Piggy Back Micromegas, new results and seal detector

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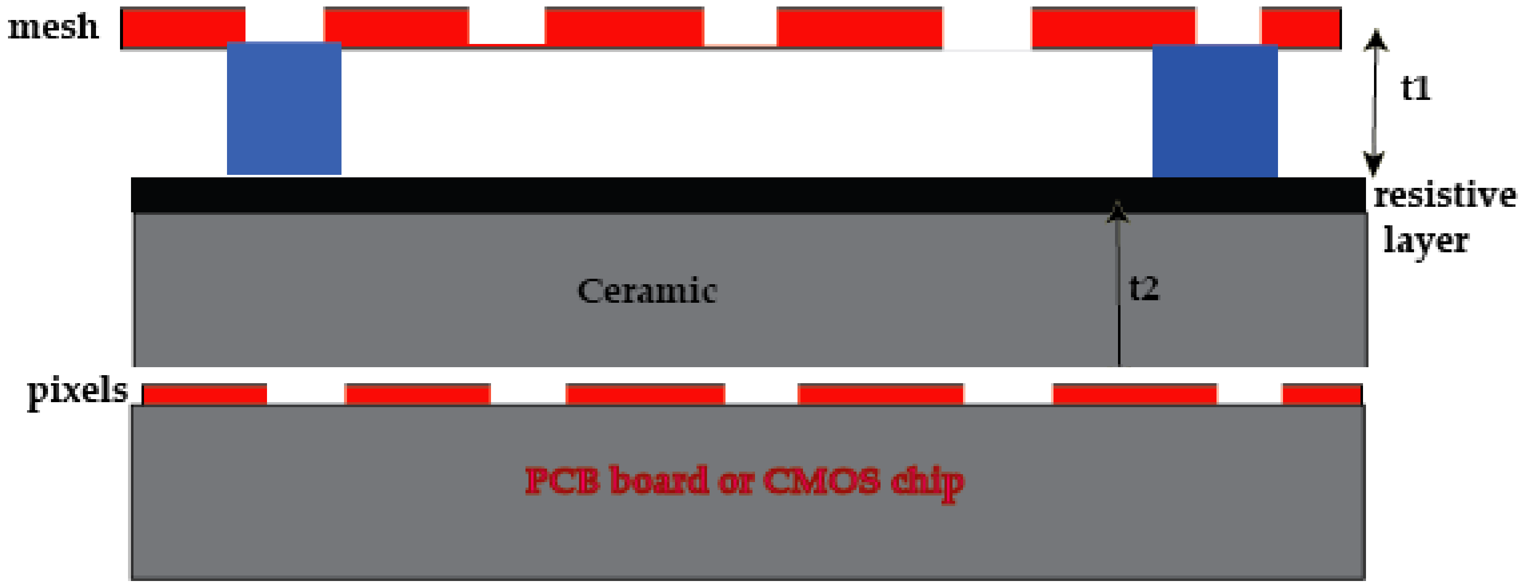
Abstract

A novel read-out architecture has been developed for the Micromegas detector. The anode element is made of a resistive layer on a think ceramic substrate. The detector part is entirely separated from the read-out element. Without a significant loss signals are transmitted by capacitive coupling to the read-out pads. The detector provides high gas gain and good energy resolution and resistive layer assures spark protection to the electronics. This scheme could be combined with modern pixel array electronic ASICs. This readout organization is free on the way the pixels are designed, arranged and connected. We present first results taken with a TimePix read-out chip.

inspired by similar work with PPAC by Menyhert Kocsisa et al., NIMA 563 (2006) 172–176

Micromegas on a resistive thin ceramic substrate
Readout pixels or strips is an independent element

In a first prototype: 300 µm thick alumina+ruthenium oxide 10 µm layer
This was the anode plane of a standard Bulk Micromegas

