioning of a MicroMegas TPC	Mike Ronan
11:35-11:55	Scintillating Fiber Intermediate Tracker R&D	Rick Van Kooten
11:55-12:15	Silicon Drift R&D at Wayne State	Rene Bellwied
12:15-12:30	Update on Frequency-Scanned Interferometry	Haijun Yang
12:30-12:55	Open for Discussion	

Tuesday, July 15, 10:55-12:55

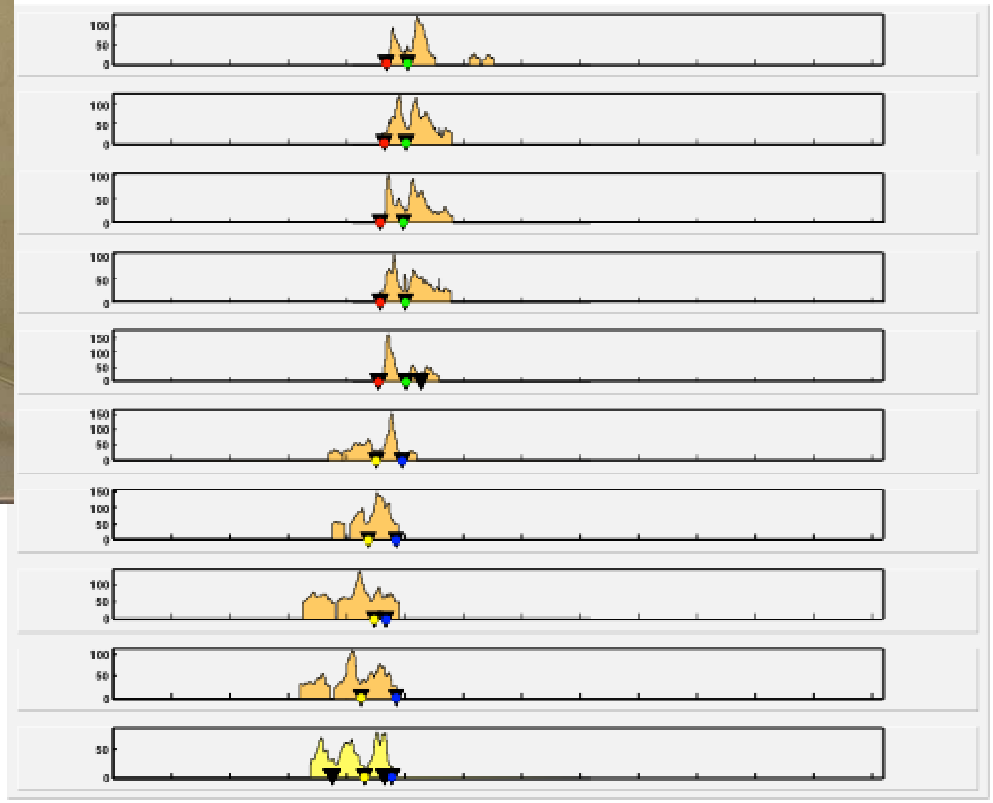
10:55-11:15	Overview of the Strip-based SD Tracker	John Jaros
11:15-11:35	Long Shaping-Time Readout R&D	Bruce Schumm
11:35-11:55	Strip-based SD Pattern Recognition: Forward	Norman Graf
11:55-12:15	South Carolina Tracking	Achim Weidemann
12:15-12:35	First Mass Production of Gas Electron Multipliers	Ian Shipsey
12:35-12:55	Open for Discussion	

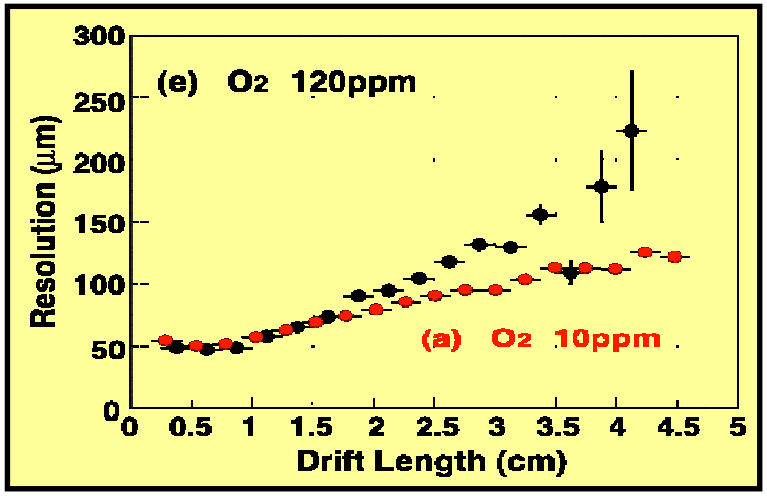
Session convenors: Bruce Schumm, Dean Karlen & Keith Riles

JLC Tracking Report, Norik Khalatyan



track separation





resolution

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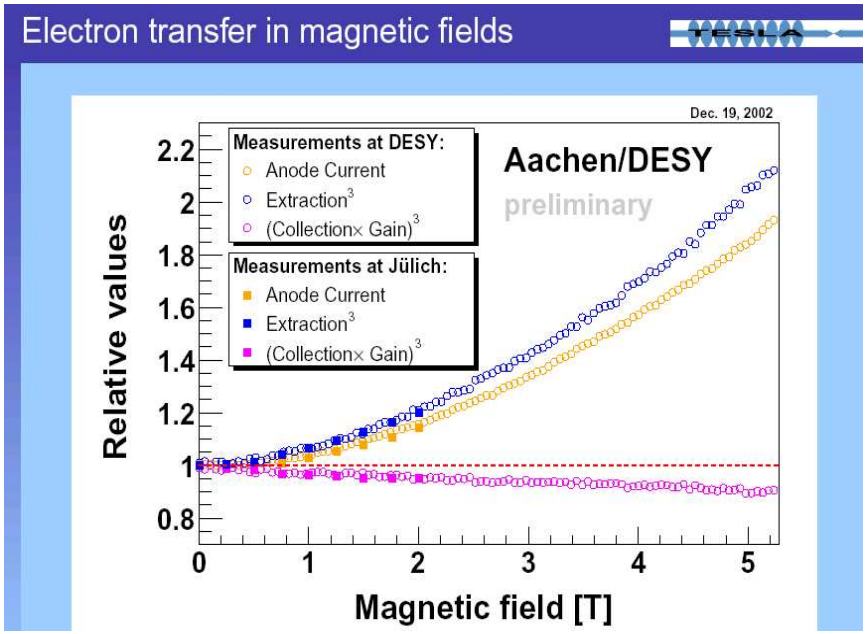
Selected LC TPC R&D Results, Ron Settles

