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***Experience with large size bulk Micromegas  
produced by the CIREA-ELVIA company***

***Damien Neyret***

***CEA Saclay IRFU/SPhN***

***RD51 5/7/2013***

# Large size pixelized MM detectors for COMPASS

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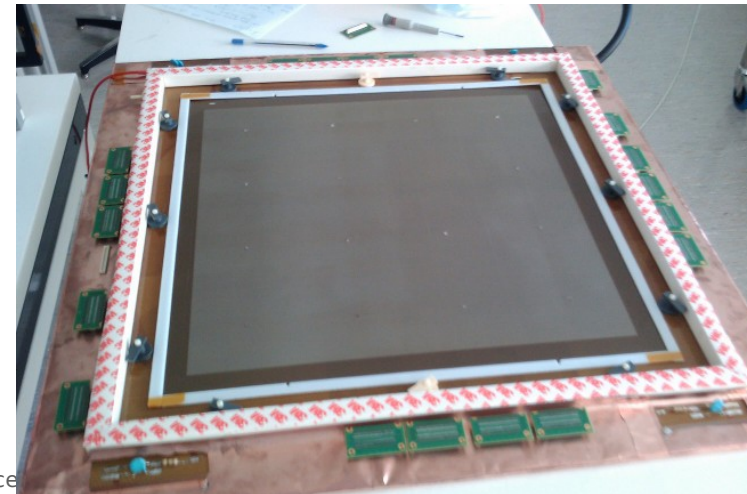
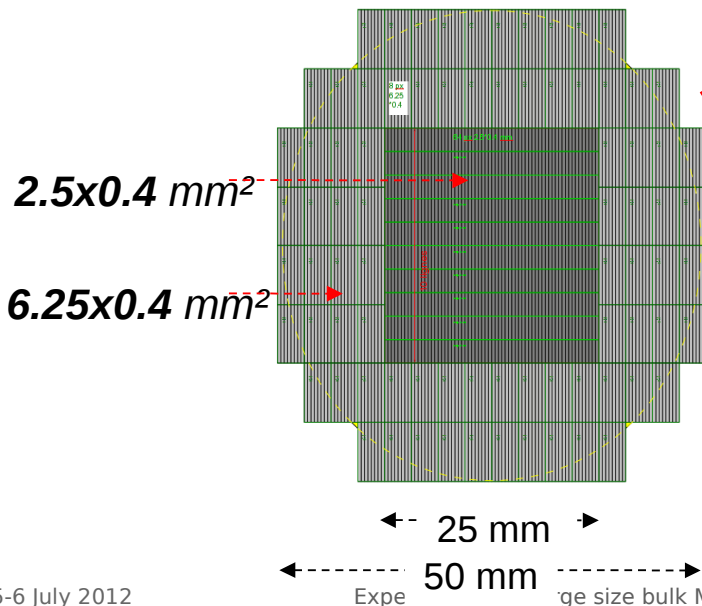
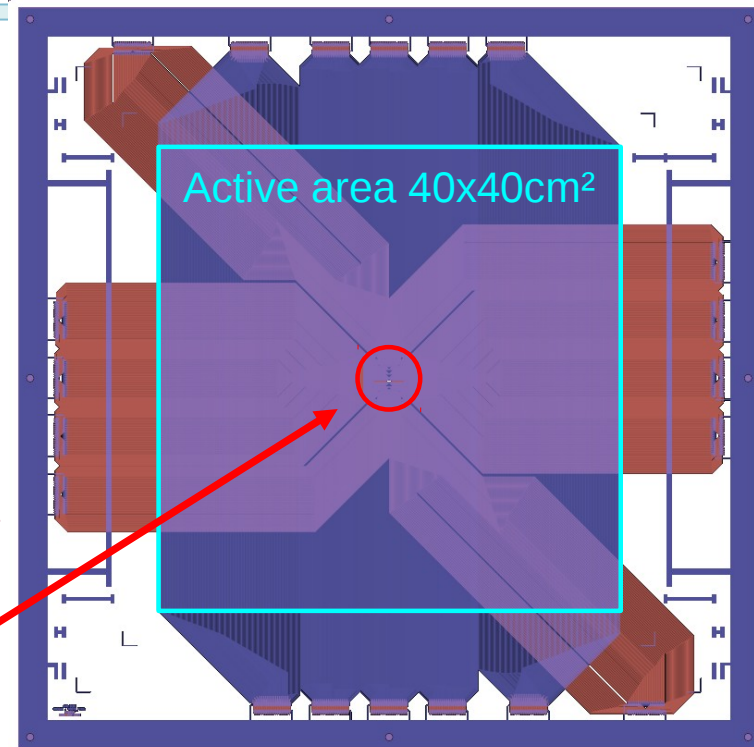
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**Goal: to replace present COMPASS MM (cf. F. Thibaud talk)**

**Large prototypes built at CERN**

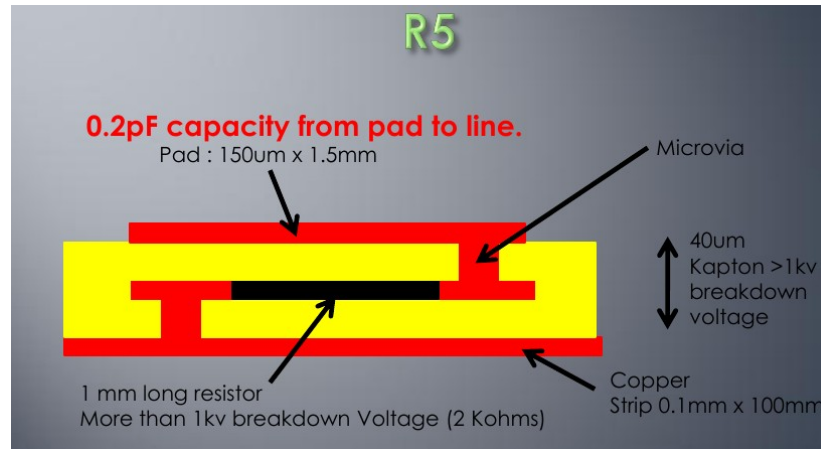
*40x40cm<sup>2</sup> active area, 400μm pitch, MM bulk technology, PCB thickness 200μm  
Tested in nominal conditions at COMPASS in 2010-2011, used as tracker in 2012*



# Two solutions to reduce discharge rate

## Resistive Micromegas

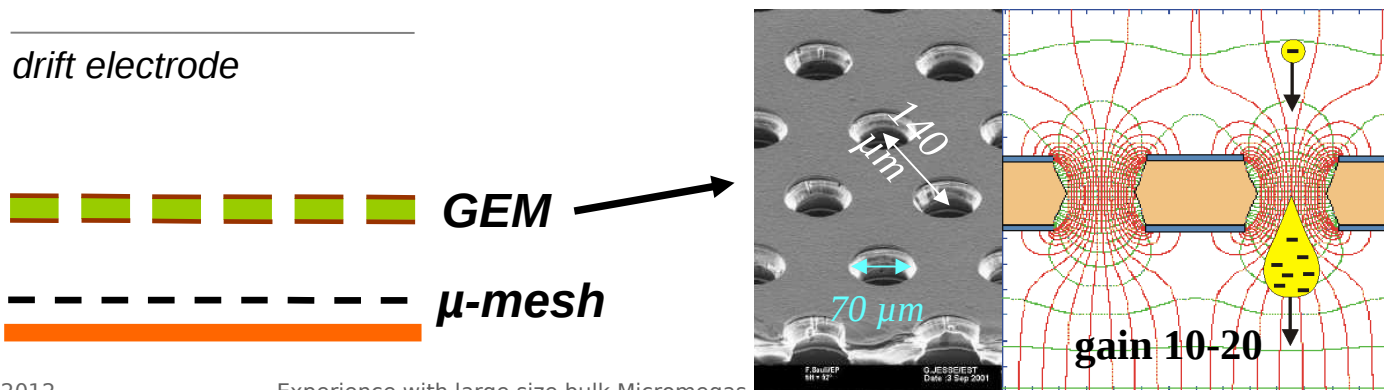
*Buried resistors scheme proposed by R. de Oliveira et al.*