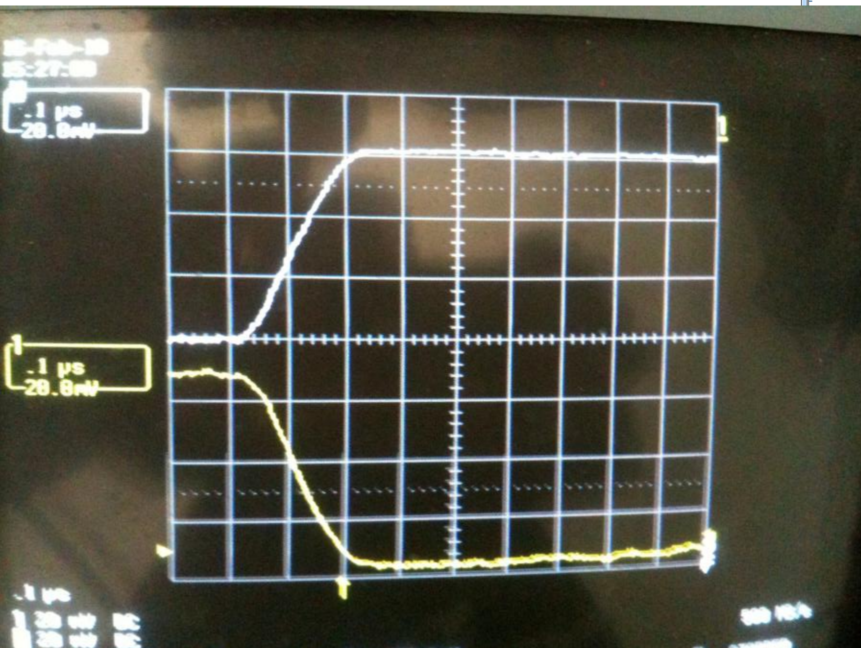


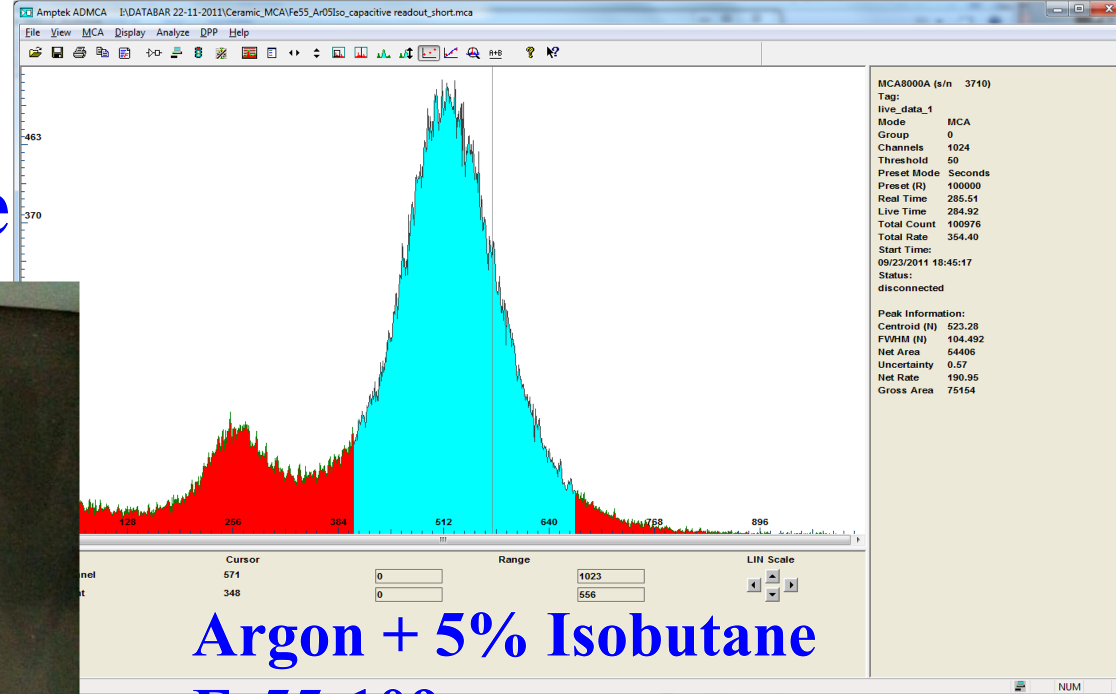
Signal propagates through capacitive coupling without loss

