The GlueX Forward Drift Chambers

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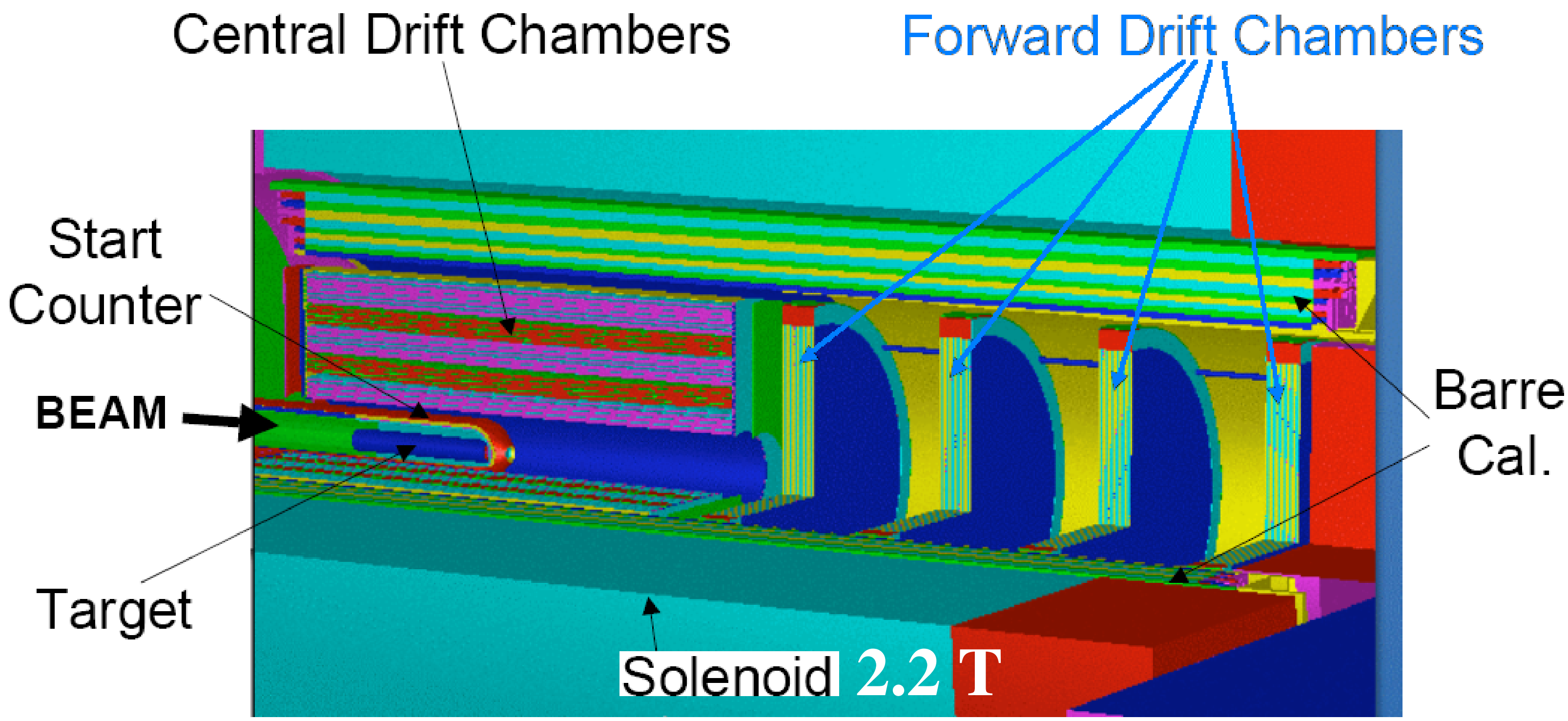
On behalf of the GlueX Collaboration



