CESR and CLEO

Lepton Photon 99

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Where to "B"

To measure a key ~~CP~~ parameter (sin(2β)) to ~ 10 % requires:

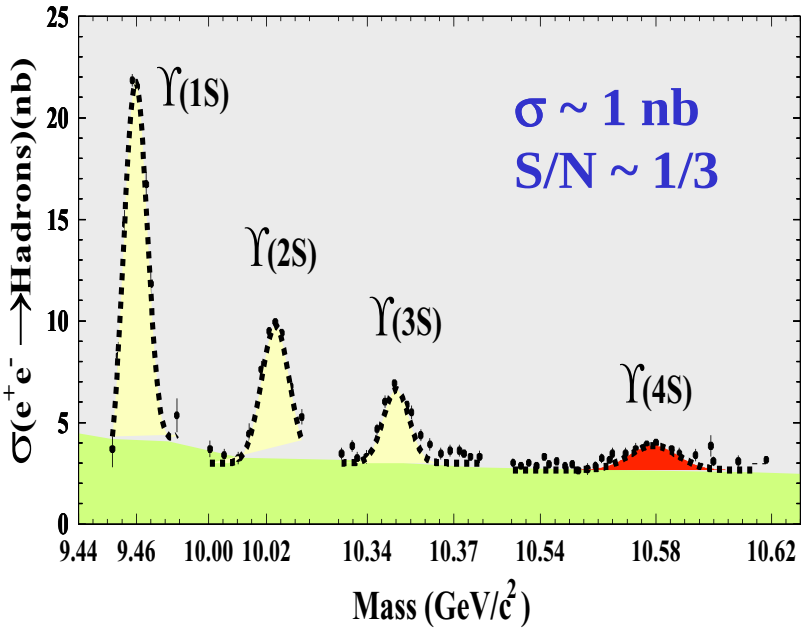
a few hundred $B^0 \rightarrow J/\psi K_s$ events

+ fully reconstructed, flavor tagged

+ BR's, efficiency, tagging…

30×10^6 BB events (Y(4S))

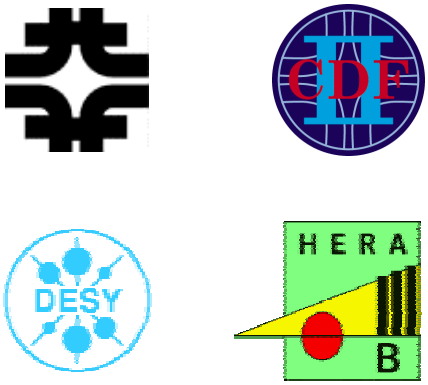
e^+e^- Annihilation



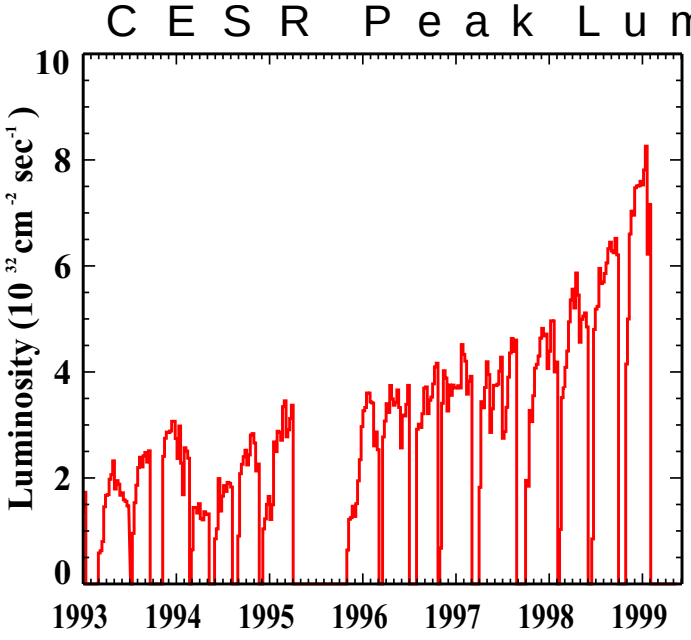
Hadro-Production

σ ~ 100 μb (Tevatron)

S/N ~ 1/500



CESR Performance

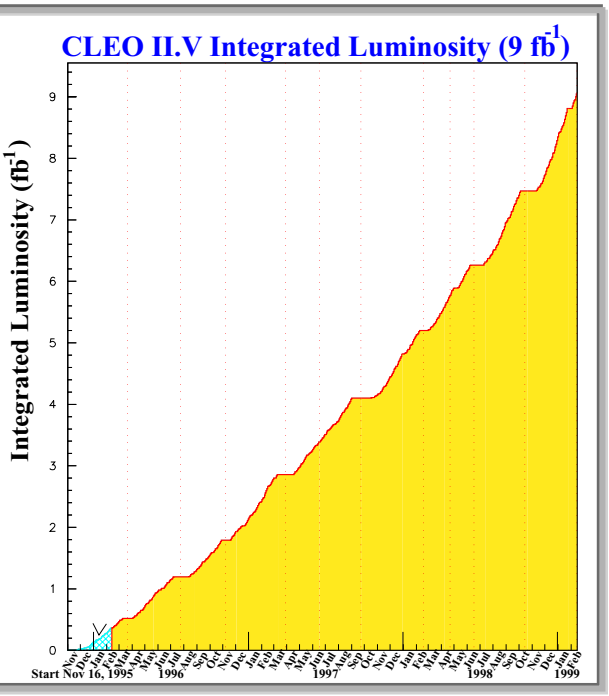


Peak Luminosity: 8.5×10^{32} cm^{-2} s^{-1}

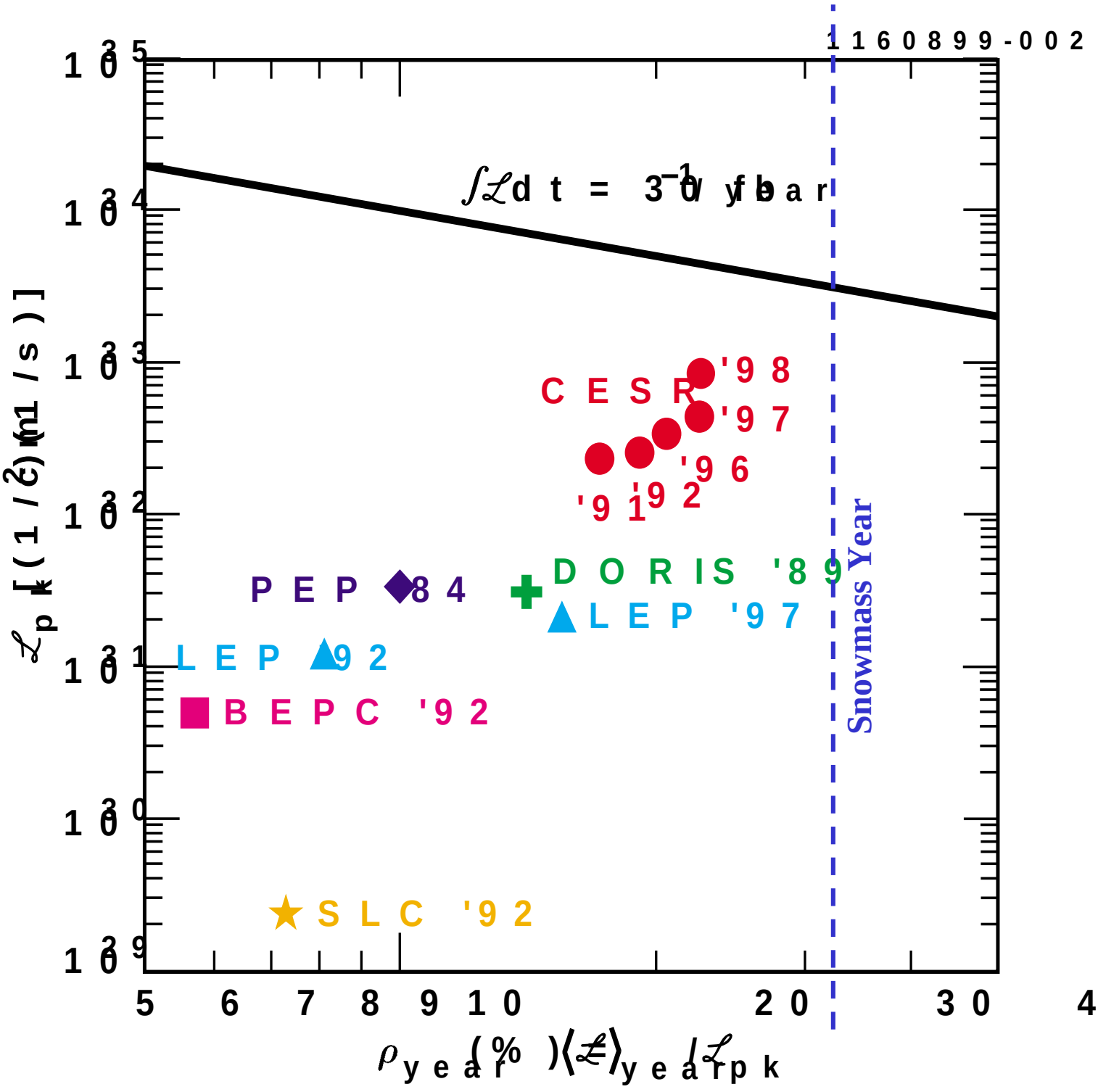
Integrated	**40 pb^{-1}**	**(Day)**
Luminosity	**750 pb^{-1}**	**(Month)**
	4400 pb^{-1}	**(Year)**

