# The GlueX Central Drift Chamber

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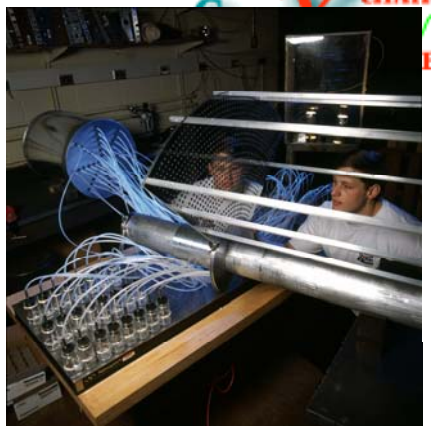
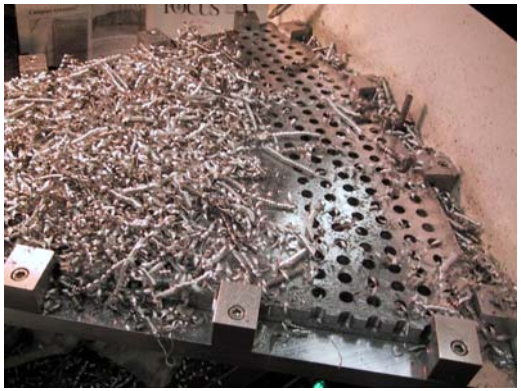
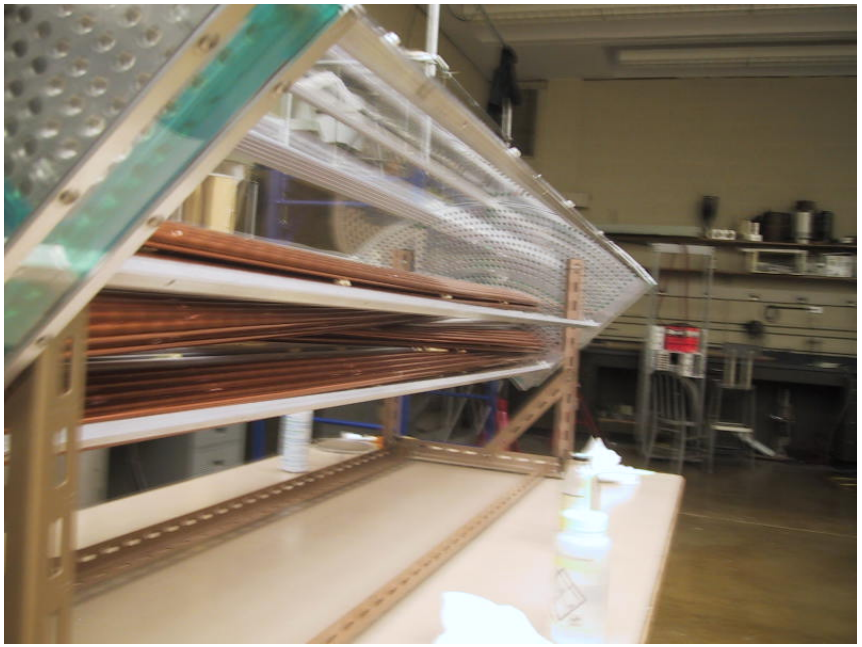
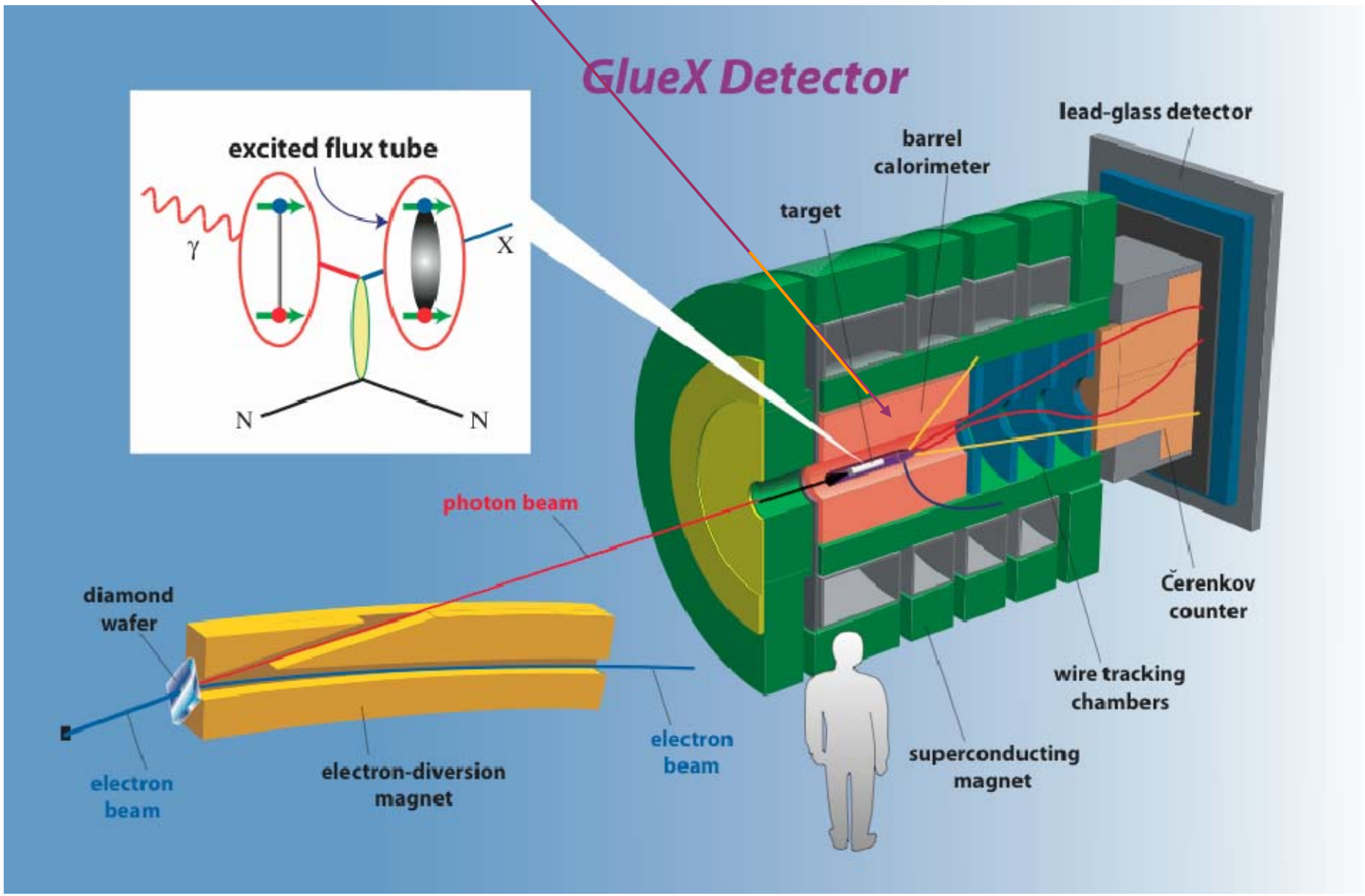






