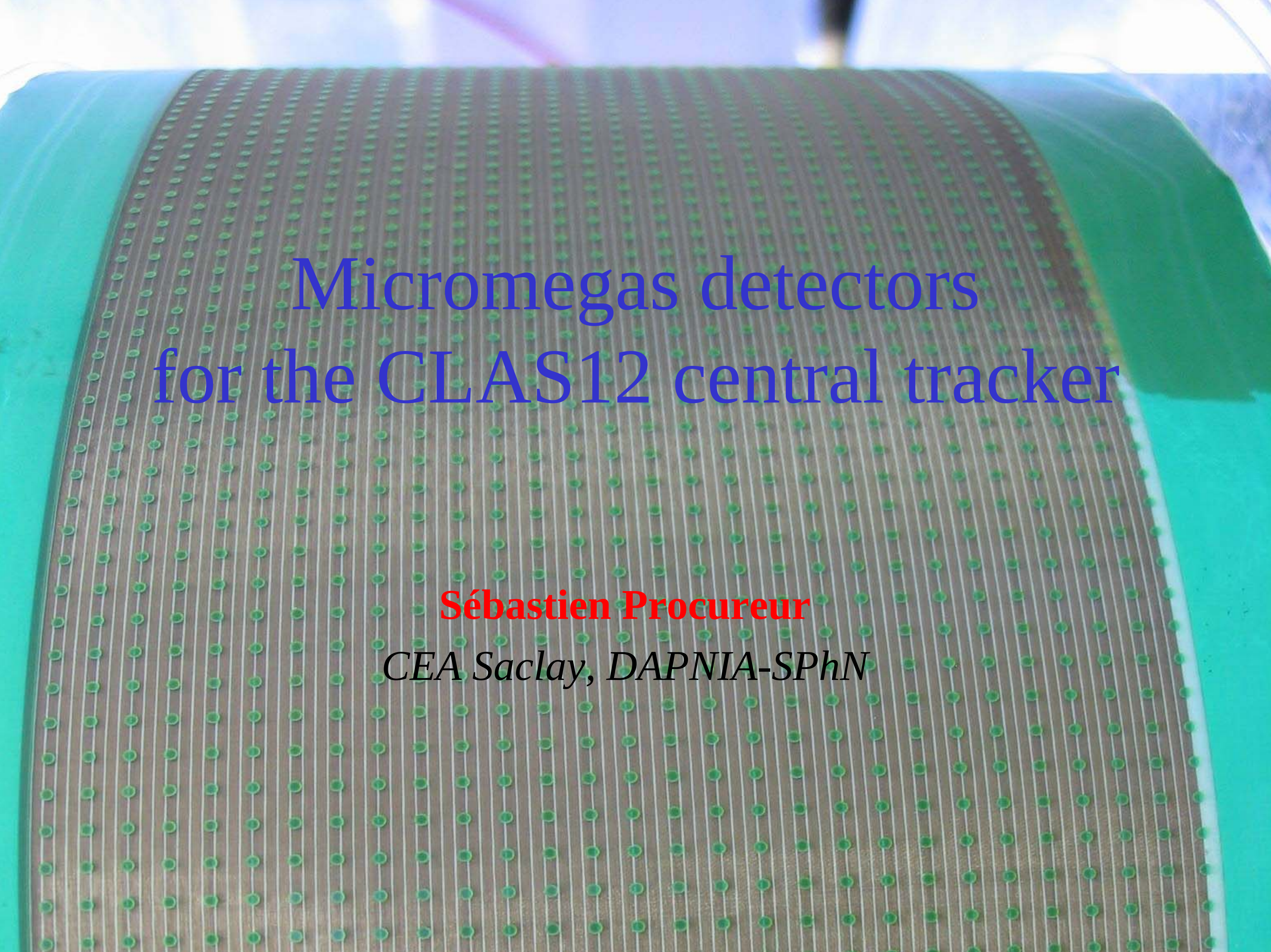
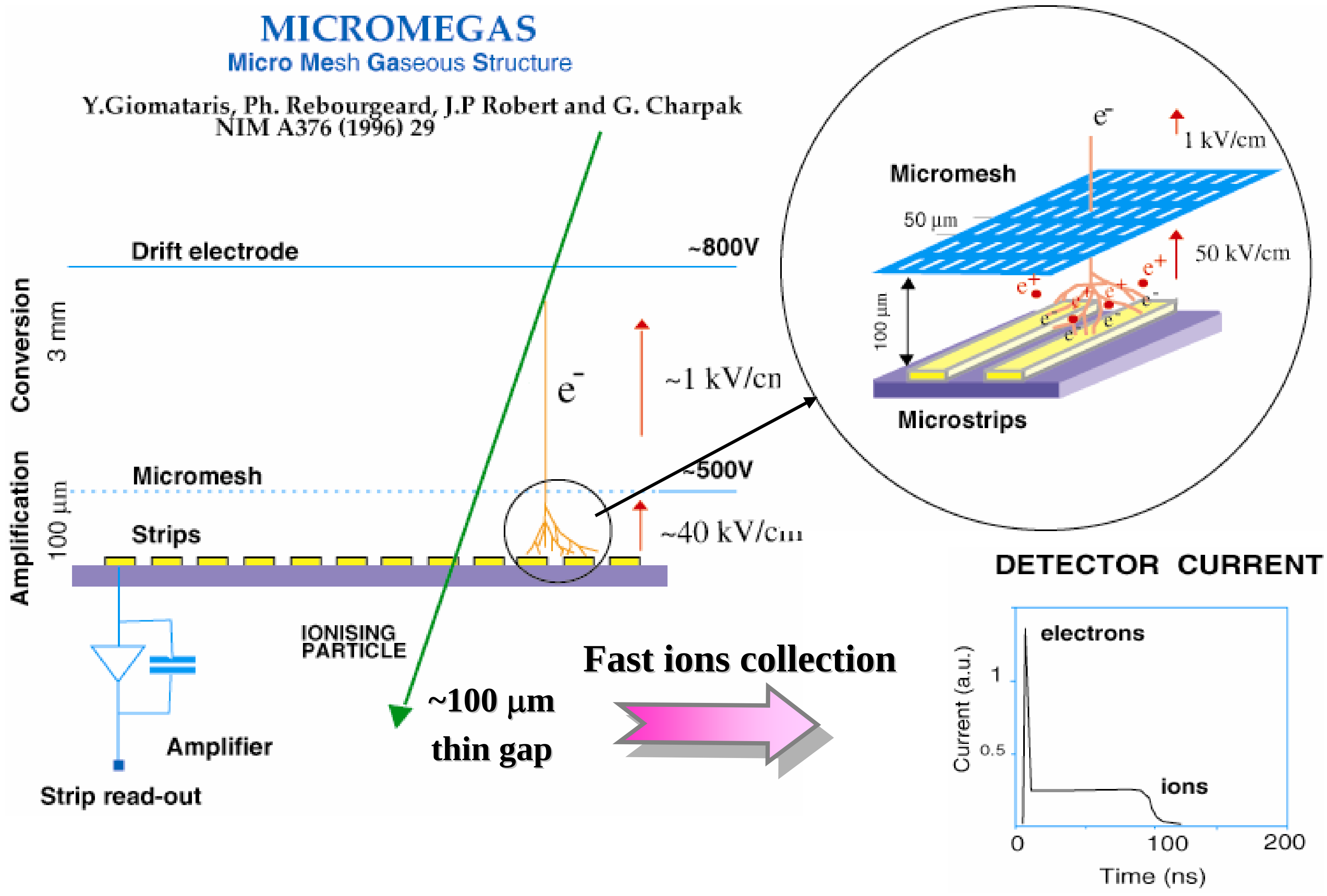


