The GlueX Central Drift Chamber

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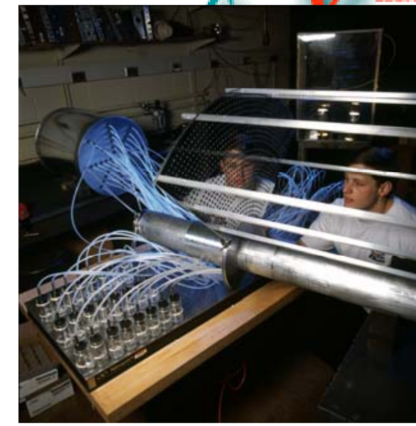
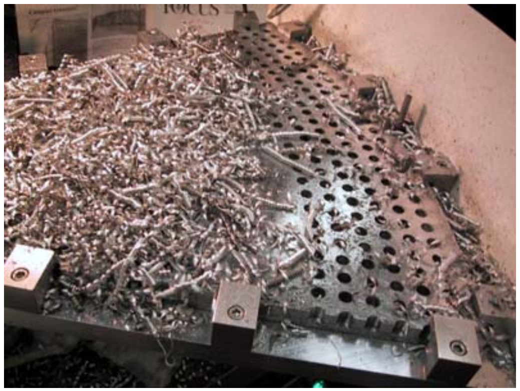
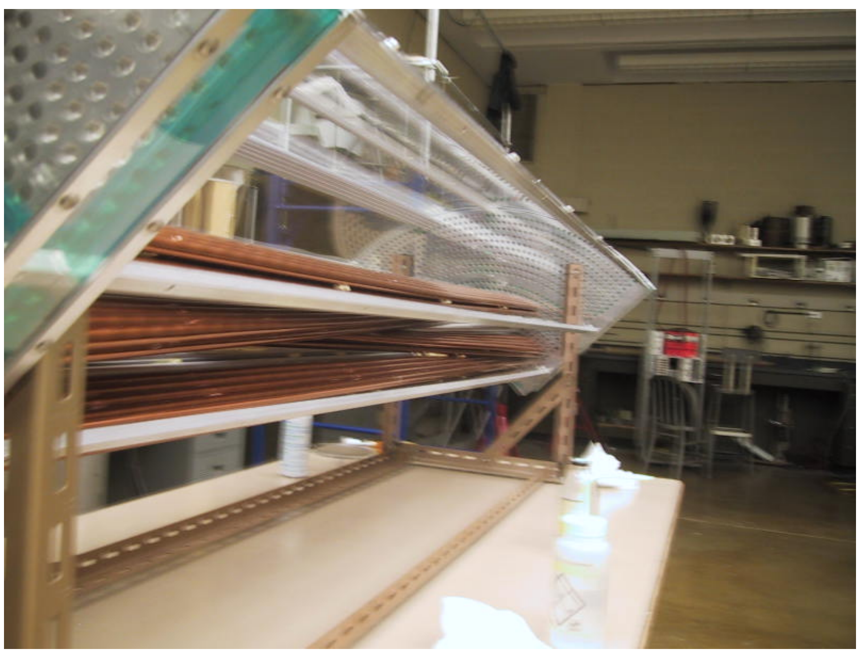
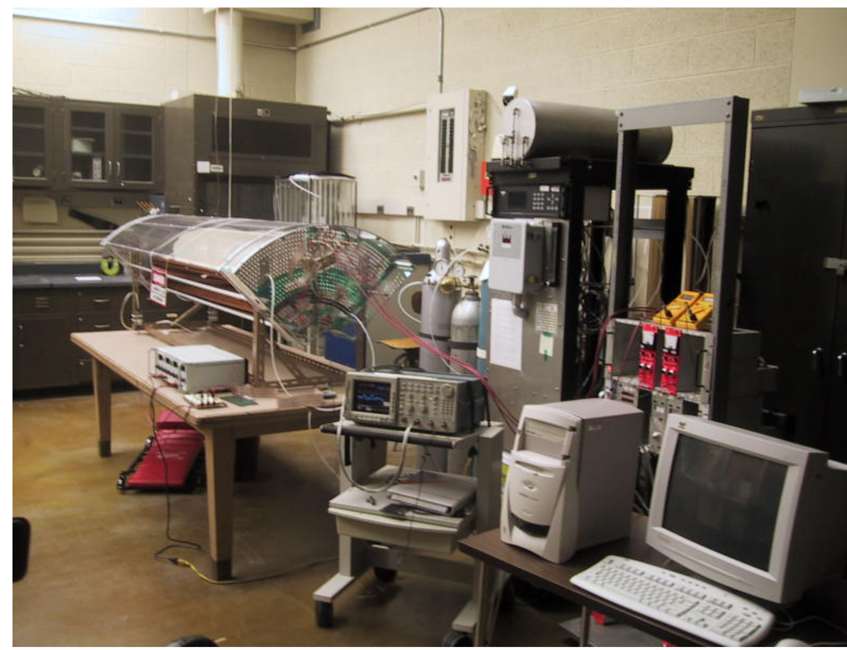








Outline

Physics requirements for the CDC

The geometry and layout of the CDC

Resolutions & Backgrounds

Installation/Alignment

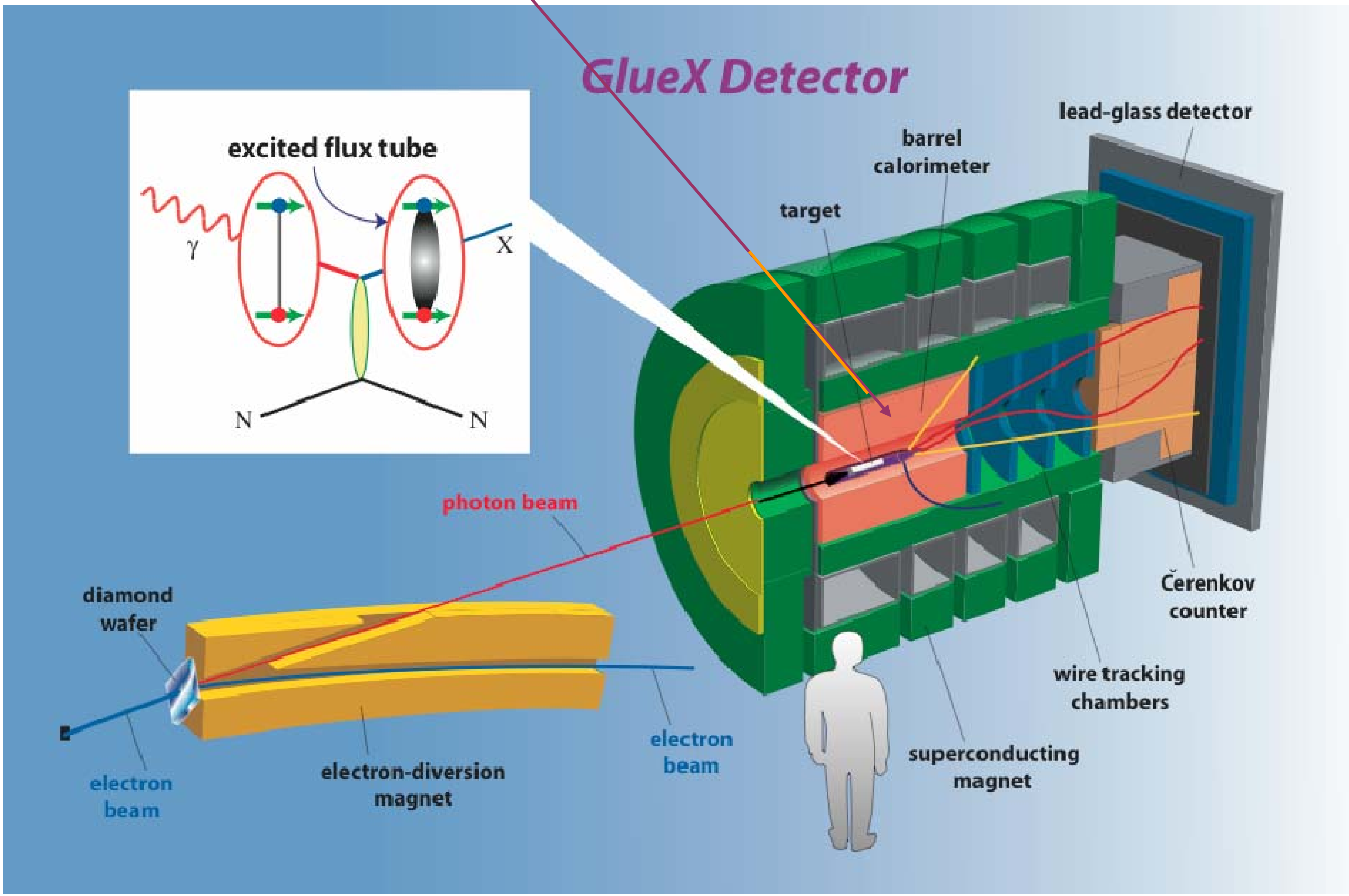
Construction of the CDC.