CLEO Datasample

	on 4S	Cont. [fb^{-1}]
CLEO II	**3.1**	**1.6**
CLEO II.5	**6.2**	**2.8**
Total	**9.3**	**4.4**



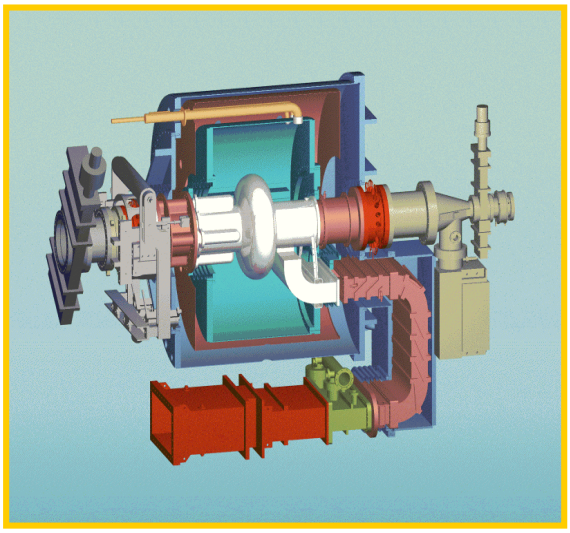
CESR Performance

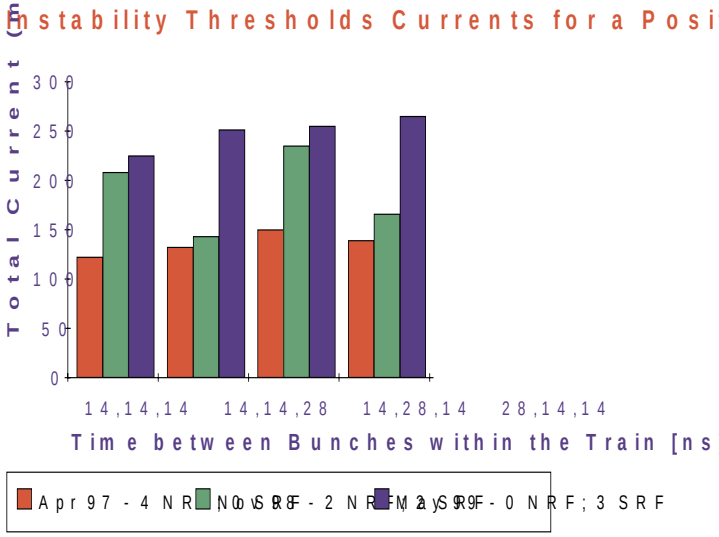


CESR Upgrades

Superconducting RF

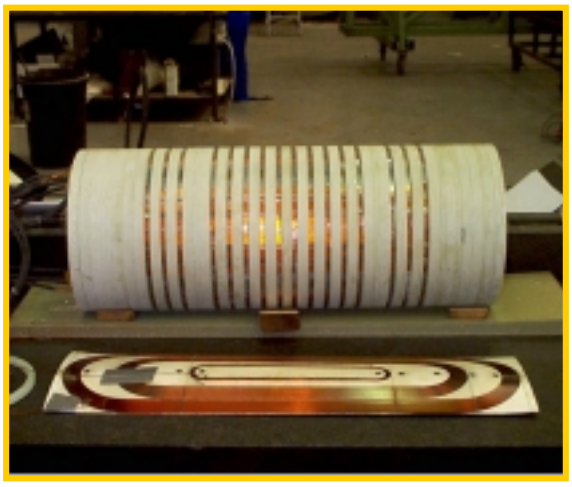
- More Power
  - 1 A beam current
- Less Impedance
  - 4 RF cells vs. 20
  - Reduced Instabilities
- Higher Gradient
  - Shorter Bunches
- Installed





