EAS muons from Strange Quark Matter

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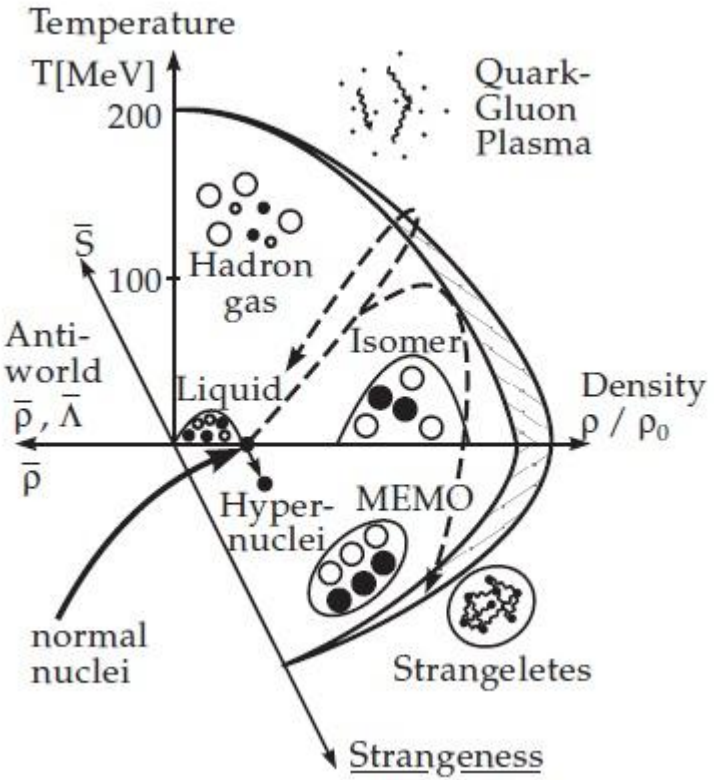
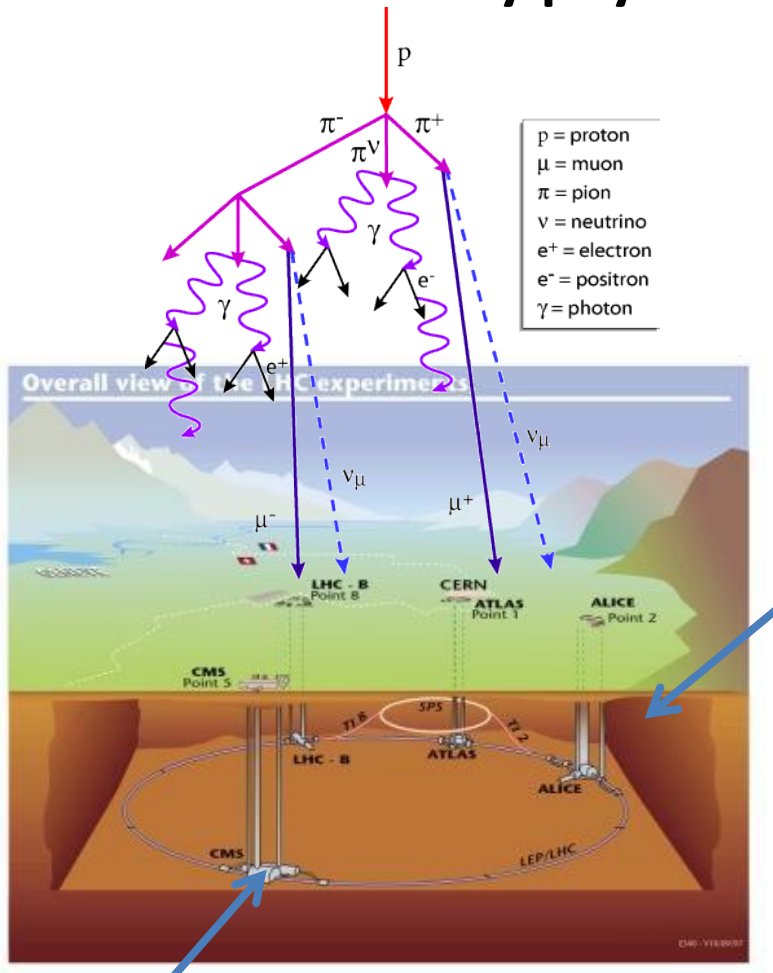
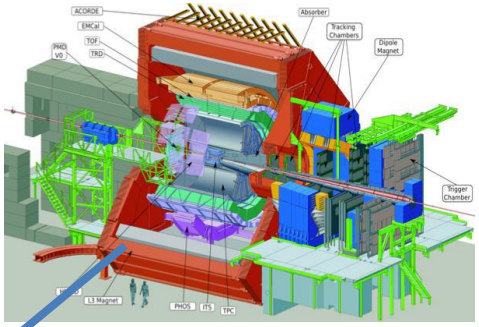
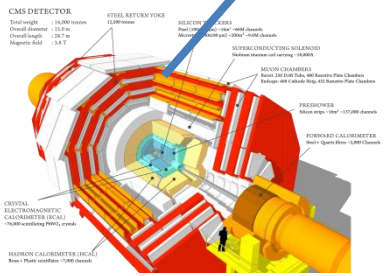


