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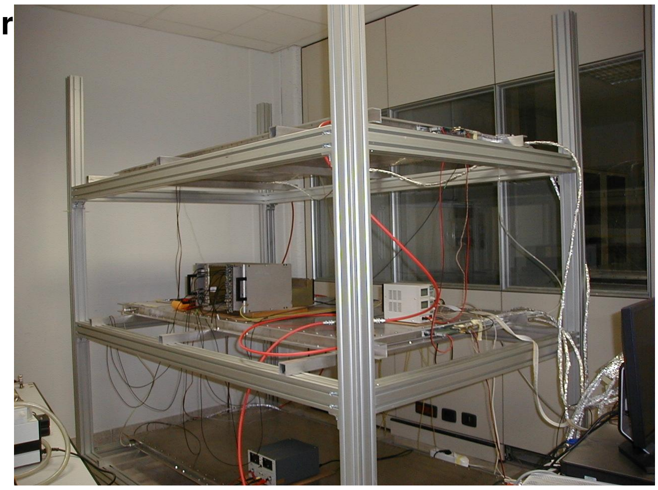
Introduction

Science education at the high school level may receive a strong support from educational projects involving students and teachers in an advanced research work, with the possibility to follow the various steps of a real scientific investigation. Cosmic ray physics is a fascinating area in this respect, since it provides several possibilities of being involved in a specific research work, yet maintaining alive its educational aspects. Along this line, several educational activities in cosmic ray physics have been exploited in our Department, in close collaboration with high school teachers and students. Such activities have been carried out over the last years with small detection systems (Geiger counters and scintillators). Since the very beginning (2005), our group has become an active member of the national Project “Extreme Energy Events” (EEE).

The EEE Project

The EEE Project is a national initiative, led by A.Zichichi, aiming at the construction and use of an extended network for cosmic ray detection in the Italian territory, to involve groups of high school teachers and students in a research work. Such Project plans to develop and install about one hundred cosmic ray telescopes. About 25 such telescopes have been already installed and most of them are taking data since last year. Catania is one of the active sites of the Project. Each site includes from one to three telescopes, distributed in the same metropolitan area, in such a way to be able to also detect extensive air showers. The telescopes, which are located inside high school institutes or University Departments, have been built at CERN by high school teams supervised by researchers and technicians.

Description of the detector



Each EEE telescope is made of 3 Multigap Resistive Plate Chambers (MRPC), with a very good spatial and time resolution, in such a way to track and reconstruct muon trajectories by the 2D information provided by each chamber. The active area of a chamber is 158 x 82 cm, with relative distances in the order of 50-80 cm. Special front-end (FE) cards provide the readout from the chambers (segmented into 24 strips). The acquisition system and control is based on VME electronics and Labview environment. The trigger unit, which has been developed in Catania, employs the 6-fold coincidences of the FE cards. The arrival of the events is time-stamped by a GPS system, with a precision of about 40 ns. The data collected by each telescope (2-5 x 10^6 events/day, a few hundred Mbytes/day) are stored on disk and transferred to a server for data exchange and analysis. The figure shows the EEE telescope actually installed and working in our Department.

The physics items of the EEE Project

Several physics topics may be addressed by the use of the EEE detectors. They include:

a) **Local scale measurements of the muon flux:** The study of the secondary muon flux at the sea level or moderate altitudes depends on various factors concerned with the Sun and the Earth atmosphere. Periodic and non-periodic time variations of the muon flux allow to investigate different physics aspects, and provide a lot of interesting educational experiments in cosmic ray physics.

b) **Detection of extensive air showers:** The correlation between the information provided by telescopes located in the same area (relative distances of 10-3000 m) allows the detection of extensive air showers, induced by a high energy primary nucleus in the atmosphere. The figure shows the simulation of an air shower induced by a 10^{16} eV proton in the metropolitan area of Catania. The use of the EEE telescopes allows to correlate the incoming orientations of the two muons, as it has been already observed for several sites, thus helping to reduce the spurious counting rate.

c) **Long-baseline correlations:** The possibility to correlate time and orientation information from telescopes located at large distances (50-1200 km) allows to also search for “exotic” events. Several mechanisms have been discussed in the past to explain the possible existence of such rare events. Among these, the photodisintegration of a heavy primary nucleus in the solar field (Gerasimova-Zatsepin effect), with the fragment deflection in the interplanetary magnetic field. A small set of data collected by several telescopes of the EEE project are already available for such analysis.

GRUPPO DI RICERCA

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