Micromegas detectors for the CLAS12 central tracker

Sébastien Procureur

CEA Saclay, DAPNIA-SPhN

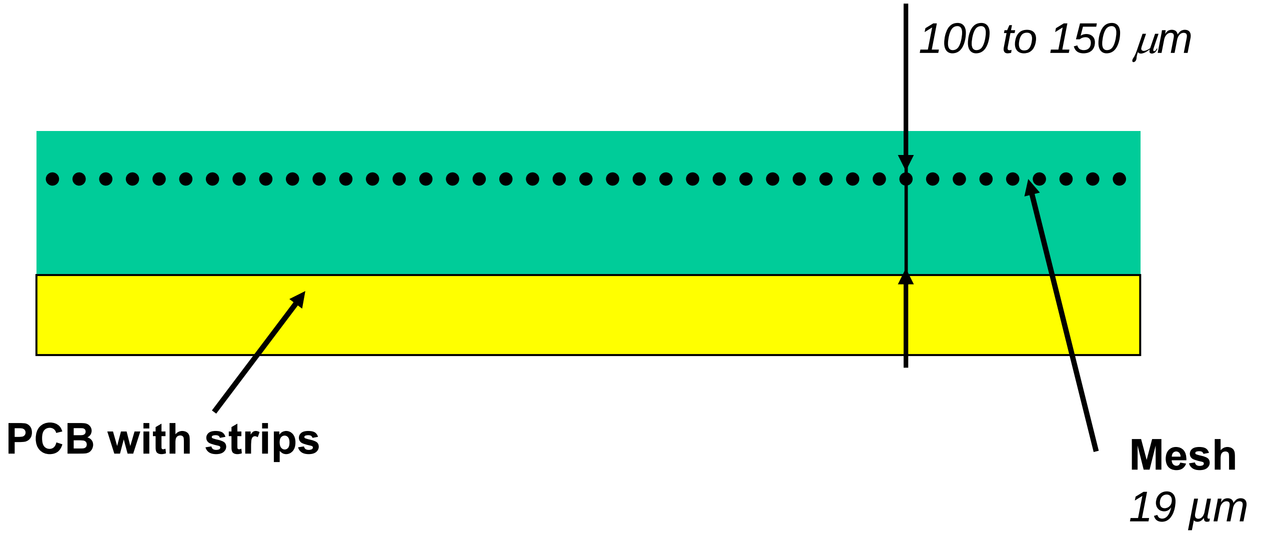
Principle of Micromegas



Principle of the bulk

The bulk concept has been developed using PCB techniques :

- ***Two Photoresist films to permanently hold the mesh between two arrays of spacers. The whole detector (pad or strip array and mesh) is in one piece, a bulk after lamination, insulation and chemical treatment.***
- ***The same process can be applied to embed the drift plane too, thus providing a full bulk detector.***



Principle of the bulk

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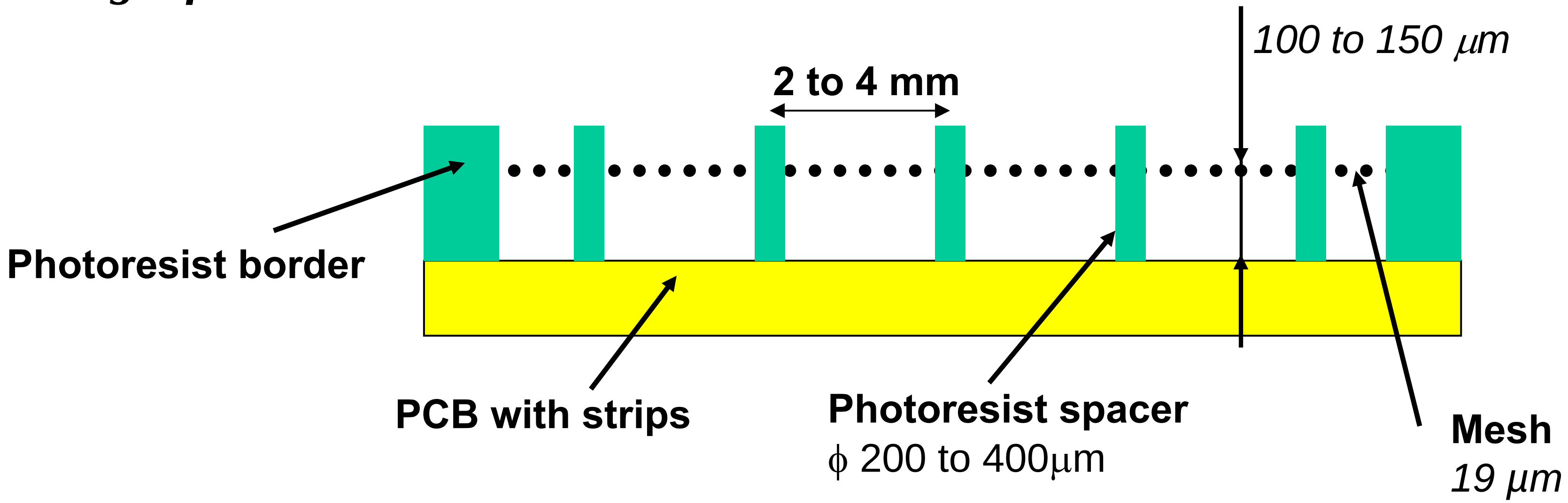


Advantages for CLAS12:

→ Smaller dead zones
→ Light material (rad. length ~3 times less than SI)
→ Cheaper

Simulation

1) Estimation of MM performances (**GARFIELD**)

→ *Optimization of detector characteristics (conversion gap, HV drift)*

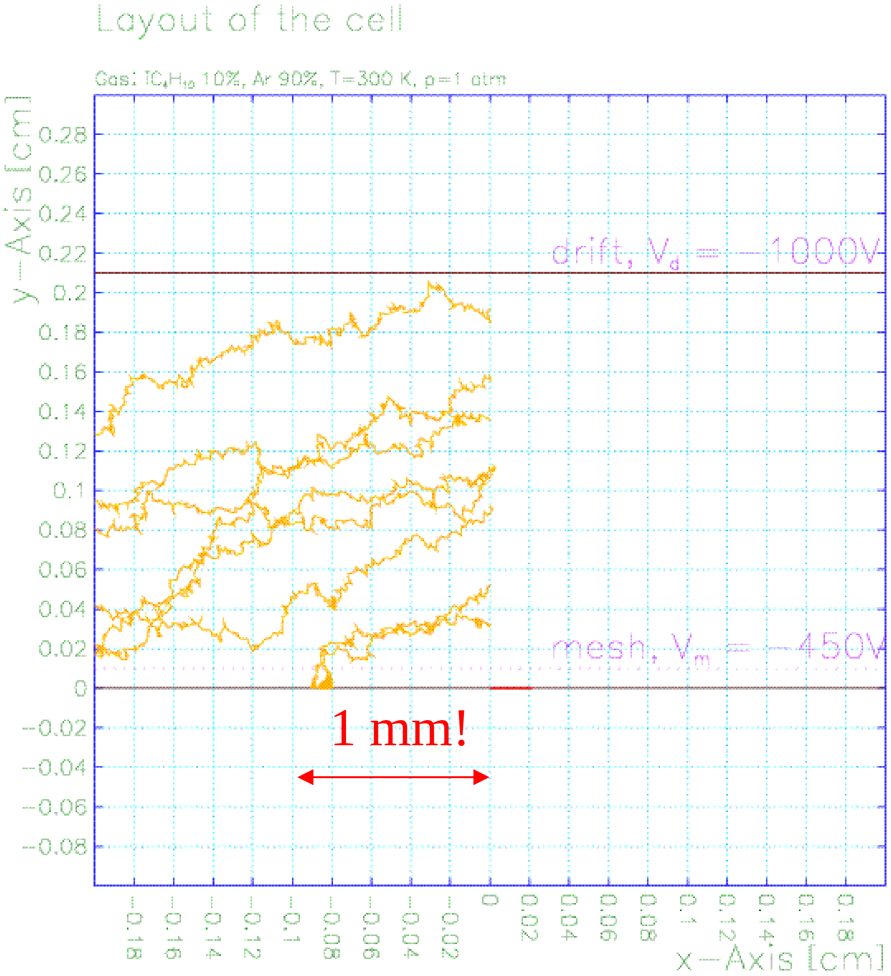
→ *Parameterization of resolution*

2) Estimation of experimental setups performances (**reconstruction program**)

→ *Resolution on momentum, angles, etc…*

Effect of the magnetic field

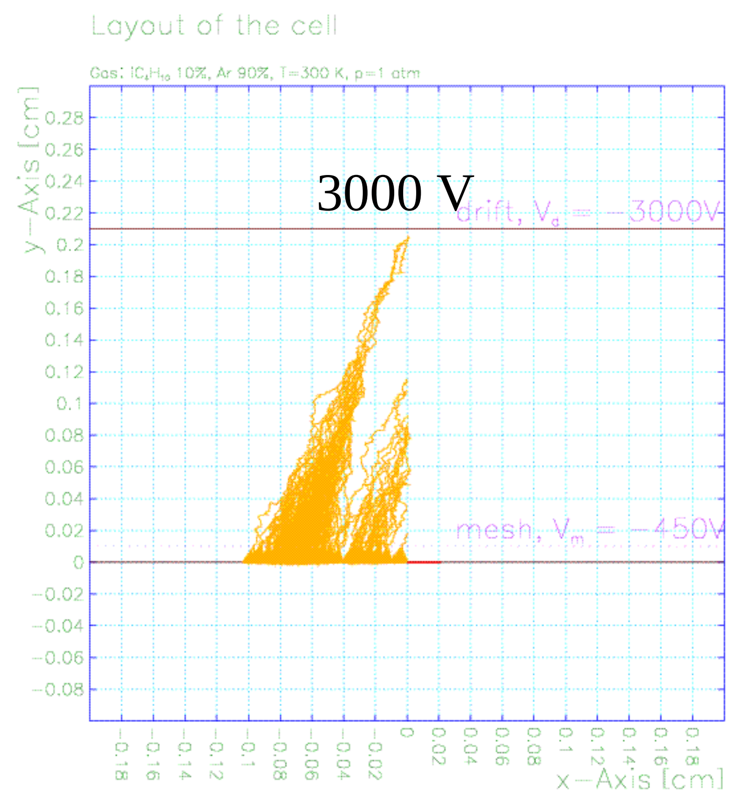
Standard electric field configuration:



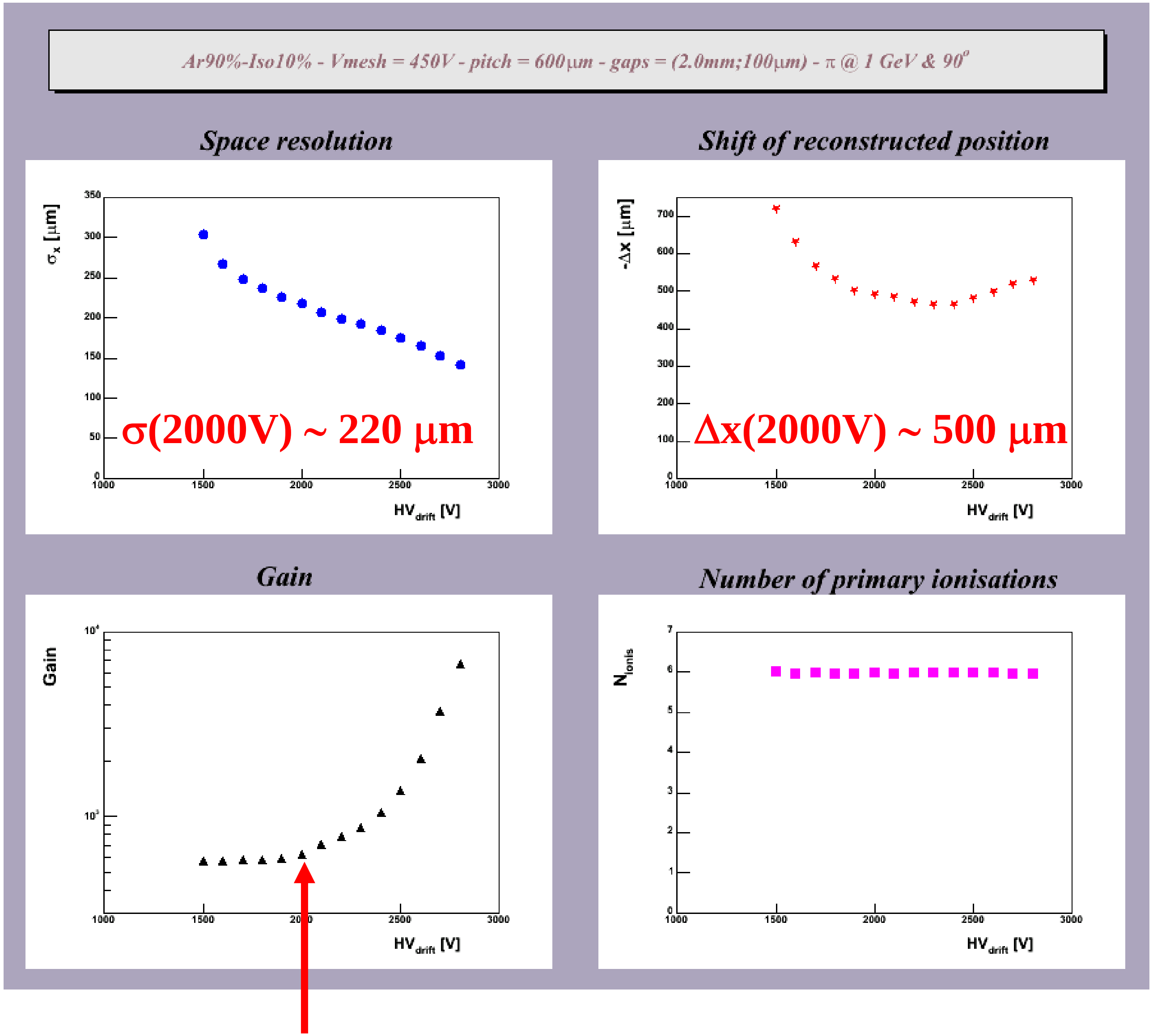
Very large Lorentz angle

- increase HV on drift

- reduce conversion gap



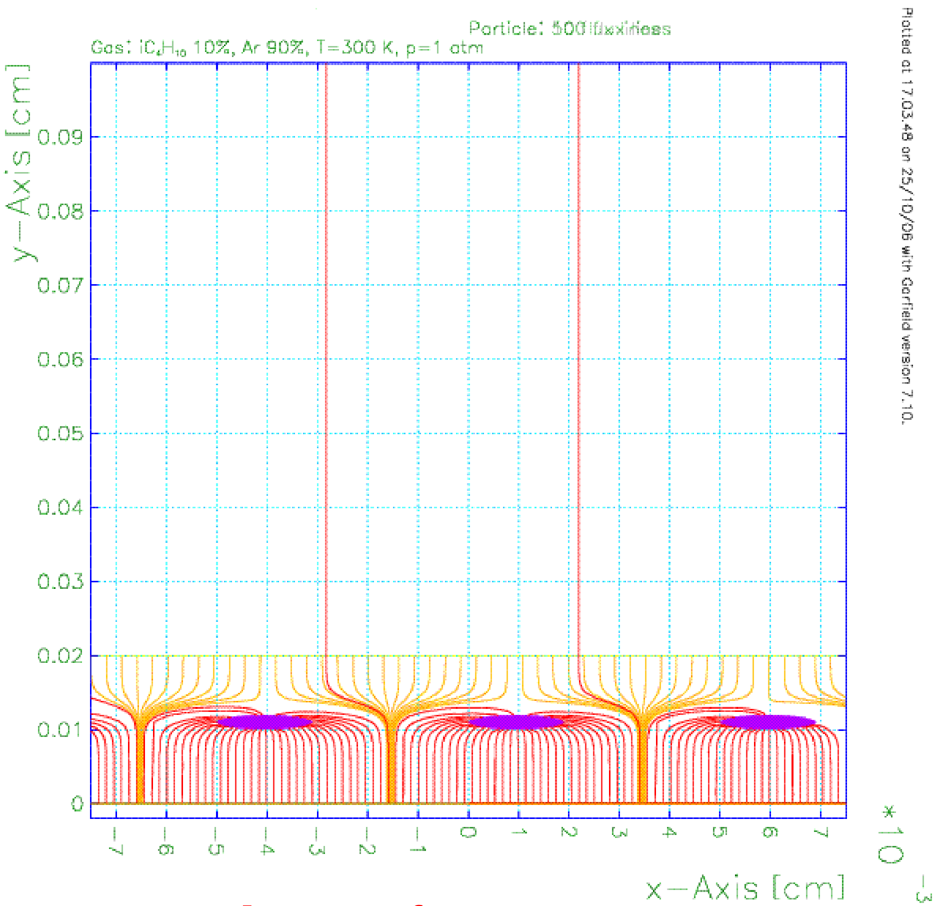
Influence of HV on drift



Preamplification starts!

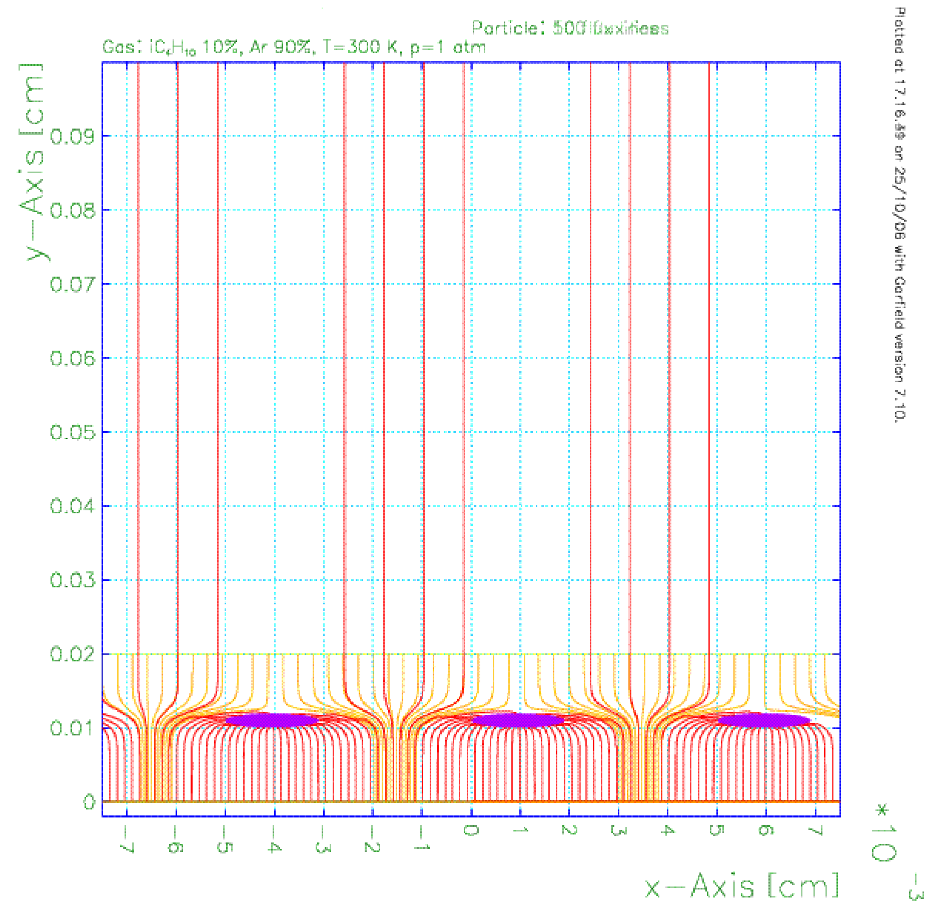
What about transparency?

