



Micro-MEsh GAsEous Detectors (MicroMegas)

Group No 23:

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Introduction

Particles

gamma, muons, electrons, ..



Interactions in detectors

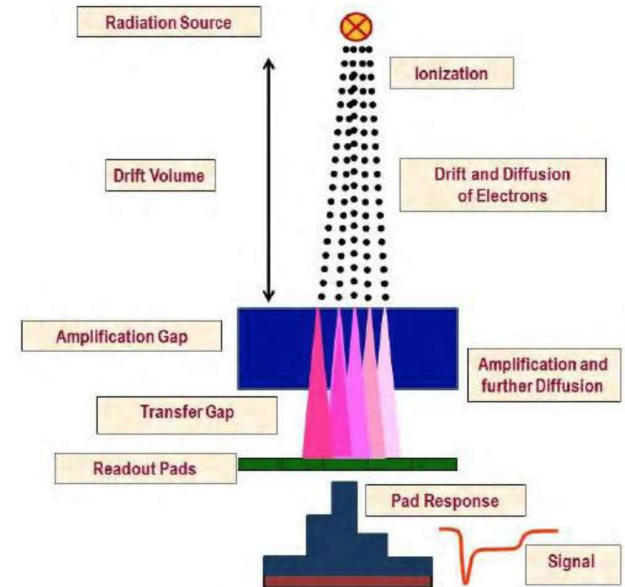
Ionization, excitation in: Semiconductor, scintillators, bubble, **gas detectors**, ...



Output signals

Gaseous detectors: MultiWire Proportional Chamber (MWPC), Micro Pattern Gas Detector (MPGD) such as **MicroMegas**, ...

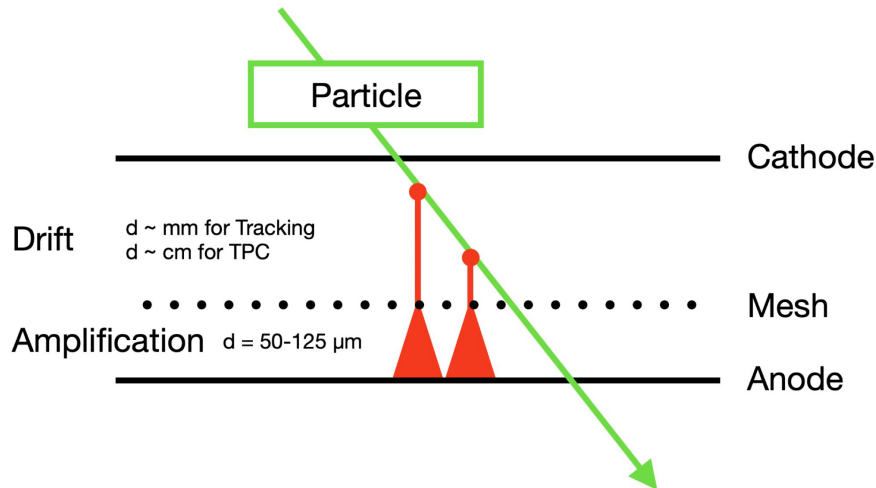
Provides information on Position, Timing, Tracking, and Imaging.



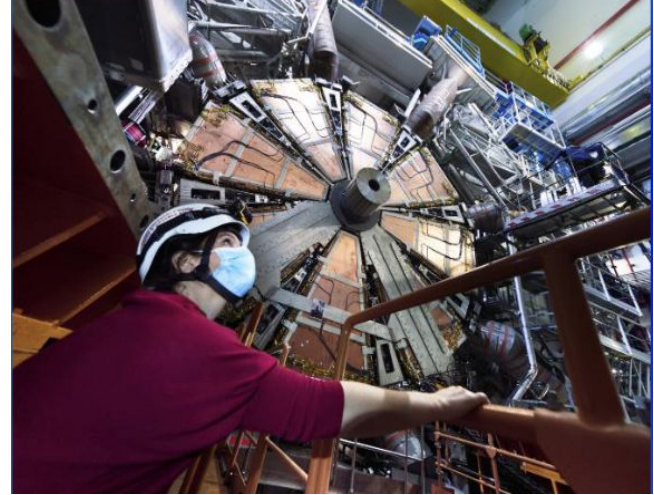
What are Micromegas ?

