SLIDES FROM: MICRO-RWELL @ MPGD 2017

The micro-RWELL detector

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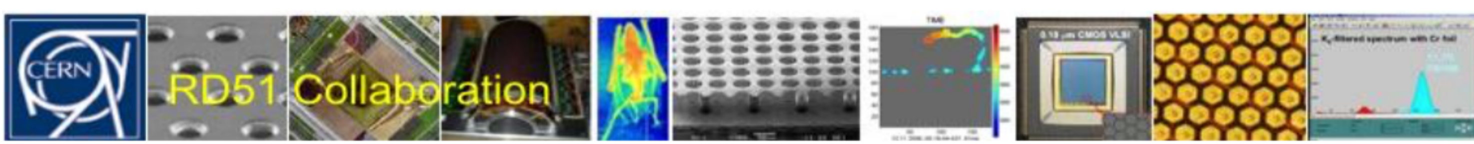
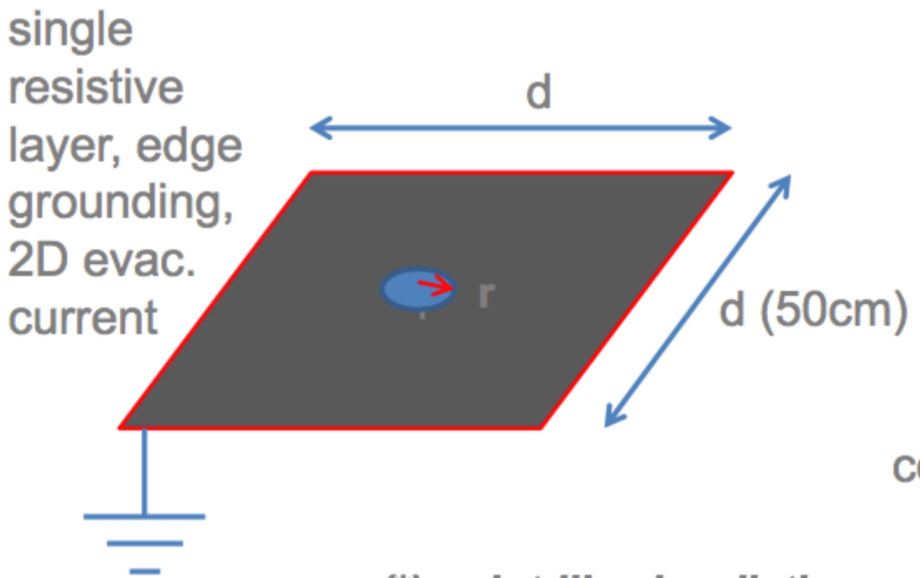
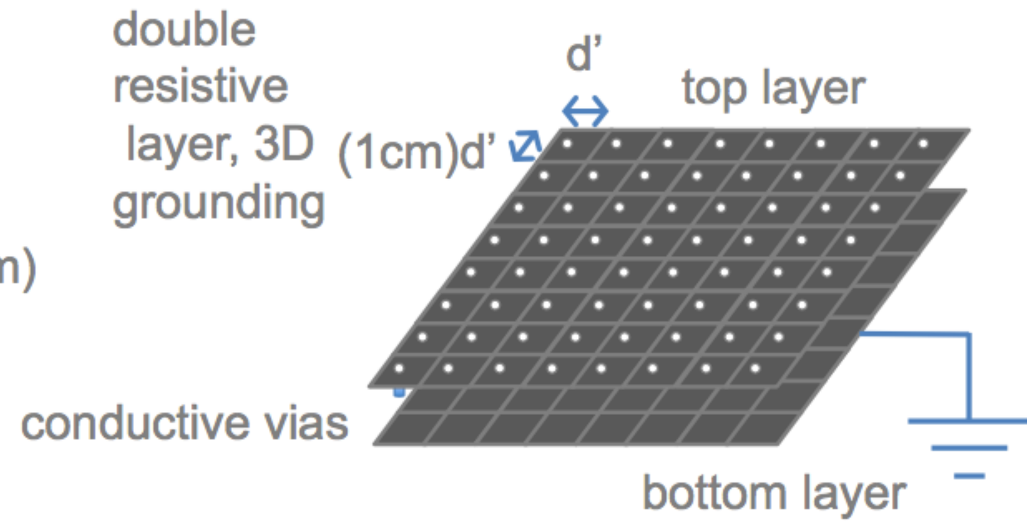
5th International Conference on Micro-Pattern Gas Detectors



