The GlueX Forward Drift Chambers

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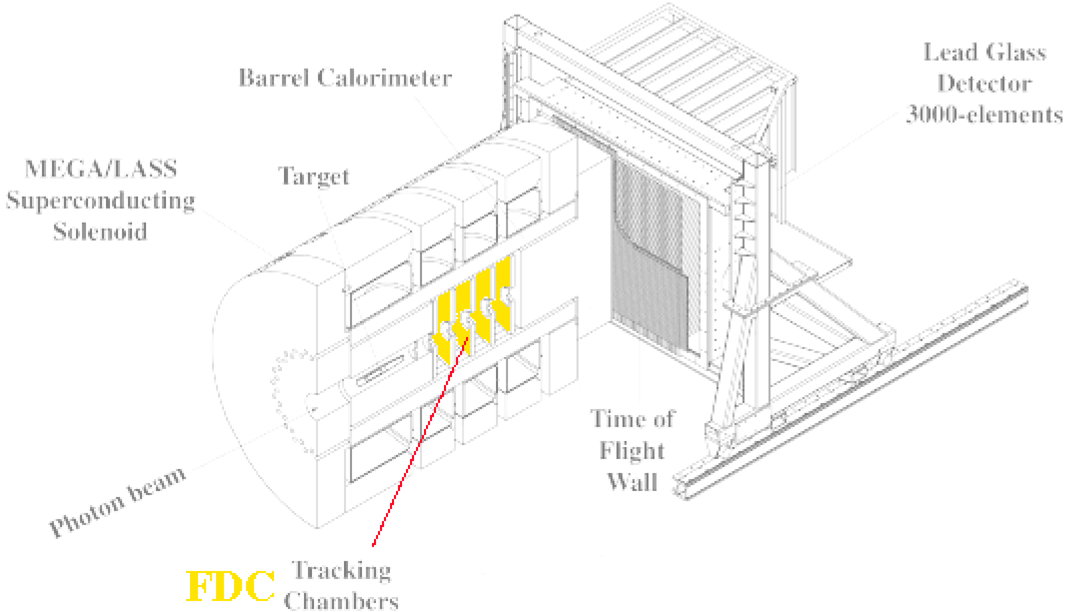
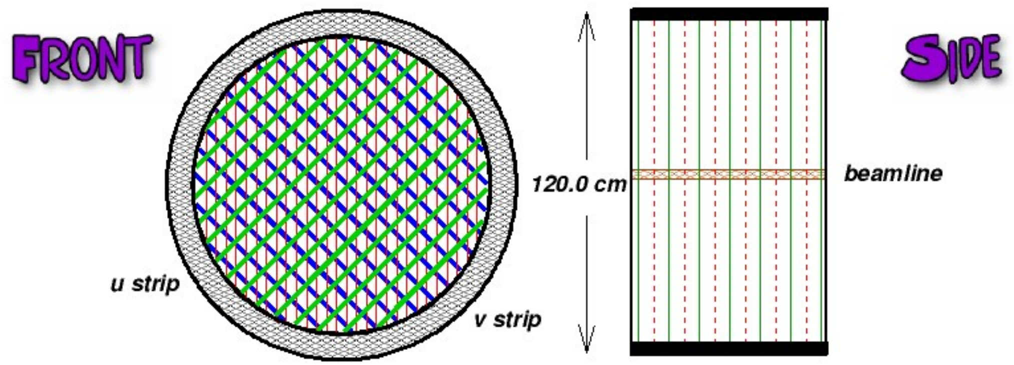
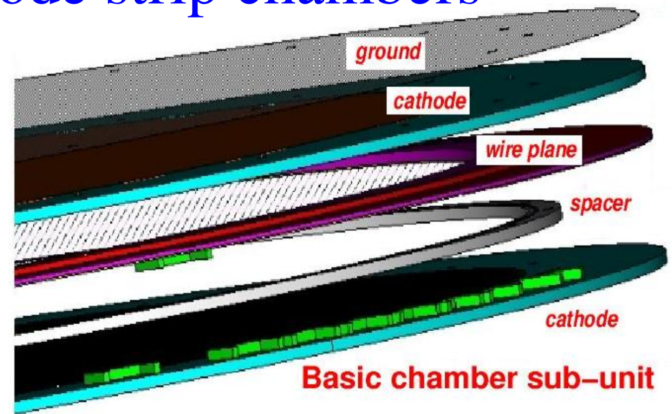
On behalf of the GlueX Collaboration