Standard electric field configuration:



Only very few ions are not collected by the mesh (η ~ 9%)

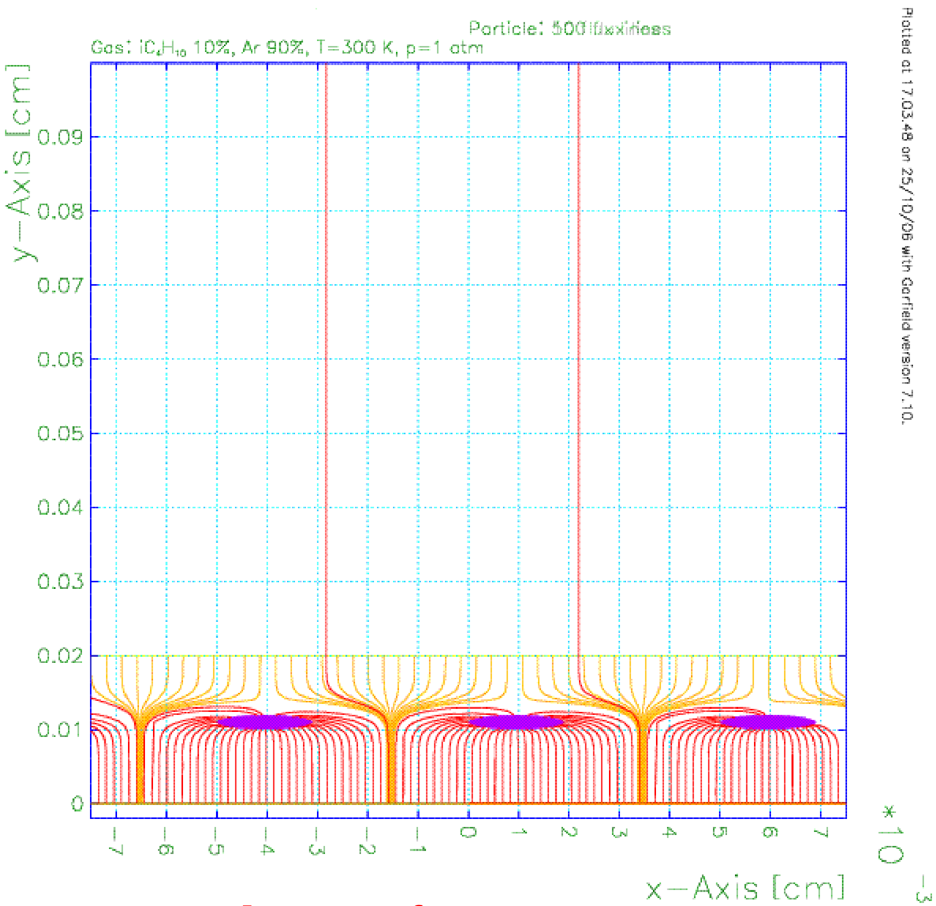
Higher HV on drift:



η ~20%

What about transparency?

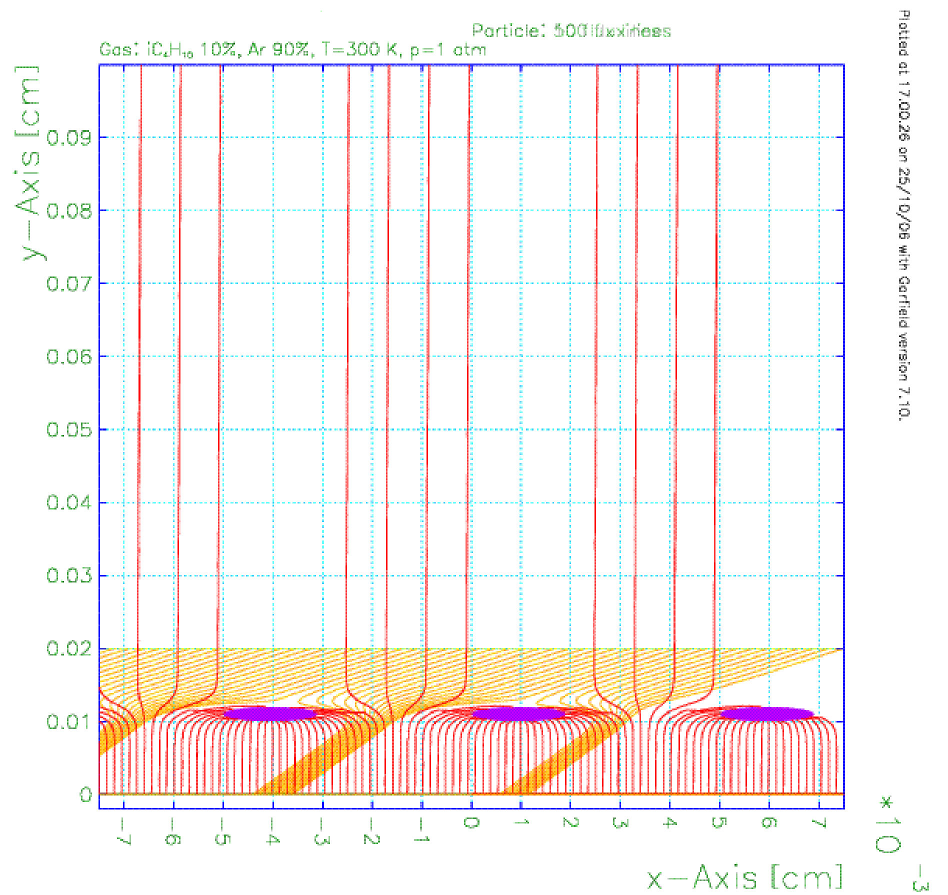
Standard electric field configuration:



Only very few ions are not collected by the mesh (η ~ 9%)

Higher HV on drift:

+ B field

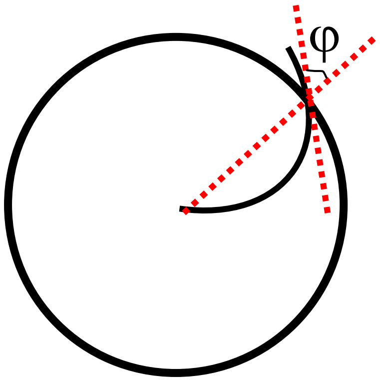


η ~11%!

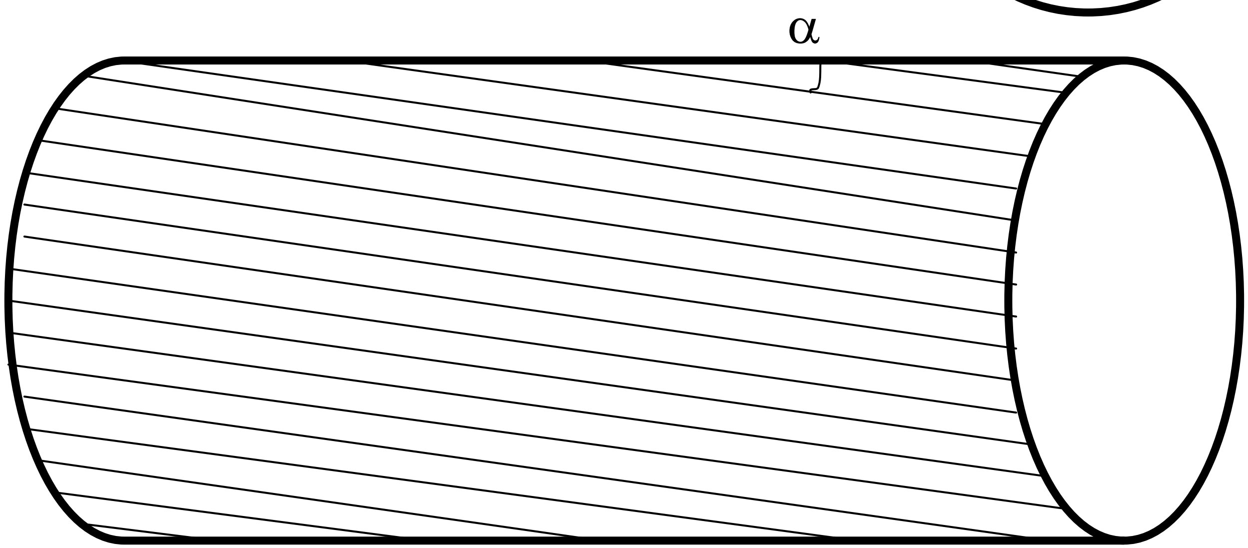
Estimation of resolution

Resolution σ and average shift Δx of electrons (due to Lor. angle) depend on:

→ (local!) φ and θ of the tracks

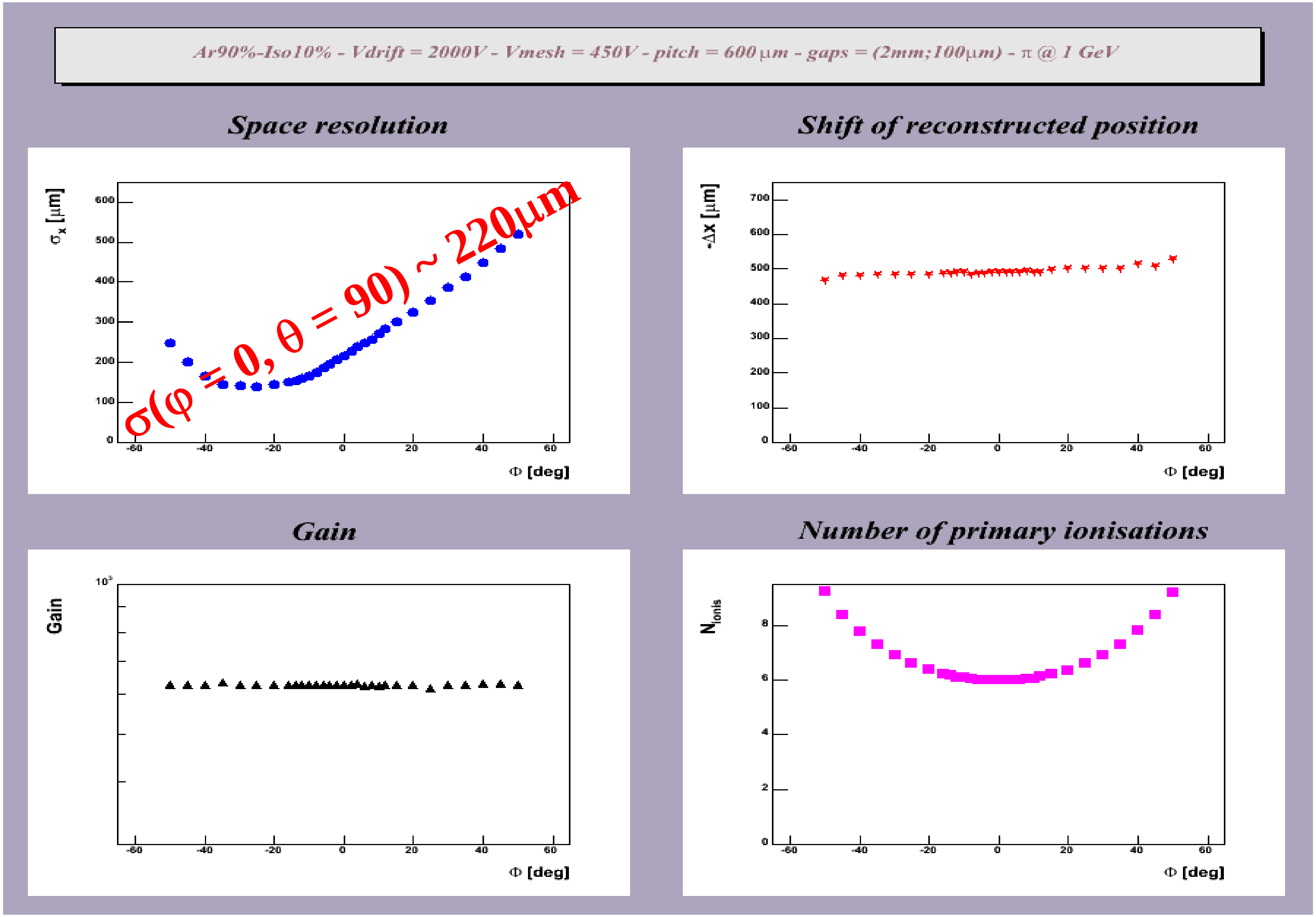


→ α angle of strips



We studied essentially α = 0 and 90°

Ex: φ dependence at $\alpha = 0°$



Estimation of resolution - 2

These studies allowed us to parameterize σ and Δx:

$$\sigma(\varphi, \theta, \alpha = 0, 90°) = f_{0,90}(\varphi) * g_{0,90}(\theta)$$

$$\Delta x(\varphi, \theta, \alpha = 0, 90°) = u_{0,90}(\varphi) * v_{0,90}(\theta)$$

See CLAS note 2007-004

*These parameterizations were used to generate hits on a reconstruction program ($\rightarrow$ **Gaus(σ, Δx)**), starting from a given track and a given experimental setup*

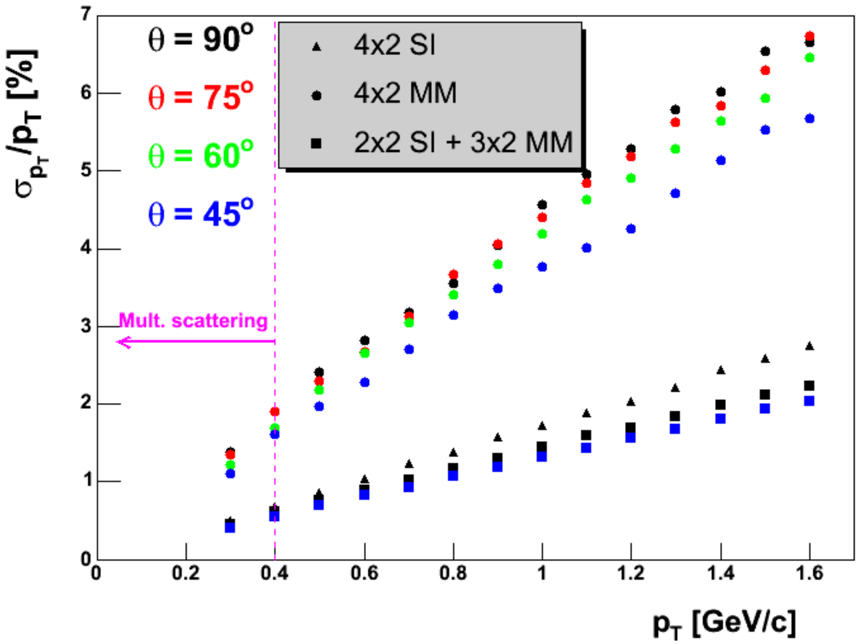
This program uses these hits to reconstruct the *whole track helix*, using MINUIT $\rightarrow$ gives access to resolution on p, φ, θ, z   See CLAS note 2007-004

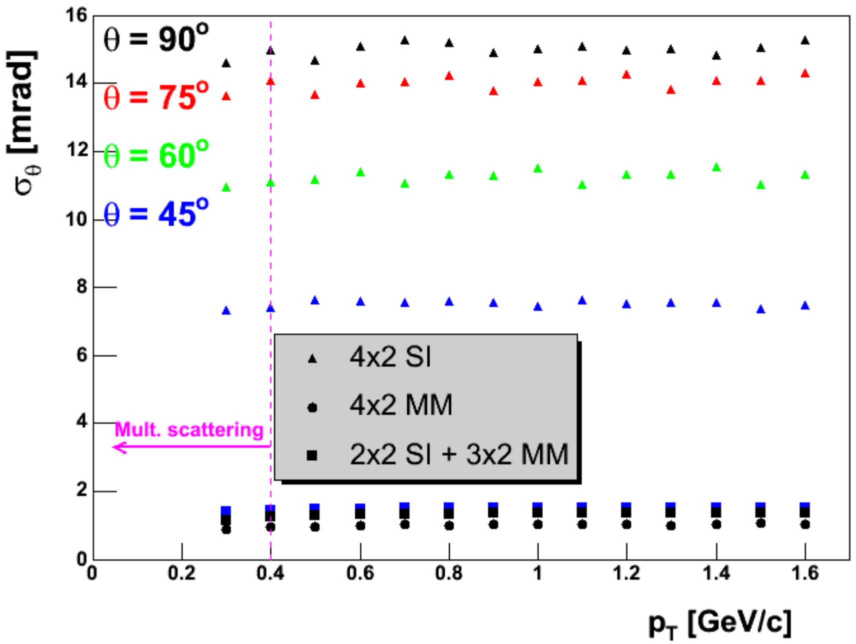
Limitations:

- no multiple scattering simulated (affects $p < 0.4$-0.5 GeV/c)
- no background hits (easy to add, but need realistic estimate)

Results of reconstruction

We studied *3 different experimental setups*:
- 4x2 MM at 6, 12, 18 and 24 cm (at α = 0 and 90°)
- 4x2 SI at ~ 4.4, 7.8, 11.2 and 14.6 cm (at $\alpha = \pm 1.5°$, and σ = 43 μm)
- 2x2 SI at ~ 4.4 and 7.8 cm + 3x2 MM at 10, 17 and 24 cm

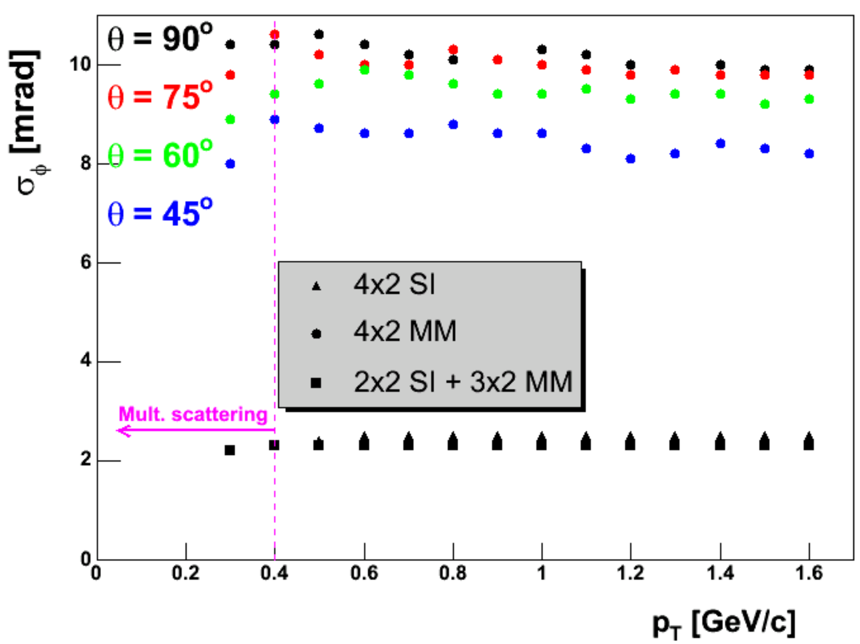


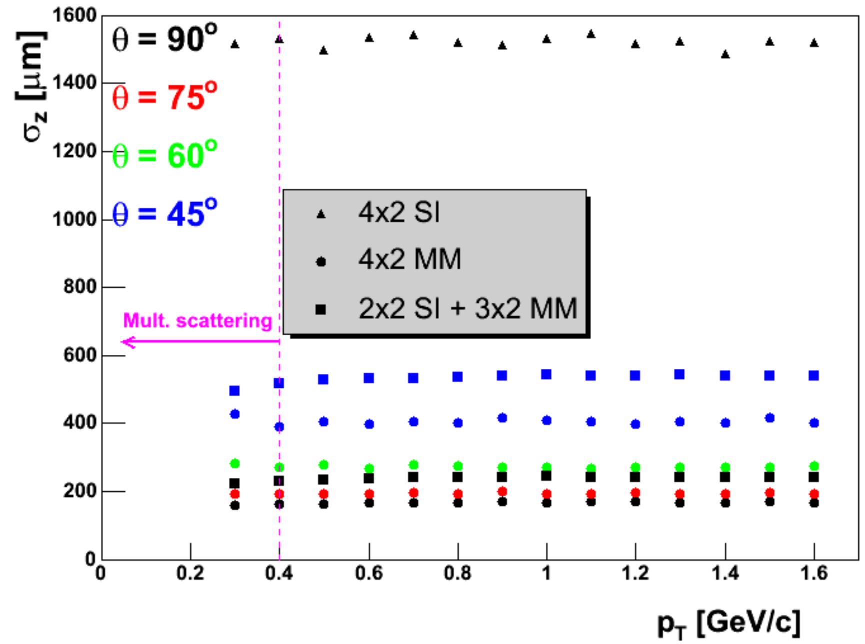


$\sigma_{pT}/p_T \rightarrow$ **SI(+MM)**

$\sigma_\theta \rightarrow$ **MM**

Results of reconstruction - 2





$\sigma_\varphi \rightarrow$ SI(+MM)

$\sigma_z \rightarrow$ MM

Comparison of exp. setups

(for π @ 1 GeV/c , θ = 60°)

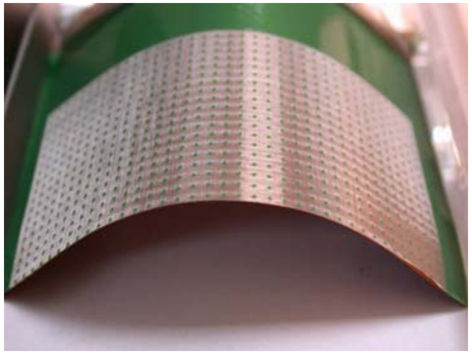
	4 x 2MM	**4 x 2SI**	**2 x 2SI + 3 x 2MM**	**Specs.**
σ_{p_T}/p_T (%)	4.2	1.7	1.4	5
σ_θ (mrad)	1.3	11.5	1.5	a few
σ_φ (mrad)	9.4	2.5	2.3	a few
σ_z (µm)	270	1550	380	tbd.

→ Mixed solution combines advantages of both SI and MM!

→ « SI only » is never the optimum

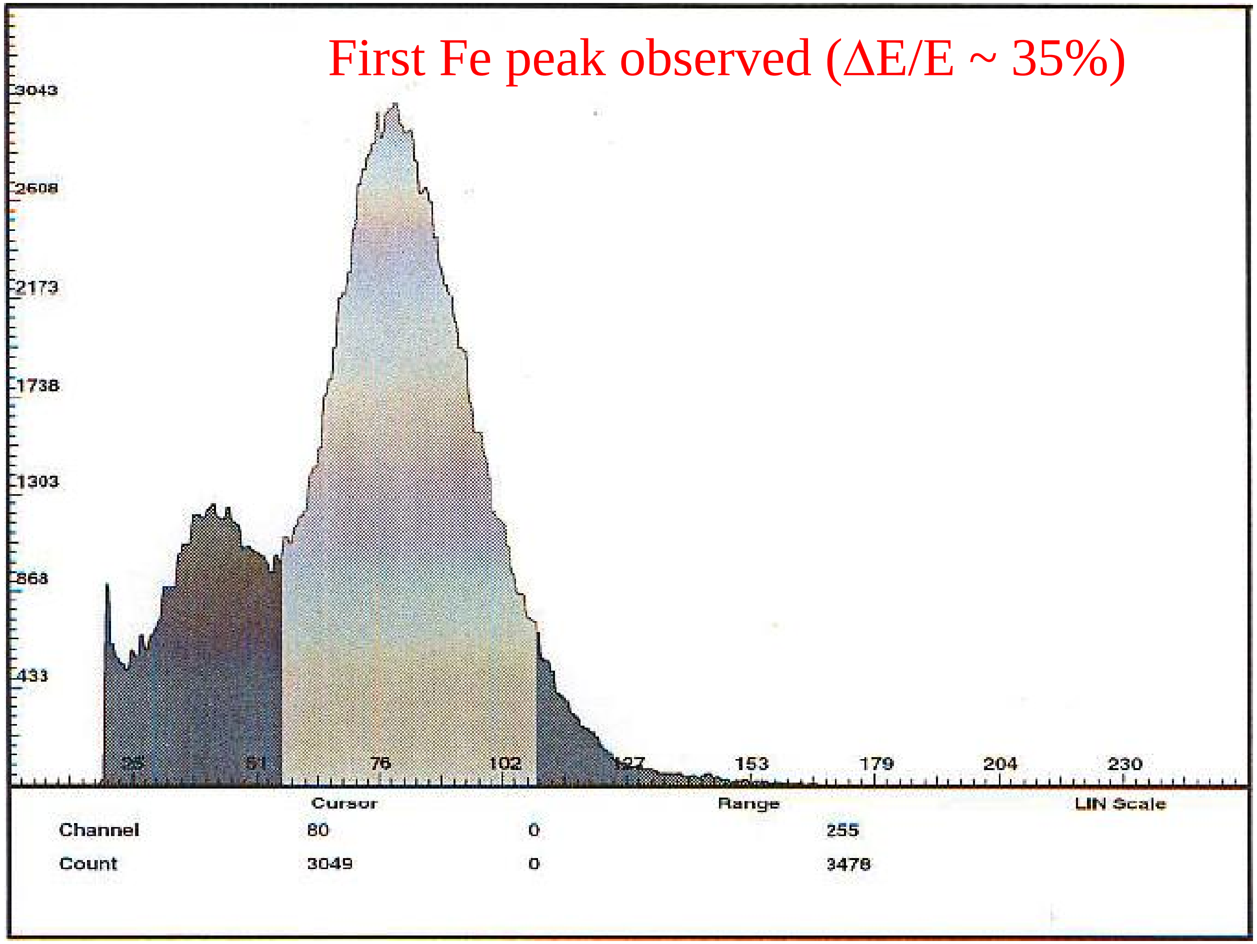
→ Need anyway clarifications concerning specifications…

