Performance Studies of Micromegas detectors under the influence of Magnetic Field

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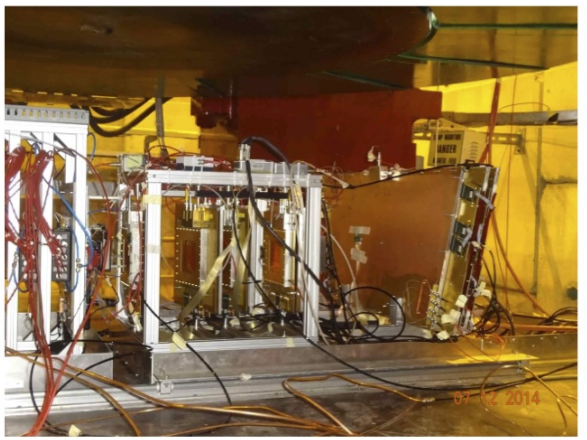
Outline I

Goal of the analysis

- Goal of this analysis $\rightarrow$ Study of the MicroMegas detector performance in magnetic field
- Test Beam @SPS, H4, CERN, December 2014
- Muon / pion beams -150 GeV
- Goliath Magnet $\rightarrow$ B range: -1 to 1 T

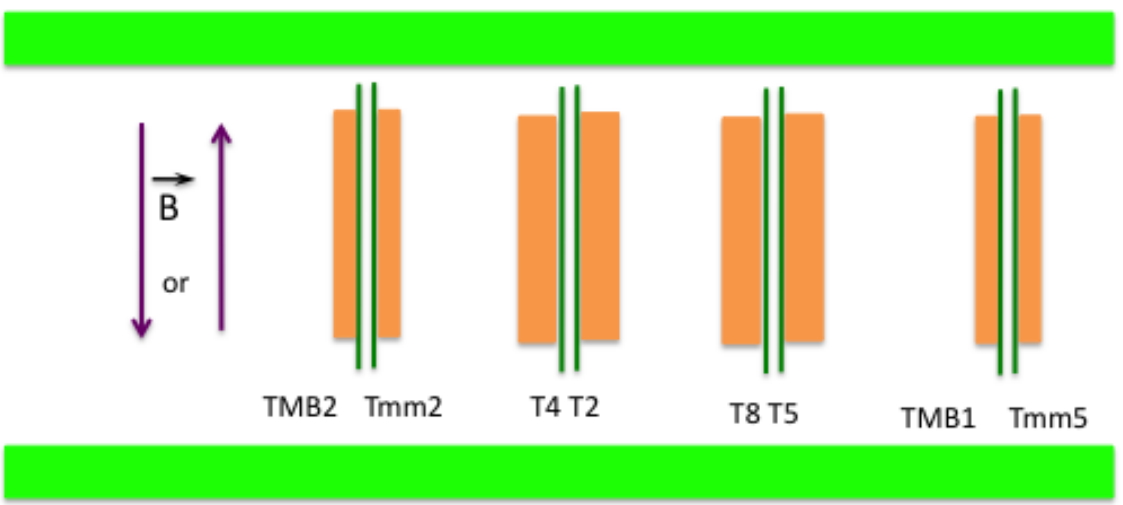
Test Beam Setup

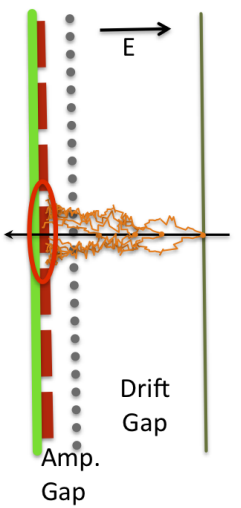


- Goliath Magnet $\rightarrow$ almost uniform **B** field in two polarities
- MMSW2 and a hodoscope with 8 MM chambers arranged in 4 doublets.
- Analysis focused on the hodoscope chambers.

Test Beam Setup

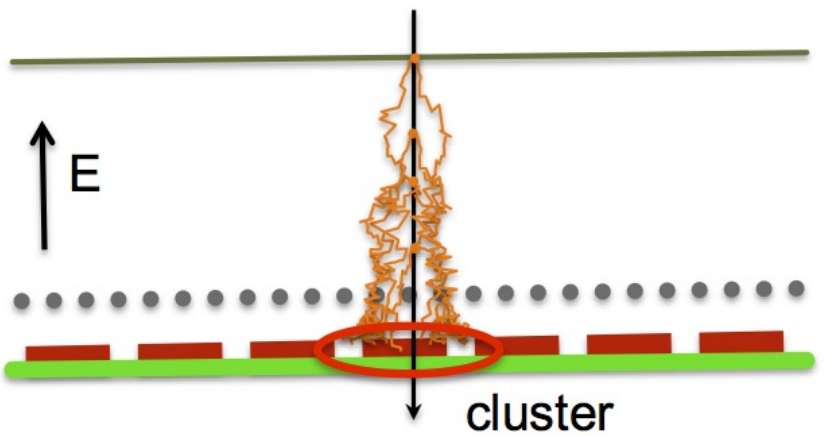
chamber	Strip Pitch(mm)	Drift Gap(mm)	Pillar Pitch(mm)	Pillar Diameter(μm)
Tmm5	0.250	2.5	5	500
Tmm2	0.250	2.5	5	500
T5	0.400	5.0	5	500
T8	0.400	5.0	5	500
T2	0.400	5.0	5	500
T4	0.400	5.0	5	500
TMB1	0.250	2.5	2.5	300
TMB2	0.250	2.5	2.5	300