Saclay 2T magnet

GEM electron transfer
In magnetic fields



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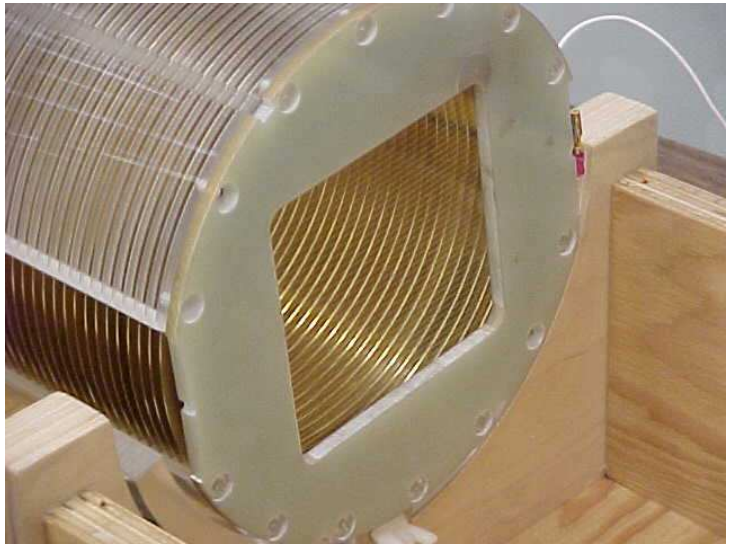
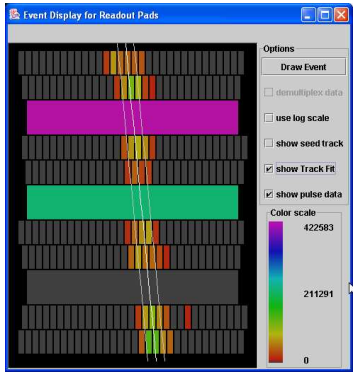
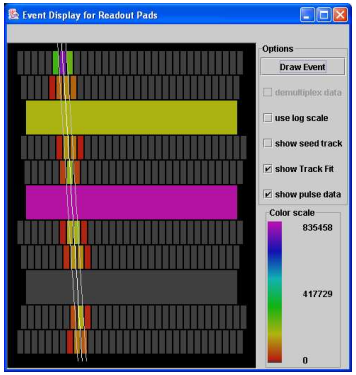
TPC R&D in Canada, Dean Karlen



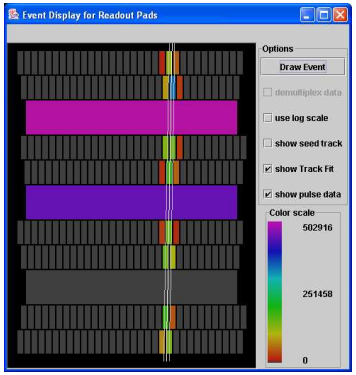
0 Tesla

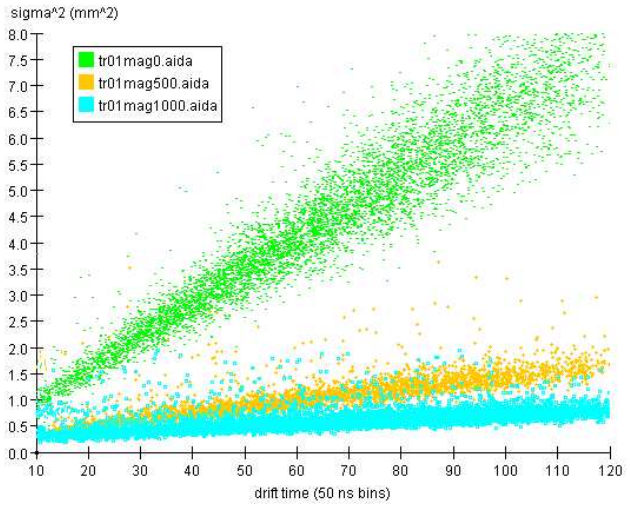


0.45 Tesla



0.9 Tesla





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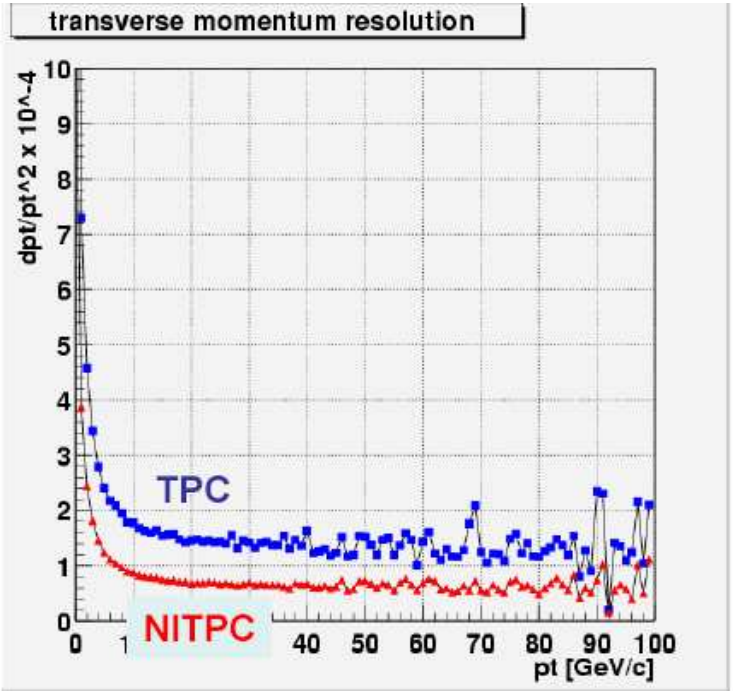
Negative Ion TPC, Alexander Schreiner