If $t_2 << t_1 \square_2/\square_1$

Ceramic provide large dynamic range of dielectric constants

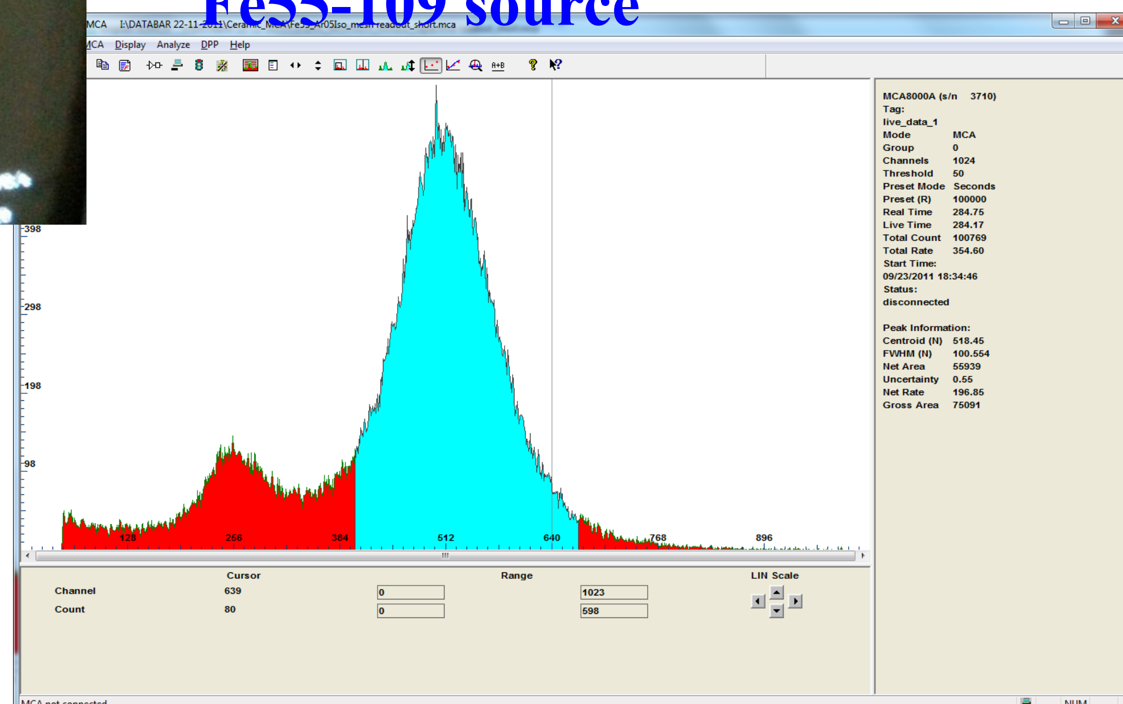
Signal induced at the read-out anode





Argon + 5% Isobutane

Fe55-109 source



Efficiency
Better than 90%

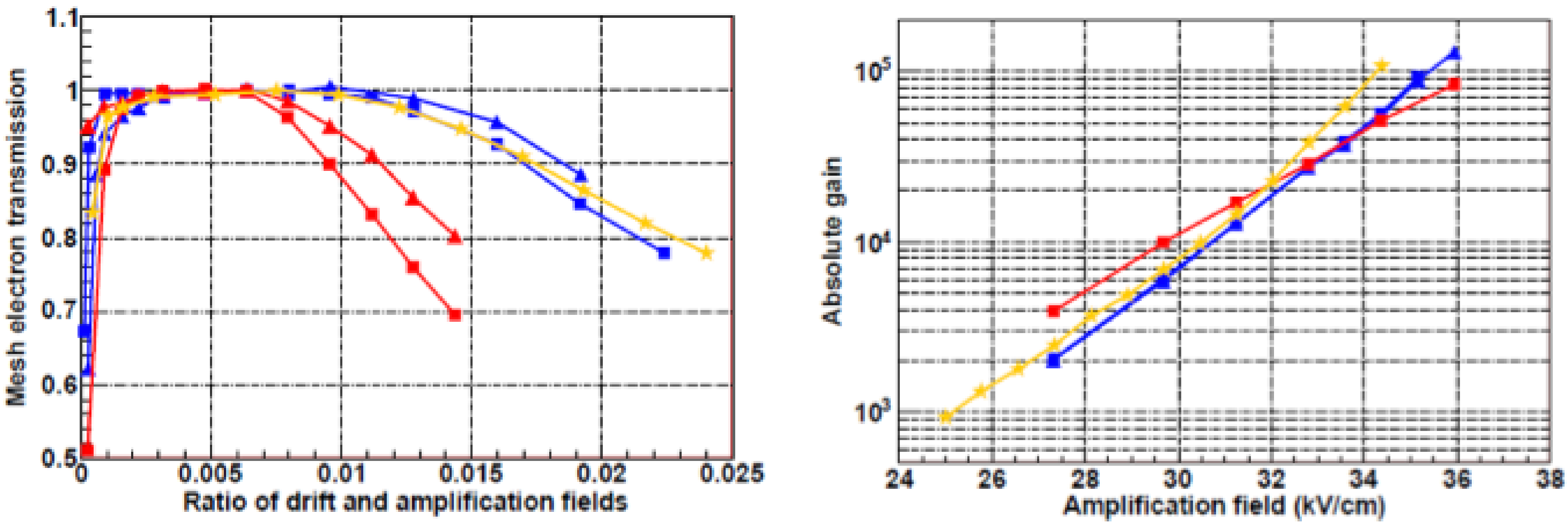


Figure 4 Dependence of the electron mesh transmission with the ratio of the drift and amplification fields (left) and gain curves (right) for the Piggyback detectors 1 (squared line) and 3 (triangled line), respectively tested in Ar+5%iC4H10 (blue) and in Ne+5%C2H6(red). The curves of a 128 um-thickness-gap bulk detector(orange stars) in Ar+5%iC4H10 extracted from [7], have been added as a comparison.

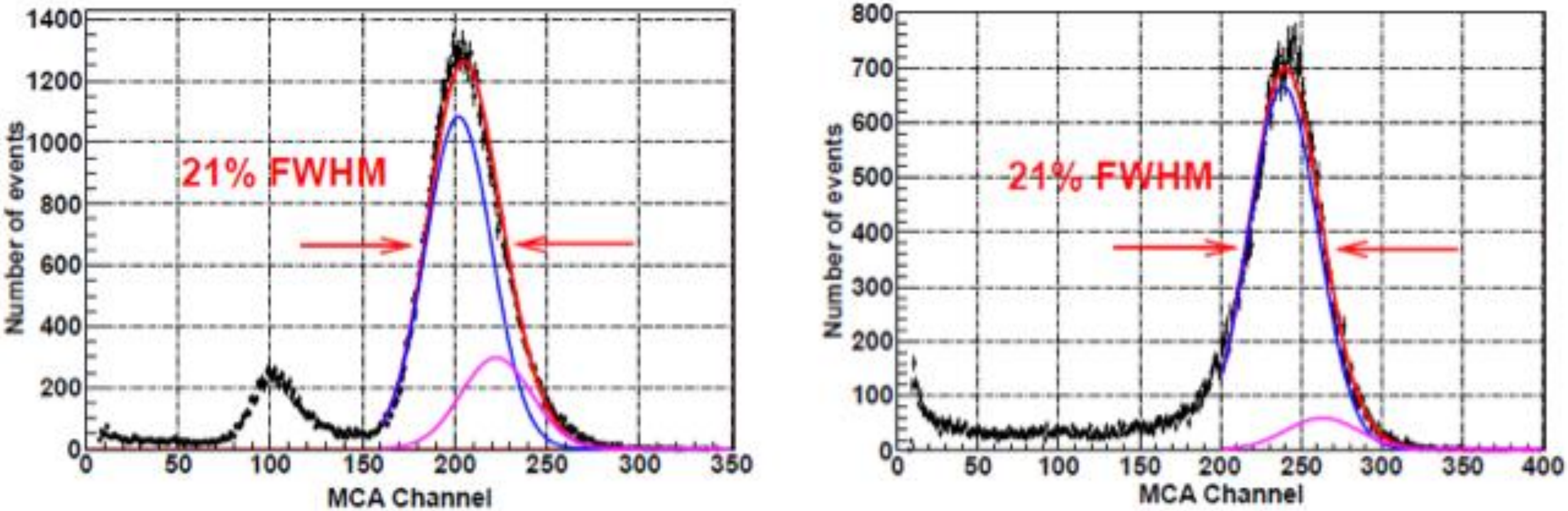


Figure 5 Energy spectra generated by the MCA irradiating the Piggyback detector 1 by a 55Fe source respectively in Ar+5%iC4H10 (left) and Ne+5%C2H6 (right). The main peak has been fitted to two gaussian functions (blue and magenta lines), corresponding to the Ka

