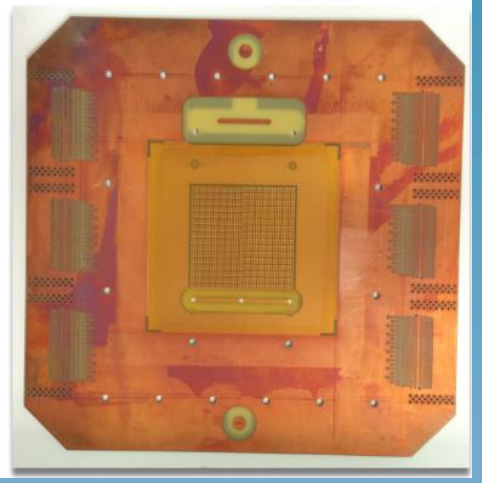
RHUM

Resistive

High

granUlarity

Micromegas



Joint project of INFN Napoli and Roma Tre

# New Resistive Micromegas structures for future detectors

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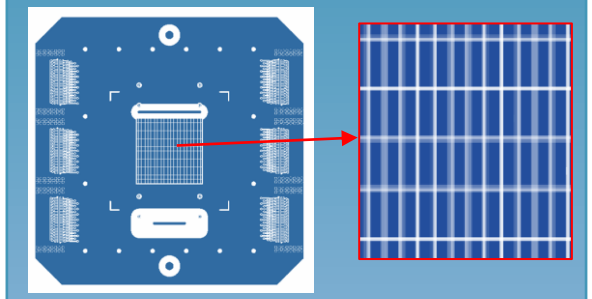
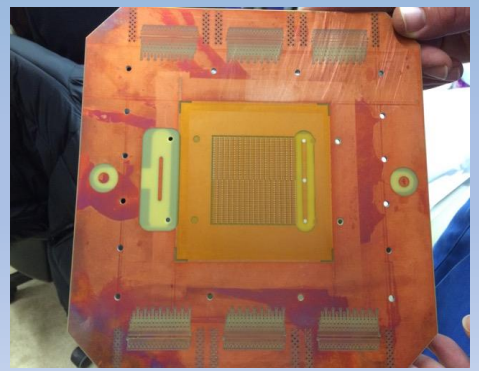
IFD2022: 17-19 October 2022

# Small-Pad resistive Micromegas detectors

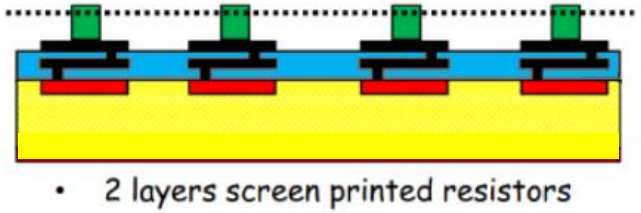
PIXELATED ANODIC PLANE



Pixelated readout:
5x5 cm$^2$ anodic plane,
pads of **0.8 x 2.8 mm$^2$**



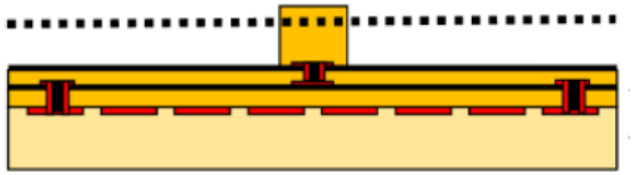
## Resistive spark protection schemes




- **PAD-P**:

  micro-mesh (dot line) + pillars (green)
  Embedded pad resistors (black)
  Coverlay insulator (blue)
  Copper readout pads (red) on PCB (yellow)
  O(10) MΩ resistance btw top pad resistor and ground;

Ref [1] Construction and test of a small-pad resistive Micromegas prototype (https://iopscience.iop.org/article/10.1088/1748-0221/13/11/P11019)



- **DLC-like** (Diamond-Like-Carbon)

  micro-mesh (dot line) + pillars (orange)
  DLC foils with 20-50 MΩ/sq (black)
  Polymide insulator (orange);
  6-12 mm vias pitch side;
  Copper readout pads (red) on PCB (beige)

Ref. [2] Alviggi et al. - NIM Research Sec. A, Vol. 936, 21 Aug 2019, pp 408-411 (https://doi.org/10.1016/j.nima.2018.10.052)