Parallel-plate chambers where the amplification takes place in a **thin gap**, separated from the drift region by a fine metallic mesh

- Short drift times and fast absorption of the positive ions
- Suited for high-rate applications.
- Time resolution: $\sim 5\text{-}10\text{ ns}$ (MIP)
- Spatial resolution: $\sim 60\text{ }\mu\text{m}$



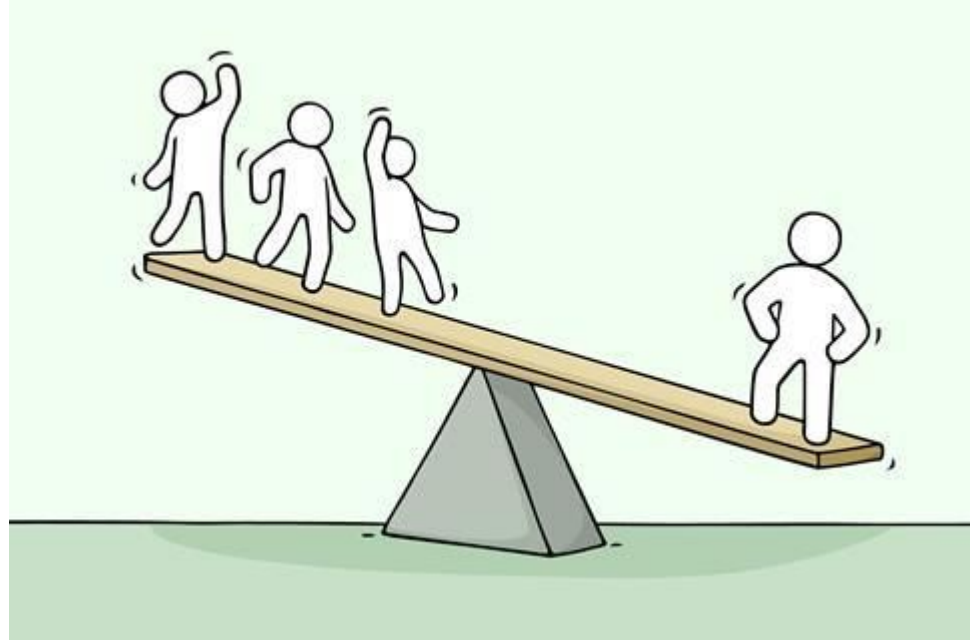
MMs in LHC upgrades



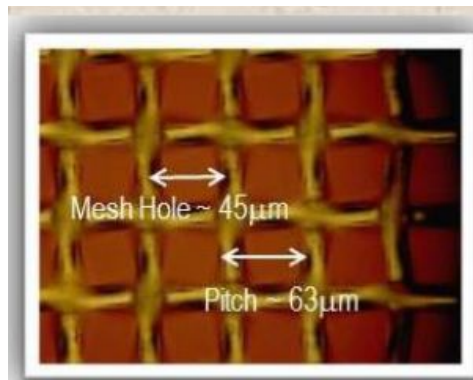
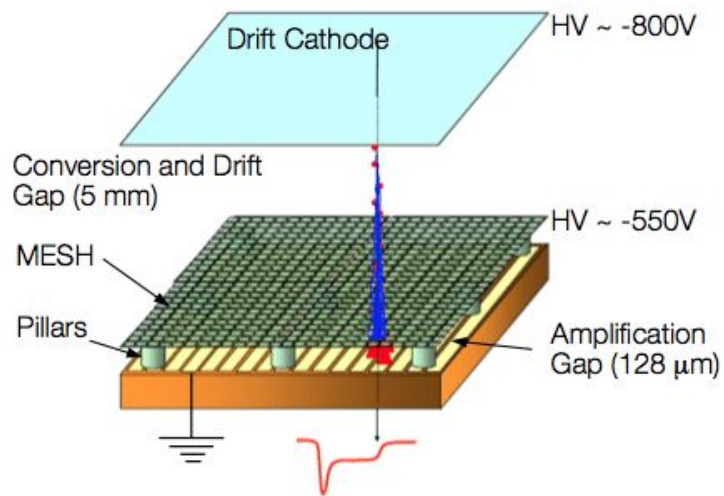
Close to 2000 Micromegas detectors were built with sizes up to 2m x 0.5m

Detector and its detection principle

- Detector construction
- Detection principle



MicroMegas structure

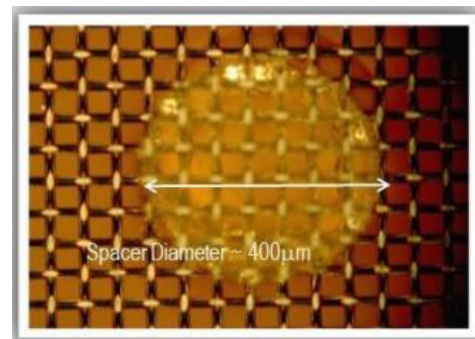


Mesh structure

- Parallel plate detector
- Composed of a very thin metallic micro mesh that separates cathode and anode.
- Regularly spaced insulating supports ensures the uniform electric field
- The field gradient at entrance of mehs hole, results funnel shape E filed.
- Funnel shape E $\rightarrow$ electron transparency ~ 1

