IL NUOVO CIMENTO **43 C** (2020) 100
DOI 10.1393/ncc/i2020-20100-x

COLLOQUIA: IFAE 2019

Characterization of plastic scintillators equipped with SiPM for the next generation of satellites for the study of cosmic radiation

D. SERINI(1)(2), P. DE LA TORRE LUQUE(1)(2), L. DI VENERE(1), P. FUSCO(1)(2), F. GARGANO(1), F. GIORDANO(1)(2), F. LOPARCO(1)(2), S. LOPORCHIO(1)(2) and M. N. MAZZIOTTA(1)

(1) *INFN, Sezione di Bari - Bari, Italy*
(2) *Dipartimento Interateneo di Fisica "M. Merlin", Università di Bari - Bari, Italy*

received 8 June 2020

Summary. — The next generation of satellite experiments for the studies of cosmic radiation will be equipped with plastic scintillators read-out by Silicon Photomultipliers (SiPMs), to be used as anti-coincidence detectors for gamma rays or for the identification of charged nuclei. For these applications, a high detection efficiency is required in order to ensure a high background rejection for the gamma-ray identification. The read-out design based on SiPM and the segmented geometry is one of the main aspects that can be optimized to reach this goal. During 2018 we performed a beam test campaign at the CERN PS and SPS to study the performance of a prototype of plastic scintillator tile equipped with a set of SiPMs with a beam of electrons and pions.

1. – Introduction

We built a squared tile prototype made of a BC-404 [1] plastic scintillator with a side of 15 cm, a thickness of 1 cm and with two angles cut at a distance of 2.5 cm from the corner (fig. 1, left). This prototype was equipped with 12 AdvanSiD SiPMs [2] sensitive to near ultraviolet (NUV) light with a photon detection efficiency (PDE) peaking at 420 nm, matching the BC-404 emission spectrum. We used SiPMs of two different sizes, $4 \times 4\,\text{mm}^2$ ("Large" SiPMs) and $1 \times 1\,\text{mm}^2$ SiPMs ("Small" SiPMs), placed along the perimeter of the tile, as shown in the left panel in fig. 1. Each SiPM was read-out using an AdvanSiD trans-impedance amplifier [2] and the analog signals were integrated and acquired with a Caen V792 QDC. The prototype was tested at the CERN PS T10 beam line with 5 GeV/c particles and at the CERN SPS H8 beam line with 20 GeV/c particles [3]. In both cases the beams were mainly composed by pions and electrons. A trigger system consisting of two plastic scintillators disposed along the beam line was also implemented as shown in fig. 1.

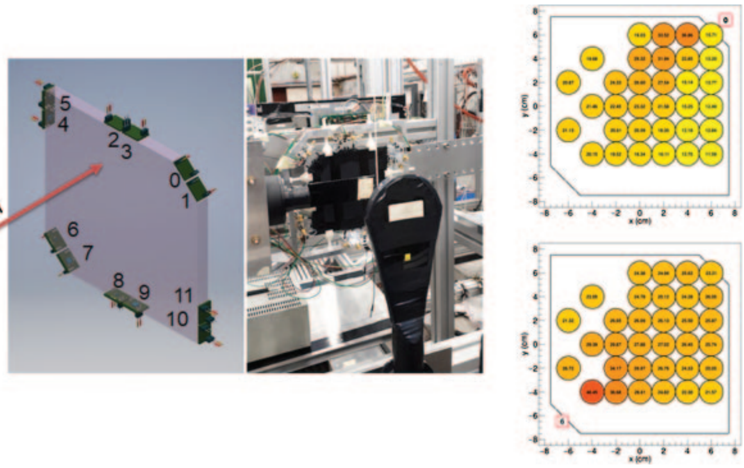

Fig. 1. – Left: prototype geometry with SiPMs enumeration on the tile and trigger system used. Right: summary of the results obtained for two large SiPMs (0 and 6). Each plot shows the number of photoelectrons detected by the reference SiPM, indicated in the red box, for all the beam position tested.

2. – Test beam measurements

At PS T10, a plastic scintillator with a hole was used as halo veto in order to select a circular beam spot of 3 cm diameter. In this case, the tile was moved with respect to the beam line within 2 cm steps in order to scan the whole scintillator in 33 different positions to study the dependence of the light collected by the SiPMs on the beam position.

At SPS H8 the tile was irradiated only in the central position with a 2 cm collimated beam. The cumulative distributions of the signal and pedestal read by each SiPM were evaluated in order to study the detection efficiency of a minimum ionizing particle.

3. – Results

The results obtained in the beam test campaign show that the response of our prototype is almost uniform in all scanned positions (see fig. 1, right) with an expected enhancement near the SiPM positions. The detection efficiency achieved is comparable with the typical values required for anti-coincidence detectors in satellite experiments, and it can be improved by combining the response of several SiPMs. In the OR configuration, we observe a higher efficiency ($\sim$99.99% at 10 photon-electrons) with respect to the single SiPM [3].

REFERENCES

[1] Saint Gobain, BC-404 scintillator datasheet, `https://www.crystals.saint-gobain.com/sites/imdf.crystals.com/files/documents/bc400-404-408-412-416-data-sheet.pdf`.
[2] AdvanSiD, `http://advansid.com/products`.
[3] Gargano F. *et al.*, *PoS* **ICRC2019** (2019) 069.