# Outline

# The GlueX Central Drift Chamber



# Physics Requirements

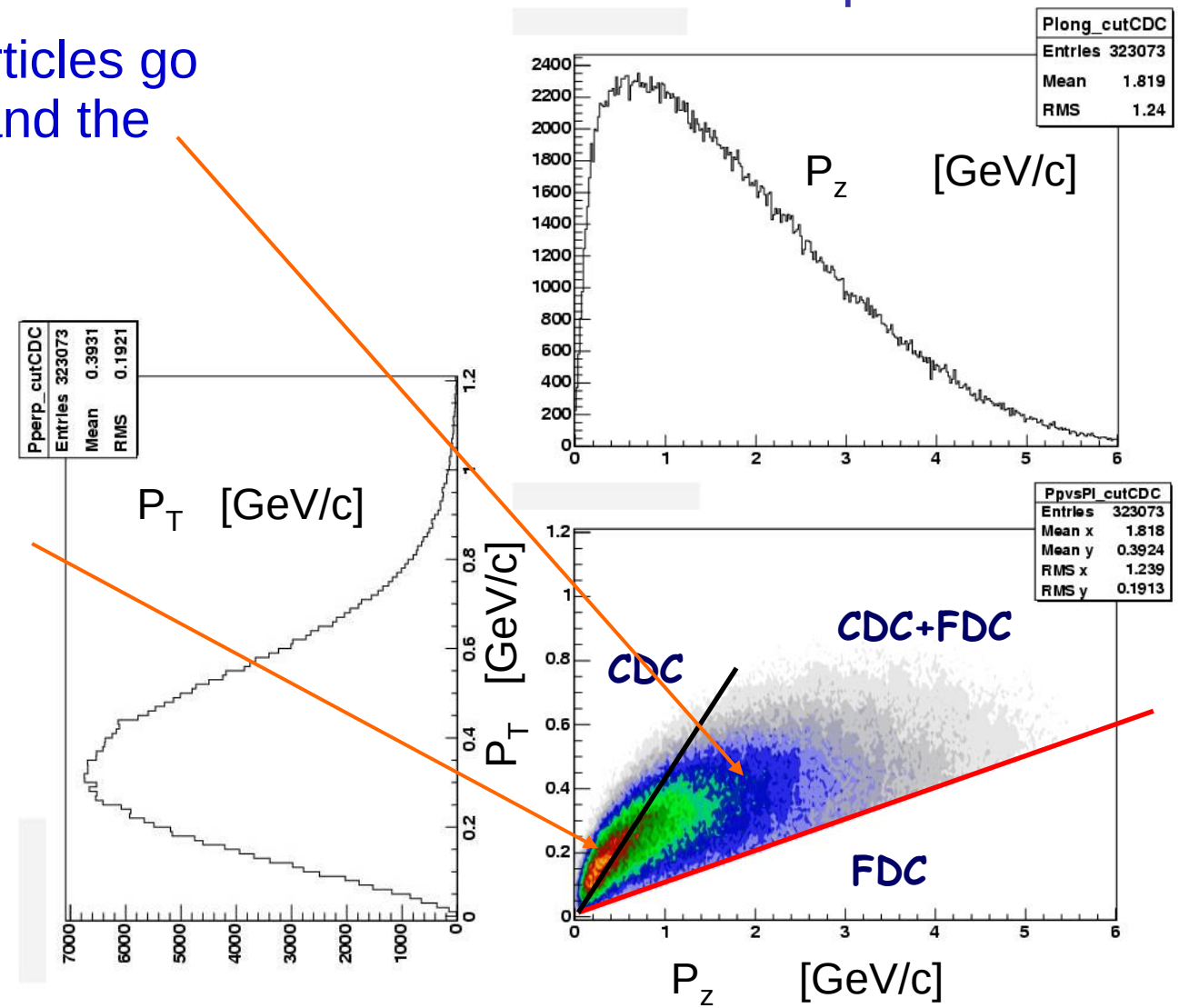
A typical exotic hybrid channel

$\gamma\, p \rightarrow \eta_1(1800)p \rightarrow 2\pi^+ 2\pi^- \pi^o p$

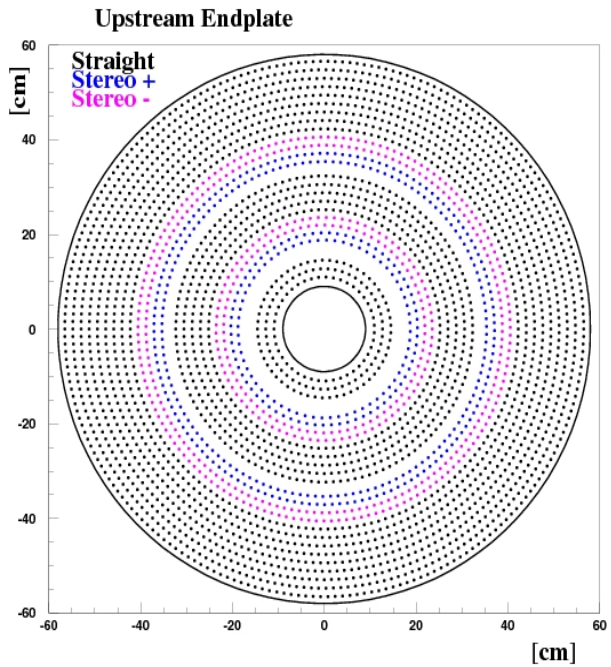
Most of the charged particles go through both the CDC and the FDC.

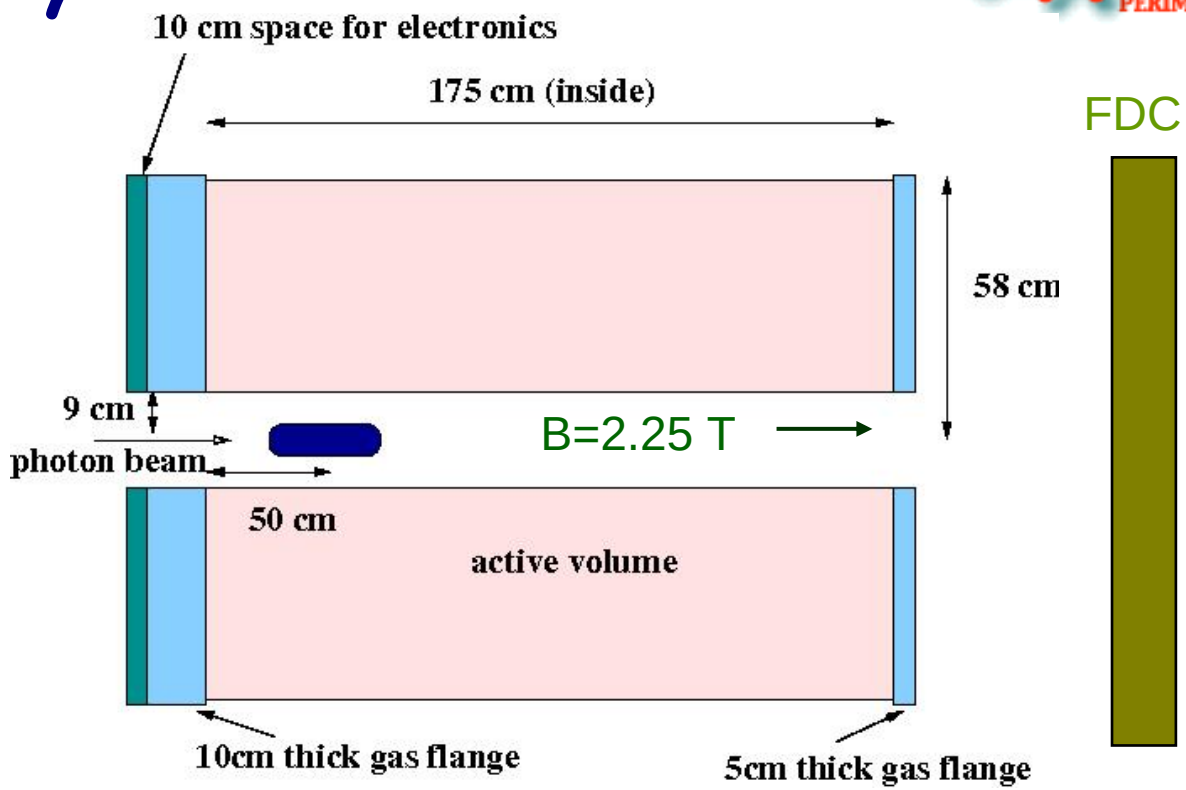
Pions in the CDC alone are typically slower. For slowest ones, dE/dx in the CDC is the only PID.