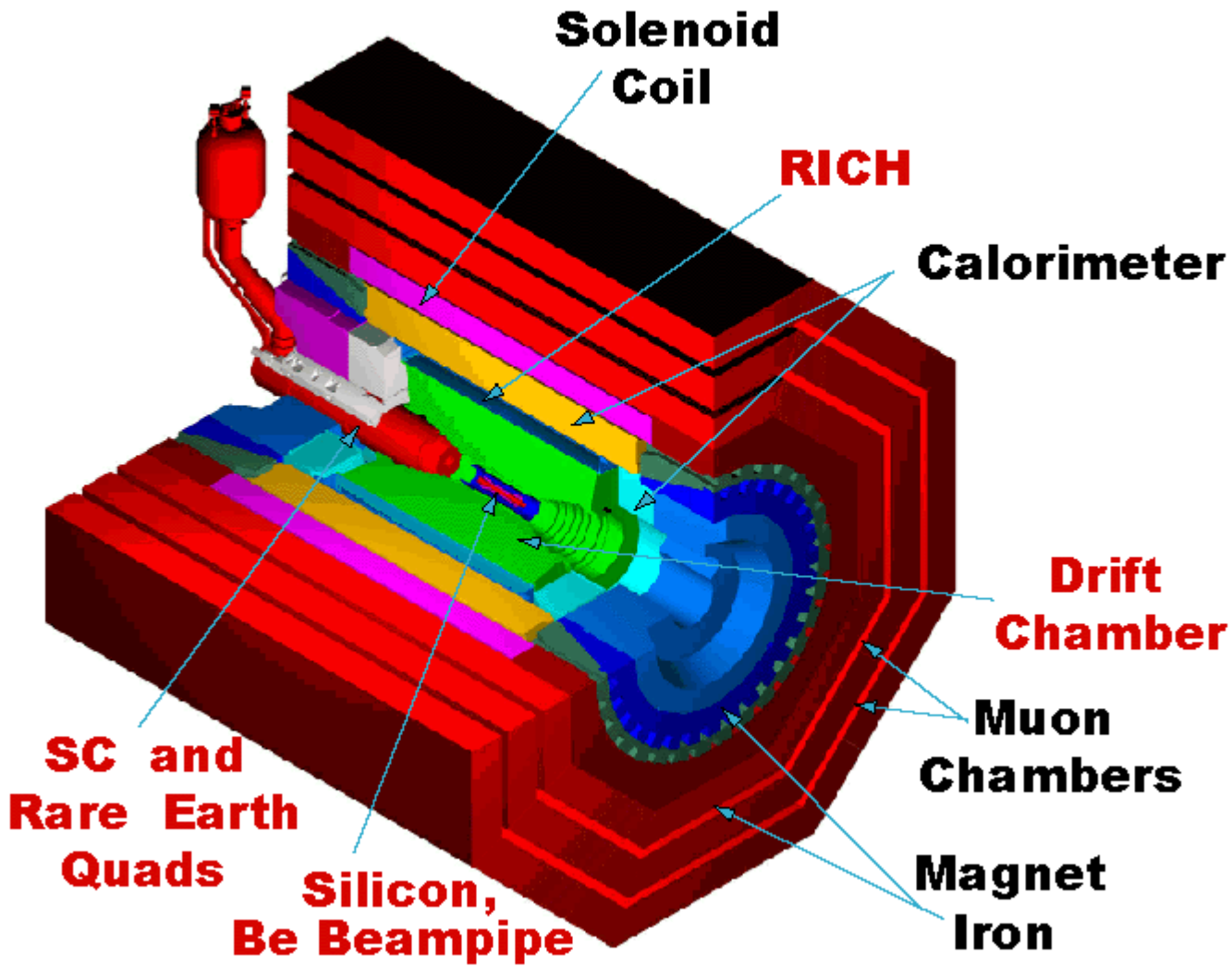
Superconducting Quads

- Better focus
  - β* from 18 to 13 mm
- Spring 2000

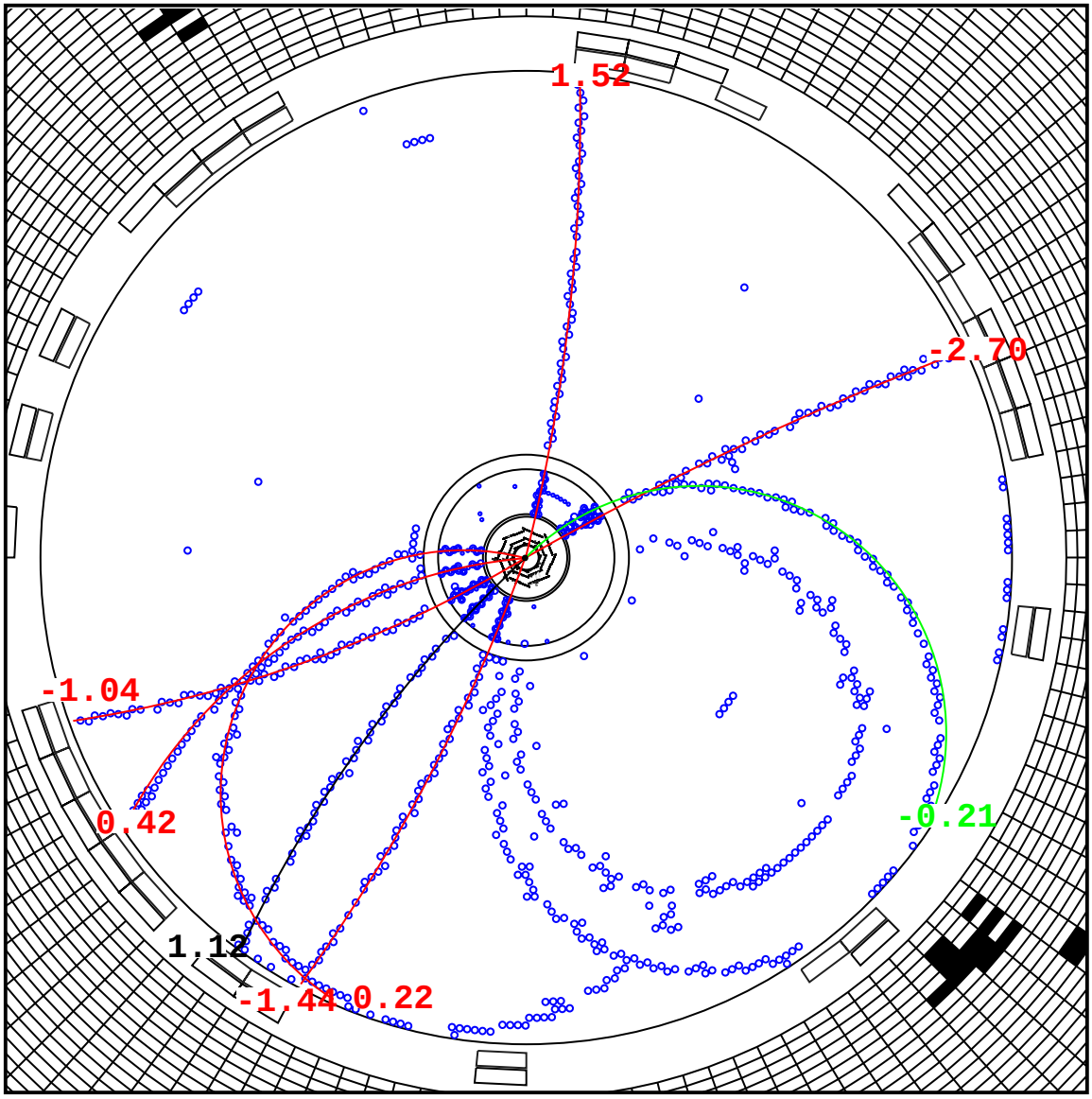


Expect to reach 2 x 10^{33} cm^{-2} s^{-1} sometime next Year.

The CLEO III Detector



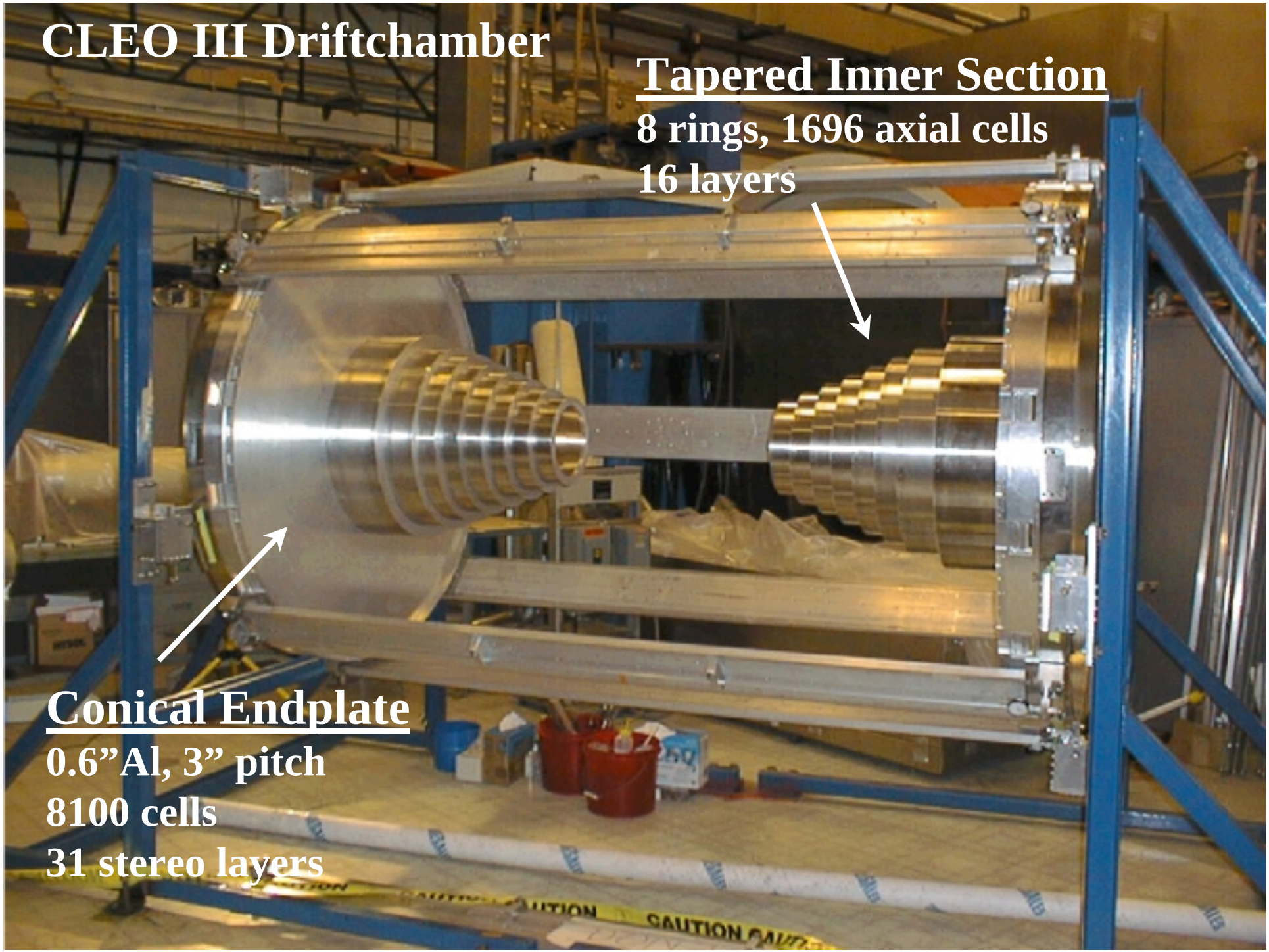
Charged Particle Tracking



Charged Multiplicity ~ 10
Typical Momentum ~ 700 MeV/c down to 100 MeV/c

Momentum Resolution = f(Length, Multiple Scattering)

CLEO II CLEO III: 20 cm smaller radius (RICH)
Final focus quads


CLEO III Driftchamber
Tapered Inner Section
8 rings, 1696 axial cells
16 layers
Conical Endplate
0.6”Al, 3” pitch
8100 cells
31 stereo layers

Reduced Multiple Scattering

Inner Gas Seal

2.5 mm Rohacell with 20 μm Al skins
X_o < 0.15%
No support function

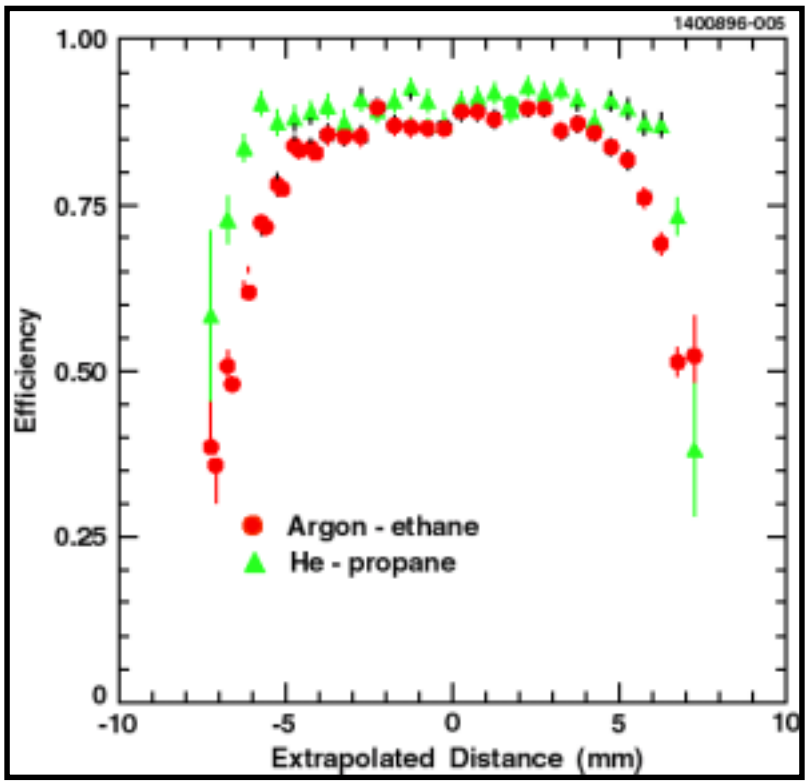
He based Gas Mixtures

Resolution
Efficiency

He:Propane	X_o > 330 m
60:40	Lorentz Angle (@ 1.5 T) < 46°
Ar:Ethane	X_o = 165 m
50:50	Lorentz Angle (@ 1.5 T) < 69°

