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Measurement of the CR primary spectrum with ARGO-YBJ

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Summary. — The study of cosmic rays below 10^{15} eV is one of the main goals of the ARGO-YBJ experiment. In this paper we will report on the measurement of the primary light component spectrum.

PACS 96.50.sb – Composition, energy spectra and interactions.
PACS 96.50.sd – Extensive air showers.

1. – The ARGO-YBJ experiment

The detector, located at the Yangbajing Cosmic Ray Laboratory (Tibet, 4300 m a.s.l., 606 g/cm^2), is composed of a central carpet large $\sim 74 \times 78\,\text{m}^2$, made of a single layer of Resistive Plate Chambers (RPCs) with $\sim 93\%$ of active area, enclosed by a guard ring partially ($\sim 20\%$) instrumented up to $\sim 100 \times 110\,\text{m}^2$. Each chamber is read by 80 external strips of dimension $6.75 \times 61.8\,\text{cm}^2$ (the spatial pixels), logically organized in 10 independent pads of area $55.6 \times 61.8\,\text{cm}^2$ which represent the time pixels of the detector. The whole system is in stable data taking with the full apparatus since Nov. 2007 with a duty cycle $\geq 85\%$. The reconstruction algorithms and the detector performance are described in Bartoli *et al.* [1].

2. – Measurement of the size spectrum

The analysis reported in this paper refers to a sample of data of about 250 days in 2009. The events are selected as follow: 1) reconstructed zenith angle $< 15°$, 2) reconstructed shower core position inside a fiducial area $A_{fid} = 40 \times 40\,\text{m}^2$ centered on the detector. Corrections to the measured rate for the barometric effect and for the instrumental response are taken into account. To calculate the extimed rate, the effective areas $A_{eff}(E, > N_s)$ have been determined with the CORSIKA/QGSJET code, while the experimental conditions have been taken into account via a GEANT3-based code. The effective areas are folded with different energy spectrum, obtaining the expected rates shown in fig. 1. The median energy for proton- (helium-) induced showers

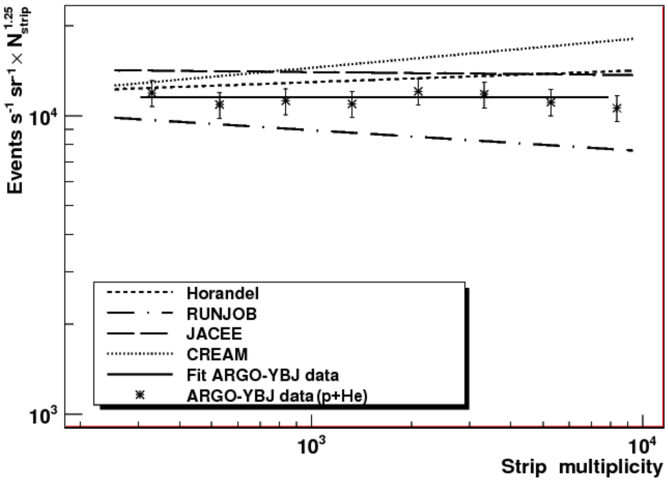

Fig. 1. – Comparison between the experimental data (stars) and the differential expected rates according to different spectra. The solid line is the best fit to data (see text for details).

ranges from 4.5 (9) TeV up to 56 (90) TeV. For example, the relative fractions (in % of the total) $R_P/R_{He}/R_{CNO}/R_{heavy}$ are 67.6/28.2/2.7/0.7 in the first multiplicity bin and 51.2/40.4/5.4/2.4 in the last multiplicity bin for CREAM-like spectra. Below 100 TeV, we select a sample of events mainly induced by proton and helium primaries. The contribution of the heavier nuclei is less than 10%, accordinh to TRACER data.

To obtain the light (p + He) component spectrum, we subtracted from the data the contribution of heavier elements, calculated with TRACER spectra. The best fit for the results reported in fig. 1 gives the following spectral indices: 1.25 ± 0.03 for data (solid line), 1.21 ± 0.03 for Hörandel spectrum (short-dashed line), 1.32 ± 0.03 for RUNJOB spectrum (dot-dashed line), 1.26 ± 0.02 for JACEE spectrum (long-dashed line) and 1.15 ± 0.03 for CREAM spectrum (dotted line). A different approach, using Bayesian unfolding procedure, has been used by the ARGO-YBJ collaboration to calculate the light component energy spectrum below 100 TeV in [2]. For the first time a ground-based measurement of the CR light component spectrum overlaps data obtained with direct methods for more than one energy decade, thus providing a solid anchorage to the CR primary spectrum measurements in the knee region carried out by EAS arrays.

REFERENCES

[1] Bartoli B. *et al.*, *Phys. Rev. D*, **84** (2011) 022003.
[2] Bartoli B. *et al.*, *Phys. Rev. D*, **85** (2012) 092005.