Momentum of pions

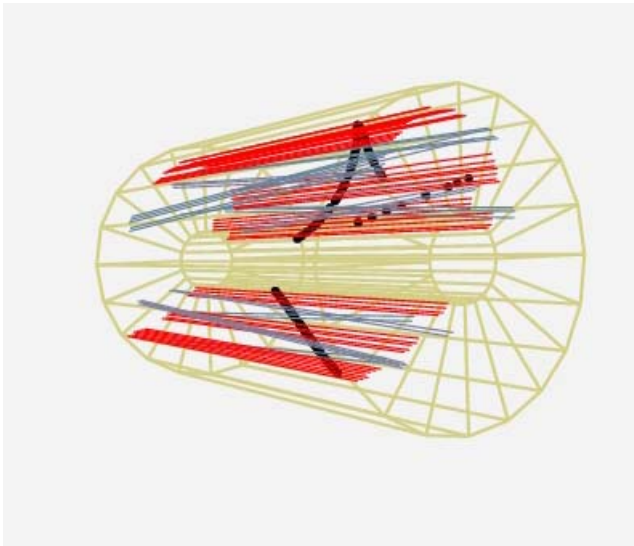


# The CDC Geometry




25 radial layers of tubes
17 straight layers
  4 +6º stereo layers
  4 -6º stereo layers
~3200 channels



3 track in the chamber. Red tubes are straight, blue are stereo.

# Chamber Requirements

To achieve the overall momentum and vertex goals of the experiment, the CDC needs to achieve:

$\sigma_{r\phi} \sim$ 150-200$\mu$m $\sigma_z \sim$ 2mm

Stereo Layers $\sigma_z = \sigma_{r\phi}/\tan(\theta_{st}) \sim 1.4$ mm

Down stream support wall need to be as thin as possible. Most tracks go through the wall into the FDCs.

6 mm Al with Delrin feed throughs

Sweep time should be as short as possible ~600-700ns

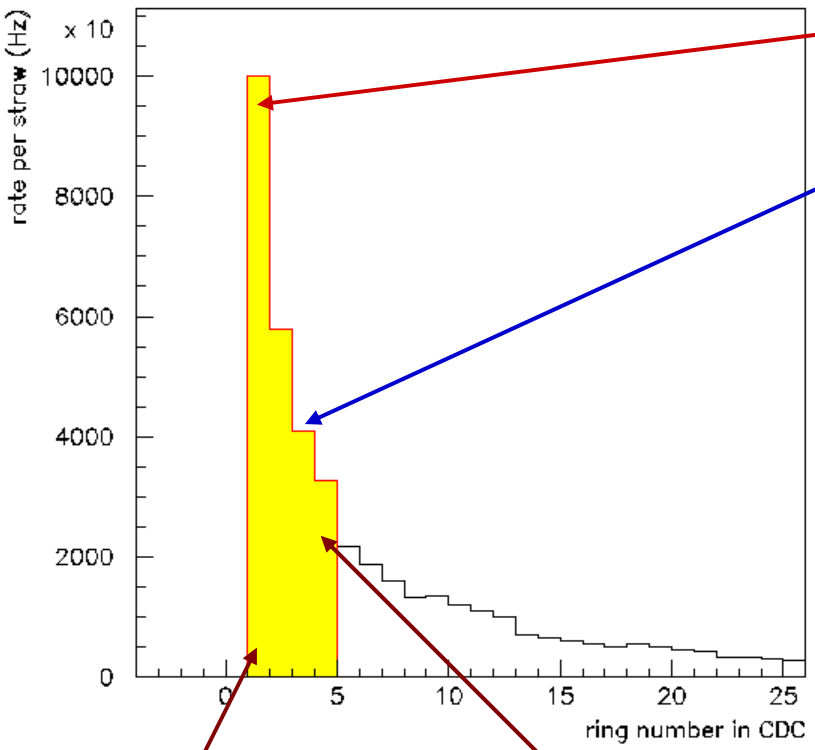
Particle ID using dE/dx for $p \leq 450$ MeV/c (proton/ pion)

Electrostatics need to be very well understood and regular due to the large Lorentz Angle. (Straw Tubes nominally have excellent electrostatics).

# Background Rates

$10^8$ $\gamma$/s on target

Electromagnetic background rates using the GEANT Monte Carlo and the highest beam rate. What is the average rate in a tube at a give radius (from the beam line)?




6 cm (tube radius) 12 cm

100 KHz per straw tube at 6 cm radius

40 KHz per straw at 10.5 cm radius

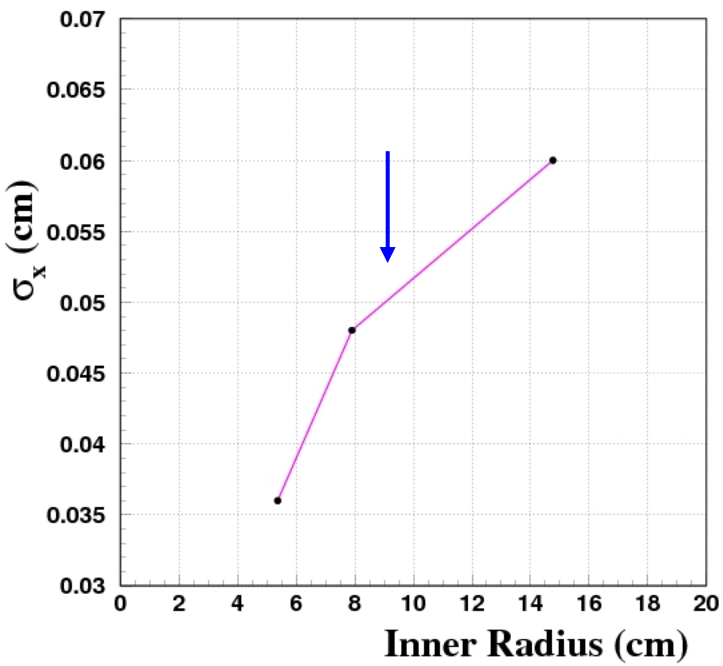
The radius of the innermost layer of tubes is limited by background rates.

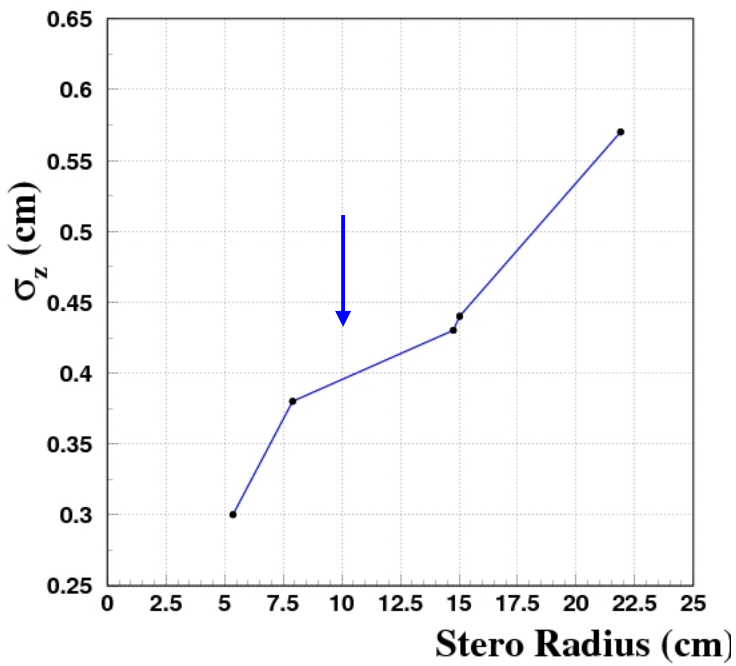
But, this is not an issue for the designs being considered.

# Vertex Resolution

Because of the z resolution is about ten times the x-y resolution, the z vertex will be less well defined. Nominally, z is driven by the radius of the stereo layers in the chamber.

Current Design Values: $r_{min}$ =10 cm $r_{stereo}$ =15 cm



# Chamber Geometry

After detector review, did a vertex study. Indicated that the layers should be shifted closer to the beam line and the stereo layers brought in. This leads to better vertex resolution.

However, the background rates increase rapidly (in a long tube) as the tube is brought in.

We also found that we could shorten the CDC from 2m (active) to 1.75m (active) and give the space to the FDC for better lever arm.

| | |
|---|---|
| Active Length: | 175cm |
| Radius of inner layer | ~10cm |
| Radius of outer layer | ~58cm |

Layers = 25 with about 3200 wires

A possibility which we still need to explore:

Loose charge division to help pattern recognition.

