Update of CLEO II Silicon Vertex Detector Performance

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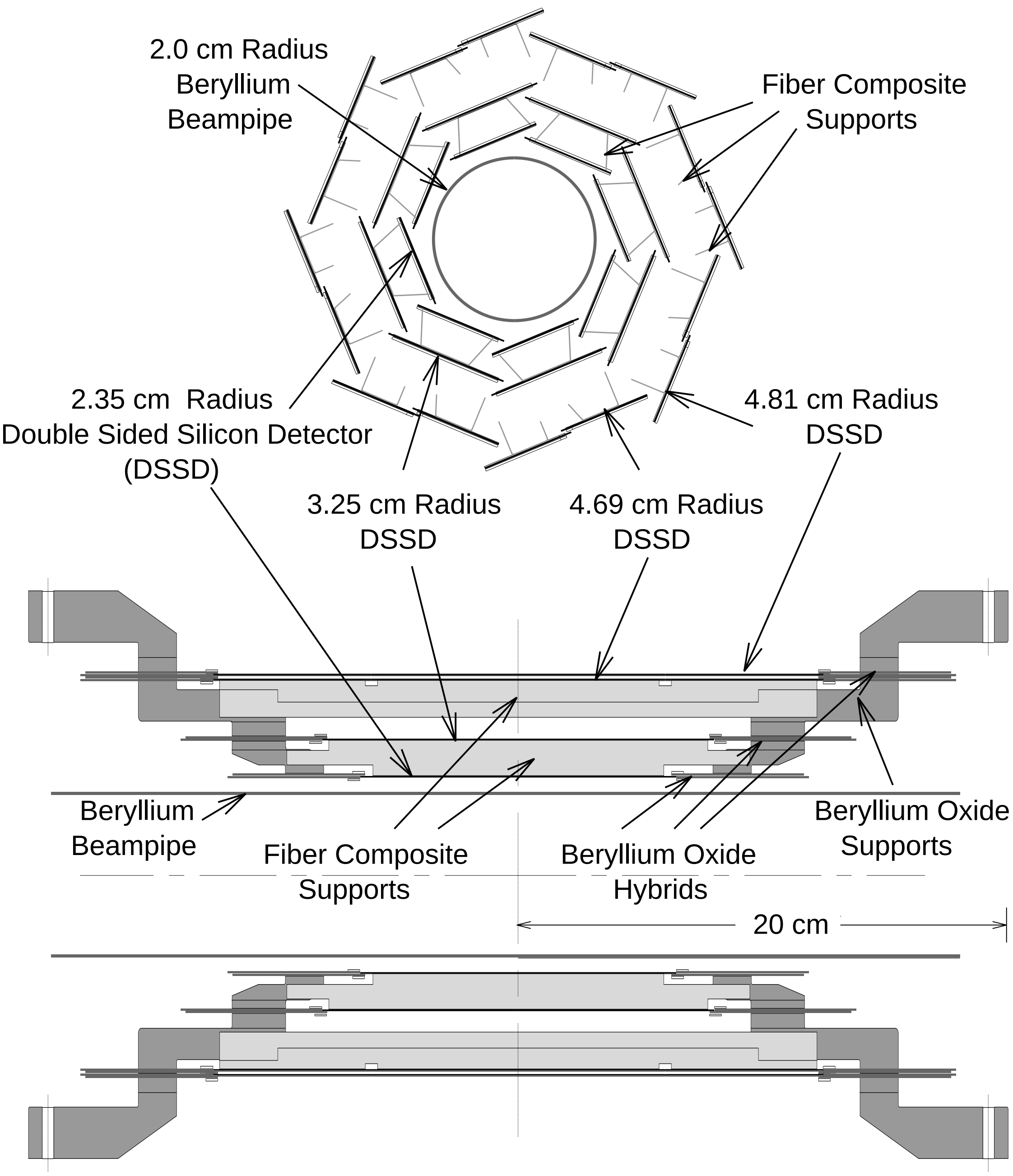
for the CLEO Collaboration

Outline

- Basic Description of CLEO II SVD
- Quick DAQ Overview
- Signal to Noise
- Efficiency
- Occupancy
- Resolution
- Results

CLEO II SVD


2.0 cm Radius
Beryllium
Beampipe
Fiber Composite
Supports
2.35 cm Radius
Double Sided Silicon Detector
(DSSD)
4.81 cm Radius
DSSD
3.25 cm Radius
DSSD
4.69 cm Radius
DSSD
Beryllium
Beampipe
Fiber Composite
Supports
Beryllium Oxide
Hybrids
Beryllium Oxide
Supports
20 cm