Design Parameters

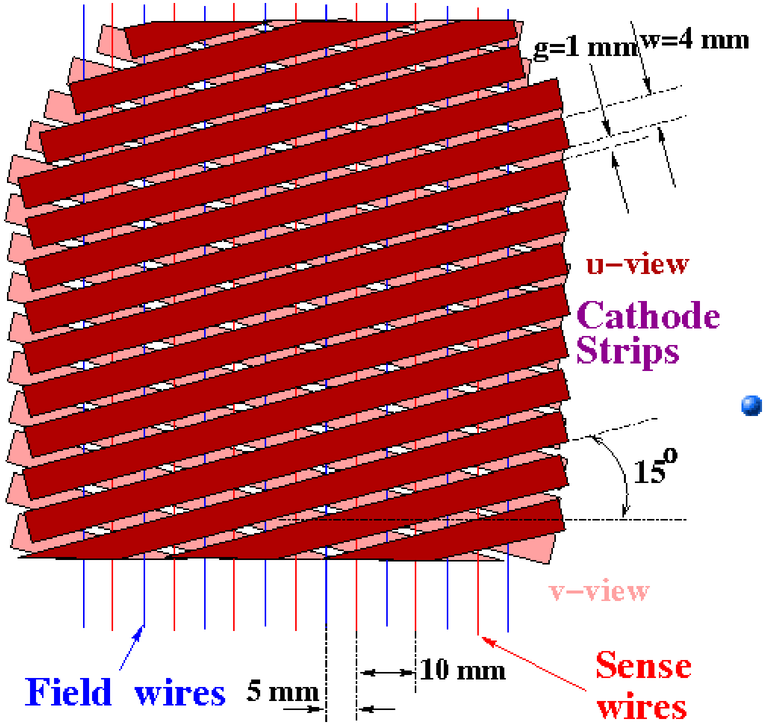
- <u>Purpose</u>: track forward-going ($\theta<20^\circ$) charged particles
- <u>Design</u>: planar drift chambers with wires perpendicular to beam line
  - 4 packages of 6 layers
  - Goal: reconstruction of track segments in each package
    → *Resolve ambiguities locally*
- Chambers inside bore of magnet
  - Need to operate in high (2.2 T) magnetic field → "Lorentz effect"
- Will operate in conditions of high electromagnetic background rate
  - Need to minimize material in active area
  - ... but also need good pattern recognition

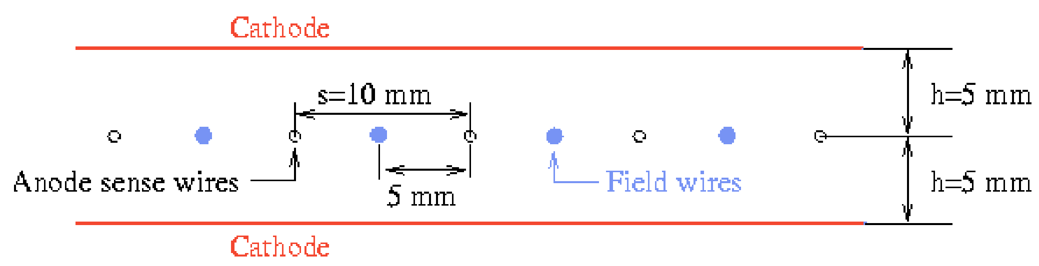
⇒ Cathode Strip Chambers

- Measure position along the wires
- + wire readout

The Forward Drift Chambers

- 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 ±75° with respect to wires
  - Each chamber rotated with respect to its neighbor by 60°