Rate capability
With X-rays from a gun (8keV)

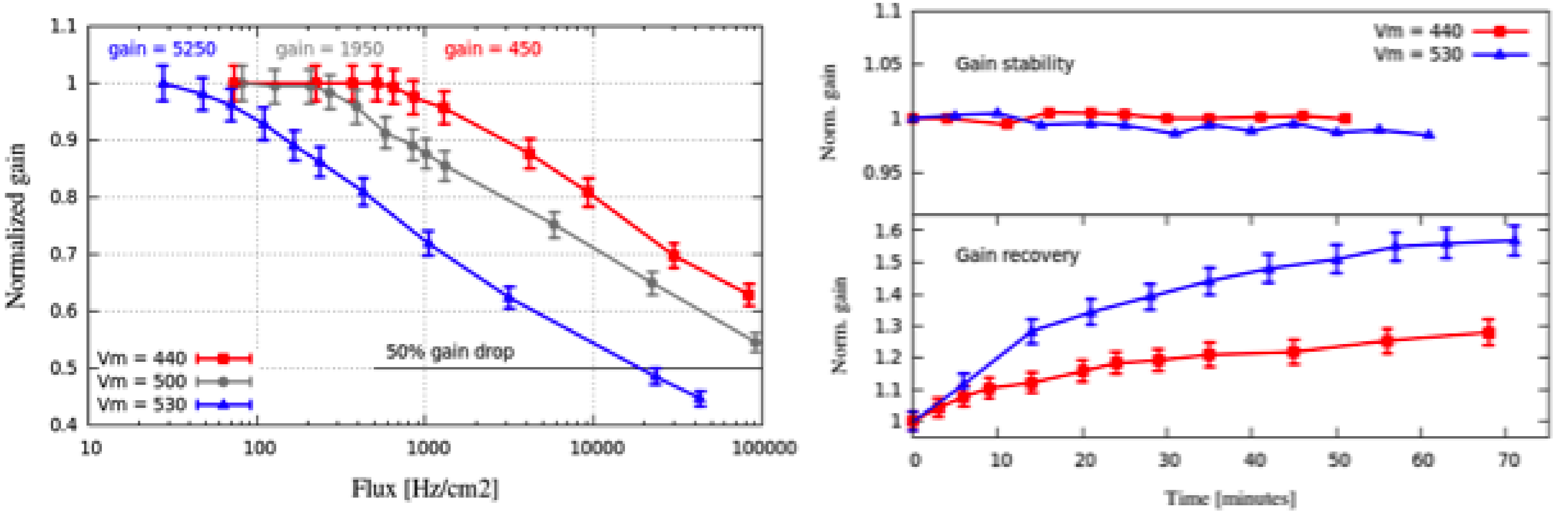


Figure 9 Relative gain drop as a function of the X-rat flux and amplification gain (left), gain stability at the plateau region (right top) and gain recovery after high flux exposure to low flux transition (right bottom).

Comparison with Monte Carlo

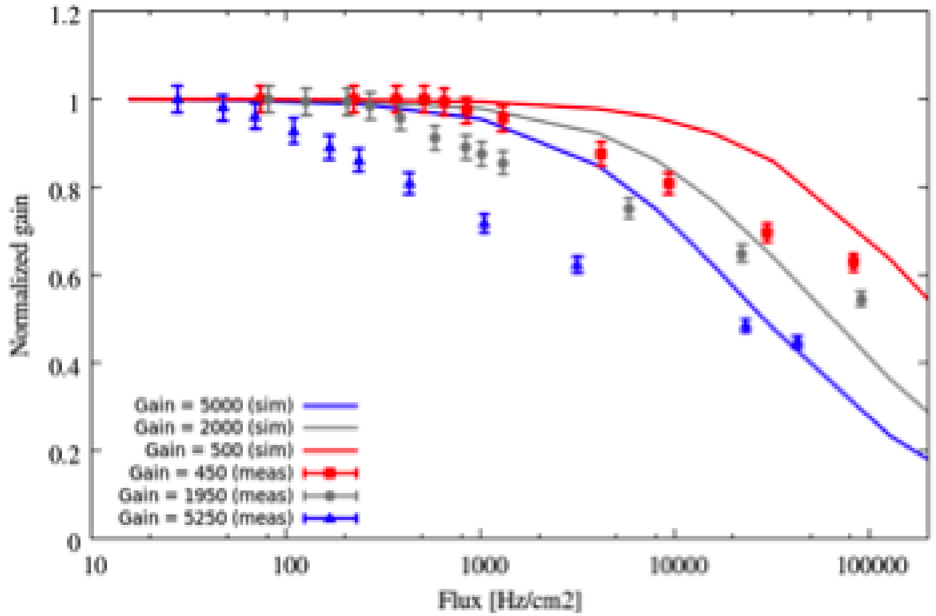


Figure 13. Comparison of the experimental gain and the simulated gain drop dependency with the applied rate. The value of the resistivity used in the simulation was 500M/sq.

