Test Beam the μ-RWELL

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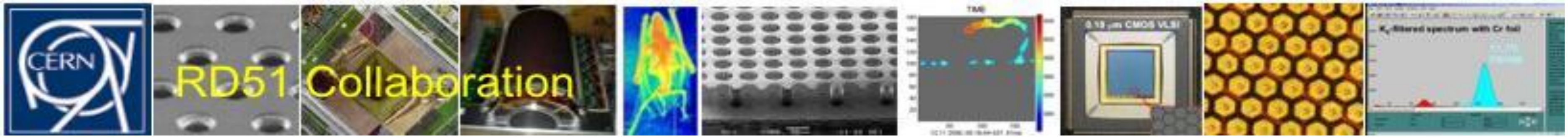


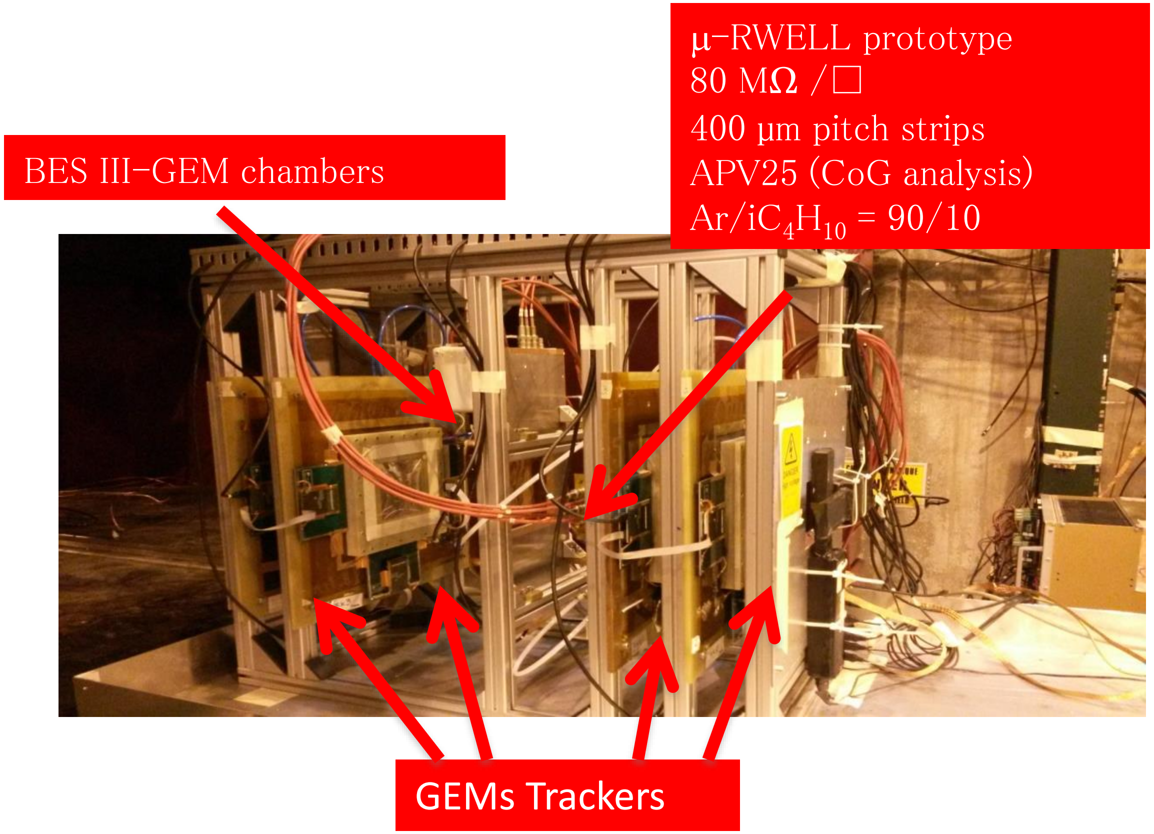
Dec. 2014 Test Beam

- μ-RWELL prototype
  80 MΩ /□
  400 μm pitch strips
  APV25 (CoG analysis)
  Ar/iC4H10 = 90/10

- 4 GEM Trackers inside magnetic field

- HV scan, B scan

- No incident angle scan



BES III–GEM chambers

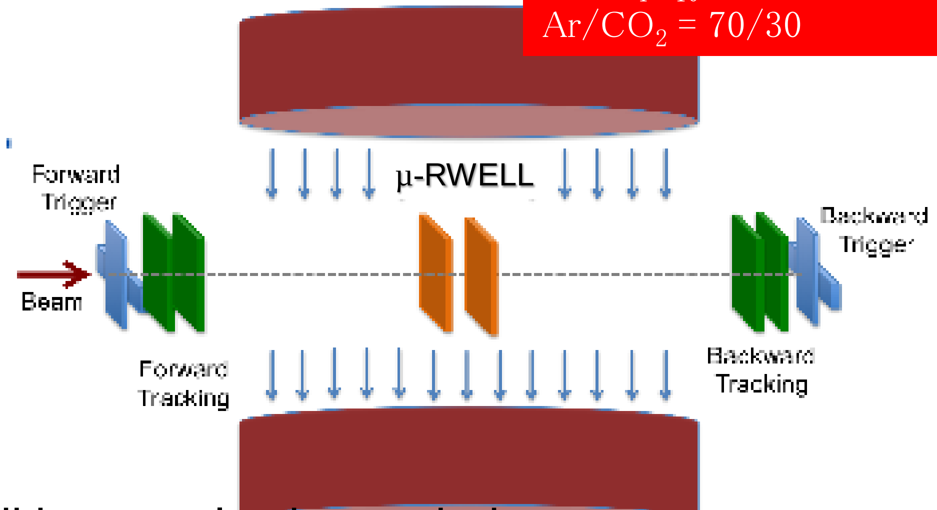
μ–RWELL prototype
80 MΩ /□
400 μm pitch strips
APV25 (CoG analysis)
Ar/iC_4H_{10} = 90/10

GEMs Trackers

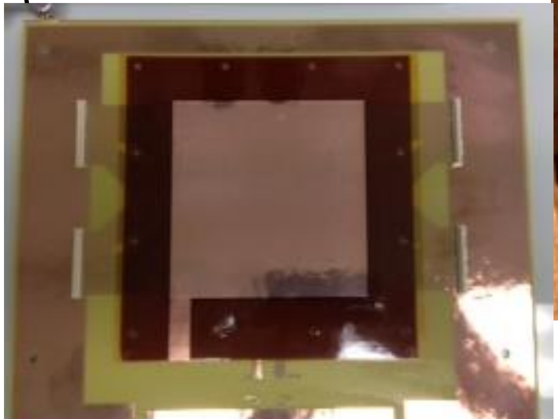
June 2015 Test Beam

- μ-RWELL prototype
  80 MΩ /☐
  400 μm pitch strips
  APV25 (CoG analysis+ micro-TPC mode)
  $Ar/iC_4H_{10} = 90/10$
  $Ar/CO_2 = 70/30$
- 4 GEM Trackers outside magnetic field
- HV scan, B scan
- Incident angle scan

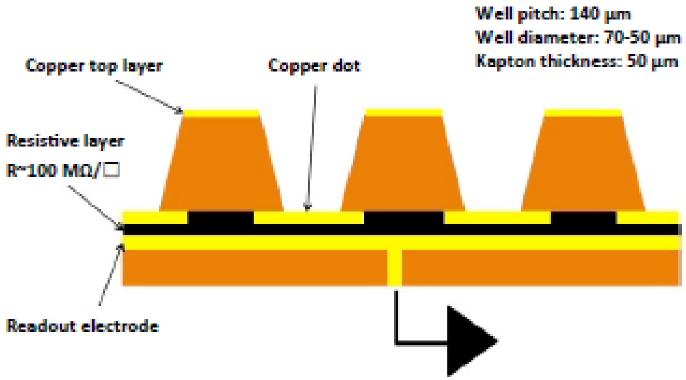
μ−RWELL prototype
80 MΩ /☐
400 μm pitch strips
APV25 (CoG analysis)
$Ar/iC_4H_{10} = 90/10$
$Ar/CO_2 = 70/30$