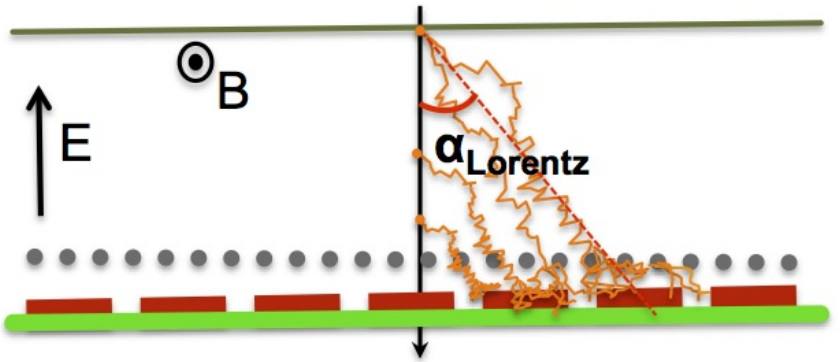
Operation of MicroMegas

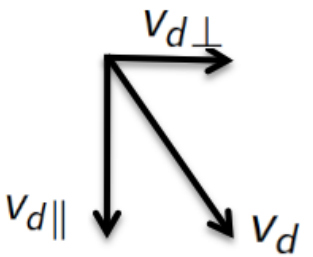
- Electrons drift following the **E** lines
- Charge collected to the strips
- Strips fired forming a cluster
- Cluster centroid corresponds to the track hit



Operation of MicroMegas inside B

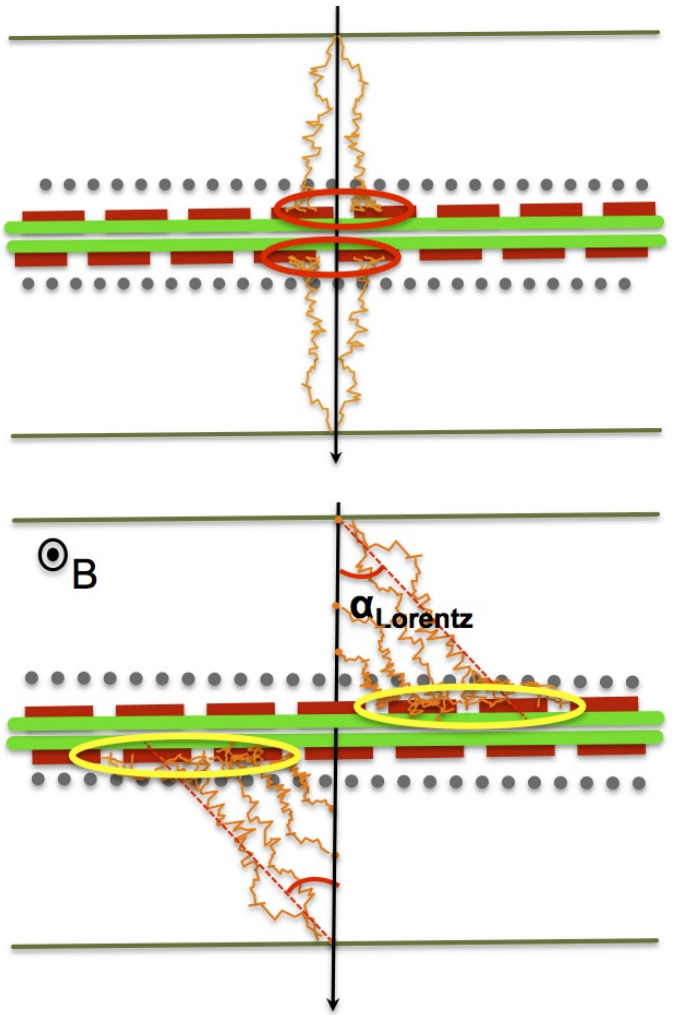
- The **B** tilts drift lines by the Lorentz angle with respect to the **E**
- **B**$\perp$ **E**
- $tan\alpha_L = \frac{v_{d\perp}}{v_{d\parallel}}$