UCLC proposal

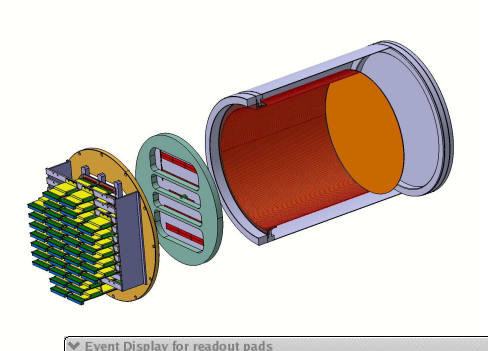
Parameter	TPC	NITPC	Comments
objective	Central Tracker in Tesla; B=3 Tesla		
geometry	azimuthal: r=0.5-2m, z=-2.7....+2.7m		
material	gas:Ar	gas: He/CS_2(80/20)	for radiation length
drift velocity	4.5[cm/μs]	20[m/s]*E[kV/cm]	Ar/CH_4/CO_2(97:5:2)
$<l_{drift}>$	1.35 m	33 cm	NITPC is divided into 12 sections azimuthally and TPC into 2 along z
σ_{long}	4 mm	0.4 mm	$0.07 \cdot \sqrt{L[cm]/E[kV/cm]}$
σ_{tr}	0.68 mm		
N_s of samples/track	144	10^4	depends on the gas
N_i of e per measurement	140	1	
$\sigma_{z\ meas}$	3 mm	2 mm*	$\sigma_{meas} = \sigma_{dif}/\sqrt{N}$
$\sigma_{azim\ meas}$	0.1 mm	0.4 mm	

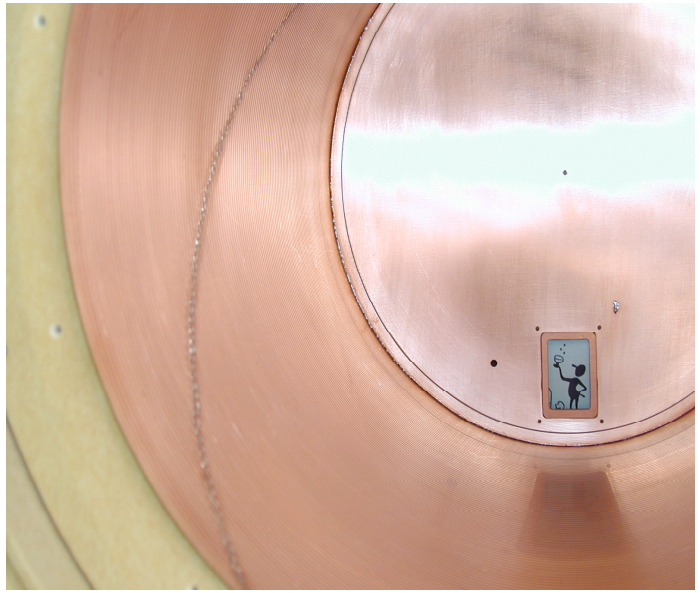
*Simulation showed a bad resolution in the direction along wires

