Resistive Micromegas for Sampling Calorimetry

M. Chefdeville, Y. Karyotakis (IN2P3/LAPP, Annecy), T. Geralis (Demokritos, Athens), M. Titov (IRFU, Saclay)*

* Introduction & Status

* Test(beam) plans

Introduction

Goal: develop a fast (high-rate friendly), linear & thin (for calorimetry) and stable (no spark) detector.
→ Resistive Micromegas

Question: what resistivity to be used?
High R → Efficient spark quenching
Low R → Minimal charge-up effects to maintain high-rate capability & signal linearity

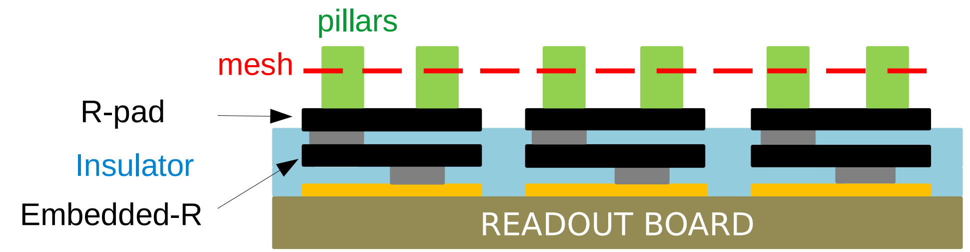
Experimental setup (*=RD51): Xray gun* (rate), testbeam* (sparking, linearity), GEM-injector (linearity)

First: what resistive coating? Embedded resistor

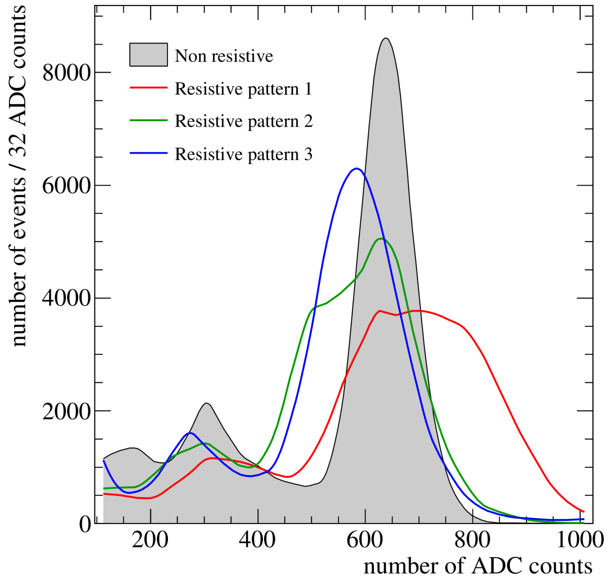
Allows charge evacuation from top-to-bottom

→ no lateral charge dispersion

→ maintain calorimeter imaging capability



RC-constant controlled with embedded R-pattern



3 first prototypes (10x10 cm2):

- Full spark suppression in prototypes with R of 1-100 MΩ.
- Coupling between resistive/readout pad ~ 100%
- Still some issues with flatness (poor energy resolution)

Charge-up effects (lab tests)

Charge-up effects can be significant (a few volts) if too many particles are crossing

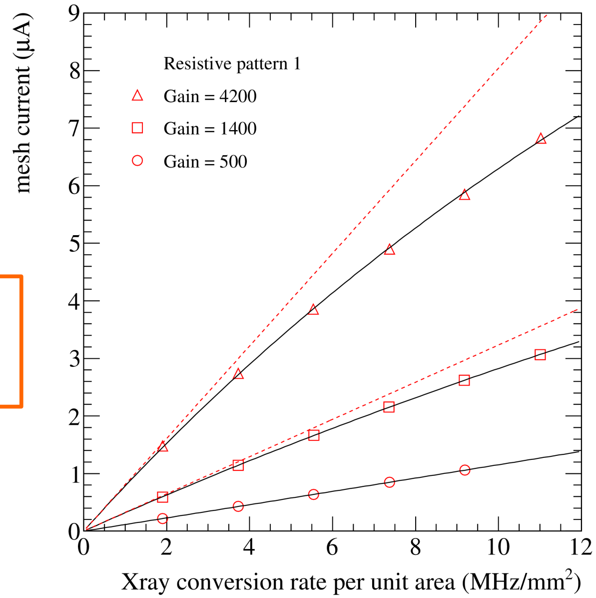
OR

During a single event if the primary charge is too large (e.g. a shower)
In this case, primary electrons with longer drift time might feel a reduced field, degrading the linearity

Study of rate effect (1/Φ >> τ)

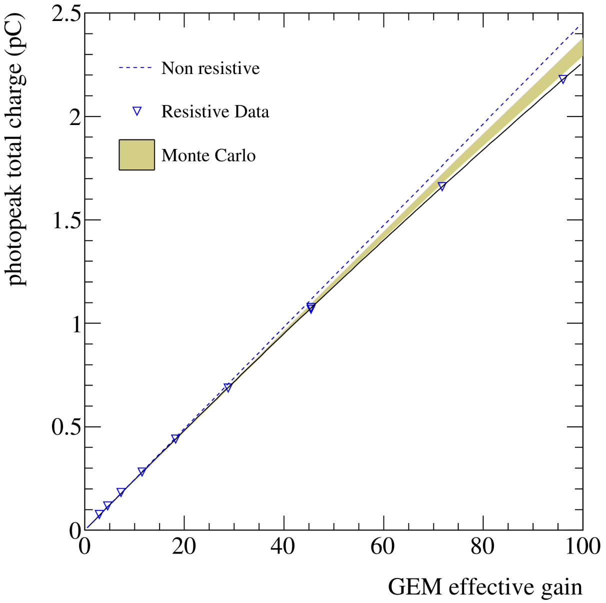
Balance between charge (Φ) & discharge (τ)
Steady regime reached after τ

Xgun RD51 lab



Study of the primary charge (1/Φ << τ)

Pad mainly charges during event.
Current model not too off.