Back to back configuration

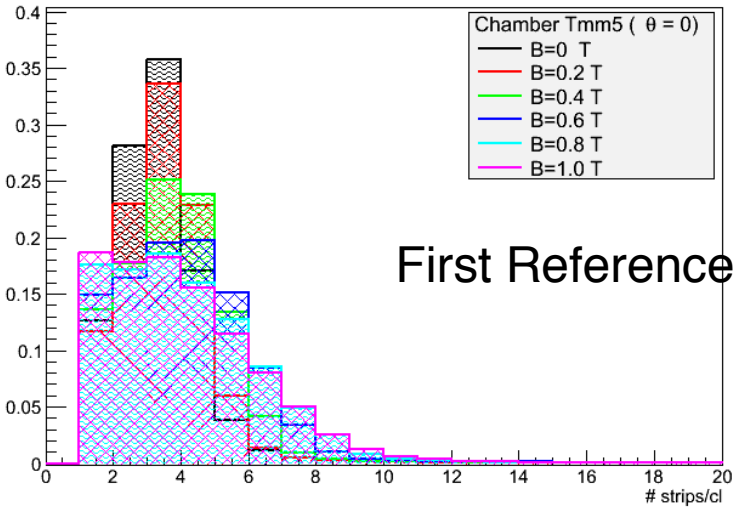
- Similar to NSW configuration in quadrplets
- Back to back cancels some systematics
- Without **B**
  - Hit position is used for the alignment
- Inside **B**
  - Clusters are wider
  - Displaced in opposite directions
  - Hit position with μTPC method



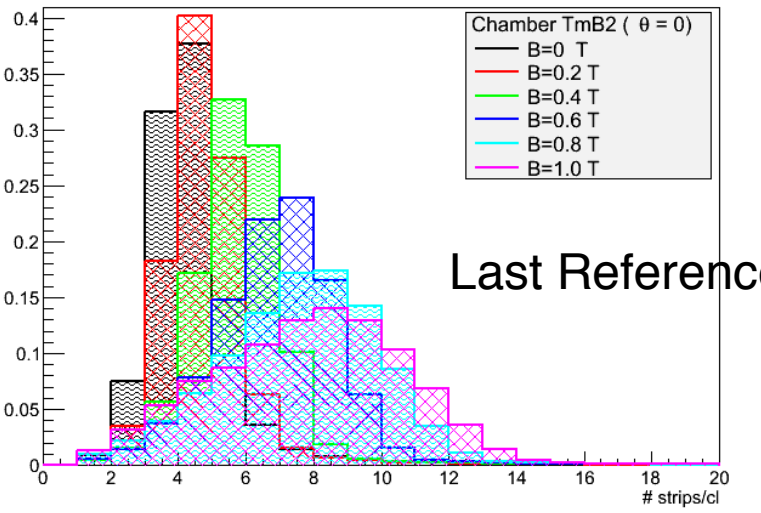
Analysis Flow

- Start from Raw Data, only $\theta = 0$
- Crosstalk removal (Leontsinis et al. algorithm)
- Reconstruction from raw data (Recomm)
  - For each fired strip $\rightarrow$ stripID, time, charge (by fitting the signal)
- Clustering (topological)
  - Number of strips/cluster Vs. distance
- Alignment of the chambers with straight tracks (B=0)
  - Iterations after moving the chambers (offline)