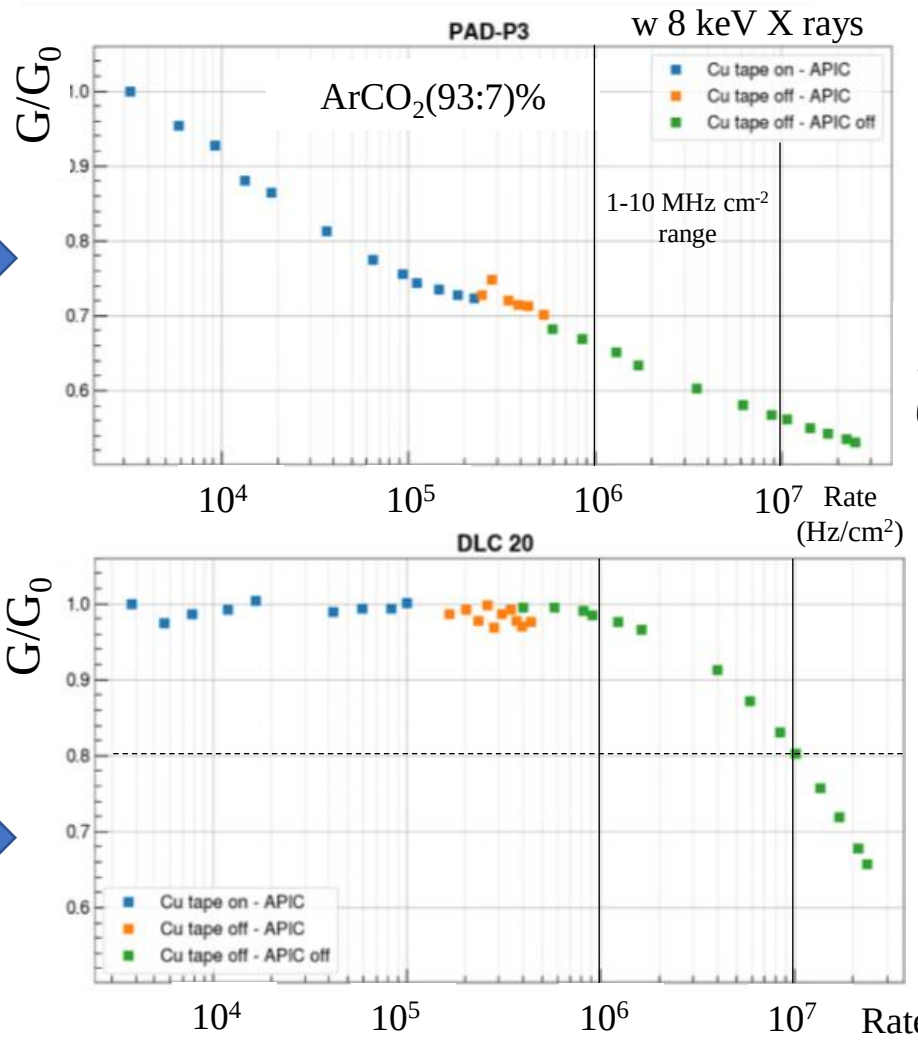
# Studies of rate capability

## PAD-P scheme

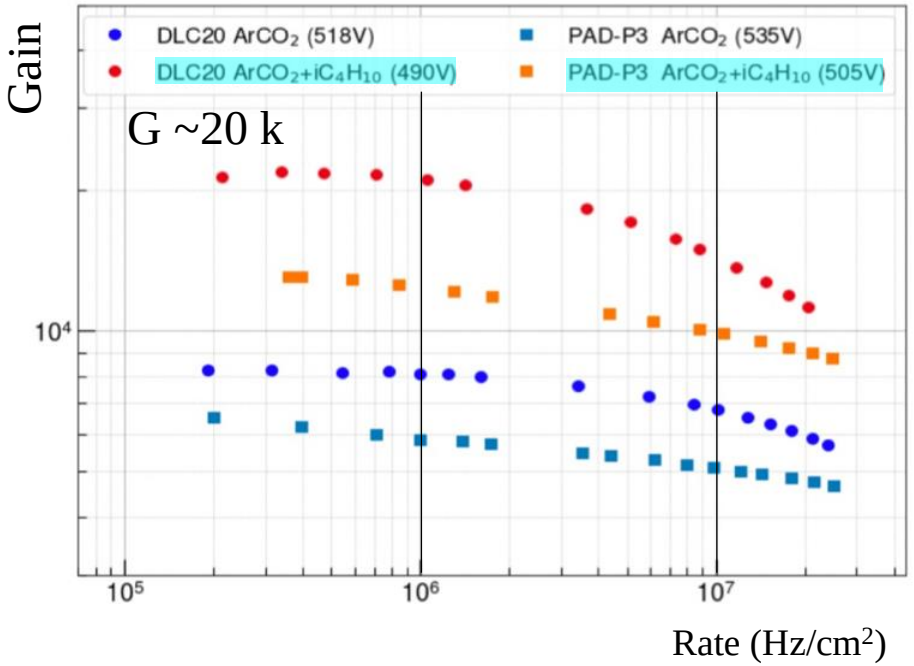
- Relatively fast loss for rate < 0.1 MHz/cm$^2$ due to charging-up;
- Slower ohmic voltage drop through the individual pads at higher rates;