## Classic Micromegas + 1 GEM foil

*Preamplification with a GEM foil (gain 10-20)*

*Micromegas stage at lower gain → less discharge*



# Production of large size prototypes at CIREA

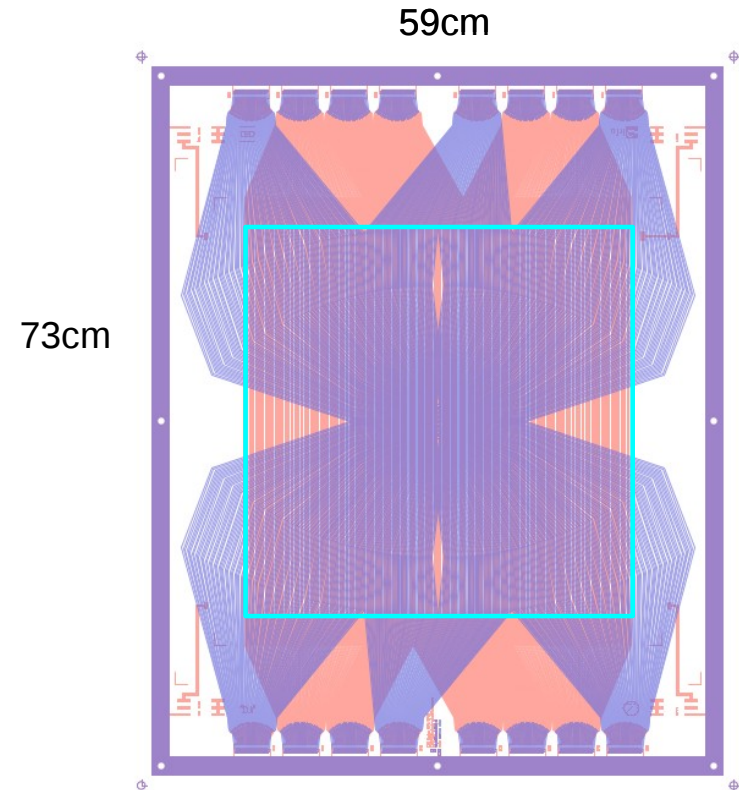
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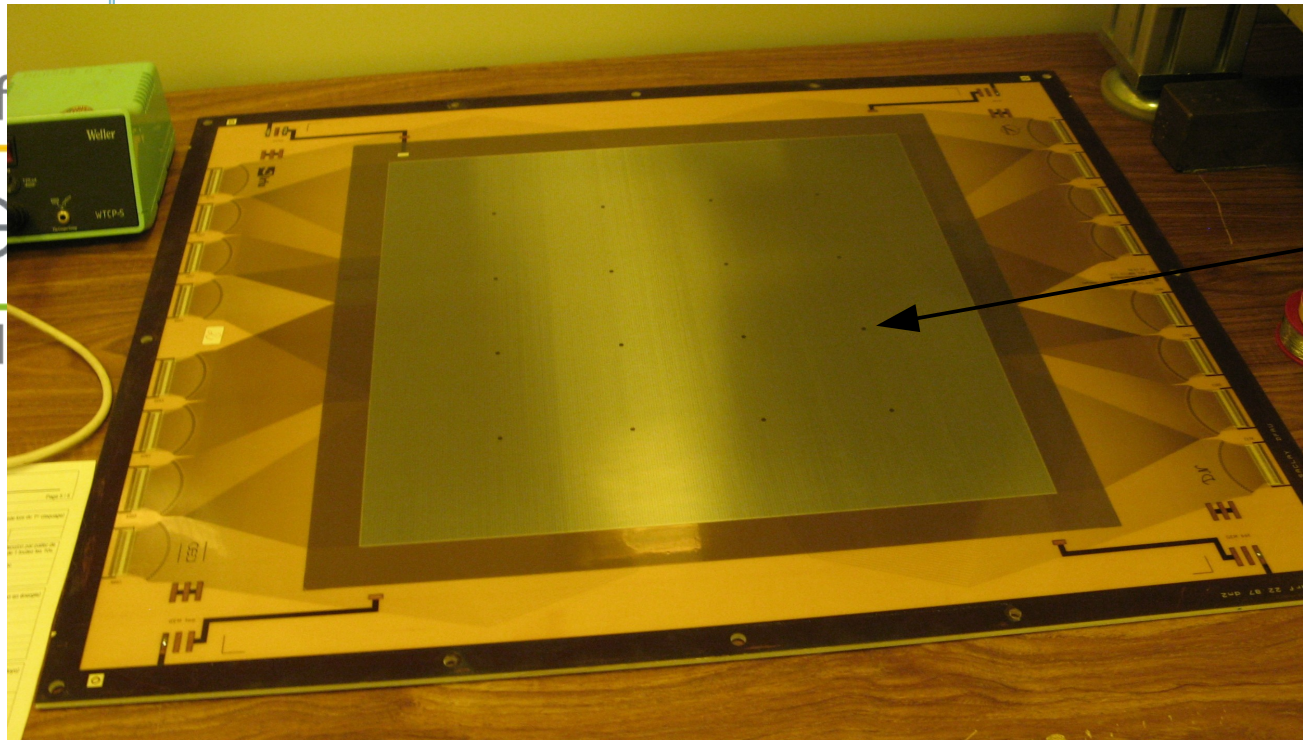
## Large size CIREA prototypes

- *Rectangular design with same active area 40x40cm<sup>2</sup>*
- *Thin board on Rohacell sandwich to lower material budget*
- *Simplified design for first prototypes  
→ less pixels (892), 100μm strips+isolation in center*
- *Bulk technology with amplification gap of 100μm instead of 128μm for CERN prototypes*
- *2 proto produced end of October*
- *1 prototype installed in beam at COMPASS end of November 2012 for 4 days*

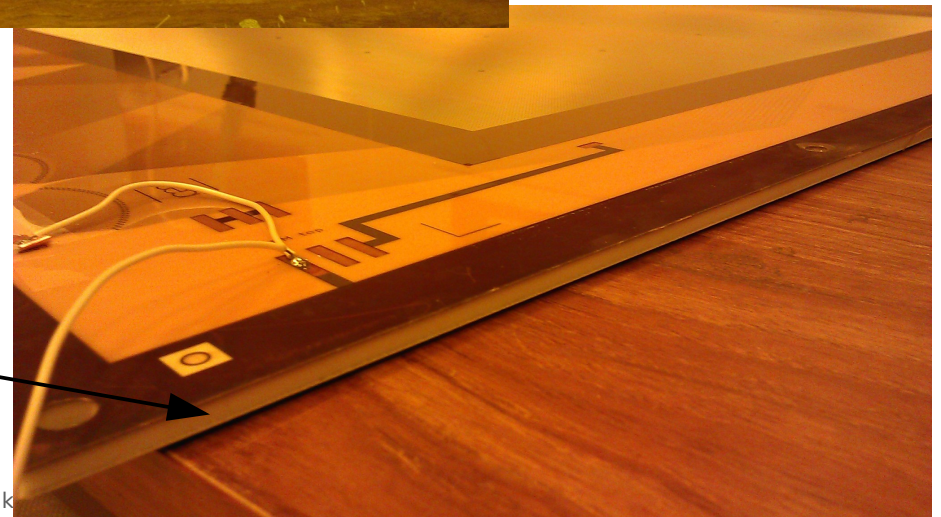




# Compass pixelMM board built at CIREA



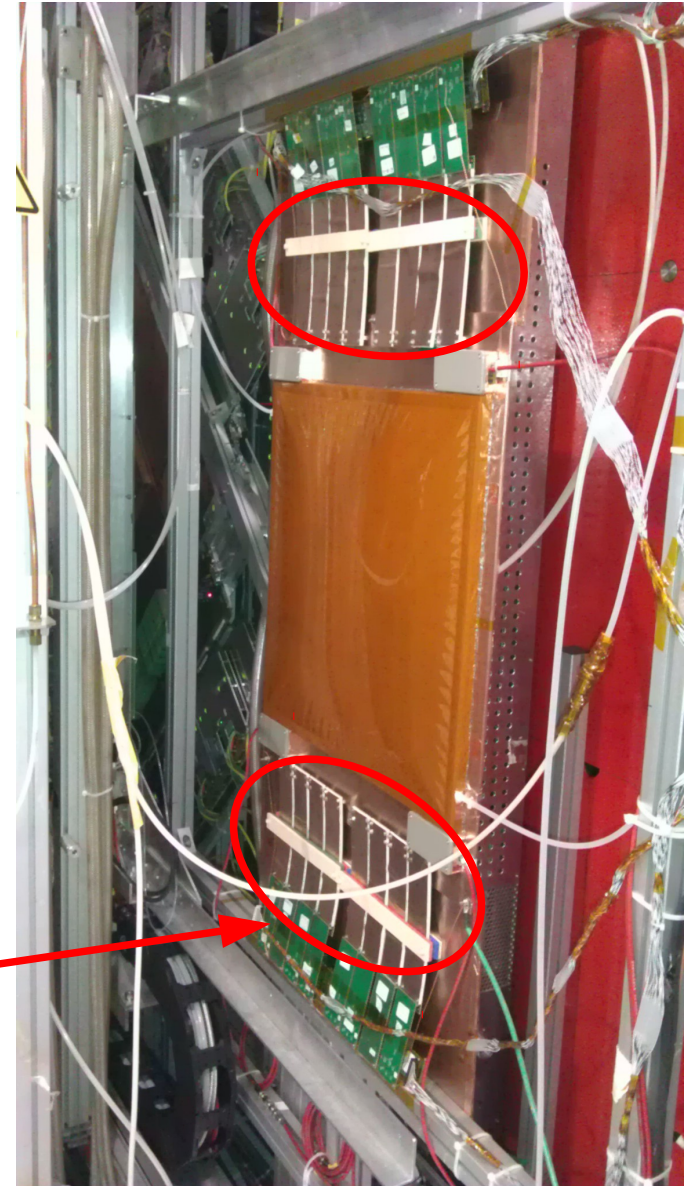
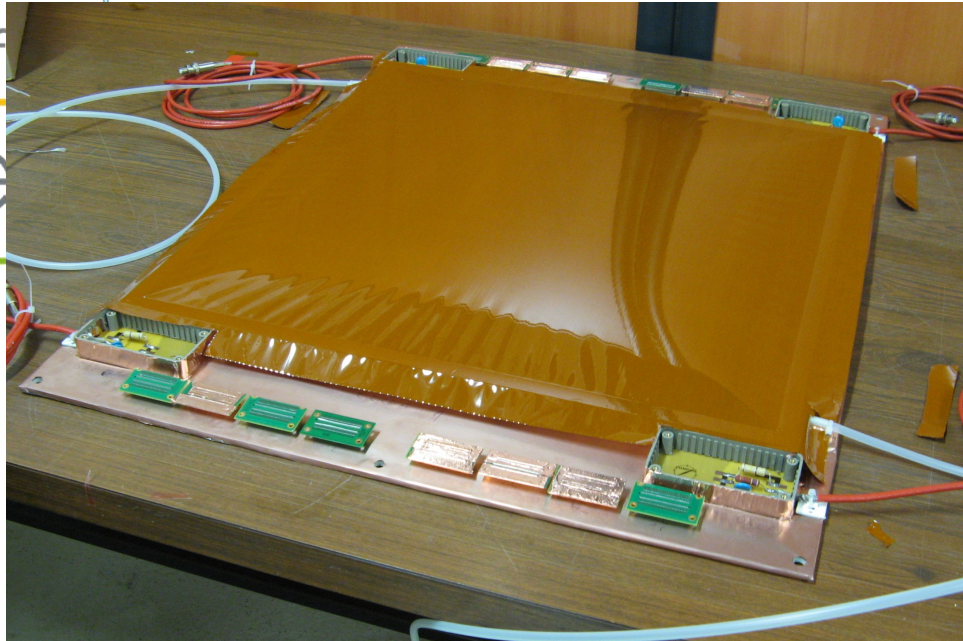
16 large pillars for spacing of the additional GEM foil