XLVI ISMD, Aug. 29 – Sep. 2, 2016, Seogwipo, Jeju Island

Cosmic ray physics with CERN experiments







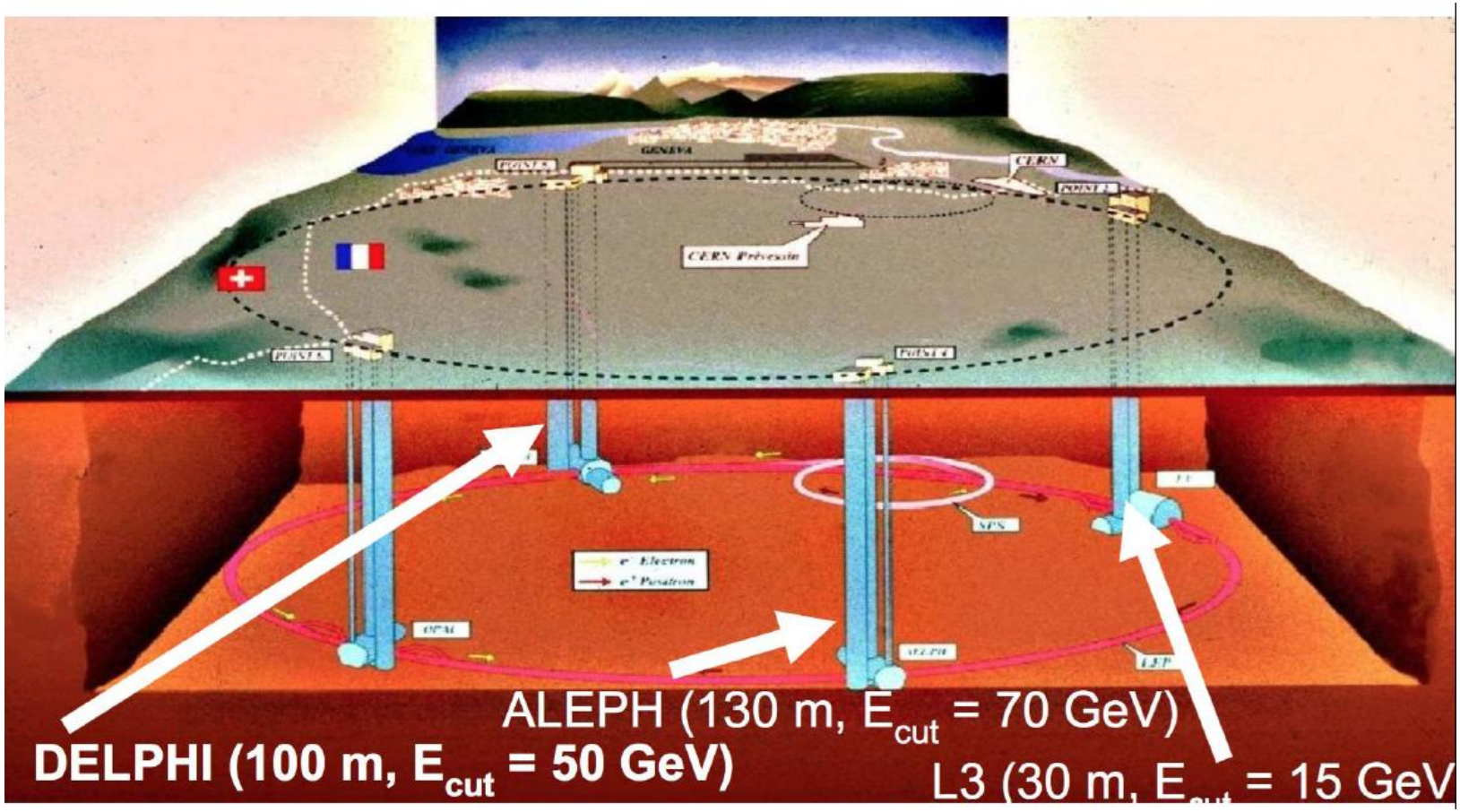
- ✓Small detectors with respect to EAS experimets
- ✓ Low underground
- ✓ Detection of muons (only!) crossing the rock
- ✓ Short time of data taking