## DLC-like scheme

- Negligible charging-up effects.
- Gain stable up to 1-2 MHz/cm$^2$, and at higher rates, gain drop due to ohmic contribution.
- At 10 MHz/cm$^2$, gain drop of ~20%



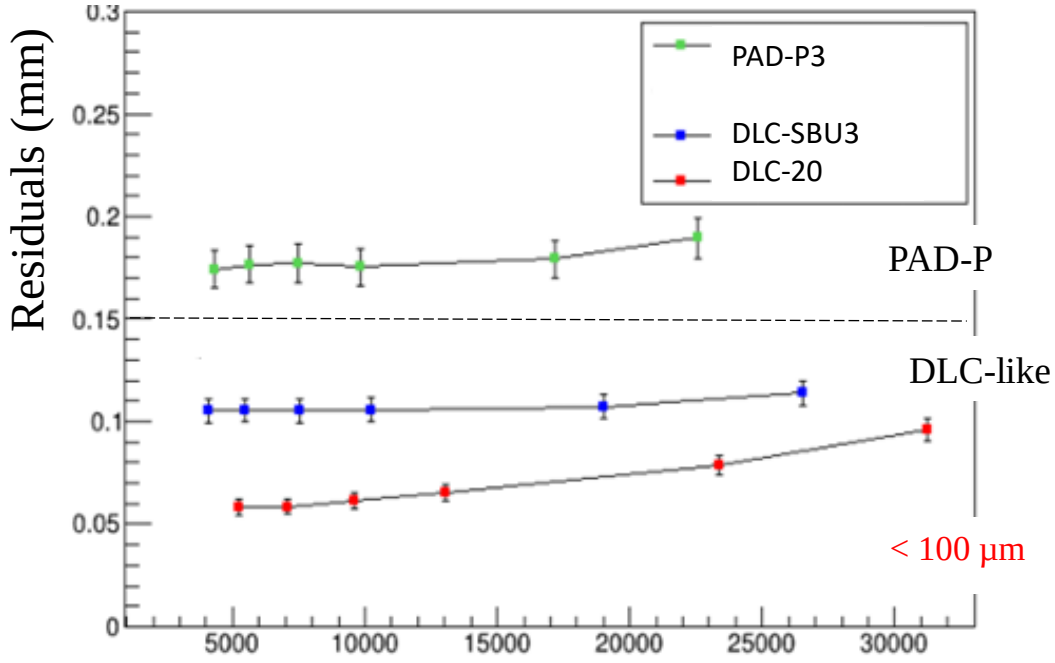

With the two mixtures, we observed compatible drops, **$ArCO_2iC_4H_{10}$(93:5:2)%** lets to work at a **higher gain** and to a **larger spark quenching.**




plots from Master thesis of S. Franchellucci (Univ. Roma Tre)