The CDC Prototype

R&D work to be completed.

Summary

The GlueX Central Drift Chamber



Physics Requirements

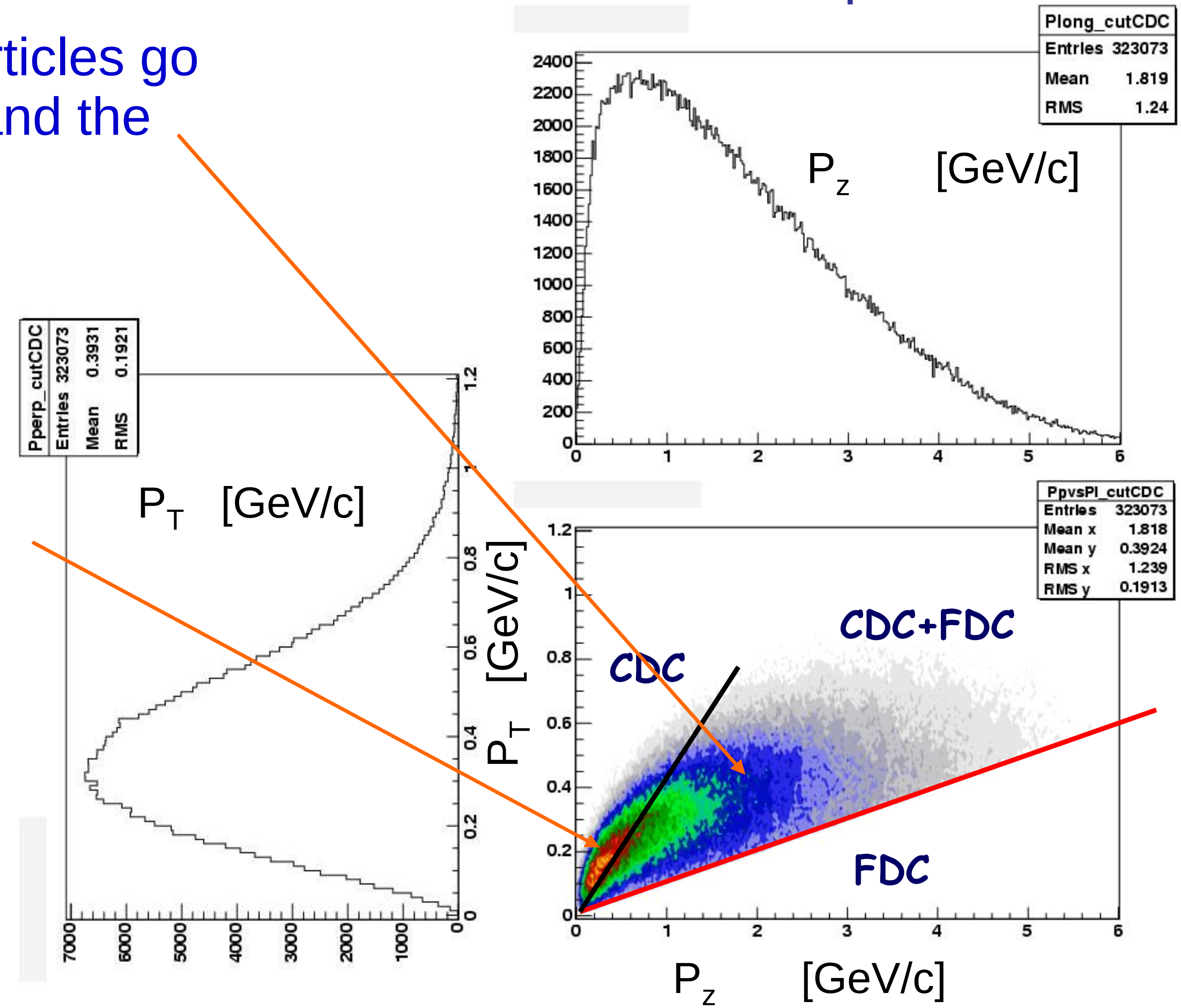
A typical exotic hybrid channel

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

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



Chamber Requirements

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

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

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

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

6 mm Al with Delrin feed throughs

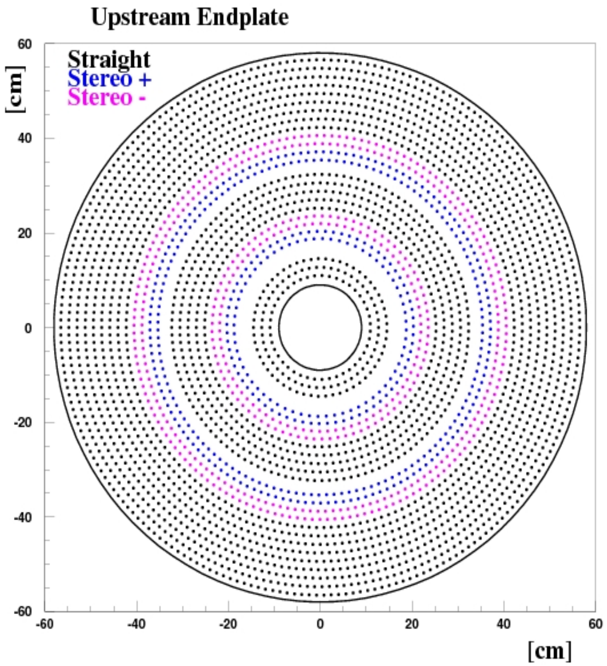
Sweep time should be as short as possible ~600-700ns

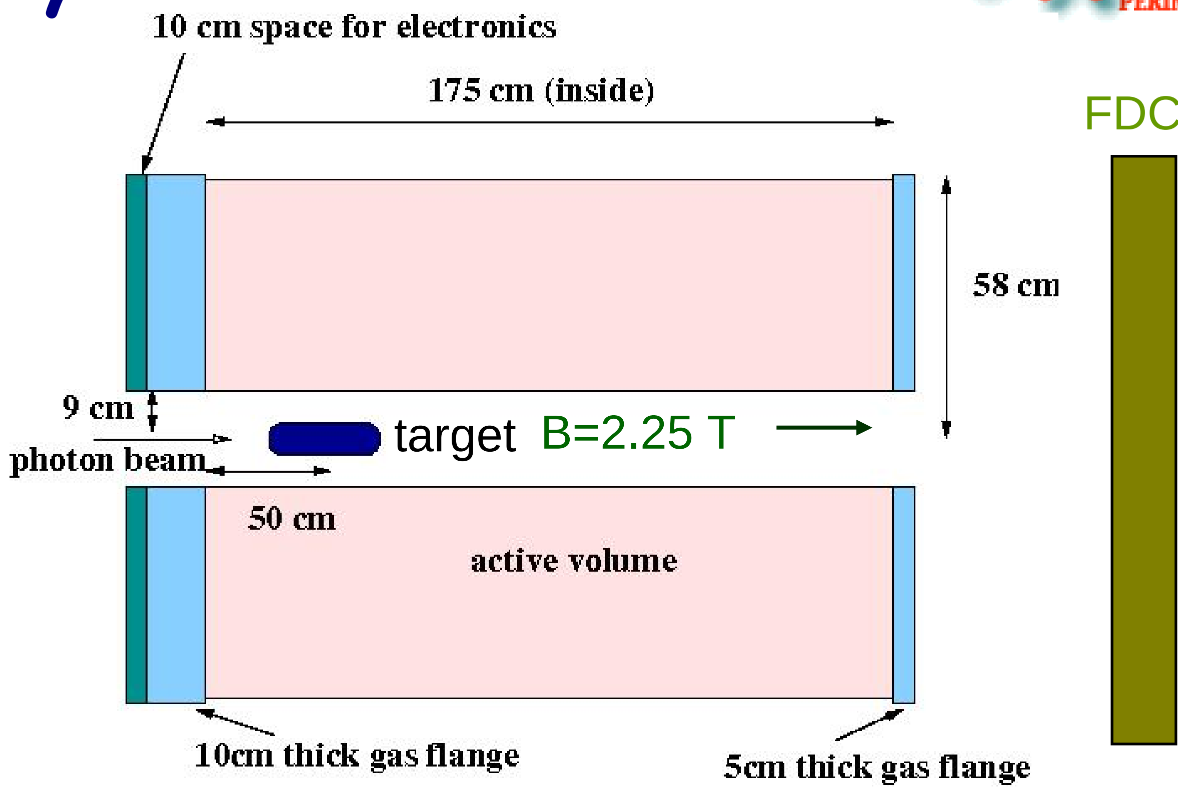
Particle ID using dE/dx for $p \leq 450$ MeV/c (proton/ pion)