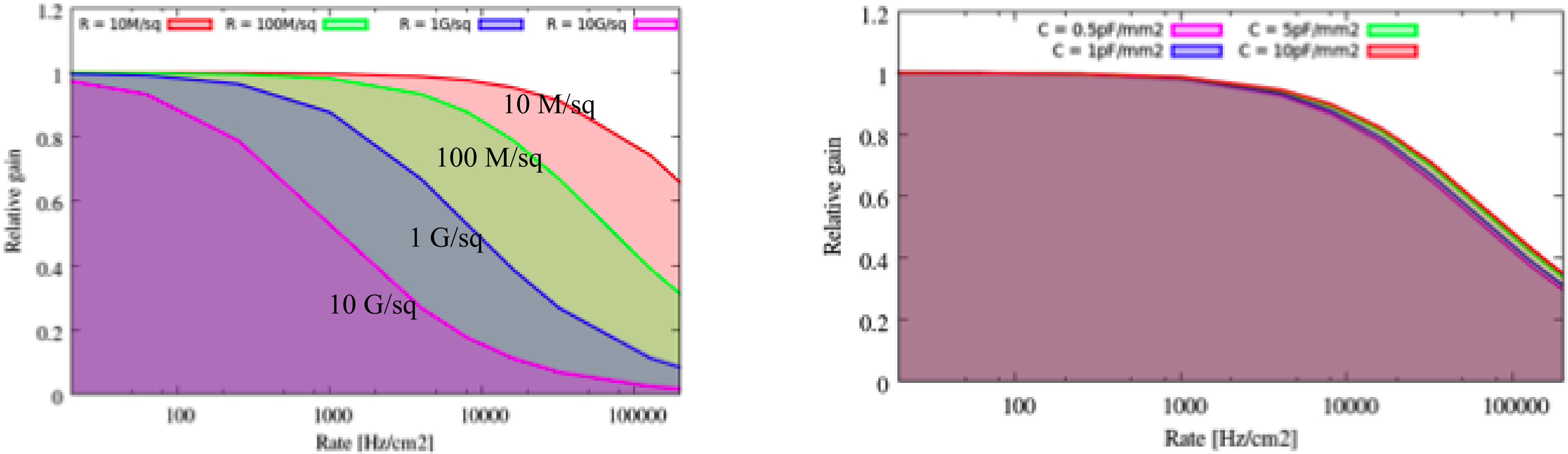
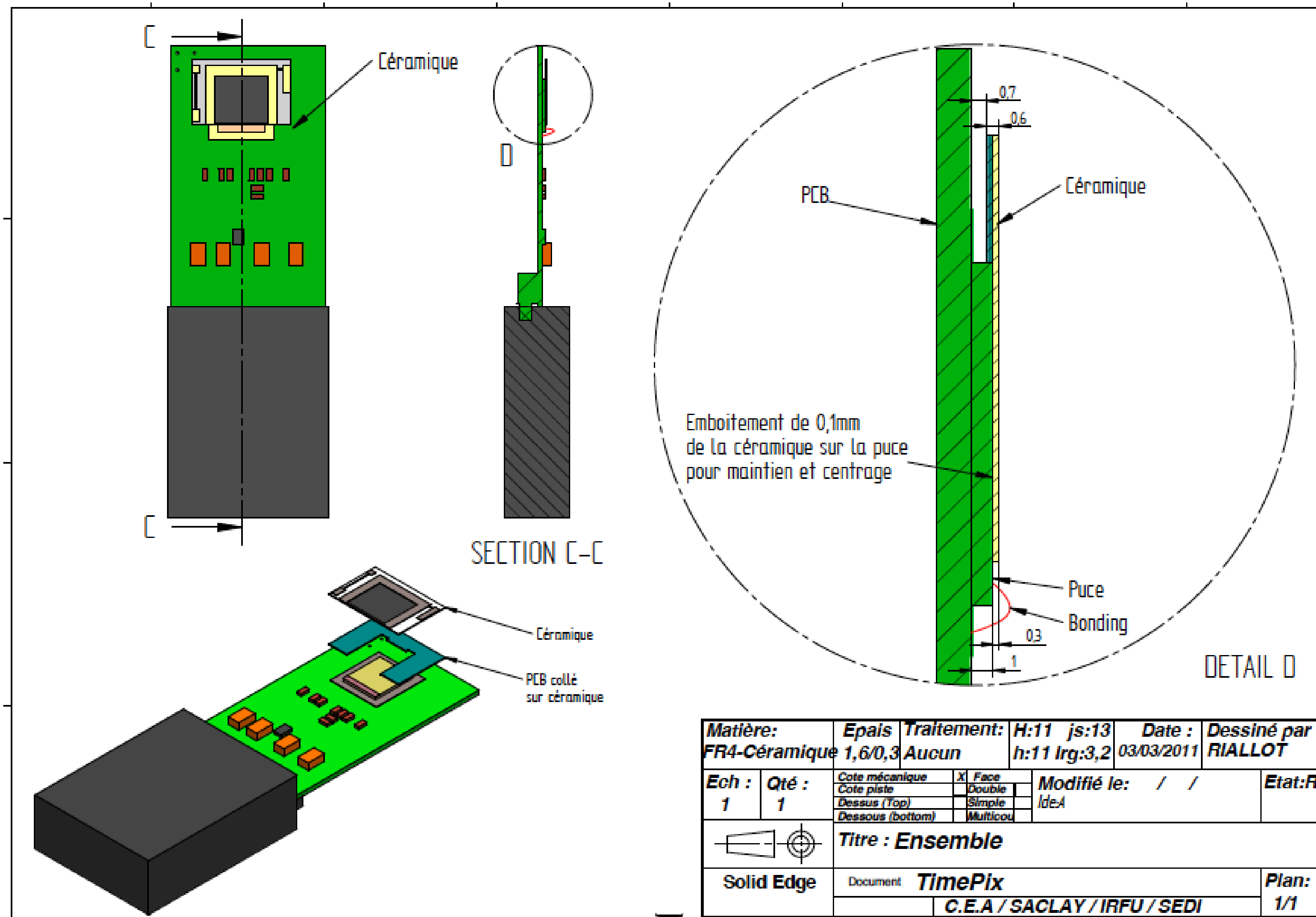
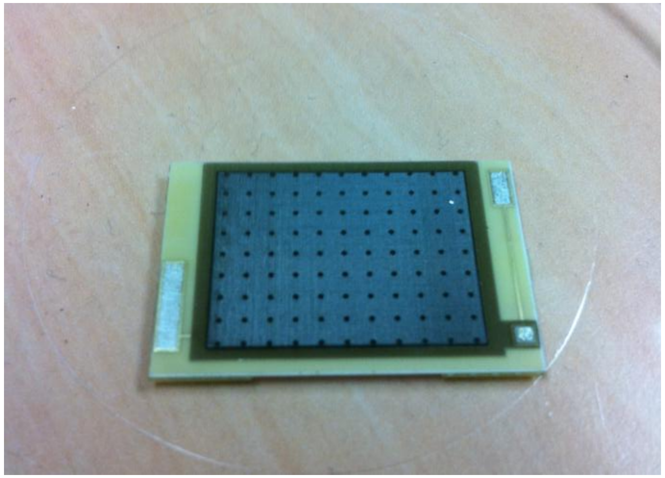