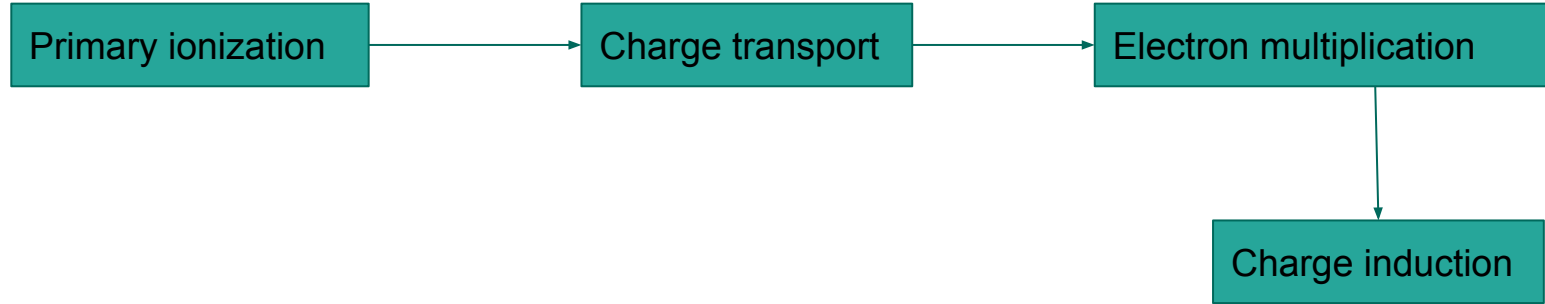
Standard configuration:

- Drift region E: **100V/cm**
- Amplification region E: **50kV/cm**
- Pillar diameter $\approx 350 \mu m$
- Mehs hole/pitch $\approx 45/63 \mu m$