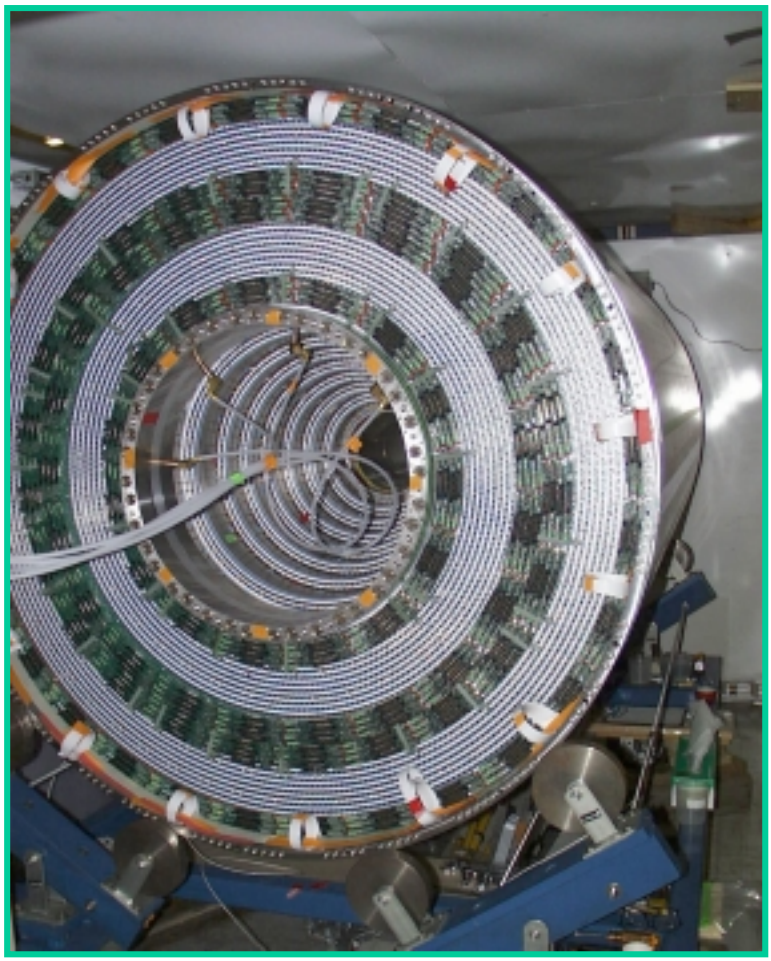
Test Beam Results (CLEO II.5)

Improved efficiency
Improved resolution
122 μm -> 112 μm
Improved dE/dx



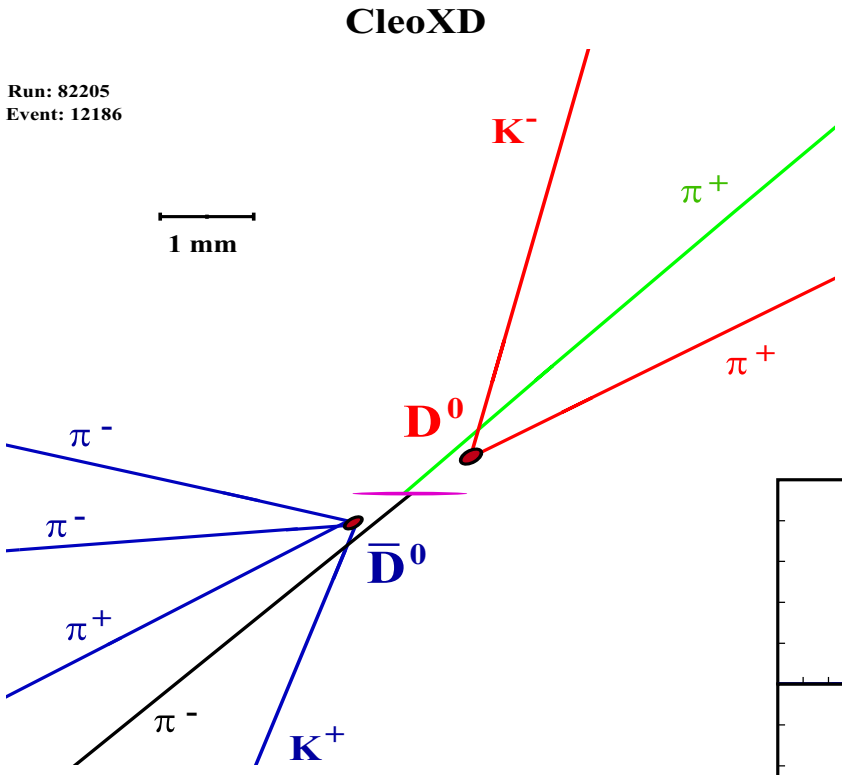
All B-Factories use
He-based drift
chamber gases