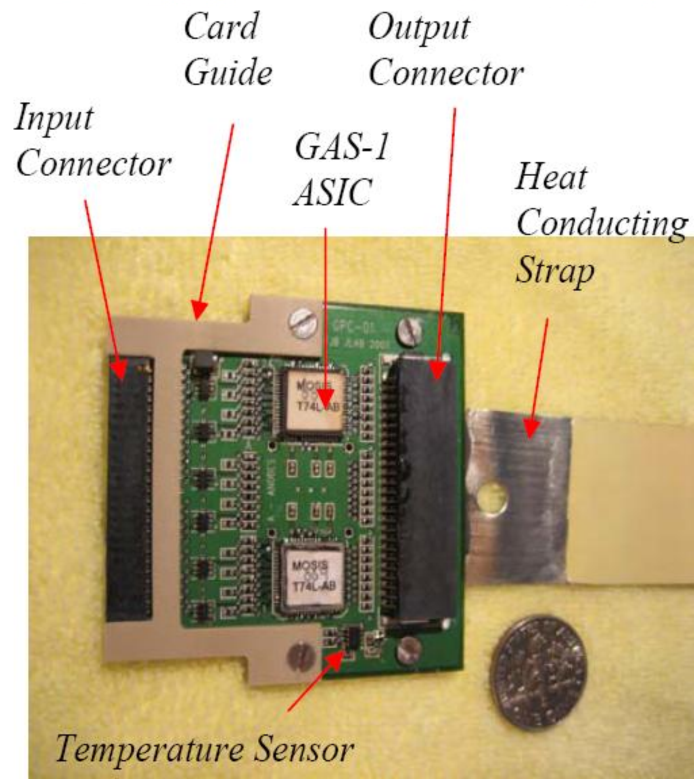


- Sense and field-shaping wires
  - Drift time + cathode data → space point (x,y,z)
    - Aids in pattern recognition

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

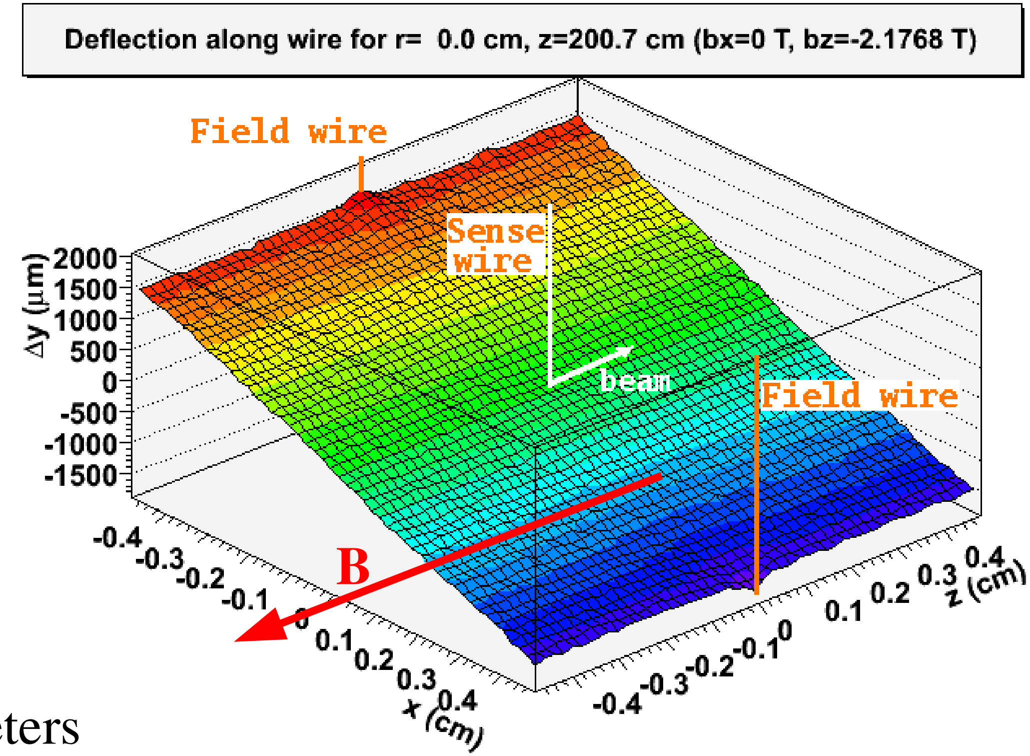
Readout Electronics

- Significant number of channels
  - 10368 strips, 2304 anode wires
- ASICs → amplification of cathode/anode signals at chamber
  - Pulse-shaping with tail cancellation
  - 0.8 mV/fC gain for anode signals, 3.9 mV/fC gain for cathode signals
  - Anode signals discriminated (same chip, different function)
- Preamplifier daughter boards allow for easy maintenance
- Signal digitization
  - Anode wires: F1 TDCs (120 ps LSB)
  - Cathode strips: 125 MS/s Flash-ADCs