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

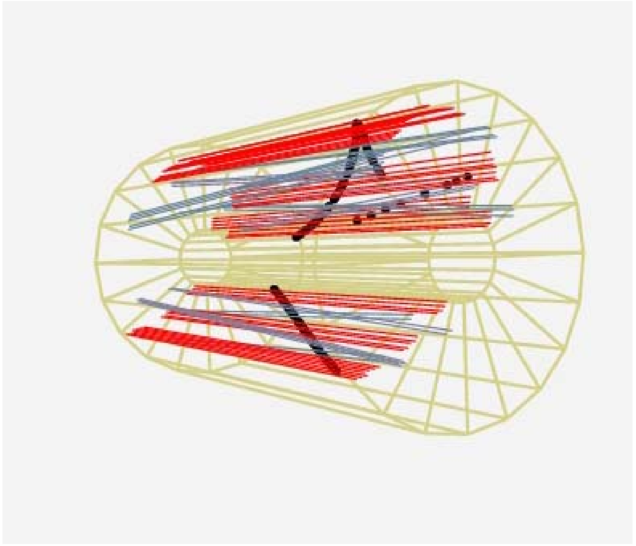
The CDC Geometry

(not to scale)





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 Geometry

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

Straight Layers

Layer	Wires	Radius
1	43	11.0 cm
2	50	12.7 cm
3	57	14.5 cm
8	99	25.2 cm
9	106	27.0 cm
10	113	28.8 cm
11	120	30.6 cm
12	127	32.3 cm
17	166	42.3 cm
18	173	44.1 cm
19	180	45.8 cm
20	187	47.6 cm
21	194	49.4 cm
22	201	51.2 cm
23	208	53.0 cm
24	215	54.8 cm
25	222	56.5 cm

Stereo Layers

Layer	Wires	Radius	Angle
4	64	16.3 cm	+6
5	71	18.1 cm	+6
6	78	19.9 cm	-6
7	85	21.7 cm	-6
13	134	34.1 cm	+6
14	141	35.9 cm	+6
15	148	37.7 cm	-6
16	155	39.5 cm	-6

Resolution

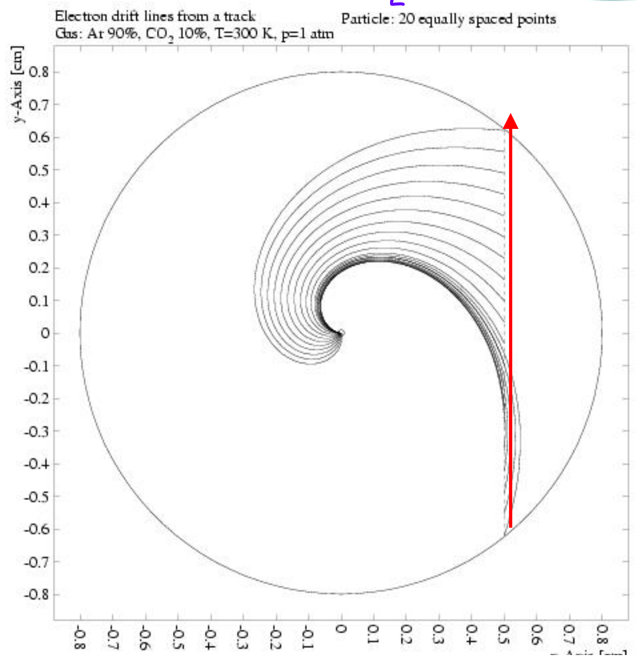
Contributions to Resolution

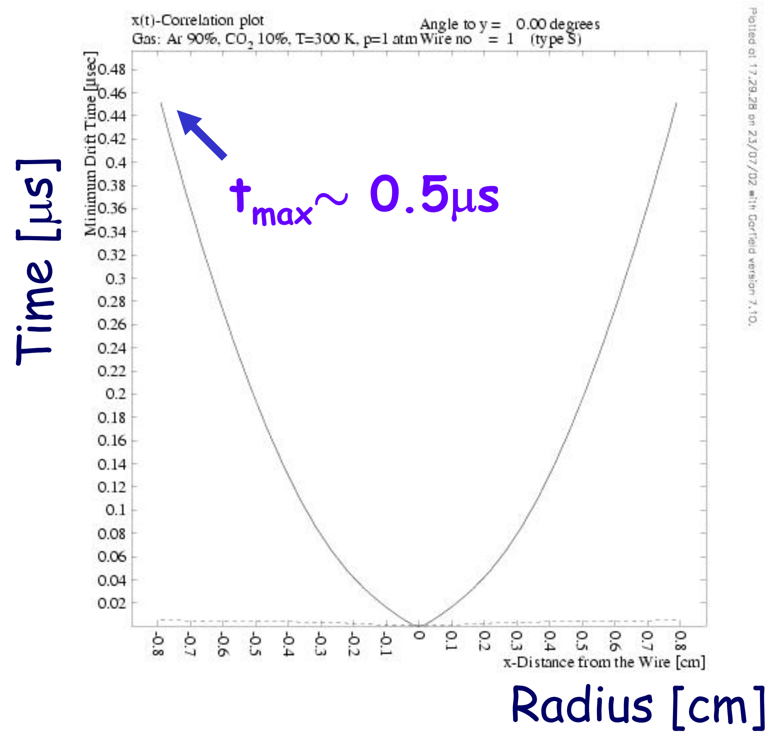
Geometrical Precision	40μm	
Gravitational Sag	56μm	
Timing Resolution	45μm	(2-3 ns)
Electrostatic Deflection	10μm	
Gas Diffusion	120μm	
Total	~ 145μm	

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

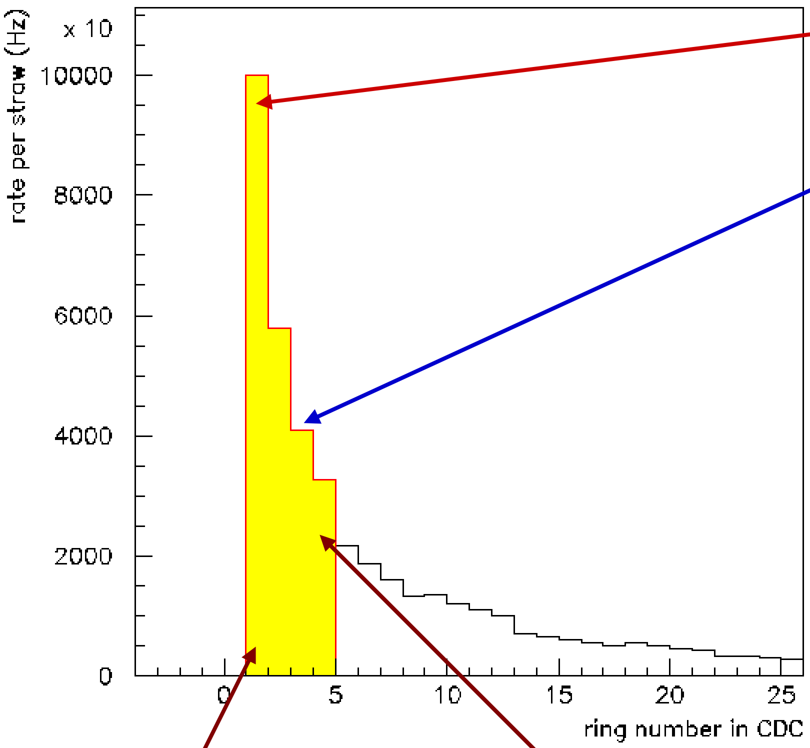




Background Rates

10^8 γ/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)?