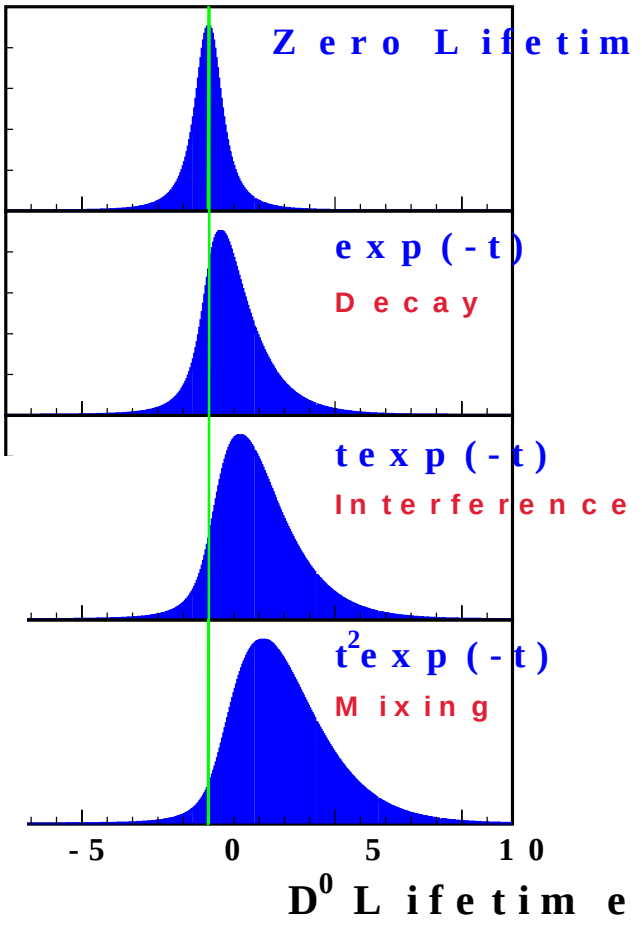
Moving Day



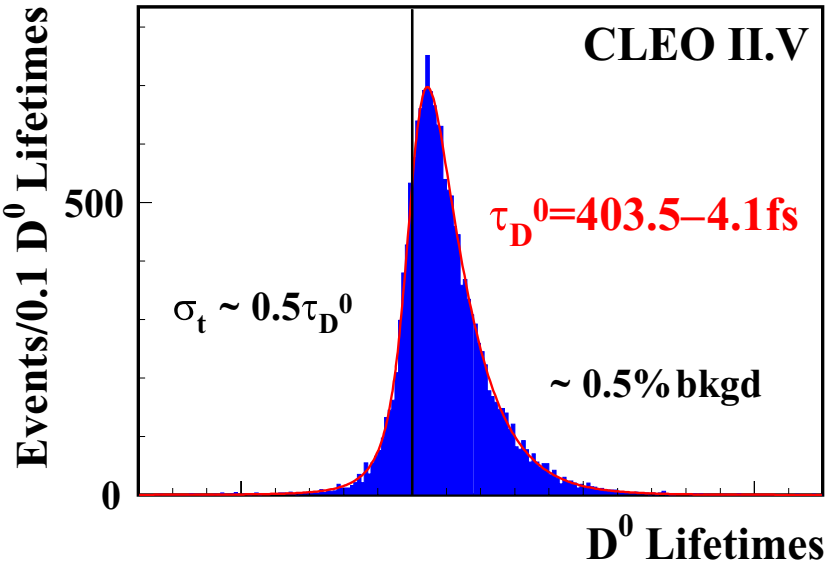
Endplate View

Charged Particle Tracking

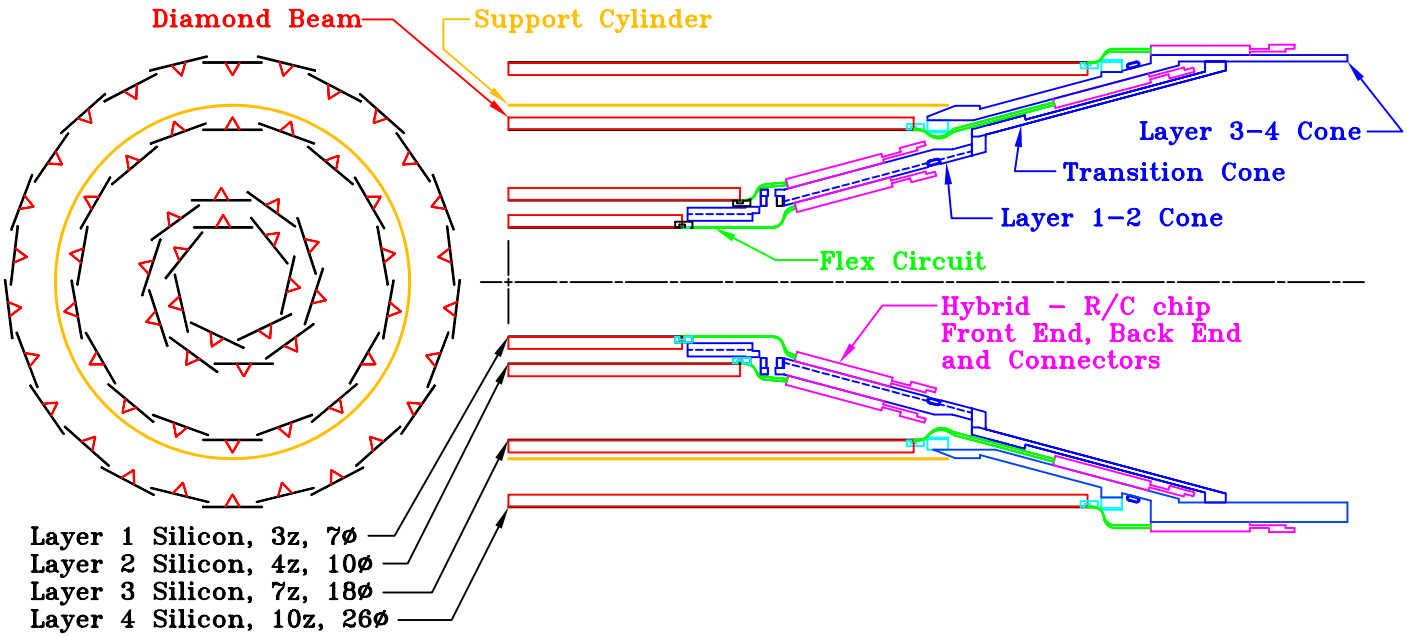




$D^{*+} \rightarrow D^0\pi^+, D^0 \rightarrow K^-\pi^+$

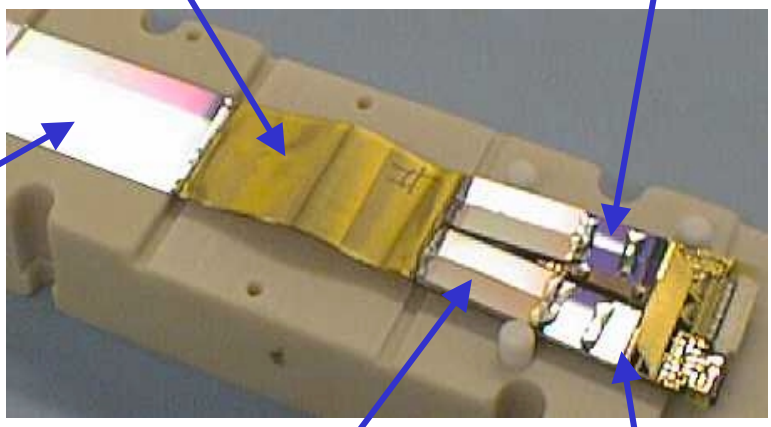


Silicon Vertex Detector



4 Layers of double sided silicon detectors, 300 μm thick.
Only active elements and minimal support material in detector fiducial region
No support structure outside outermost silicon layer.
Conical support structure to maximize acceptance.

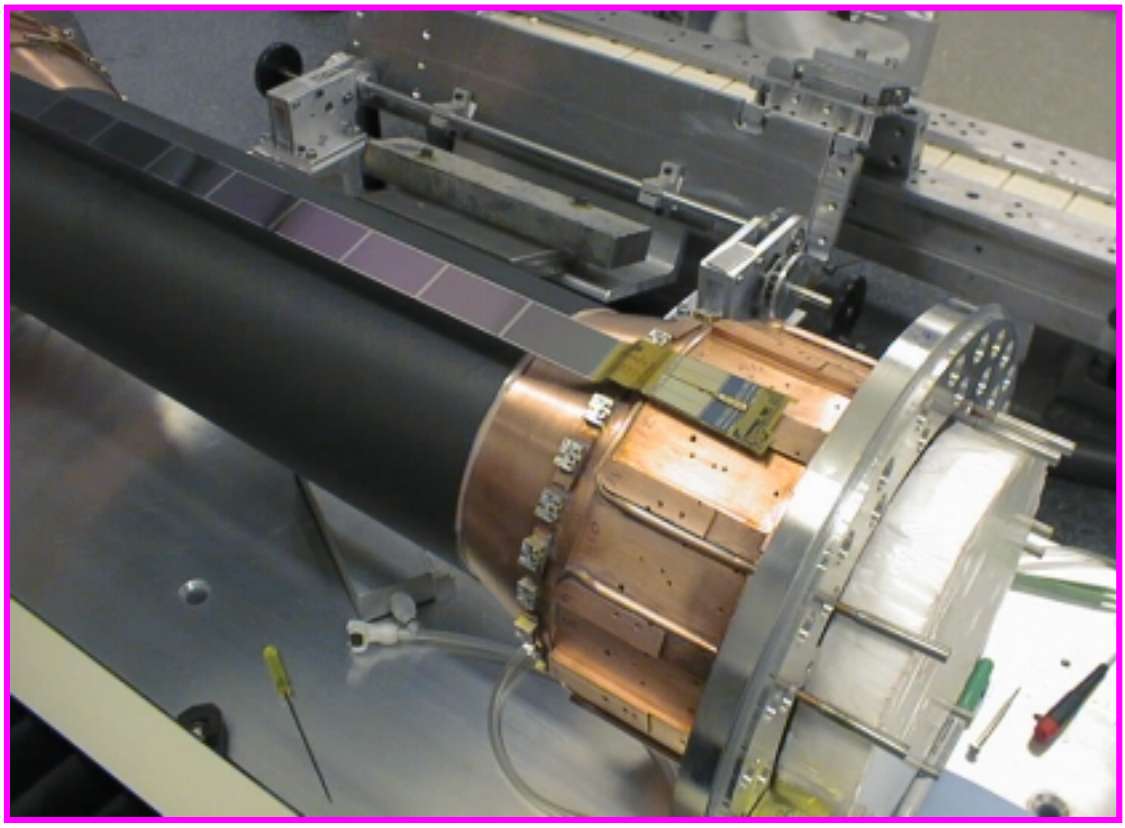
Read Out Electronics



- **Up to 5 silicon sensors daisy-chained to one readout.**
- **Radiation hard (100 kRad)**
- **Very low noise, Viking based Front-End chip.**
- **Back-End chip based on SVX II**
- **BeO Hybrids mounted on copper cones (cooling)**
- **S/N > 15:1 (worst case)**

