T 145: Cosmic Ray VIII

Time: Thursday 17:30–19:00 Location: POT/0351

T 145.1 Thu 17:30 POT/0351

Status of the production and calibration of the scintillation detectors for the IceCube Surface Array Enhancement — •Shefali Shefali for the IceCube-Collaboration — Institut für Astroteilchenphysik, Karlsruher Institut für Technologie (KIT), Karlsruhe, Germany

The surface array of IceCube, IceTop, operates as a veto for the astrophysical neutrino searches, as a calibration detector for the IceCube in-ice instrumentation, as well as a cosmic ray detector. However, the snow accumulation on top of these detectors results in an increased uncertainty in the number of detected particles and consequently, the air shower reconstruction. Enhancing IceTop with a hybrid array of scintillation detectors and radio antennas will lower the energy threshold for air-shower measurements, provide more efficient veto capabilities, enable the separation of the electromagnetic and muonic shower components and improve the detector calibration by compensating for snow accumulation. After the initial commissioning period, a prototype station at the South Pole has been recording air shower data and has successfully observed coincident events with the IceTop array. The production and calibration of the scintillation detectors for the full array has been ongoing. Additionally, one station each at Pierre Auger Observatory and Telescope Array have been installed for R&D of these detectors in different environmental conditions. This contribution will present the status of the scintillation detectors for the IceCube Surface Array Enhancement.

T 145.2 Thu 17:45 POT/0351

A new approach for the reconstruction of low-energy air showers at the IceCube Neutrino Observatory — •Federico Bontempo for the IceCube-Collaboration — Karlsruhe Institute of Technology, Institute for Astroparticle Physics, 76021 Karlsruhe, Germany

The IceCube Neutrino Observatory is an experiment located at the geographic South Pole. It is composed of two detectors: an array of ice-Cherenkov tanks at the surface called IceTop and an optical array deep in the ice. The combination of the two detectors can be exploited for the study of cosmic rays. This work will primarily focus on the IceTop response, mainly dominated by the electromagnetic component of cosmic-ray air showers, with the goal of developing a new reconstruction technique for low energy air-showers. Some preliminary plots of the reconstructed quantities will be shown, like the energy proxy, zenith and azimuth angle or core position.

T 145.3 Thu 18:00 POT/0351

A Two Component Lateral Distribution Function for the Reconstruction of Air-Shower Events with IceCube — •Mark Weyrauch for the IceCube-Collaboration — Karlsruhe Institute of Technology

The IceCube Neutrino Observatory, located at the geographic South Pole, consists of a surface detector comprised of ice-Cherenkov tanks, IceTop, and an optical in-ice array. With this combination, IceCube provides the unique possibility to perform coincident measurements of the low-energy ($\sim$ GeV) and high-energy ($\gtrsim 400\,\mathrm{GeV}$) muon component in cosmic-ray air shower events. Since IceTop does not feature dedicated muon detectors, an estimation of the GeV muon component on basis of individual air showers is challenging. However, an event-by-event GeV muon estimator can constitute a useful tool for, amongst others, cosmic ray composition analyses and, in combination with the TeV muon component, strongly constrain hadronic interaction models. One possibility for an event-by-event estimation of low-energy muons is given by the Two Component Lateral Distribution Function (Two Component LDF), combining an analytical description for the electromagnetic and muon lateral distribution of the full detector signal. In this talk, I will discuss the main principle of the Two Component LDF and present first results of the reconstruction of simulated air-shower events.

T 145.4 Thu 18:15 POT/0351

Measurement and reconstruction of laser shots of the Aeolus satellite in the Pierre Auger Observatory — •Felix Knapp for the Pierre Auger-Collaboration — Karlsruher Institut für Technologie

The Pierre Auger Observatory is a large-scale experiment for the detection of ultra-high-energy cosmic rays. To this end, a combination of surface detectors as well as fluorescence telescopes is used to measure extensive air showers initiated by cosmic-ray particles in the atmosphere. Aeolus is a satellite, operated by the ESA, with the purpose of measuring global wind profiles. To achieve this, it uses a UV-lidar which emits laser beams towards the surface of the Earth. When the satellite passes over the Pierre Auger Observatory, light scatters off the laser beam in the atmosphere which can be detected by the Fluorescence Detector. The laser data taken by the Observatory allowed for a reconstruction of the laser tracks for several overpasses each year since its first appearance in 2019. The reconstructed laser tracks provide an interesting approach to study the aerosol content of the atmosphere above the Observatory, as well as a novel way to perform ground-truthing for space-based lidards.

In this presentation, we will explain the methods used to reconstruct laser tracks from the Fluorescence Detector data, show some results of this reconstruction and introduce a possible application of the data for the measurement of aerosols.

T 145.5 Thu 18:30 POT/0351

Radio Interferometry for extensive air showers using Information Field Theory — •Matthias Boddenberg, Martin Erdmann, Maximilian Straub, and Alex Reuzki for the Pierre Auger-Collaboration — III. Physikalisches Institut A, RWTH Aachen University

Ultra-high-energy cosmic rays induce extensive air showers (EAS) in the Earth's atmosphere. During its propagation through the atmosphere, radio waves are emitted by to the geomagnetic effect and the Askaryan effect, which can be observed by the ground based antenna array at the Pierre Auger Observatory.

In this contribution we apply an interferometry method for extensive air showers and and show its potential use in deriving the depth of shower maximum and the arrival direction of the cosmic ray. We will present a method to reconstruct the location of a point source in the atmosphere. Furthermore we discuss the impact of antenna positions and noise on the radio traces on the location reconstruction.

Finally, we will show an alternative interferometry method for the reconstruction using information field theory (IFT) and discuss its potential uses.

T 145.6 Thu 18:45 POT/0351

Nanosecond time synchronisation with GNNS antennas for application in autonomous astroparticle physics detectors. — •Qader Dorosti[1], Markus Cristinziani[1], Stefan Heidbrink[2], Noah Siegemund[1], Jens Winter[2], and Michael Ziolkowski[2] — [1]Center for Particle Physics Siegen, Experimentelle Astroteilchenphysik, Universität Siegen — [2]Elektronikentwicklungslabor des Departments Physik, Universität Siegen

The new generation of commercially available navigation satellite receivers, known as highly accurate multi-band GNSS timing modules, are designed to meet the requirements of the 5G mobile standard. They can achieve local time synchronisation with an accuracy of 5 ns (1 sigma) with respect to the Universal Time Clock. This accuracy is obtained by exploiting a dual-frequency technique that effectively compensates for the dominant source of error in signal propagation through the ionosphere without the need for additional correction data. The stricter requirements for the future mobile radio standard 6G will lead to a further significant improvement in time synchronisation with an expected accuracy of less than 1 ns. This is relevant for the instrumentation of future astrophysical experiments and is being pursued by our group through the testing and evaluation of novel GNSS products in the field. Here we present our investigations on the latest multi-band GNSS receivers, where we achieved time synchronisation of clock signals of 3.5 ns from two GNSS receivers operating 40 m apart for several hours. Strategies for improving performance will be discussed.