100 KHz per straw tube at 6 cm radius

40 KHz per straw at 10.5 cm radius

6 cm (tube radius) 12 cm

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

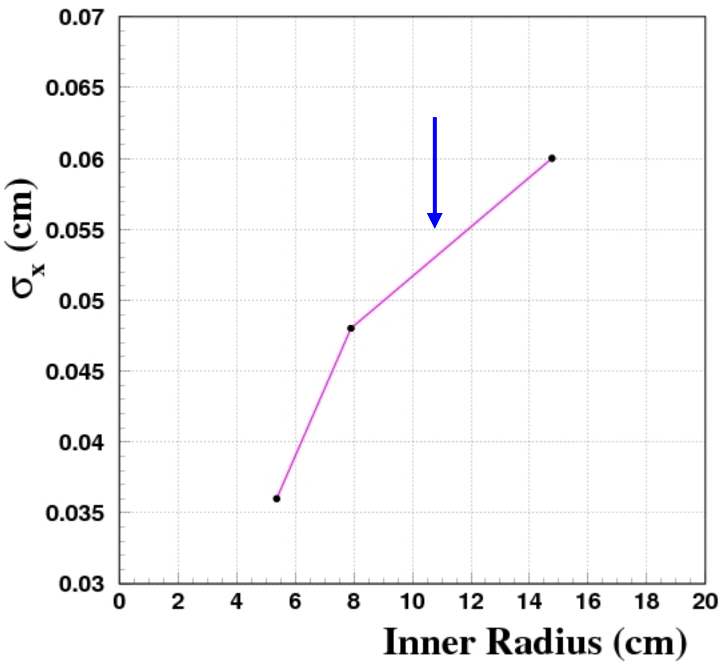
But, this is not an issue for the designs being considered.

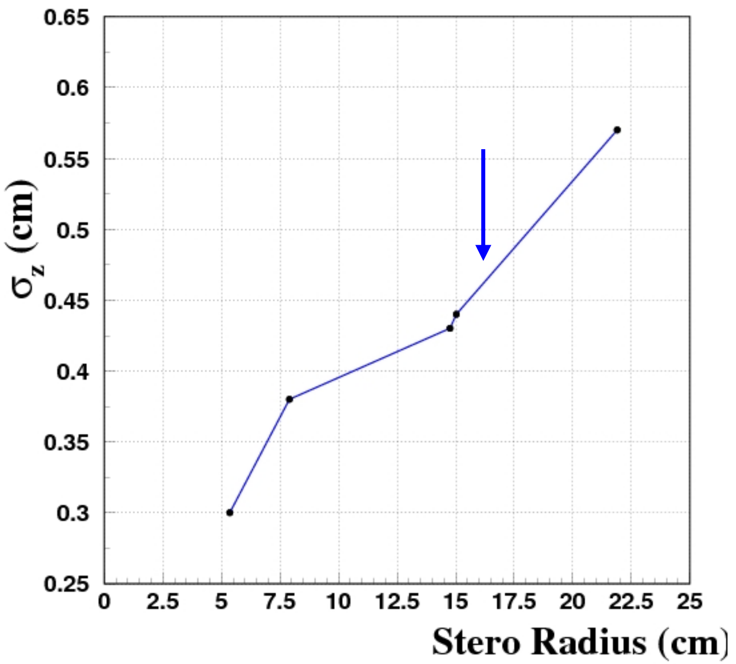
Vertex Resolution

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.

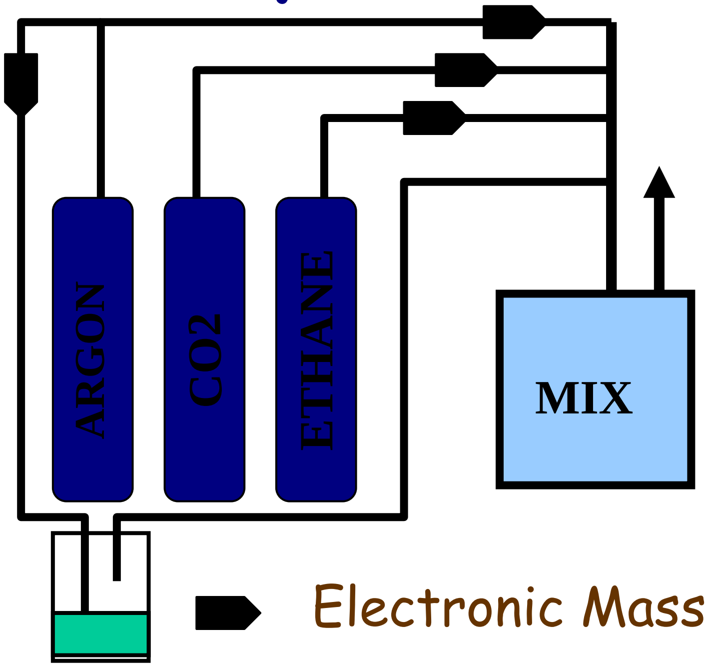
Current Design Values: r_{min} = ~11 cm r_{stereo} = ~16 cm

$\sigma_{xy} \approx 0.5$ mm $\sigma_z \approx 4.5$ mm

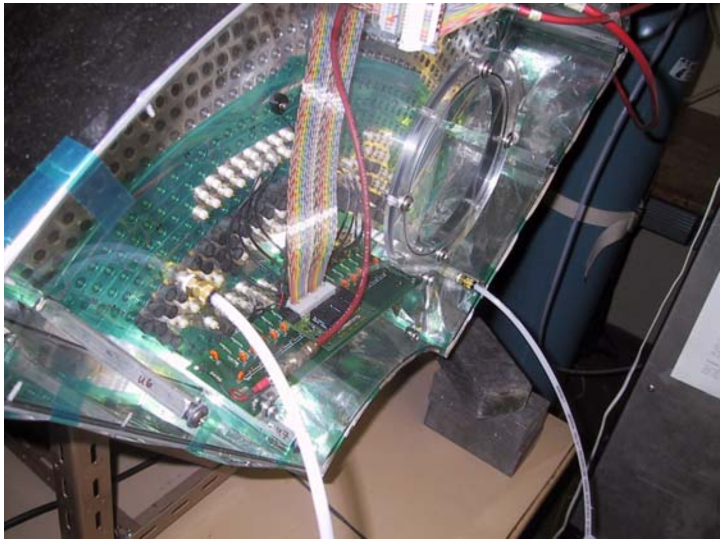




Gas System

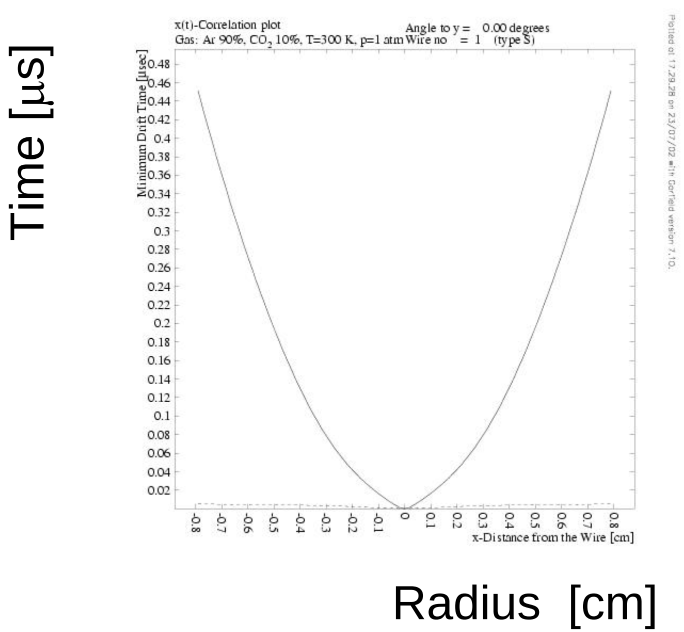


Electronic Mass Flow



Ethane Alarmed

Shut off Ethane at 10% of explosive level



Mix 3 Gasses

Bubble one through
temp. controlled. liquid.

All gasses filtered

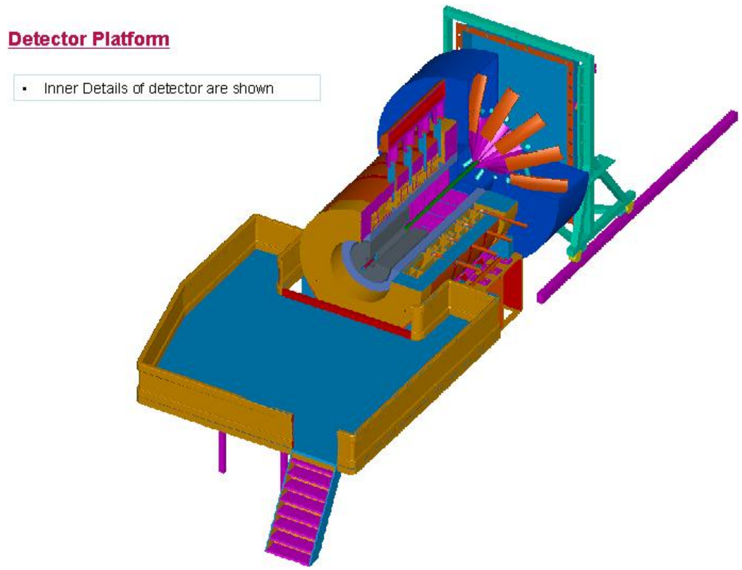
Exhaust gas is discarded.