Vertex Detector Assembly

Layer 4



Layer 3

Detecting Neutral Particles

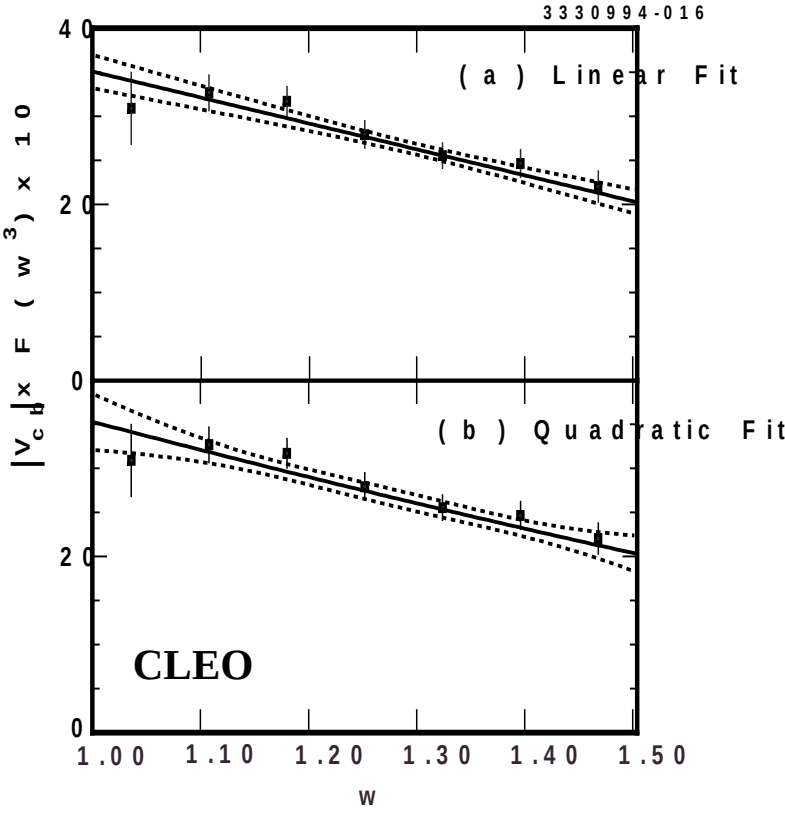
How to measure V_{cb}?

HQET: use B→D*l ν at q^2_{max}

D* at rest (in B frame)

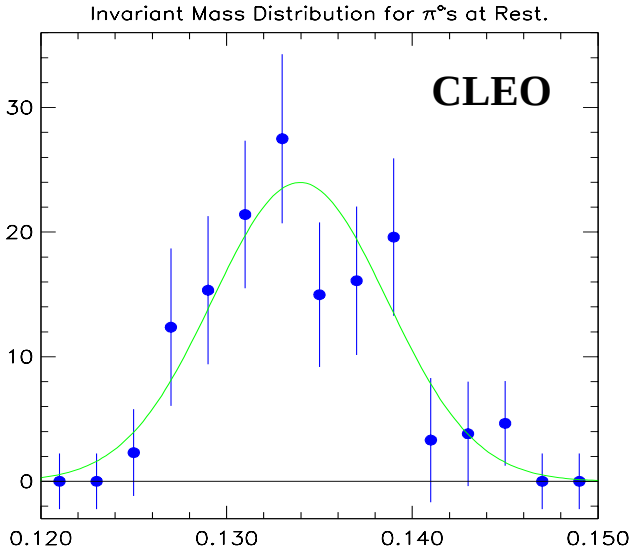
with D*→Dπ and almost no phasespace the π is as rest as well.

How to find a π at rest?



With good resolution (at low energies) and high granularity try:

π^{0}'s

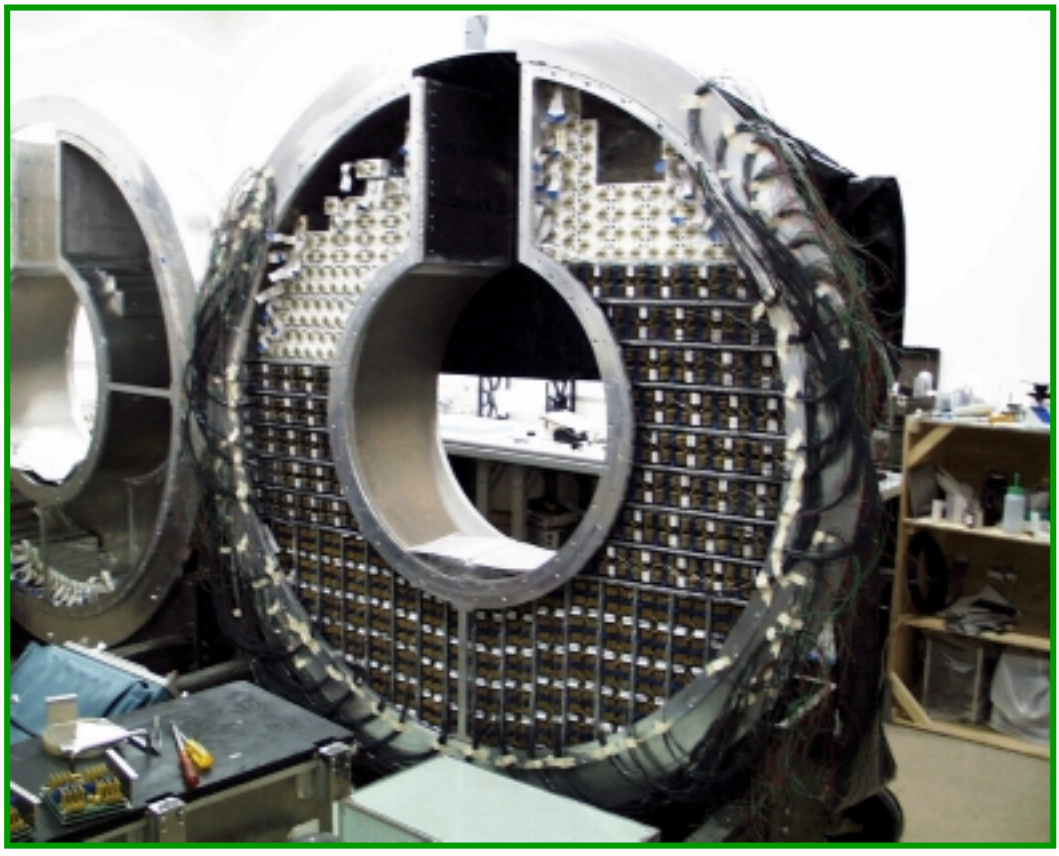


Electromagnetic Calorimeter

- CLEO pioneered use of CsI calorimeter
- 7800 crystals.
- 2% energy resolution at 1 GeV.
- 4 mr angular resolution at 1 GeV.
- no radiation damage observed.
- reduced material in front of endcaps.

↳ All B-Factories use CsI calorimeter

Re-Stacking the Calorimeter Endcap



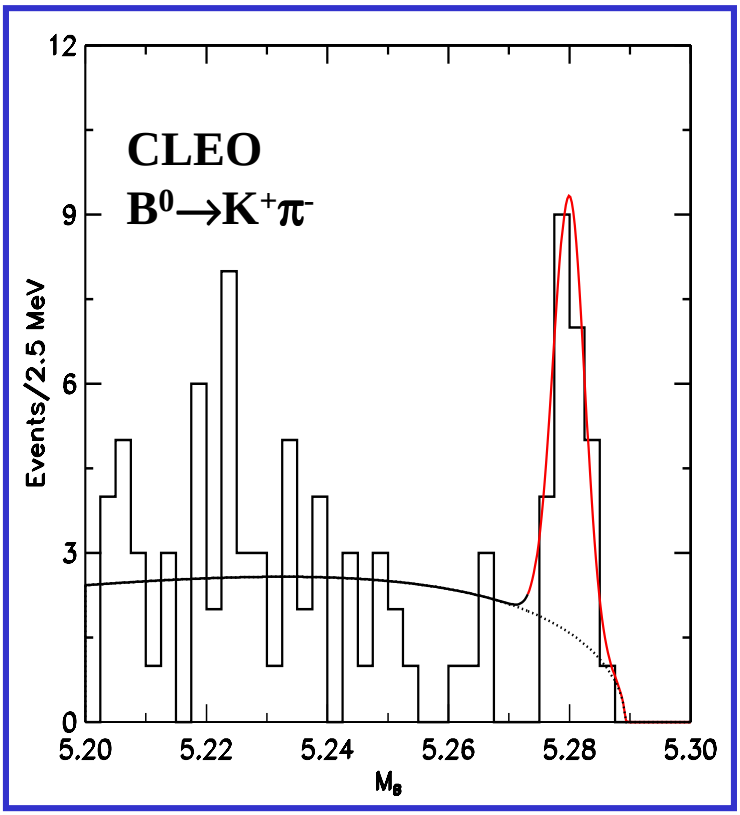
Particle Identification

Search for B → ππ and B → Kπ

- important for CP
- very rare

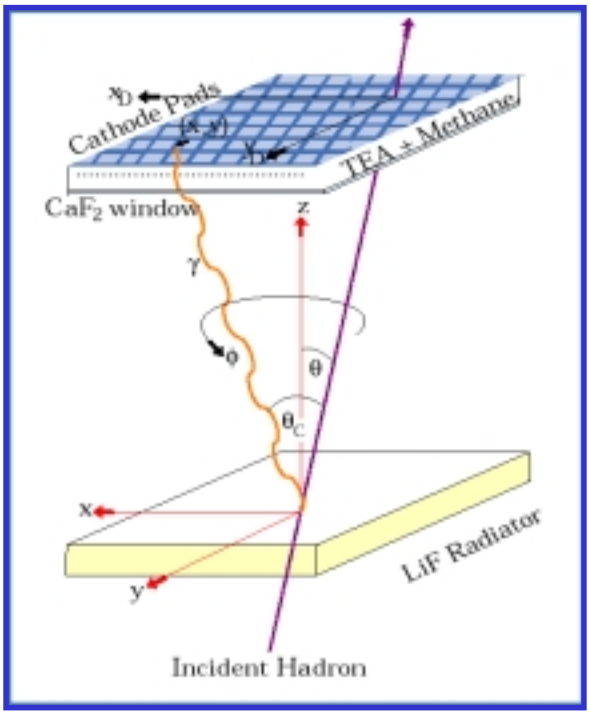
  $B^0 \to K^+\pi^-$ = 1.8 x 10^{-5}

  B → ππ = ?