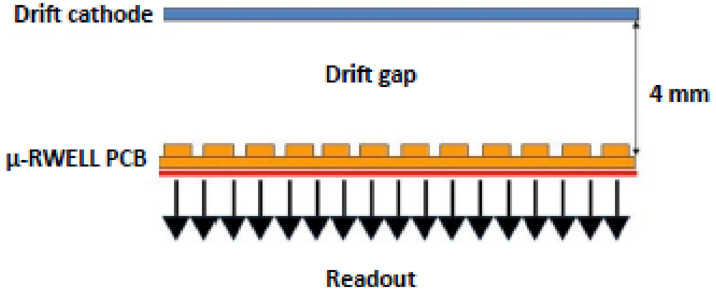


In addition we also have tried to test a new μ-RWELL prototype with a suitable “current evacuation” scheme (but …)



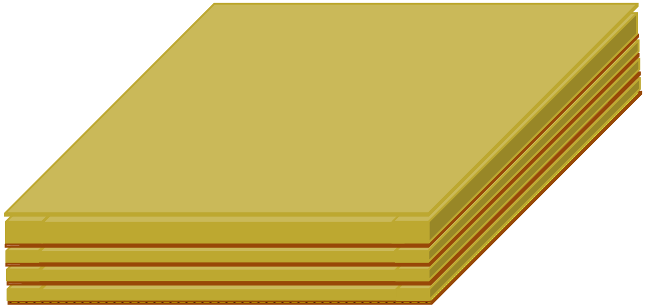
The μ-RWELL architecture



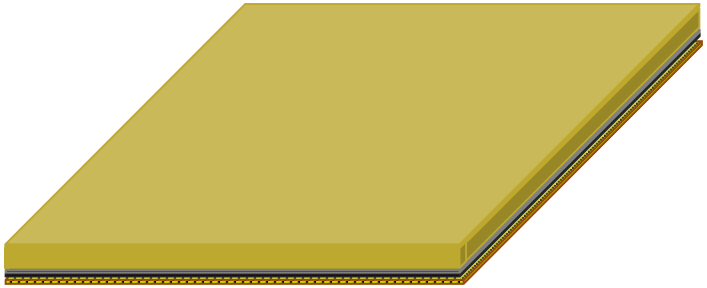


- The μ-RWELL is realized by coupling a“suitable patterned GEM foil”with the readout PCB plane coated with a resistive deposition.
- The resistive coating is performed by (cheap) screen printing technique.
- The WELL matrix is realized on a 50 μm thick polyimide foil, with conical channels 70μm (50 μm) top (bottom) diameter and 140μm pitch.
- A cathode electrode, defining the gas conversion/drift gap, completes the detector.

The µ-RWELL: a GEM-MM mixed solution

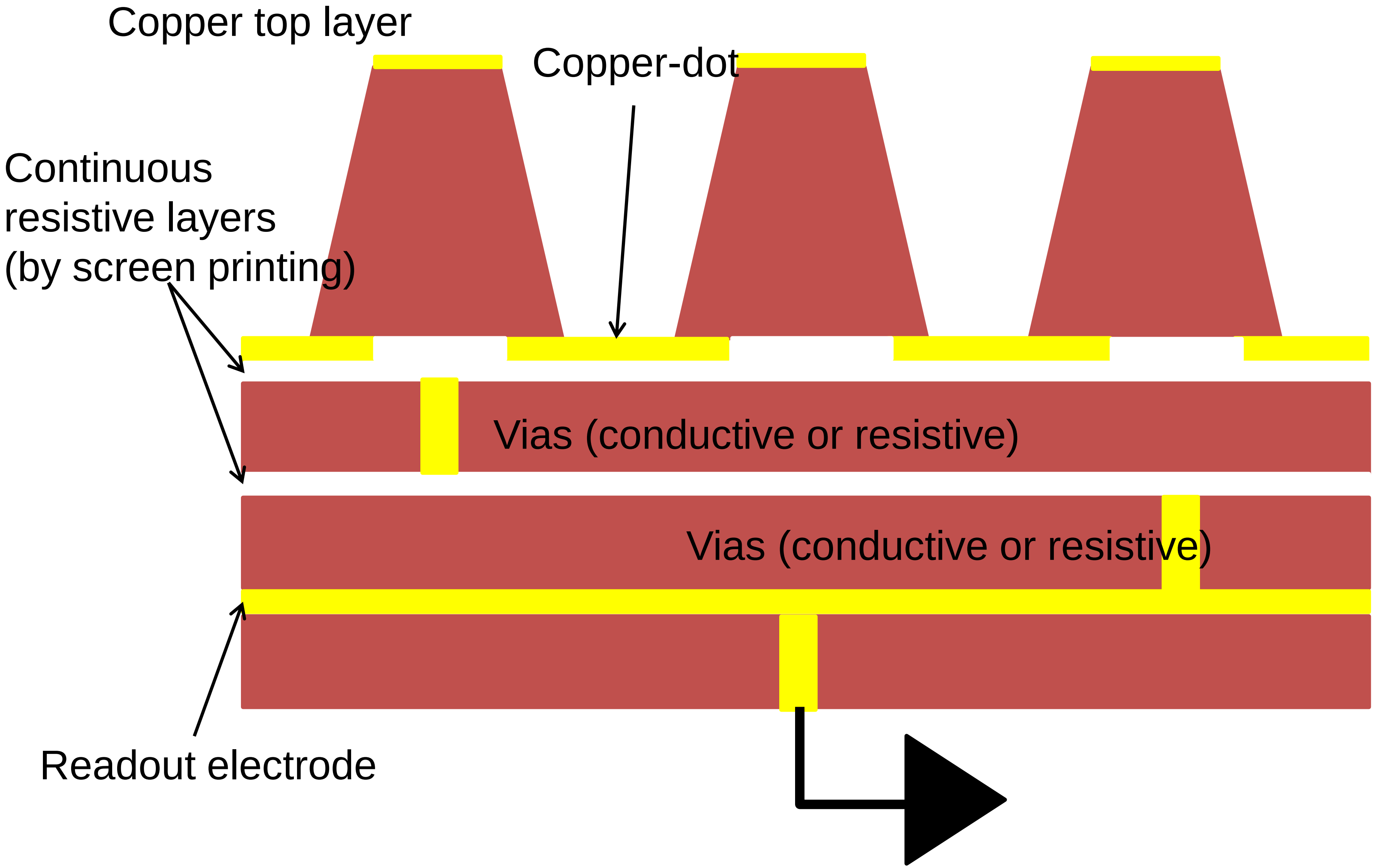


GEM detector sketch



MM detector sketch

he μ–RWELL: double resistive–layer w/current evacuatio scheme



Copper top layer

Copper-dot

Continuous resistive layers (by screen printing)

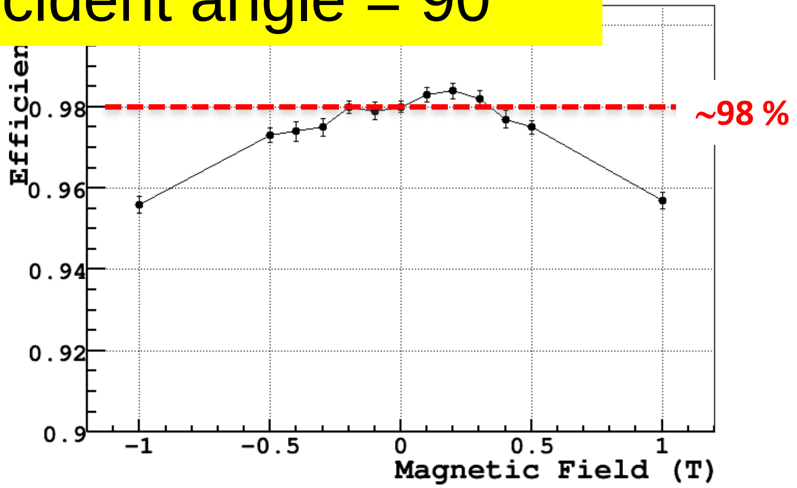
Vias (conductive or resistive)