Rohacell sandwich



# CIREA pixelMM preparation and installation at COMPASS



Ok in laboratory (800V in air)  
Prepared with a GEM foil  
Electronics moved out of acceptance  
using 20cm extension cards

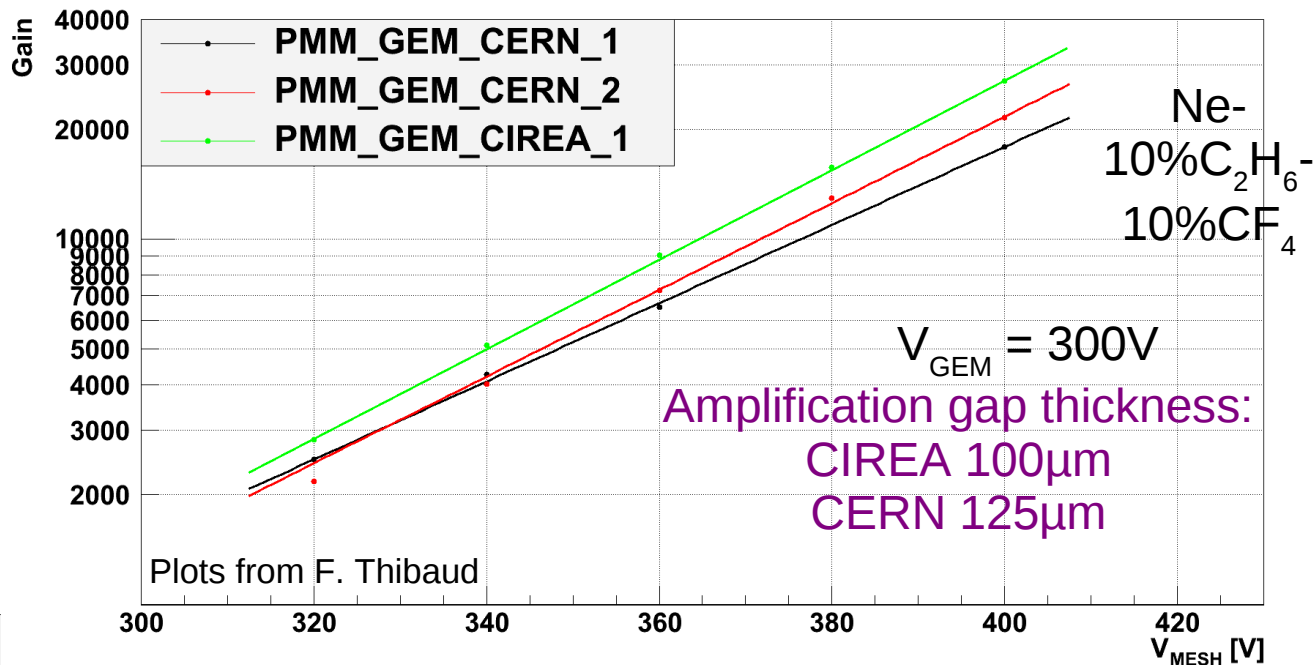
# Gain of CIREA prototype compared to CERN prototypes

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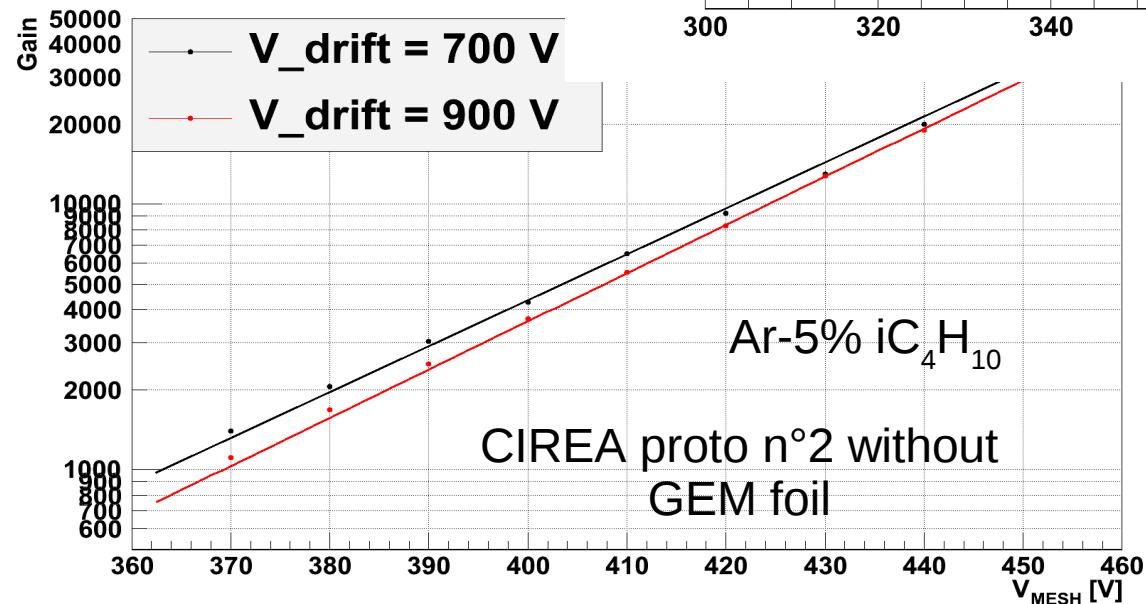
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Gain vs  $V_{MESH}$

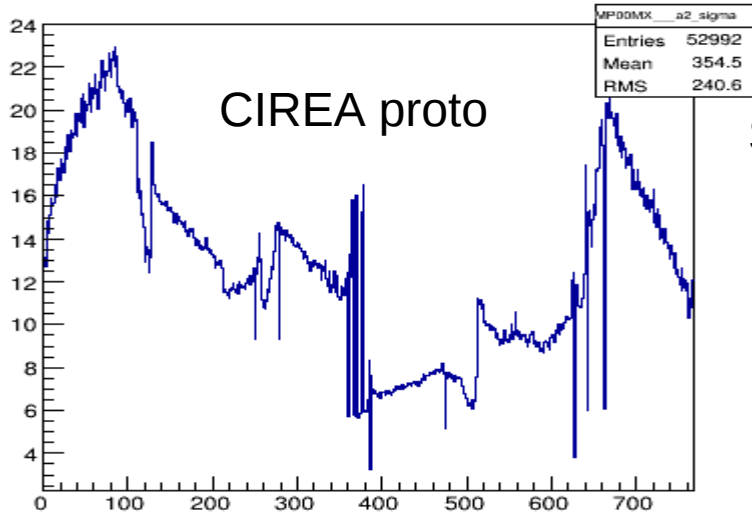


Gain vs  $V_{MESH}$



# Noise level with APV electronics

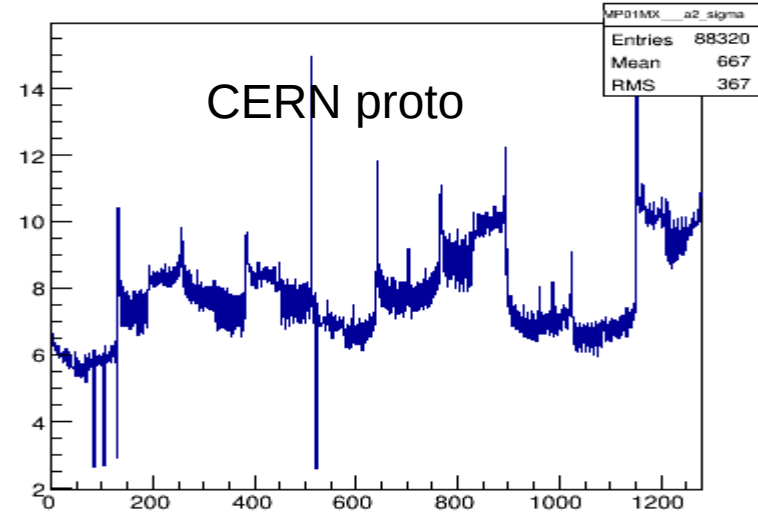
MP00MX\_\_a2\_sigma



CIREA proto

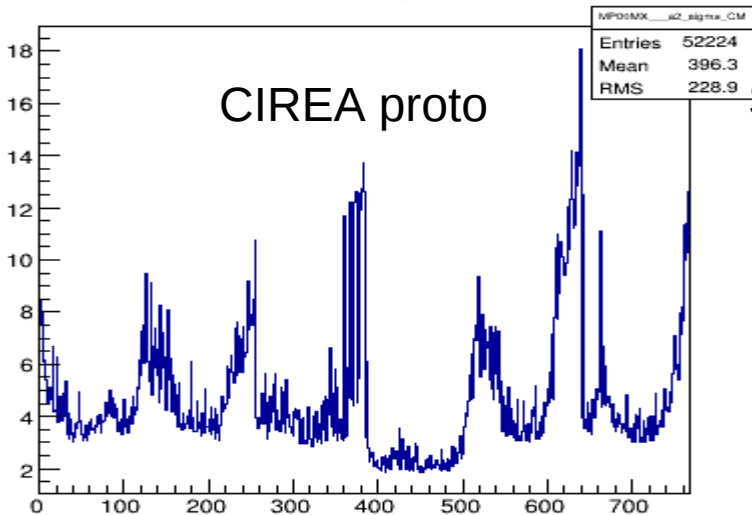
Sigma of raw noise  
1 ~ 400e<sup>-</sup>