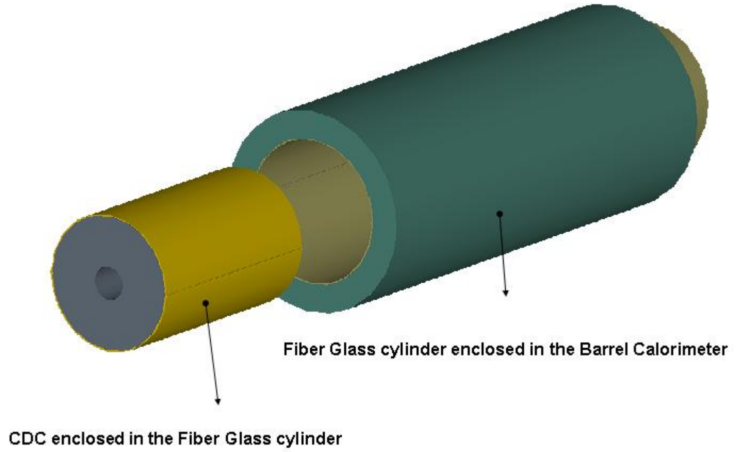
Monitor of temperature and pressure needed to correct for gas density (velocity).

Installation/Alignment

Chamber will ride on a pair of rails mounted inside the Barrel Calorimeter. Insertion and Extraction from the up-stream end of the detector.

Alignment: We are still investigating alignment procedures. This will be a combination of pins, fiducial marks and external survey. It is crucial the FDC and CDC are well aligned.





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)

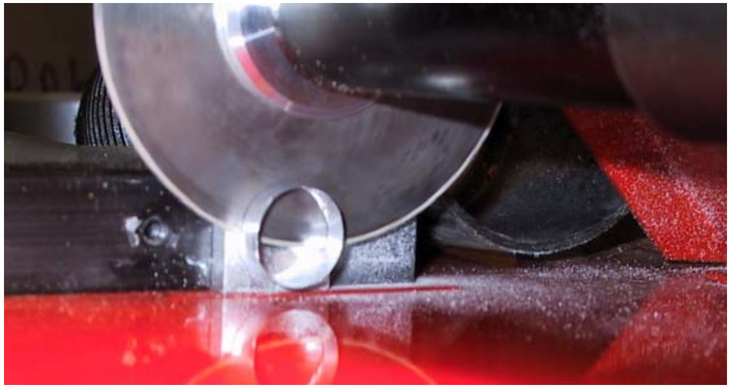
Electrical and gas hookup times are still not definitive.

3 to 3.5 year to build the final chamber

Building The Final Chamber

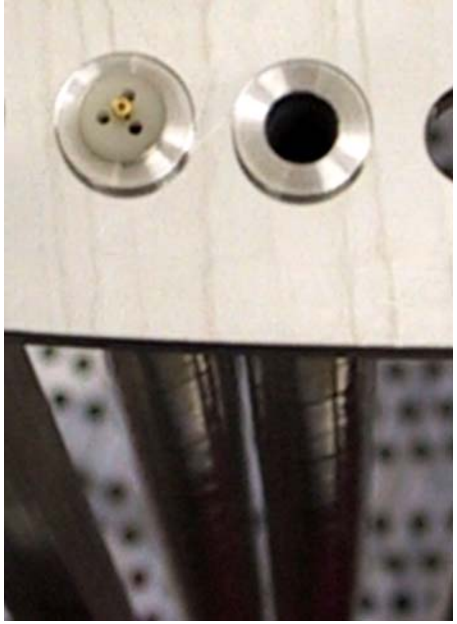
Select tube

Cut to length

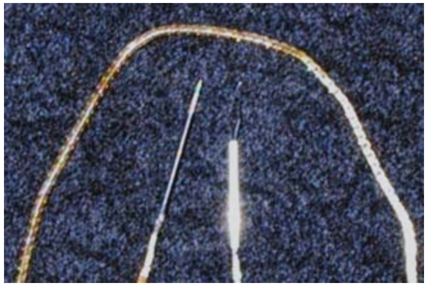


Glue donut

Glue in chamber



Magnetic Feeds



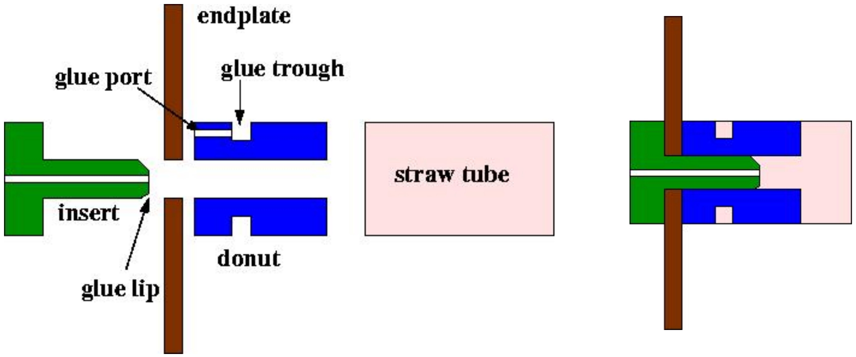
Pneumatic crimper

Vertical stringing

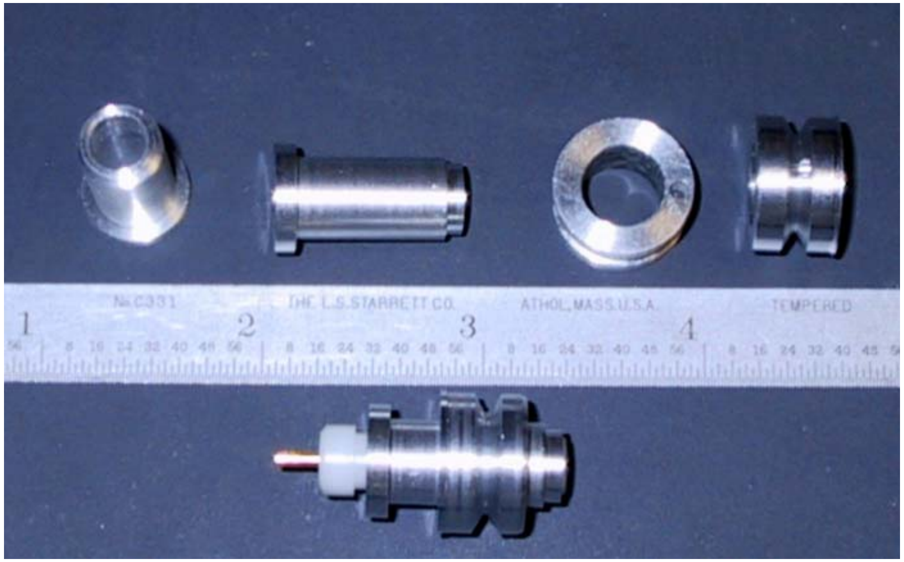
Gas Leaks

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

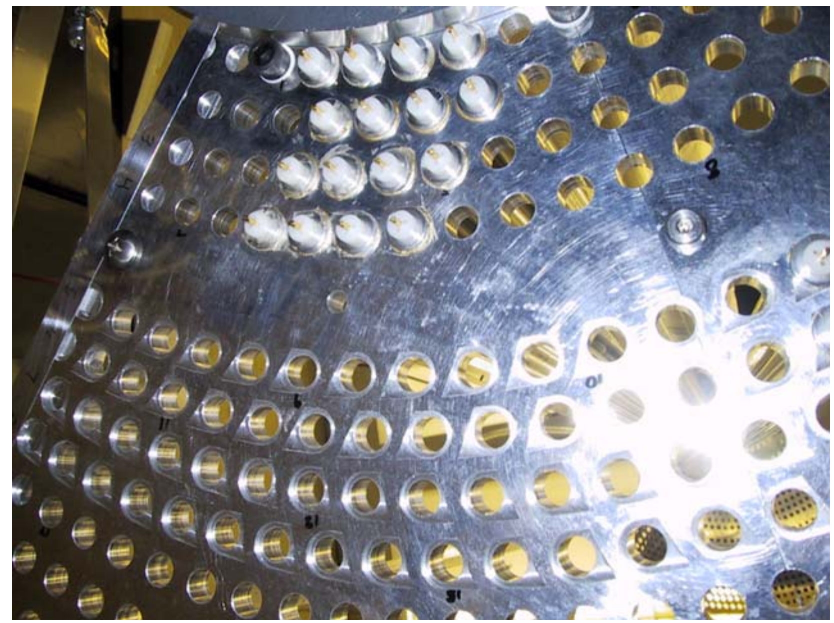
Designed, built and tested a feed through system that forms a solid glue seal.



System has held several psi overpressure for nearly a year.