Vias (conductive or resistive)

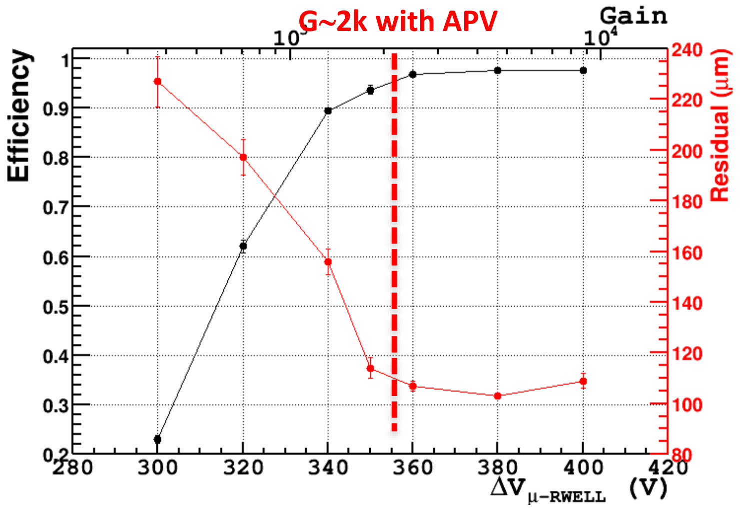
Readout electrode

Test Beam Results 2014

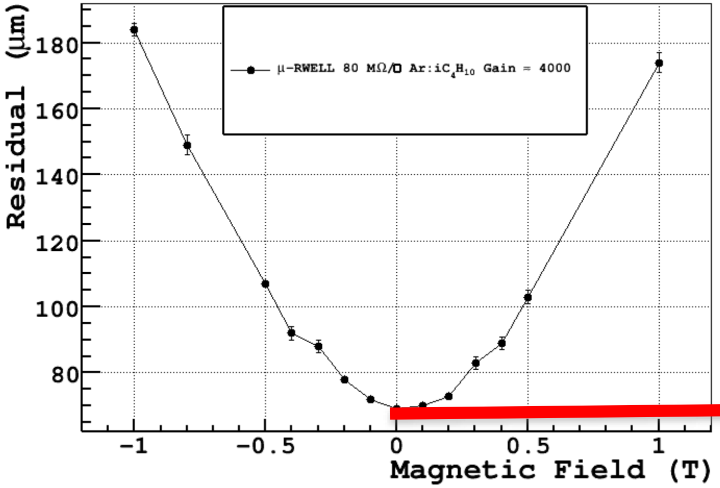
Ar/isobuthane = 90/10
Incident angle = 90°



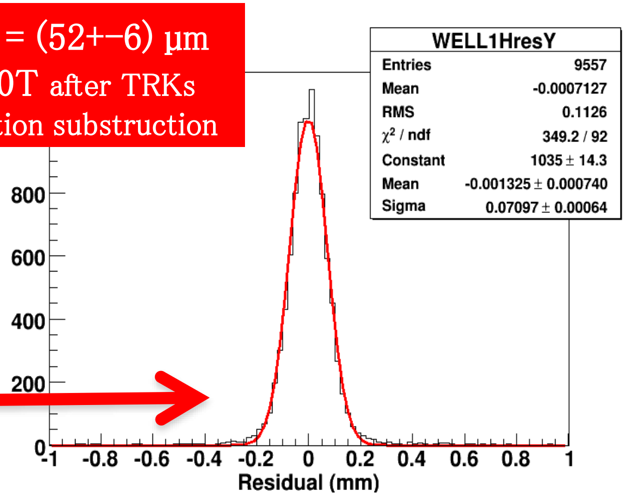
μ-RWELL vs HV (B = 0.5 T)



μ-RWELL vs B (G = 4000)