MP01MX\_\_a2\_sigma



CERN proto

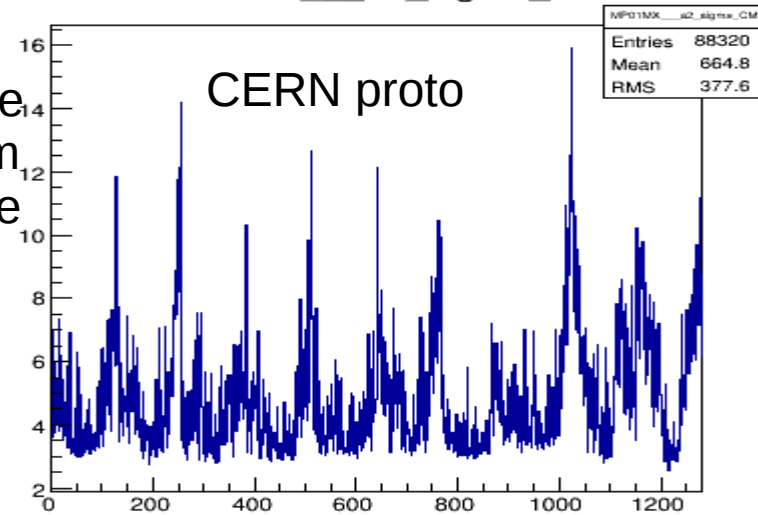
MP00MX\_\_a2\_sigma\_CM



CIREA proto

Sigma of noise corrected from common noise

MP01MX\_\_a2\_sigma\_CM

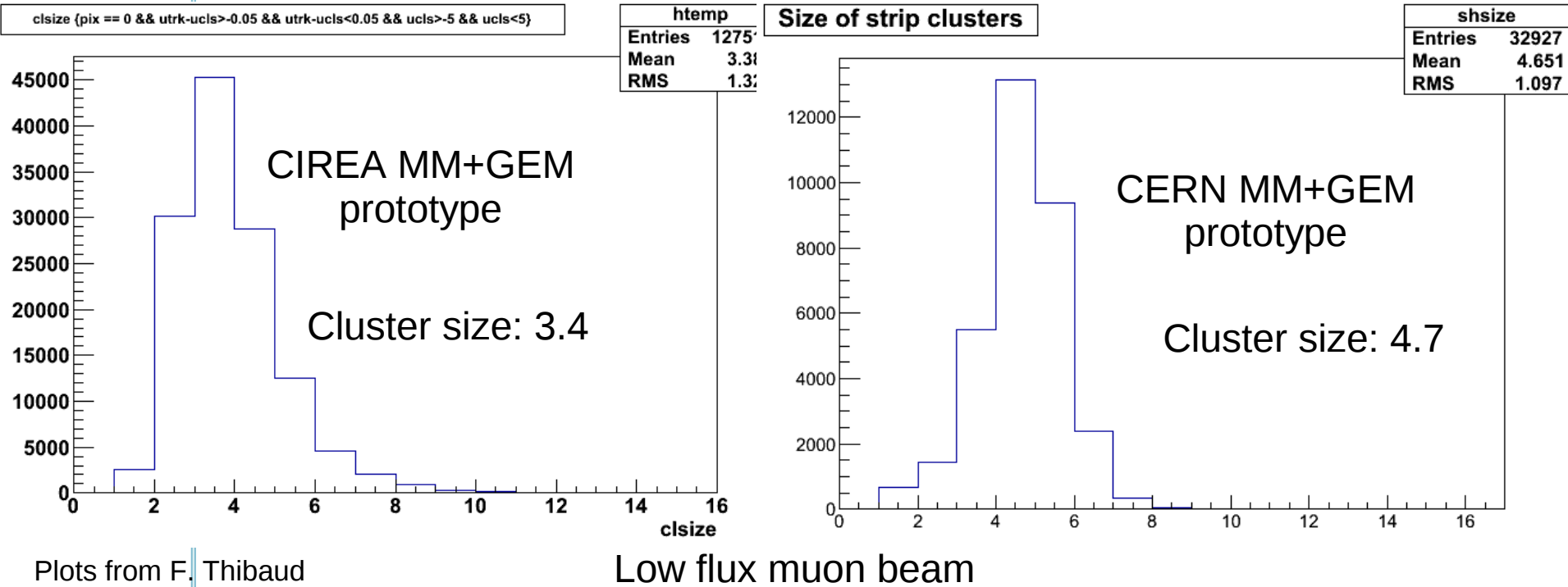


CERN proto

Noise level higher (>15% more), probably linked to new design

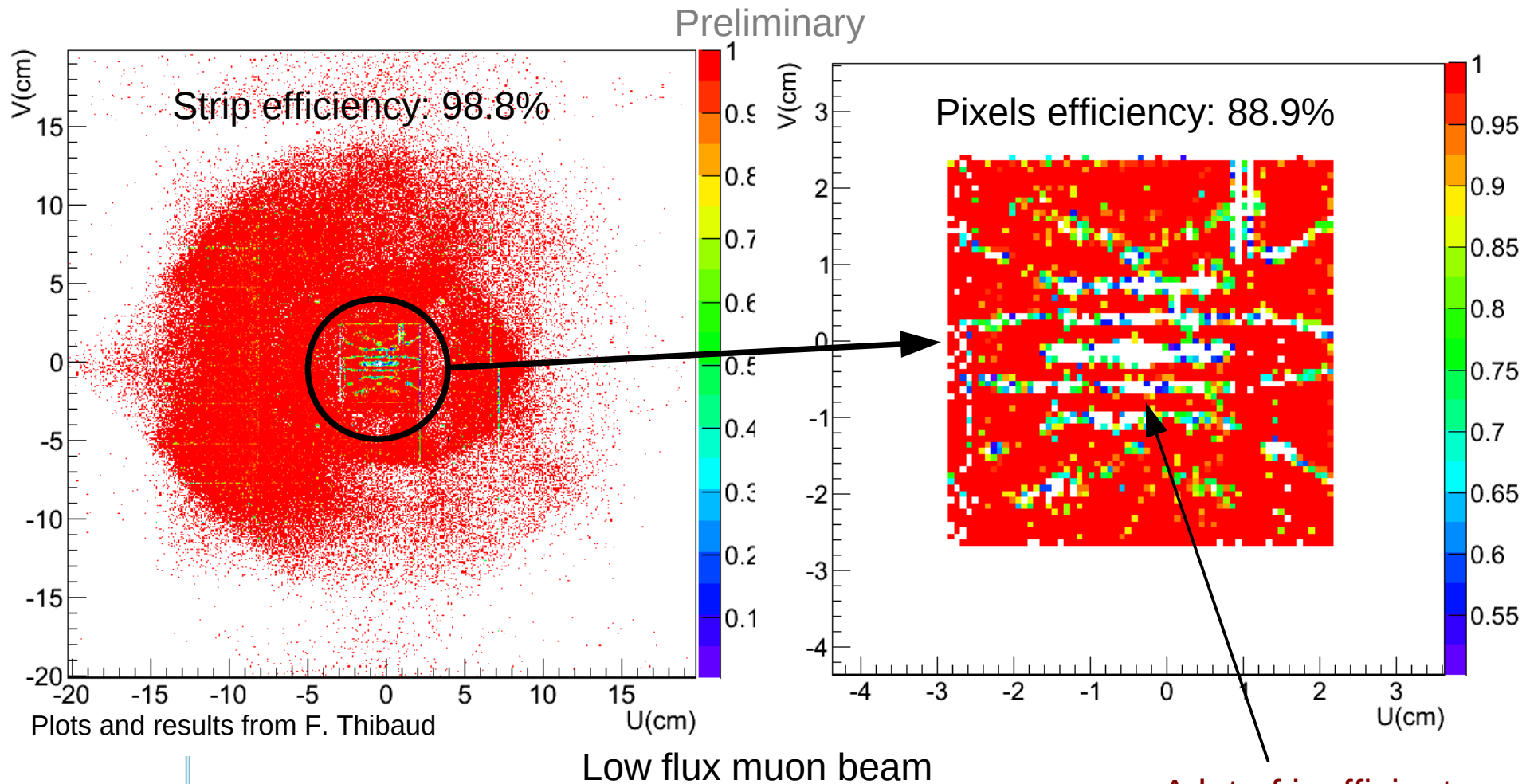