Hardware tests and results



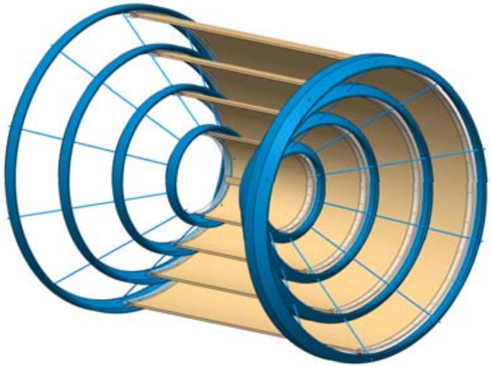
→ 13 test detectors were built up to now, 11 tested

→ Process is almost finalized (*the best detectors are the last!*)



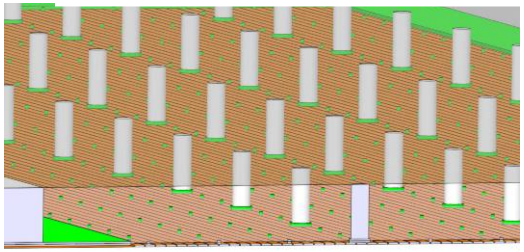
Gain ~ 1 to 4 .10^4 regularly obtained

Hardware plans



- validate simulations with test in 1.5 T (within 2 months)

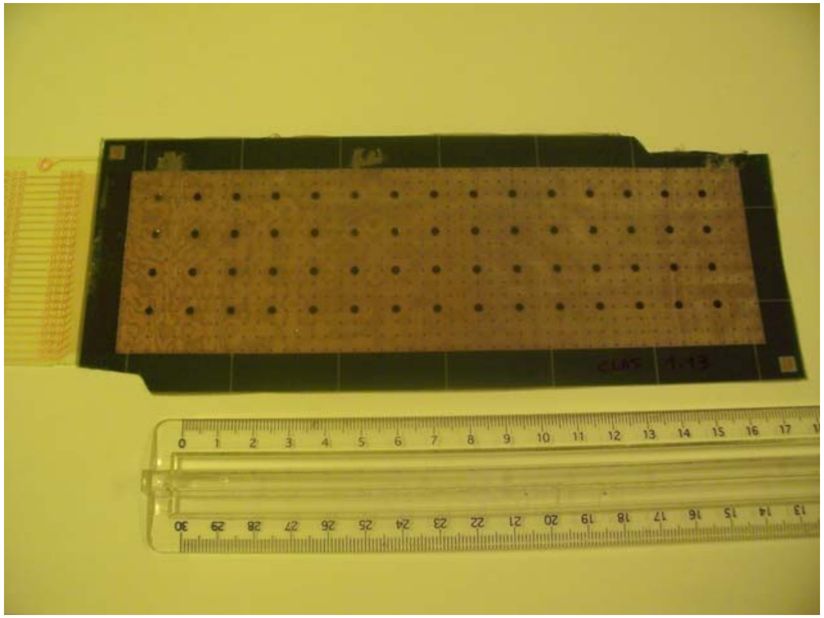
- integrated drift, with spacers similar as for the mesh

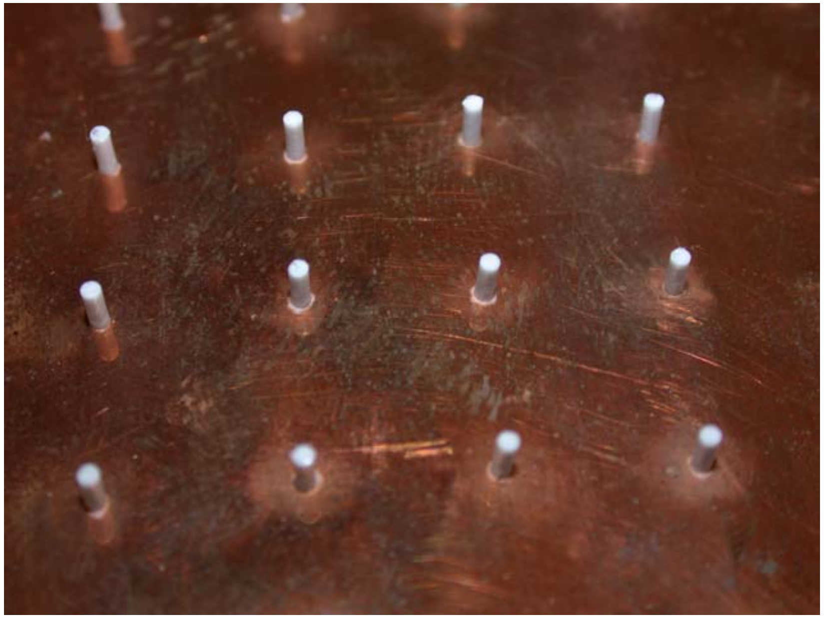


- build plane (x,y) proto for FVT

- work on integration (elec+mechanics)

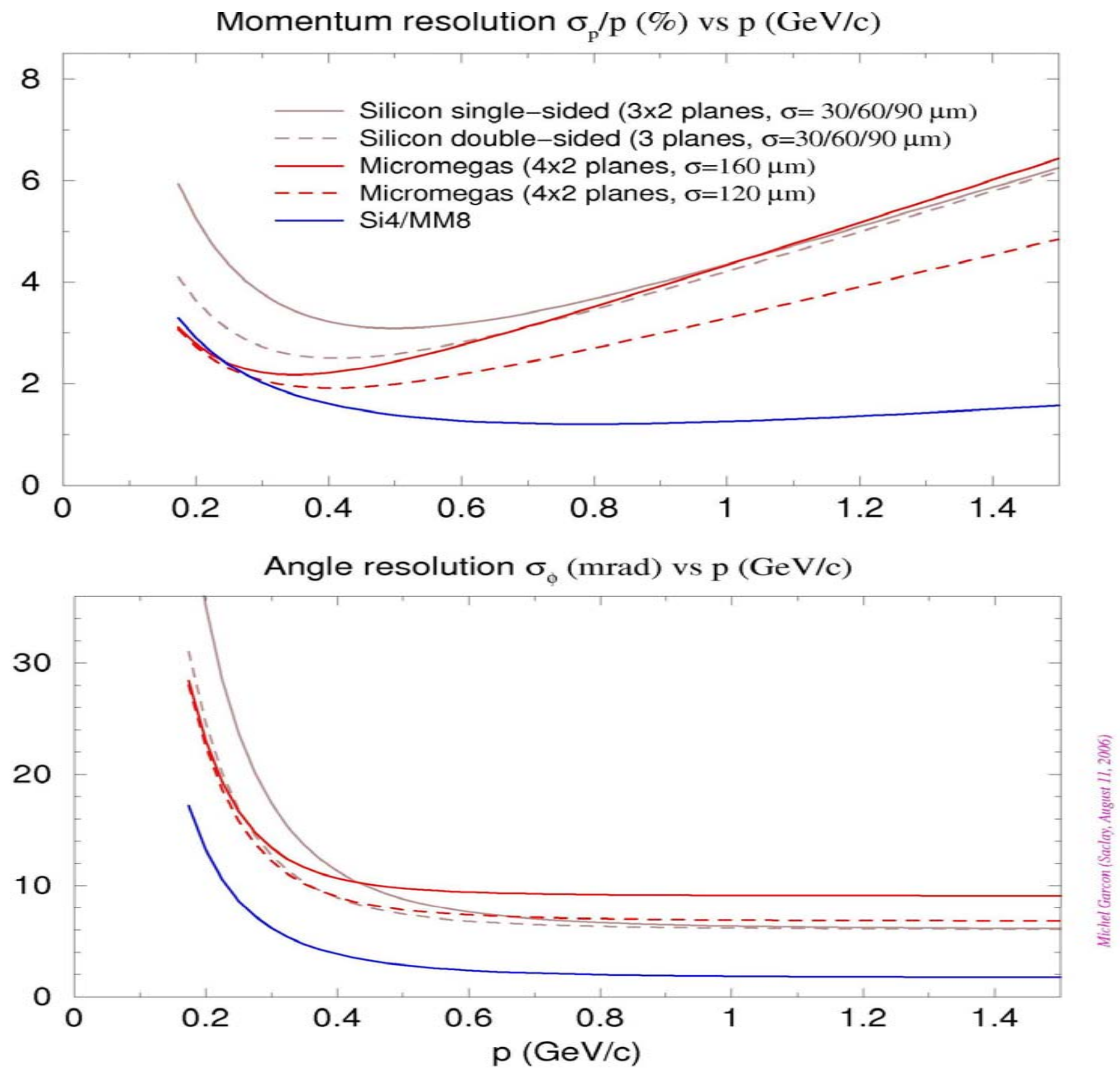
- build a cylindrical (x,y) proto with 2k channels for mid-2008