CLEO II SVD

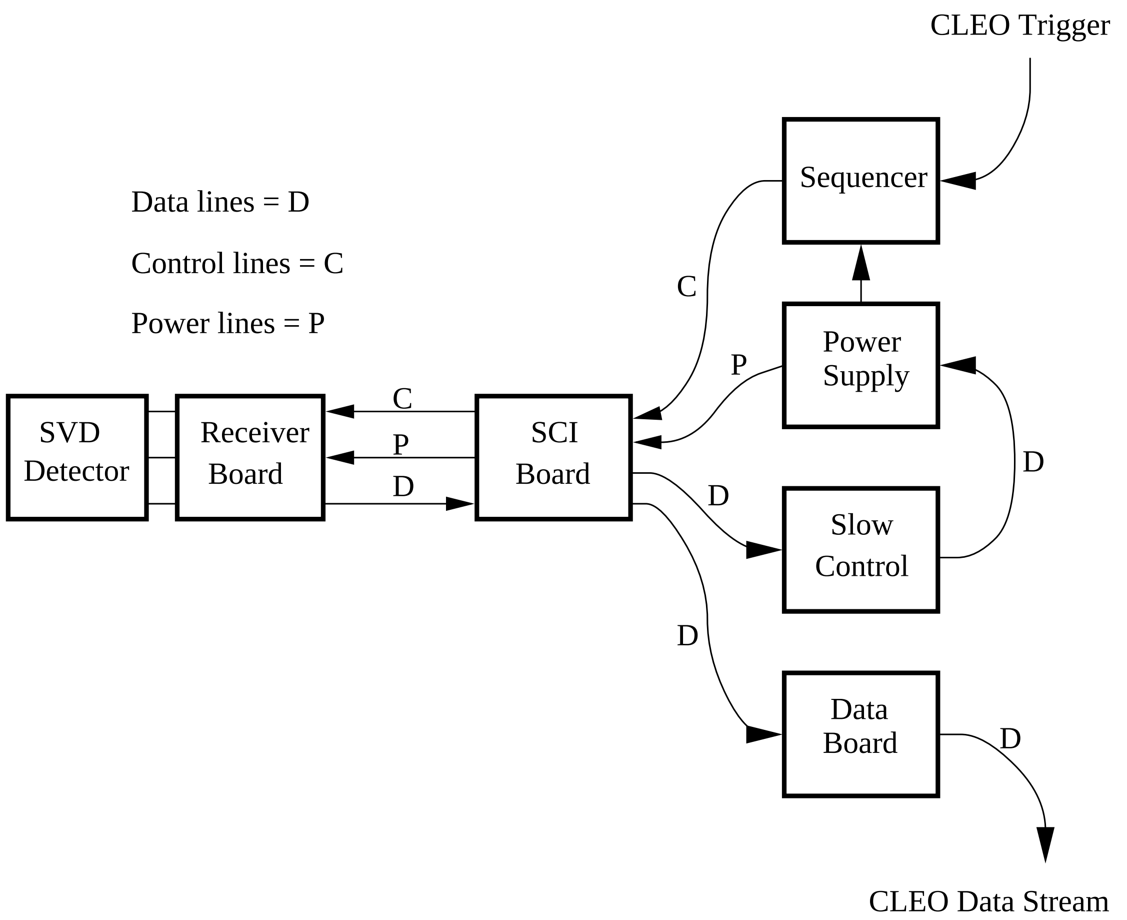
- Double sided detector generates charge correlated $r\phi$ and z information
- ϕ segmented in octants $\rightarrow$ 45° wafer acceptance
- $0.5\,mm$ overlaps in ϕ octants
- Wafers located 2.35, 3.25 and $4.81\,cm$ from beam
- Overall length is $24\,cm$ ($|cos(\theta)| \leq 0.93$)
- Normal path through silicon is 1.2% radiation lengths, beampipe is 0.6% radiation lengths
- 26208 channels
- Takes data at $55\,Hz$ (upgrading to $75\,Hz$)
- We have taken $4\,fb^{-1}$ of silicon data
- We have received $\sim$ 25% of our radiation "death dose"

CLEO II SVD Wafers

	Layer 1	Layer 2	Layer 3
Radius (mm)	23.5	32.5	46.9, 48.1
Active Half Length (mm)	59.5	76.4	119.1
Active Width / Side (mm)	21.2	28.9	21.2
Active Thickness (μm)	300	300	300
Number of J/CAMEXes / Side	3	4	3
Readout Strips / Side	189	252	189
Number of Hybrids / Octant	1	1	2
$r\phi$ Side (p implant)			
Implant Pitch (μm)	28.0	28.5	28.0
Readout Pitch (μm)	112	114	112
Strip Capacitance (pF)	9	11	18
Amplifier Chips	CAMEX	CAMEX	CAMEX
z Side (n implant)			
Implant Pitch (μm)	105	101	105
Strip Capacitance (pF)	28	34	56
Number of Sense Strips	567	756	1134
Amplifier Chips	CAMEX	CAMEX	JAMEX

CLEO II SVD DAQ System

- Receiver Boards - connects SVX to rest of DAQ
- SCI (Sequencer-CAMEX Interface) Boards - level shifts all signals to and from SVX and crates, provides Slow Control
- Sequencers - interfaces SCI and CLEO trigger system, produces J/CAMEX control signals
- Databoards - 16 68040 CPU-controlled VME boards performs the common mode noise calculation and SVD zero supress algorithm
- Power Supplies - distributed HC11 CPU system provides SCI and sequencer power



CLEO II SVD Signal to Noise

Our S/N calculation is based on normally incident minimum ionizing tracks that deposit all charge into a single strip. We don't have many of these events so we pathlength correct minimum ionizing tracks (bhabhas) and use the average noise from the strips in the cluster to determine S/N.