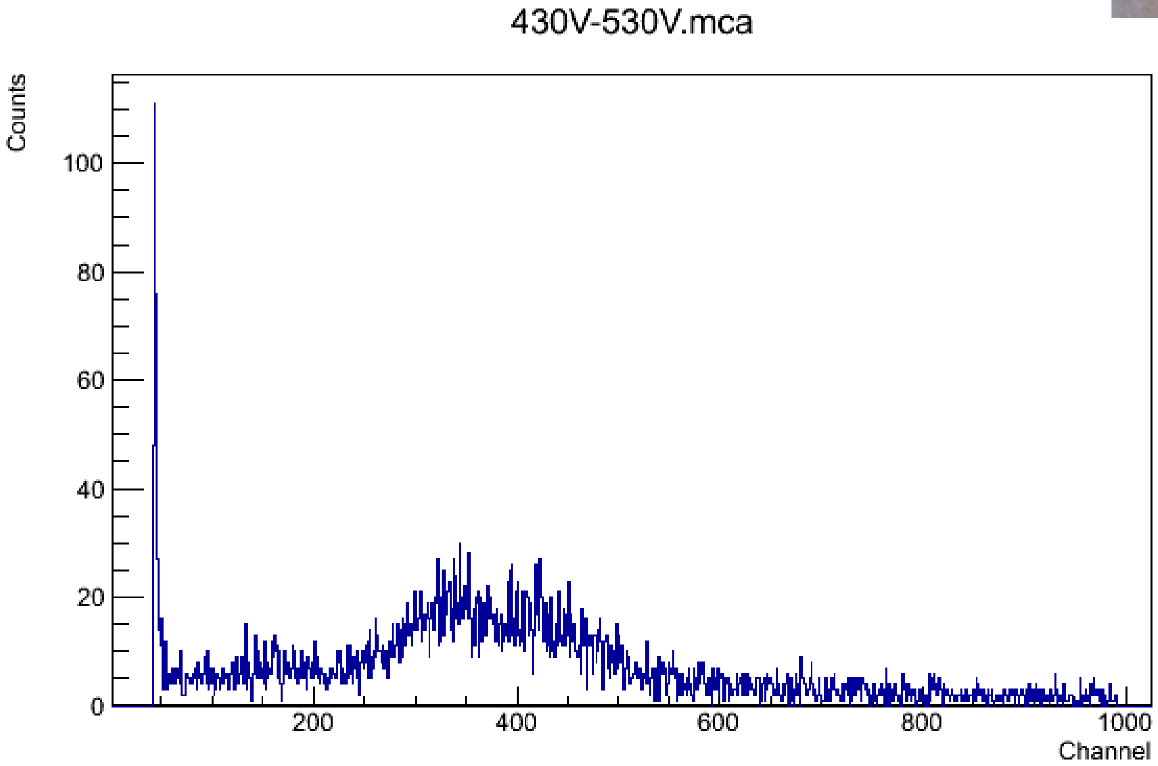
Figure 12. On the left, relative gain versus the particle flux for different resistivity values at 1pF/mm2. On the right, relative gain versus flux for different capacitances at a resistivity of 100M/sq.