# Resolution

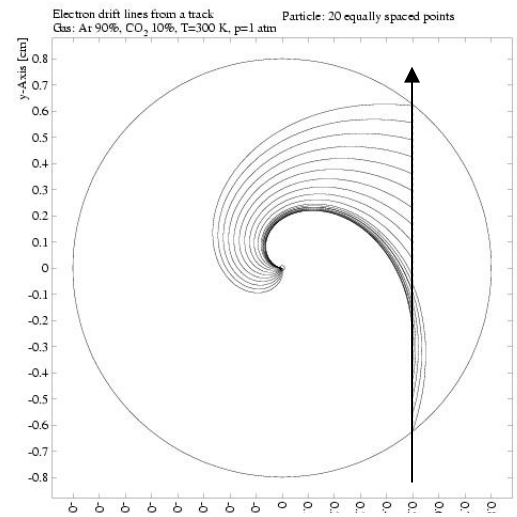
Contributions to Resolution

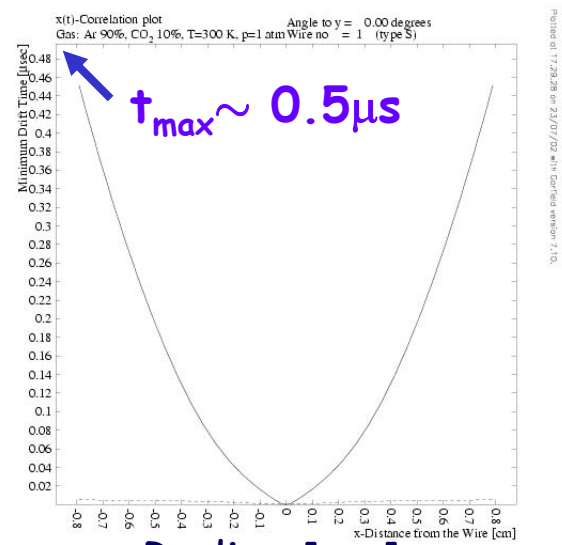
| | | |
|---|---|---|
| Geometrical Precision | 40μm | |
| Gravitational Sag | 56μm | |
| Timing Resolution | 45μm | (2-3 ns) |
| Electrostatic Deflection | 10μm | |
| Gas Diffusion | 120μm | |
| Total | ~ 145μm | |

We have a gas mixture that should work, but we would like to optimize this .

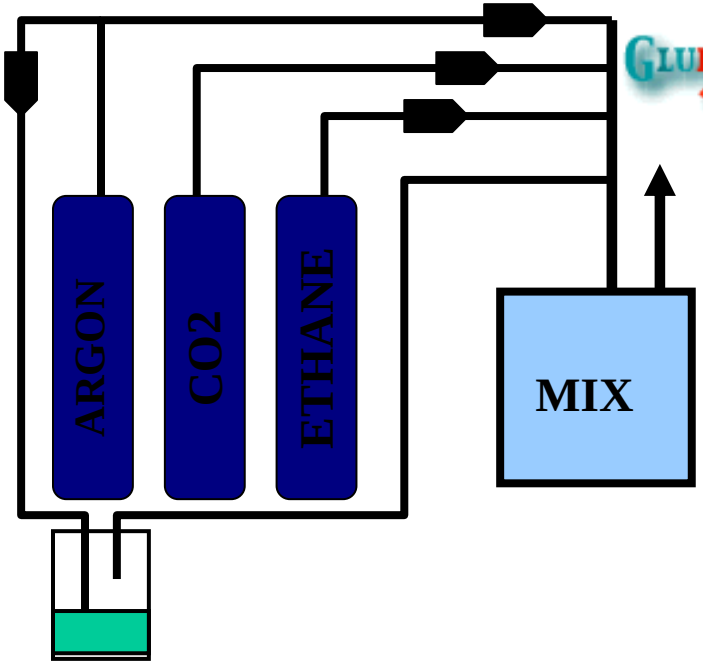
Would like to use the same gas in both the FDC and the CDC.

90-10 Ar-$CO_2$



# Gas Mixing System




Electronic Mass Flow

Mix 3 Gasses
Bubble one through
temp. controlled. liquid.