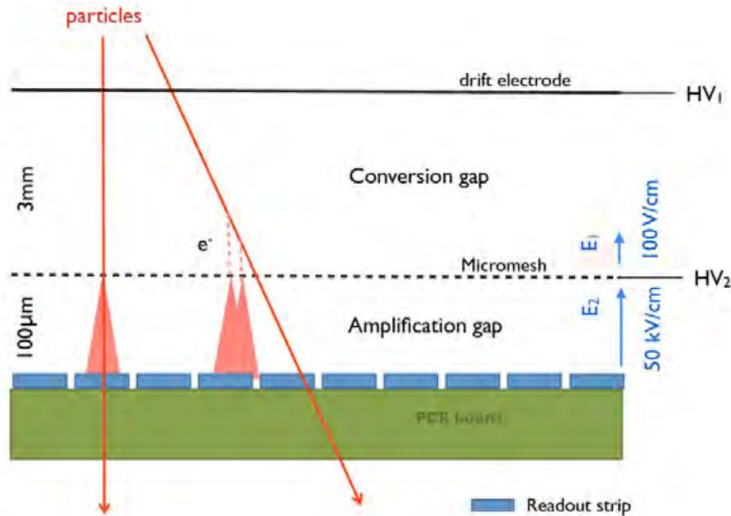


Mesh structure

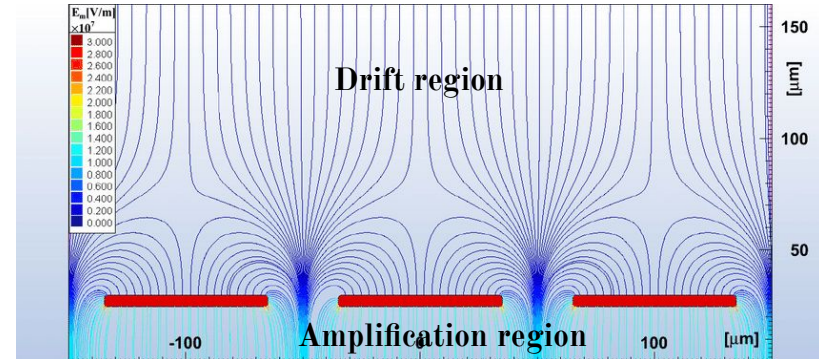
Working principle



Schematic diagram

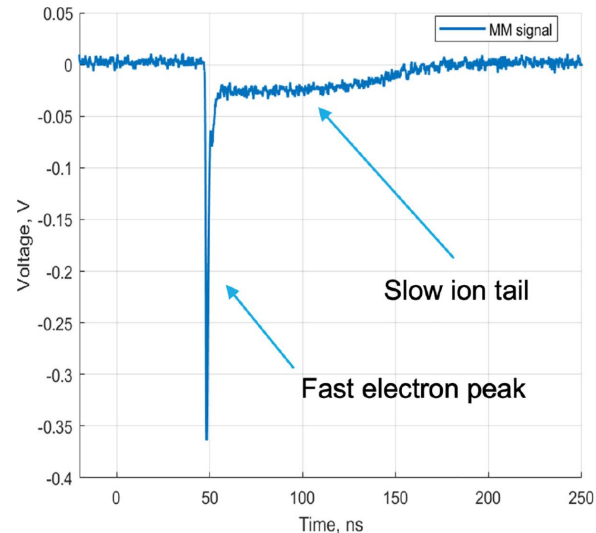
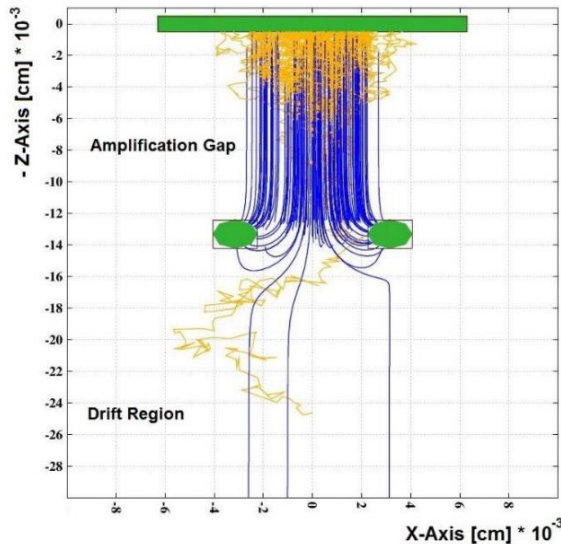


Electric field region



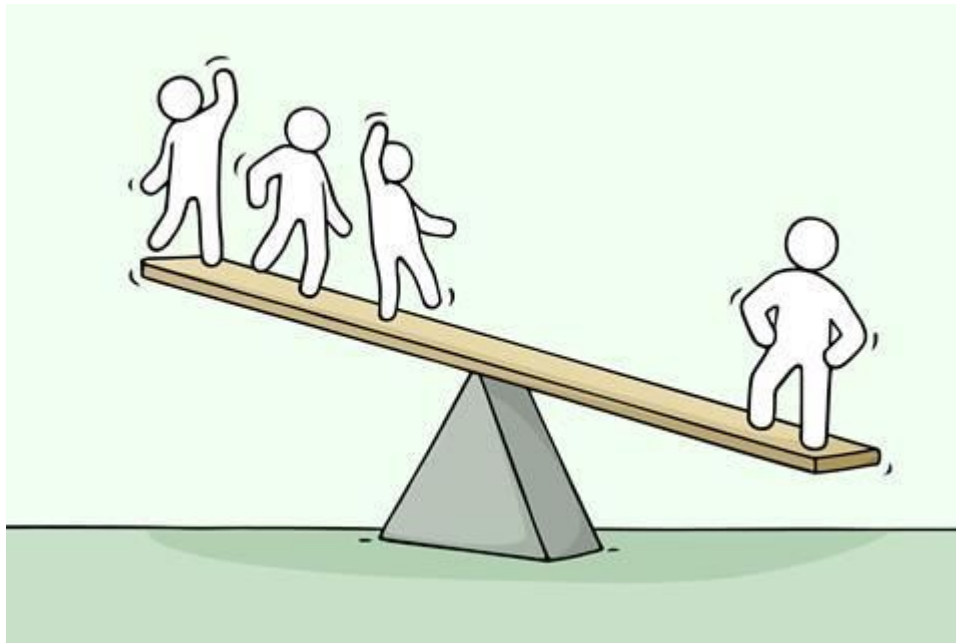
Ion FeedBack

- Ions drift velocity $\ll$ electron drift velocity; leads to slow pulse tail
- Micromegas provide an **intrinsic ion feedback suppression** due to the **highly asymmetric** fields between drift and amplification region
- **High Rate capability** $\rightarrow$ Good for high luminosity experiment