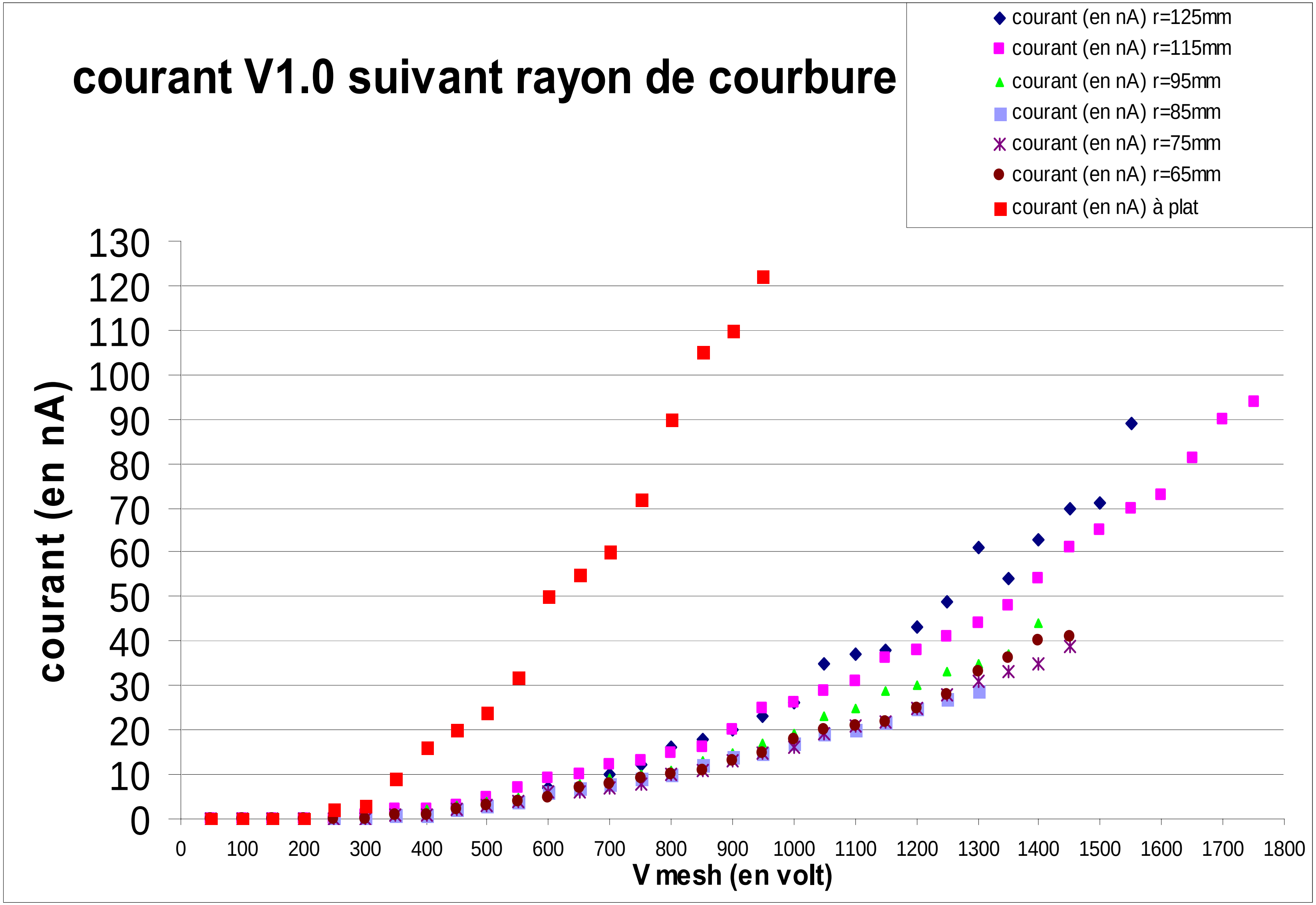


Additional slides for discussion

Effect of Mult. Scat. (Michel)



Other results with bulk



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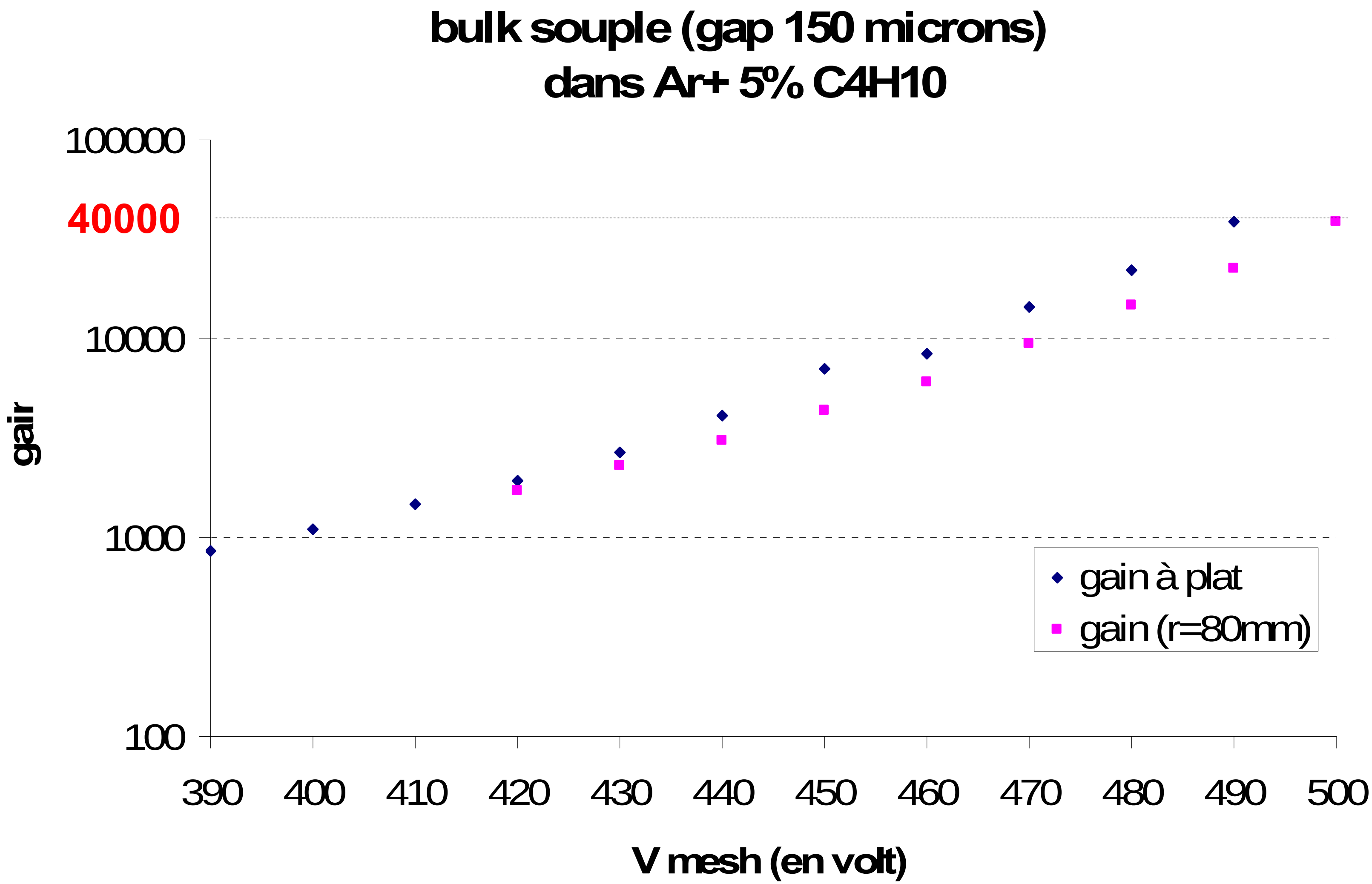

Configurations

Mixed solution: Silicium + Micromegas bulk

- Central detector
  - 2 planes of Silicium (X,Y)
  - 3 cylindrical bulks (XY): 3m², pitch 0,6 mm ,10k channels.
- Forward detector
  - 4 plane bulks (XY): 1 m², 3k channels.