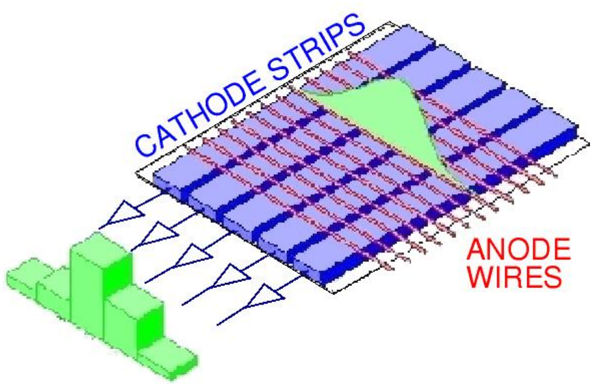
The Forward Drift Chambers

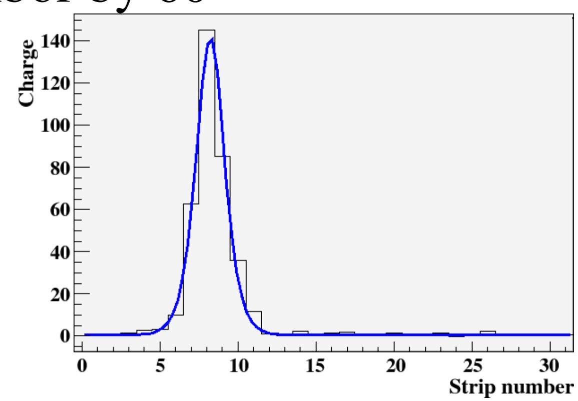
- Purpose: track forward-going ($\theta<20^\circ$) charged particles
- Design: 4 packages each containing 6 cathode strip chambers





- Cathode strip chamber: cathode plane / wire plane / cathode plane
  - Cathode planes divided into strips oriented at $\pm 75^\circ$ with respect to wires
  - Each chamber rotated with respect to its neighbor by 60°