Towards the High Rate scheme





(*) point-like irradiation, r << d
Ω is the resistance seen by the current generated by a radiation incident in the center of the detector cell

$$\Omega \sim \rho_s \times d/2\pi r \qquad \Omega' \sim \rho_s' \times 3d'/2\pi r$$

$$\Omega/\Omega' \sim (\rho_s/\rho_s') \times d/3d'$$

$$\text{If } \rho_s = \rho_s' \rightarrow \Omega/\Omega' \sim \rho_s/\rho'_s * d/3d' = 50/3 = 16.7$$

(*) Morello's model: appendix A-B (G. Bencivenni et al., 2015_JINST_10_P02008)

The High Rate scheme (LHCb)

1

Copper layer 5 μm

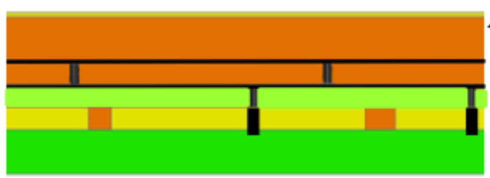
Kapton layer 50 μm

DLC layer: 0.1 – 0.2 μm
(10-200 MΩ/☐)

2

2nd resistive kapton layer with ~ 1/cm^2 "*through vias*" density

3



DLC-coated kapton base material

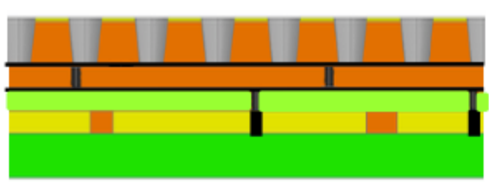
2nd resistive kapton layer