These detectors are not designed to cosmic ray physics!

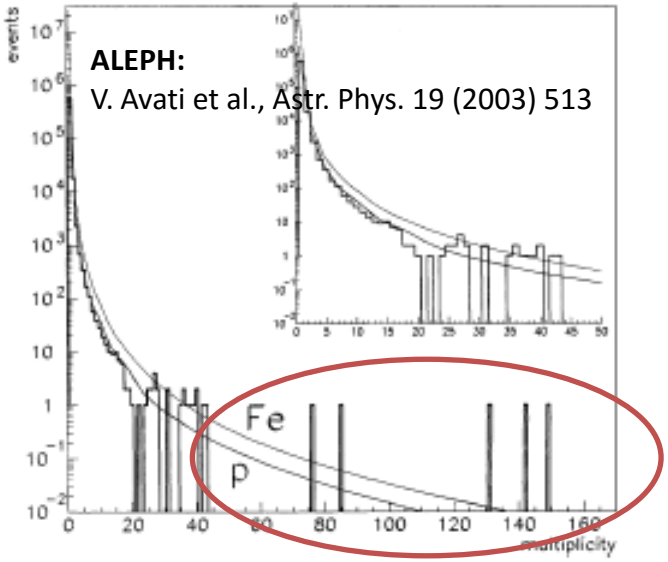
Advantages:

- Detectors with very high performance
- Presence of magnetic field

Detection of CR by CERN LEP experiments

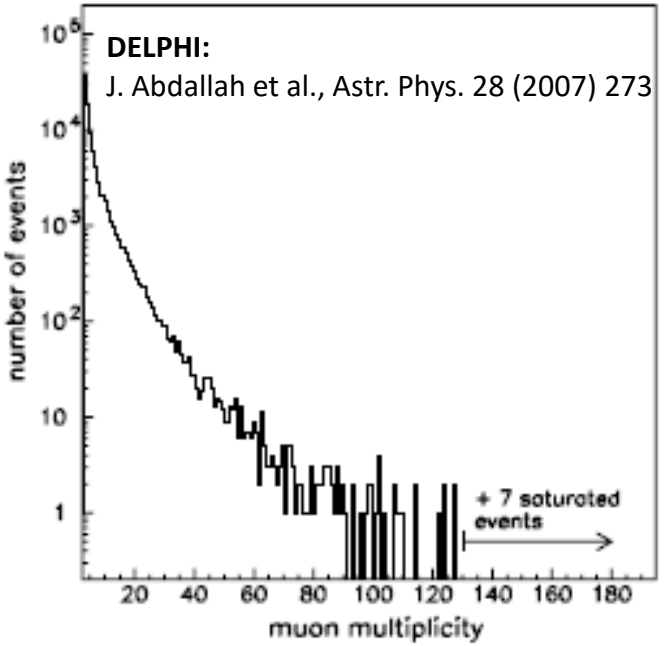


LEP: Muon multiplicity spectra



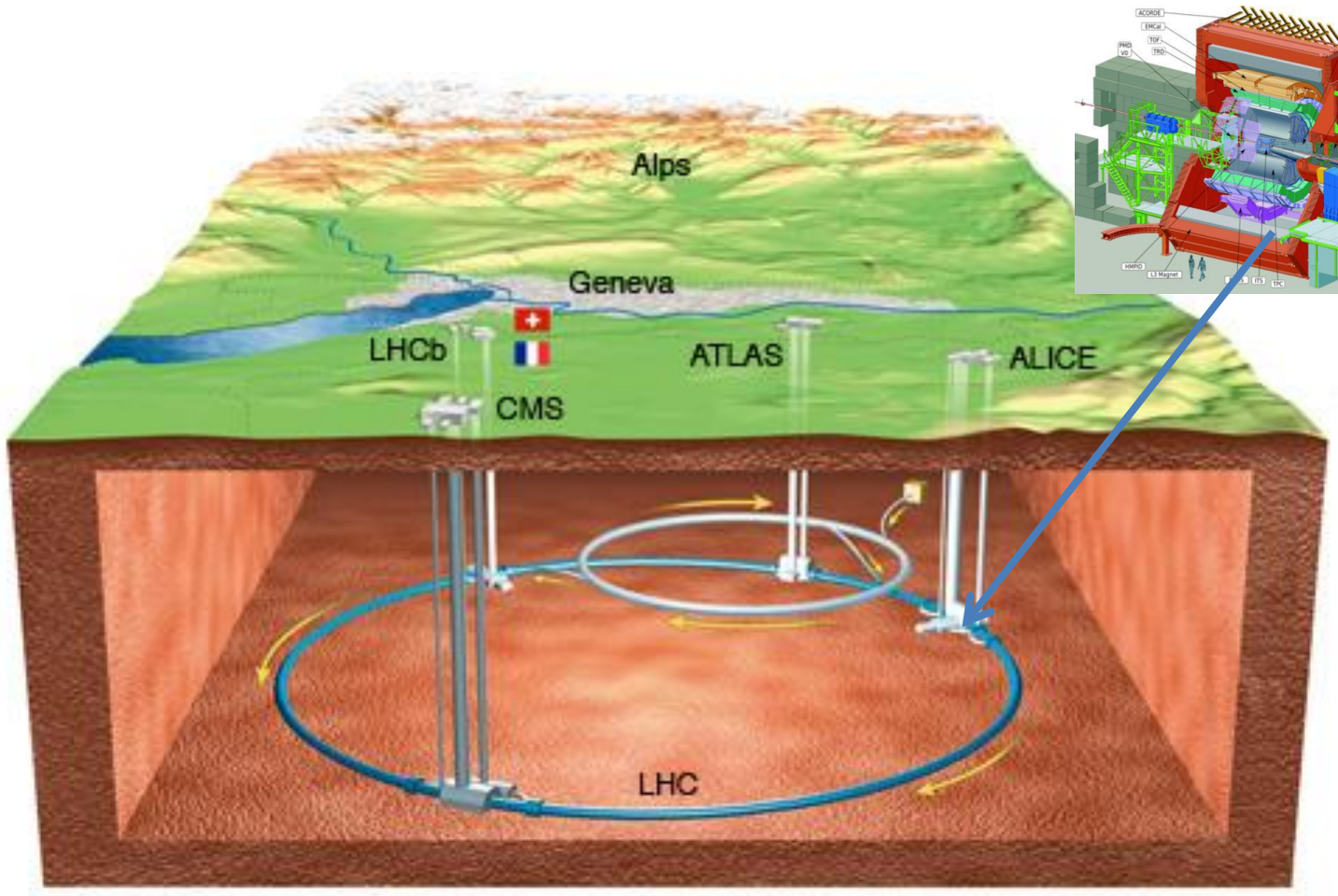
Data indicate that heavier component is needed to explain higher multiplicity muon bundles
These muon bundles are not well described (almost an order of magnitude above the simulation).

The conclusion is similar to ALEPH:
However, even the combination of extreme assumptions of highest measured flux value and pure iron spectrum fails to describe the abundance of high multiplicity muon groups.