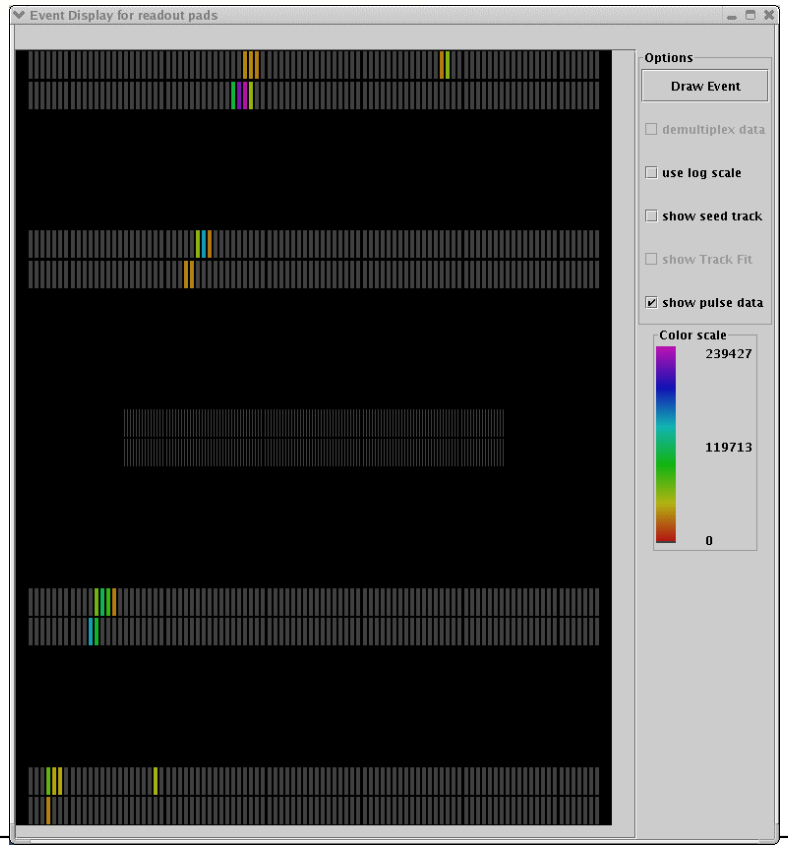


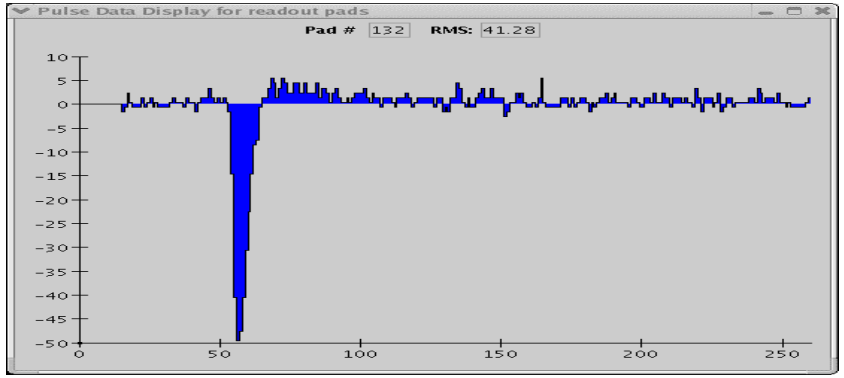
Vertexing and Tracking Summaries, D. Peterson, ALC Workshop, Cornell, July 2003

Commissioning of a Large Micromegas TPC, Mike Ronan









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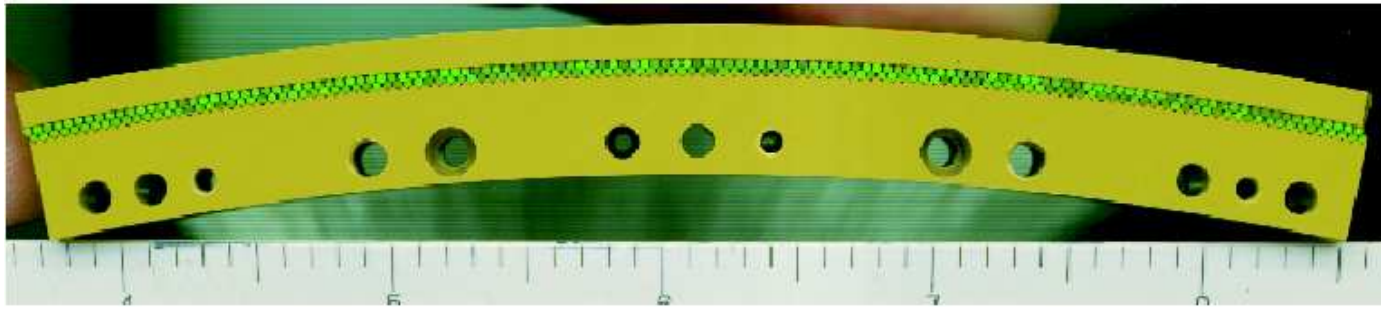
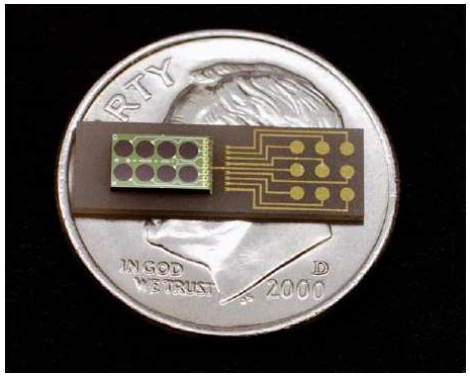
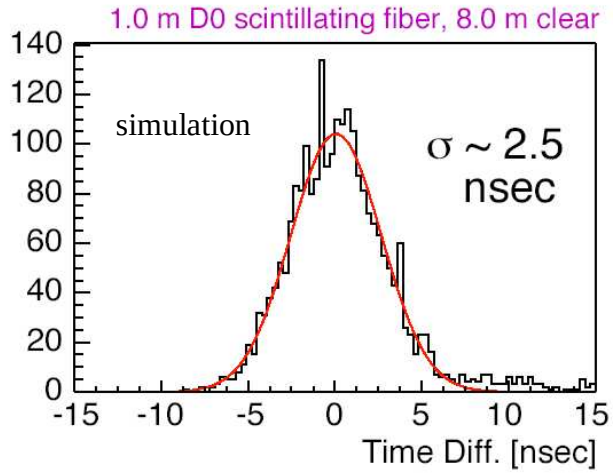
R&D of Scintillating Fibers for Intermediate Tracking and Bunch Id

Rick Van Kooten

Motivation is to provide ~1 ns time stamp for each track to identify background tracks coming from multiple collisions within the integration time of detector components.