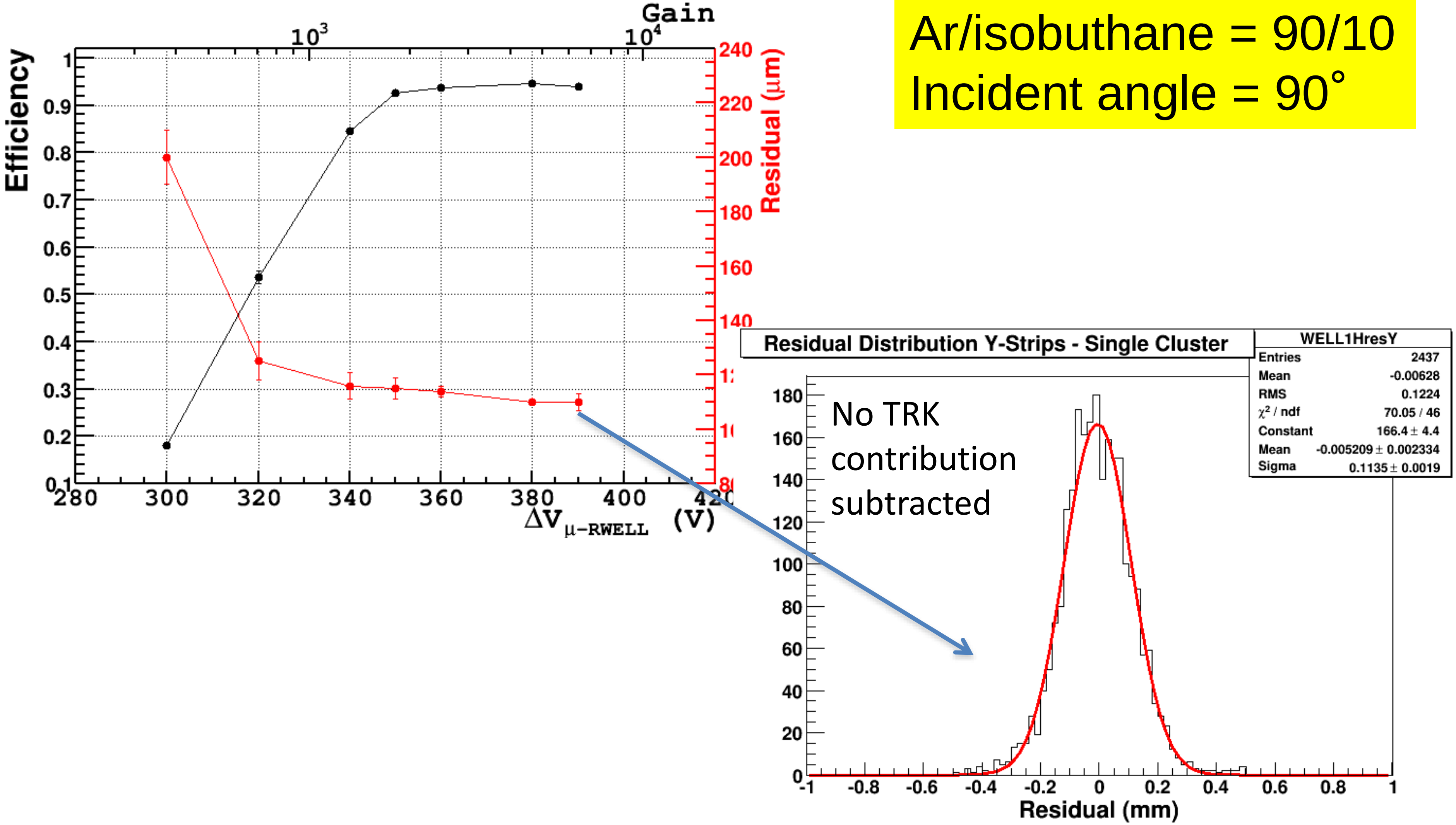


σ_{RWELL} = (52+−6) μm
@ B= 0T after TRKs
contribution substruction



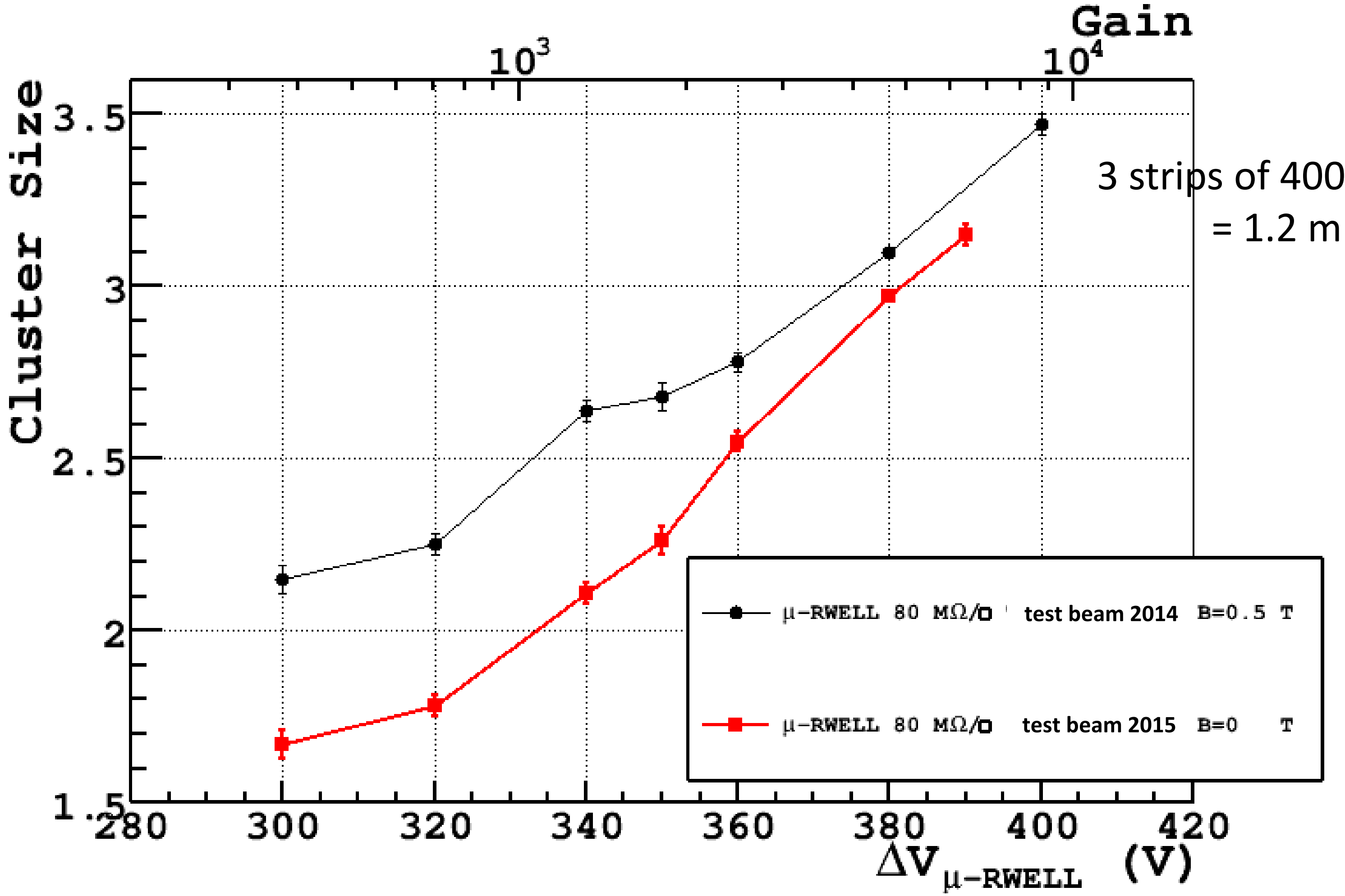
Test Beam Results 2015

Ar/isobuthane = 90/10
Incident angle = 90°



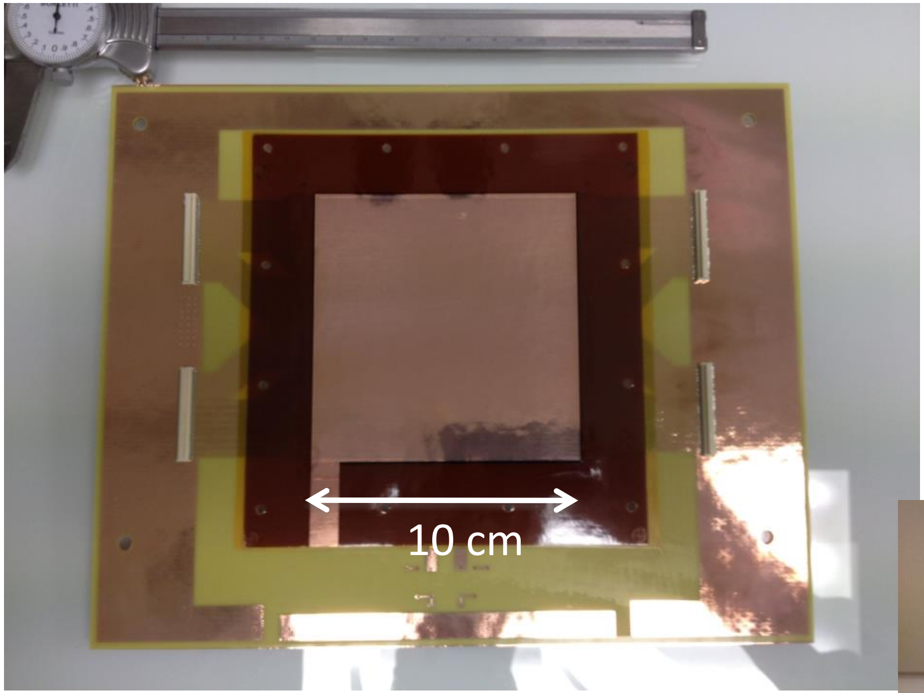
No TRK contribution subtracted

Cluster Size Comparison