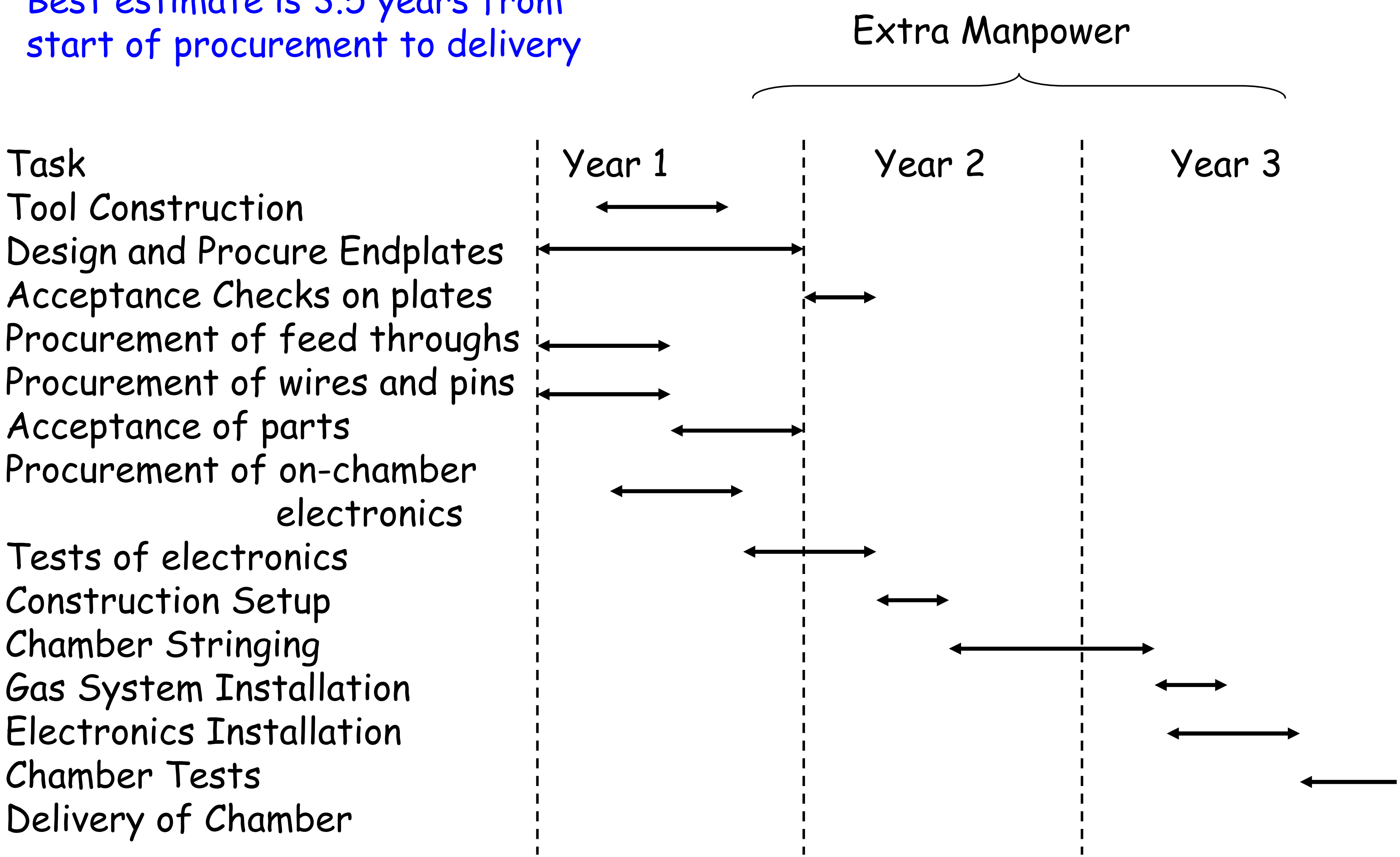


Prototype Construction

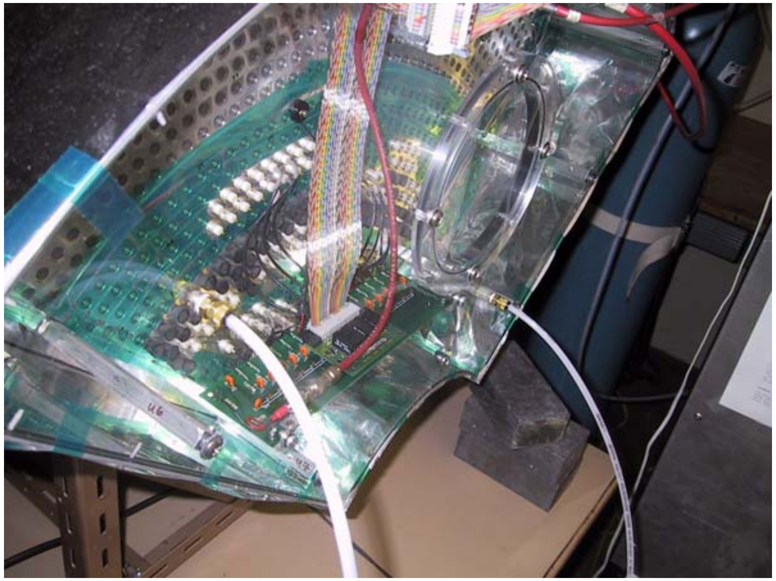


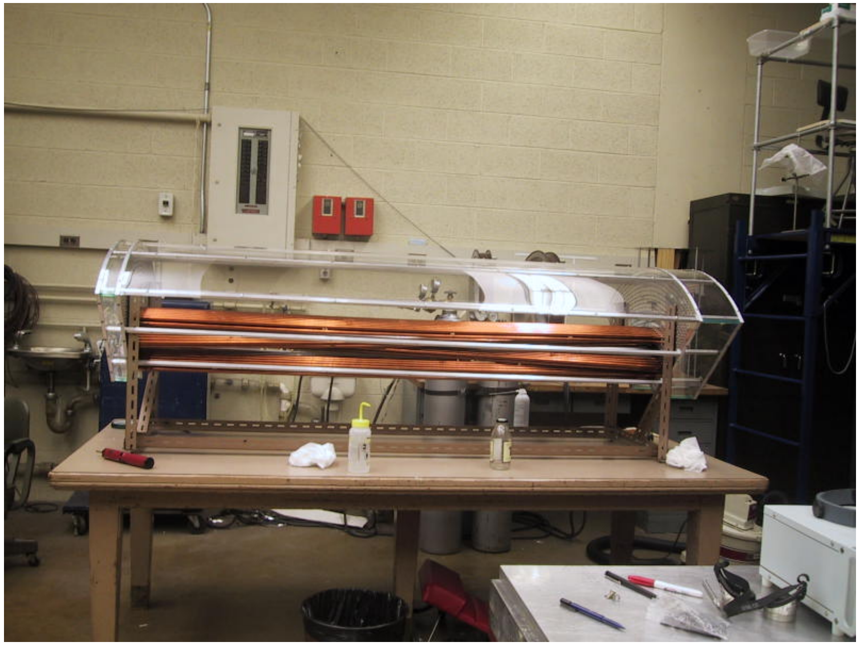
Chamber Construction Timeline

Best estimate is 3.5 years from start of procurement to delivery



The Prototype CDC





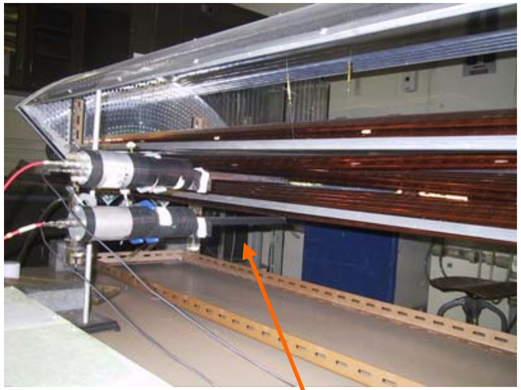
2m long built with both Mylar & Kapton Tubes

Full radius, but $\frac{1}{4}$ circle endplates.