Effect of Magnetic Field

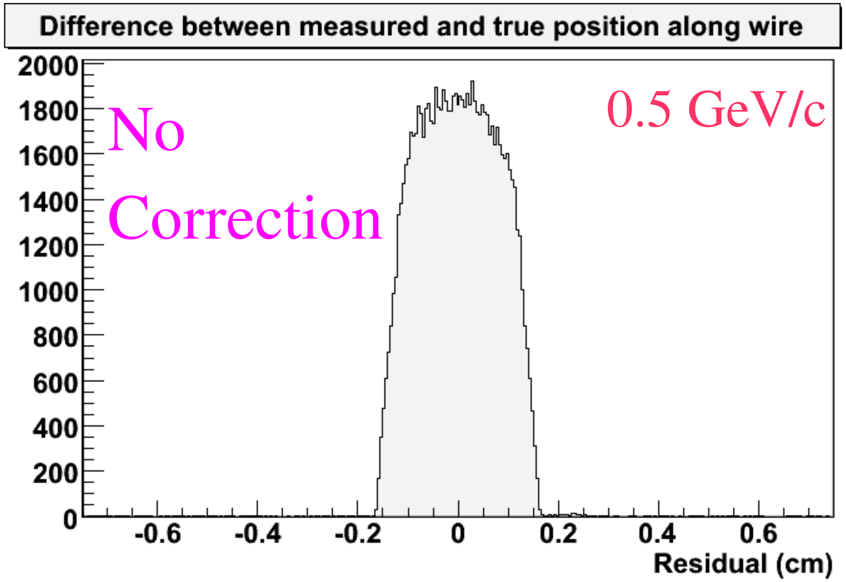
- Lorentz force causes deflection of avalanche position along wire relative to B=0 ("Lorentz Effect")
  - Effect can be minimized with appropriate choice of gas mixture
  - Amount of deflection along wire well-characterized by a plane for 40% Ar / 60% CO_2



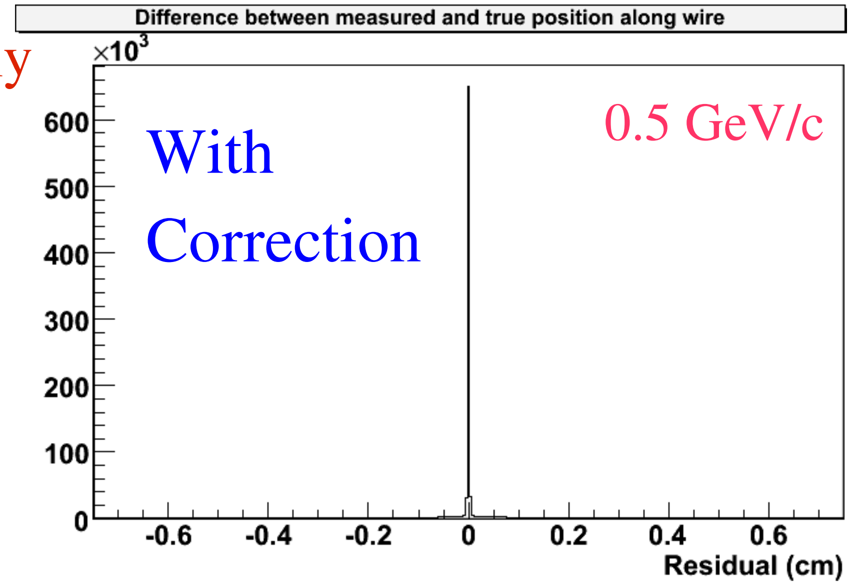
- GARFIELD calculations using map for full magnetic field
  - Created table of deflection parameters describing planes as function of r and z (position along beam line)
  - Code interpolates deflection from table assuming ionization point at distance of closest approach to the wire

Correcting for the "Lorentz Effect"