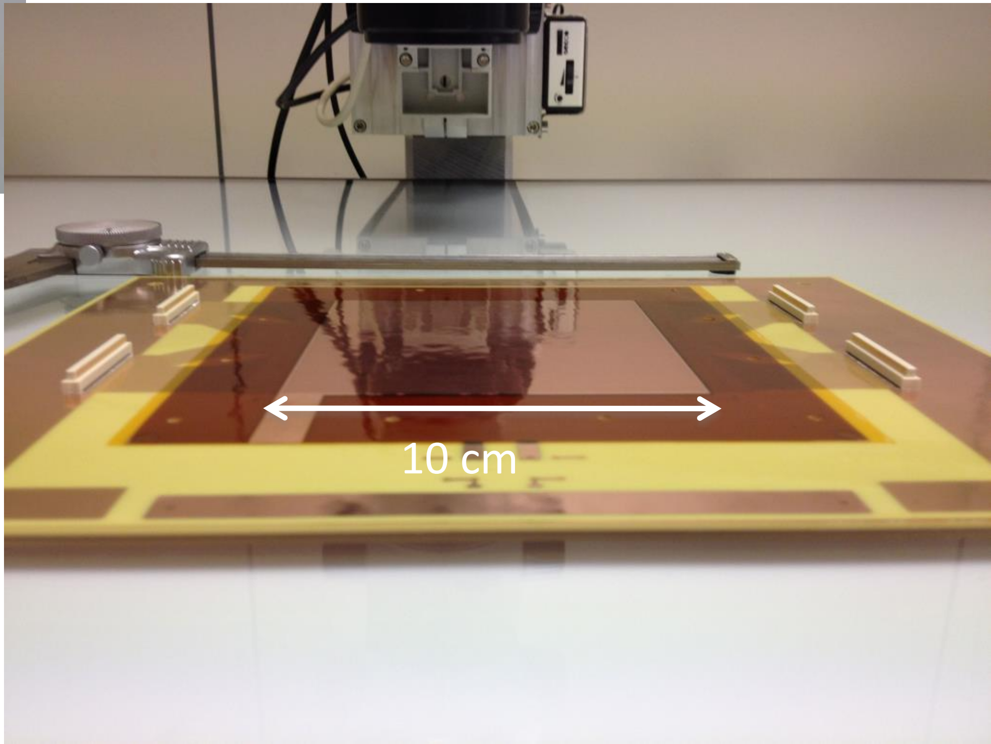


3 strips of 400µm pitch
= 1.2 mm

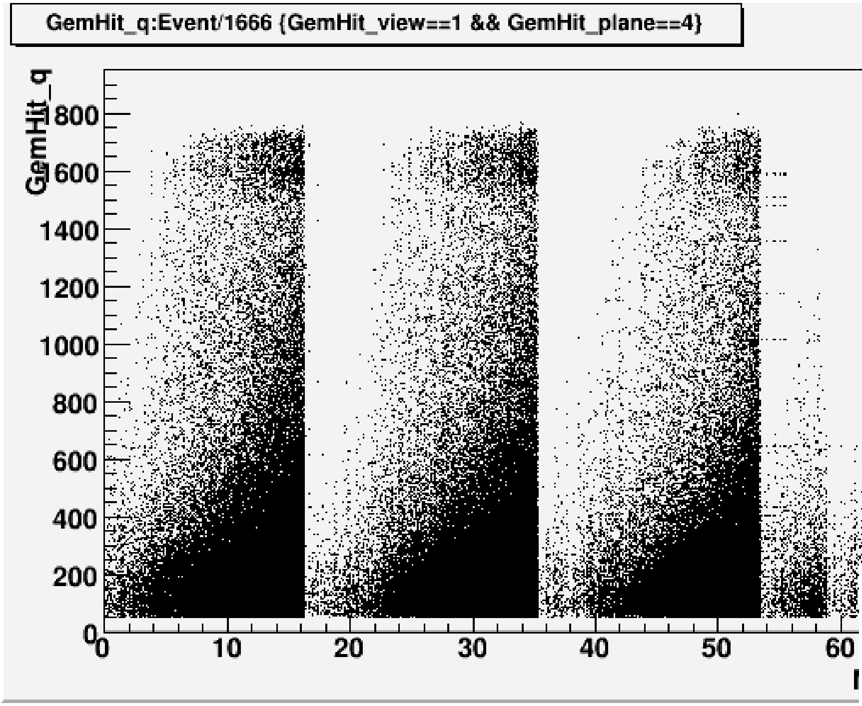
New μ-RWELL detector



1 MOHM/square (not good)
400 micron strip pitch

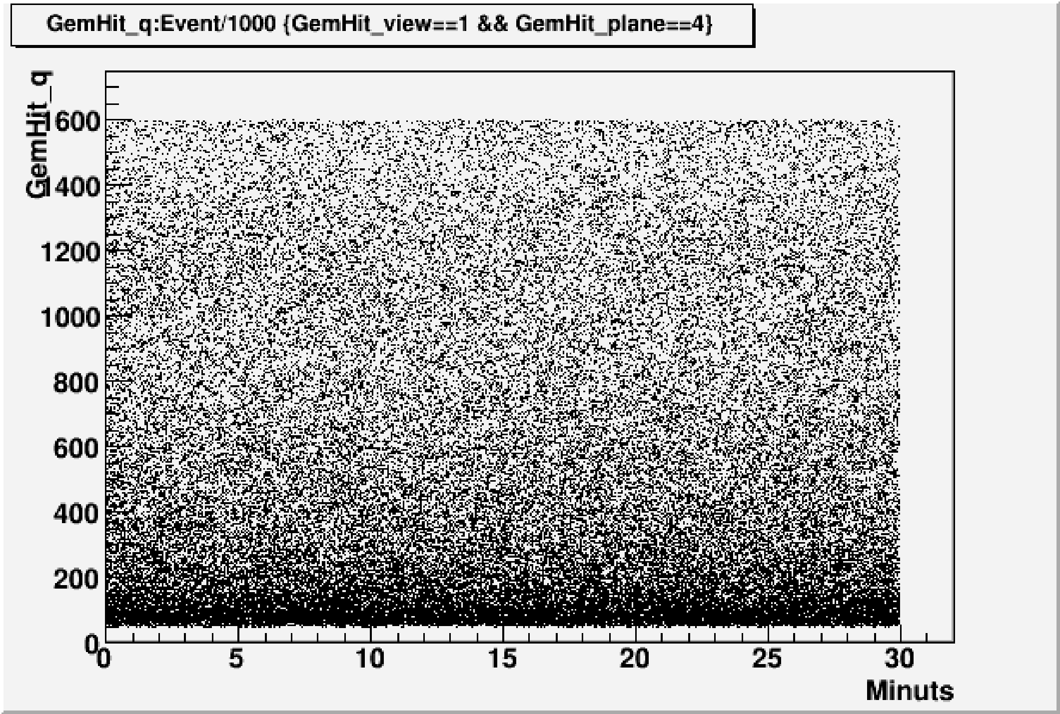


New µ-RWELL



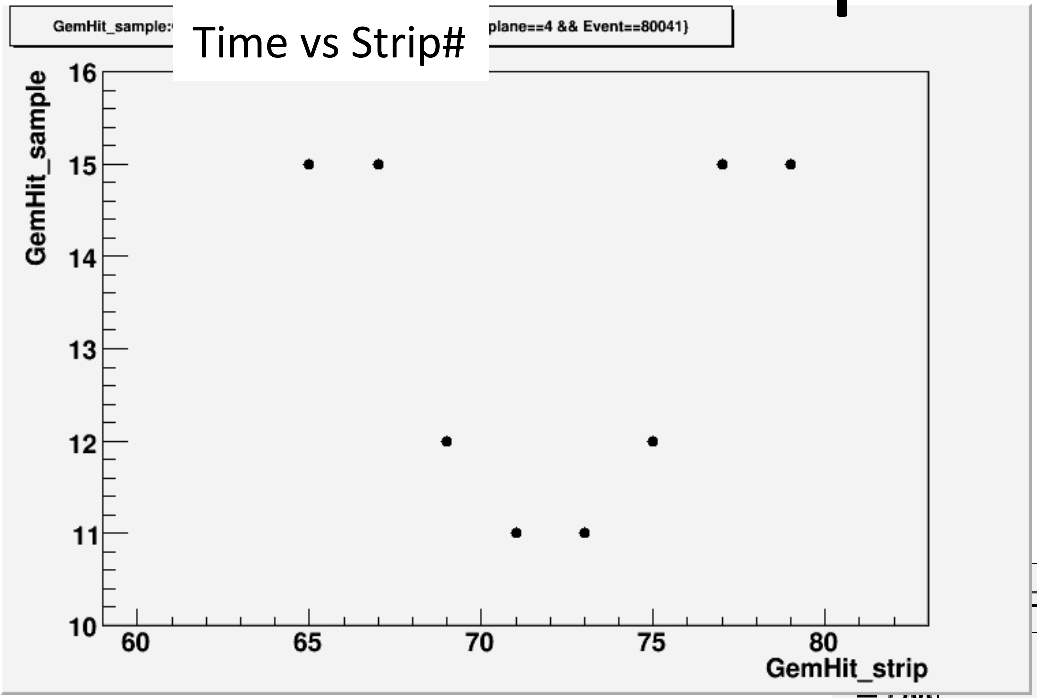
Charge vs time
No grounding of resistive layer

