Available online at www.sciencedirect.com
ScienceDirect
Nuclear Instruments and Methods in Physics Research A 572 (2007) 476–478
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A
www.elsevier.com/locate/nima

Performance of the resistive plate chambers in the ARGO-YBJ experiment

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Available online 27 November 2006

Abstract

The ARGO-YBJ experiment is designed for the detection of Extensive Air Showers (EAS) in the primary energy range 100 GeV–10 TeV. Its full-coverage feature allows to lower the energy threshold about one order of magnitude with respect to sampling EAS detectors. Here the performance of the RPC array is described and the current status of the experiment is presented.

PACS: 29.40.Cs; 95.55.Vj; 95.85.Pw; 96.50.sd

Keywords: Resistive Plate Chambers; Extensive Air Showers; Gamma-ray astronomy

1. Introduction

The need for ground-based detectors for cosmic-ray astrophysics and gamma-ray astronomy comes from the limitations of satellite measurements at energies higher than ~100 GeV. Due to the decreasing power law for gamma-ray flux, it would take years to collect significant statistics from a high-energy gamma source on a ~1 m^2 detector at those energies. Ground-based detectors can investigate a much wider energy range by exploiting the EAS amplification effect. The two main experimental techniques exploited so far for EAS detection on the ground are based on Air Cherenkov Telescopes (ACTs) and sampling EAS arrays.

In order to improve the performance of ground-based EAS arrays, two main goals must be pursued:

- lower energy threshold (<500 GeV);
- higher sensitivity (~1/10 of the Crab gamma-ray flux).

A possible strategy in this respect may be summarized as follows:

- high-altitude experimental site;
- secondary photon conversion;
- increased active area, approaching 100%.

The ARGO-YBJ detector [1] is designed to meet the above requirements.

2. The experimental setup

The ARGO-YBJ experiment is located at Yang Ba Jing (Tibet, China), 90°31′50″E, 30°06′38″N, 4300 m above sea level. The detector is a full-coverage layer of Resistive Plate Chambers (RPCs) [2,3].

The ARGO-YBJ chambers are placed one next to the other in a full-coverage array, surrounded by a "guard ring" to improve the detection of showers not fully contained in the central area. The complete layout is shown in Fig. 1, where two subsequent zooms show the detailed structure of a *cluster* (a group of 12 adjacent chambers) and the pads inside a chamber.

The trigger for the events is provided by a minimum required pad multiplicity in the central part of the detector

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0168-9002/$ - see front matter
doi:10.1016/j.nima.2006.10.307

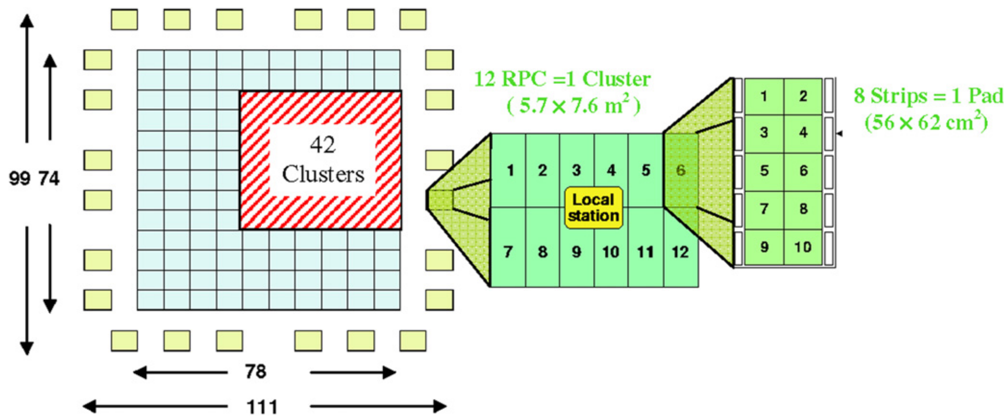

Fig. 1. Layout of the ARGO-YBJ experiment. The central full-coverage area is surrounded by a "guard ring". The 42 clusters used for the first measurements are evidenced. The side lengths of the experimental setup are in meters. Zooms show the structure of a cluster (12 adjacent chambers) and the pad positions inside a chamber.