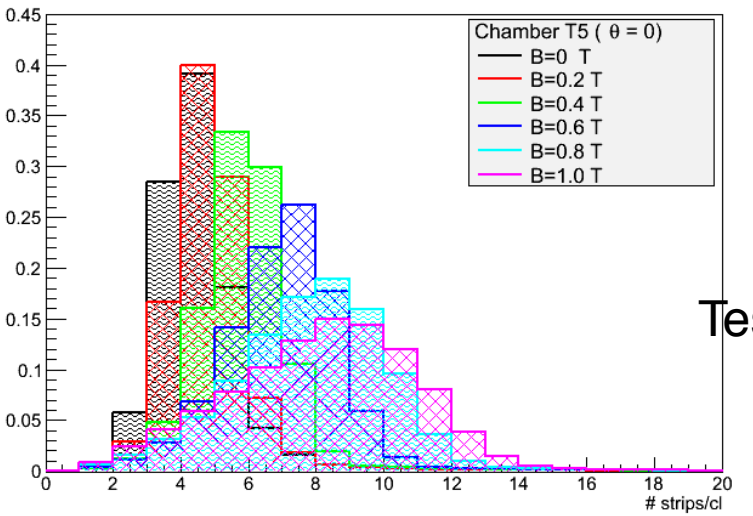
Strip Multiplicity per cluster



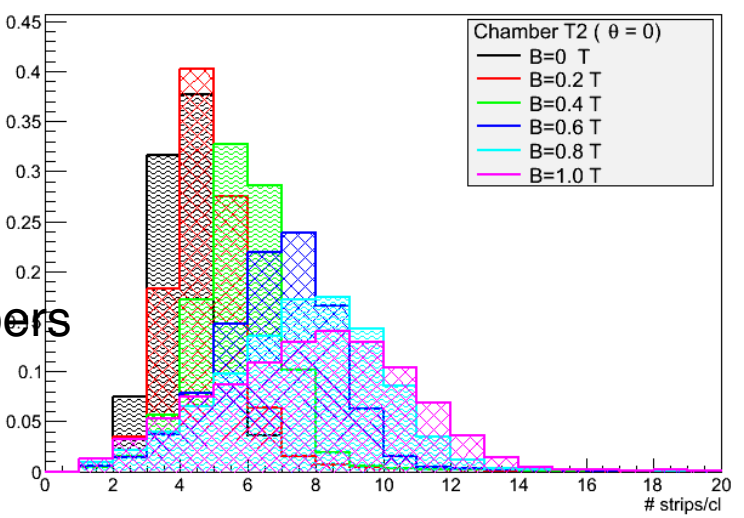
First Reference



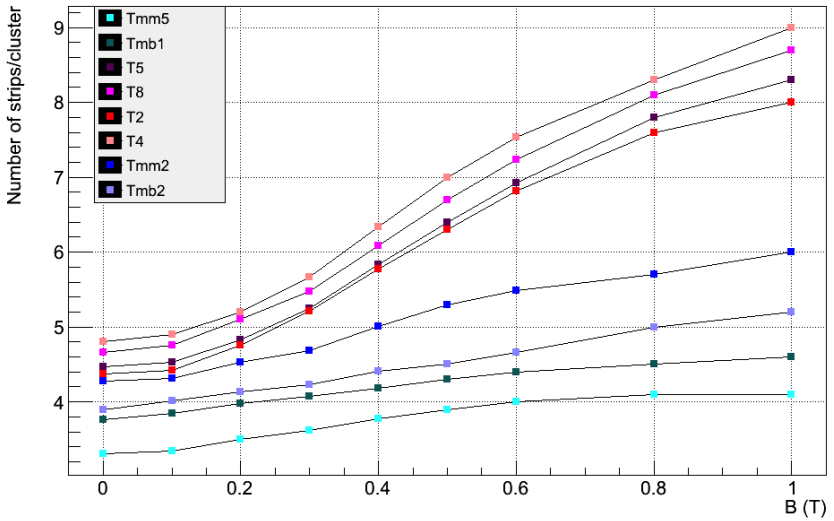
Last Reference

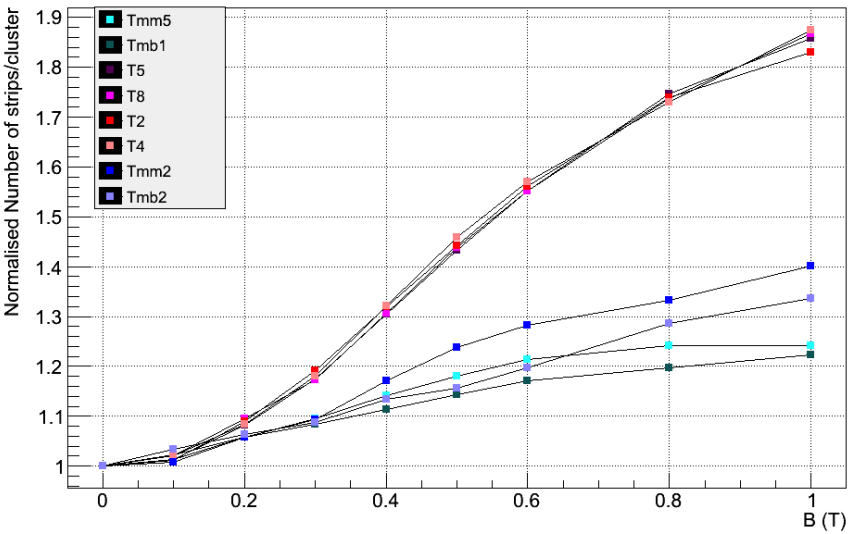


Test chambers

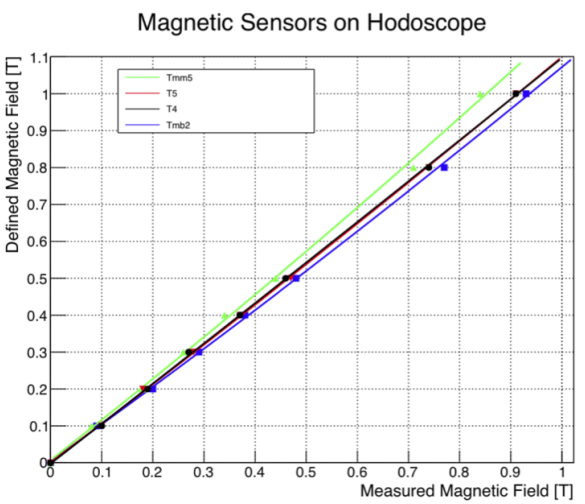


Cluster size Vs. B



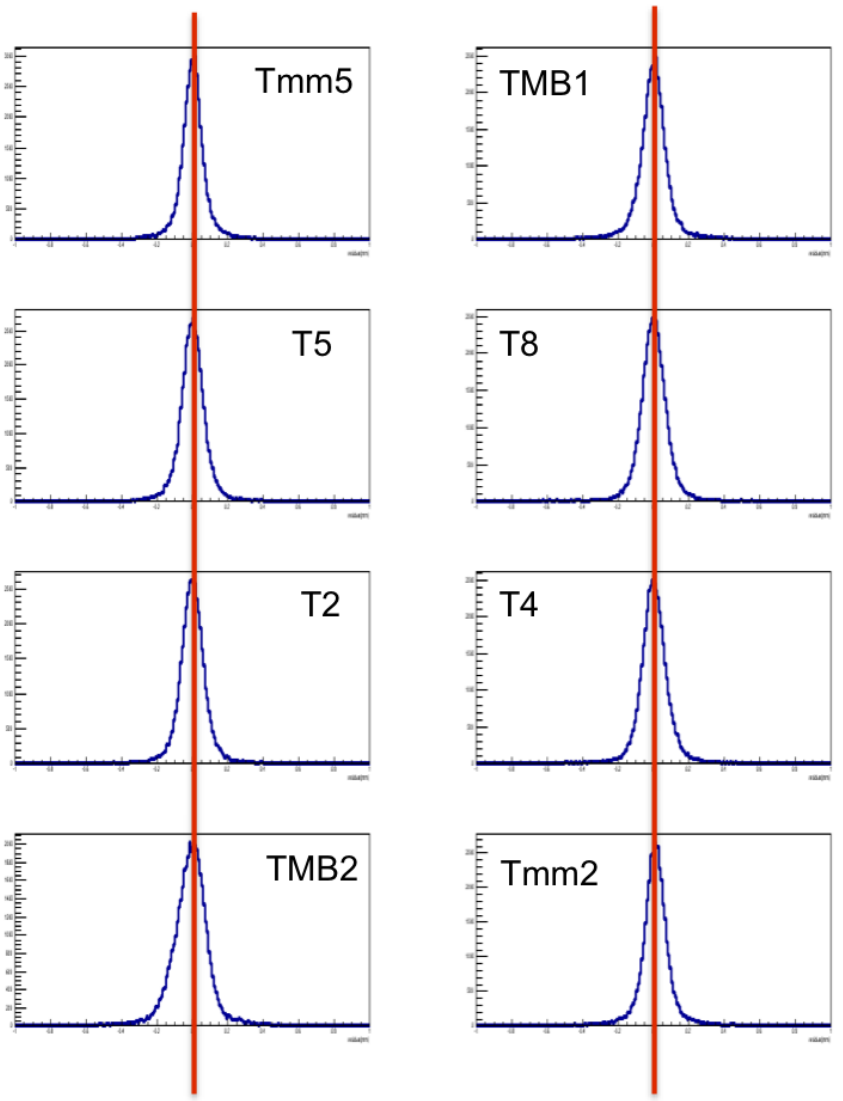


- B measured on the 4 doublets
  non uniformity of level 10%,