insulating layer

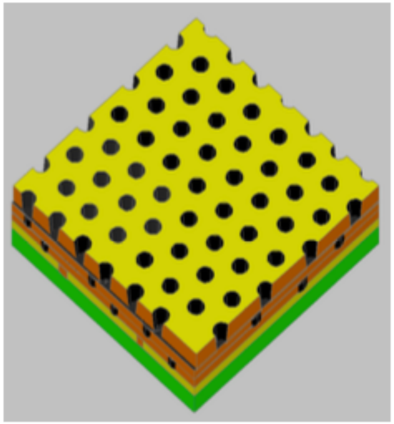
pad/strips readout on standard PCB

"through vias" for grounding

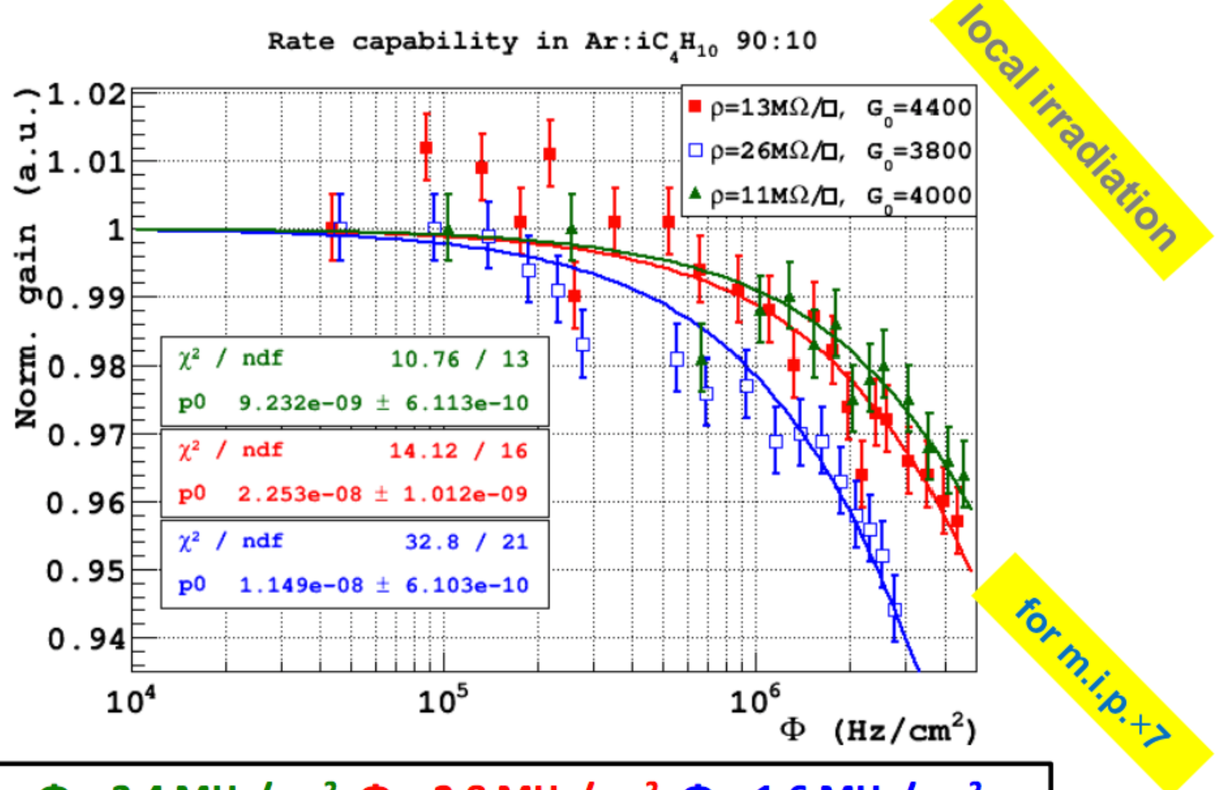
4



DLC-coated base material after copper and kapton chemical etching (WELL amplification stage)



Double resistive layer w/ 1x1 cm² *through-vias* grounding pitch

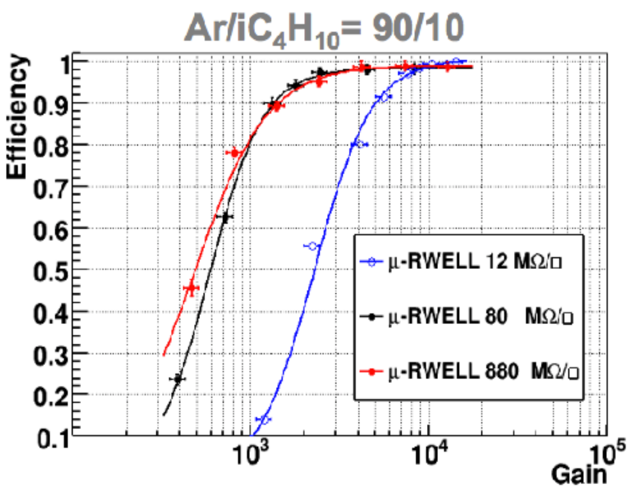


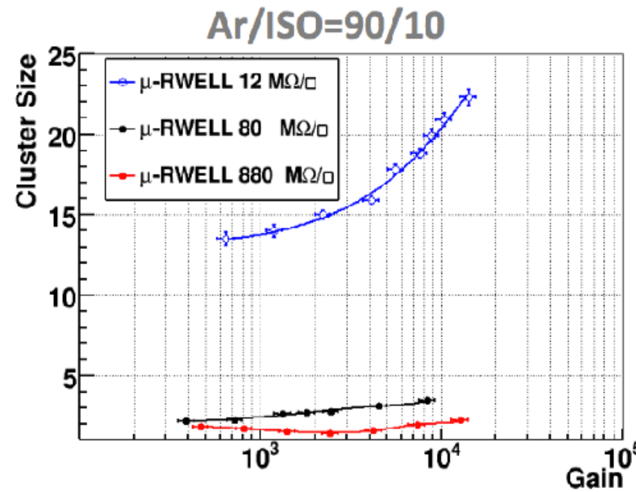
Φ = 3.4 MHz/cm²; Φ = 2.8 MHz/cm²; Φ = 1.6 MHz/cm²

Local irradiation is practically equivalent to global irradiation

The μ-RWELL performance: Beam Tests

Analysis performed with the CC method, 400 μm strips pitch



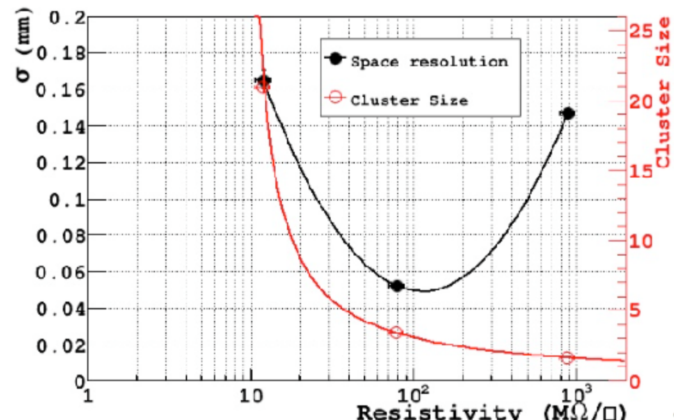


At low resistivity the spread of the charge (cluster size) on the readout strips increases, thus requiring a higher gain to reach the full detector efficiency.