	Layer 1	Layer 2	Layer 3
Cosmic Ray Data			
$r\phi$ (p-side)	18	14	11
z (n-implant)	10	8	10
Colliding Beam Data			
$r\phi$ (p-side)	13	11	10
z (n-implant)	10	9	10

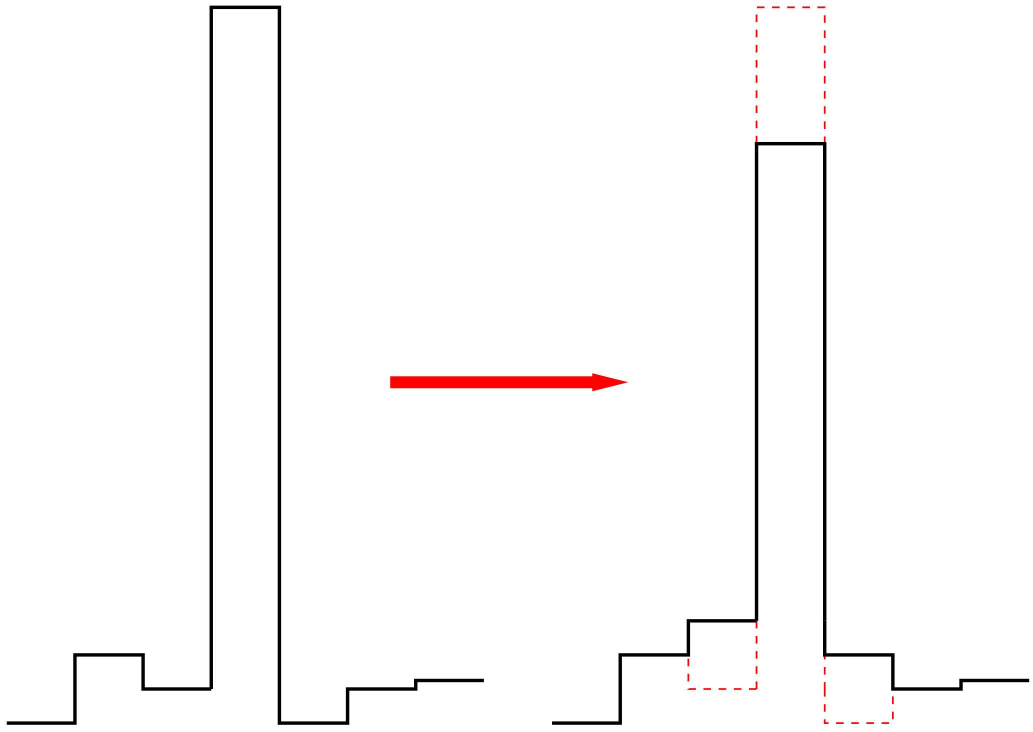
Poor control signal processing is responsible for the degradation and is being rectified during this month's shutdown.