  as seen in K. Ntekas' presentation



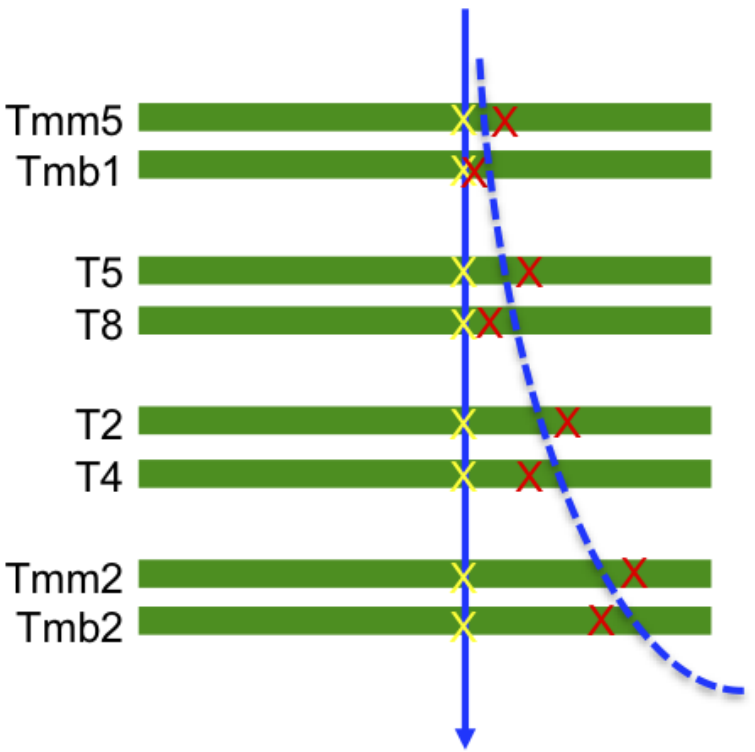
Chamber Alignment

- Track reconstruction
  - at least 6 chambers
  - events with 1 cluster
- Residuals distribution for every chamber
- Chamber shifting according to gaussian mean
- Repeat track reconstruction with new chamber position
- After few iterations $\rightarrow$all chambers aligned within few microns