# Cluster size on strips at low flux, no magnetic field



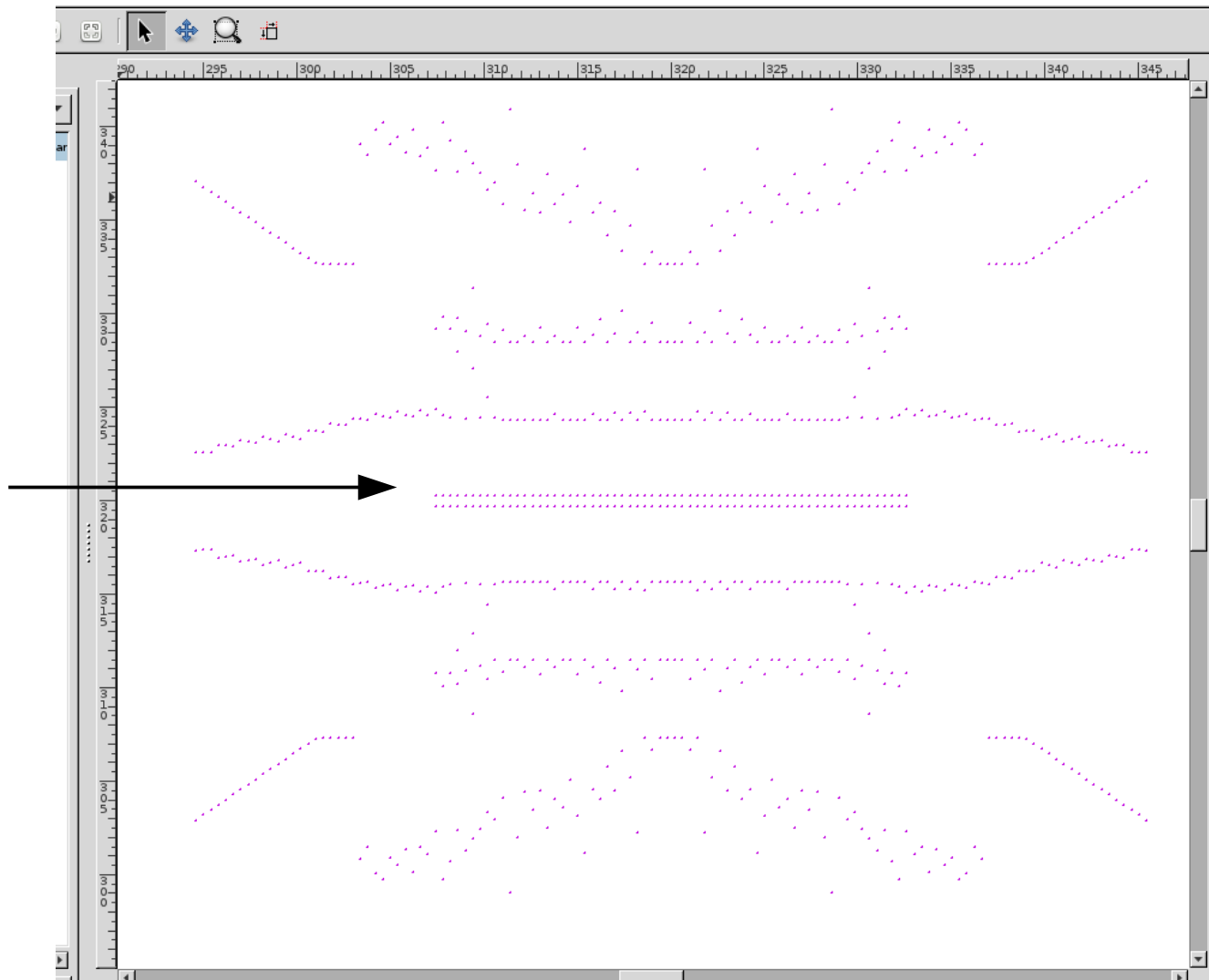
Cluster size lower than CERN prototypes, due to larger noise (-> larger thresholds)  
Similar to BR proto (3.7) and larger than classical MM (2.6)

# Efficiency results at low flux, no magnetic field



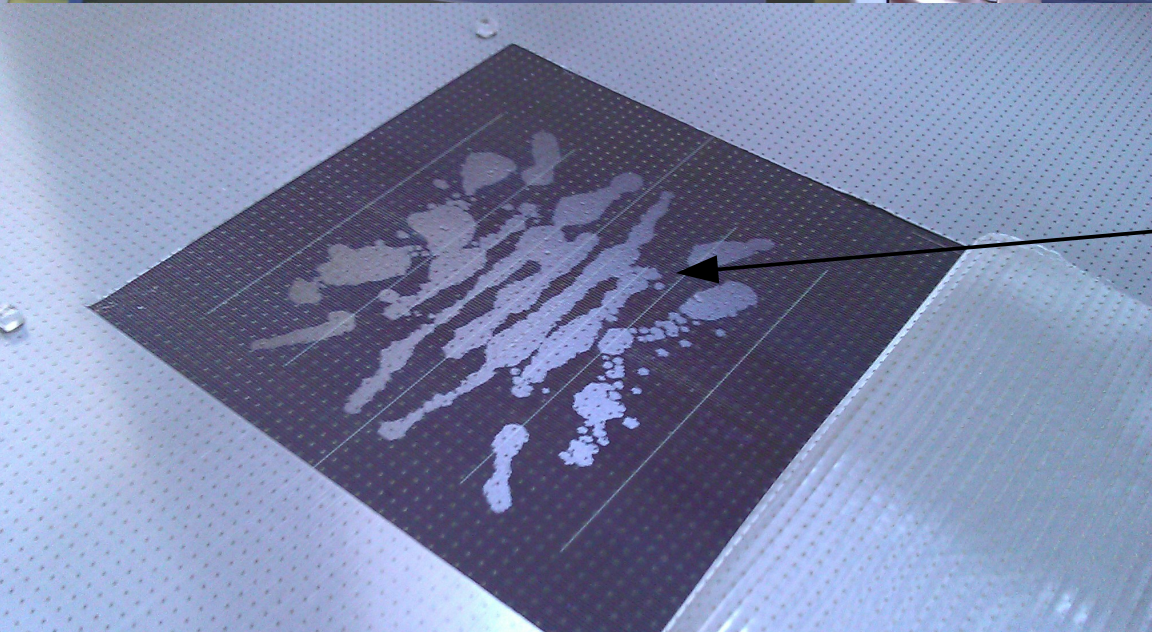
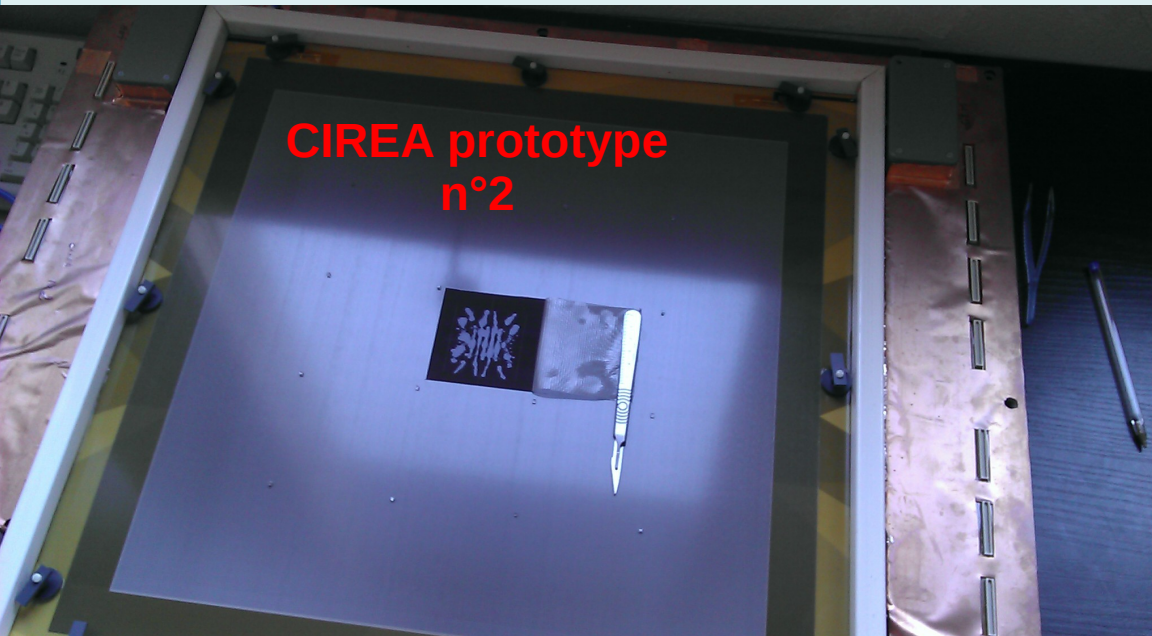
# Bad efficiency spots in pixel area