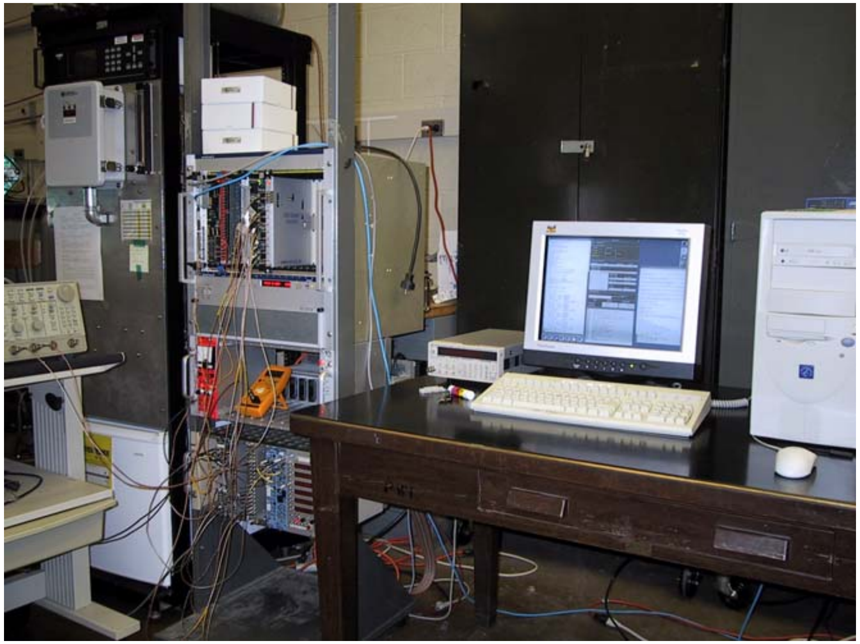
About 70 tubes in the chamber.

16 can be fully instrumented (electronics).

Cosmic Ray Studies



Trigger Scintilators



Small (~1 cm square scintillator telescope) is aligned over a block of 16 fully instrumented straw tubes (limited by FADC system).

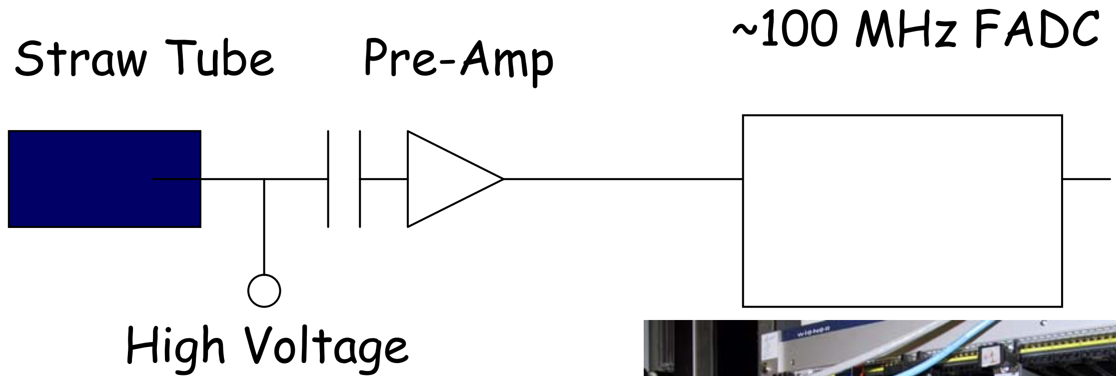
Using a 200 MHz FADC, but can simulate a 100 MHz system.

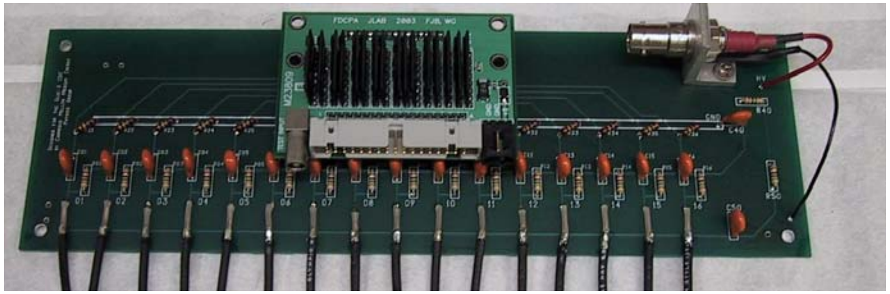
Currently collecting data at about 0.1 Hz, of which about 20% have sufficient tubes for use in studies.

