Recent developments in gaseous tracking detectors

presented by **Magali GRUWÉ**
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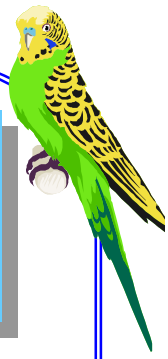
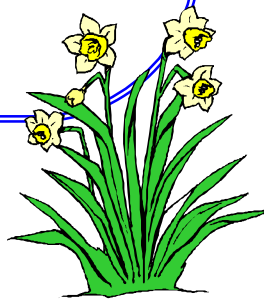
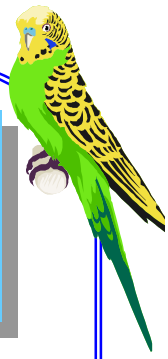
LCWS at Sitges
01/05/99



Layout

- **Introduction**
- **New gaseous detectors**
  - **GEM**
  - **Micromegas**
  - **MGWC**
  - **What do they look like?**
  - **How do they work?**
  - **How do they perform?**
- **Conclusions and prospects**





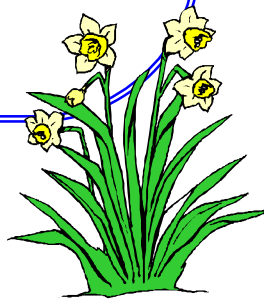
Introduction: why?

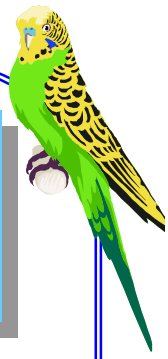
Why new gaseous detectors?

Need:

- High gain
- Good spatial accuracy
- Good time resolution
- High rate capability
- Stability
- etc…

for tracking detectors.

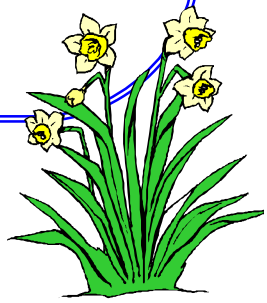


Introduction: what?

Which new gaseous detectors?

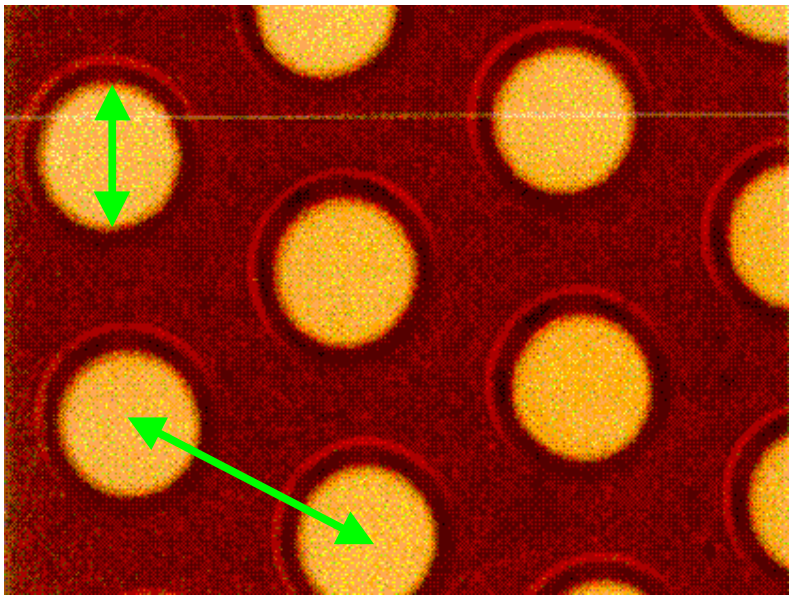
- **GEM**
  - developed by the GDD group at CERN
  - first paper: NIM A 386 (1997) 331
- **Micromegas**
  - developed by CEA-Saclay
  - first paper: NIM A 376 (1996) 29
- **MGWC**
  - developed by IReS-Strasbourg
  - first paper: NIM A 398 (1997) 195



GEM: description

Gas Electron Multiplier

- ~50 mm thick insulator (kapton)
- ~15 mm thick metallic layer on both sides
- regular matrix of holes
- with appropriate voltages
- in gas