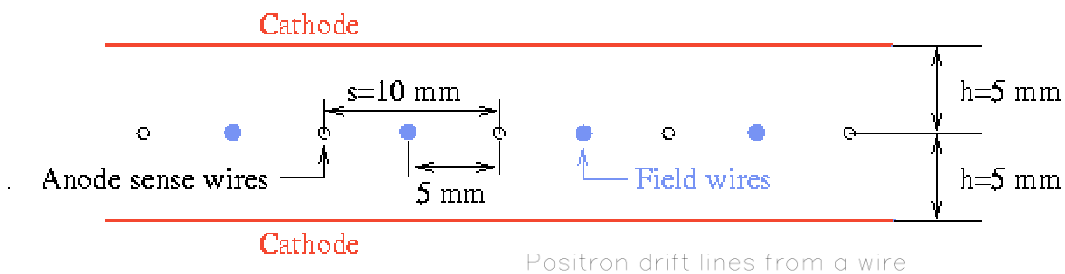


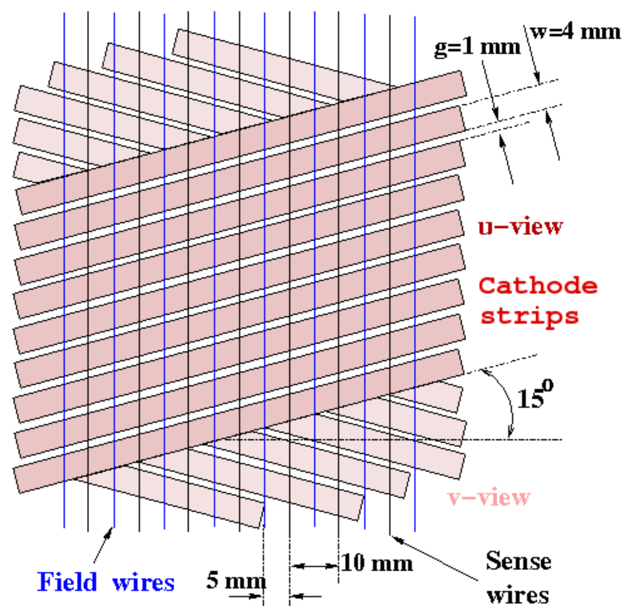


Electrode Configuration

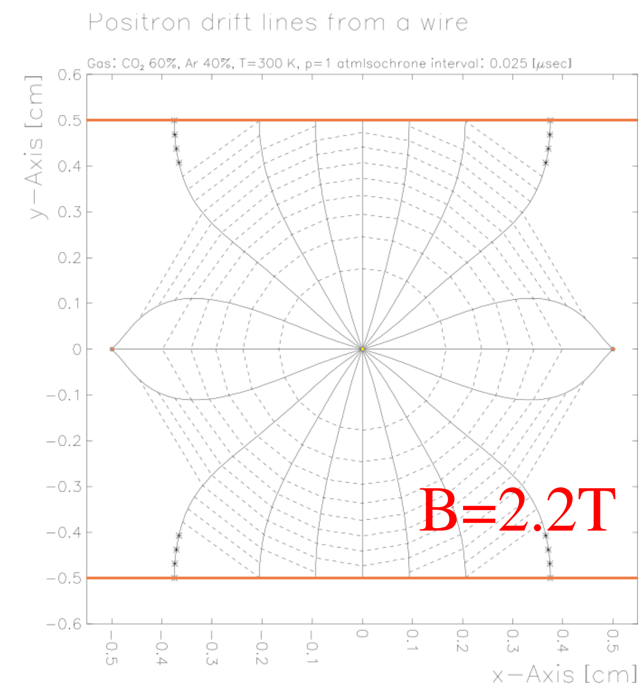
- Our design: sense and field-shaping wires
- Drift time + cathode data → space point (x,y,z)

- 2 cathode layers, 5 mm strip pitch, +/- 75° with respect to wires
- 96 sense wires (10 mm pitch)
- 97 field wires (10 mm pitch)