Old µ-RWELL



New µ-RWELL

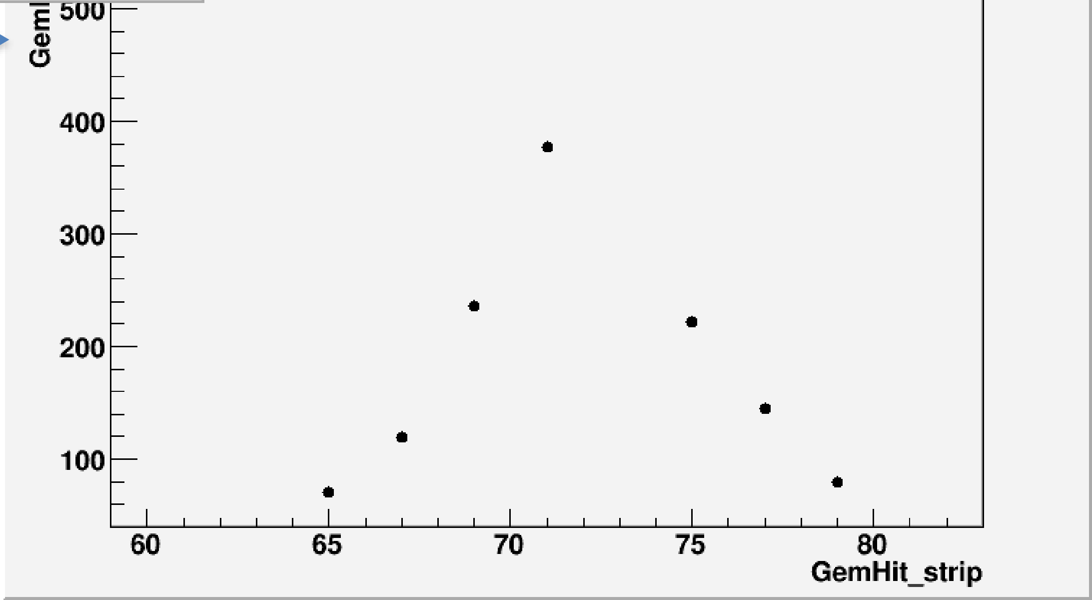
Time vs Strip#



Low resistivity effects

15 strips of 400µm pitch
= 6 mm

Charge vs Strip#

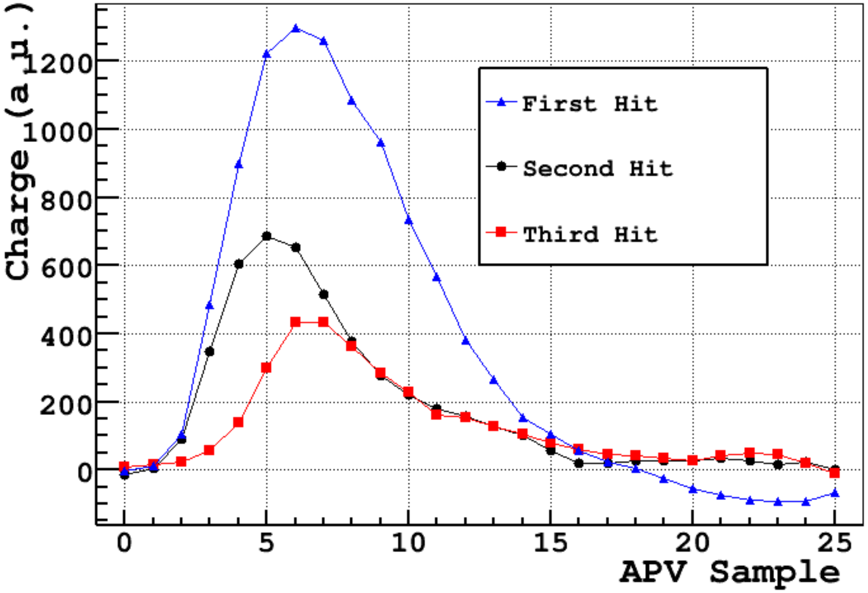


Thanks for the attention

Spares slides

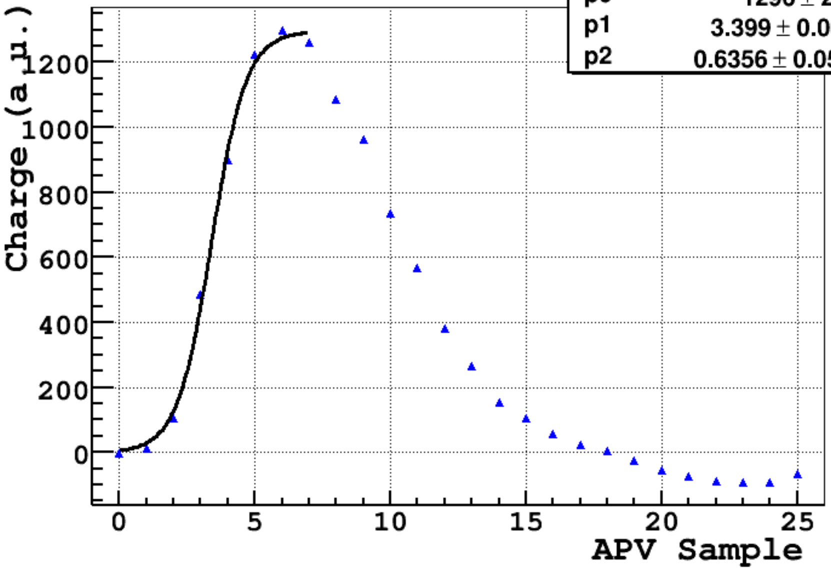
μ-RWELL READOUT in μ-TCP mode (I)
B = 1 T

1 Event readout with 3 Hits



$$FD(t) = \frac{p0}{1 + exp^{\frac{-(t-p1)}{p2}}}$$

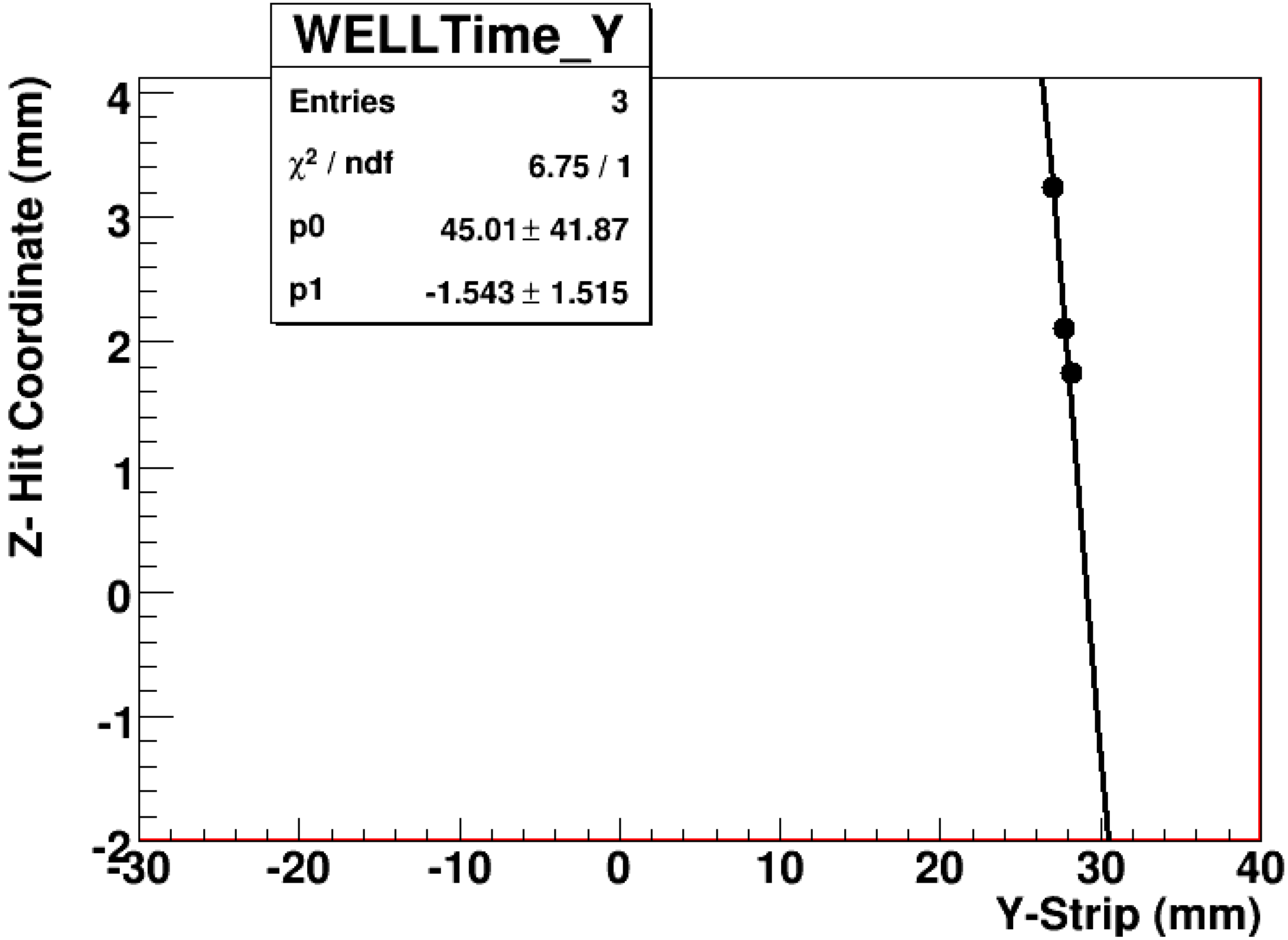
χ^2 / ndf	5510 / 5
p0	1296 ± 27.23
p1	3.399 ± 0.06971
p2	0.6356 ± 0.05357