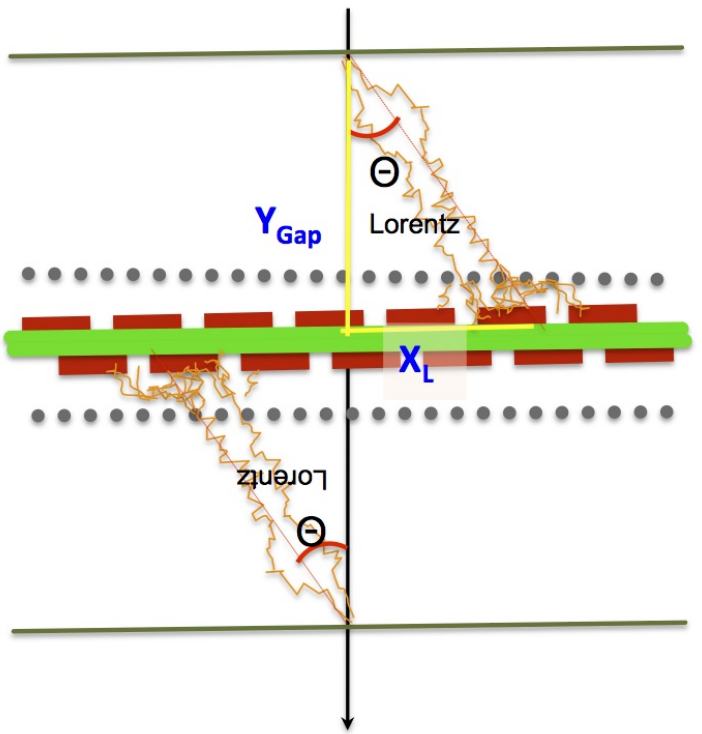
Back to back geometry in Magnetic Field

- D_1: Hit position in 1st chamber in doublet
- D_2: Hit position in 2nd chamber in doublet
- X_B: Beam deflection
- X_L: Displacement due to Lorentz angle