# Studies of tracking performances ($ArCO_2iC_4H_{10}(93:5:2)\%$ )

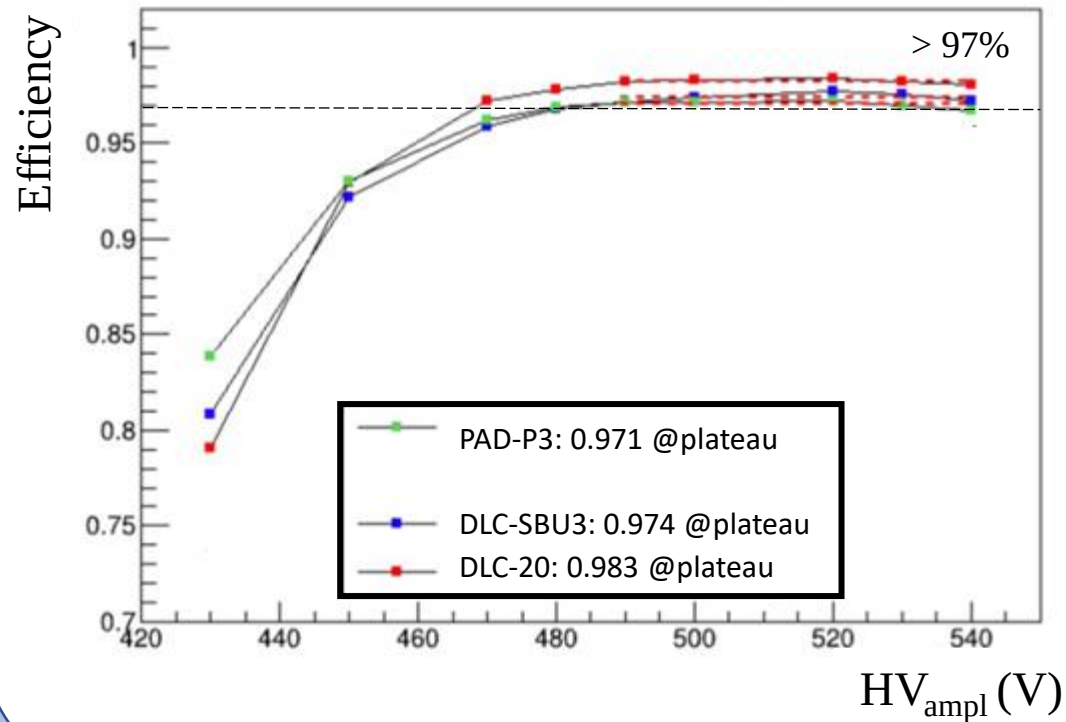
**Spatial resolution** (along pad short side)




w 80 GeV/c muon beam

**Tracking efficiency**

based on cluster search within 1.5 mm fiducial range along the extropated track position in the pad short side



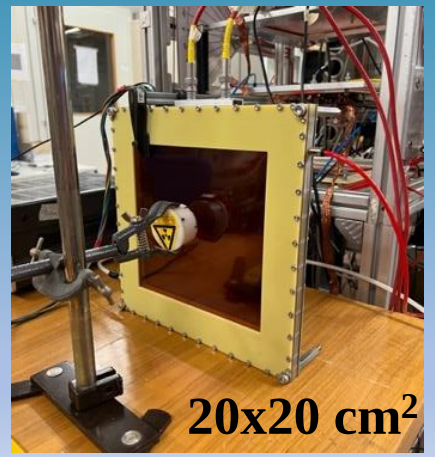

On going studies of **time resolution:**

with the investigated gas mixtures and APV25 FE chips, detectors have similar time performances (O(10 ns)). To improve

- «Faster» gas mixtures (with a small fraction of $CF_4$);
- New FE chips as VMM, tiger, fatic (in touch with the respective groups).

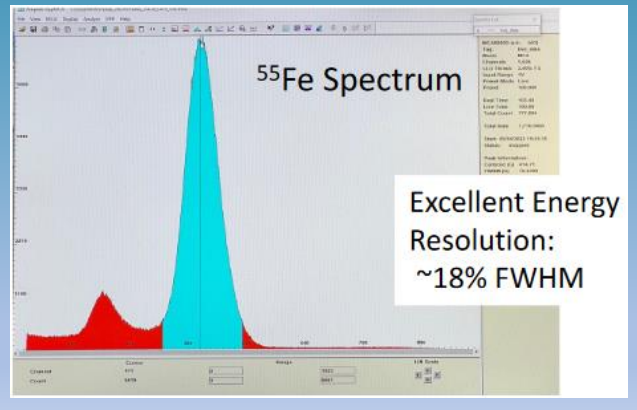
plots from Master thesis of C. Gimmillaro (Univ. Roma Tre)