All gasses filtered

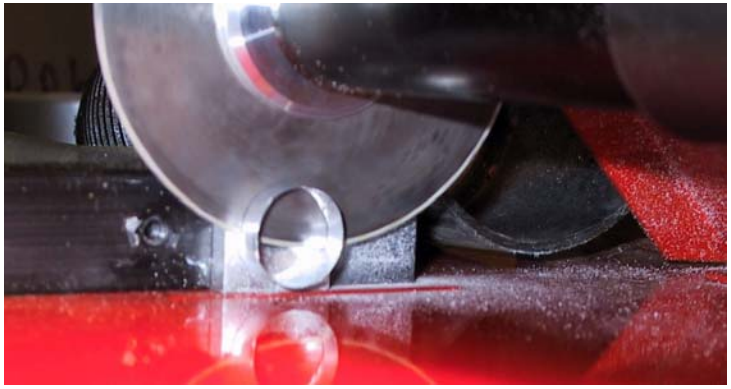
Ethane Alarmed

Shut off Ethane at 10%
of explosive level

# Stringing The Chamber

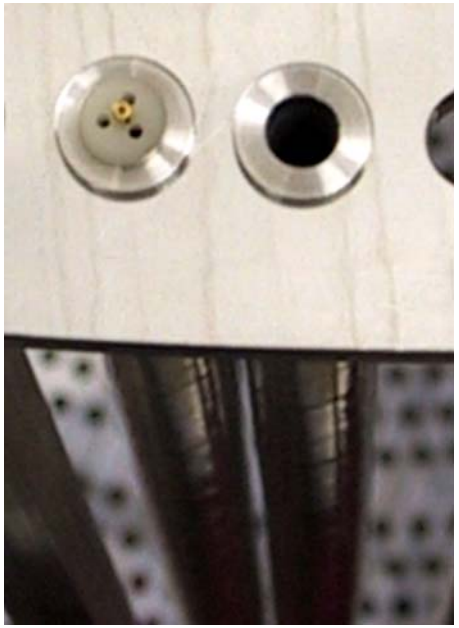
Select tube

Cut to length

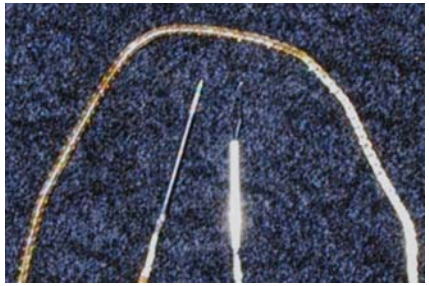


Glue donut

Glue in chamber



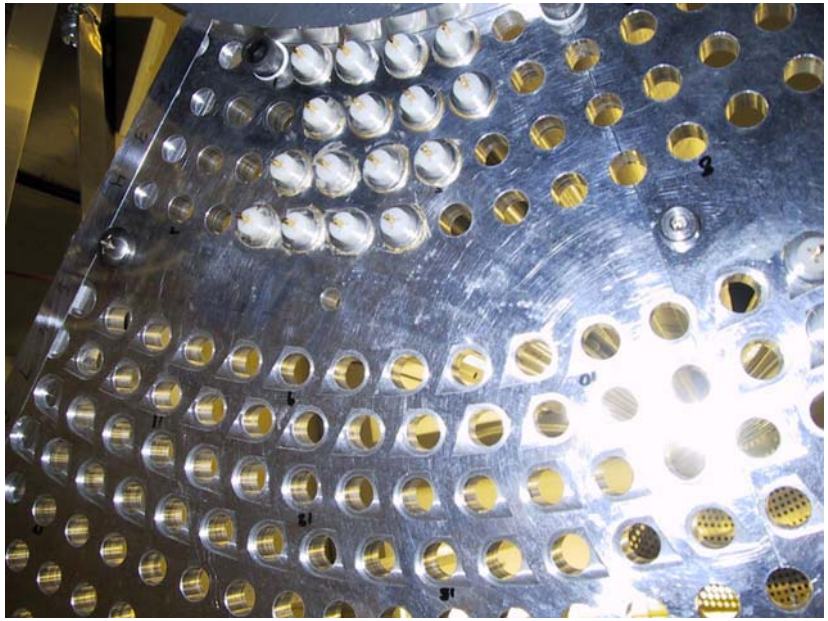
Magnetic Feeds



Pneumatic crimper

Vertical stringing

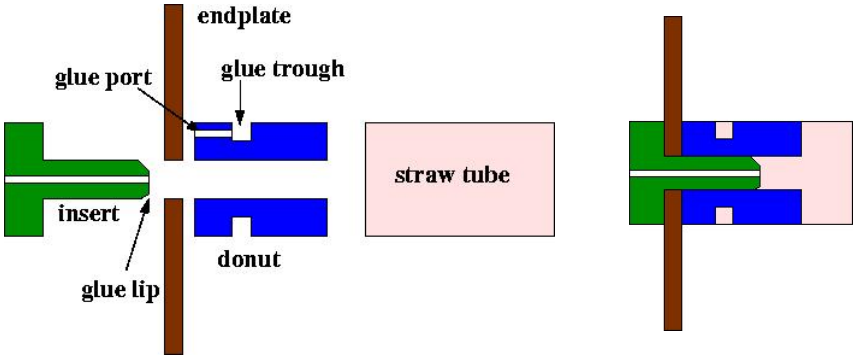
# Prototype Construction



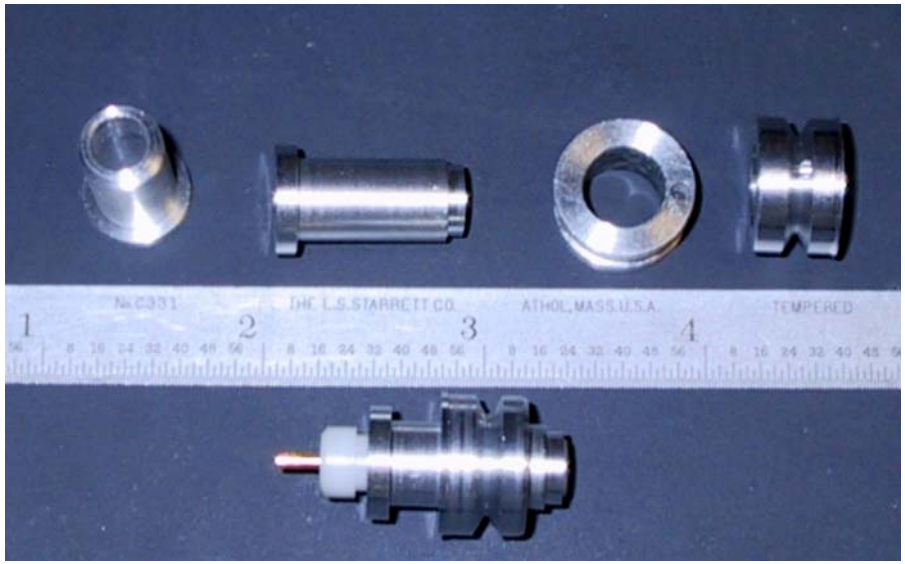
# Gas Leaks

A problem with straw tube chambers is that the glue joints leak.

Designed, built and tested a feed through system that forms a solid glue seal.




System has held several psi overpressure for nearly a year.

# Building the Final Chamber

Machine Endplates in industry
Acquire Shells
Machine Al and Delrin Donuts
Acquire Crimp pins
Acquire Straw tubes
Acquire Wire

} Parts need to be spec'd, ordered and checked.

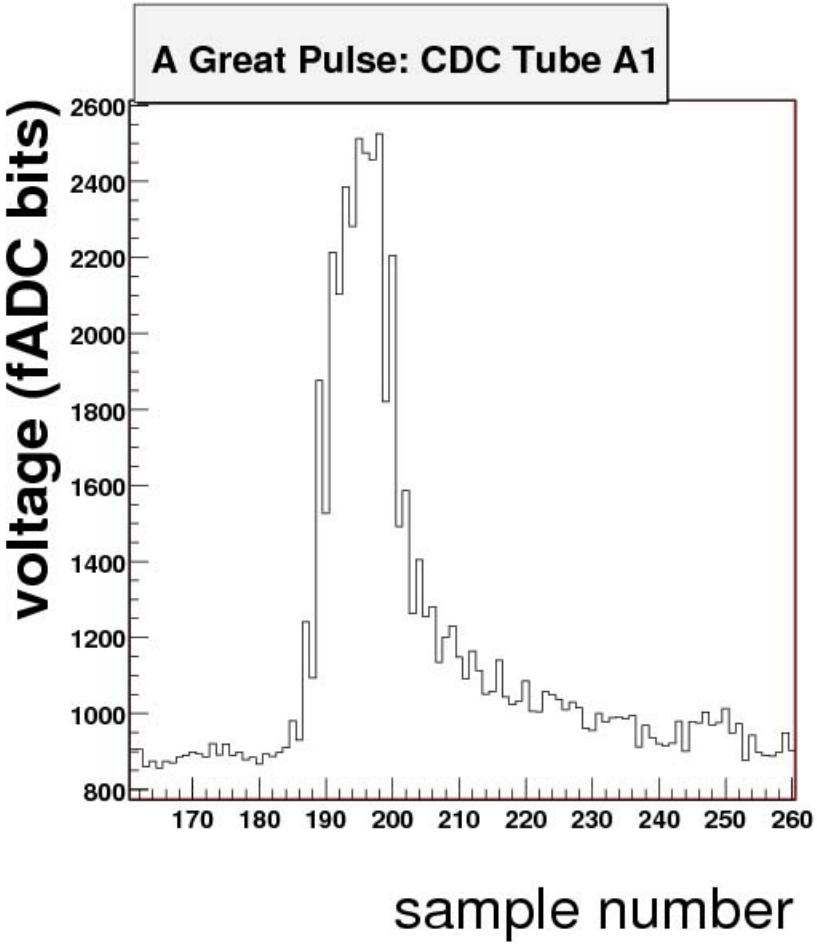
Tube building takes about 15 minutes per tube (1 person)

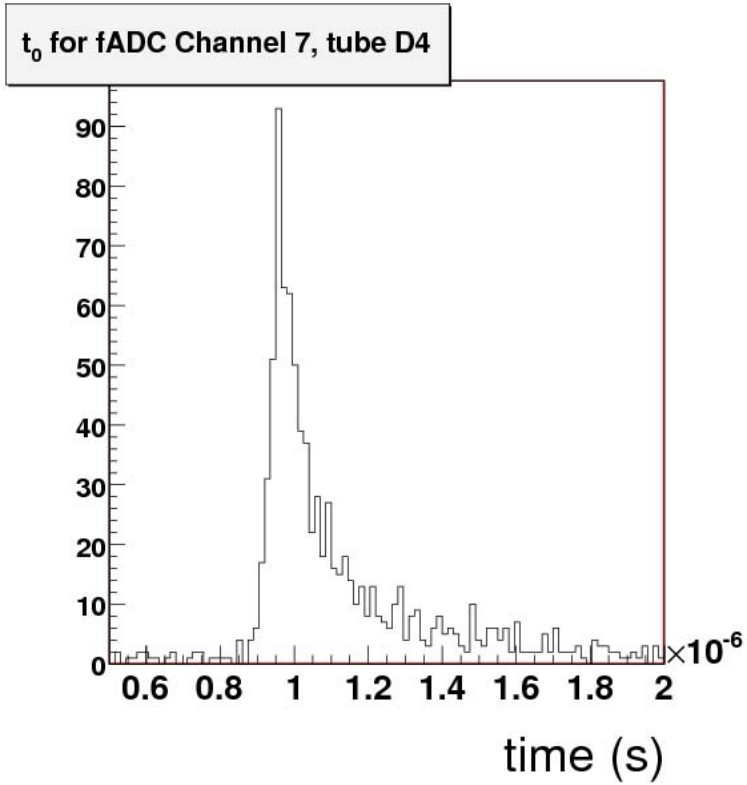
Tube installation takes about 15 minutes per tube (2 people)