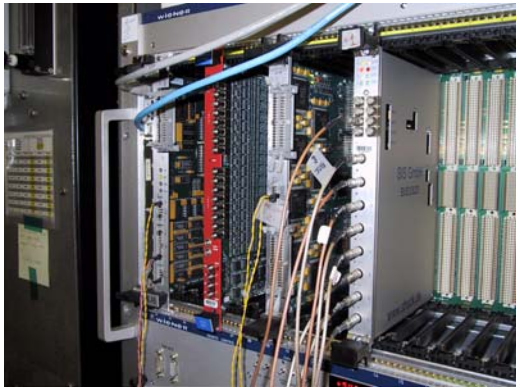
Electronics

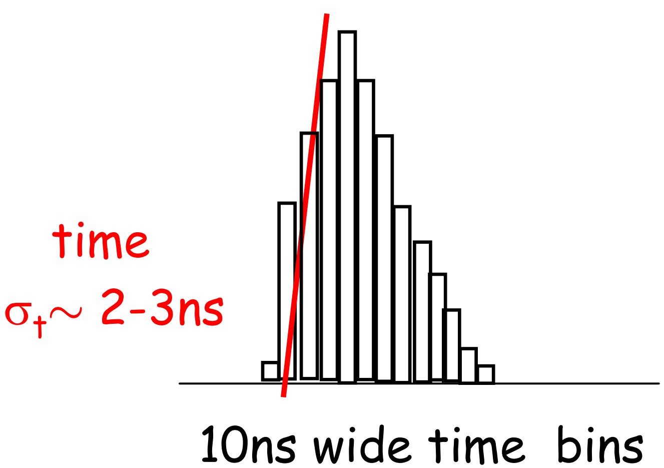
FADC: JLab/IU

Preamp: Alberta/JLab





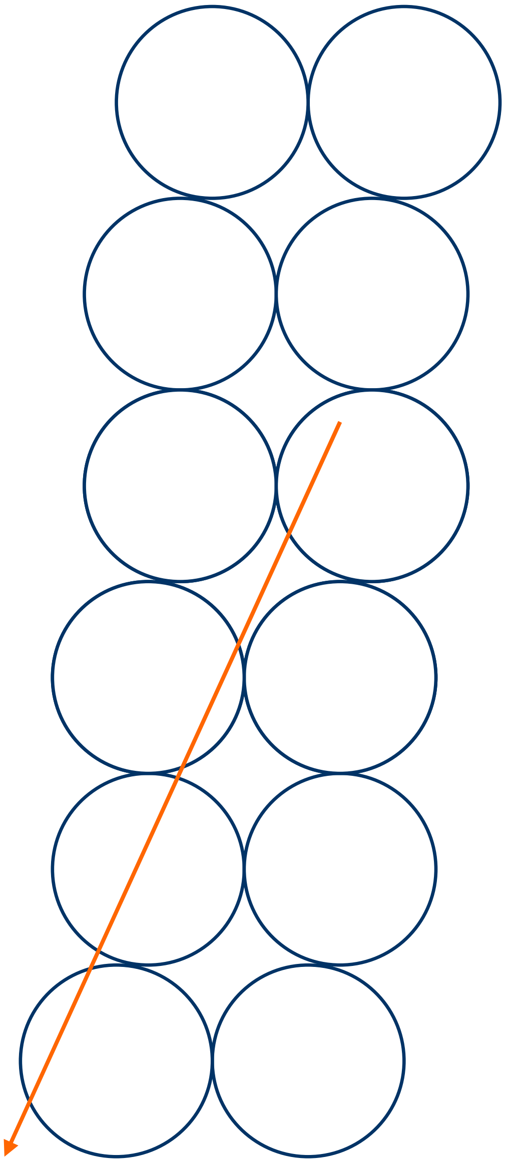


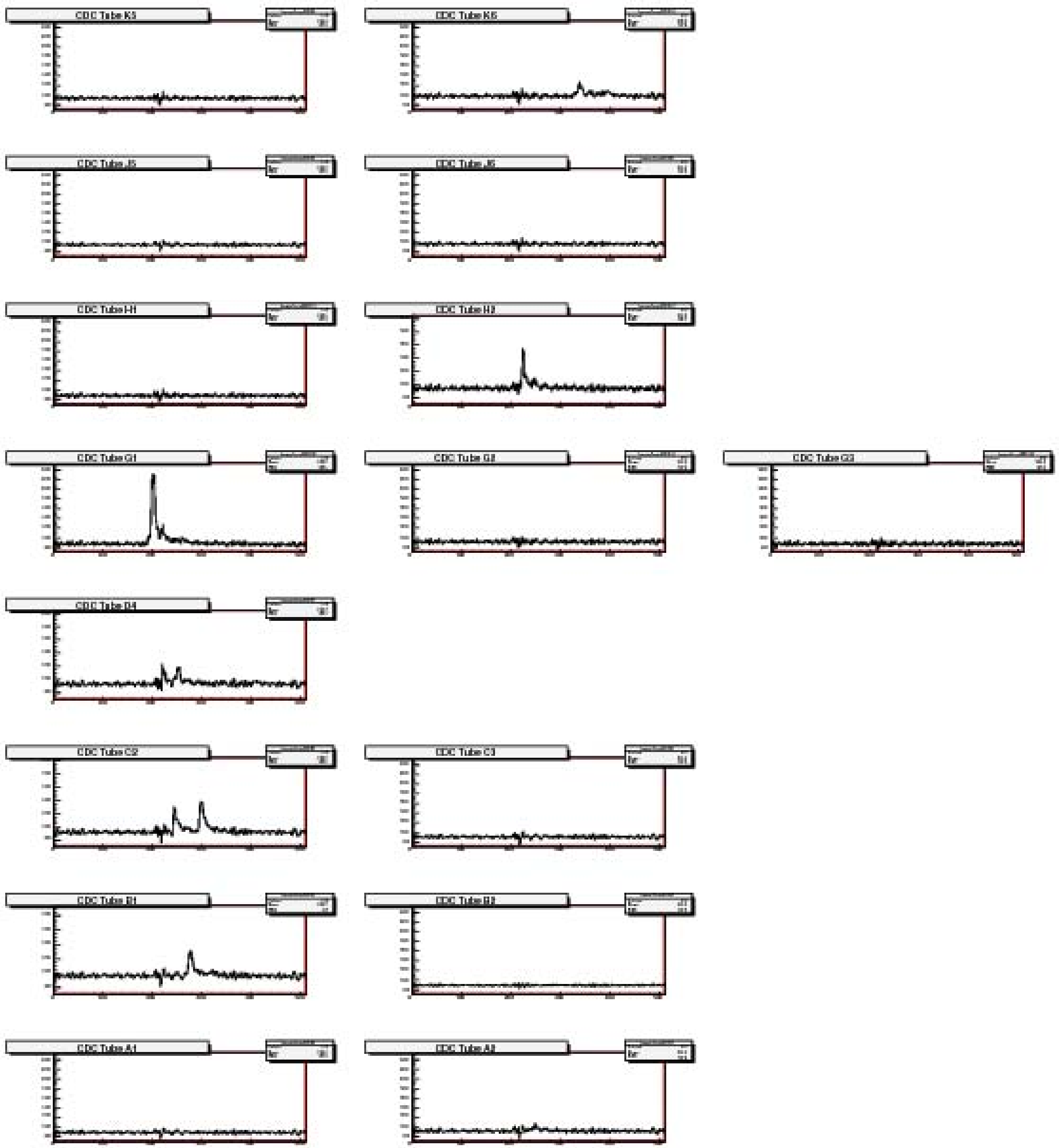


ADC yields dE/dx information

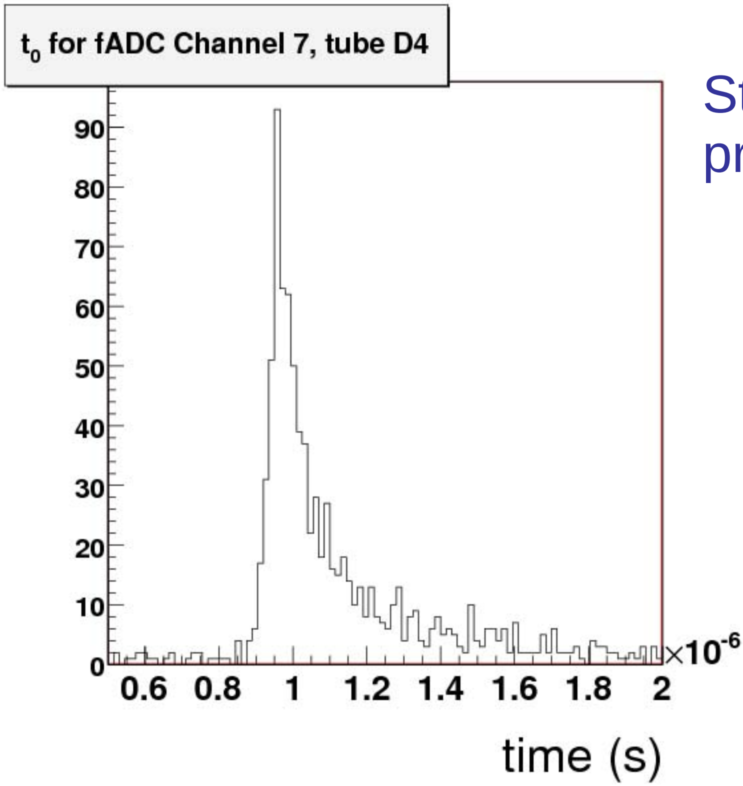
JETSET: NIM **A367**, 248 (1995)
dE/dx at 10% resolution in straw tubes.

Cosmic Rays



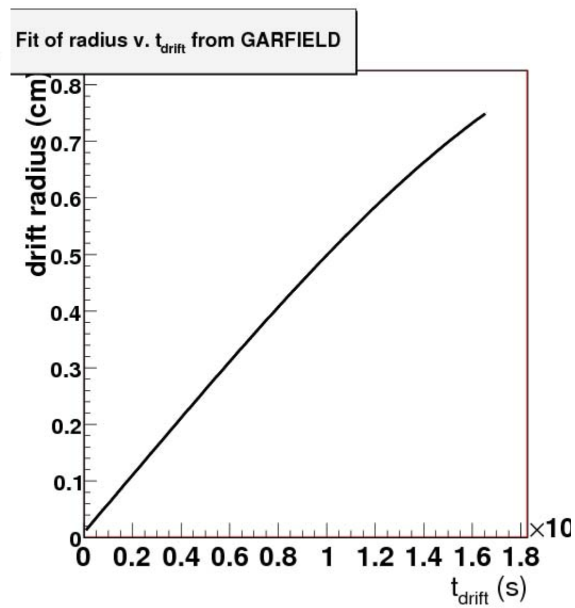


Statistics from cosmic tracks collected in the prototype chamber.

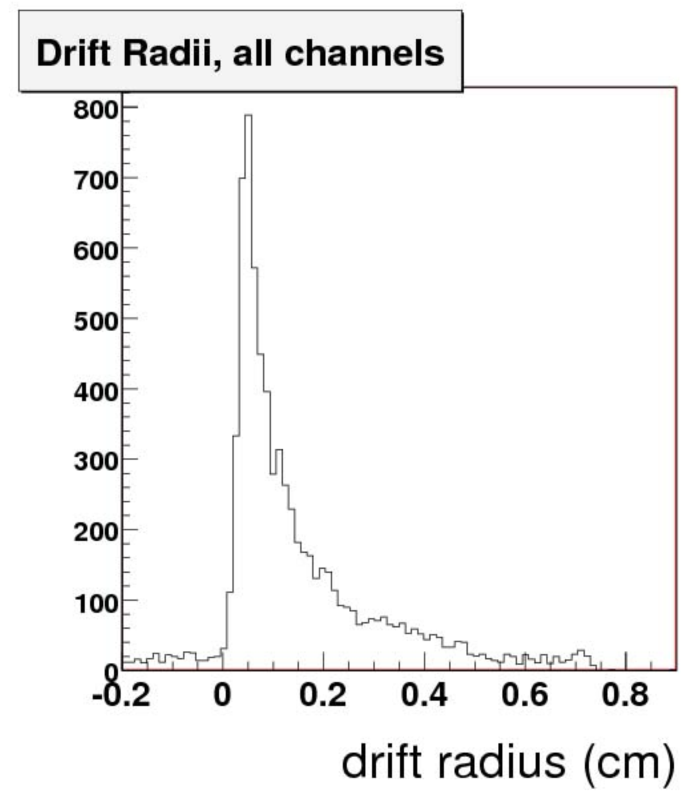


Time from the FADC. In order to get drift time, a time-zero needs to be subtracted.

A drift-time to radius conversion as computed by GARFIELD



The radius of the hits (distance from the wire).



Work In Progress

Developing straight-line track fitter to get resolution. This will allow us to measure resolution as a function of position and angle.

Plan to investigate "loose" charge division for use in pattern recognition.

Plan to investigate dE/dx and what the path length corrections are that we will need.

We are in the middle of a Post-Doc search for someone to play a lead role in the remainder of the R&D work.

Summary

The CDC as designed meets the physics requirements of GlueX.

The choice of straw tubes over wire cages is driven by:

1) Minimizing the material in the down stream endplate.
2) Uniform electrostatics in the straw tube.

We have a reasonable time line (from start of procurement to delivery) based on building the prototype chamber.

A “full scale” prototype has been built and is being studied at Carnegie Mellon. We anticipate additional manpower in the next six months that will be able to speed this process up.