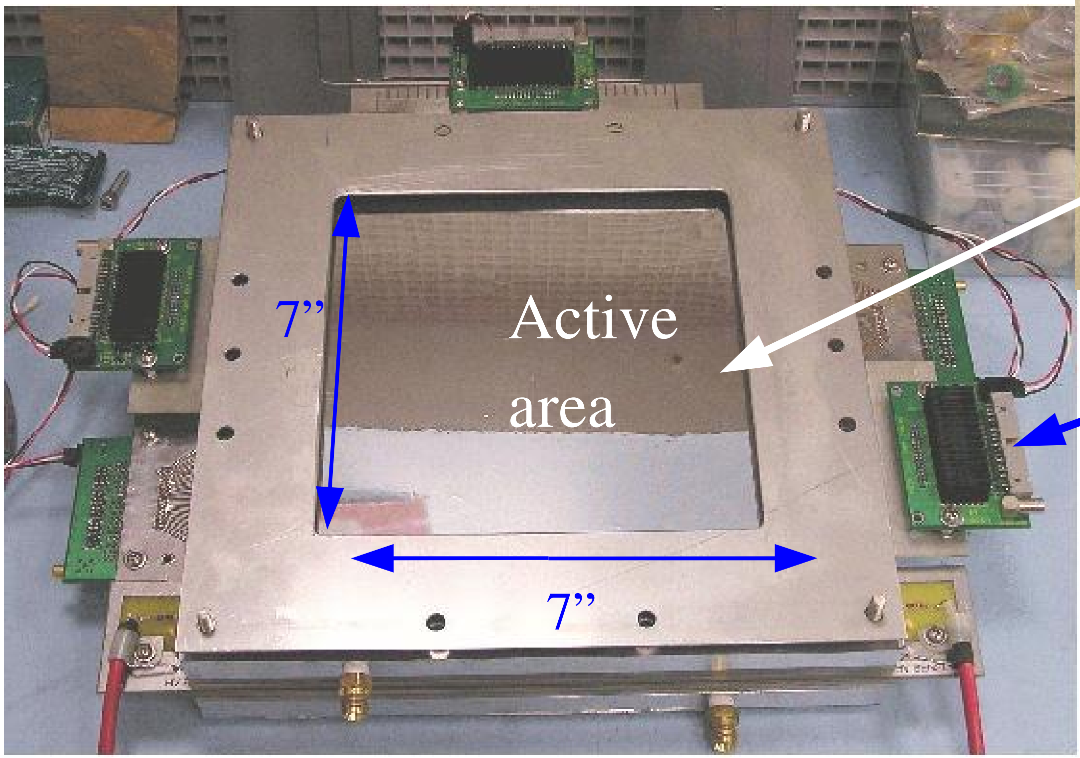
- Simulated π^+ tracks incident on FDC packages (θ =1°– 19°)
  - Lorentz effect on in simulation
    - Direction of deflection depends on side of wire π^+ passes through gas volume
    - No additional position smearing

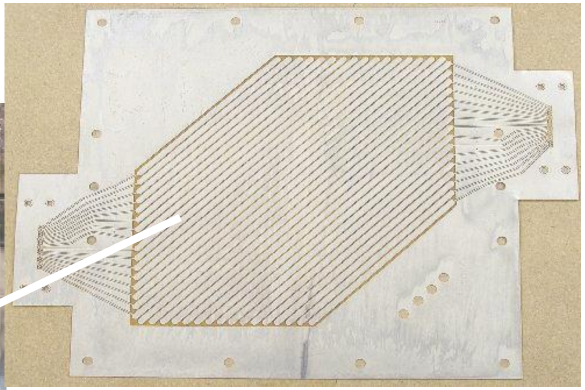


- Reconstruction: resolve ambiguities locally
  - Fit track segments within single FDC package
  - Interpolate correction from table obtained with Garfield