# Towards large areas

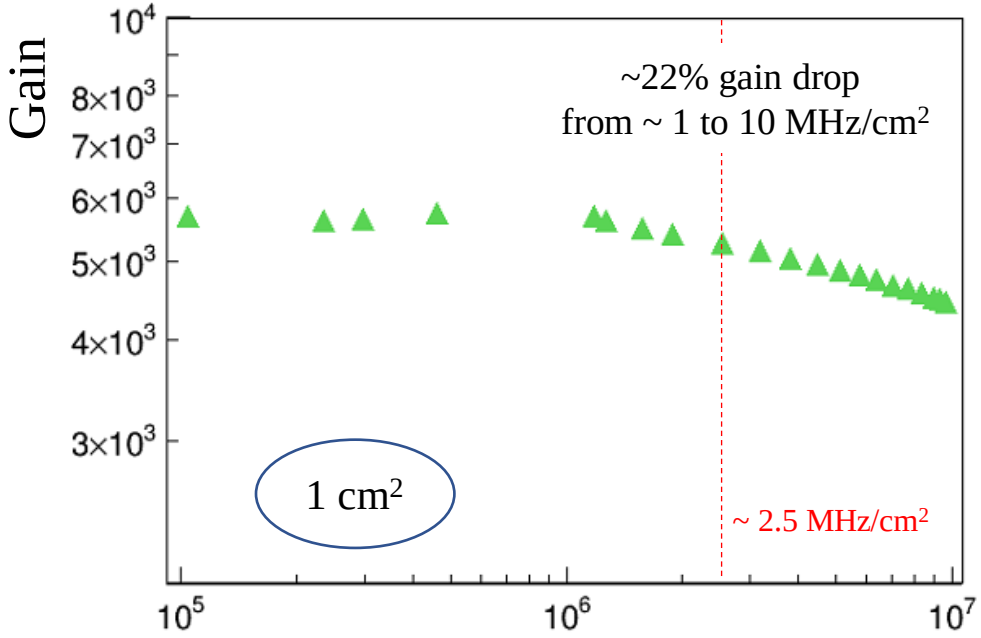



- **Pad size:** 1x8 mm²
- **Number of Pads:** 4800
- **DLC-like layout** w 8 mm grounding vias pitch
- FE connectors on the back of the detector (partial readout)

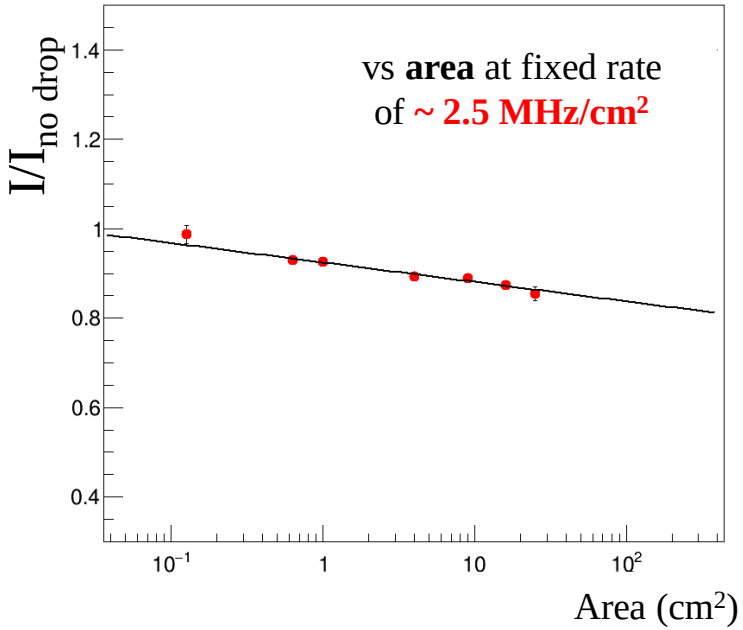
**Tomorrow in TB**




Repeated gain/rate capability studies with $ArCO_2$(93:7)%, varying irradiated area up to 25 cm² max area until now.




Area dependence tends to saturate,




as already observed for smaller areas in previous study
https://indico.cern.ch/event/868940/contributions/3813865

# Conclusions

The results show that small-Pad resistive Micromegas:

are **excellent candidates for particle tracking and trigger operation** up to rate O(1-10 MHz $cm^{-2}$) with

- **stable HV behaviour,**
- **O(100 um) spatial resolution;**
- **O(10 ns) time resolution**

reached a consolidated constructive techniques for large area detectors, in touch with ELTOS company for the technological transfer