- Depends more on light decay time and no. photoelectrons

More Light

Shorter clear fiber runs

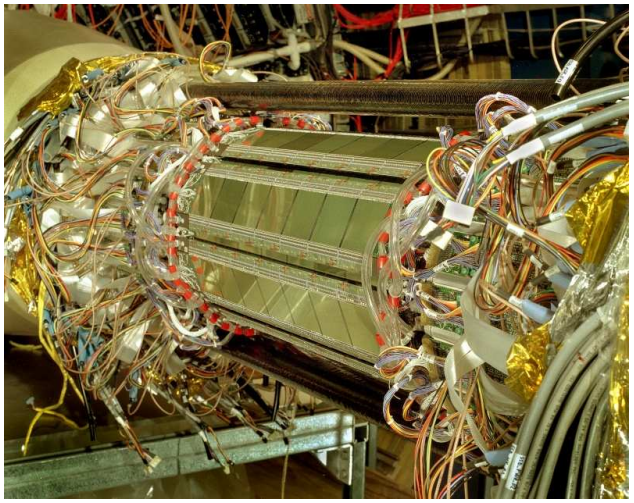
Brighter, faster fibers

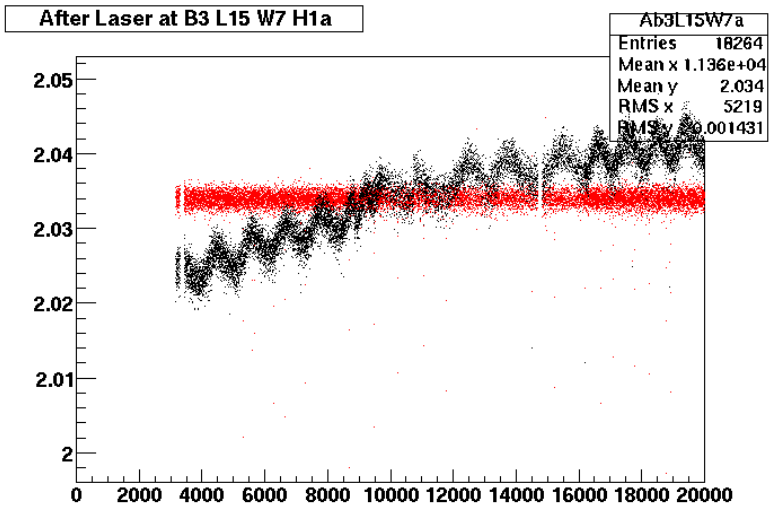
Notre Dame & Fermilab on SBIR and STTR projects collaborating with Ludlum Corp. and Penn to produce new dyes with larger light-yields and faster decay times

Vertexing and Tracking Summaries, D. Peterson, ALC Workshop, Cornell, July 2003

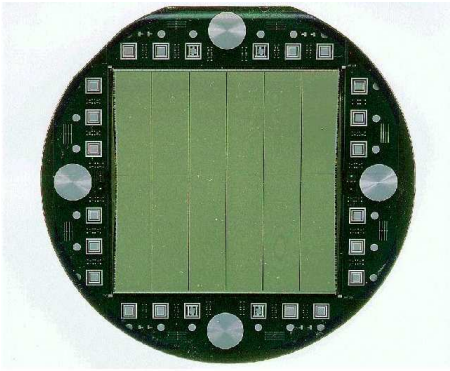
Silicon Drift Tracker R&D Program, Rene Bellwied