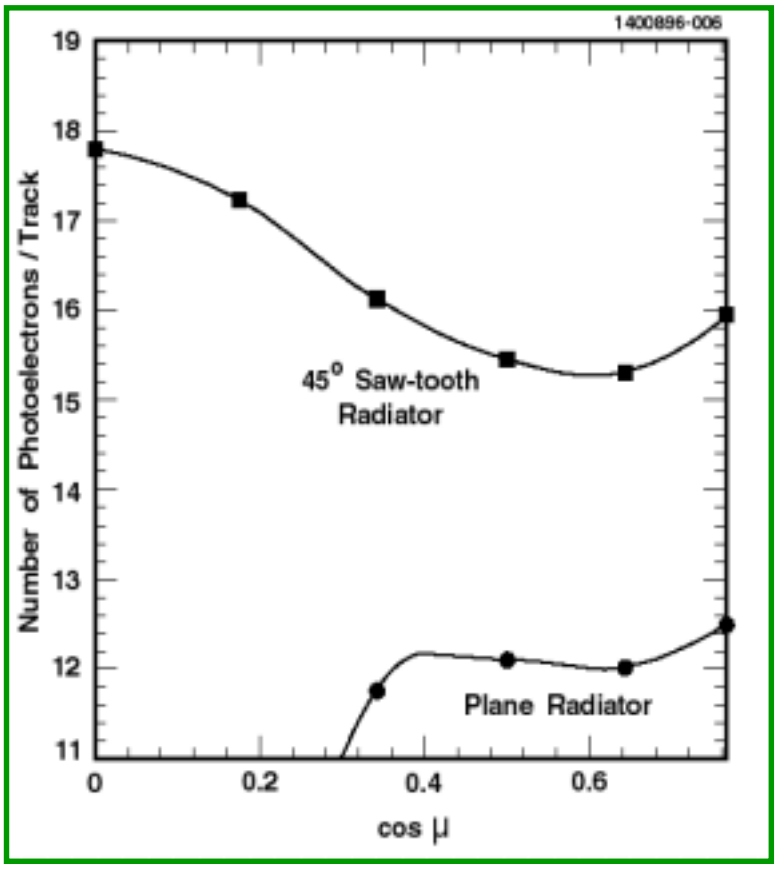


CLEO gets RICH

- 4σ K/π separation at 3 GeV
- LiF radiator, saw tooth + plane
- N_2 expansion volume (16 cm)
- TEA/CH_4 based photo detector
- ~250,000 electronic channels