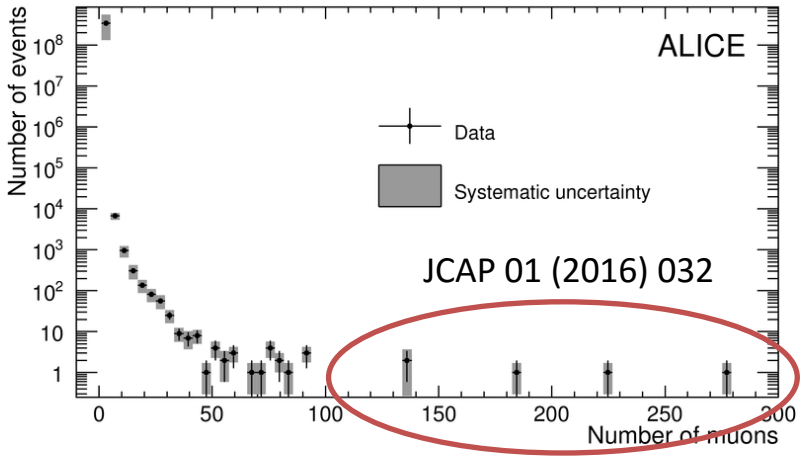
The only one result from LEP that did not agree "perfectly" with the Standard Model was the observation of high multiplicity muon groups in cosmic events (muon bundles).

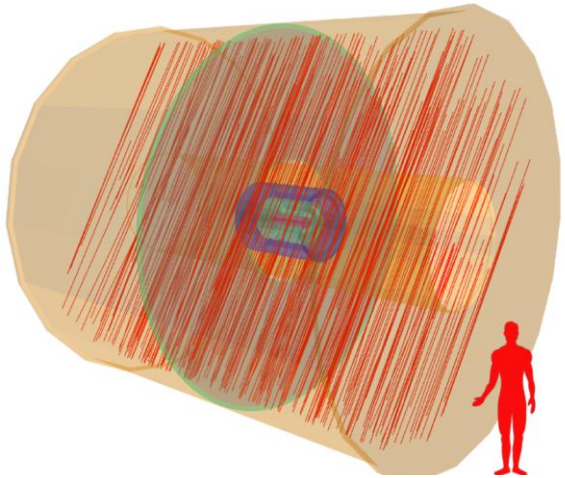
Detection of CR by the LHC ALICE experiment



ALICE is located 40 m underground
- 30 m of rock (molasse)
- 10 m of air

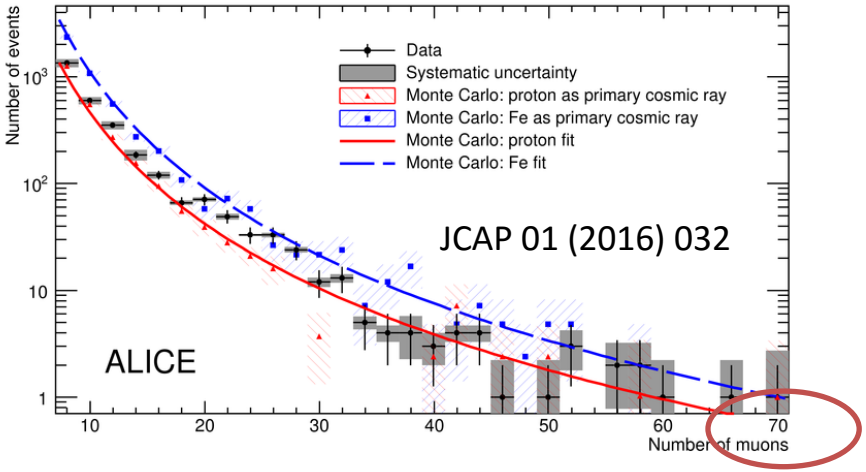
Recently the ALICE experiment has been used to perform studies that are of relevance to astro-particle physics.