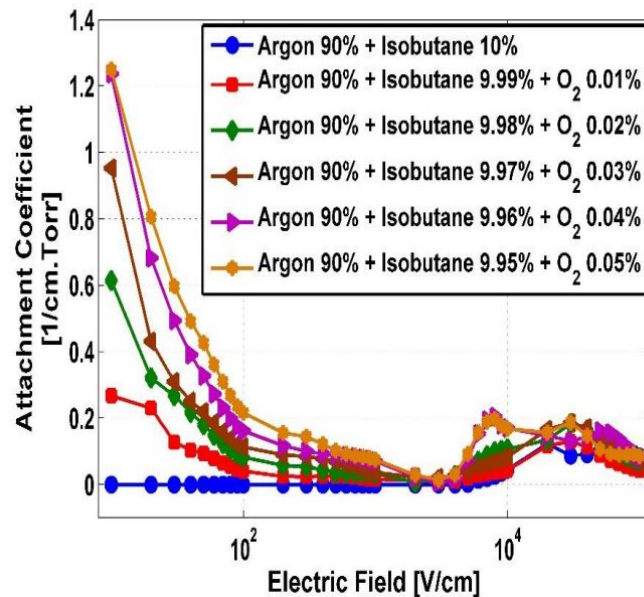
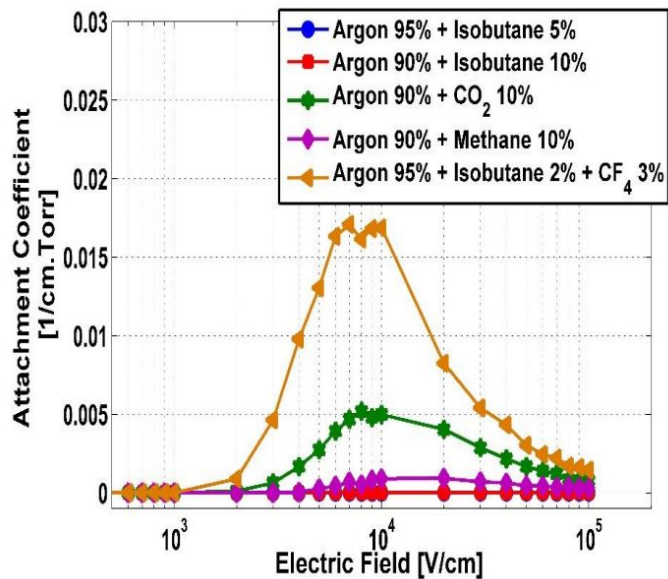
Optimization of MicroMegas

- Efficiency
- Transparency
- Uniformity
- Gain
- Position resolution
- Time resolution
- Energy resolution



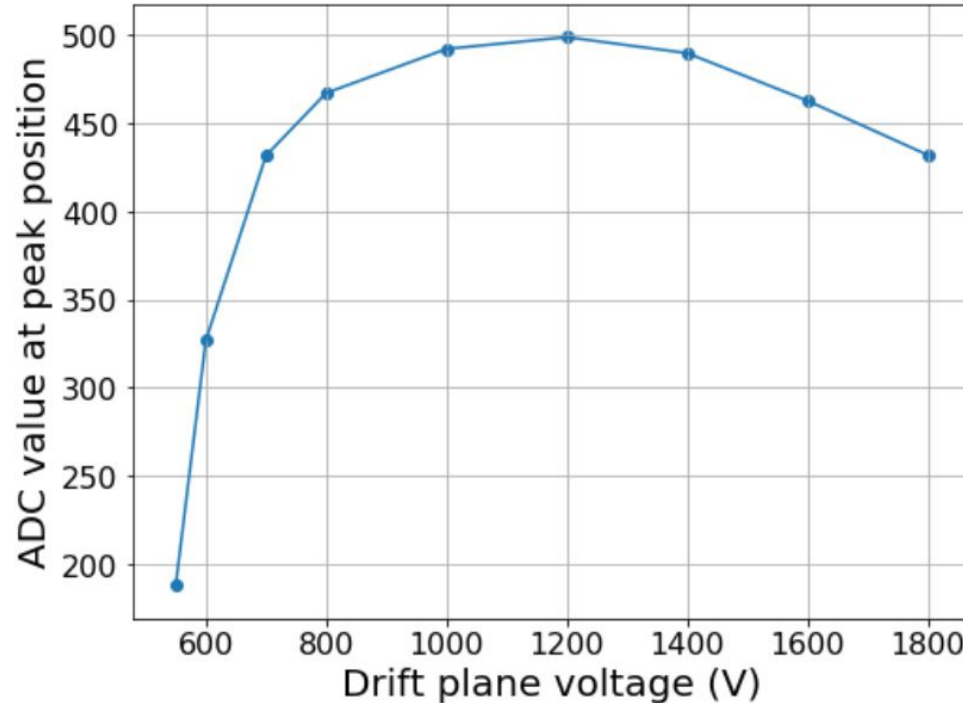
Optimization of MicroMegas...