Each Charge Distribution is fitted with a Fermi-Dirac:
p1 is the time at Half-Maximum of the Charge Distribution

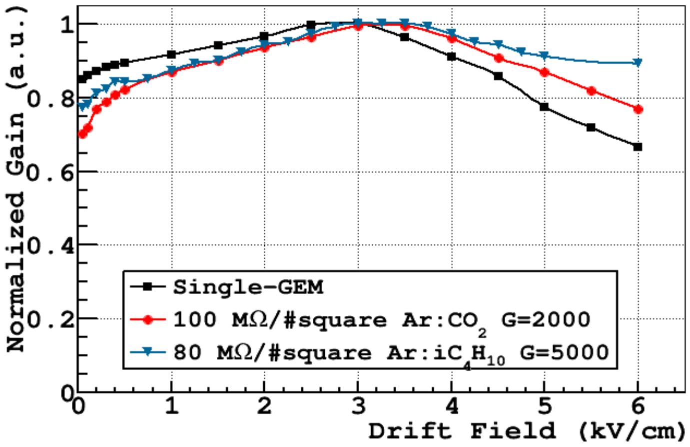
μ-RWELL READOUT in μ-TCP mode (III)
B = 1 T

Track in μ-TCP mode



The µ-RWELL performance (II)

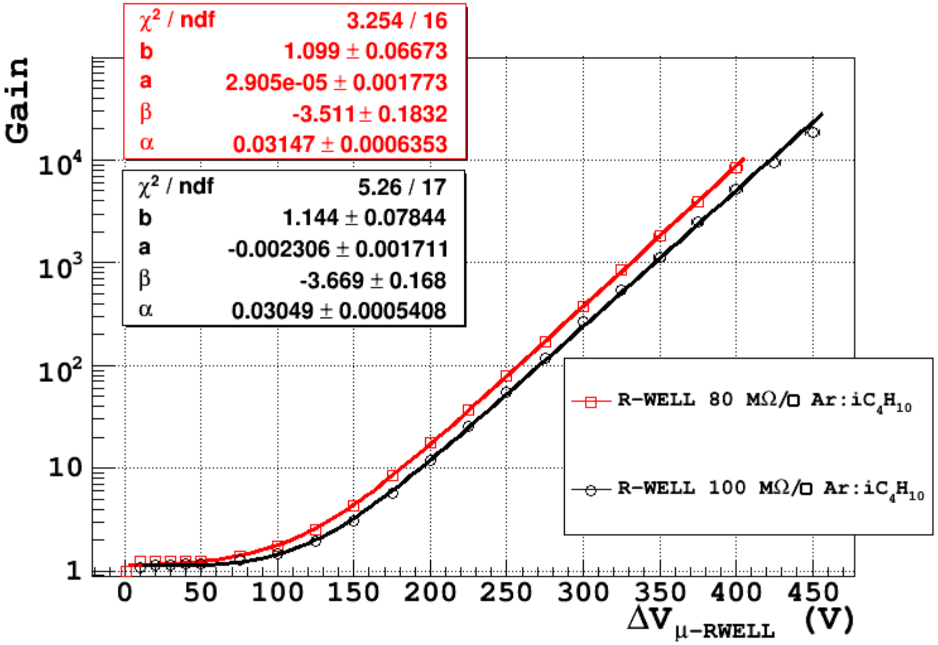
Gain with Ar/i-C_4H_{10} =90/10



The main difference between the two prototypes is the coupling between the top-layer of the well and the resistive-plane:

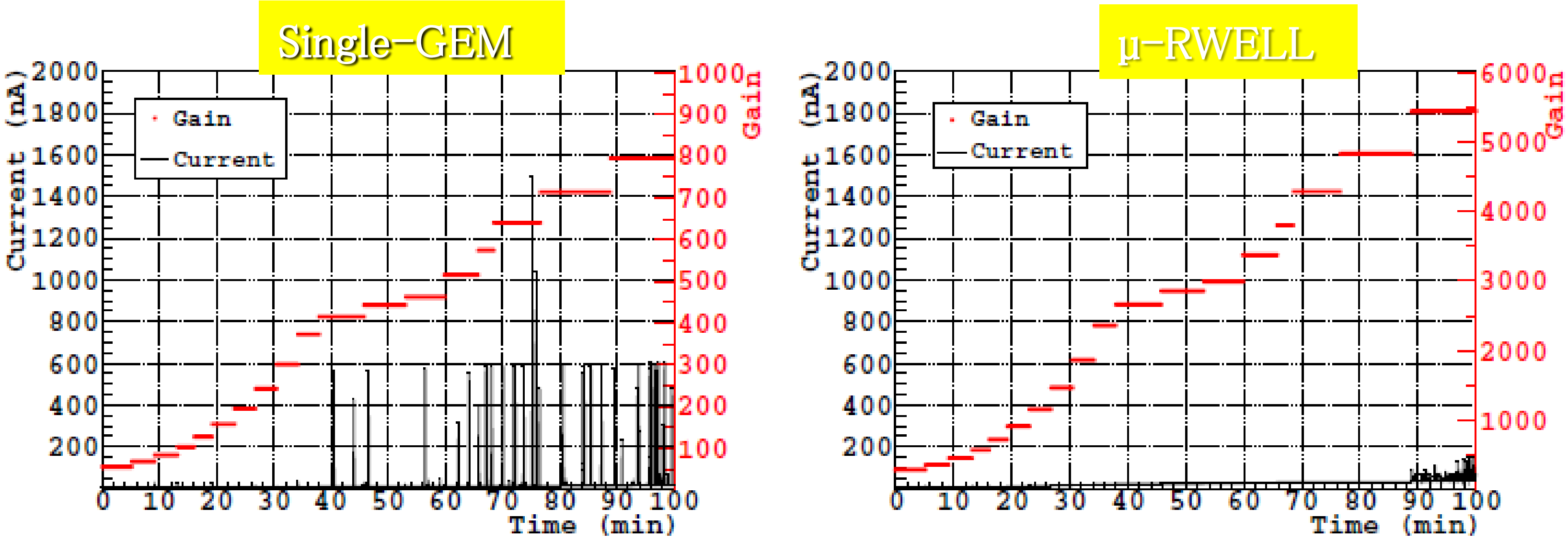
- for the 100MΩ/☐ is through the copper-dots;
- for the 80MΩ/☐ is without the copper-dots;

The use of <u>isobutane</u> (better quencher) based gas mixtures, allows to achieve <u>higher gas gain (10^4)</u>.