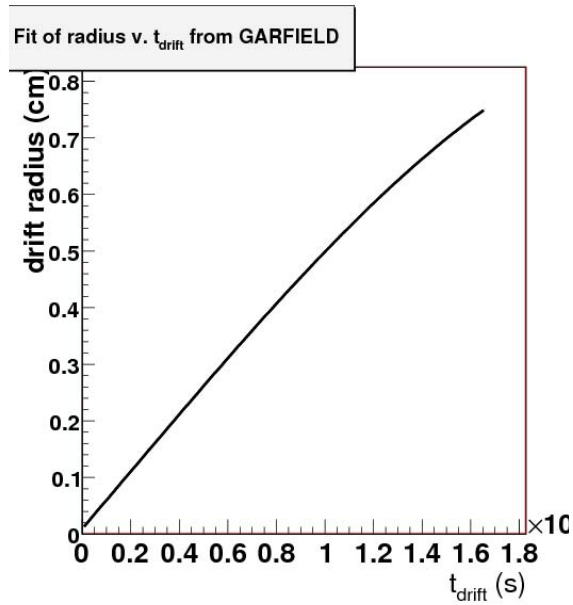
Tube stringing takes about 15 minutes per tube (2 people)

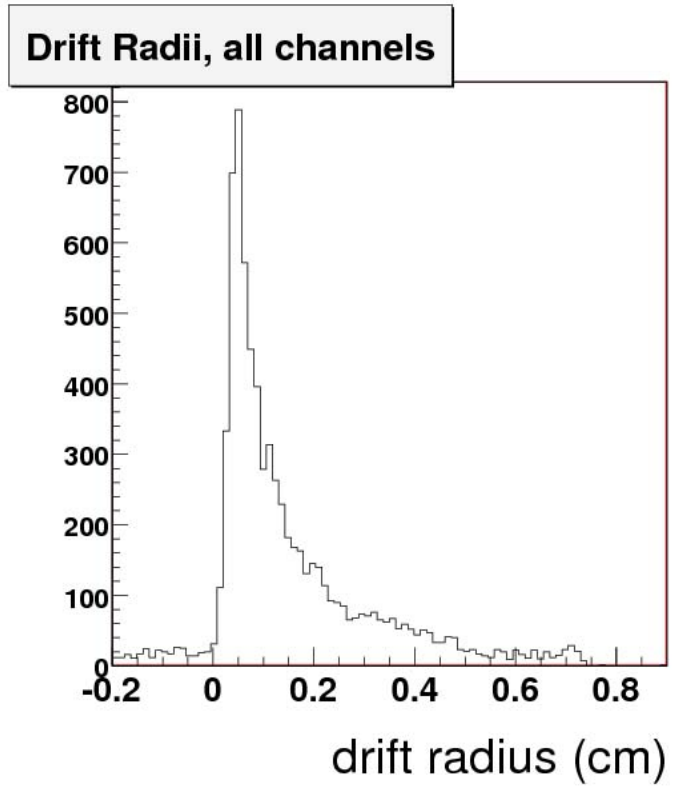
Electrical and gas hookup times are still not definitive.

3 to 3.5 year to build the final chamber


A Great Pulse: CDC Tube A1
voltage (fADC bits)
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
170
180
190
200
210
220
230
240
250
260
sample number

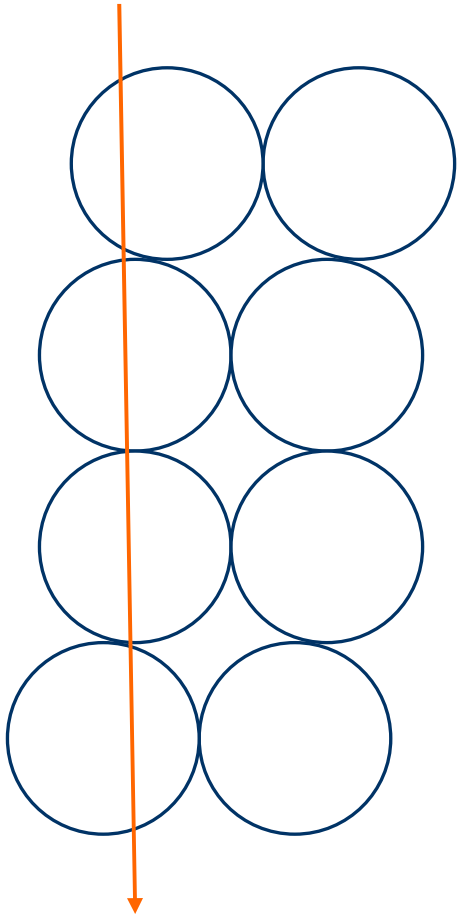

$t_0$ for fADC Channel 7, tube D4
90
80
70
60
50
40
30
20
10
0
0.6 0.8 1 1.2 1.4 1.6 1.8 2
$\times 10^{-6}$
time (s)

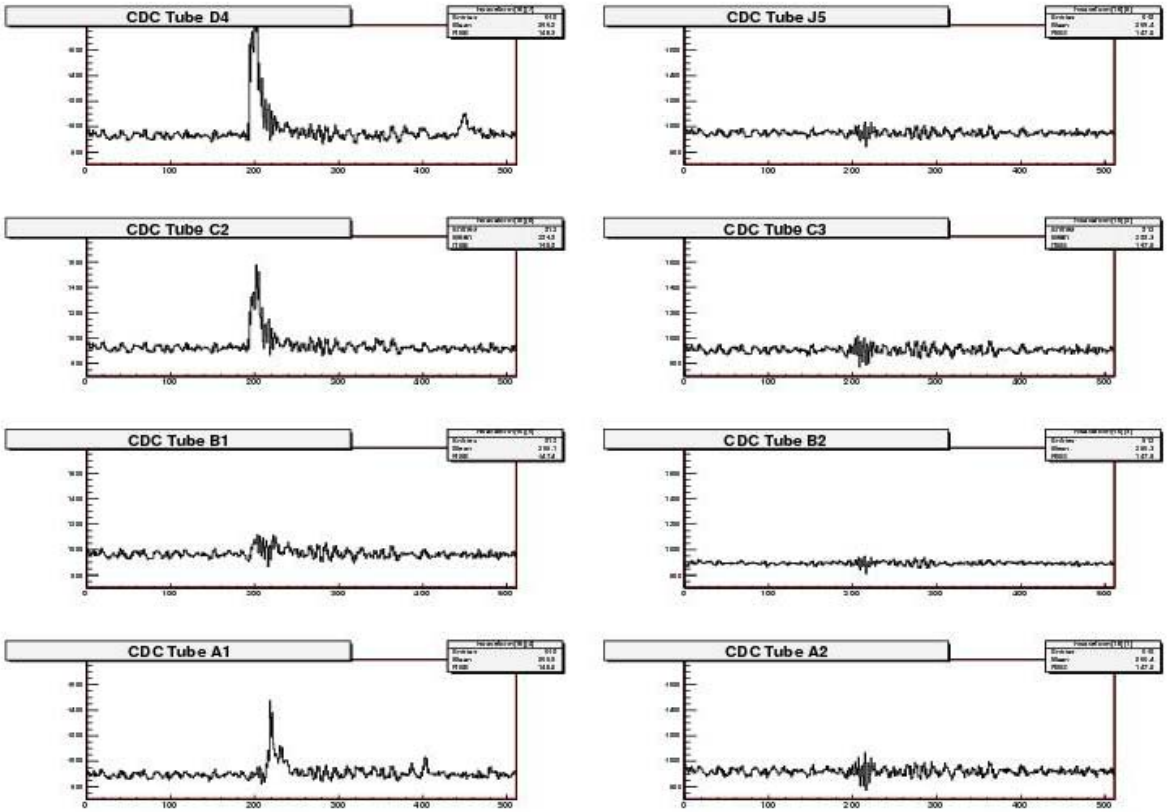

Fit of radius v. $t_{drift}$ from GARFIELD
drift radius (cm)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8
$t_{drift}$ (s)