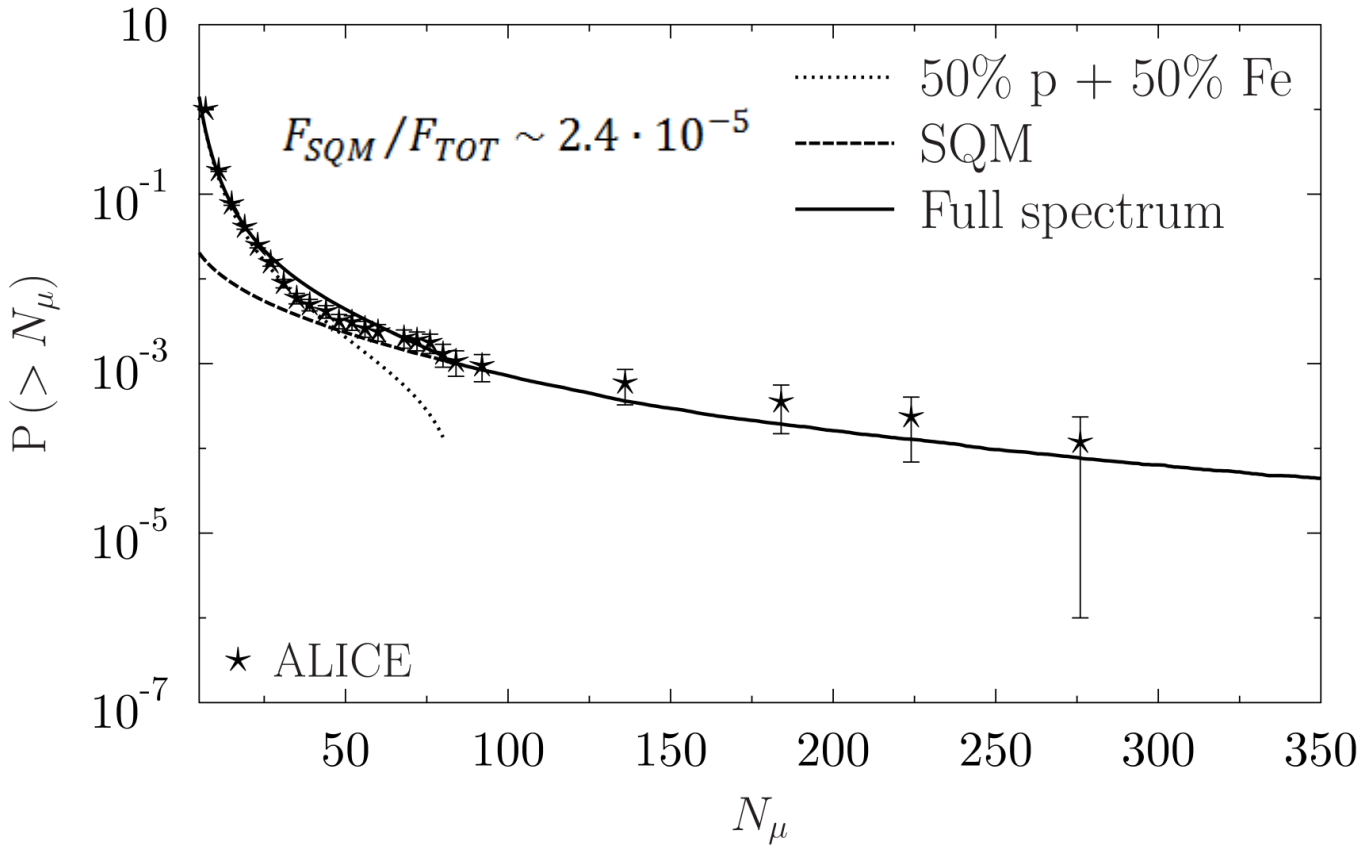
$0° < \Theta < 50°$

$E_\mu > 16\ \mathrm{GeV}/\cos\Theta$



ALICE experiment registered the presence of large groups of muons produced in EAS by cosmic ray interactions in the upper atmosphere.

High multiplicity muon bundles from Strange Quark Matter



Integral multiplicity distribution of muons for the ALICE data (stars) published in JCAP 01 (2016) 032. Monte Carlo simulations for primary nuclei composed with 50% of protons and 50% of iron nuclei (dotted line) and for primary SQM with mass A taken from the $A^{-7.5}$ distribution (broken line). Full line shows the summary (calculated) distribution.

More details at the Poster

Conclusions

✓Accelerator apparata can be suitable for cosmic-ray physics.

✓ The measured by the CERN ALICE experiment low multiplicities of muon groups favor light nuclei as primaries, medium multiplicities show tend to heavier primaries.

✓ At high multiplicities of muon groups the common interaction models fail to describe muon bundles.

✓ A relatively small (of the order of 10^{-5} of total primary flux) admixture of SQM of the same total energy allows to reproduce the high muon multiplicity groups.

✓ Our estimate of SQM flux do not contradict the results obtained recently by the SLIM Collaboration, Z. Sahnoun et al., Radiat. Meas. 44, 894 (2009).

More details at the Poster