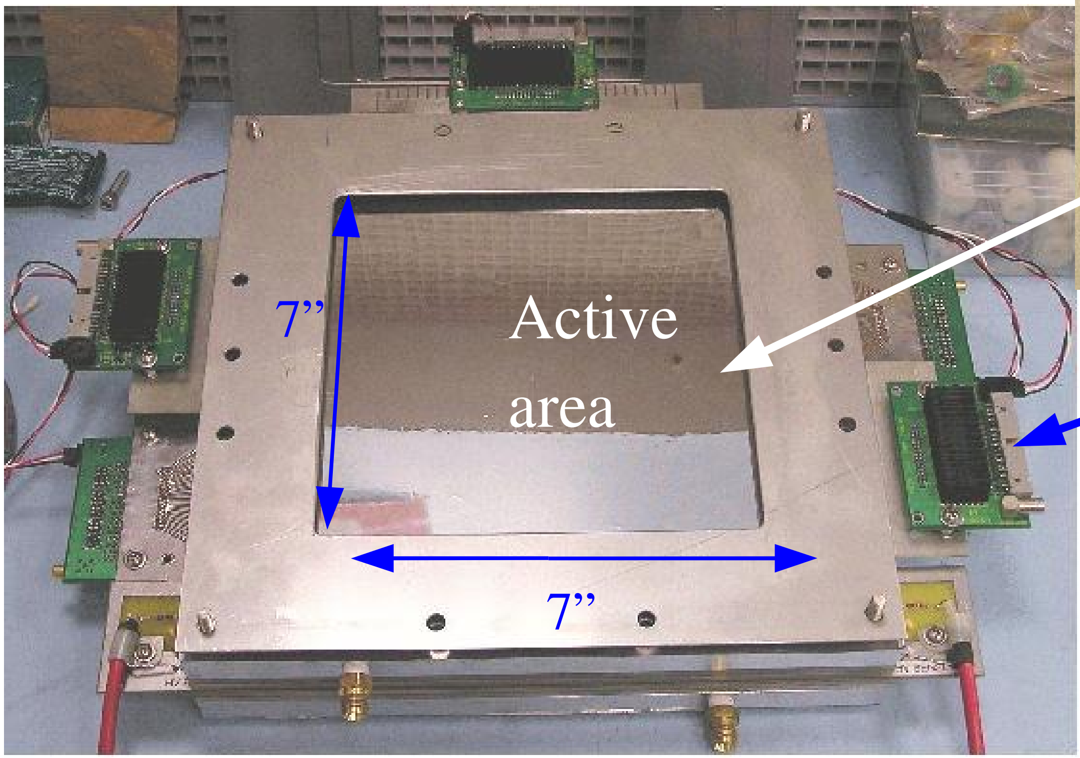


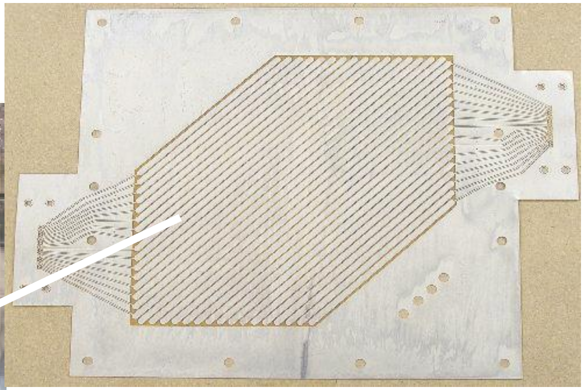


Goal: measure space point with <200 μm resolution in each coordinate



Small-scale prototype





- Preamplifier boards: SIPs
  - Gain ~2.3 mV/µA
  - No pulse shaping
  - No tail-cancellation
- Gas mixture:
  - Nominal: 40% Ar / 60% CO_2

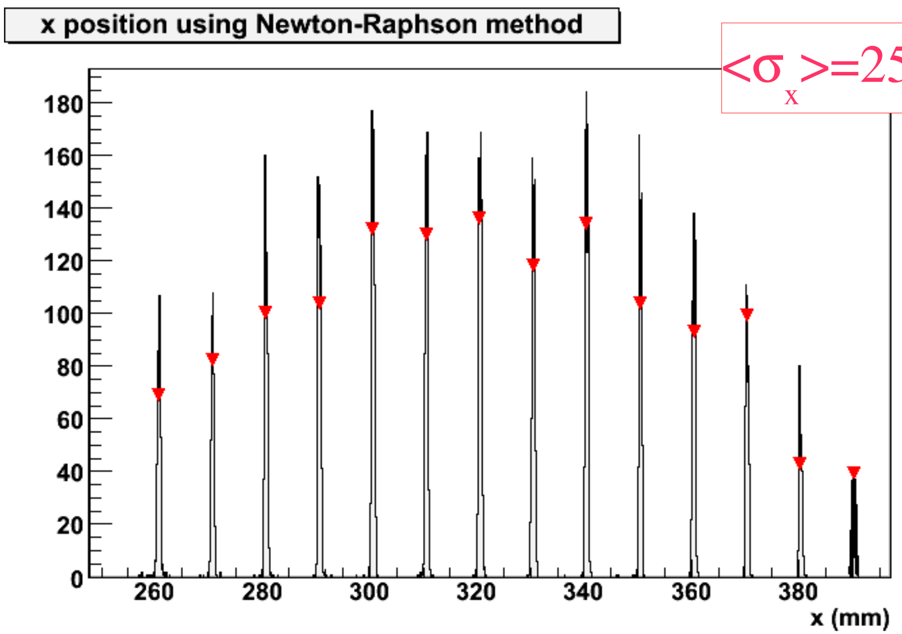
- Readout for cathode strips: CAEN V792 charge-integrating ADCs
- Readout for sense wires: CAMAC discriminator / F1 TDC

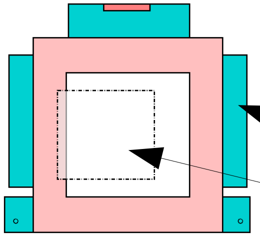
Imaging the wires

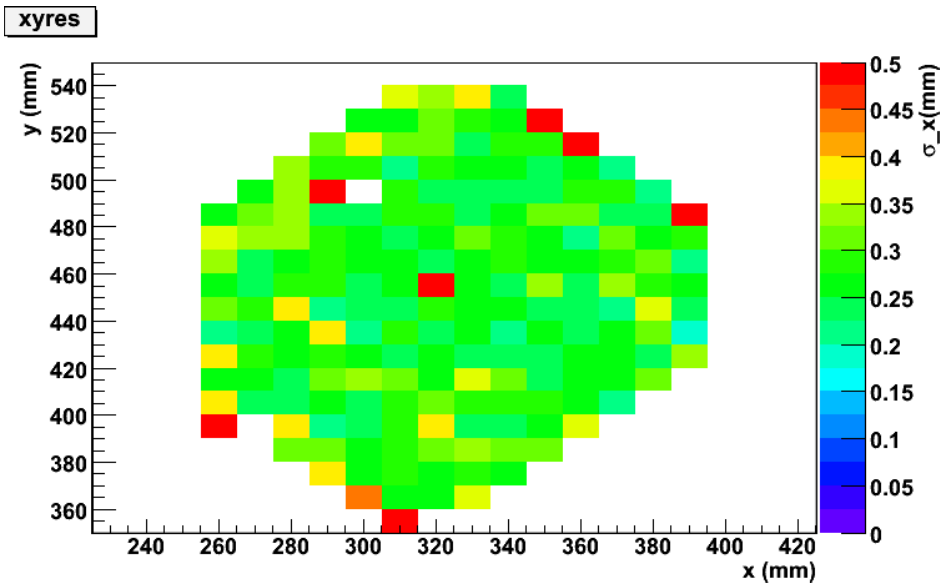
- Use centroids on both views to reconstruct wire positions
  - Avalanche occurs near wire → x-positions quantized
  - First prototype: ±45° between strips and wires