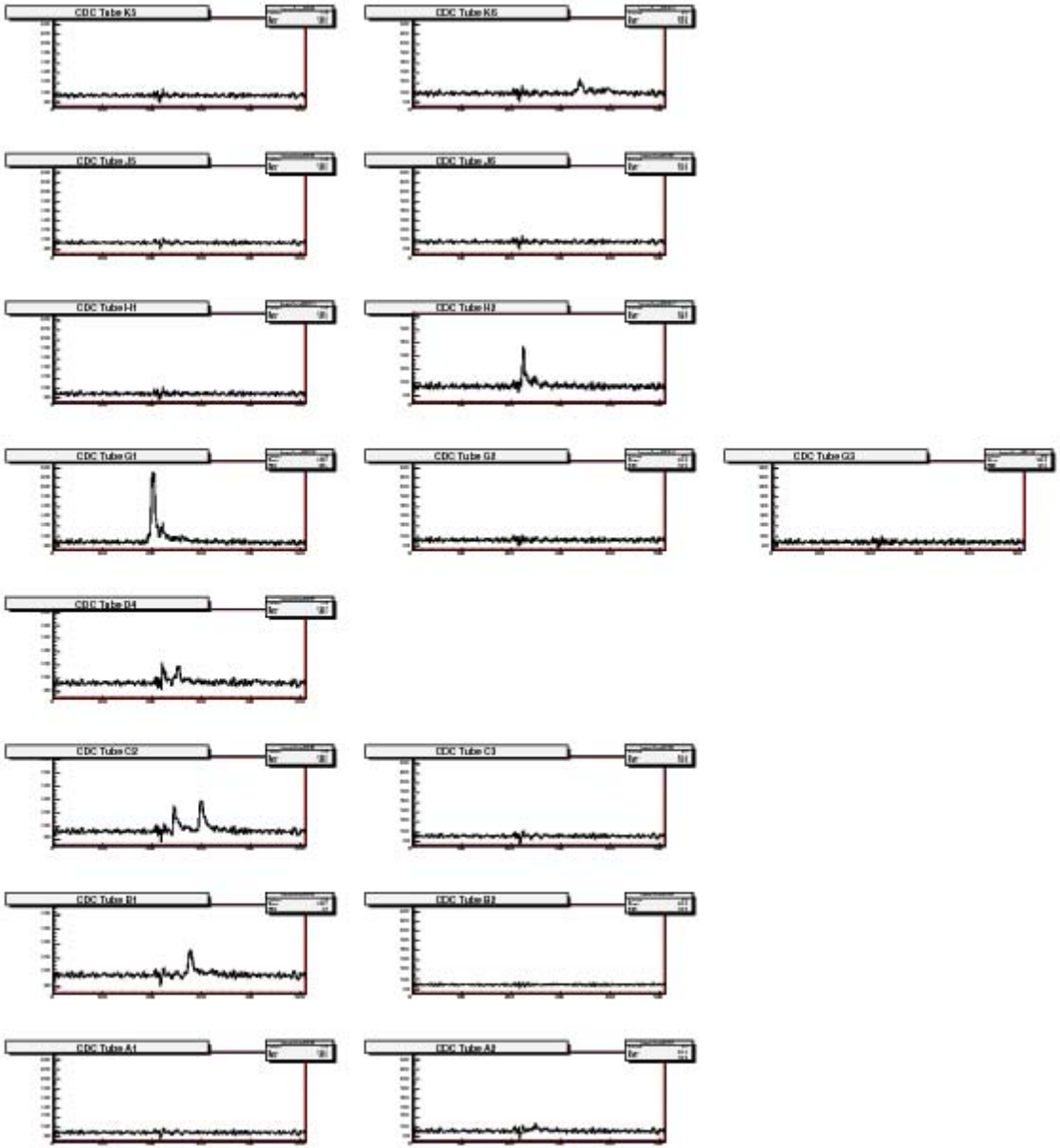

Drift Radii, all channels
800
700
600
500
400
300
200
100
0
-0.2 0 0.2 0.4 0.6 0.8
drift radius (cm)

# Cosmic Rays

Currently setup with 16 instrumented tubes. This is from a case where we had eight tubes instrumented.



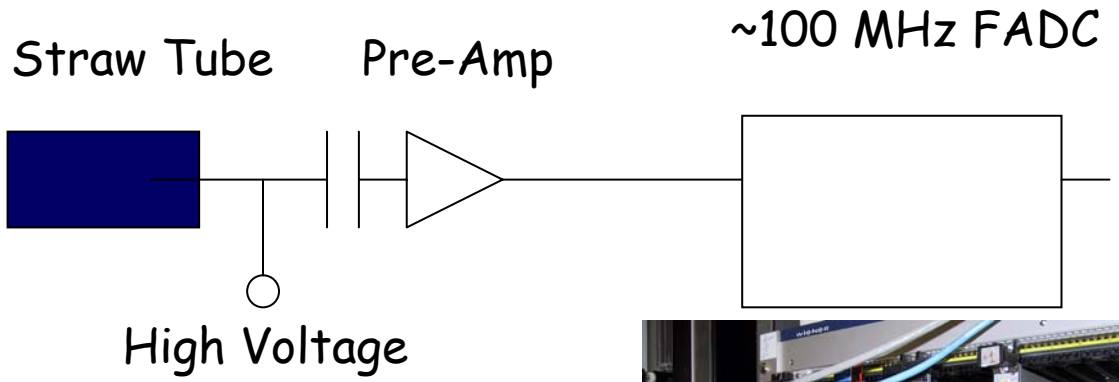


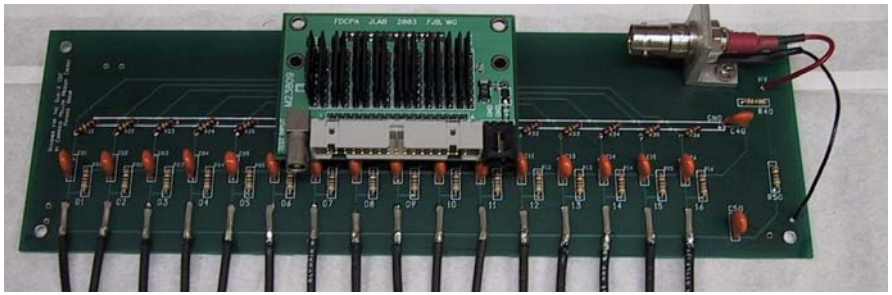

CDC Tube K5
CDC Tube K6
CDC Tube J5
CDC Tube J6
CDC Tube H1
CDC Tube H2
CDC Tube G1
CDC Tube G2
CDC Tube G3
CDC Tube D4
CDC Tube C2
CDC Tube C3
CDC Tube B1
CDC Tube B2
CDC Tube A1
CDC Tube A2