Position of  
vias in pixel  
area



Detector inefficient on vias positions

# Bad efficiency spots in pixel area



Gluing resin spilled  
through via holes



# Efficiency results at high flux, with magnetic field

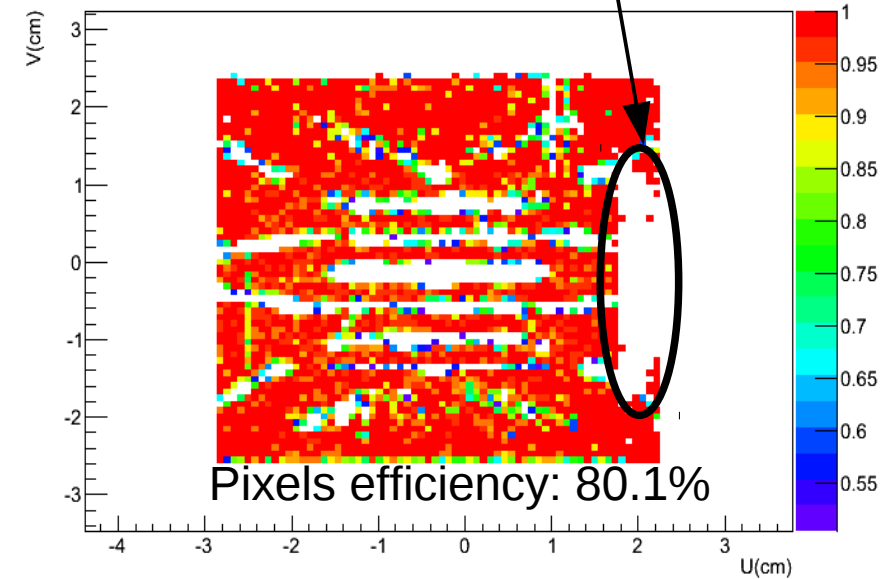
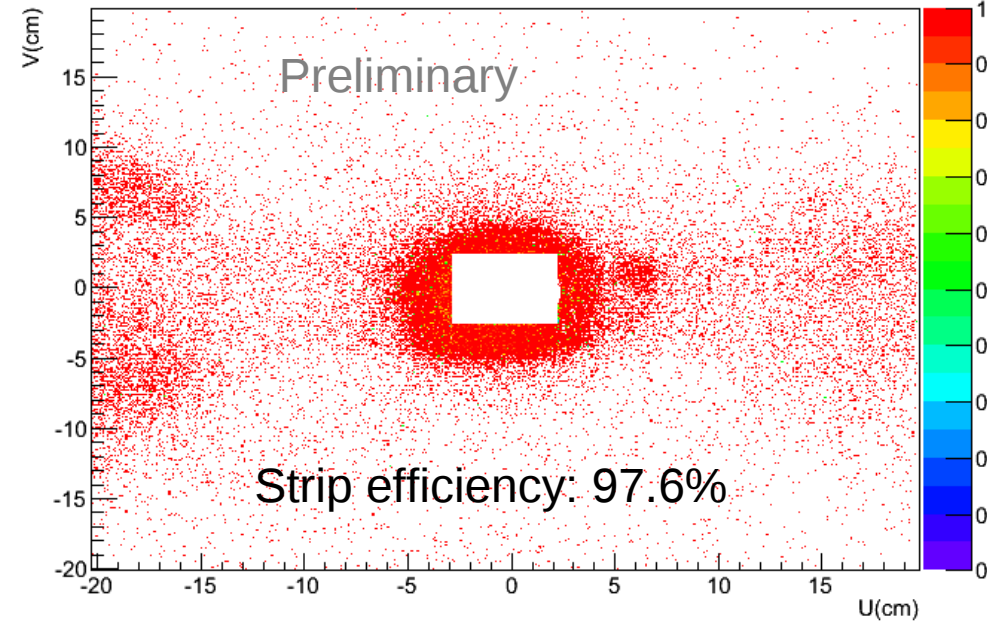
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High flux muon beam

No track  
reconstructed  
there

Efficiency of strip part = 97 %

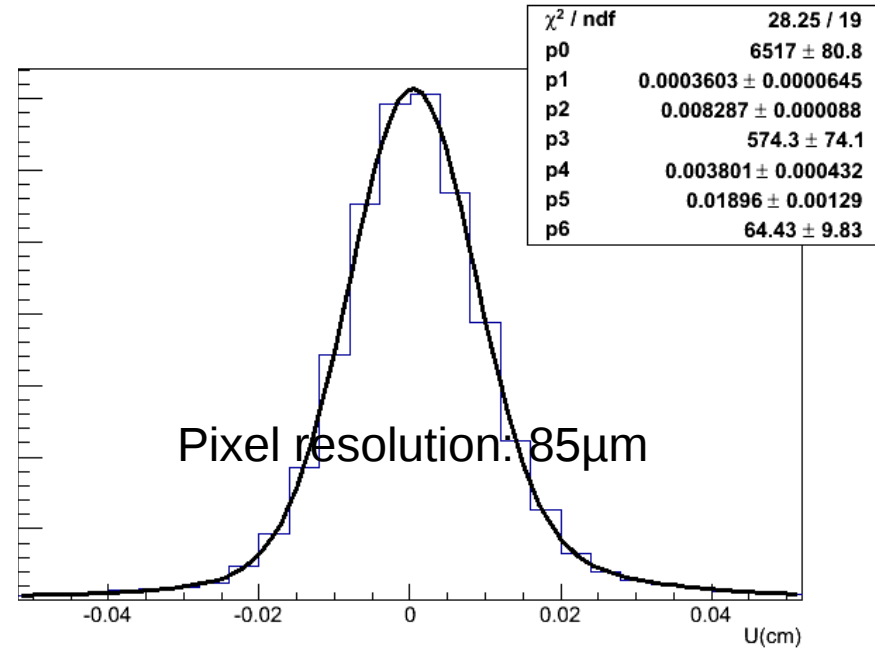
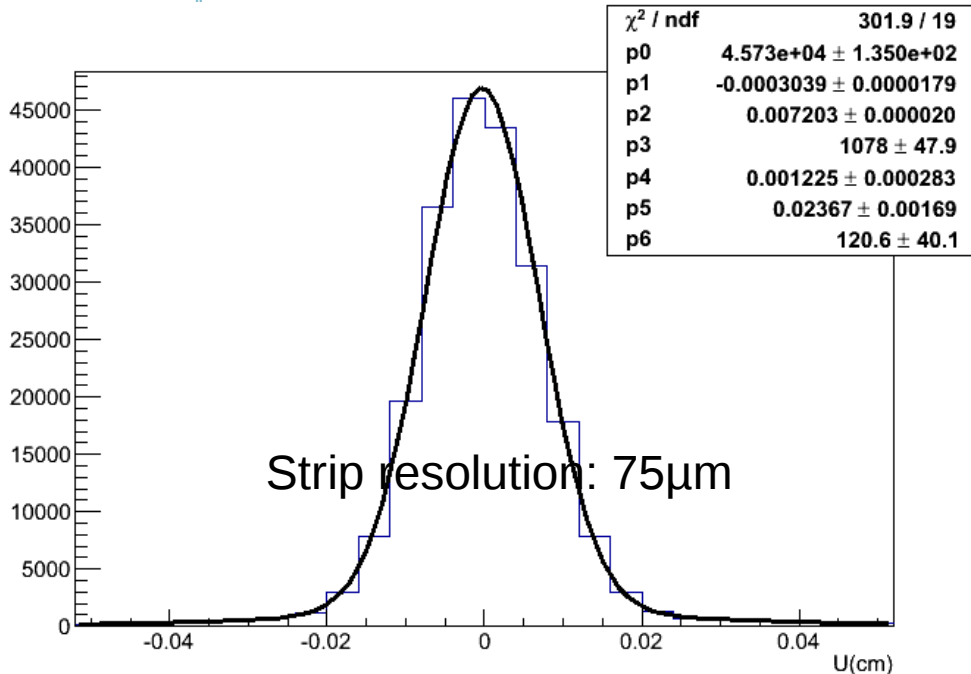
Efficiency of pixel part = 79 %



Plots from F. Thibaud

Good efficiency on strip area  
Pixels efficiency looks good out of the resinated spots

# Spatial resolution results at low flux, no magnetic field



Plots from F. Thibaud

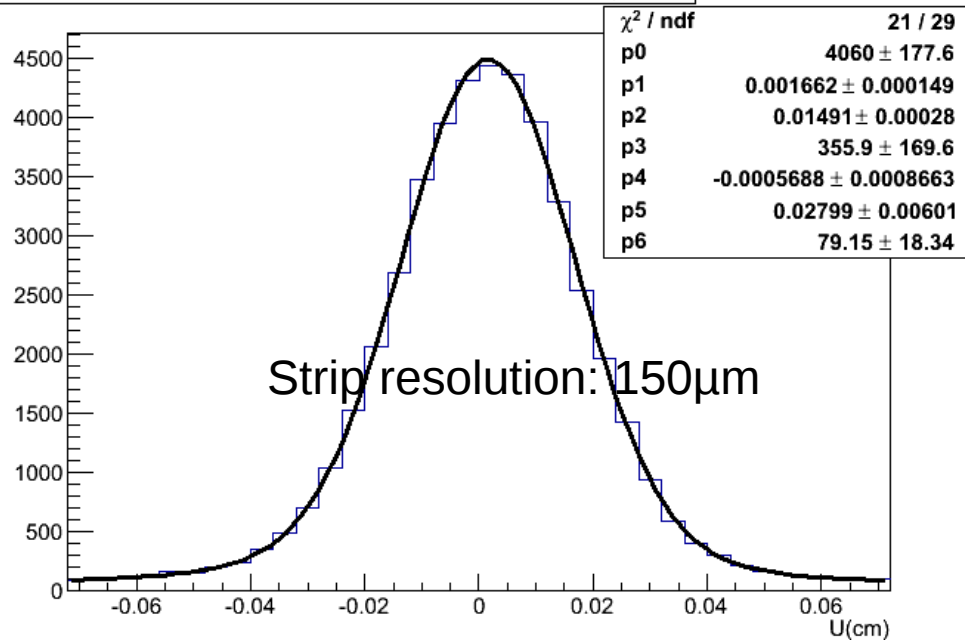
Low flux muon beam

Spatial resolution on strips not as good as for CERN MM+GEM (57 $\mu\text{m}$ )

