

Executive Summary – Outreach and educational activities within the EEE cosmic ray network

The Extreme Energy Events (EEE) project consists in a large array of particle detectors installed in Italian high-school buildings and physics laboratories spanning an area of more than 10^5 km², from CERN to Sicily. The experiment aims to study cosmic radiation by detecting and tracking the muon component of the Extensive Air Showers (EASs) produced by the interaction of high energy primary cosmic rays in the Earth atmosphere. The project has a large educational impact, with the involvement of thousands of students and high-school teachers every year. The detectors of the network are made of three Multigap Resistive Plate Chambers (MRPCs), that have been built at CERN by high-school teams under the supervision of EEE researchers.

The very good performance of the EEE detectors allows a large physics program, with the aim to investigate several aspects of the secondary muon flux, including the search for anisotropies of the secondary component at the sub-TeV scale, the extensive air showers detection, the measurement of upward-going particles, the long distance correlation studies among detectors located hundred kilometres apart, several performance and simulation tools developments, the study of solar phenomena (such as the Forbush decreases), and also several applications of cosmic ray physics. However, the milestone of the EEE activity is its educational mission. Indeed, the EEE project aims to provide a full research experience to high-school students, involving them in all the relevant steps of the experiment. Students and teachers build the MRPCs at CERN, under the supervision of EEE researchers. After the assembly of the chambers, the telescopes are sent and installed in Italian high-schools, where students and teachers take care of the commissioning of the station and of the start of data taking operations. Finally, students are responsible for the daily monitoring, reporting data acquisition conditions into an online e-log (reporting weather parameters, HV and current settings, acquisition rate, etc.), and take care of the maintenance of the telescopes. Analyzing data, comparing and discussing results with other high-school fellows allow the students a glimpse of how professional scientific research works.

Data taking is organized in Runs which follow the school year, from October to June. In the last years, over a hundred billion events have been collected. Since 2017, the EEE network has undergone an upgrade process, which includes the construction of over 50 new chambers, with 250 μ m gaps that allow a lower operating voltage, and the test for new eco-friendly gas mixtures for the MRPCs.

All the students of the project are involved in several meetings and conferences. On a monthly basis, students attend a Run Coordination Meeting, in which they can present updates on the ongoing analyses and discuss tests and detector updates. Every six months, students and teachers involved in the project are invited to conferences usually held at Ettore Majorana Foundation And Centre For Scientific Culture in Erice (Sicily), where masterclasses, measurement campaigns and general lectures on cosmic ray physics are organized. During such occasions, students have also the possibility to take part to experiments with atmospheric muons.

The students of the project are involved in many local and international outreach activities, such as the International Cosmic Day (ICD) or the European Researcher's Night (ERN), with the aim of heighten young people's interest in a career in science. Specifically, in November students take part to the ICD, which is an outreach event for astroparticle physics organized by DESY in cooperation with Netzwerk Teilchenwelt, IPPOG, QuarkNet, Fermilab, INFN and Centro Fermi. During this day, groups of high-school students and teachers meet scientists to learn about cosmic rays and perform together an experiment with cosmic particles. The students are pushed to work together like in an international collaboration, discussing their results in joint video conferences where scientists give lectures providing an insight into the current astroparticle physics research.