  $x_{wire} \propto 1/\sqrt{2}$ (<u>+<v>) using cathode data only

Field HV = -500 V
Sense HV=+2450 V
40% Ar / 60% CO_2



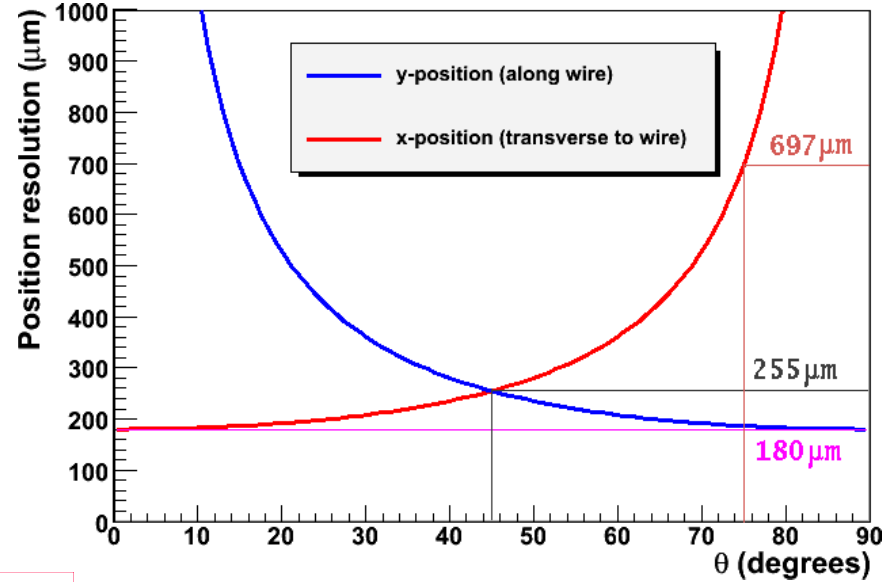


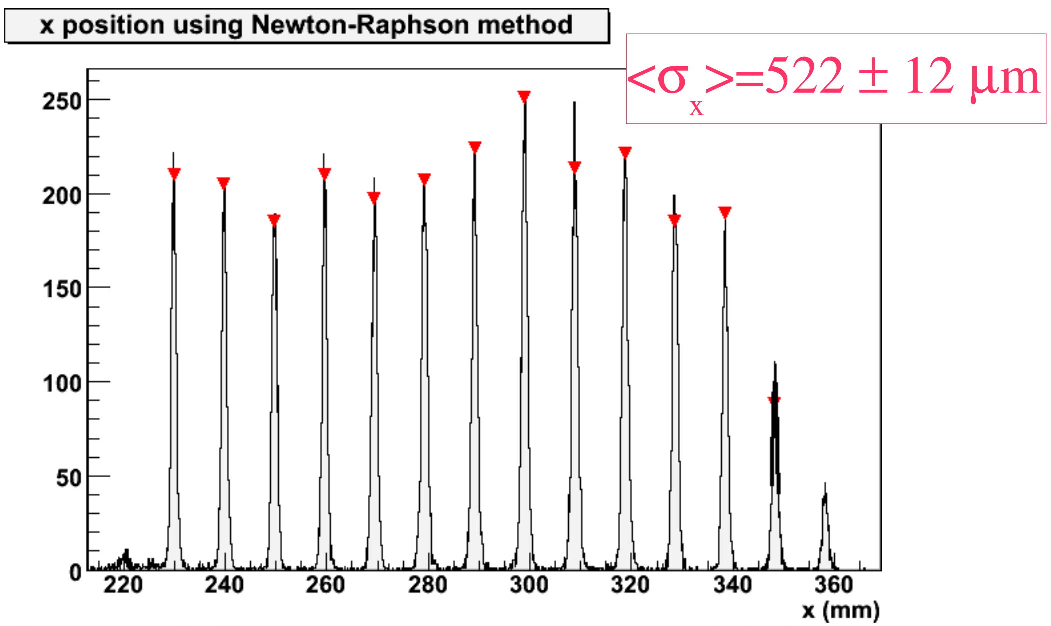


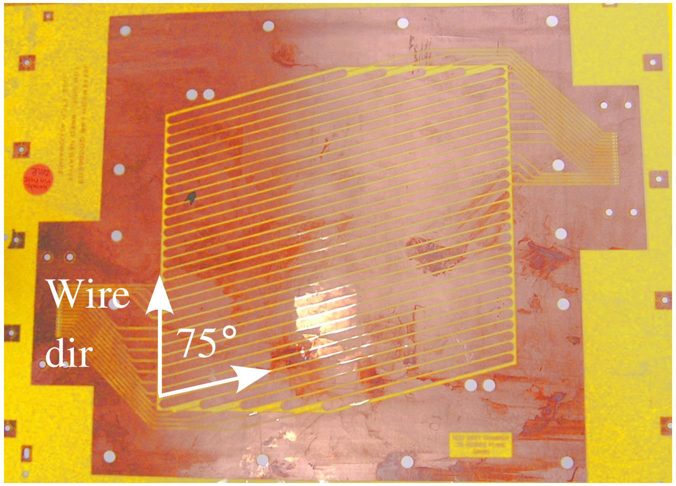
Strip lengths vary between 12.8 cm and 27.8 cm