Gas mixture used in our experiment: Ar:Isobutane = (90:10)



Characterization of MicroMegs

ADC Count at Peak vs. Drift Voltage



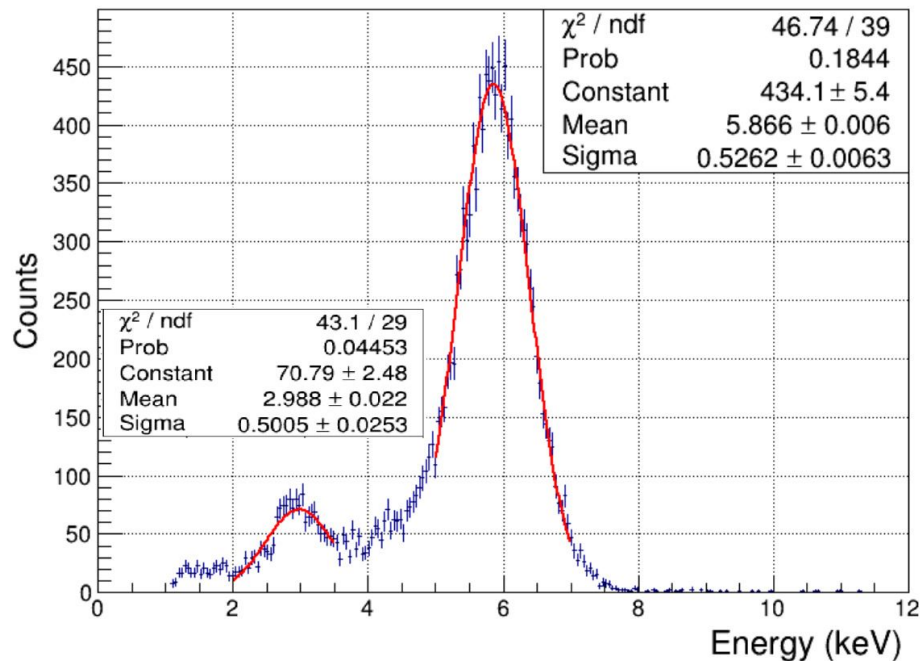
Fe-55 is used as a source and the count is taken for two minutes.

The Electric field in amplification region is kept constant.

The maximum transparency is at 1200 volts.

Characterization of MicroMegs...

Drift plane voltage:1200V, Mesh voltage: 500V

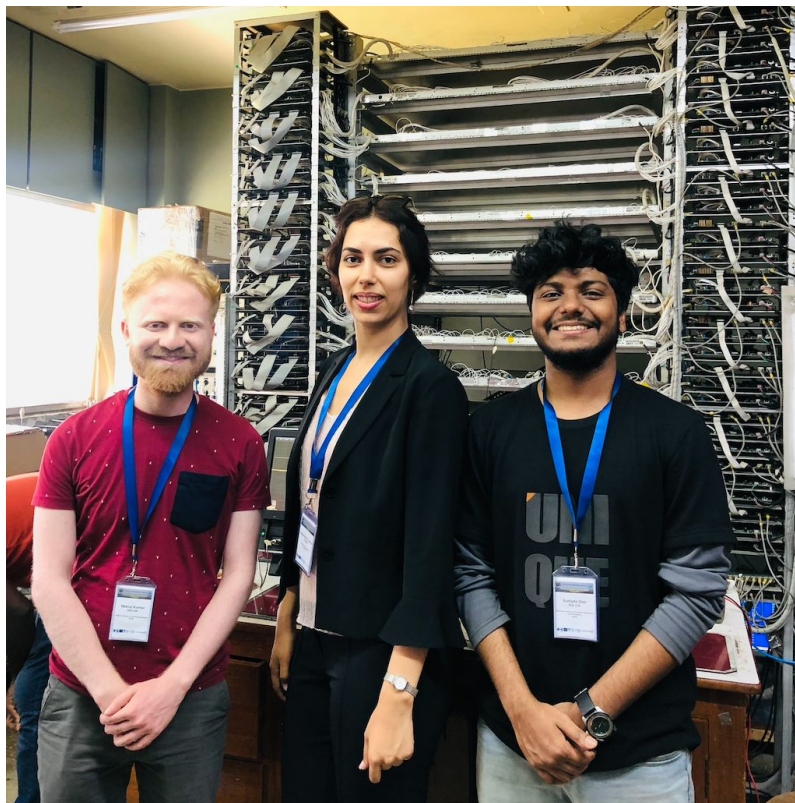


Energy Resolution

	σ_E (keV)	σ_E/E
2.988	0.500	0.167
5.866	0.526	0.090

Summary

- The Micromegas detector detects particles by amplifying the charges that have been created by ionisation in the gas volume.
- The Position and Time resolution of MicroMegas is the order of 10 nano-seconds and 100 micro-meters respectively.
- High Rate capability.
- MicroMegas is already used in several experiment (T2K, CAST ...). It will be used in the ATLAS experiment, as part of their upgrade of its future muon spectrometer.

