T 17: Cosmic Ray I

Time: Monday 16:30–18:00 Location: POT/0013

T 17.1 Mon 16:30 POT/0013

Radio emission-mechanism of horizontal air showers measured with AERA at the Pierre Auger Observatory* — •Rukije Uzeiroska for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal, Germany

The Pierre Auger Observatory is the world's largest detector measuring ultra high energy cosmic rays. The Auger Engineering Radio Array (AERA) is an ensemble of 153 antennas each with two polarization directions covering an area of 17 km^2 in order to detect the radio signal of the extensive air showers. These radio emissions consists of two components: the geomagnetic and the charge-excess emission. They can be disentangled by measuring the direction of the electric field vector. This talk presents current efforts to determine the relative contributions of these two processes using the polarisation pattern of the antenna stations for events measured with AERA, which helps to understand the development of air showers.

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T 17.2 Mon 16:45 POT/0013

Directional Calibration of radio antennas by using a drone emitter and information field theory for interpolating measured data at the Pierre Auger Observatory — Matthias Boddenberg, Martin Erdmann, •Alex Reuzki, and Maximilian Straub — III. Physikalisches Institut A, RWTH Aachen University

Ultra-high-energy cosmic rays in the Earth's atmosphere induce extensive air showers. At the Pierre Auger Observatory those air showers are measured using various detection techniques including the type of Short Aperiodic Loaded Loop Antennas (SALLA) as part of the AugerPrime upgrade.

SALLA antennas have been calibrated in a limited solid angle using the galactic background together with simulations. Here we introduce a recently started drone campaign to enable the relative directional calibration over the full sphere. Following pilot measurements with a small drone, we use a well defined biconical antenna mounted to a sizable drone. With that we will be able extract the antenna pattern from any direction and distance. Furthermore we will use an additional GPS unit to measure the drone's position to cm accuracy such that the positional uncertainty is strongly reduced.

Finally we will interpolate the discrete measurements using information field theory (IFT) to obtain the full antenna pattern for all directions and frequencies.

T 17.3 Mon 17:00 POT/0013

Development of a Signal Model for the Radio Emission of Inclined Air Showers for GRAND — •Lukas Gülzow, Jelena Petereit, Tim Huege, and Markus Roth — Karlsruhe Institute of Technology (KIT), Institute for Experimental Particle Physics, Karlsruhe, Germany

Ultra-high energy (UHE) neutrinos induce particle cascades in the atmosphere after interacting with the Earth's crust. With its unprecedented sensitivity, the Giant Radio Array for Neutrino Detection (GRAND) will be able to consistently detect the radio signals emitted by extensive air showers caused by UHE neutrinos and UHE cosmic rays. GRAND plans to cover a detection area of 200 000 km^2 with a spacing of one radio antenna per square kilometre. The radio array will be optimised for the detection of inclined air showers and cover a wide frequency band from 50 to 200 MHz. In contrast to existing arrays, GRAND will operate autonomously, i.e. on radio events alone, hence efficient radio triggering techniques need to be developed.

We use CORSIKA air-shower simulations to develop a more advanced signal model of the radio emission with an emphasis on the high frequencies GRAND will utilise. The model will be instrumental for the development of the novel autonomous trigger* as well event reconstruction for large-scale detector systems.

This talk gives an overview on the radio emission of extensive air showers, the details of the signal model, and how it can be used for trigger development and event reconstruction.

* *NUTRIG project, ANR-DFG Funding Programme (HU 1830/6-1)*

T 17.4 Mon 17:15 POT/0013

Cosmic ray radio detection with the IceCube Surface Array Enhancement — •Megha Venugopal for the IceCube-Collaboration — Institute of Astroparticle Physics (IAP), Karlsruhe Institute of Technology, Germany

The IceCube Neutrino Observatory has been recording neutrino events and cosmic rays at the South Pole for more than a decade. The cosmic ray observatory of this experiment, IceTop with 162 Cherenkov tanks, has played an important part in understanding the high-energy universe. A Surface Array Enhancement(SAE), made up of scintillators and radio antennas, is planned to address the rising uncertainties from IceTop measurements due to snow accumulation and to improve measurement capabilities. A prototype station was deployed in January 2020 and has taken measurements which have been correlated with reconstructed events from IceTop. This contribution focuses on the current status of radio detection of cosmic rays at the SAE. The calibration and characterization of hardware components were performed and prepared for deployment. Reconstruction of Xmax, the atmospheric depth of the shower maximum, was done with initial measurements and with data from IceTop. The main goal is to characterize uncertainties and to prepare the experiment to do physics.

T 17.5 Mon 17:30 POT/0013

A new approach to efficiency estimation of radio arrays — •Vladimir Lenok — Bielefeld University, Germany

The progress of in the field of radio detection of air showers in the last decades paved the way for the large-scale radio observatories of cosmic rays and neutrinos. One of the remaining challenges regarding this kind of instrumentation is estimation of their efficiency, which is a complicated problem due to high computational complexity of the required large Monte-Carlo libraries. We developed a new approach to this problem that is based on explicit probabilistic treatment or each of the components of the detection process. With this approach we built an efficiency model for the Tunka-Rex radio array as for example. The model uses a parametrization of the air-shower radio footprint and probability densities for signal detection on the antenna level and shower detection on the array level. The model was validated against full-fledged Monte-Carlo simulations and against the observational data that showed that it is suitable for selection of the full-efficiency regions usually used in all cosmic-ray studies. In the talk we will present the details of the approach and the results of its application to the Tunka-Rex array.

T 17.6 Mon 17:45 POT/0013

First Radio Measurements of an IceCube Surface Enhancement Station at the Pierre Auger Observatory — •Carmen Merx for the Pierre Auger and IceCube-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology

Radio detection of air showers has become a powerful method to measure cosmic rays at energies of several 10 PeV and above. IceTop, the surface array of the IceCube Neutrino Observatory at the South Pole as well as the Pierre Auger Observatory in Argentina are being upgraded with antenna stations to improve the accuracy of air-shower measurements.

A prototype station of the surface enhancement of IceCube has recently been installed at the Pierre Auger Observatory. This station comprises eight scintillation panels and three SKALA antennas. The frequency band of the SKALA antennas reaches up to 350 MHz, which is significantly higher than the 30-80 MHz currently used at Auger.

During my presentation, I will discuss first measurements of this prototype station at the Auger site.