UCLC proposal

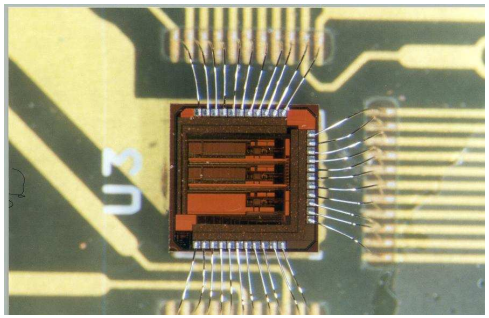




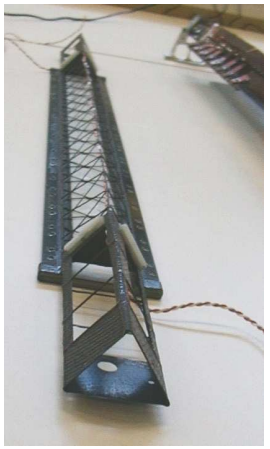
8 μm in anode direction, 13 μm in drift



Proposed wafer R&D



Proposed front-end R&D



Proposed wafer R&D

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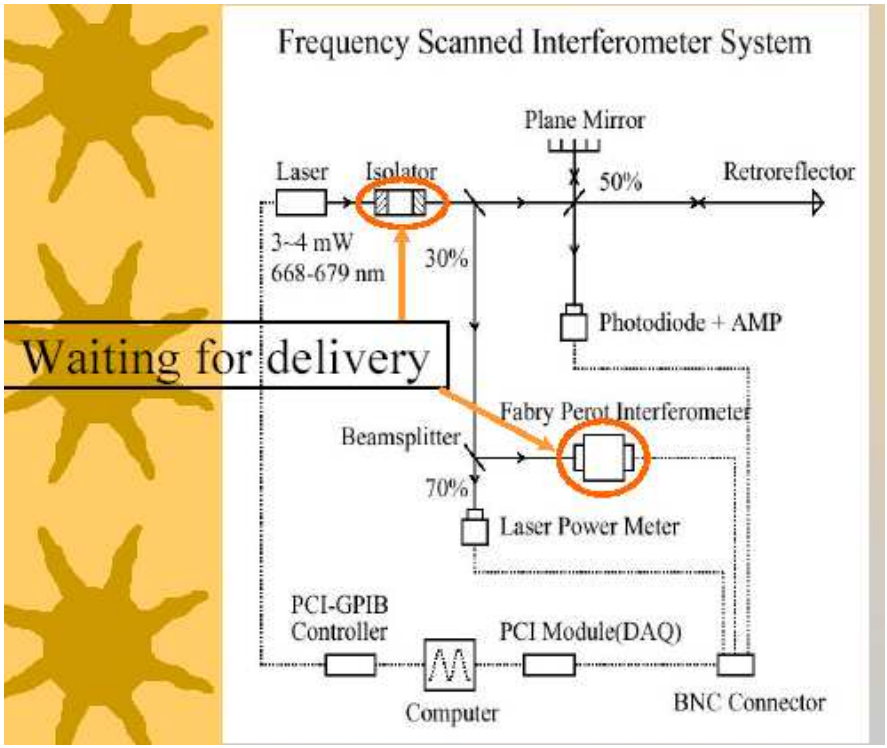
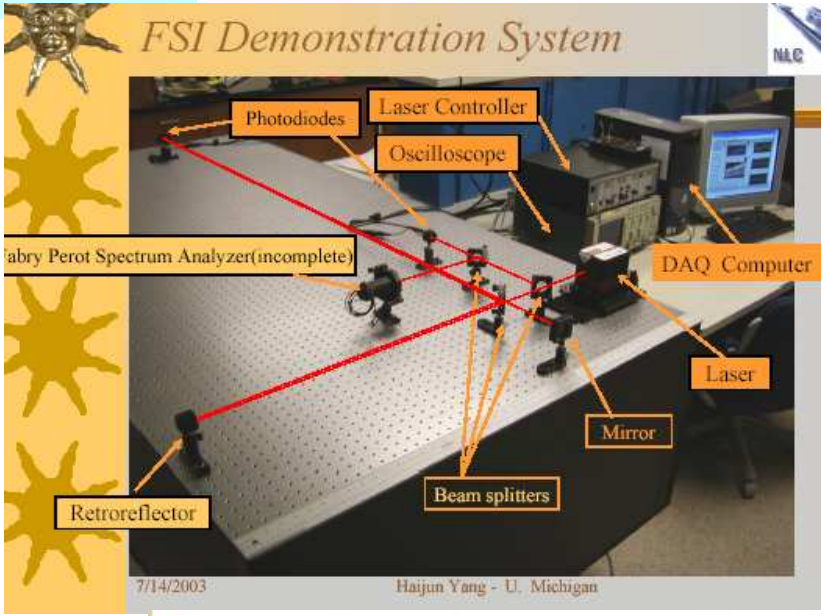
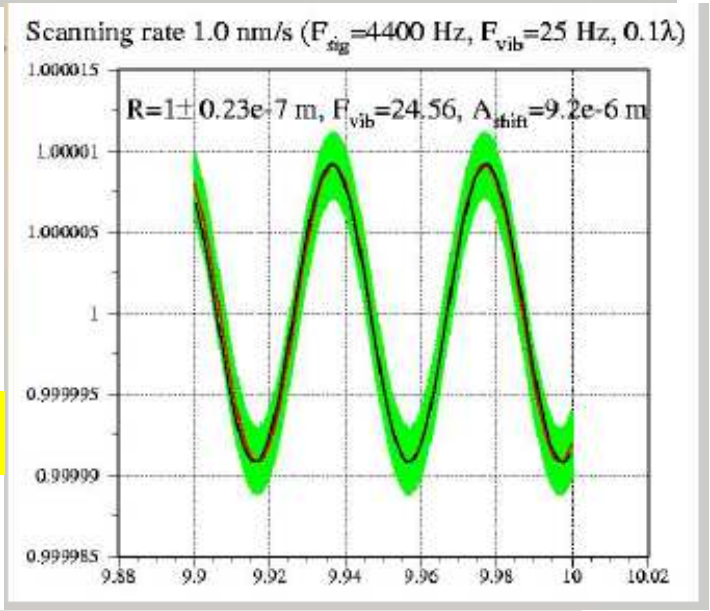
Frequency-Scanned Interferometry Haijun Yang





simulation



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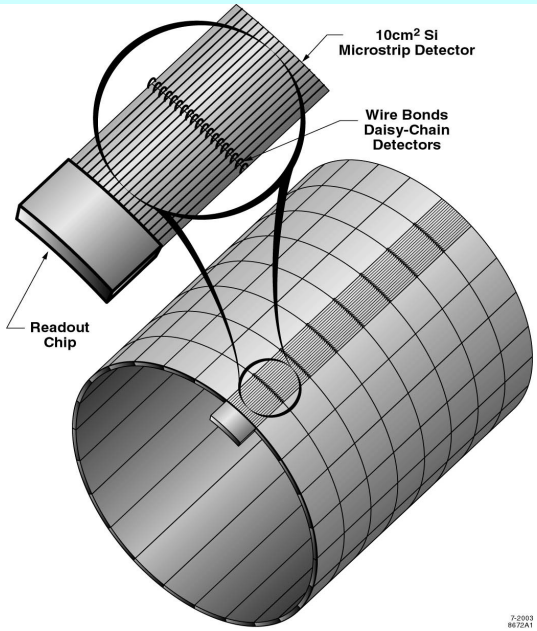
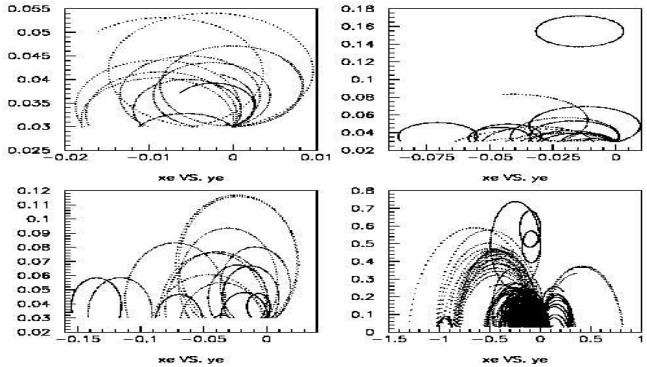
Silicon Detector Tracking, John Jaros



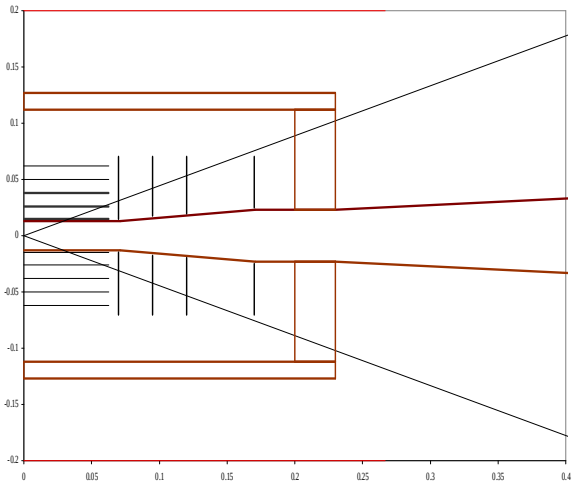


•**Summary for Layer 1** (half barrel r=25cm)