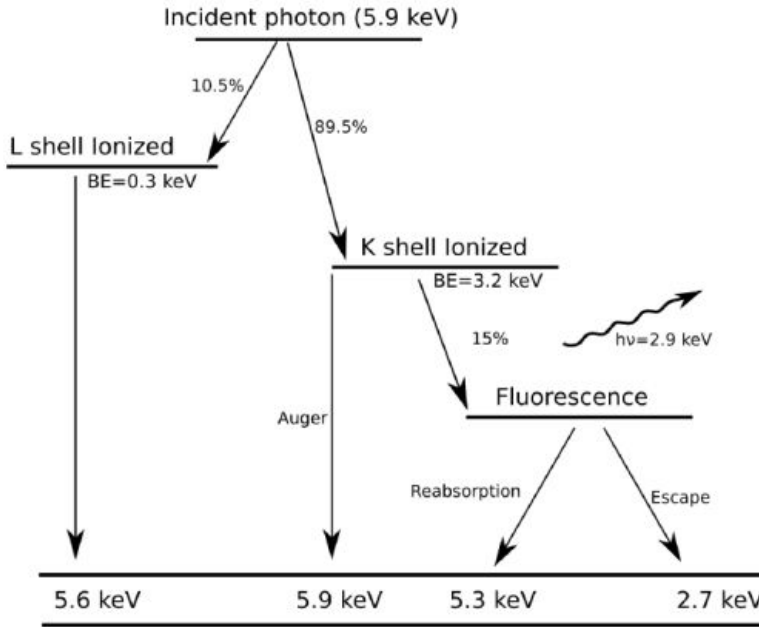


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Thank you

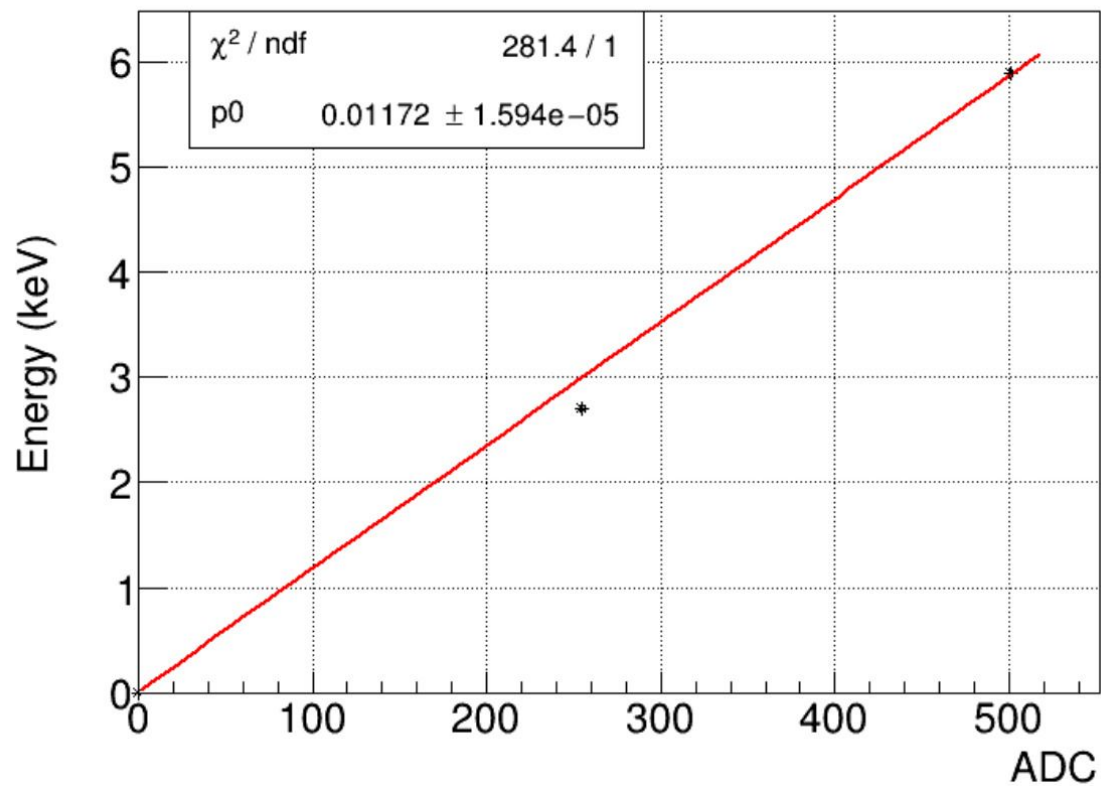
Backup



Fe-55 emission energies

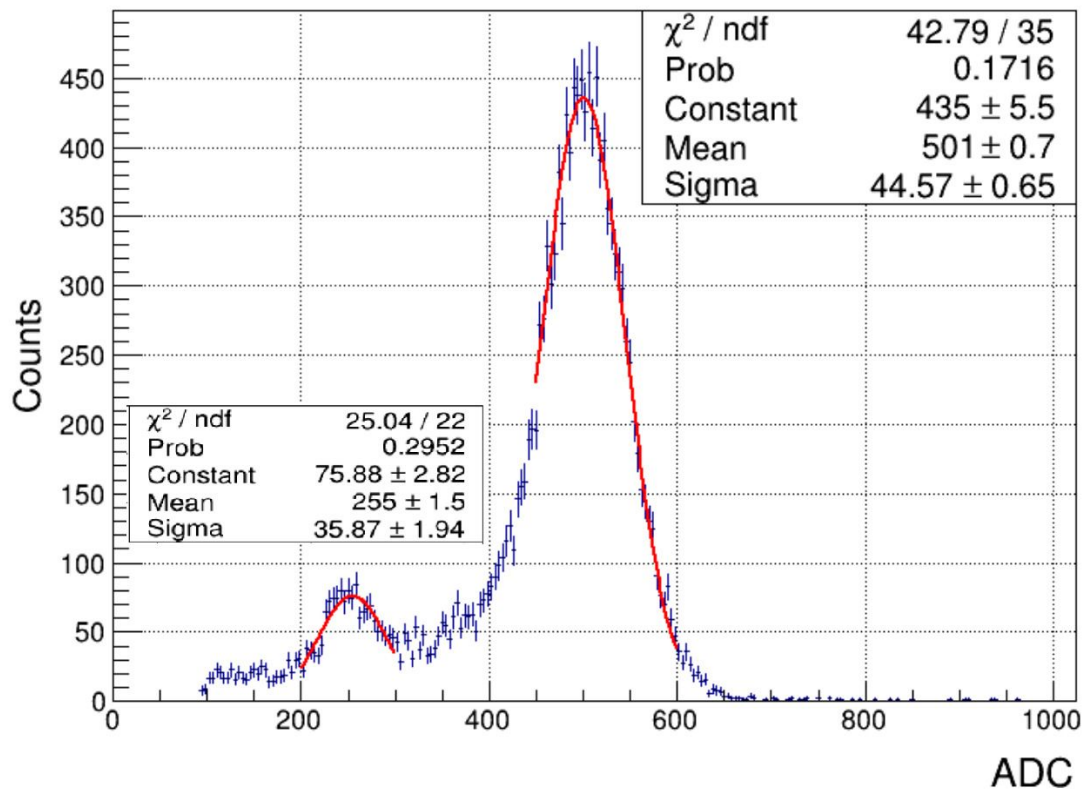
Backup