CLEO II SVD Floating Strips

This is a placeholder for the floating strips plot

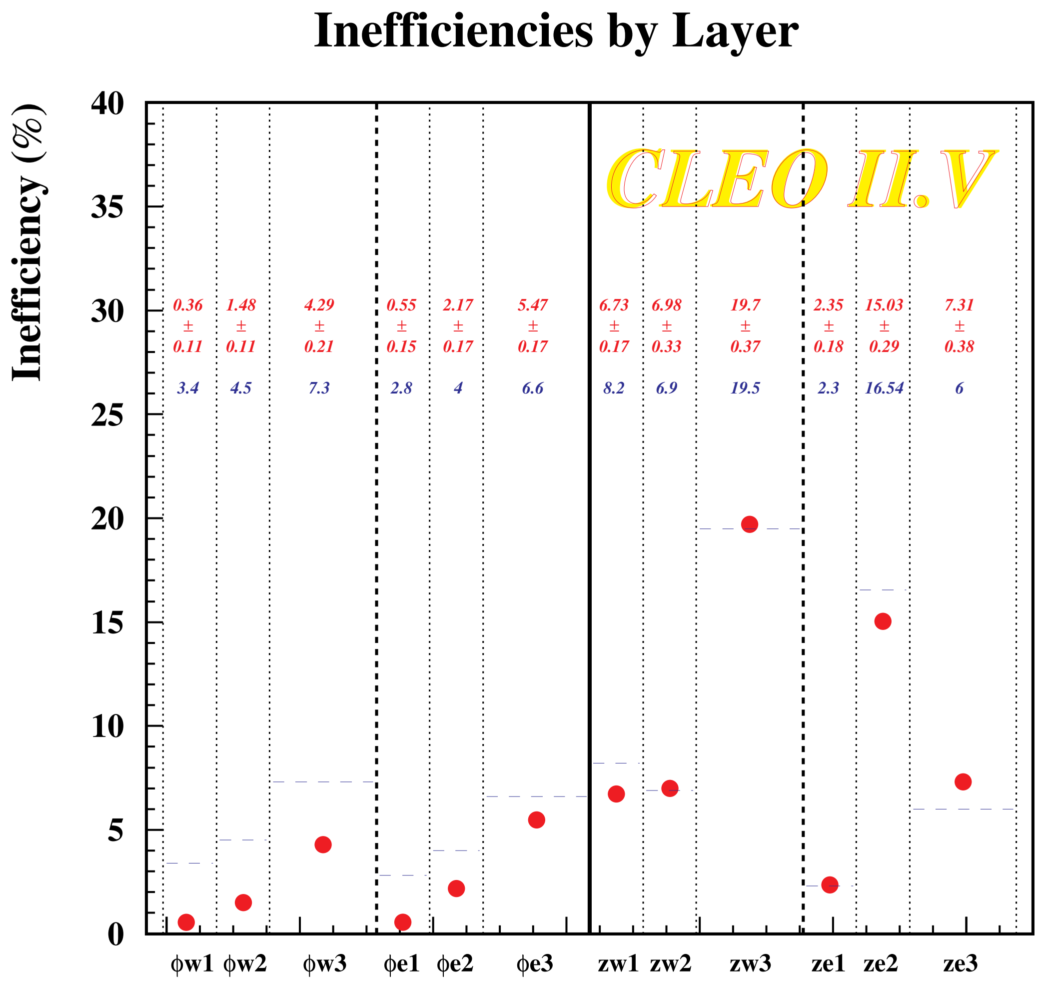
CLEO II SVD Signal Spreading

	Layer 1	Layer 2	Layer 3
$r\phi$ Side (p implant)			
Nearest neighbor	$9.71\% \pm 0.3\%$	$8.95\% \pm 0.3\%$	$8.09\% \pm 0.4\%$
Next nearest	$1.33\% \pm 0.04\%$	$1.54\% \pm 0.05\%$	$2.1\% \pm 0.1\%$
Total	$11.0\% \pm 0.3\%$	$10.5\% \pm 0.3\%$	$10.2\% \pm 0.4\%$
z Side (n implant)			
Nearest neighbor	$2.5\% \pm 0.3\%$	$1.7\% \pm 0.4\%$	$0.8\% \pm 0.4\%$



A 1 strip cluster becomes a 1,2 or 3 strip cluster with signal spreading!

CLEO II SVD Harware Inefficiencies



The inefficiencies track the exceptional channel rate.

CLEO II SVD Exceptional Channel Rate

	Disconnected	Broken Hybrids	Too Noisy to Start a Cluster	Total Exceptional Channels
Layer 1 $r\phi$	1.0%	0.0%	2.1%	3.1%
Layer 2 $r\phi$	2.0%	0.0%	2.3%	4.3%
Layer 3 $r\phi$	3.3%	0.0%	3.7%	7.0%
Layer 1 z	0.6%	0.0%	4.7%	5.3%
Layer 2 z	1.5%	6.3%	3.9%	11.7%
Layer 3 z	2.6%	6.3%	3.9%	12.8%

Exceptional channels are those that are either disconnected, on broken hybrids or are too noisy to start a cluster.

CLEO II SVD Hardware Efficiencies

	Vertex 96	Vertex 97
Layer 1 $r\phi$	0.957 ± 0.008	0.995 ± 0.001
Layer 2 $r\phi$	0.947 ± 0.008	0.982 ± 0.001
Layer 3 $r\phi$	0.854 ± 0.014	0.951 ± 0.002
Layer 1 z	0.799 ± 0.014	0.955 ± 0.002
Layer 2 z	0.791 ± 0.014	0.890 ± 0.003
Layer 3 z	0.759 ± 0.015	0.865 ± 0.004

CLEO II SVD Occupancy

Raw Occupancy: the number of strips that are passed into the CLEO data stream.

Currently our raw occupancy is $\sim 5\%$.