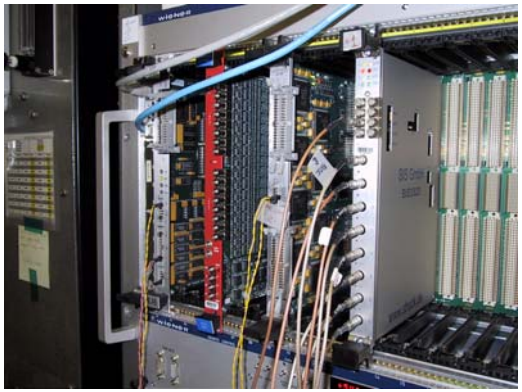
# Electronics

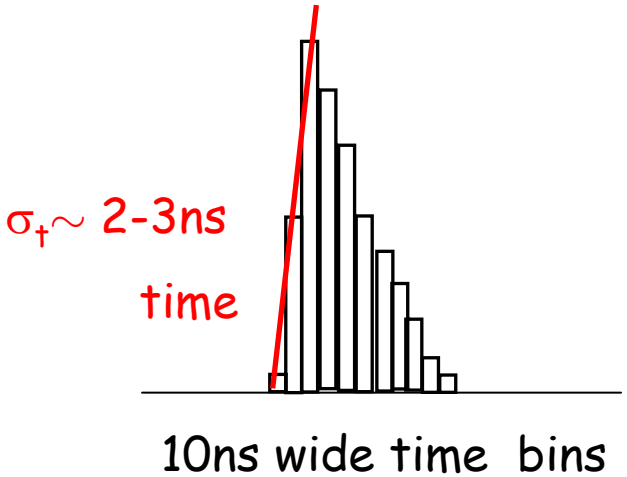
FADC: JLab/IU

Preamp: Alberta/JLab



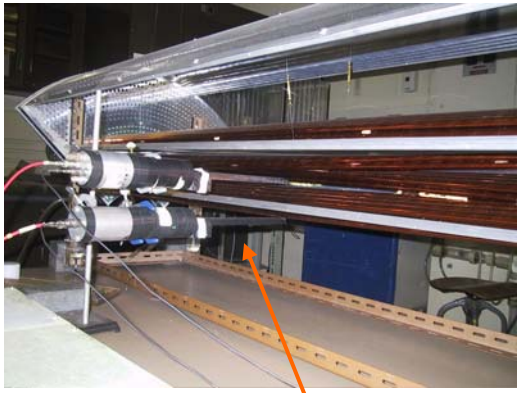




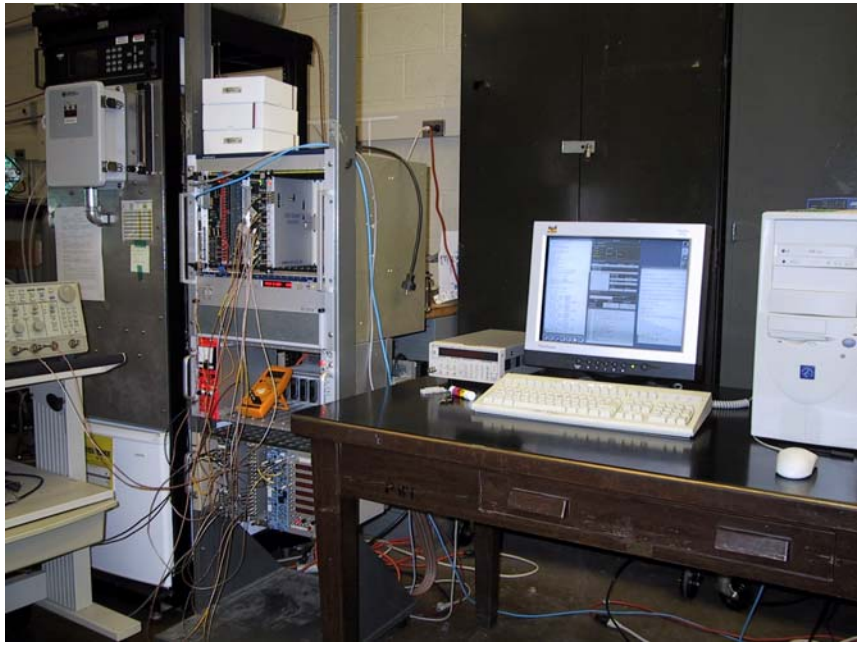

ADC yields dE/dx information

JETSET: NIM **A367**, 248 (1995)
dE/dx at 10% resolution in straw tubes.

# Data Acquisition System



Trigger Scintilators



Insert details of system.

200 MHz FADC
(Expect that ~100 MHz
will work. Can simulate it
with the 200 MHz system).

# Cosmic Ray Tests

Add plots of time zero calculations.

Add plot of time-to-distance relation

Add plot of “radius” of hit.

Discussion of reconstruction algorithem

# Building the Chamber

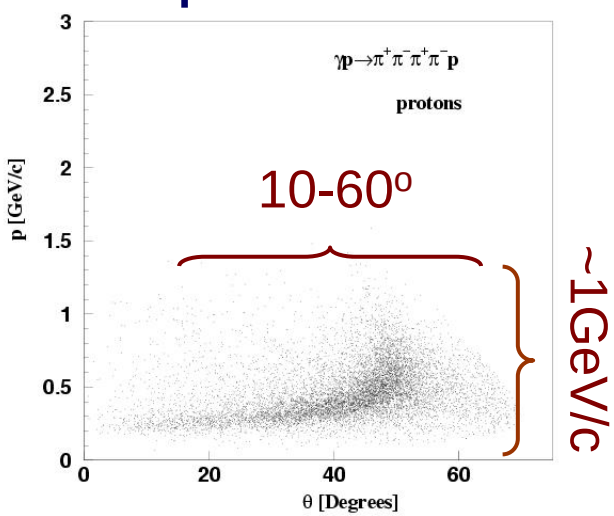
# Physics Requirements

99% Charged particle acceptance
98% Photon acceptance

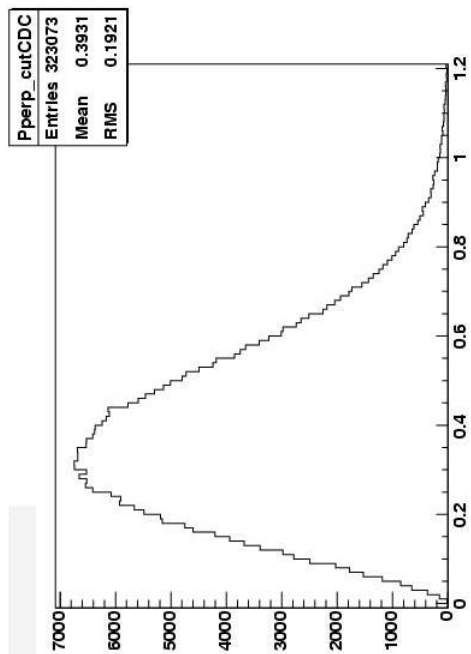
Momentum of tracks in the CDC

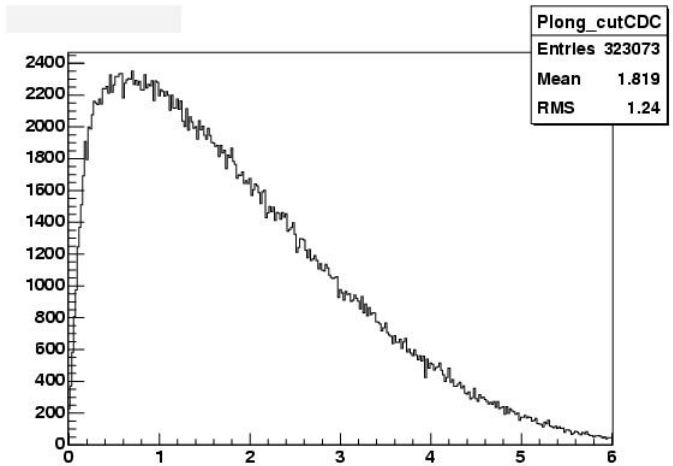
$\gamma\, p \rightarrow \eta_1(1800)p \rightarrow 2\pi^+ 2\pi^- \pi^\circ p$

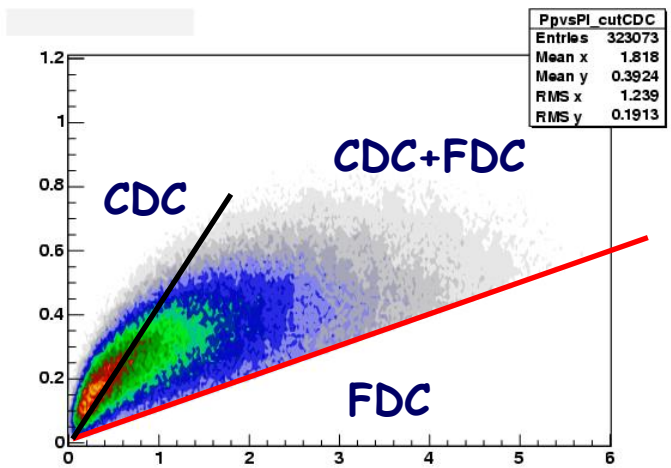
protons




pions



# Simulations