The space resolution exhibit a minimum width around 100 MΩ/□.

At low resistivity the charge spread increases → worse spatial resolution

At higher resistivity → ~ 1 fired strip



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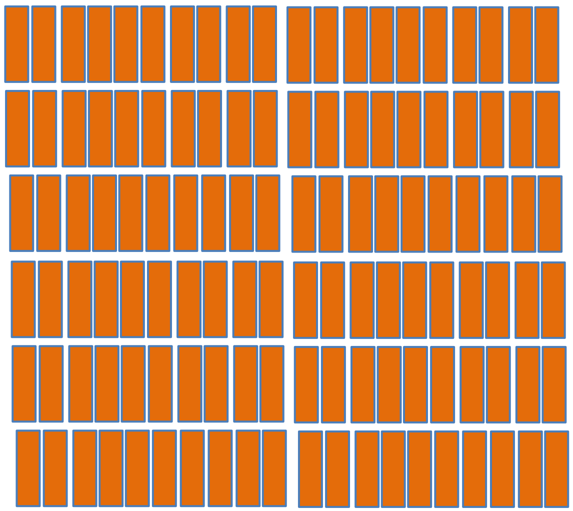
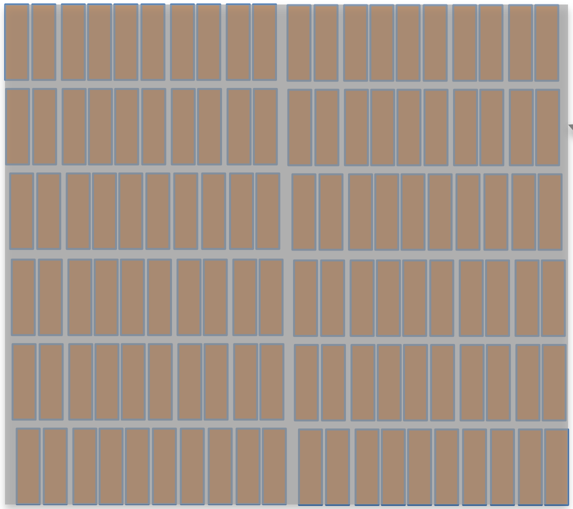


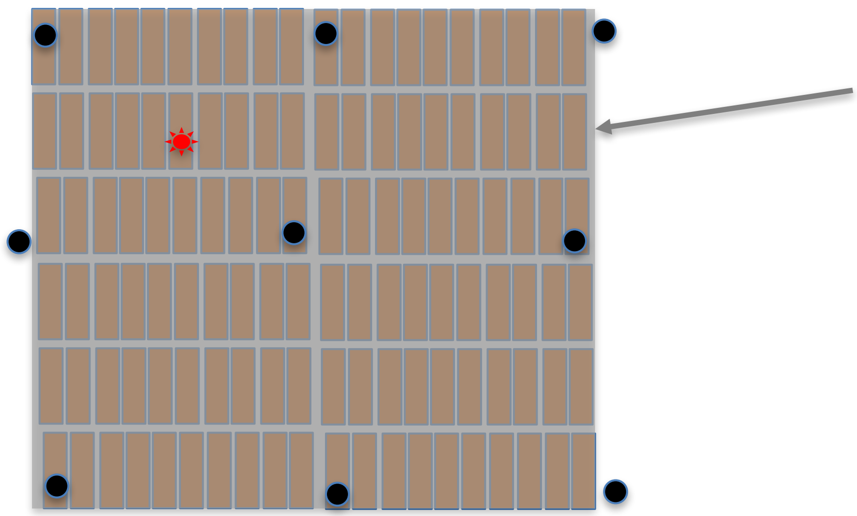
PATTERN OF "PADDY-NEXT"
3x1 mm2 pads (same as Paddy1-2)

Presently available DLC foils at Rui's LAB :
- 2 MΩ/sq → VERY LARGE CHARGE SPREAD. Charge protection? Rate capability?
- 50 MΩ/sq → OK for charge spread but too high for high rates (voltage drop?)