Results for 75° planes

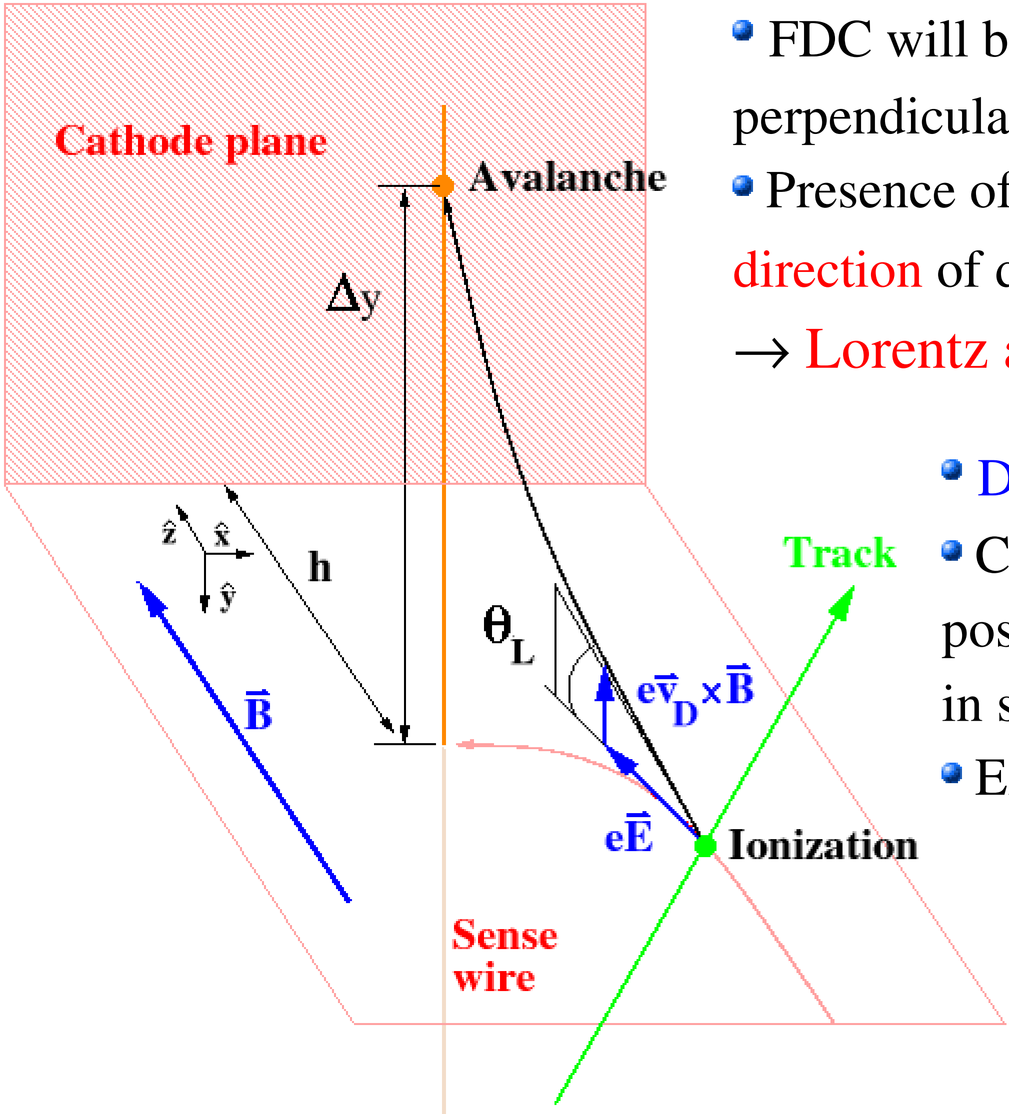
- Tune angle between strips and wires
  - Trade off ability to associate wires and strips vs. position resolution along wire
    - ~35% y-position resolution improvement possible relative to ±45°