There are 4 sources of raw occupancy in the CLEO SVD

- Pedestal widths (incoherent noise) $\sim 2\%$
- Extra strips or "cluster wings" $\sim 2\%$
- Beam $\sim 2\%$
- Calibration drift

CLEO II Beam Related Occupancy

- $I_{LEP} \sim 2 \times 10^{-3}\, A$
- $I_{CESR} \sim \frac{1}{2}\, A$

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CLEO II Beam Related Occupancy

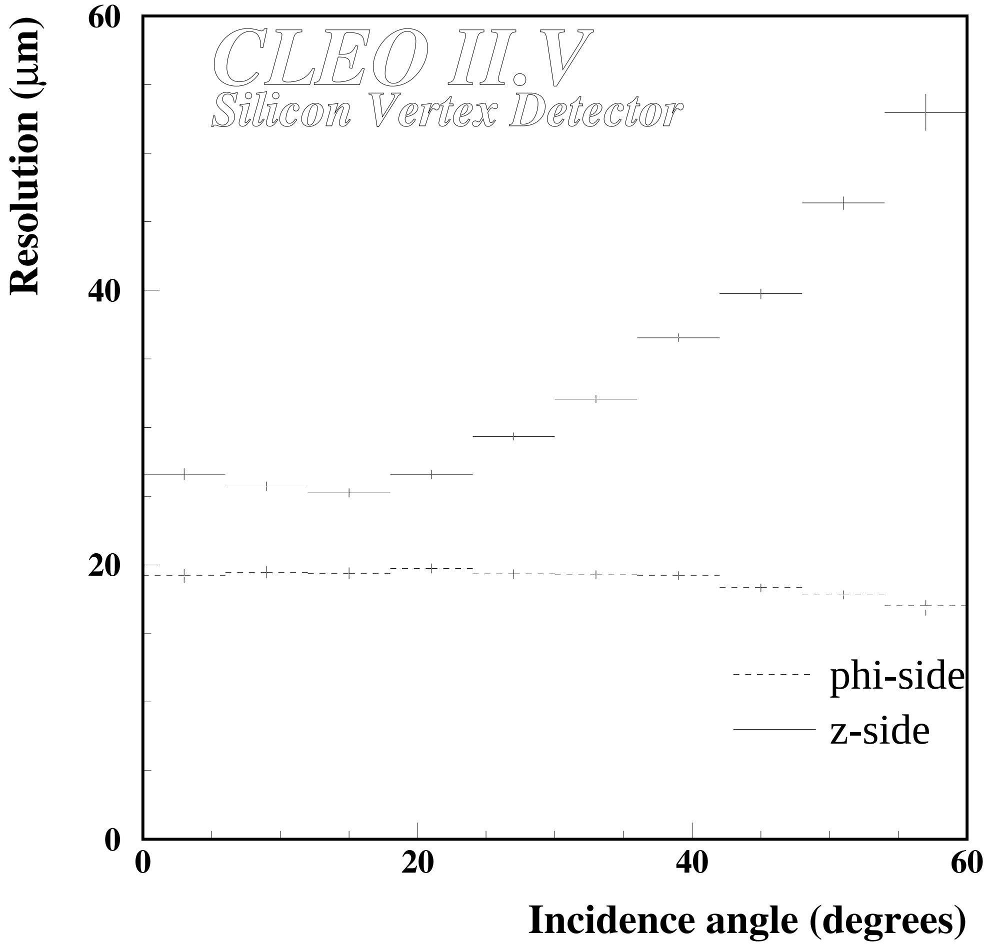
	Beam Related Occupancy
Layer 1	$1.42\% \pm 0.02\%(stat)$
Layer 2	$0.76\% \pm 0.01\%(stat)$
Layer 3	$0.28\% \pm 0.01\%(stat)$

- These numbers are calculated for $I_{Beam} = .25\,A$.
- The simulation prediction for layer 1 occupancy under current interaction region conditions is $1.2\% \pm 0.6\%$.
- A 6-hit track contributes 0.02% to the occupancy.