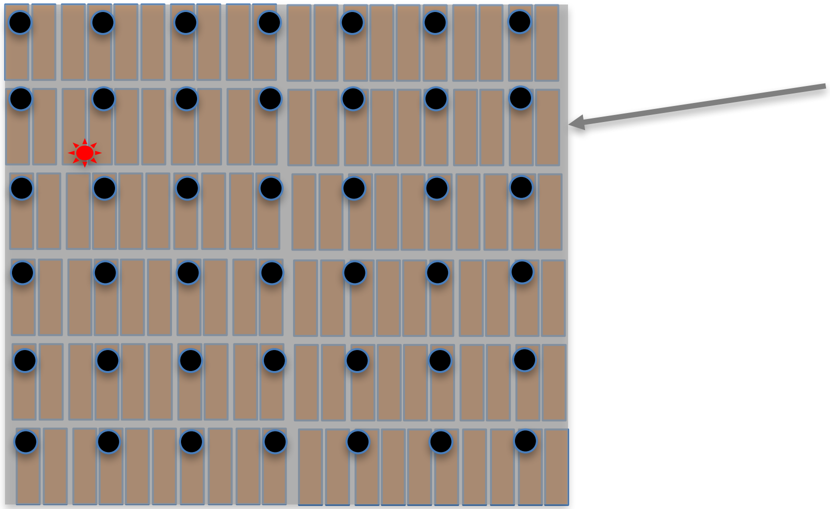
50 MΩ/sq
this is OK for the “cluster size” or ”charge spread”
It is NOT OK for the rate capability i.e. too high resistance

10 mm x 10 mm evacuation channel grid → Max distance hit-evacuation = 7.1mm



50 MΩ/sq
this is OK for the “cluster size” or ”charge spread”
It is NOT OK for the rate capability i.e. too high resistance.
The resistance (FROM THE HIT POINT TO GROUND) depends on the distance of the evacuation channels
($\Omega = \rho_s \times 3d/2\pi r$)

3 mm x 3 mm evacuation channel grid → Max distance hit-evacuation = 2.1 mm



50 MΩ/sq
this is OK for the "cluster size" or "charge spread"
It is NOT OK for the rate capability i.e. too high resistance.

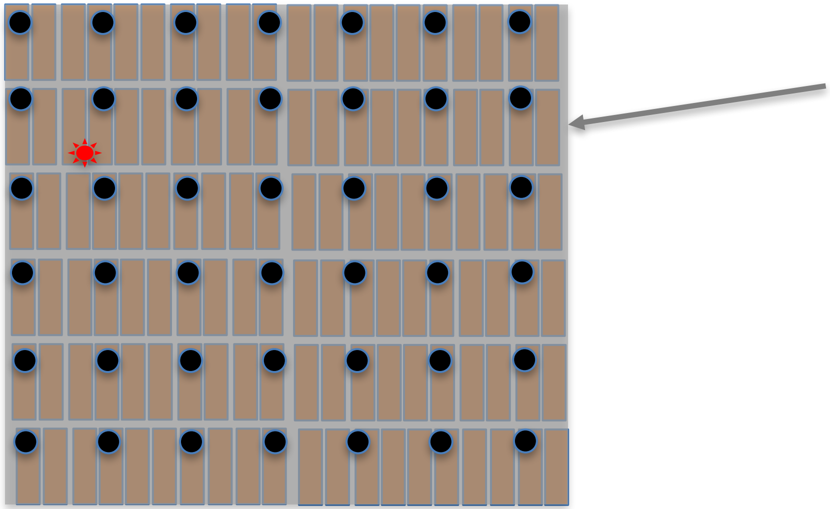
Pattern in previous slide had d=10mm
Pattern here d=3 mm

Resistance with this pattern is reduced by a factor 10/3 ~ 3.3 (similar to: ~7.1/2.1 = 3.4)

→ Same as ~15 MΩ/sq with 1x1 cm grid ??????????

ADVANTAGE OF THIS CONFIGURATION

EACH VIAS is a point of irregularity. Rui says each vias can be EASILY covered with pillars
→ Pillars will be aligned on top of the vias. That is in a grid 3x3 mm