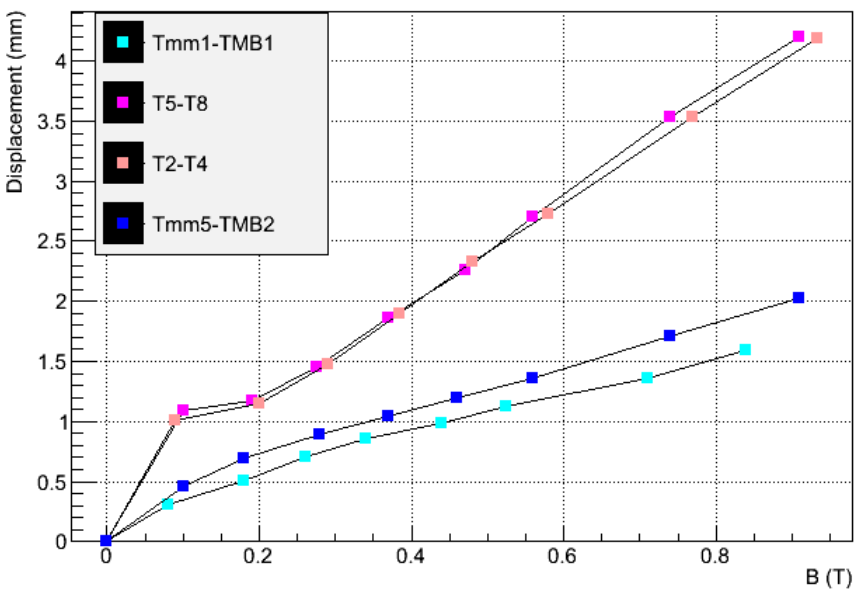
Lorentz angle – Beam Position

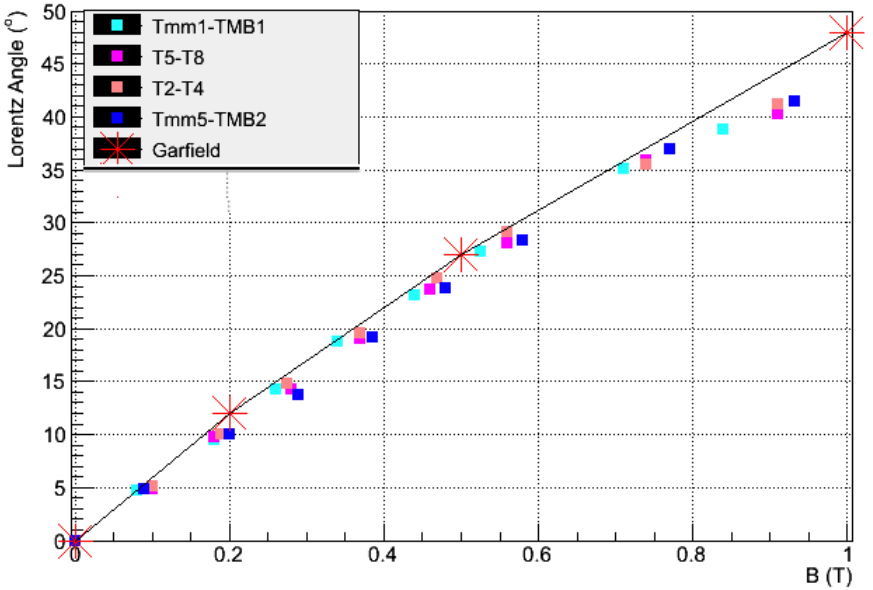
- $\left.\begin{aligned} D_1 &= X_B + X_L \\ D_2 &= X_B - X_L \end{aligned}\right\} X_L = (D_1 - D_2)/2$
- $\Theta_L = atan\frac{X_L}{Y_{Gap}}$
- $\left.\begin{aligned} D_1 &= X_B + X_L \\ D_2 &= X_B - X_L \end{aligned}\right\} X_B = (D_1 + D_2)/2$



Lorentz Angle reconstruction

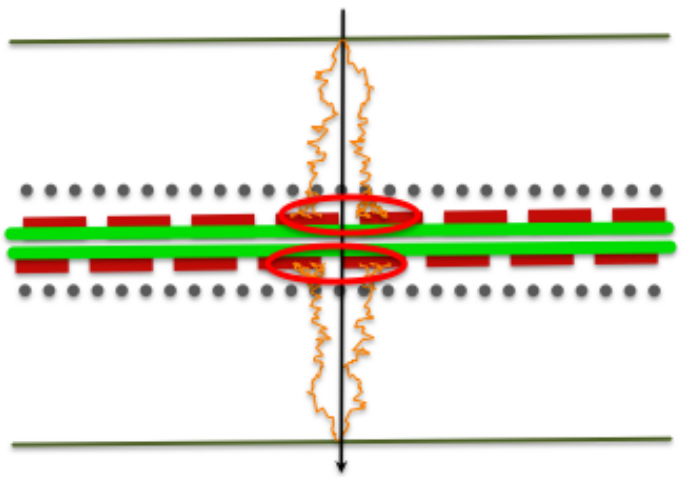
- Lorentz angle can be reconstructed using
  - Cluster displacement and
  - Drift Gap
- Results consistent with Garfield prediction.



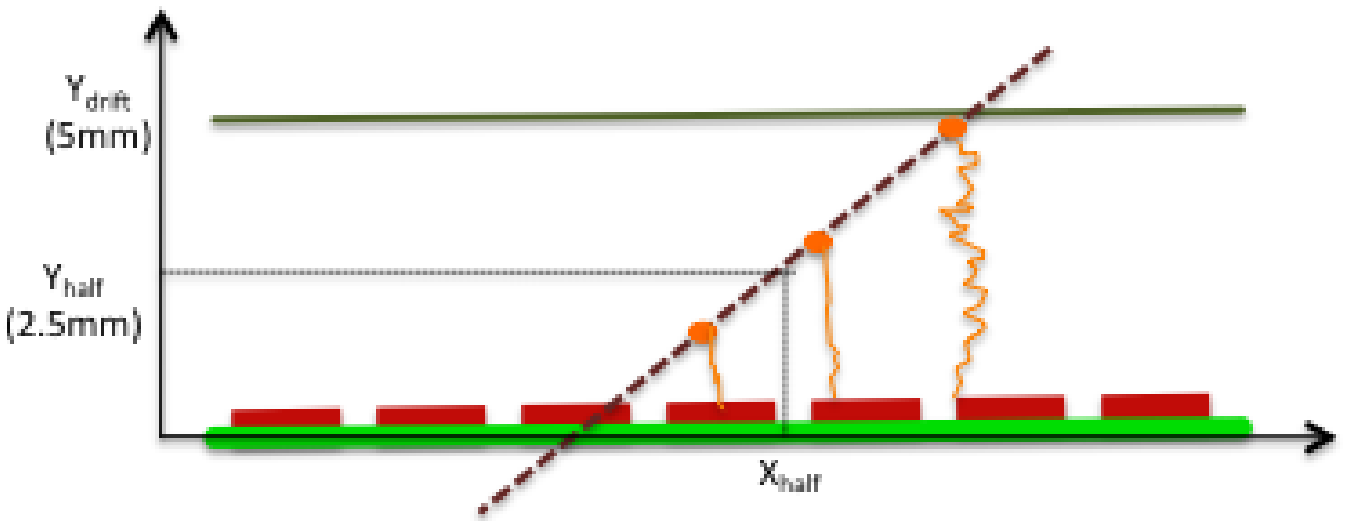


Spatial Resolution

- Resolution is obtained from the gaussian σ of the *hit* difference of two back to back chambers: $\sigma(x) = \frac{\sigma_{gaus}}{\sqrt{2}}$
- For small incident angles $\rightarrow$ hit position defined by cluster centroid, $x_i = \frac{\sum x_i Q_i}{\sum Q_i}$