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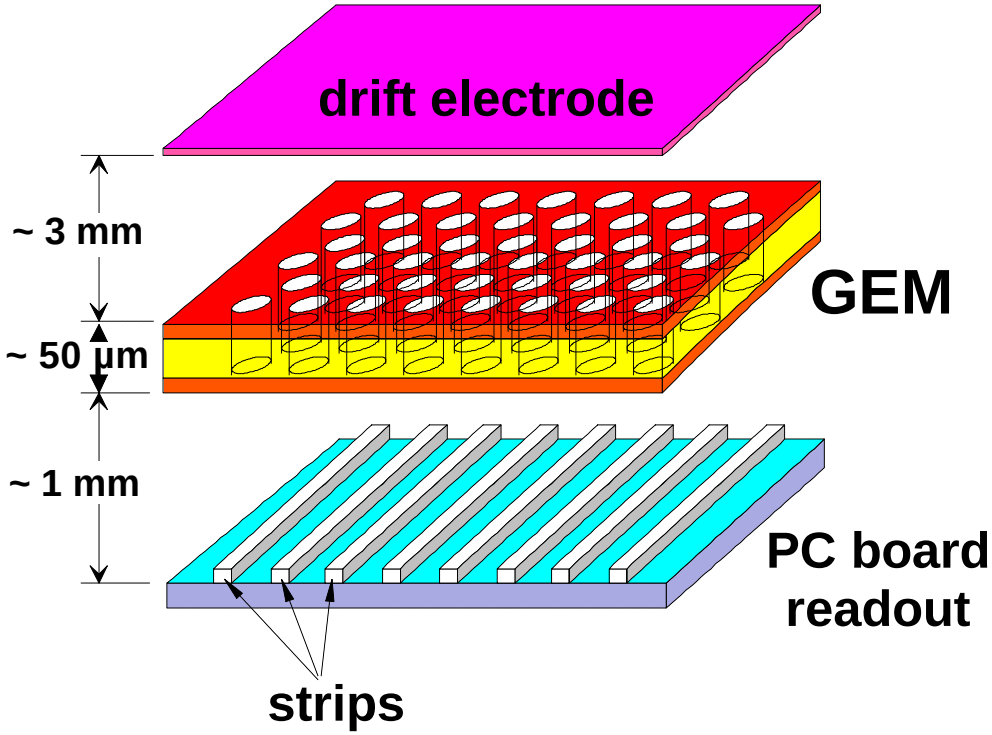
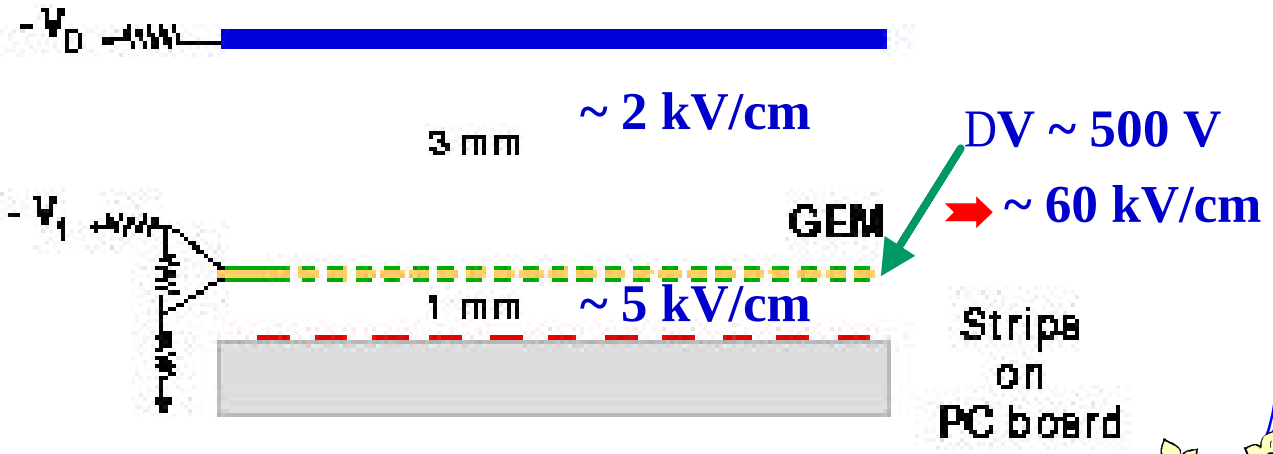
GEM: principle

GEM + PC board:

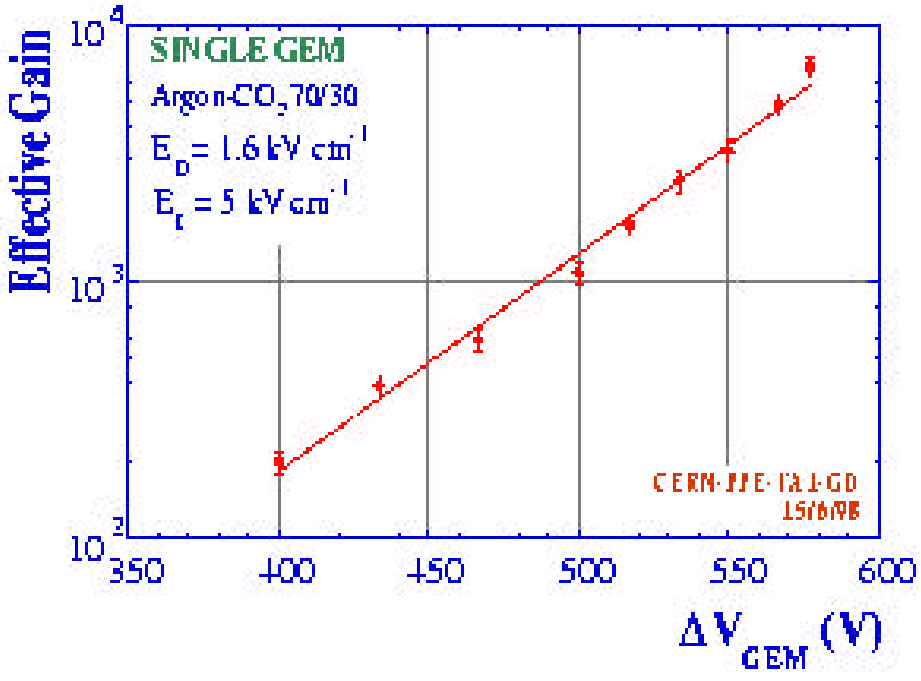




GEM: performances

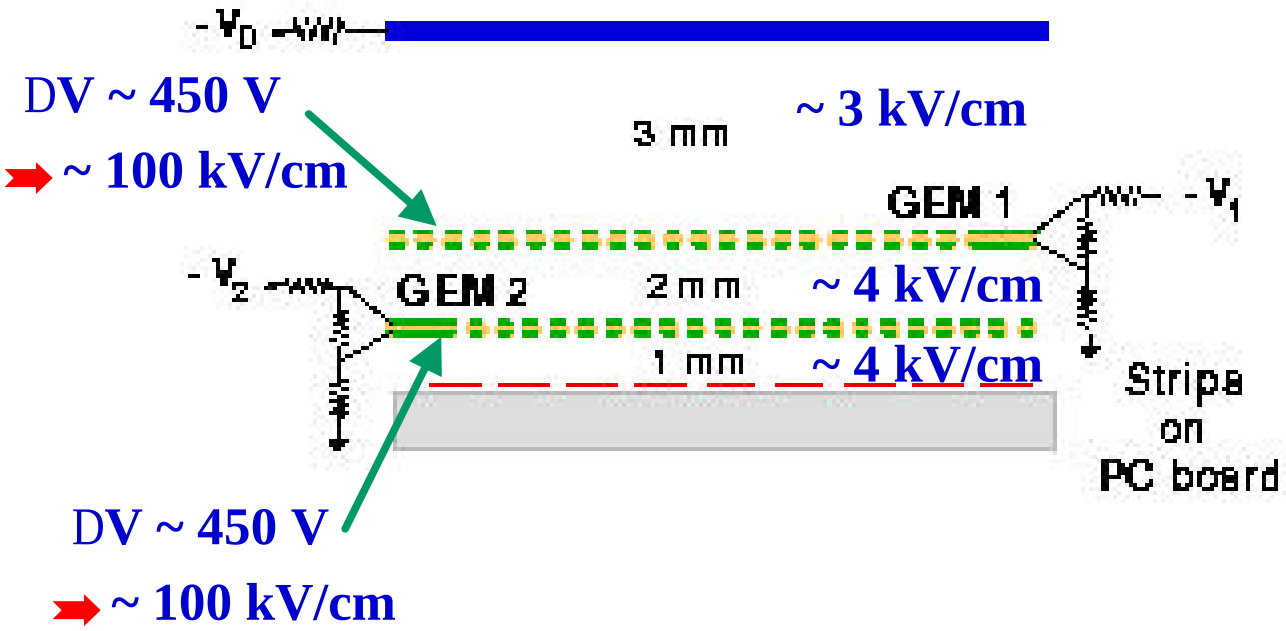
- Very high gain: > 2000, up to 10000
- Good spatial resolution: ~ 45 mm
- Good gain uniformity: ~10 %
- Good efficiency
- Signal to Noise ratio: ~ 50
- Reasonable energy resolution:

  20 % fwhm
- Ion feedback suppression



Double GEM

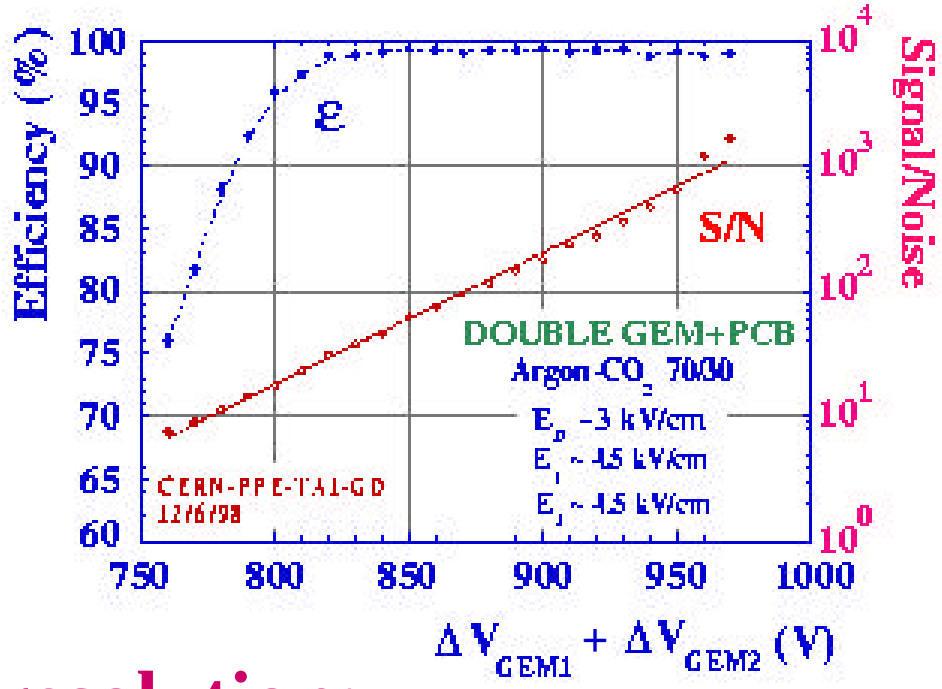
Use 2 GEMs:



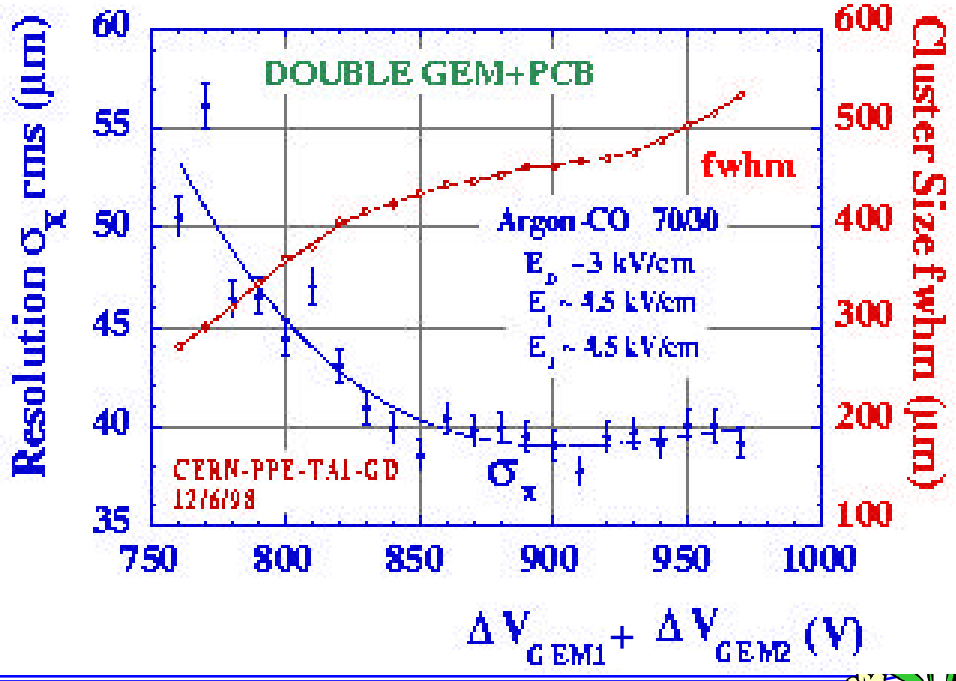
➡ **Better performances**

Double GEM: performances I

Efficiency and Signal to Noise ratio:

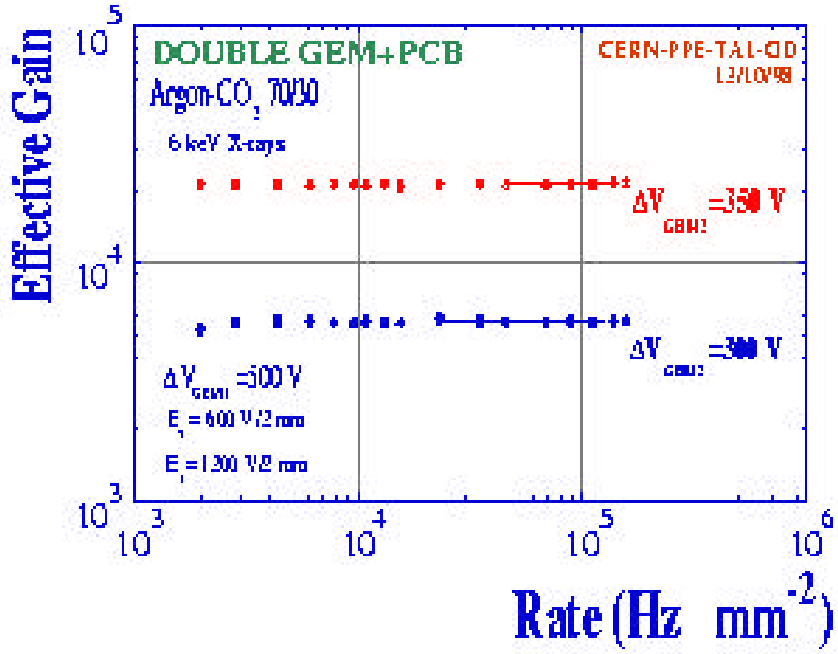


Spatial resolution:



Double GEM: performances II

Stability:



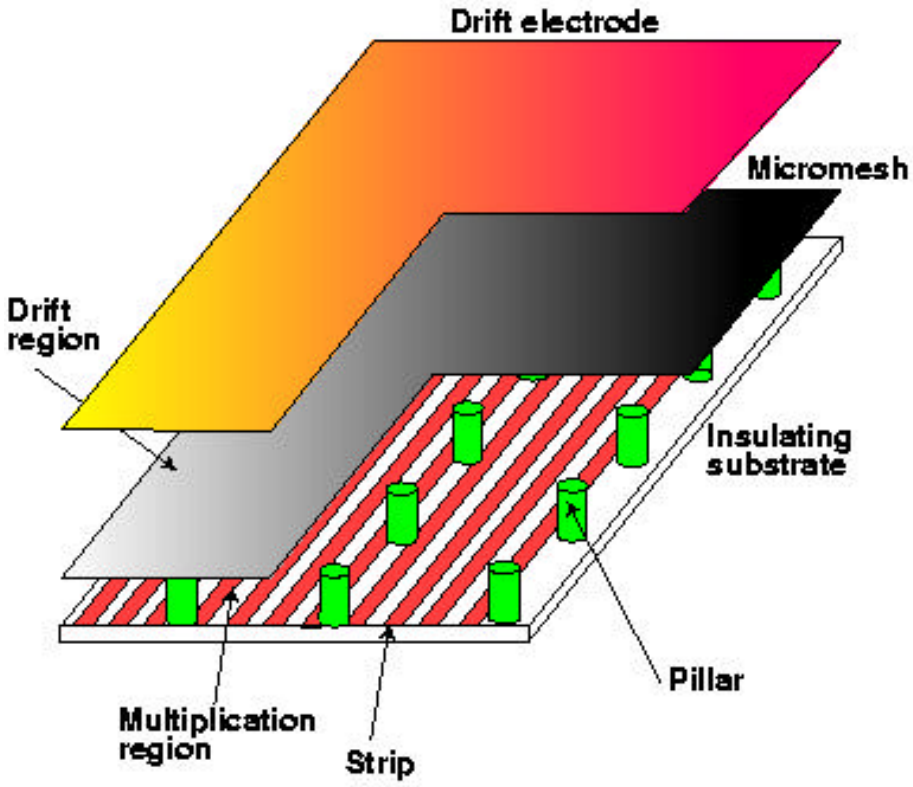
Performances:

- gain > 10^4
- spatial resolution ~ 40 mm rms
- stability up to > 10^5 Hz/mm^2
- efficiency 99 %
- signal to noise ratio up to 10^3
- time resolution ~ 15 ns fwhm

Micromegas

MICROMEsh GAseous Structure

- asymmetric 2-stage parallel-plate avalanche chamber:
  - ~ 3 mm conversion gap
  - ~ 100 mm amplification gap
- wire plane replaced by a ~ 5 mm thick micromesh (50 mm opening pitch)



