TPC Studies at University of Victoria

ALCPG meeting
SLAC, January 2004

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University of Victoria / TRIUMF
Outline

- Victoria group & TPC
- Reminder of GEM defocusing
  - Results from TRIUMF magnetic field tests
- Update since Cornell
  - Results from DESY magnetic field tests
- Plans for the coming year
Victoria TPC R&D

Victoria TPC Group:
- D.K.
- Research associate: Paul Poffenberger
- Graduate students: Gabe Rosenbaum, Thanos Michailopoulos

Victoria TPC:
- 30 cm drift, double GEM, 2x7 mm² pads, STAR electronics
TPCs with GEM readout

- Even with very low transverse diffusion in the drift volume, relatively wide pads (few mm) can be used with GEM readout:
  - Use gas diffusion between the GEMs to spread the charge over a larger region
    - Since the defocusing occurs during and after the gain stage, the track resolution is not sacrificed
    - For the best two-particle separation, defocus as little as required

![Diagram of TPC with GEM readout](image)
Example: P5

Transverse Diffusion (cm/√cm)

Drift

Transfer

Induction

E (kV/cm)

B=0.05T

B=1.0T

B=5.0T
Limited defocusing

- Minimum defocusing required to retain track resolution:
  \[ \sigma \approx \frac{1}{4} \text{ pad width} \]

- Charge sharing typically over 2 pads:
  - Important to account for non-linear sharing
  - Track fitting is performed by maximum likelihood:
    \[ x_0, \phi_0, \sigma, r^{-1} \]
First GEM-TPC tracking in B fields

- TRIUMF tests (0 – 0.9 T)
Example events at ~ 25 cm drift

- Gas: P10

0 Tesla

- $\sigma = 2.3 \text{ mm}$

0.45 Tesla

- $\sigma = 1.2 \text{ mm}$

0.9 Tesla

- $\sigma = 0.8 \text{ mm}$
Tracking resolution (preliminary)

- Fit track to all but one row:
  - fix $\phi_0$, $1/r$, and $\sigma$, fit to one row alone
  - $x_0$ residual fit to Gaussian

Resolution vs. Drift Distance

TDR spec. goal

B = 0
B = 0.45 T
B = 0.9 T

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Comparison with MC simulation

- Simple simulation of GEM operation
- Good agreement with data
- Preliminary results...

Resolution vs. Drift

- B = 0
- B = 0.45 T
- B = 0.9 T

3 cm Drift time (50 ns bins) 30 cm
DESY tests (0 – 5.3 T)
Example events at ~ 25 cm drift

- Gas: P5

B=0T  B=0.9T  B=2.5T  B=4.5T
Tracking resolution (preliminary)

- B = 0
- B = 0.9 T
- B = 1.5 T

Resolution (mm)

Drift time (50ns time bins)

3 cm, 30 cm
Preliminary results

- Tracking resolution $\leq 100 \, \mu m$ for all drift distances for $B \geq 1.5 \, T$
  - Further improvement for higher fields not yet realized...

- Defocusing values larger than expected
  - Maintain $\sigma \approx \frac{1}{4} \nu$

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<th>$B(T)$</th>
<th>$\sigma_0$ (mm)</th>
<th>$\text{sim } \sigma_0$ (mm)</th>
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<tr>
<td>5.3</td>
<td>0.51</td>
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Plans for the coming year…

- Full analysis of DESY/TRIUMF data sets
- Further modification of STAR readout electronics:
  - Remove baseline ramp-up during first 0.5 μs
    - Remove reset of preamp at each trigger
  - Remove ion tail correction
- Try out micromegas readout (Purdue/3M), with resistive anode to spread signal
  - Build a second readout endplate for quick change between GEM and micromegas
Plans for the coming year…(cont.)

- Prepare for laser tests in 5T DESY magnet
  - Build a new outer acrylic cylinder with quartz windows
  - Design remote laser transport optics for use in DESY magnet (2 cm clearance)
  - Perform laser tests without field in Canada
  - If all goes well, bring system to DESY (late summer 2004?)
    - Study distortions with single tracks: calibration
    - Demonstrate 2 track resolving power
    - Examine distortions from ion feedback
    - Compare GEM and micromegas readouts