Effect of Magnetic Field ("Lorentz Effect")



- FDC will be operated in large (2.2 T) field perpendicular to wires
- Presence of magnetic field causes change of direction of drifting electrons relative to B=0

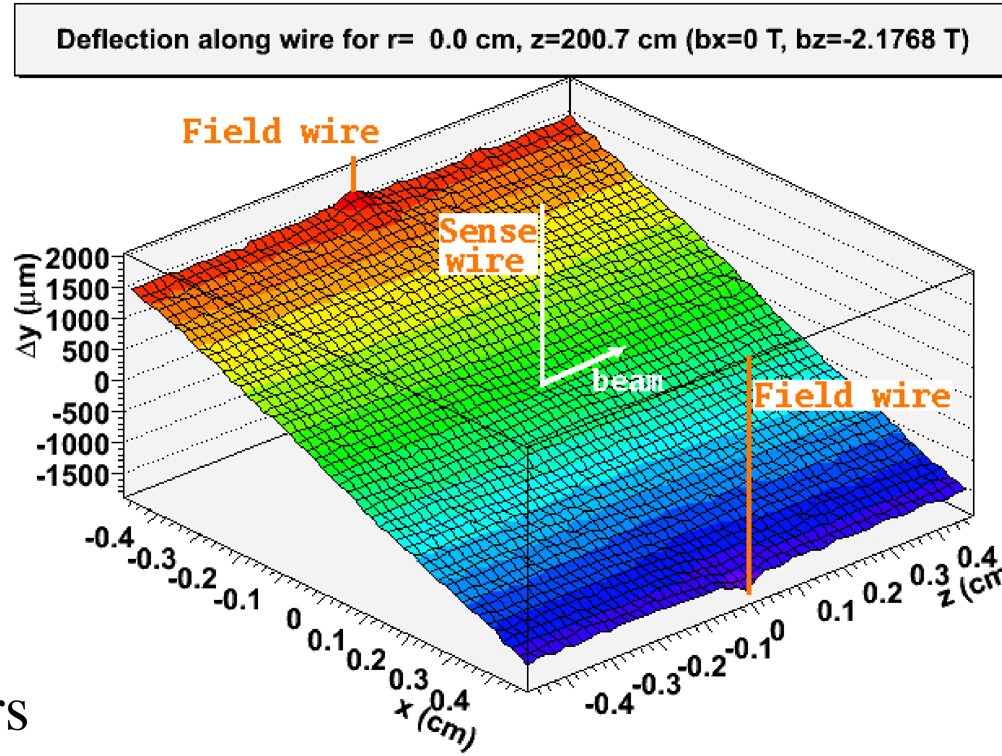
→ Lorentz angle $\tan\theta_L \approx \frac{\left|\vec{v}_D \times \vec{B}\right|}{\left|\vec{E}\right|}$

- Drift velocity depends on gas choice
- Causes displacement of avalanche position along wire → can correct for this in software
- Expected to worsen spatial resolution...

Effect will be smallest for most downstream FDC package, largest for packages nearest to CDC...