2nd ptototype
PiggyBack and TimePix

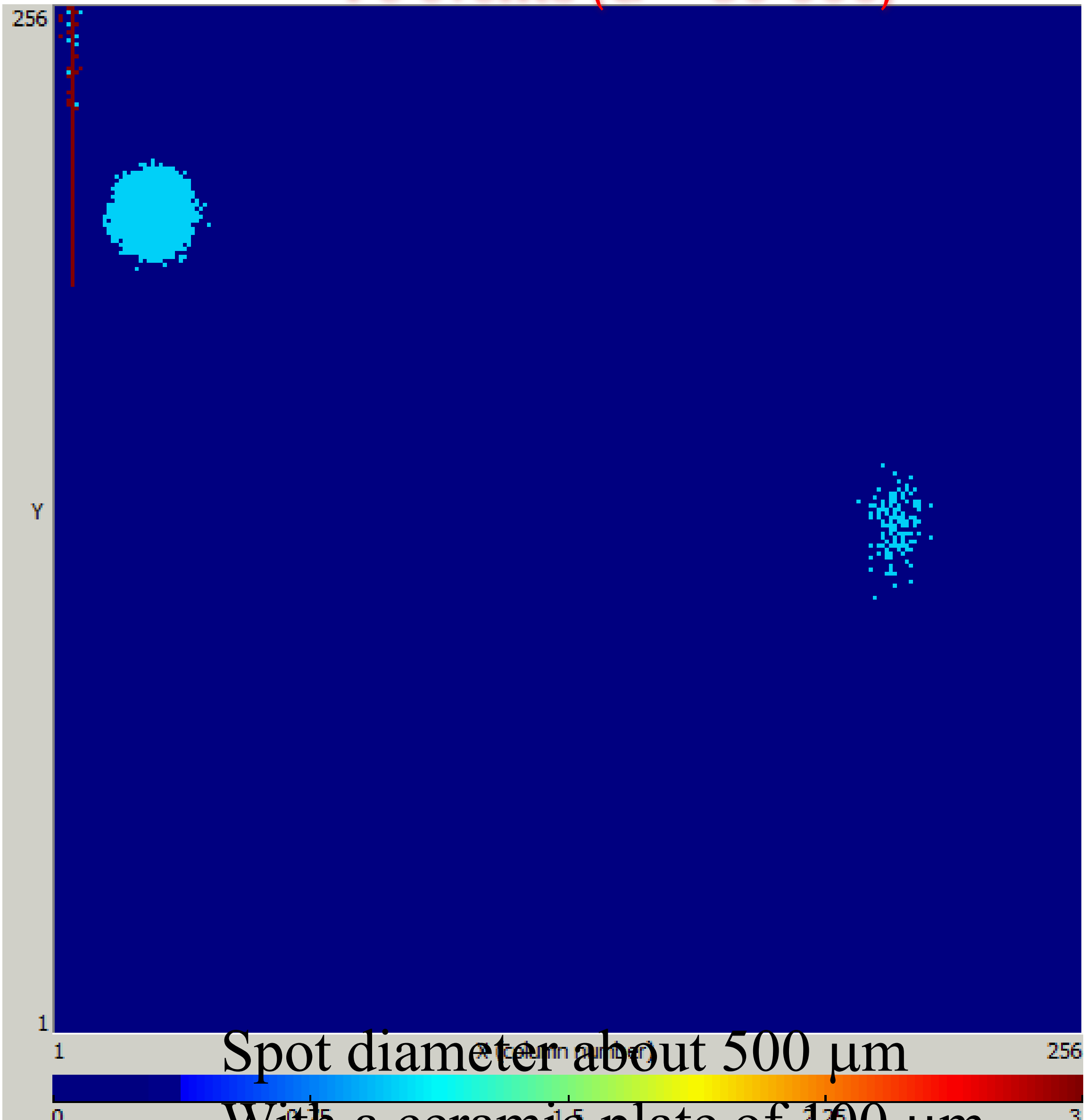


- Bulk on ceramic (300 µm) → Piggyback
- First test in Argon/Iso 5%
- Signal observed on Medipix chip
- No damage of the chip during operation at high gain





^{55}Fe events (G ~ 50 000)