CLEO II SVD Calibration Variations

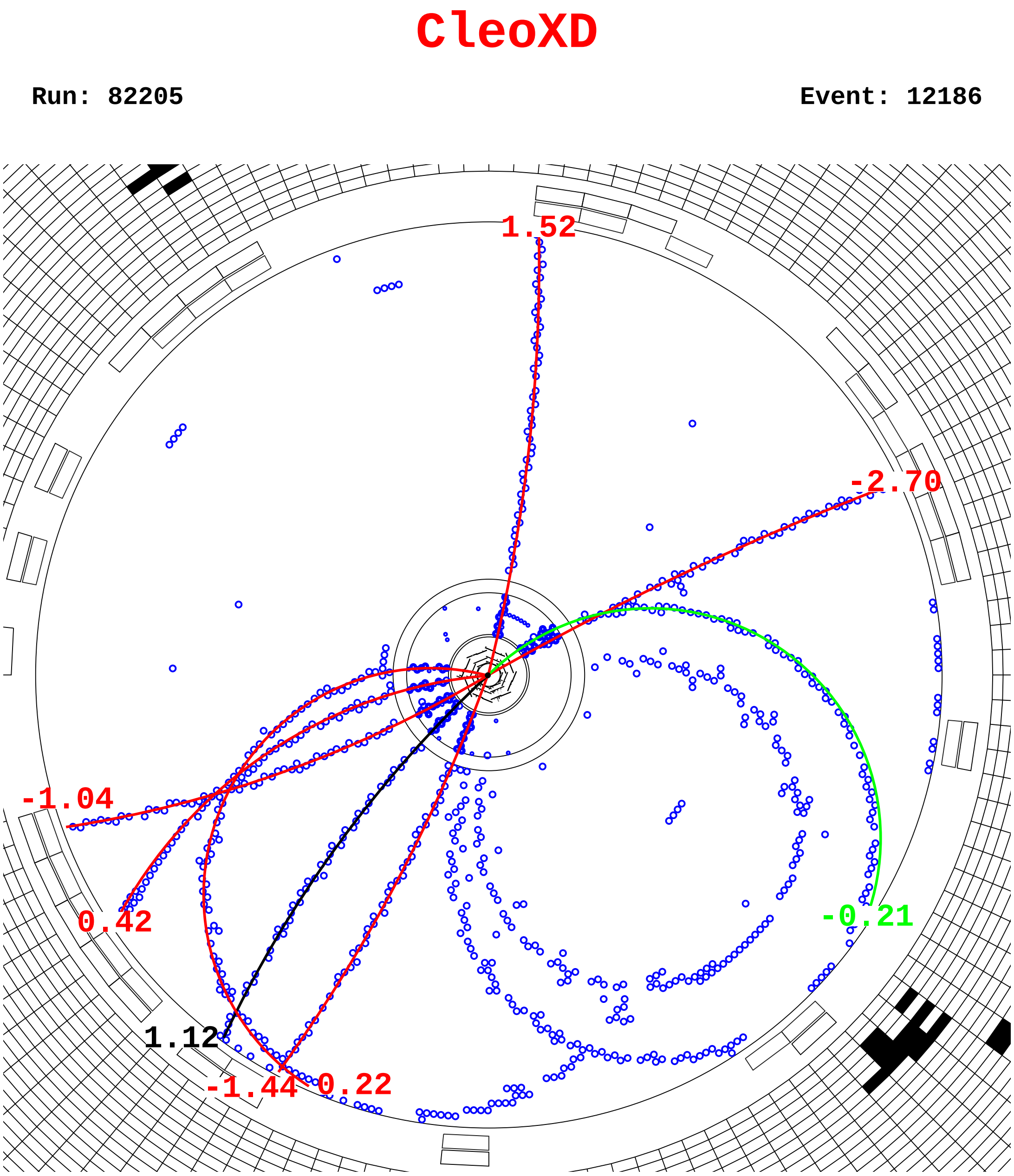
	Layer 1	Layer 2	Layer 3
	Channel to Channel Gain Variations		
$r\phi$ (p-side)	$2.65\% \pm 0.05\%$	$2.78\% \pm 0.04\%$	$5.29\% \pm 0.07\%$
z (n-side)	$3.43\% \pm 0.06\%$	$4.63\% \pm 0.07\%$	$12.92\% \pm 0.28\%$
	Chip Gain Variations		
$r\phi$ (p-side)	$1.8\% \pm 0.2\%$	$1.9\% \pm 0.2\%$	$3.5\% \pm 0.3\%$
z (n-side)	$2.3\% \pm .3\%$	$3.8\% \pm 0.4\%$	$5.2\% \pm 0.6\%$