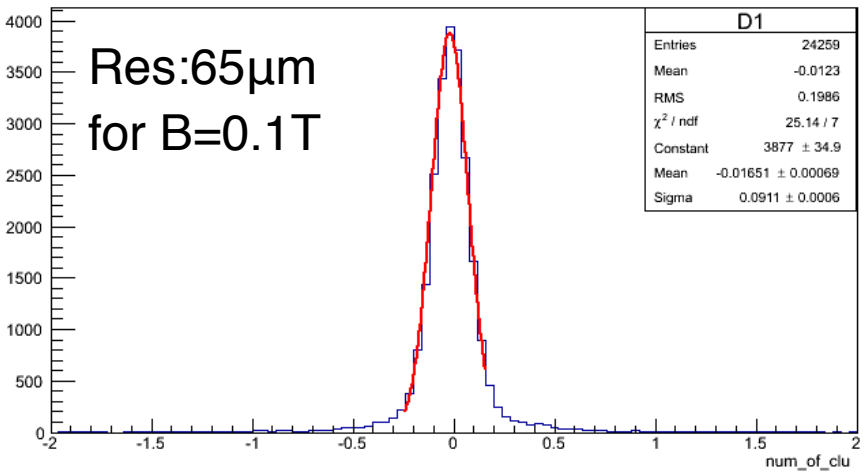


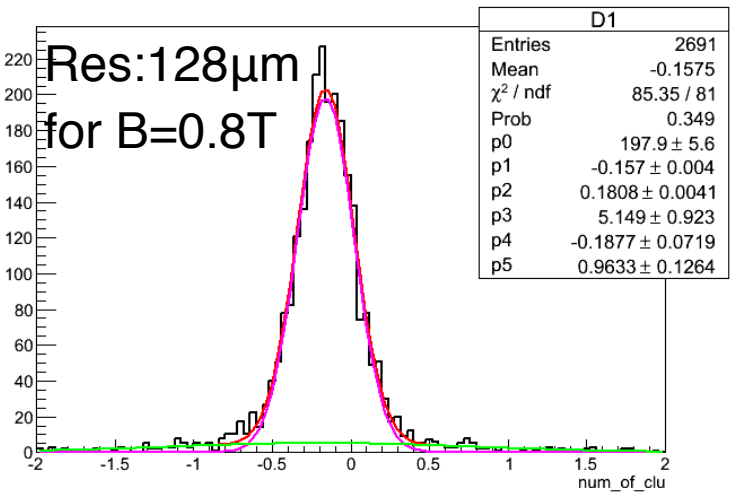
- For larger incident angles ($> 10°$) $\rightarrow$ hit position defined by μTPC method. A tracklet is reconstructed in the drift gap using the time information of the signal and the x_{half} (the x in the middle layer) is considered as the hit position.



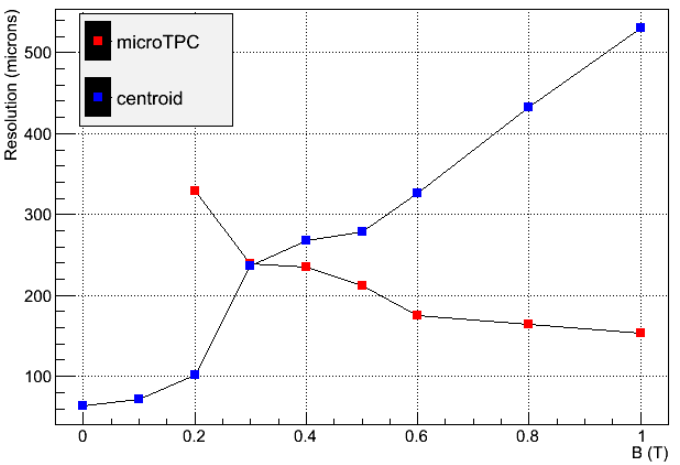
- For $B > 0.1$T, use of μTPC even for perpendicular tracks

Spatial Resolution





- Resolution improvement: One hit position is computed for each doublet, and the difference of the doublet hits is used to find the resolution.
(proposed by C. Bini)



Conclusion

- The results of the test beam of MicroMegas in magnetic field are well understood.
- Results are in agreement with the simulation as well as the expectations from the previous test beam results.
- Room for improvement in μTPC method
- Further studies with inclined tracks are in progress