Small-scale prototype



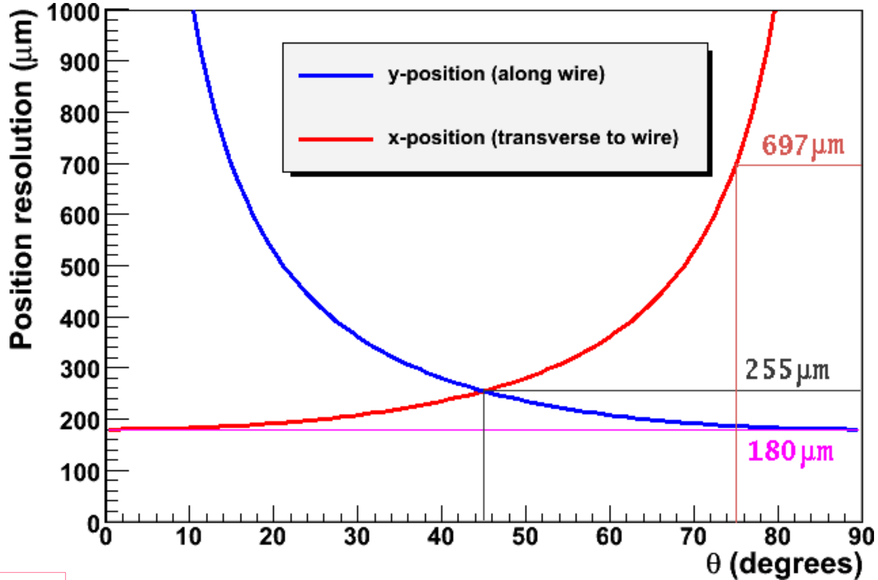


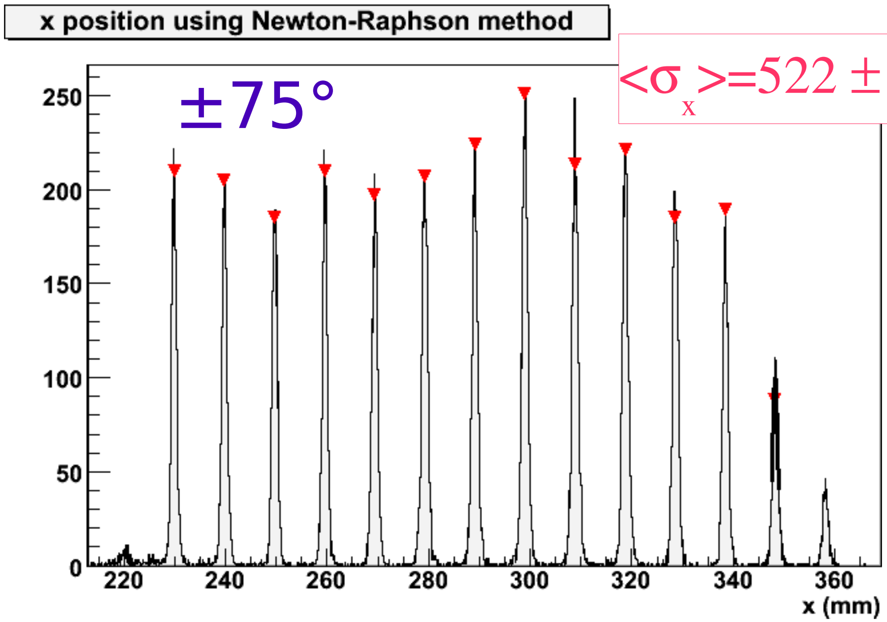
- Preamplifier boards
  - Gain ~2.3 mV/µA
  - No pulse shaping
  - No tail-cancellation
- Gas mixture:
  - Nominal: 40% Ar / 60% CO_2

- Readout for cathode strips: CAEN V792 charge-integrating ADCs
- Readout for sense wires: F1 TDC (pipeline)

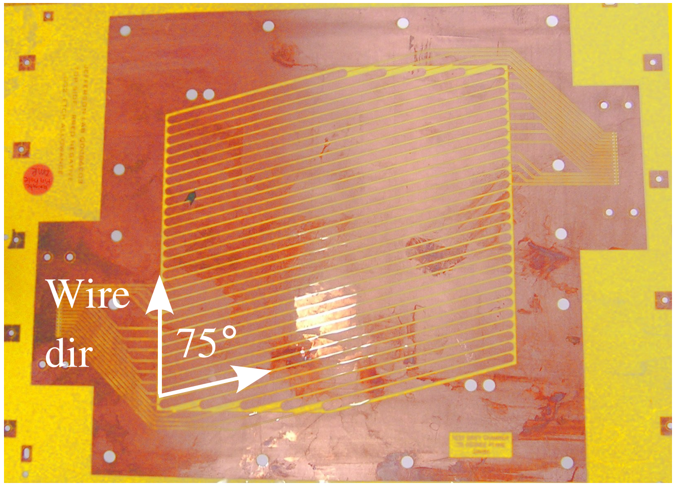
Choice of Wire/Strip Angle

- Imaging the wires: at ±45°, measured 255 μm resolution
- Tune angle between strips and wires
  - Trade off ability to associate wires and strips vs. position resolution along wire
    - ~35% position resolution improvement along wire possible relative to ±45°





$<\sigma_x>=522 \pm 12$ μm



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...