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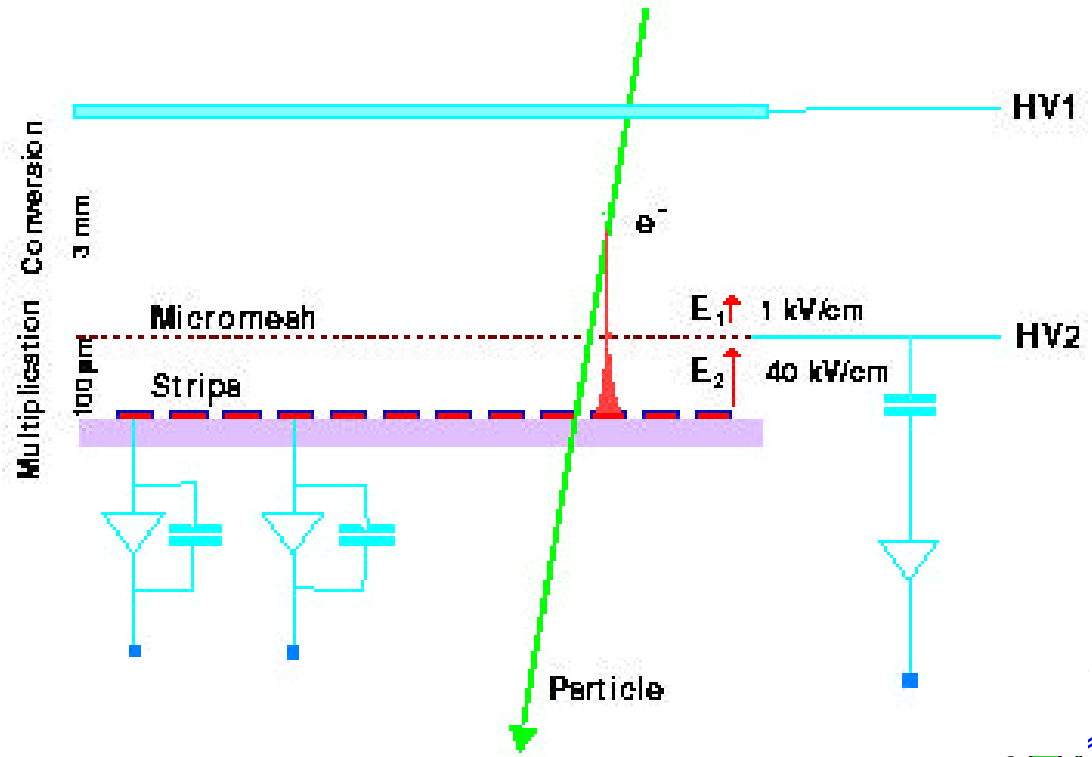
Micromegas: principle

- **Reasonable voltage (~ 400 V)**
  - ↳ **Very high electric field in amplification gap**
- **Avalanche in amplification gap**
  - ↳ **Electrons collected by the strips**
  - ↳ **Ions collected by the micromesh**



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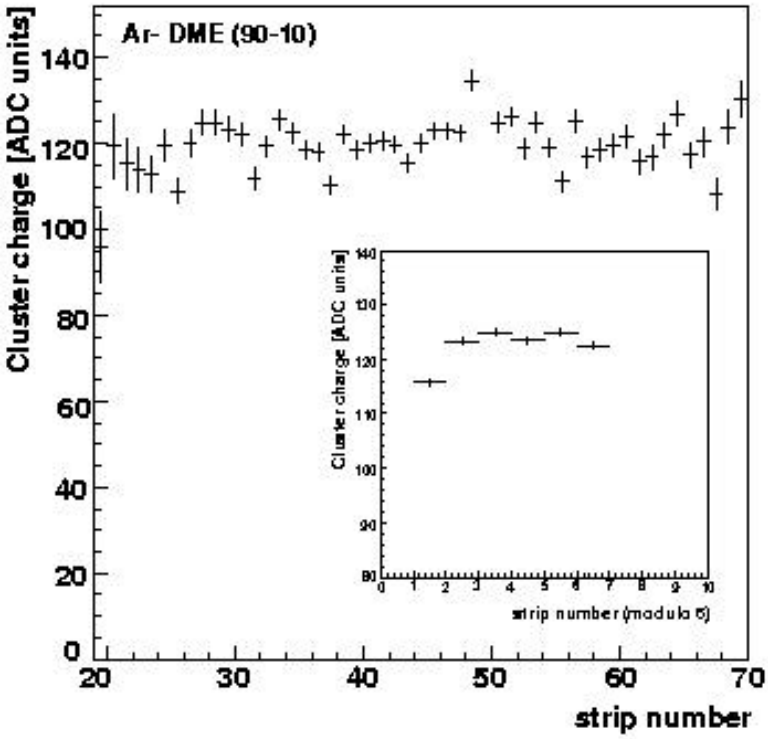
Micromegas: performances I

