IL NUOVO CIMENTO **43 C** (2020) 67
DOI 10.1393/ncc/i2020-20067-6

Colloquia: IFAE 2019

Studies on the optimization of the spark protection resistive layer in Small-pad MICROMEGAS detectors

M. T. Camerlingo(1)(2)(*)

(1) *Dipartimento di Fisica E. Amaldi, Università di Roma Tre - Rome, Italy*
(2) *INFN, Sezione di Roma Tre - Rome, Italy*

received 8 June 2020

Summary. — Motivated mainly by future detector upgrades at HL-LHC and at future colliders, the Small-pad resistive MICROMEGAS prototypes were designed to overcome the actual limitations of more standard strip resistive MICROMEGAS. In these new prototypes, small pads with a few mm^2 area replace the readout strips to reduce the occupancy, and the spark protection resistive layer has been redesigned and optimized with different techniques to permit a safe behaviour of the detector, without efficiency loss, at rates of the order of tens MHz cm^{-2} over large surfaces.

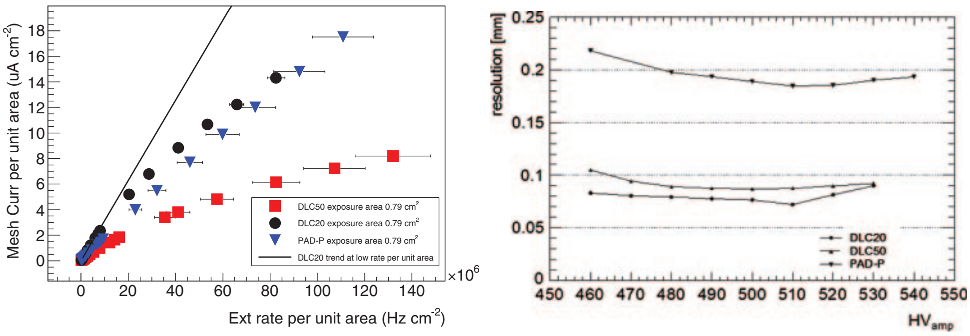
1. – Spark protection resistive layers in Small-pad MICROMEGAS detectors

Two different spark protection resistive layers were implemented for the Small-pad resistive MICROMEGAS prototypes to match the new pad readout geometry. Characterization studies have been carried on to determine the responses of the prototypes to high-rate X-rays and to charged particle beams. The firstly developed design exploits a pad-patterned embedded resistor layout (PAD-P) by screen-printing while the most recent involves uniform sputtered DLC (Diamond-Like Carbon structure) layers to optimize some aspects of the pad-patterned embedded resistor layout. In the second concept, all the dielectric components are fully covered by the DLC layers, minimizing the observed charging-up phenomenon in the PAD-P prototype [1,2]. However, the comparative studies at very high rate show that the first layout is still preferable in specific applications at very high rate and large exposure area, as reported in the next section.

2. – Instantaneous performances under X-rays and charged particle beam

The study of the detector current trends per unit area as a function of rate per cm^2 allows a direct measurement to estimate the best prototype in terms of rate capability.

(*) E-mail: `mariateresa.camerlingo@uniroma3.it`



(a) **(b)**

Fig. 1. – Mesh current per unit area as a function of rate per unit area (left) and spatial resolution as a function of amplification voltage (right).

At fixed gaseous mixture (Ar:CO_2 = 93:7), drift voltage and gain factor, the comparative studies show that a lower resistivity moves the significant voltage drop toward higher rates in DLC prototypes when the detectors were irradiated by 8 keV X-rays with a variable hit rate in the range 0.5–120 MHz cm^{-2}, as can been seen in fig. 1(left). In addition, the drop of the effective amplification voltage is independent of the exposed area in the PAD-P prototype in the investigated range, differently to the DLC case [3].

From the test beam data, the DLC prototypes show a better spatial resolution ($\leq$100 μm) in the precise coordinate with a 1 mm pitch than PAD-P ($\leq$190 μm), as reported in fig. 1(right) [2].

3. – Conclusions

The performed studies show that the PAD-P prototype is affected by charging-up already at moderately low rates ($\sim$100 kHz) causing a voltage drop which saturates at values of about 30%, an effect that is not present in the DLC series. Moreover, its spatial and energy resolutions are worse than those measured with the prototypes with a uniform DLC resistive layer, due to the edge effects of the resistive pads causing a more irregular electric field in the PAD-P detector. On the other hand, it shows a better linear current response with respect to the DLC detectors, up to very high rates, and independence of behaviour on the irradiated area.

In general, both spark protection resistive configurations are suitable for Small-pad MICROMEGAS. The optimal solution strongly depends on the specific application, requirements and rate range.

Further investigations are in progress to additionally validate these results and further optimise and characterise the resistive configuration and parameters.

REFERENCES

[1] Alviggi M. *et al.*, *Small-pad resistive Micromegas for operation at very high rates*, in *Proceedings of ICTIPP* (Springer) 2017, pp. 138–142.
[2] Alviggi M. *et al.*, *Nucl. Instrum. Methods Phys. Res. Sect. A*, **2019** (936) 408.
[3] Alviggi M. *et al.*, *Pixelated resistive bulk Micromegas for tracking systems in high rate environment*, in *15th Topical Seminar on Innovative Particle and Radiation Detectors*, `https://indico.cern.ch/event/843258/contributions/3610713/attachments/1929394/3195257/03_Alviggi.pdf` (2019).