Particle Identification

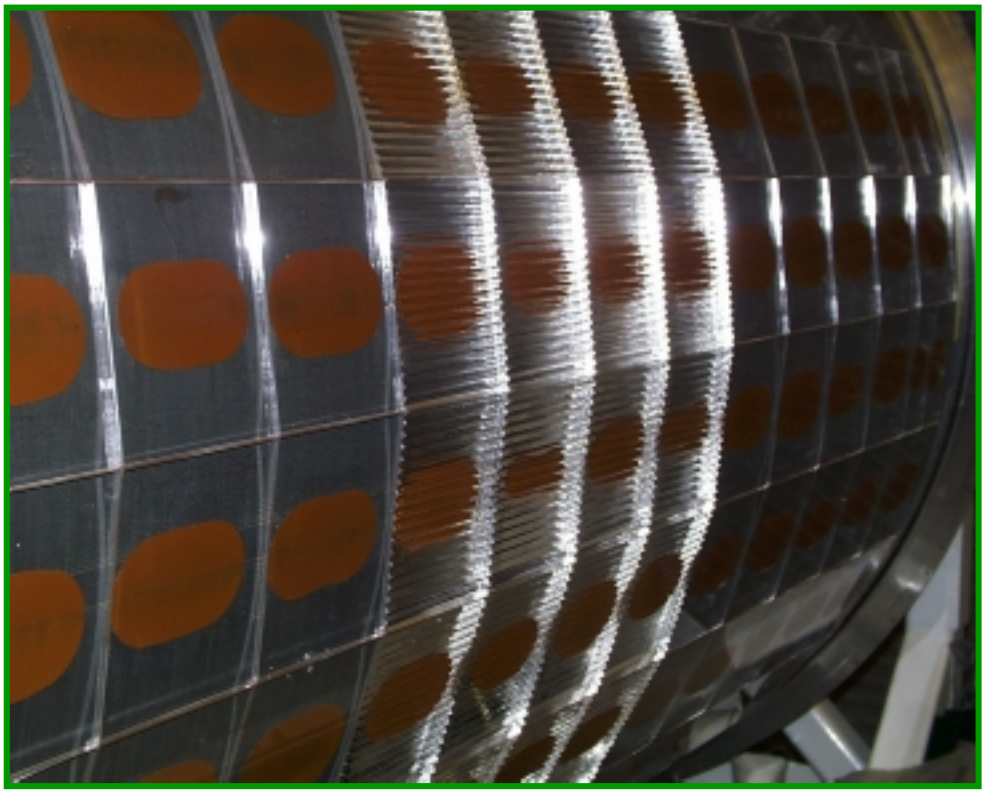


420 LiF radiators

- **300 Plane**
- **120 Saw-tooth**
- **17.5 x 17 x 1 cm^3**

UV transparent

- **135-165 nm**

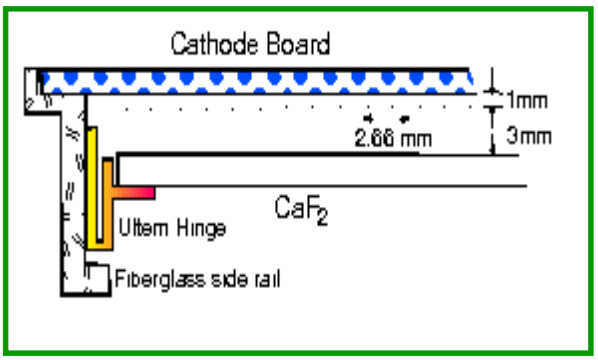


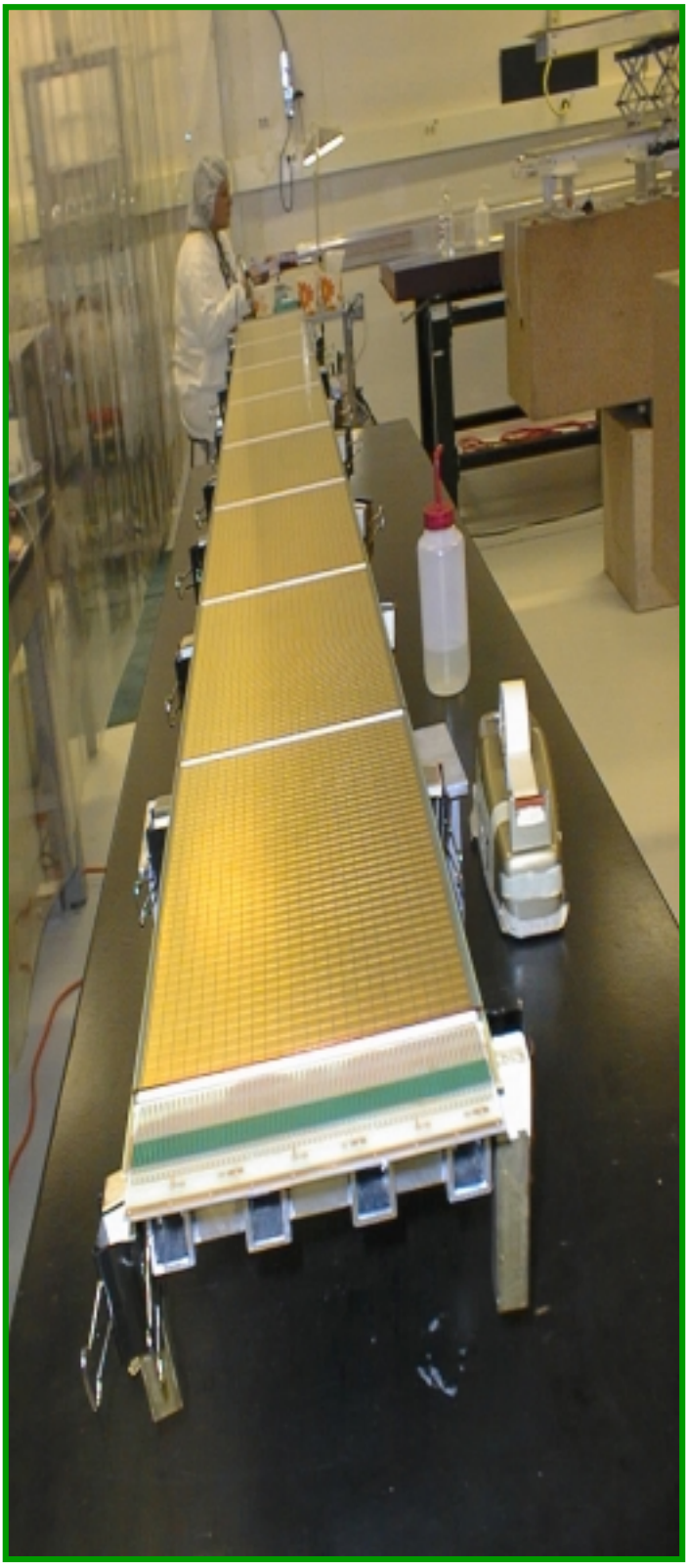
Photon Detection

MWPC + Pad Readout
~230,000 pads
(8 mm x 7.5 mm)
TEA/CH_4
Gas gain ~25,000

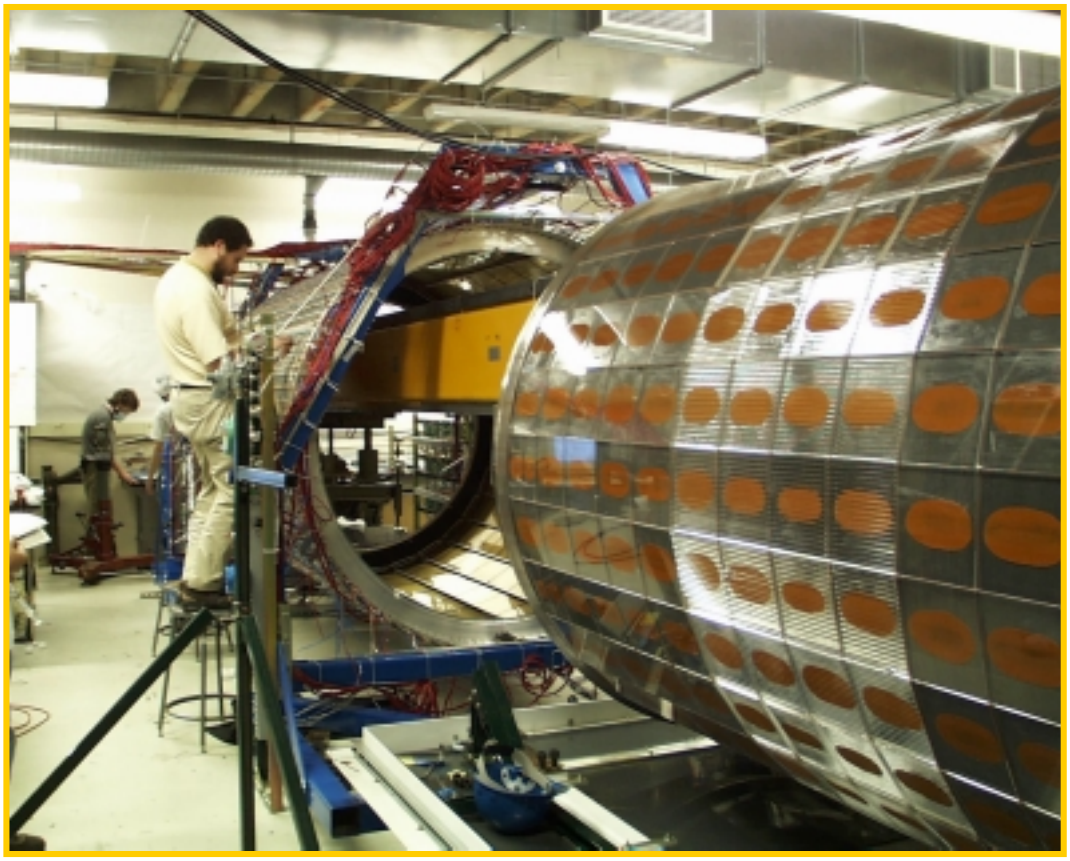
8 CaF windows
100 μm strips, every 2.5 mm
(field shaping)
G10 frame
(and ribs for flatness)

CaF, LiF Transmission ~ 90%

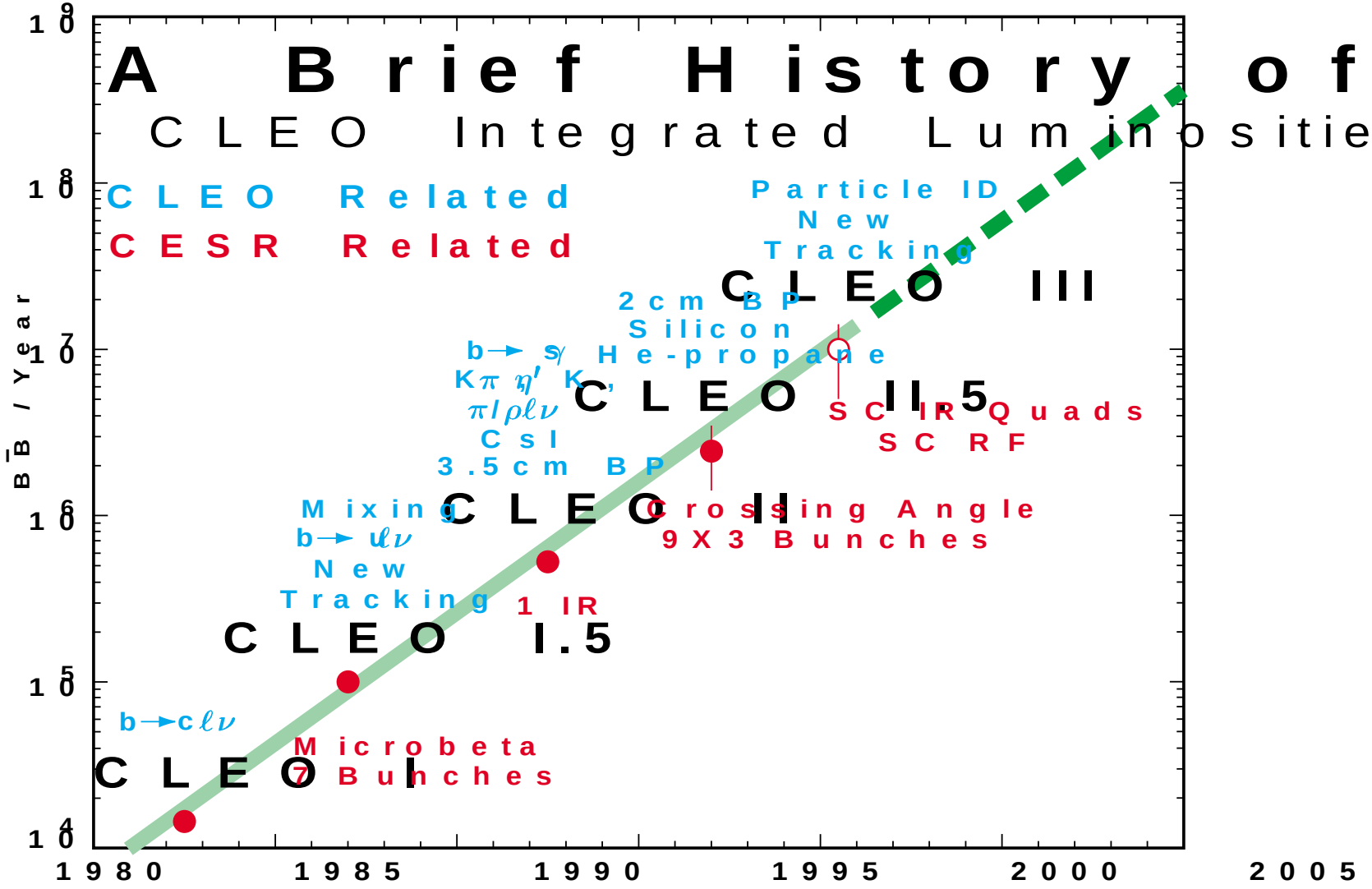




RICH Assembly



Arrival at Wilson Lab


A Brief History of C
CLEO Integrated Luminosities
CLEO Related
CESR Related
Particle ID
New
Tracking
CLEO III
2cm BP
Silicon
b→sγ
He-propane
Kπ η′ K*
πlρℓν
CLEO II.5
SC IR Quads
SC RF
CsI
3.5cm BP
Mixing
CLEO II
Crossing Angle
9X3 Bunches
b→uℓν
New
Tracking
1 IR
CLEO I.5
b→cℓν
Microbeta
CLEO I
7 Bunches
B B̄ / Year
10^9
10^8
10^7
10^6
10^5
10^4
1980
1985
1990
1995
2000
2005