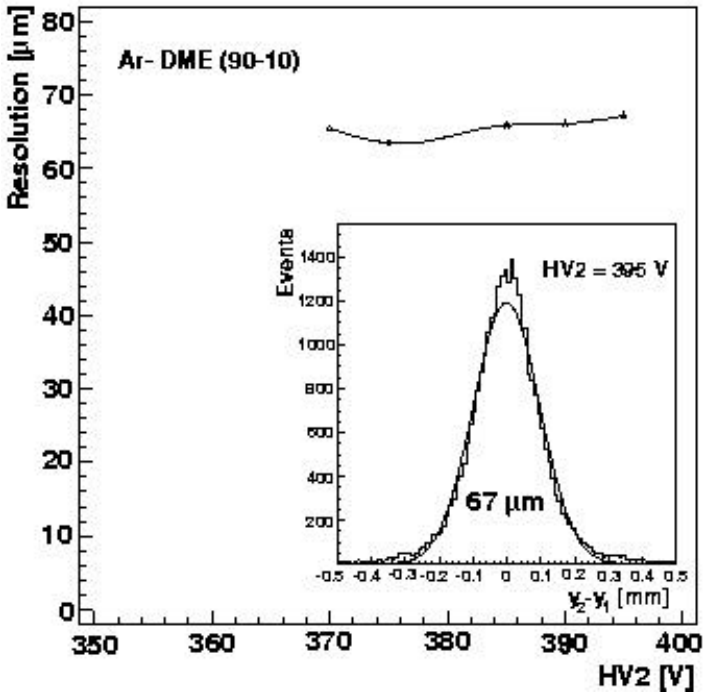
Gain:

Uniformity:



Micromegas: performances II

Resolution:



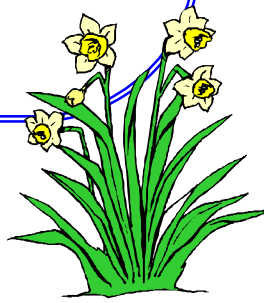
Performances:

- gain > 10^4 even with 10^5 Hz/mm^2
- efficiency 99 %
- uniformity
- spatial resolution ~ 70 mm rms
- energy resolution ~ 13 % fwhm
- time resolution ~ 5 ns rms
- ion collection by the micromesh

GEM and Micromegas

Why should one use GEM or Micromegas?

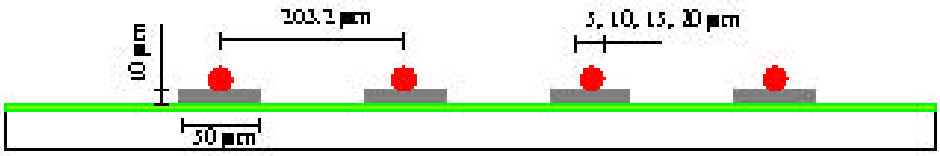
- High gain, uniformity
- Efficient
- Good spatial resolution
- Fast electron signal
- Modular, light
- Robust
- Radiation hard, high rate capability, little aging
- Ion feedback suppression
- Cheap
- etc...

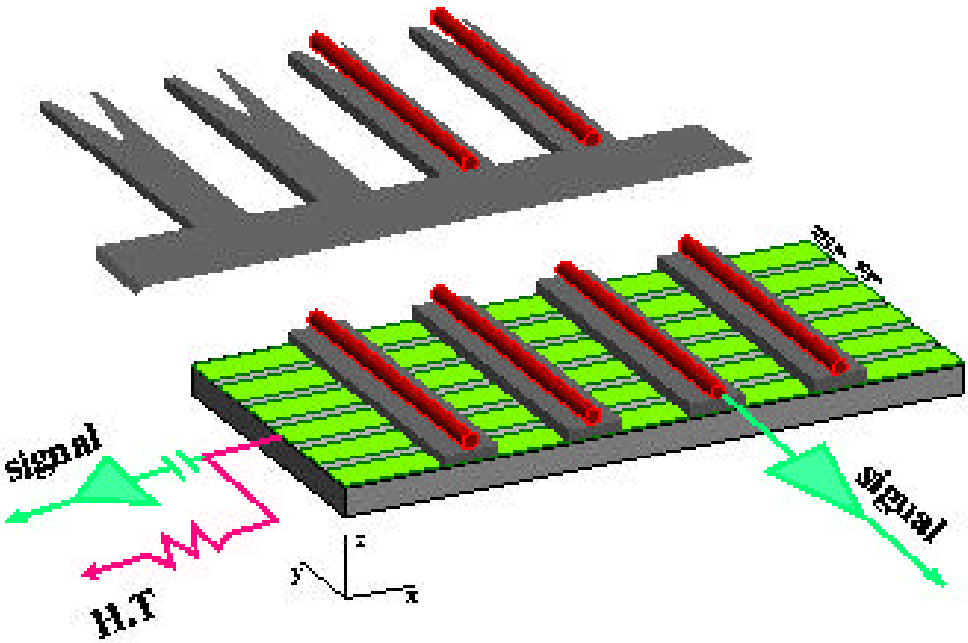


MGWC

Micro Gap Wire Chamber

- anode wires held 10 mm above cathode plane
- cathode plane segmented into strips
- 2D readout