Photon Hits	0.42%
e+e- Hits	~0.10 %
Noise Hits	0.20%
Total Occupancy	**0.7 %**

$P=(1 - .007)^4 = 97.2\ \%$

SD Pattern Recognition looks OK

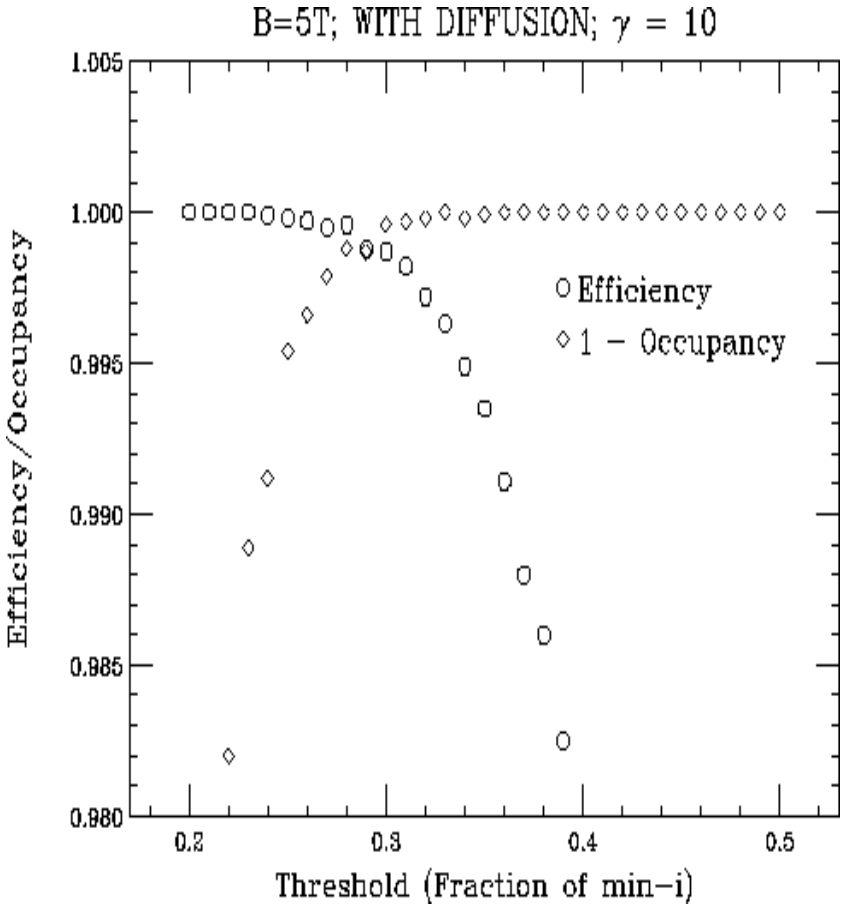


Ω Coverage (requiring N layers, any orientation)

5 CCD layers	.97	(vs .90 TDR VXD)
4 CCD layers	.98	(vs .93 TDR VXD)

Vertexing and Tracking Summaries, D. Peterson, ALC Workshop, Cornell, July 2003

Long Shaping-Time Readout for Silicon Strips, Bruce Schumm



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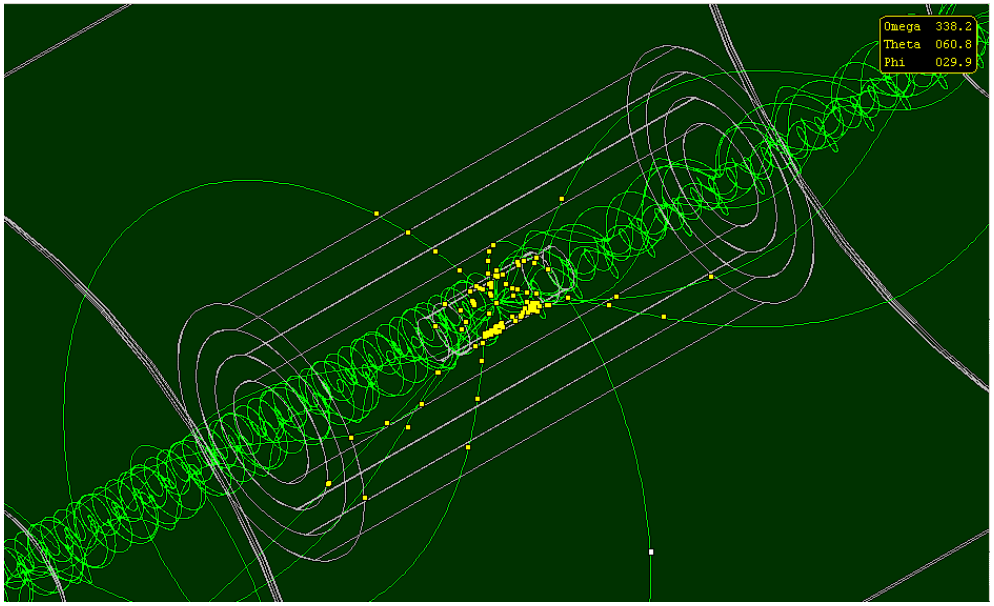
Forward Tracking Simulation, Norman Graf