GEM injector above R-Bulk

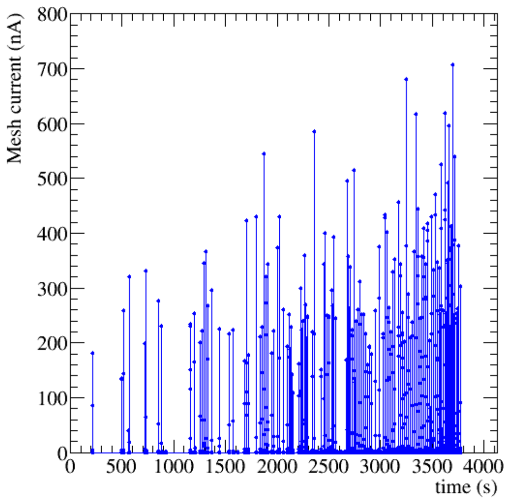
We observed charge-up effects under high rates (10 MHz/mm2) and under high primary ionisation (2000 MIPs). They are below the percent level up to very high rate or dE/dx.

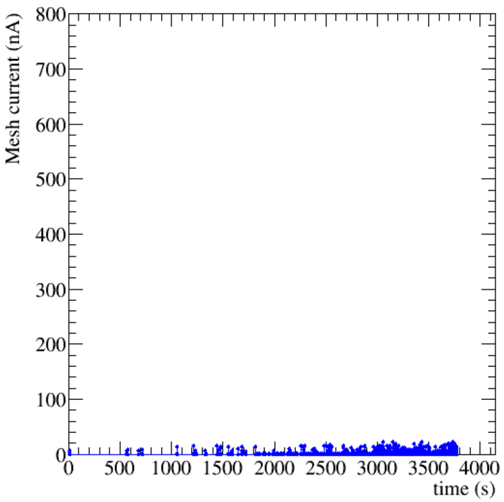
Findings (beam tests)

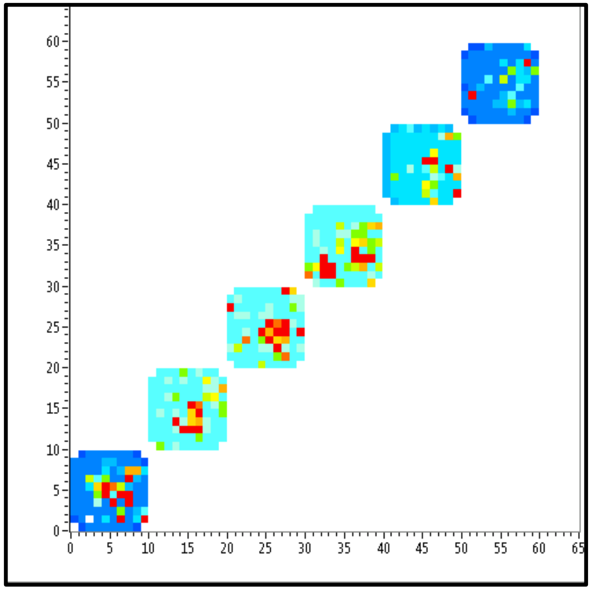
We joined the RD51 testbeam last December

* to assess the spark suppression in a high-rate pion beam with absorber
→ mesh current monitoring

* to measure the variation of the measured charge with shower energy and event rate
→ 96 pads read out with Gassiplex electronics (x 6 detectors: 4 R-Bulk + 2 non-R-Bulk)







Spark are suppressed
→ 3 new prototypes with factor 10 lower R (available from workshop tomorrow after some delay)

No significant variation of the measured charge with shower energy
Probably because of large event-to-event variation of deposited energy (hadrons!), meaning that on average the deposited energy is (too) small.
→ repeat measurement with high-energy electrons (small variations of shower max.)

Test plans

Test protocol is unchanged

- get the new prototypes (this week, June week 2);
- solder connectors and cables (week 3);
- test with GEM injector (at LAPP) (week 4);
- close chambers (week 4, in parallel of previous test)
- test with Xgun (RD51 lab) (July week 1)
- testbeam, move in during July 7-8 MD (installation can already start on the July 1st)

Timing looks tight but all components are available and protocols are well established

Foreseen measurements in H4

Charge-up effect due to primary charge

Electron beam (50-300 GeV) + couple of X0 absorbers + detector stack

Measure charge VS shower energy at moderate rates (1/flux << RC, typically a few 100's)
Repeat measurement for all prototypes including old ones, i.e. 4+3 resistive + 1 non-resistive)
Swap prototype in the stack so each tested prototype sees the same shower signal.
+ Measure **muon** MIP distribution for offline normalisation and comparison between prototypes

Assess spark suppression

Hadron beam (150 GeV pions) + Fe absorber + detector stack

Foreseen setup in H4

Foreseen setup is unchanged:

- XY-table with remote control to align detector stack with beam (only once)
- detector support structure + PMT support structure
- CAEN HV mainframe (which we would like to borrow from RD51) + RD51 slow-control system
- VME and NIM crates for Gassiplex readout and trigger electronics
- PCs in H4 and inside control room

- Gas: Ar/CO2 premix
- Services from beamline to control room: ~ 10 lemos, 1 ethernet