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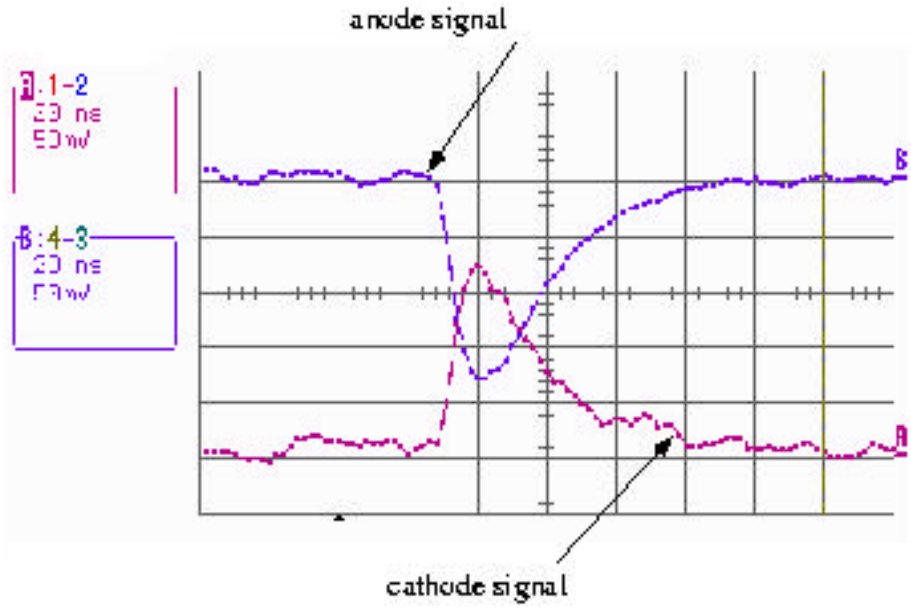
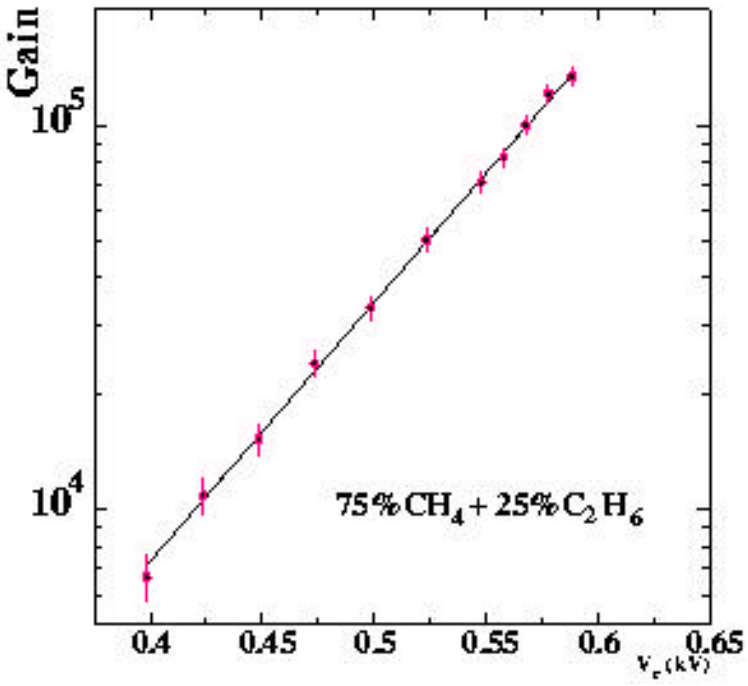
MGWC: performances

Signal:



Gain:



↳ **Looks promising**

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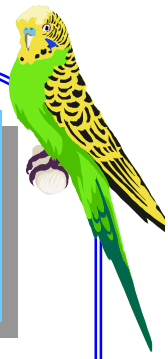

Conclusions and prospects

3 new gaseous detectors:

- **GEM**
- **Micromegas**
- **MGWC**

– **under development and tests**

– **look very good and promising**

Prospects for Linear Collider Detector:

– **Inner tracker?**

– **Intermediate tracker?**

– **Readout of TPC?**

↳ **Under study**