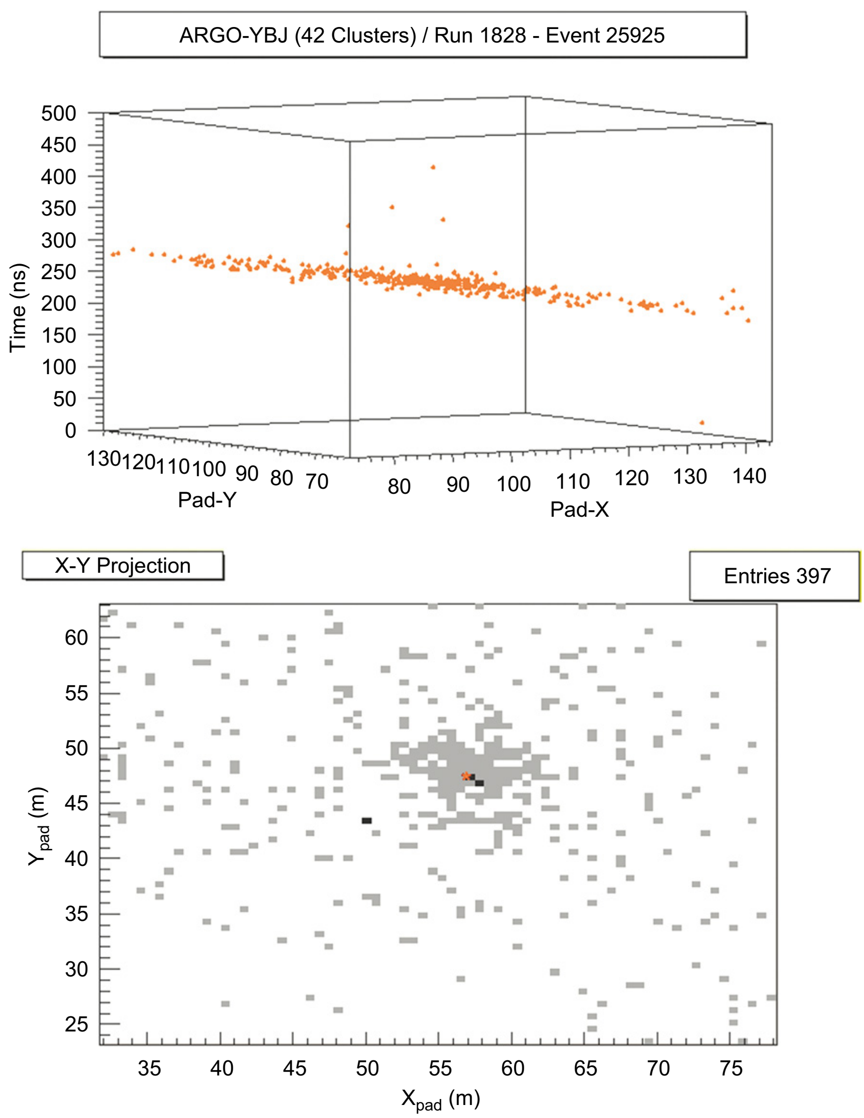

Fig. 2. Space–time profile and hit projection on the detector (42 clusters) of a fully contained shower.

(at least 6 fired pads in 10 or more clusters in the first measurements with 42 clusters), with space–time consistency for a shower front.

The ARGO-YBJ Detector Control System (DCS) is crucial since it includes all the control and monitoring tasks necessary to guarantee a safe and reliable operation of the detector [4].