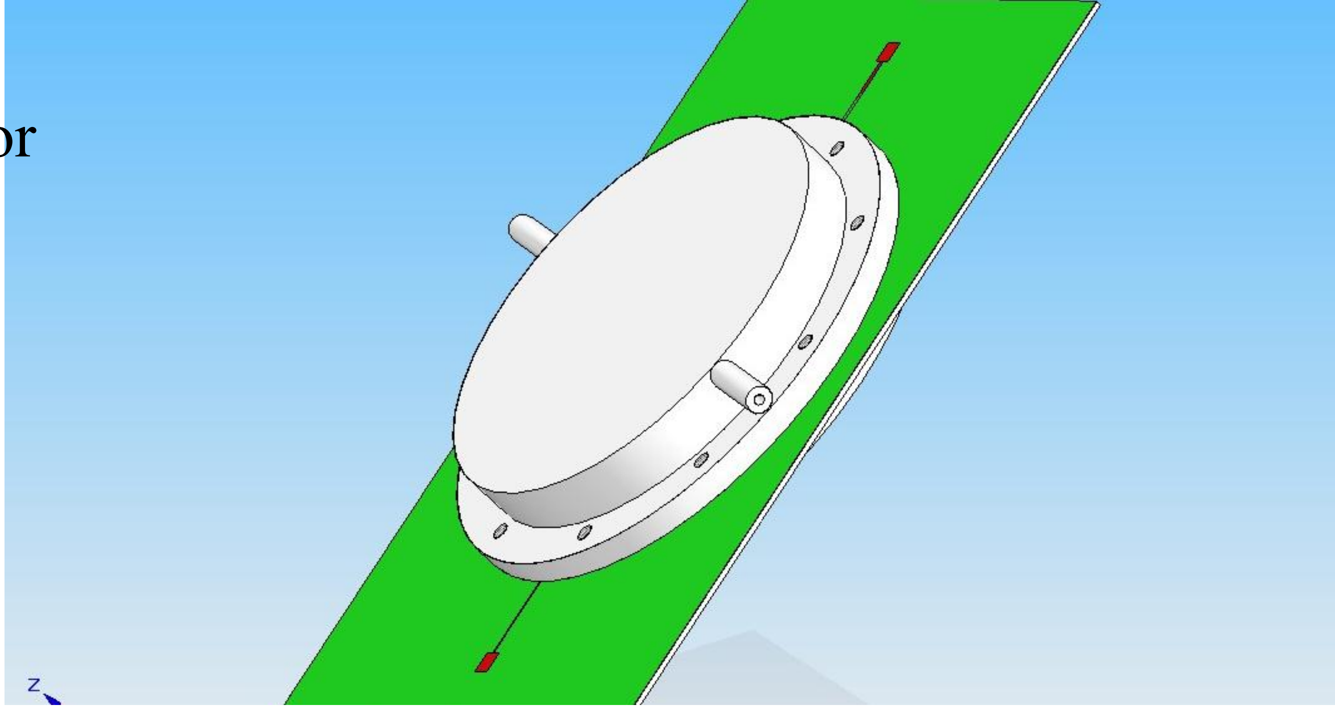


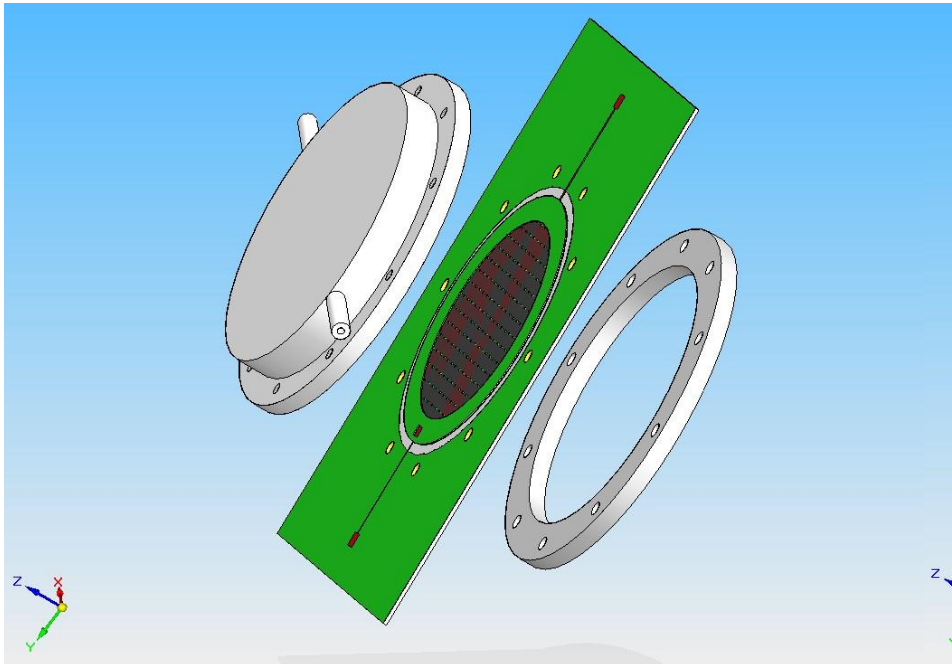
Spot diameter about 500 µm

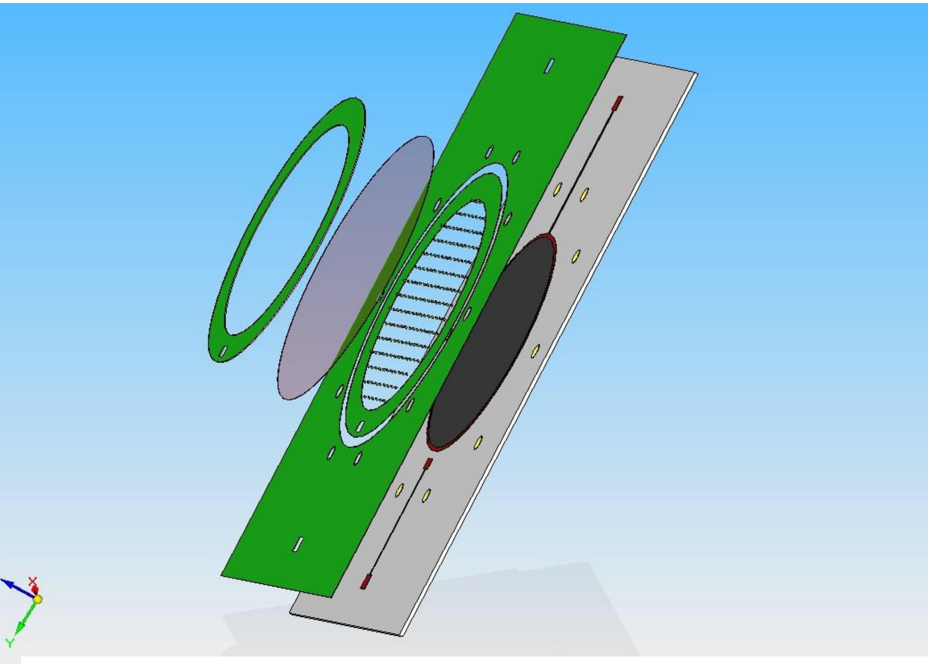
With a ceramic plate of 100 µm

We expect to get it down to 150 µm

Towards a seal detector
Saclay-CERN collaboration







Conclusions

1. Resistive layer on top of ceramic plate at 600 degrees provides robust structure
1. Provides spark protection
2. Detector dissociated from read-out plane
3. Read-out of CMOS pixel ASICs
4. Read-out of large pads with thick ceramic
5. Study of high rate vs resistivity
6. Seal detector is under development