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First Results from the L3+C Experiment at CERN

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I. INTRODUCCIÓN

The L3 detector[1] at CERN's LEP accelerator is located near Geneva (6.02^0 E, 46.25^0 N) at an altitude of 450 m. L3 is underneath 30 m of molasse (15 GeV muon cutoff). High precision muon drift chambers are installed in a 1000 m^3 B-field of 0.5 T. The L3 muon spectrometer has been converted in a detector of atmospheric muons. It was done by means of an additional equipment of a "t0" detector composed by scintillators, and of an independent trigger and DAQ electronics. It has been fully operational from 1999. A small air shower array was added on surface, in correlation with the underground detector, and it is operating since April 2000.

The growing evidences for the neutrino oscillation and solar neutrino deficit make, among other, the study of the related muon flux, its energy spectrum and ratio between both charged components more and more interesting. Wide energy ranges, good filtering of the secondaries, precise momentum measurement and huge statistics can be achieved. The conjuntion with the air shower array put at reach studies of primary energy and primary composition and very forward production.

II. THE L3+C EXPERIMENT

The muon spectrometer consists in 80 drift P-chambers to measure positions in the bending plane of the magnet and 96 drift Z-chambers to measure the coordinate along the magnetic field.

The arrival time of the muons is needed to determine the drift time in the chambers. It is provided by the t0 detector,consisting on 202 m^2 of scintillators installed outside the magnetic yoke on face of three upper octants. The resultant acceptance on zenit angle is $\sim 50^0$ and the geometrical acceptance is ~ 200 m^2 sr.

The air shower detector is installed on the flat roof belonging to a building located at the surface, above L3. It is composed of 50 scintillators of size 0.5 m^2,distributed over an area of 30×54 m^2. This air shower can measure the energy and direction of atmospheric showers. The energy resolution of the air shower array is 30% for events with the core inside the array. An accuracy of $1\text{-}2^0$ on the zenith angle is expected. The L3 muon spectrometer together with the surface array constitutes the L3+C experiment.

III. PERFORMANCE AND DATA ACQUISITION

The molasse layer provides a shield against the electro-magnetic and hadronic components of the air shower. It also imposes a muon threshold of 15 GeV/c and limits the angular resolution to 0.2 degrees above 100 GeV/c. A double measurement (one on the top half and one in the bottom half of the detector) enables the determination of the resolution, which at 100 GeV/c has been found to be 7.4%. The full system performance has been determined at 45.6 GeV/c during the L3 calibrations at the peak of the Z resonance, using the $e^+e^- \rightarrow Z \rightarrow \mu^+\mu^-$ reaction. After requiring one of the muons to cross the scintillator region and the best quality for both tracks, a resolution of 5.1% in E(beam)/E(μ) has been

achieved in the 1999 calibrations. During data taking in 1999 and 2000 billion of atmoshpheric muon triggers and ~35 million air showers events were recorded.

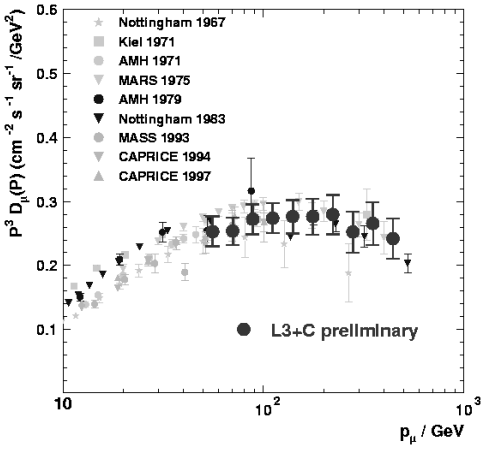

Figura 1. The differential differential and vertical flux of atmospheric muons weighted with p^3 as a function of momentum p at 450 m above sea level.

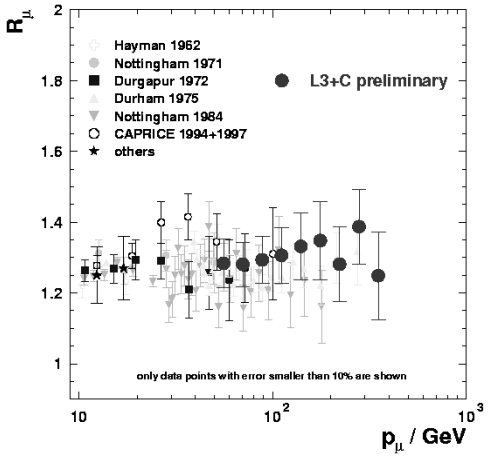

Figura 2. The muon charge as a function of momentum.

IV. FIRST RESULTS

Data from September to November of 1999 were used to determine a first muon momentum spectrum from 50 to 500 GeV/c. The total livetime used was slightly more than 30 days. Strict quality cuts have been applied among others, the need for a good measurement in both upper and lower octant separate track segments and a good match between both to build the final track. The zenith angle has been restricted to a range of 0^0 to 10^0 to measure the vertical flux. The measured flux weighted by p^3 can be seen (fig. 1) together with the results of other experiments[2]. The systematic error of 9% dominates the total error plotted. We hope to reduce the total error to 2.5% and to extend the momentum range from 20 to 2000 GeV/c. The charge ratio was calculated from the same event sample. The preliminary result can be seen (fig. 2) along with the results of other published measurements[2]. With the small sample used for the analysis up to now the statistical error is dominant at high momenta.

V. CONCLUSIONS

A new type of cosmic ray detector, L3+C combines air shower data with precise muon momentum measurements. First preliminary results on the muon spectrum and charge ratio in the range from 50 to 500 GeV/c have been presented.

Referencias

[1] Adeva B. et al,NIM, A289 (1990) 35.

[2] O.C. Allkofer *et al.*, Lett. Nuovo Cim. **12** (1975) 107; B. Baschiera *et al.*, Il Nuovo Cim. 2C (1979) 473; B.C. Rastin. J. Phys G.: Nucl. Phys. **10** (1984) 1629; M.P. De Pascale *et al.*, J. Geophys. Res. **98** (1993) 3501; J. Kremer *et al.*, Phys. Rev. Lett. **83**, 4241 (1999); Hebbeker T. and Timmermans C., A compilation of High Energy Atmospheric Muon data at Sea Level, (to be published).