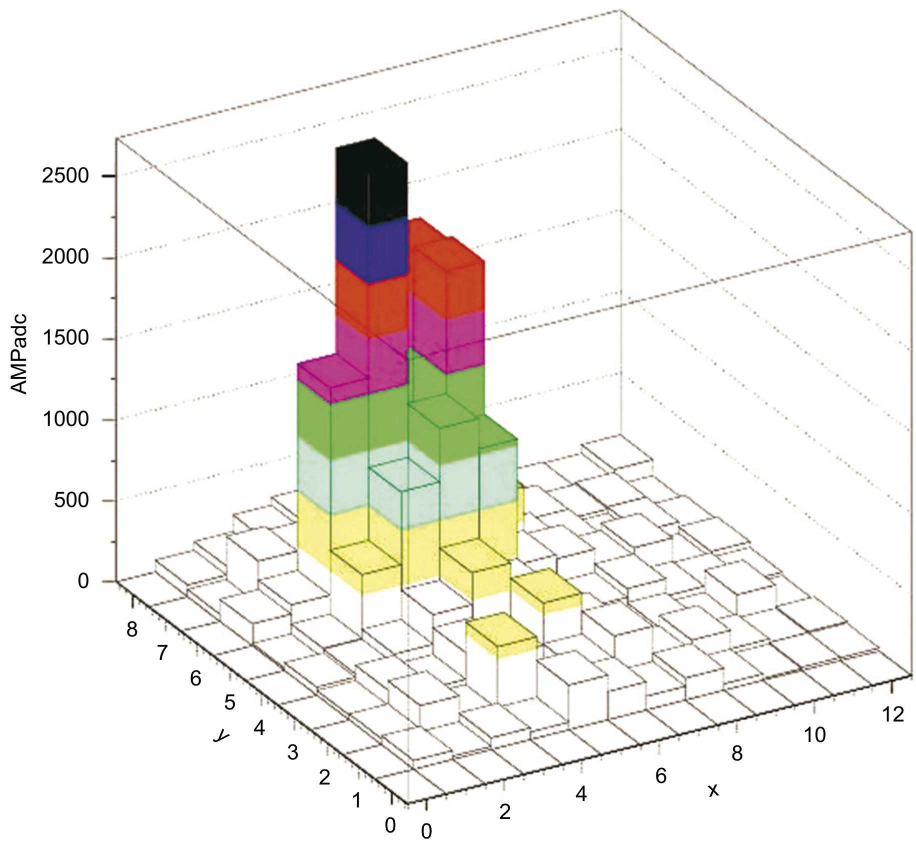

Fig. 3. Analog charge distribution on the big pads of four clusters for a fully contained event.

3. First measurements

From January till October 2004, data have been taken with a reduced setup (16 clusters, about $700\,m^2$ sensitive area) in order to optimize the operational parameters of the detector, to monitor its long-term performance and to test the off-line reconstruction algorithms. Starting from the end of 2004, the experimental setup was extended to 42 clusters (about $1900\,m^2$ sensitive area). A further extension to 104 clusters (about $4500\,m^2$) was made in February 2006.

In Fig. 2 an example of a fully contained shower is shown. The upper plot represents the space–time shape of the shower front, while the lower plot shows the hit pads on the detector plane.

A first measurement of the analog charge distribution in the events was made on four clusters (about $180\,m^2$) to test the system capabilities [5]. In Fig. 3 the charge distribution for a fully contained event is shown: the core position is clearly visible.

4. Conclusions

During the measurement sessions with a reduced area, the performance of the ARGO-YBJ detector was in good agreement with the expectations. The first results based on the collected data were presented at the International Cosmic Ray Conference in Pune, India (August 3–10, 2005) [6–10]. The completion of the detector carpet is foreseen in 2006.

References

[1] The ARGO-YBJ Collaboration, Astroparticle physics with ARGO, Technical Proposal, 1996; The ARGO-YBJ Project, Addendum to the Proposal (1998), ⟨http://argo.na.infn.it/argo_pub_artic.html⟩.

[2] R. Santonico, R. Cardarelli, Nucl. Instr. and Meth. A 377 (1981) 187;
R. Cardarelli, R. Santonico, Nucl. Instr. and Meth. A 263 (1988) 200.

[3] The ARGO-YBJ Collaboration, Layout and performance of RPCs used in the ARGO-YBJ experiment, Nucl. Instr. and Meth. A 562 (2006) 92–96.

[4] P. Camarri, et al. for the ARGO-YBJ Collaboration, Proceedings of the 29th International Cosmic Ray Conference, Pune, India, August 3–10, 2005.

[5] M. Iacovacci, et al. for the ARGO-YBJ Collaboration, Proceedings of the 29th International Cosmic Ray Conference, Pune, India, August 3–10, 2005.

[6] G. Di Sciascio, et al. for the ARGO-YBJ Collaboration, Proceedings of the 29th International Cosmic Ray Conference, Pune, India, August 3–10, 2005.

[7] S. Cui, et al. for the ARGO-YBJ Collaboration, Proceedings of the 29th International Cosmic Ray Conference, Pune, India, August 3–10, 2005.

[8] S. Vernetto, et al. for the ARGO-YBJ Collaboration, Proceedings of the 29th International Cosmic Ray Conference, Pune, India, August 3–10, 2005.

[9] T. Di Girolamo, et al. for the ARGO-YBJ Collaboration, Proceedings of the 29th International Cosmic Ray Conference, Pune, India, August 3–10, 2005.

[10] Z. Cao for the ARGO-YBJ Collaboration, Proceedings of the 29th International Cosmic Ray Conference, Pune, India, August 3–10, 2005.