CLEO SVD Intrinsic Resolution



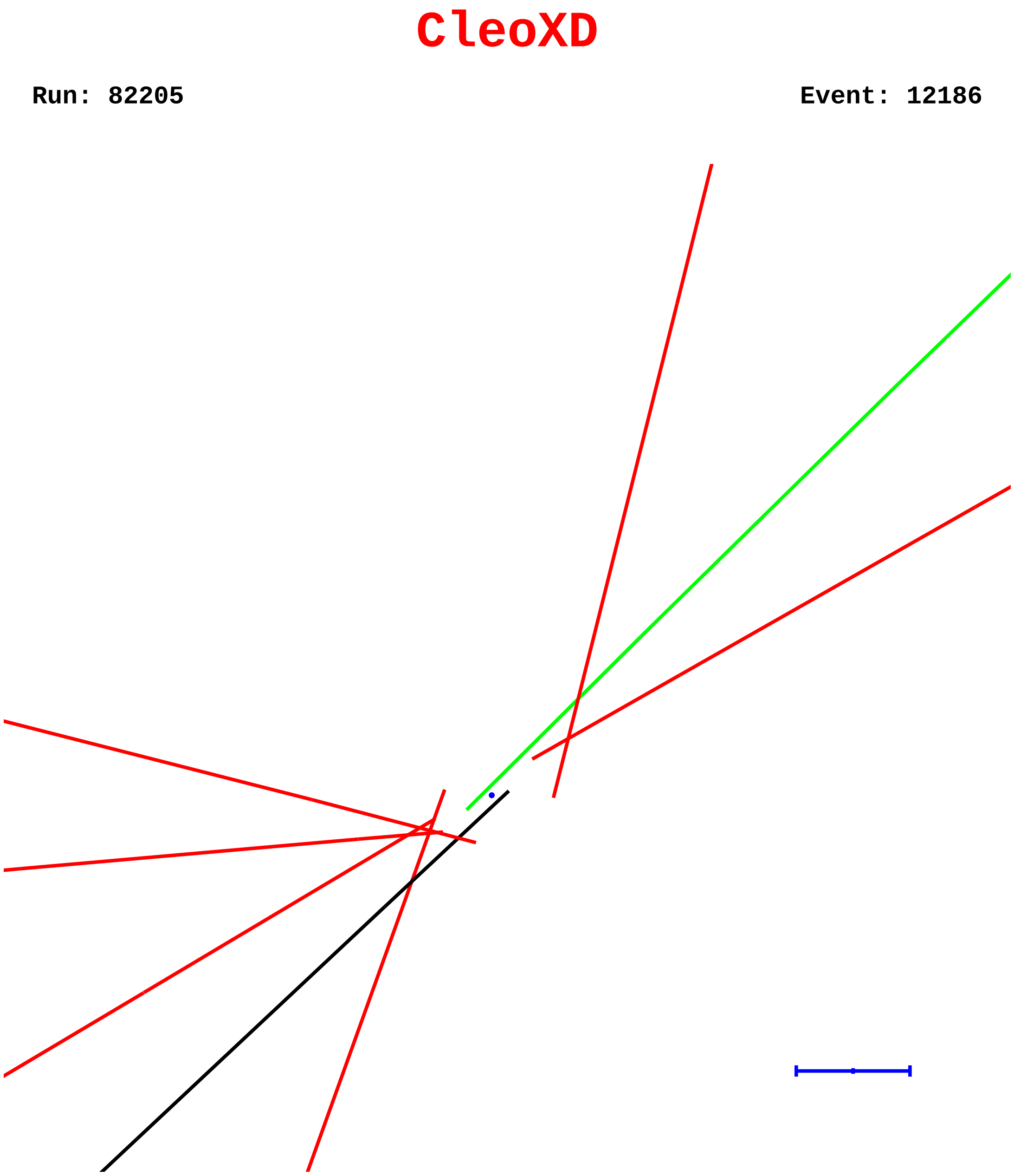
$r\phi$-side and z-side device resolutions using μ-pair events.

CLEO II Event



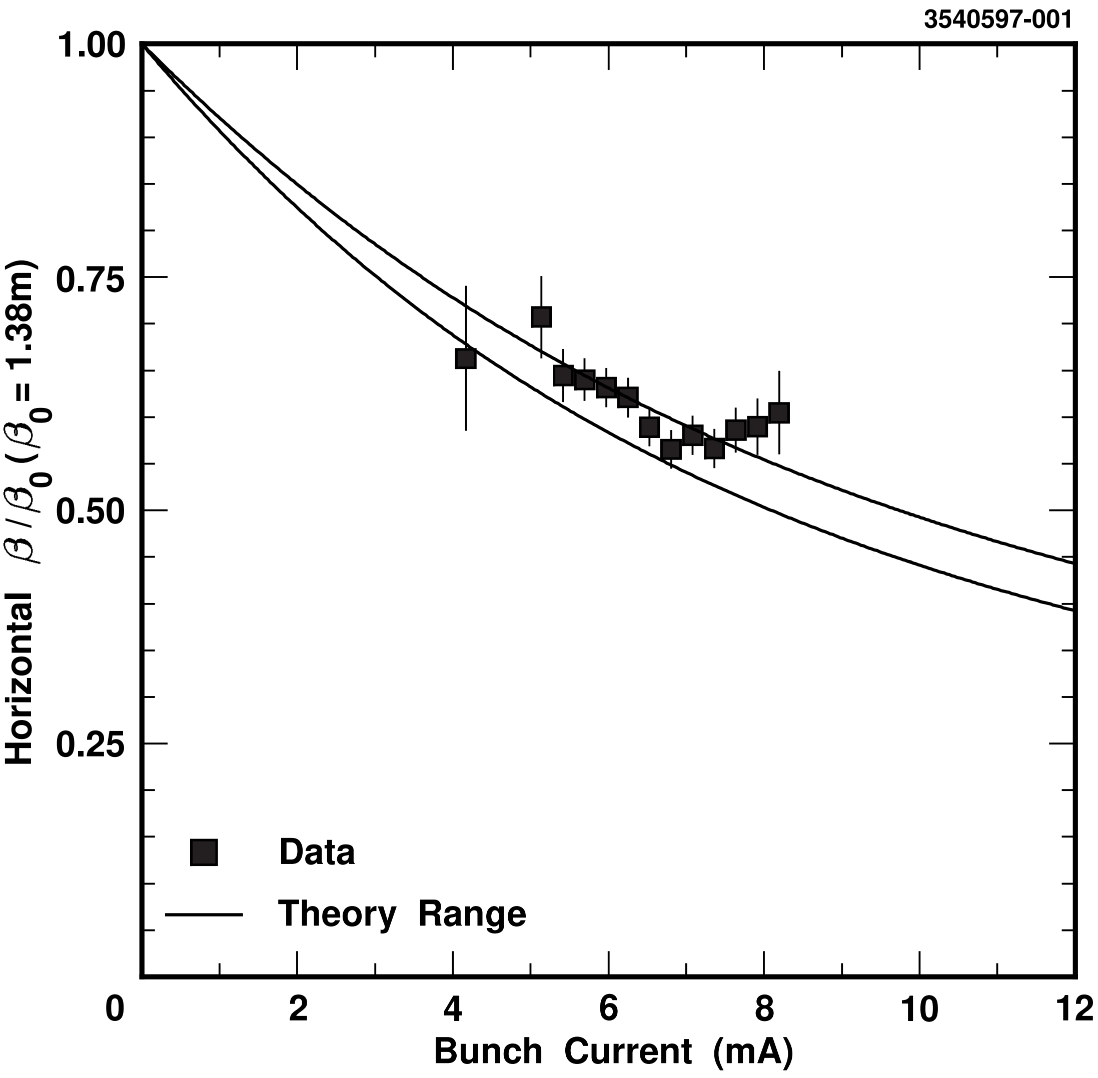
This event is interpreted as $e^+e^- \to D^{*\pm} + D^0 + \pi$.