Modeling the "Lorentz Effect"

- GARFIELD calculations using map for full magnetic field



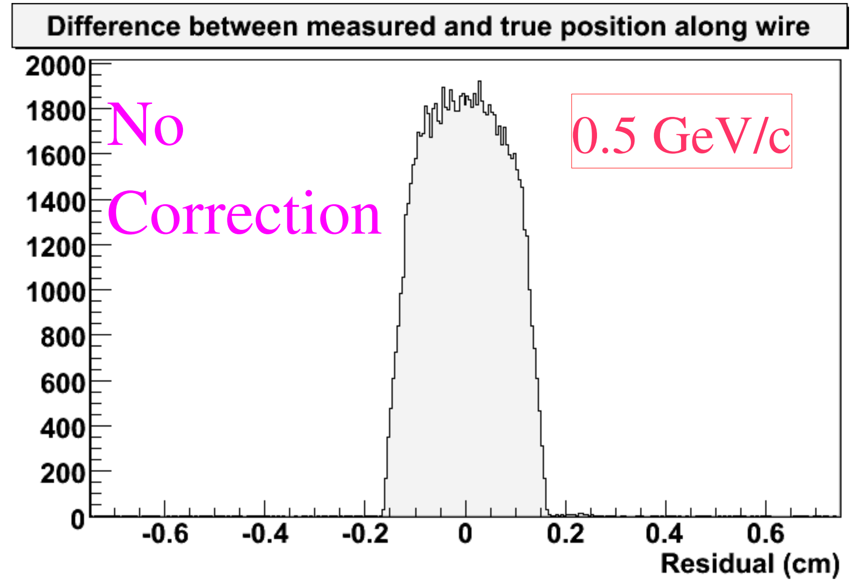
- Amount of deflection along wire well-characterized by a plane for 40% Ar / 60% CO_2

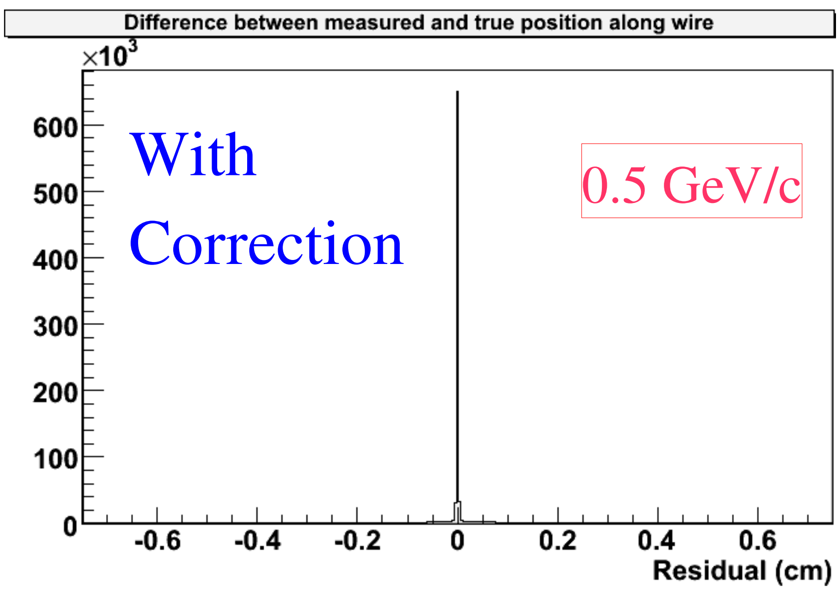
- Created table of slope parameters describing planes as function of r and z (position along beam line)

- Code interpolates deflection from table assuming ionization point at DOCA

Correcting for "Lorentz Effect"

- Simulated π^+ tracks incident on FDC packages (θ =1°– 19°)
  - Lorentz effect on in simulation
    - Direction of deflection depends on side of wire π^+ passes through gas volume
  - Reconstruction: resolve ambiguity locally, interpolate correction from table obtained with Garfield





Note: no additional smearing...

Left-right ambiguity appears to be resolved correctly for majority of hits...

Summary and Outlook

- Forward Drift Chambers track forward-going particles with Cathode Strip Chambers
  - Design goal $\sigma_y < 200\ \mu m$ along wire achievable with $\pm 75°$ planes
  - Deflection of avalanche position due to magnetic field can be modeled and corrected for in software
  - Construction of full-scale prototype underway...