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Supplemental figures for
Study of cosmic ray events with high muon multiplicity using the ALICE
detector at the CERN Large Hadron Collider

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Abstract

This note contains additional figures for the analysis of the cosmic ray data taken in the period 2010-2013 and published in [1]. The angular distribution of the muons crossing the TPC gives a description of the environment above the ALICE detector with its main shafts. The location of the five high muon multiplicity events found in the data, i.e., events with more than 100 muons reconstructed in the TPC, is given in the scatter plot θ (zenith angle) vs Φ (azimuth angle).

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1 Angular distribution of the muons

To obtain a sort of radiography of the ALICE environment and investigate the effects of the main access shafts on the distribution of cosmic muons seen by our experiment, we have used a large sample of data, in which most of the events are single muon events. With this sample we have studied the angular distribution of the muons reconstructed in the TPC.

An illustration of the ALICE environment at underground level, with the tunnels and the access shafts at Point 2, is given in the scheme of Fig. 1 taken from an LHC Design Report [2], in which the reference system used for cosmic events with zenith angle (θ) and azimuth angle (Φ) is also shown. Fig. 2 depicts the θ vs Φ scatter plot of the arrival direction of the muons detected with the data.

Shaft PM25 is located at $\Phi = 0^\circ$ and 360° while shaft PX24 is located at $\Phi = 90^\circ$, both are well visible in Fig. 2. The more distant shaft PGC2 is less visible and it is located at $\Phi = 270^\circ$.

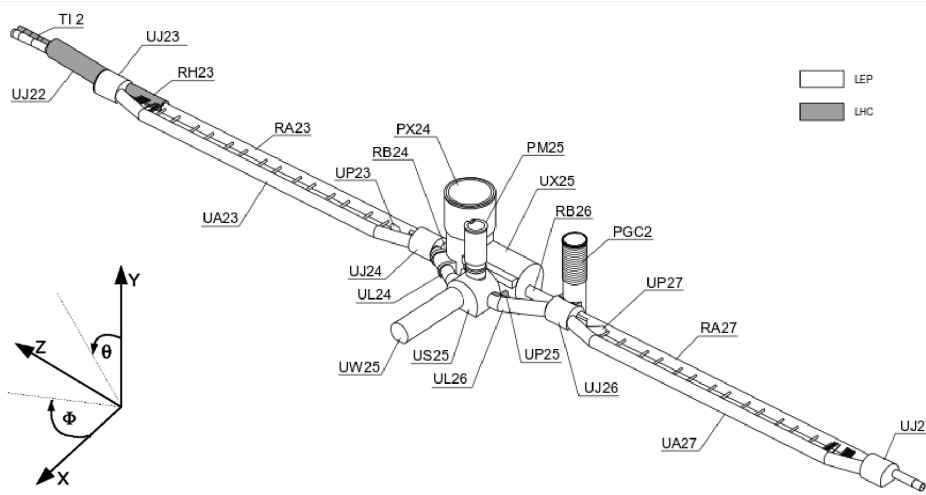


Fig. 1: Layout of Point 2 at underground level.

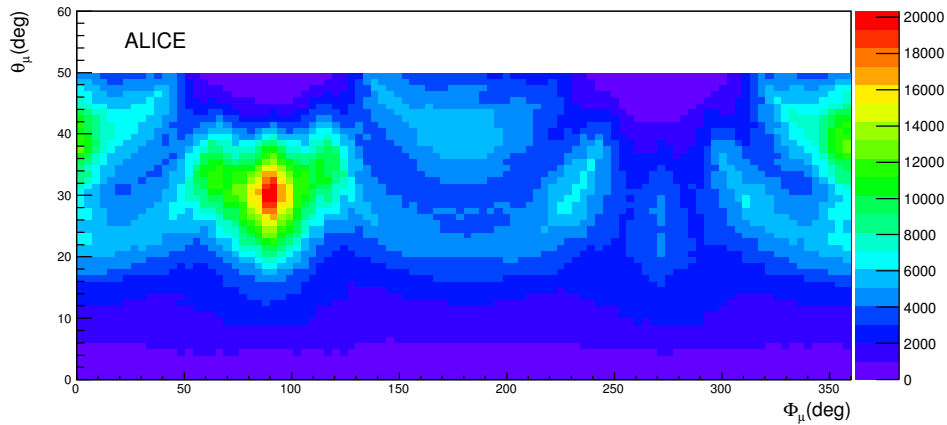


Fig. 2: Zenith vs Azimuth angle distribution of the muons in ALICE (Data).

The same distribution with the location of the five high muon multiplicity events ($N_\mu > 100$) (white circle on a black square) is shown in Fig. 3.

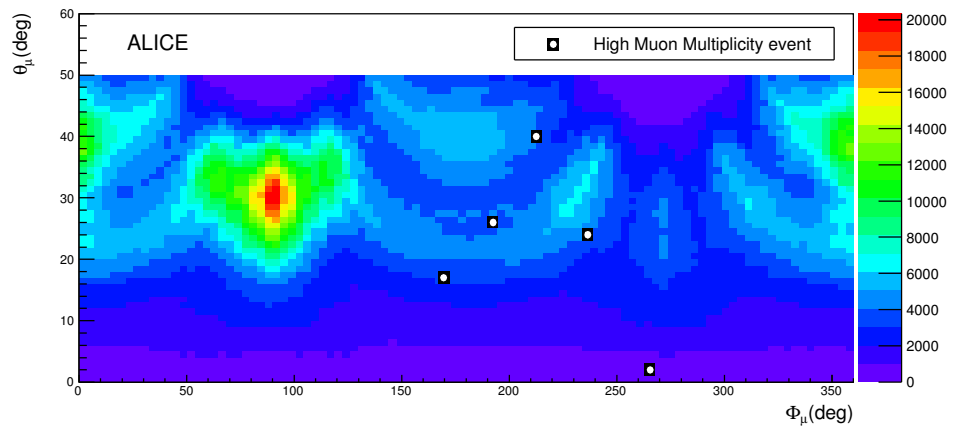


Fig. 3: Zenith vs Azimuth angle distribution of the muons in ALICE with superimposed the location of the five high muon multiplicity events (white circle on a black square).

References

- [1] ALICE Collaboration, J. Adam *et al.*, “Study of cosmic ray events with high muon multiplicity using the ALICE detector at the CERN Large Hadron Collider,” *JCAP* **1601** no. 01, (2016) 032, arXiv:1507.07577 [astro-ph.HE].
- [2] O. Bruning, P. Collier, P. Lebrun, S. Myers, R. Ostojic, J. Poole, and P. Proudlock, “LHC Design Report. 2. The LHC infrastructure and general services,” *CERN-2004-003-V-2* (2004). <http://cds.cern.ch/record/815187>.