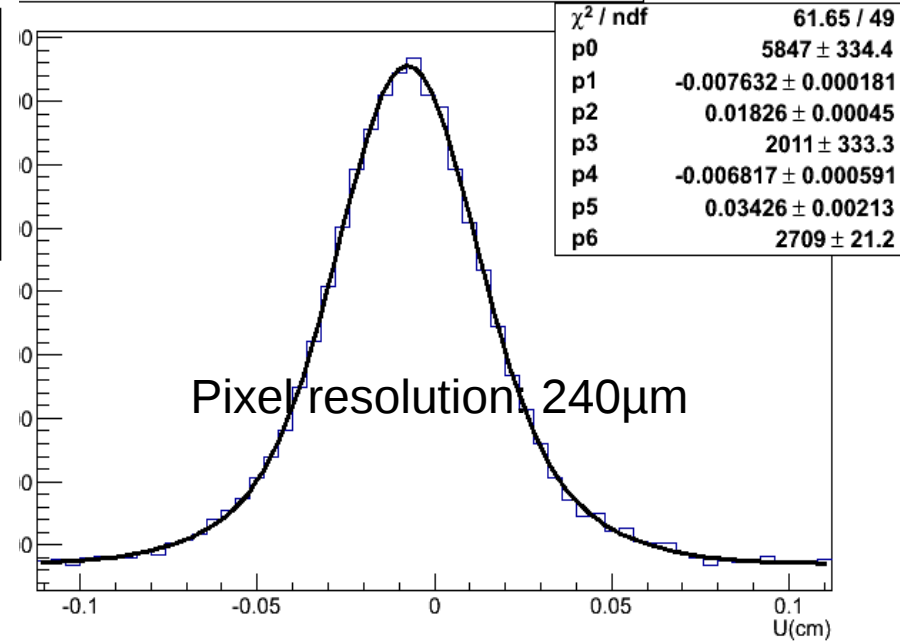
Bad resolution on pixels due to resinated spots

# Spatial resolution results at high flux, with magnetic field

Residual distribution of strip part -  $\sigma = 168 \mu\text{m}$



Residual distribution of pixel part -  $\sigma = 246 \mu\text{m}$

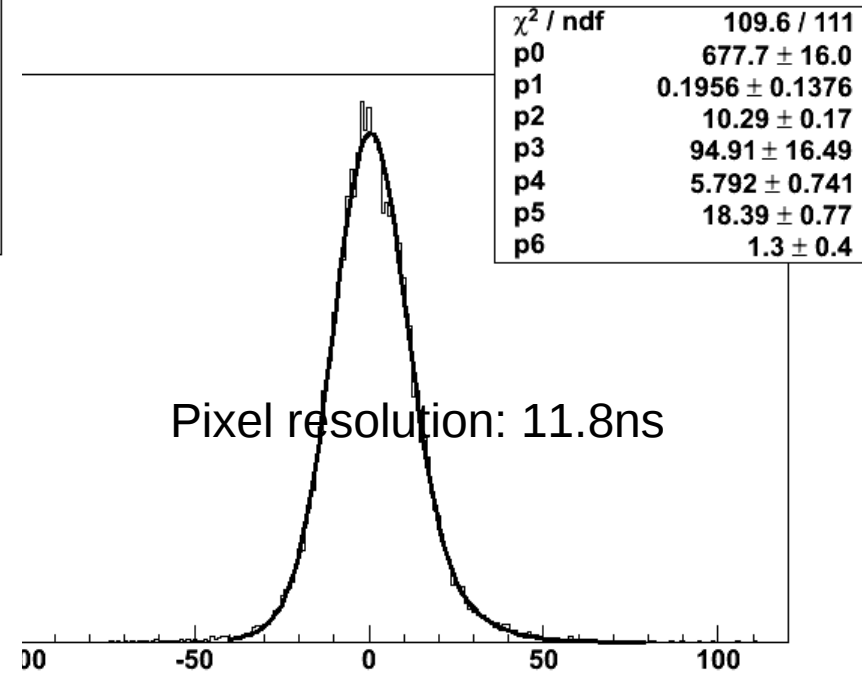
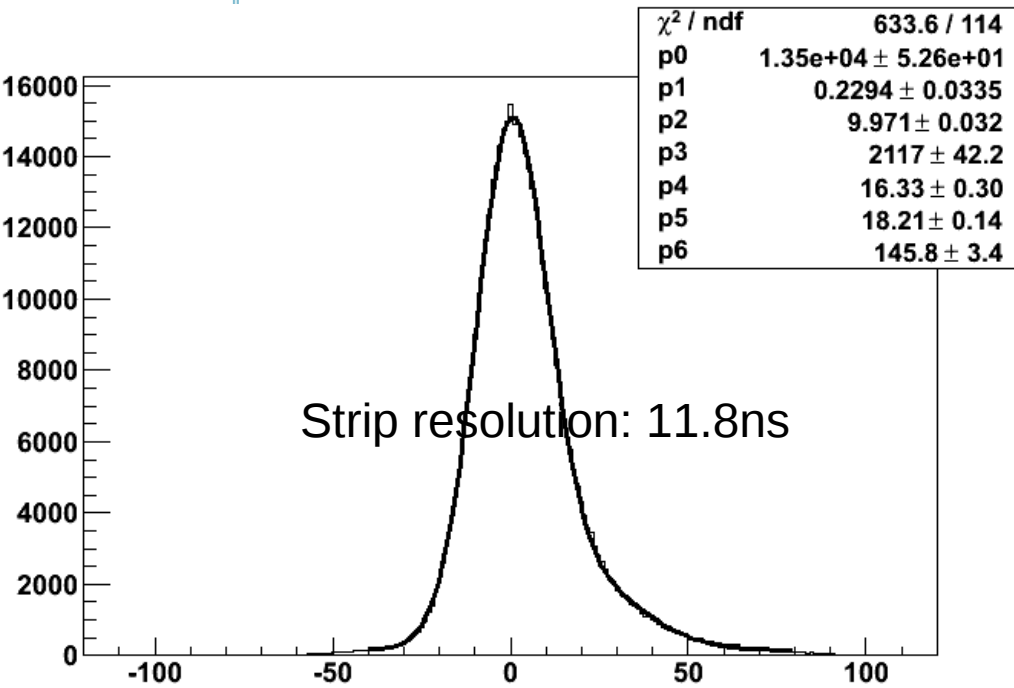


Plots from F. Thibaud

High flux muon beam

Spatial resolution on strips similar to CERN MM+BR (140 $\mu\text{m}$ ) placed in the same position and with same field

# Time resolution results at low flux, no magnetic field



Plots from F. Thibaud

Low flux muon beam

Gas: Ne+10%C<sub>2</sub>H<sub>6</sub>+10CF<sub>4</sub>

Time resolution not as good as for CERN MM+GEM (~9ns), probably linked to larger noise level



# Conclusions

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## Large size CIREA prototype

- *Production without big problem*
- *2 prototypes delivered, one tested with beam in MM+GEM configuration*
- *Normal behavior during data taking: no leak current, no discharge*

## Performances

- *Impacted by resin spilled through pixel via holes, to be filled in the next production*
- *Good performances (efficiency, spatial and time resolution) but not as good as CERN prototypes, impacted by larger noise level*
- *Probably linked to design, improvement done on it*

# Perspectives

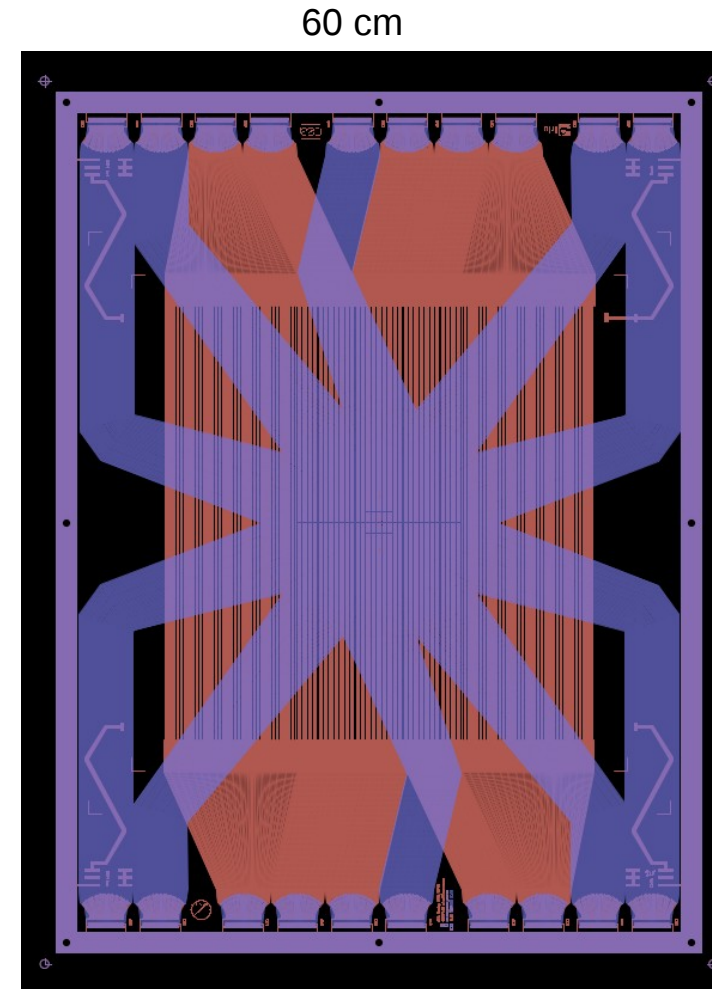
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## Next steps with CIREA-ELVIA for COMPASS