CLEO II Up Close

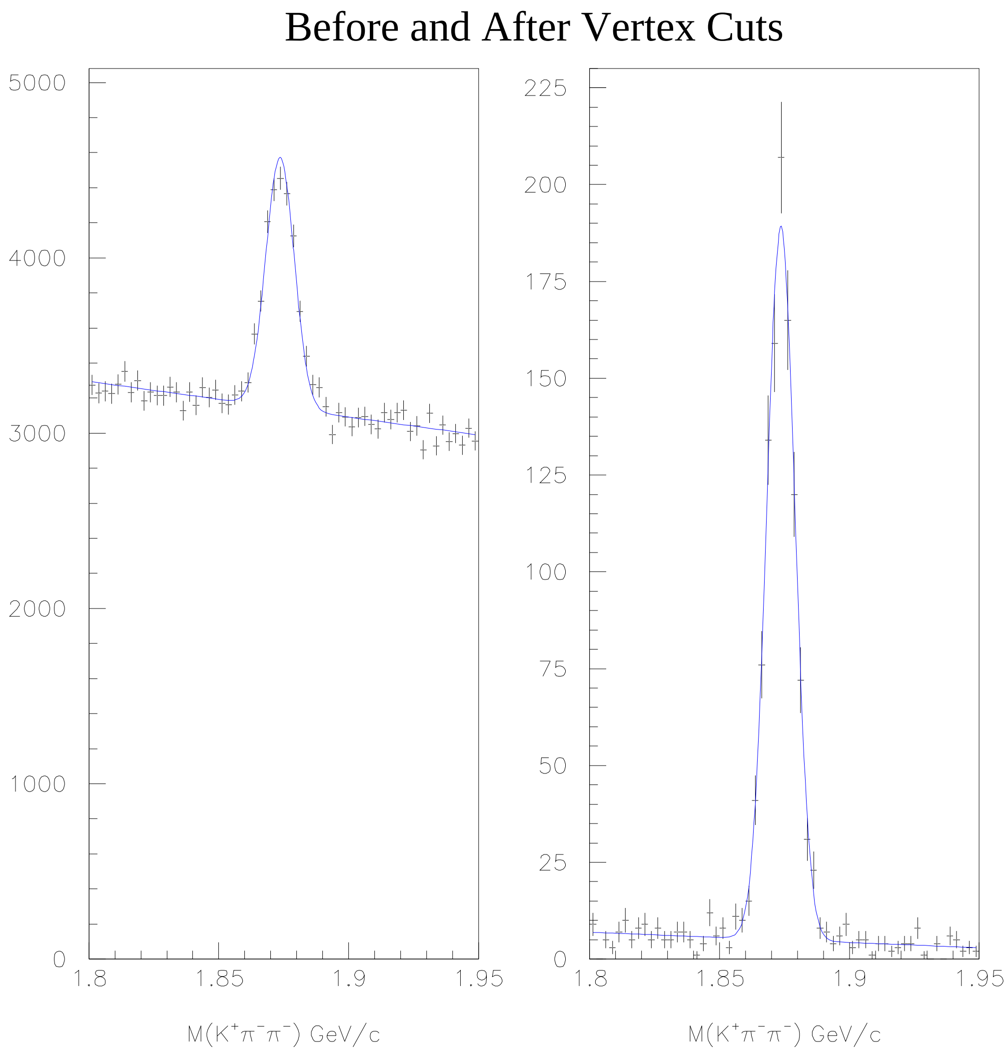


The lower left vertex is the D^0 decay, the upper right vertex is the D^0 decay from the $D^{*+} \to D^0\pi$ decay where the slow π is the green track, the black track is a fragmentation track. The blue scale is $1\,mm$.

CLEO II SVD Measures Dynamic Beta Effect



SVD is Searching for Vertices from D Decays



$D^{\pm} \to K\pi\pi$ mass peaks before and after 7σ vertex cut from run averaged beam spot.