COSMIC RAY STUDIES WITH ALICE DETECTORS

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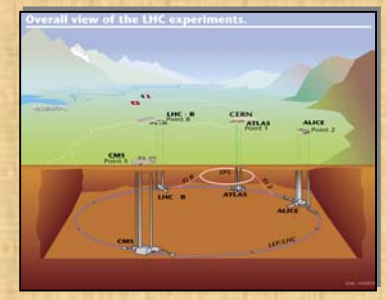


ALICE is located underground with 30 m of overburden rock. Only atmospheric muons with energy E_μ > 15 GeV can reach the experiment.

For each event triggered by ACORDE it is possible to measure :
- The muon multiplicity ; Number of muons crossing the TPC
- Muon direction, charge sign and finally energy

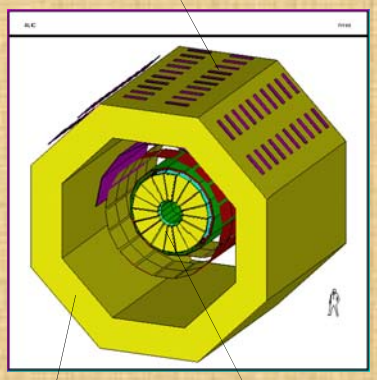
The momentum resolution of the muons improves with the magnetic field strength B in the central detectors. At B = 0.5 T $\Delta p/p$ = 30% for p_μ = 500 GeV/c.

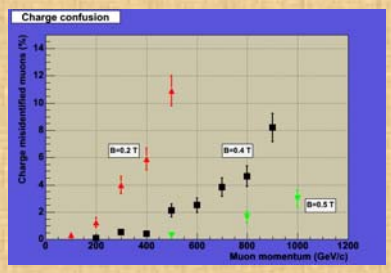
ALICE setup, includes the ACORDE (trigger system) on top of the magnet.
The TPC is the main detector to track atmospheric muons.
The TRD and the TOF can be used to improve the event information.

Main physics topics that can be addressed with ALICE detectors as stand alone are :
- Inclusive muon spectrum
- Charge ratio μ^+/μ^-
- Muon bundles
- Antiproton flux limits at TeV energies

The performances of the TPC allow to detect a very high density of muons up to ρ_μ = 200 μ/m^2.
The momentum of each muon can be measured with good resolution up to the TeV energy with a small percentage of misidentified charge sign.

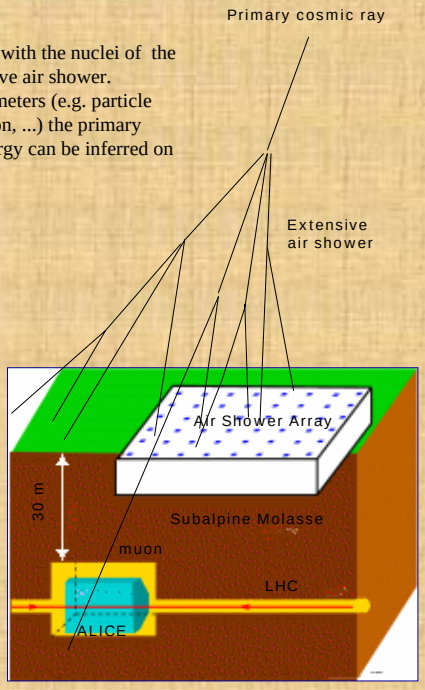
ACORDE, the proposed trigger system, is an array of 60 scintillator modules located on the three top octants of the magnet. They give the trigger signal when atmospheric muons cross the ALICE detectors.





Muon charge sign misidentification for different values of the magnetic field B.

The primary cosmic ray interacts with the nuclei of the atmosphere generating an extensive air shower. Measuring some air shower parameters (e.g. particle type, direction, density distribution, ...) the primary cosmic ray mass number and energy can be inferred on a statistical base.



The Air Shower Array located above ALICE actually operating with 50 counters can measure :
- The number of charged particles called the size N_e
- The location of the core of the shower (x_c,y_c)
- The direction of the shower (θ,ϕ)

The size Ne is an observable that gives information of the energy E of the primary cosmic ray. The core and the direction of the shower give the location of the primary.

Correlated events, namely events detected both from the Shower Array and from the ALICE detectors, with a very large number of measuerd observables will allow studies of cosmic ray composition in the energy range around the knee (E = 3 10^{15} eV) with new possibilities with respect the past experiments.

Summary

The underground location of the ALICE experiment, with about 30 m of overburden rock, is well suited for the detection of atmospheric muons, with energy above the threshold of E_μ=15 GeV imposed by the site. These secondary muons are generated subsequently the primary cosmic ray interaction with the nuclei of the atmosphere. Based on simulation results we propose some cosmic ray measurements with ALICE as stand alone detector, such as : the inclusive muon energy spectrum in the energy range 30 GeV - 1 TeV, the ratio μ^+/μ^- and multi-muon event rates.
The existence of an air-shower apparatus, located above ALICE on the roof of surface building, opens also the possibility of studying correlated events between ALICE and the surface apparatus.
In these events, the measurement of specific observables related to the air showers, allows for the analysis of the cosmic ray composition in the energy range around the knee (10^{14}-10^{16} eV). Many useful information on the cosmic ray propagation and acceleration mechanisms can be obtained from these studies.
The ALICE cosmic ray trigger is based on the ACORDE system, an array of 60 plastic scintillator slabs 188 x 20 cm^2, placed on the top sides of the central magnet. Its layout provides a good acceptance to carry out, with the appropriate statistics, the previous outlined physics subjects.

ACORDE