Energy calibration

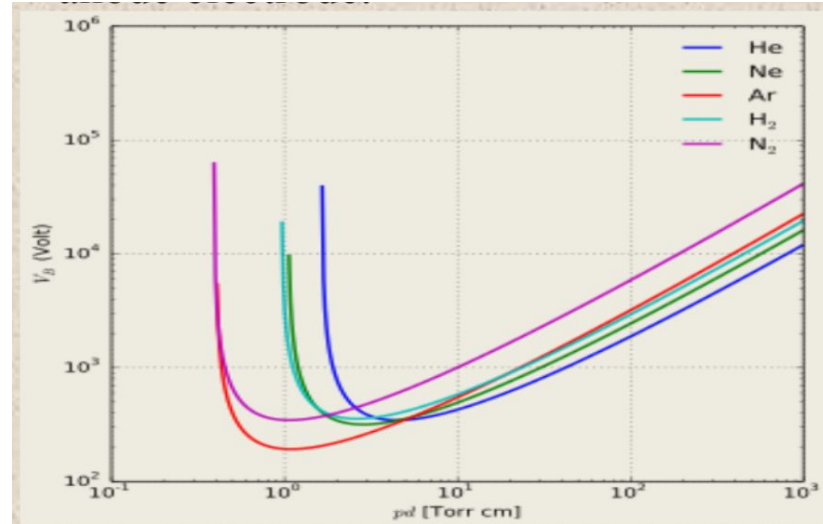


Backup

Drift plane voltage: 1200V, Mesh voltage: 500V



Backup



Paschen curve: Breakdown voltage between two electrodes in a gas as a function of pressure and gap length.