The μ-RWELL performance (III)

Discharge study: μ-RWELL vs single-GEM



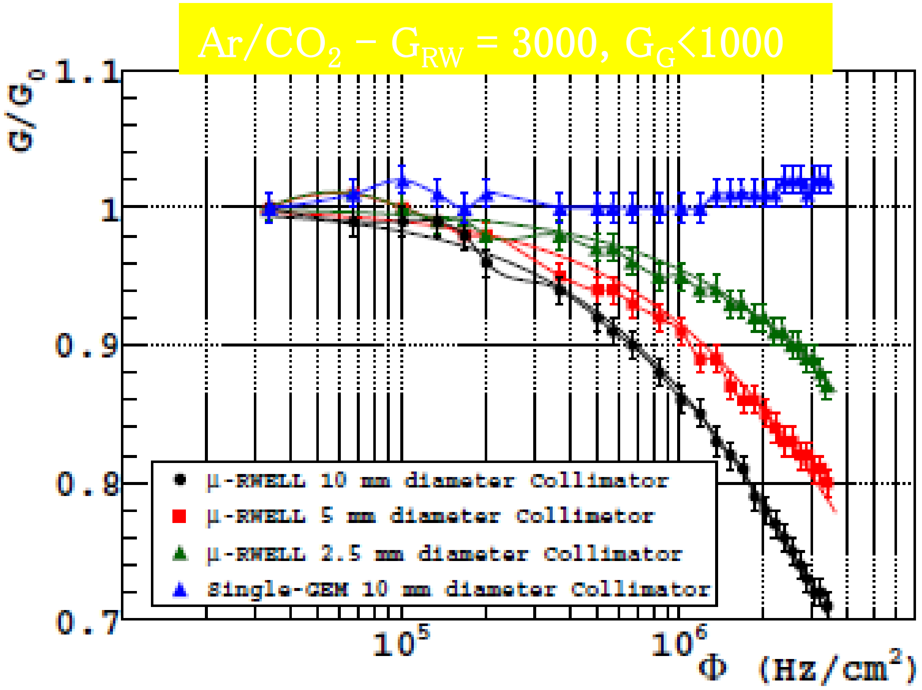
The <u>max. ΔV achieved</u> for the gain measurement is correlated with the <u>onset of the discharge</u> activity, that, comes out to be <u>substantially different</u> for the two devices:

- ☐ discharges for <u>μ-RWELL</u> of the order of <u>few tens of nA</u> (<100 nA @ max gain)
- ☐ for <u>GEM</u> discharges the order of <u>1μA</u> are observed at high gas gain

<u>Further systematic and more quantitative studies must be clearly performed</u>

The μ-RWELL performance (IV)

A drawback correlated with the implementation of a resistive layer is the reduced capability to stand high particle fluxes: larger the radiation rate, higher is the current drawn through the resistive layer and, as a consequence, larger the drop of the amplifying voltage.



The curves are fitted with the function:

$$\frac{G}{G_0} = \frac{-1 + \sqrt{1 + 4p_0\Phi}}{2p_0\Phi}$$

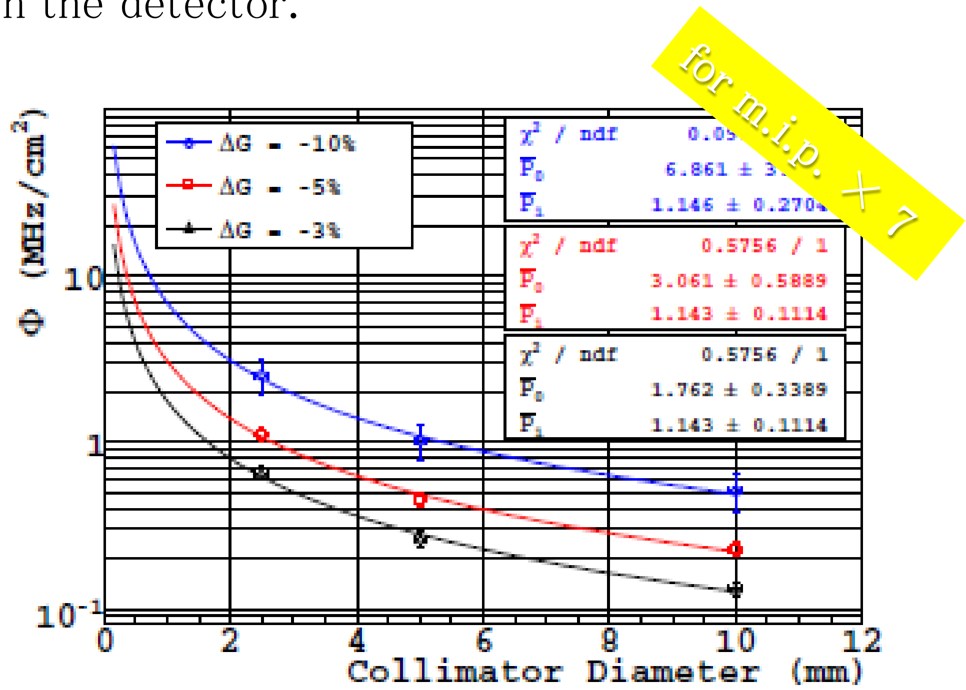
$$p_0 = \alpha e N_0 G_0 \Omega \pi r^2$$

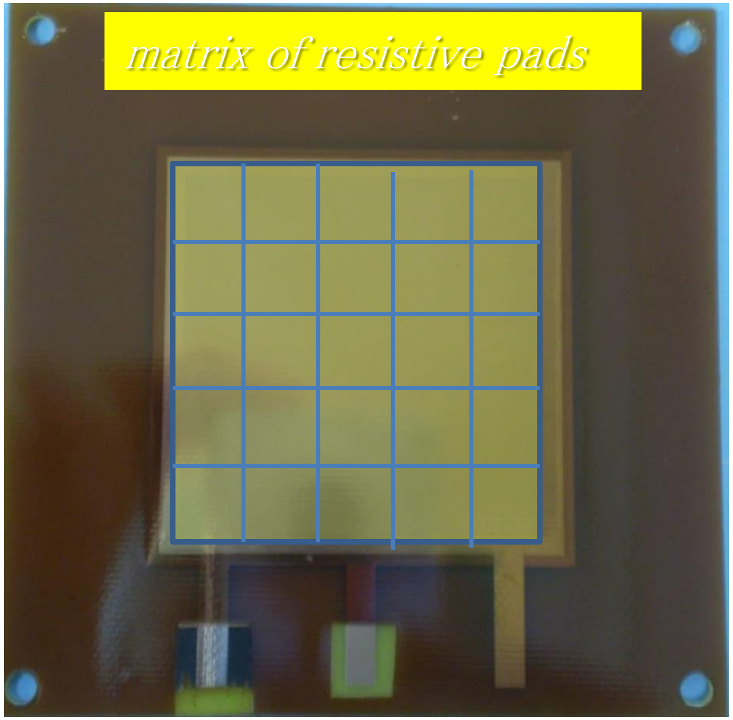
The function allows the evaluation of the radiation flux for a given gain drop of 3%, 5% and 10% for all the collimators.

Normalized gain vs X-ray flux for GEM and μ-RWELL for irradiation at the center of the active area, with three different collimator diameters: 10 mm, 5 mm and 2.5 mm.

The µ-RWELL performance (V)

The <u>particle flux</u> that the <u>µ-RWELL</u> is able to stand, in agreement with an <u>Ohmic behavior</u> of the detector, <u>decreases</u> with the <u>increase</u> of the <u>diameter of the X-ray spot</u> on the detector.





The <u>rate capability</u> of the detector, for a fixed surface resistivity, can be <u>tuned</u> with a <u>suitable segmentation</u> (NIMA 732(2103)199) of the <u>resistive layer</u> (under study): a "***matrix of resistive pads***" each one independently connected to ground (~1 MHz/cm^2 for m.i.p. seems achievable)