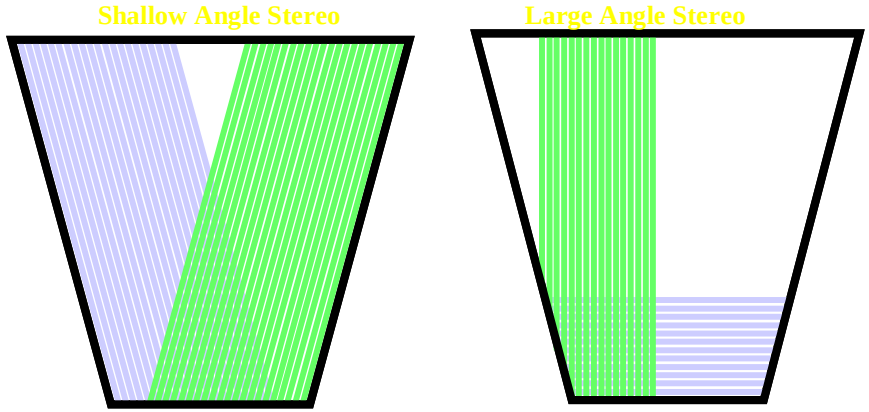
single crossing simulation
(pairs only)

shown for vertex detector and Si tracker

will be applied to forward tracking



- Many open issues:
  - Tiling of disks with wafers:
    - Phi segmentation?
    - Radial segmentation?
  - Mix of Si pixel and μ-strip detectors?
  - If pixel, APD or CCD?
  - If μ-strip, double-sided or back-to-back?
  - Strip orientations within wedges.
    - Shallow- or large-angle stereo?



Vertexing and Tracking Summaries, D. Peterson, ALC Workshop, Cornell, July 2003

South Carolina Tracking Plans, **Achim W. Weidemann**

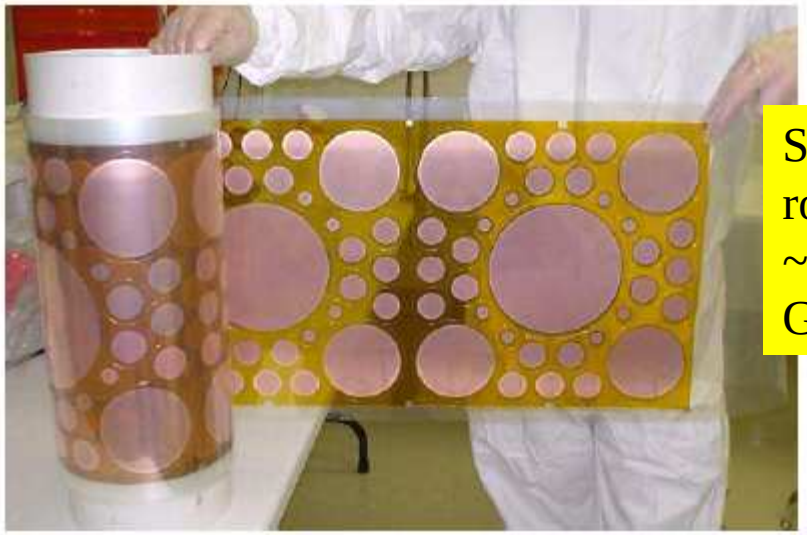
LCRD proposal

Planned Tracking Study

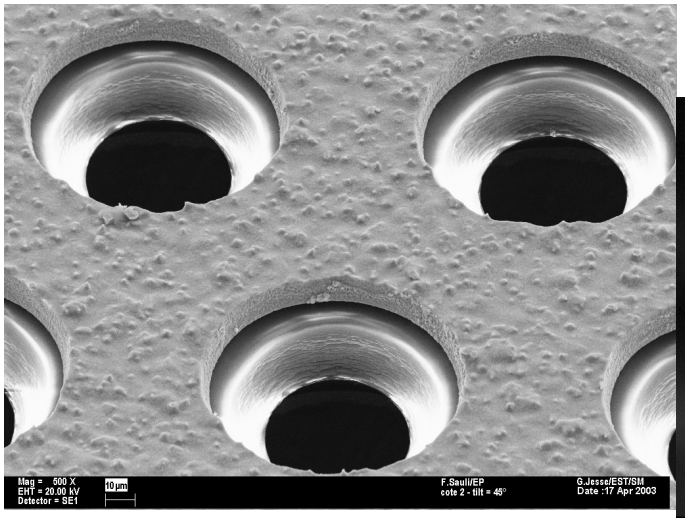
- Study existing tracking code
- Tracking efficiency, fake rates for existing trackers
- Compare different configurations
- Develop new tracker with Si strip planes
- Physics impact: Higgs, SUSY,… physics yields, resolutions

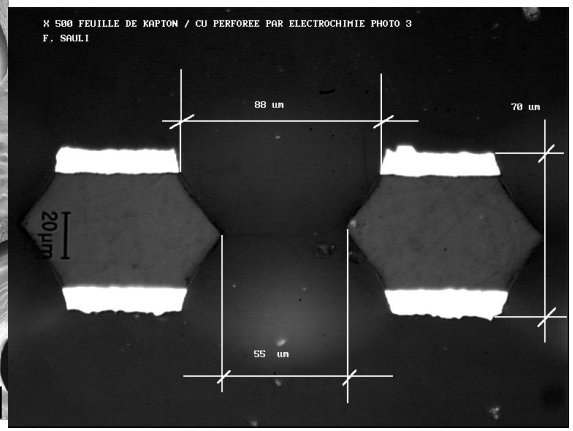
Ian Shipsey

- **3M Microinterconnect Systems Division** Reel-to-reel process, rolls of 16”’x16” templates of detachable GEMs in any pattern. Optional processes possible.
- First batch of 1,980 GEMs recently produced. Low cost per unit! (~2 USD/GEM not counting R&D)
- Two fabrication techniques (additive, substractive) tested.

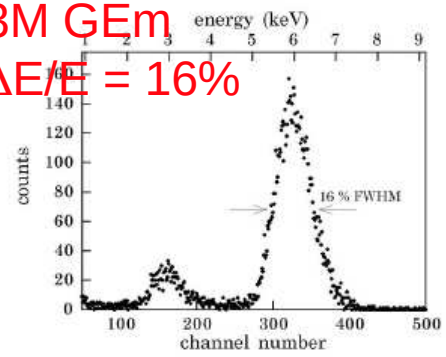


Single roll of ~1,000 GEMS





3M GEm
ΔE/E = 16%



Fe_{55} spectrum

Vertexing and Tracking Summaries, D. Peterson, ALC Workshop, Cornell, July 2003