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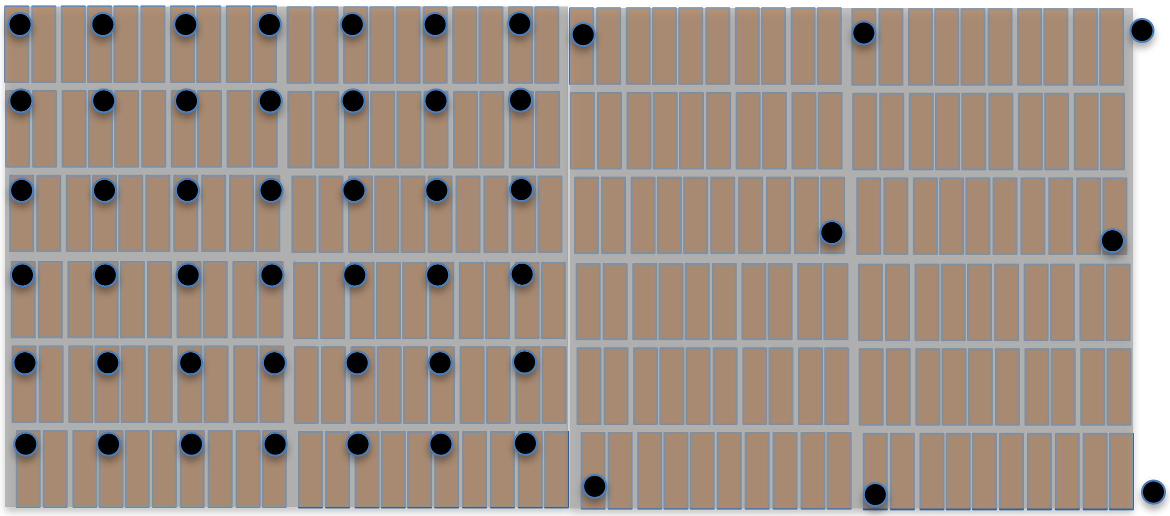
POSSIBLE PROPOSAL TO SEE VIAS PITCH EFFECT

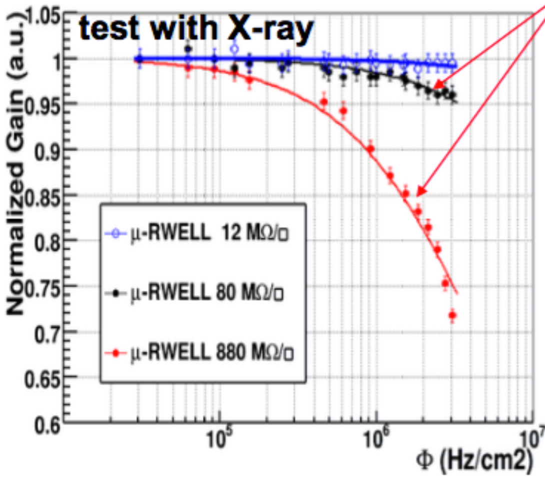


One low-rate zone in the detector

BACKUP

rate capability vs layer resistivity

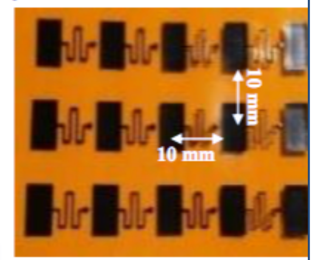
Ar/ISO =90/10, G = 1000

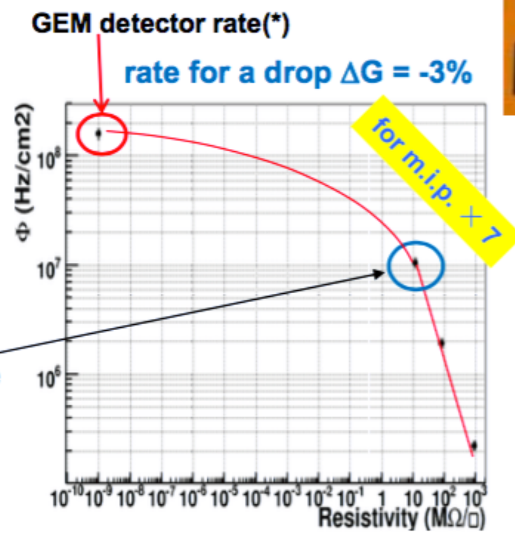


the **gain decrease** is correlated with the voltage drop due to the **resistive layer**

Solution for high rate: local evacuation of the current through embedded resistors on a kapton layer and connected by vias directly to the strips of the detector

➔ **grounding pitch**





a re-scaling with the right gain would be required

with a **1×1 cm² grounding pitch** & a resistivity of **≈10 MΩ/□** a rate capability of **≈10 MHz/cm²** can be achieved.

(*) Bellazini et al. NIMA 423 (1999) 125
Sauli et al., NIMA 419 (1998) 410

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Layer Resistivity : ~ 10 MΩ/sq ?? Is it ok ? And what is the value of the embedded resistor ???