Analysis of Micromegas Detectors using Test Beam Data

Catching electrons with a colander

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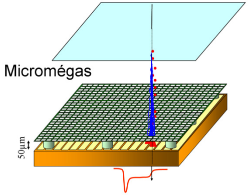
Description

Micromegas [1, 2]

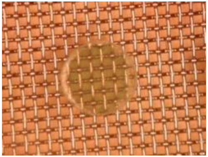
- MICRO-MEsh-GAseous Structure
- Gaseous detector
- Charged particles ionise gas
- Drift voltage to catch electrons
- Amplification voltage (high) to multiply ionisation



Micromegas sketch

Advatages

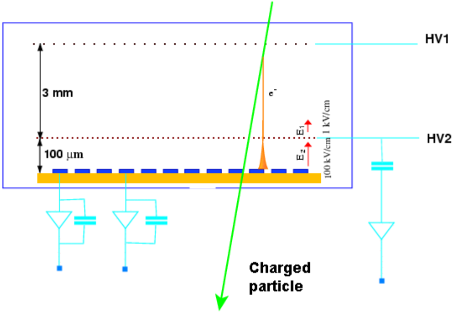
- High resolution ($\approx$ 50 µm, down to 12 µm [2])
- Fast signal ($\approx$ 100 ns [2])
- Radiation hardness



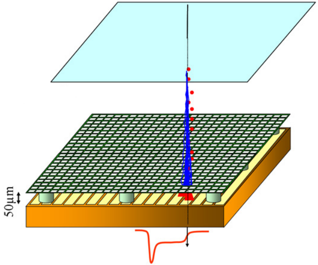
The micro-mesh

Proposed to be used for the ATLAS NSW (endcap muon spectrometer) in phase-I upgrade

Micromegas

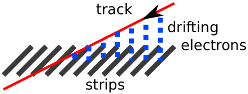


(a) Sketch of Micromegas functioning [3]



(b) Insight in Micromegas [4]

- Tracks produce signal in multiple strips (cluster)



- Use timing to get track angle

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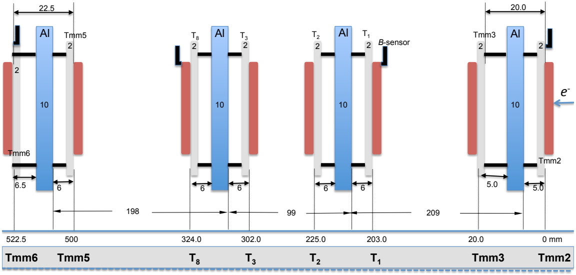
Detector setup



Valid run>= 10102 after 12:00 13.06.2013

TEST BEAM SETUP Jun2013 (10.06.2013 – 19.06.2013), small Freiburg frame

- Beam: Electrons with 1-5 GeV
- Magnetic field: 0-1 T in x-direction
- Different angles possible for certain chambers

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Analysis

- Detector Alignment
  - Crucial for resolution calculation
  - Using χ^2 minimisation: $\chi^2 = \sum_{\text{tracks}} \chi_i^2(\{y_d\}, \{z_d\})$
  - y-alignment: Easily done
  - z-alignment: Very difficult
    - Did not converge
    - Solution: Iterative alignment (select best events, align, repeat)
  - Alignment tested with simulated data
  - Other alignments conceivable (angles, etc.) presumably difficult
- Observables
  - Detector resolution
  - Particle momenta (in magnetic fields)
  - Beam properties
    - Beam energy
    - Size / angular spread

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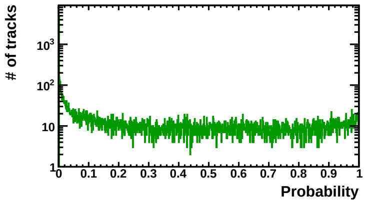
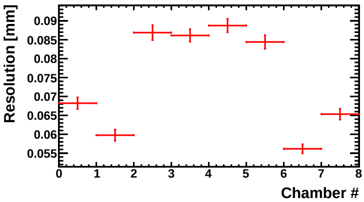
Results

Run 10102: 22137 events $E = 5$ GeV, $B = 0$, $\theta = 0$

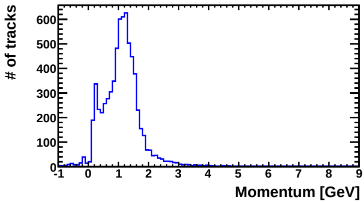


(a) Track probability distribution



(b) Detector resolution

Run 10204: 20626 events $E = 2$ GeV, $B = 0.8$ T, $\theta = 0$



(c) Momentum resolution

Outlook

What to do next?
Several ideas:

- Regard Lorentz angle in magnetic field
- Try alternative way of hit reconstruction (µTPC)
- Use angular information

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Thanks

Thank you for your attention.

References

- Y. Giomataris, P. Rebourgeard, J. Robert, G. Charpak, *MICROMEGAS: A High granularity position sensitive gaseous detector for high particle flux environments*, Nucl.Instrum.Meth. **A376**, 29 (1996)
- G. Charpak, J. Derre, Y. Giomataris, P. Rebourgeard, *MICROMEGAS, a multipurpose gaseous detector*, Nucl.Instrum.Meth. **A478**, 26 (2002)
- URL `http://irfu.cea.fr/Phocea/Vie_des_labos/Ast/ast_technique.php%?id_ast=471`
- URL `http://newsline.linearcollider.org/readmore_20061019_feature1%.html`

Questions?

Are there any questions?

Backup

$$\chi^2 = \sum_{\text{tracks}} \chi_i^2(\{y_d\},\{z_d\}) \tag{1}$$

Problem: Small percentage of tracks seems to be completely wrong, disturb the alignment.

Possible solution: Exclude tracks with very high χ^2 probability.

However: Introduces a bias; χ^2 depends on the alignment. We align using those tracks, that already fit best to the alignment we currently have...

To avoid this bias: An iterative approach

1. Select best 90% of all tracks (according to χ^2-probability). Typically 30% of the tracks have a very low χ^2 probability (10^{-3}).
2. Align the detectors with χ^2 minimisation.
3. GOTO 1. (repeat 5 to 10 times)