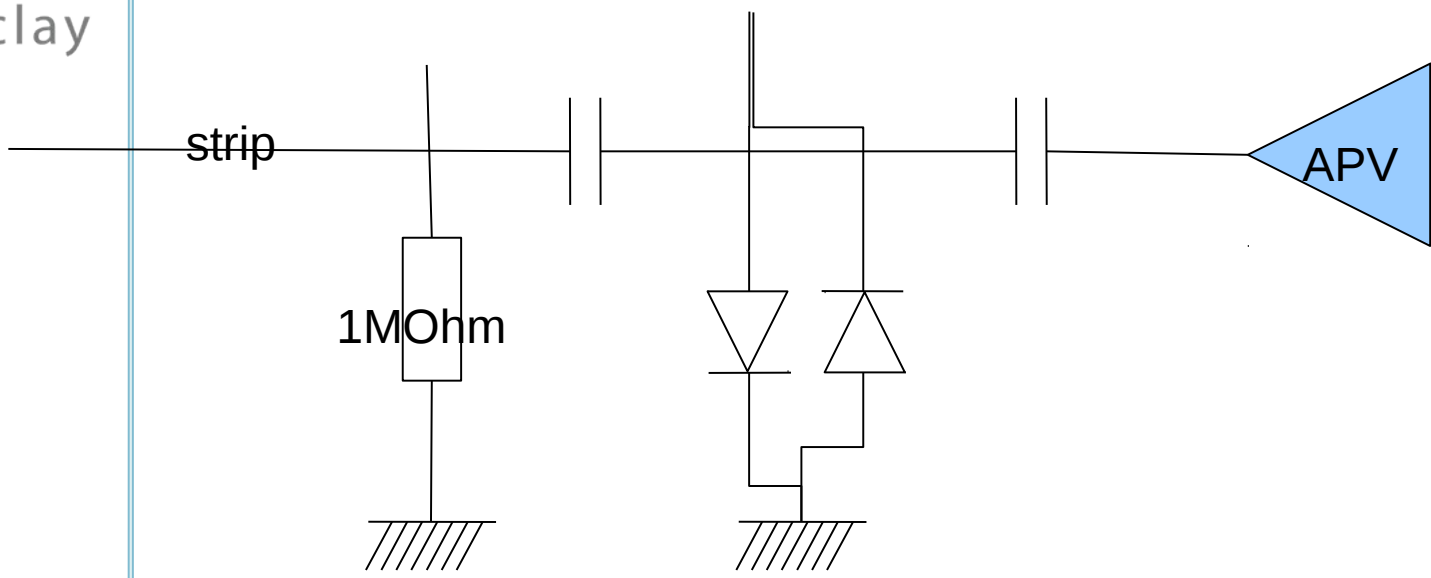
- *Production of small prototypes (TF10, 6x10cm<sup>2</sup>) with buried resistors in progress, expected in ~~February~~ July*
- *Large size non-simplified prototype (60μm strips+isolation) production launched, delivery foreseen in July*
- *Large size resistive prototype production depends on several inputs*
- *Final prototypes in Fall, serial production to be started before end of year*
- *Installation of 12 detectors Spring 2015*



# Spares

# MM protection circuit

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# R&D on production at CIREA company

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## Collaboration between Saclay and CIREA company since late 2010

*CIREA: producer of large size PCB at Cholet (France), part of ELVIA group*

*Also knowledge on resistive layers in ELVIA group*

*Collaboration improved since late 2011 with financing from ANR french funding agency*

## Activities on bulk production

*A few small prototypes (6x10cm<sup>2</sup>) produced during 2011, 1 with good gain performances*

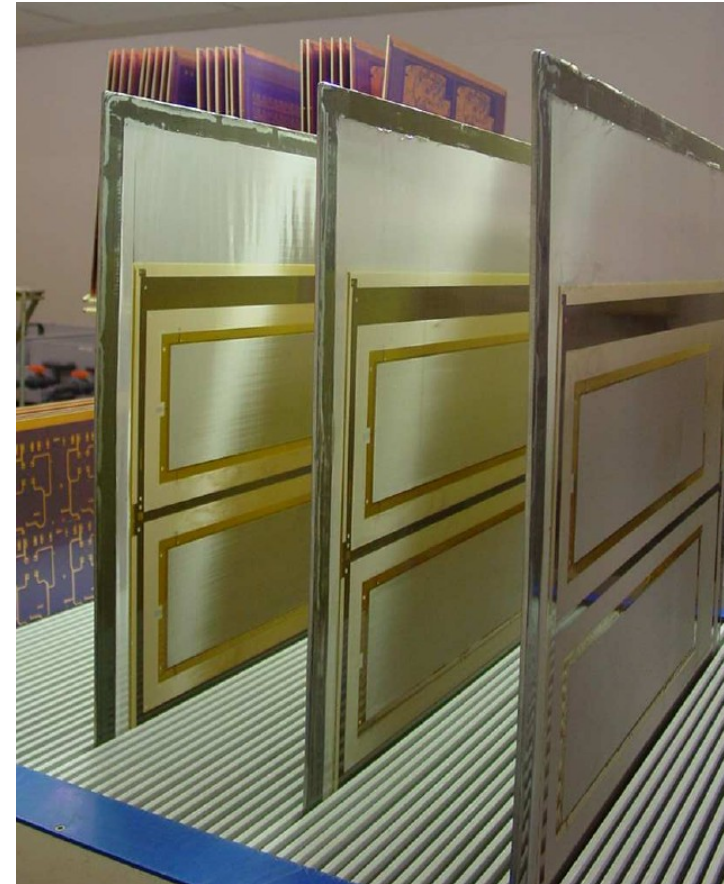
*Several larger PLV3 prototypes (12x50cm<sup>2</sup>) batches produced since end of 2011 on thick boards*

*Also PLV3 on thin boards glued on Rohacell sandwich*

*Several problems at the beginning: bubbles in coverlay, pillars unstuck off board, low pillar thickness, waves on mesh*

*Quality has been improved with the time, almost good now*

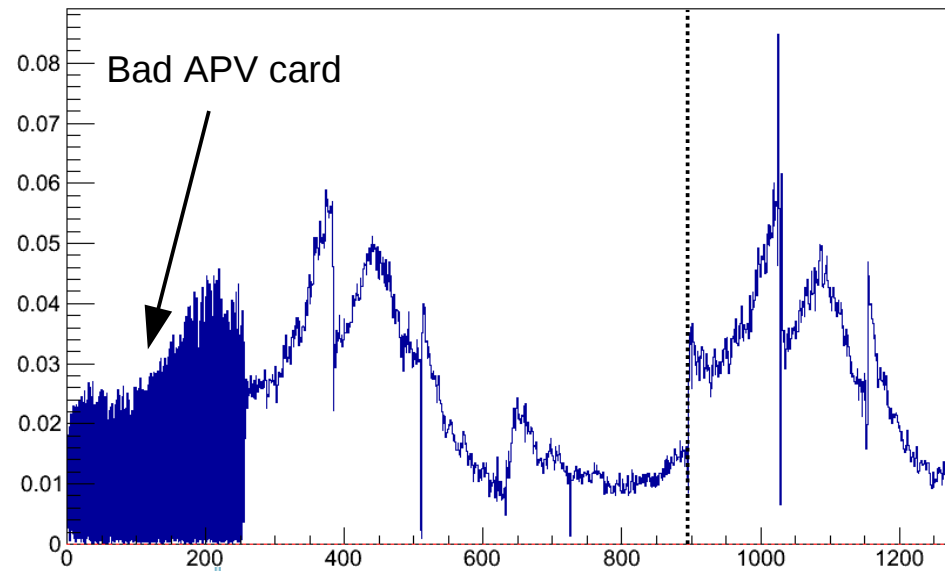
*Production of resistive BXY prototypes from June 2012 for ATLAS*



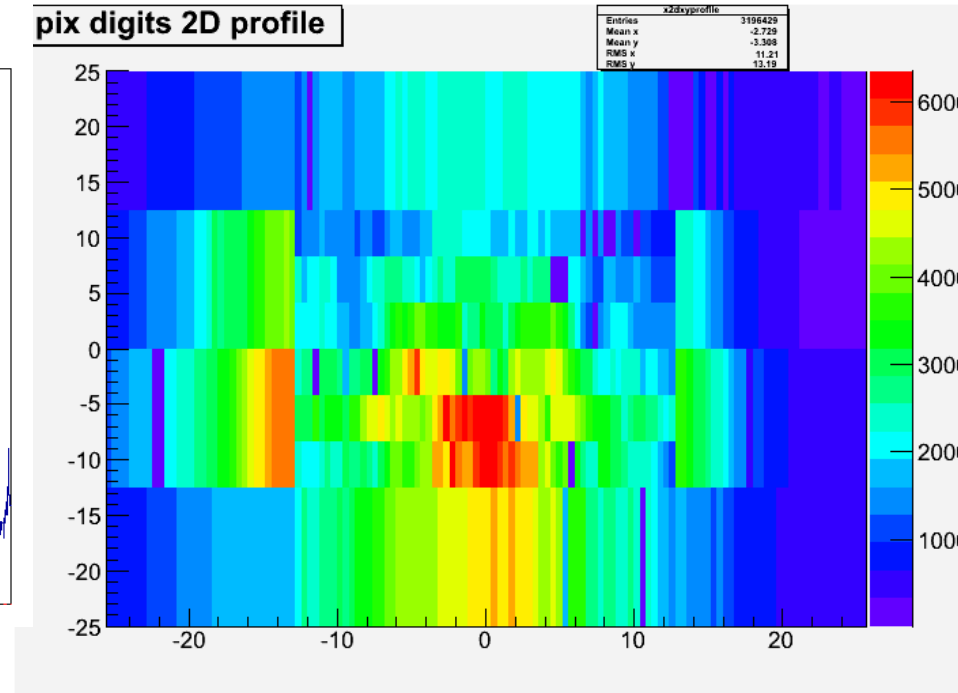
# First profiles with CIREA pixelMM



MP00X1\_\_occupancies



pix digits 2D profile



Pixels profile