T 13: Kosmische Strahlung I

Zeit: Montag 16:00–18:20 Raum: S13

Gruppenbericht T 13.1 Mo 16:00 S13

Recent developments from the Auger Engineering Radio Array (AERA) * — •Marvin Gottowik — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal

The Auger Engineering Radio Array (AERA) is designed to measure the radio emission of extensive air showers initiated by cosmic rays above an energy of 10^{17} eV. AERA is an extension of the Pierre Auger Observatory located in Mendoza, Argentina. It is operated n coincidence with the other detectors of the observatory. The 153 autonomous radio antenna stations are distributed over an area of 17 km^2 on a grid with a spacing ranging from 150 - 750 m. Each antenna station comprises two dipole antennas sensitive to frequencies of 30 - 80 MHz. Data taking started in 2011.

Special emphasis is put on the detection of inclined air showers, where the radio emission footprint extends over several square kilometers. This motivates the upcoming radio extension of the Pierre Auger Observatory with a radio antenna mounted to each station of the surface detector array. With an optimized radio event reconstruction dedicated to inclined air showers and a possible combination of radio and particle data an independent mass scale and an absolute energy calibration from first principles can be achieved. In this talk an overview of the current status of the experiment and the latest scientific results is given.

* Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A17PX1).

T 13.2 Mo 16:20 S13

Reconstruction of inclined Extensive Air Showers from transient radio pulses at the Pierre Auger Observatory — •Felix Schlüter — Karlsruhe Institute of Technology - Institut for Nuclear Physics (IKP)

The detection of transient radio pulses provides information on the electromagnetic component of Extensive Air Showers, e.g., information on the calorimetric energy deposit and longitudinal shower development in the earth's atmosphere. This has been demonstrated for vertical showers in the last decade by next-generation digital radio detectors such as the Auger Engineering Radio Array (AERA). For inclined air showers, radio detection can be combined with complementary measurements of the muonic shower component in hybrid observations to determine the mass composition of cosmic rays at the highest energies. The Radio Upgrade of the Pierre Auger Observatory will be dedicated to exploit these showers with 1660 hybrid detector stations. A reconstruction of the radio signal from inclined air showers has to account for asymmetries in the lateral distribution arising from geometrical effects as well as from the superposition of different emission mechanisms. One proposed model corrects for all asymmetries and describes the radio signal at ground with a rotationally symmetric lateral distribution function. In this talk, this model will be further refined using a greater understanding of the emission processes. With this model shower quantities such as the shower core or electromagnetic energy will be reconstructed for AERA observations.

T 13.3 Mo 16:35 S13

A Simulation study for the Radio Upgrade of the Pierre Auger Observatory — •Tobias Wiegert — Karlsruhe Institut für Technologie, Germany

The study of air showers in our atmosphere provides information about the highest energy particles in our universe, as well as the highest energy accelerators in and out of our galaxy. In recent years, the detection of radio pulses from air showers is becoming increasingly important. Radio antennas measure radio pulses from a large part of the sky 24 hours a day, and are particularly suitable for measuring inclined air showers. As the shower inclines, the area illuminated by radio signals increases. In order to reconstruct such showers well enough, radio antennas must be distributed over a large area. The antenna signals provide information about the electromagnetic component of the shower which can be used in conjunction with the data of surface particle detectors to further characterize the shower and its composition. In view of this, the Pierre Auger Observatory will be extended with additional radio antennas on top of each of the 1660 surface detectors, resulting in a coverage of 3000 km2 and allowing the collaboration to determine the mass composition of cosmic rays arriving at high angles of inclination. This presentation provides an overview of the performance of the planned radio upgrade with antennas on a 1500 m grid, with special regard to the detection of (highly) inclined air showers. Particular focus is put on the minimum energy of the shower at which a detection with the antennas is possible, and its dependence on the zenith angle.

T 13.4 Mo 16:50 S13

Measurements of radio emission induced by Ultra-high energy Cosmic rays with energies above 1 EeV with AERA — •Florian Briechle and Martin Erdmann — RWTH Aachen University, III. Physikalisches Institut A

Ultra-high energy cosmic rays induce extensive air showers emitting radiation in the radio regime which can be used to reconstruct their properties. The radio array AERA of the Pierre Auger Observatory is due to its large size of 17 km**2 able to achieve large event statistics. Incoming cosmic rays at high zenith angles are particularly interesting due to their large footprint on ground which can be measured in many stations. However, their reconstruction is challenging. In this talk a lateral distribution function for fitting the energy fluence on ground of these showers is presented with an emphasis on the energy reconstruction. This allows an energy estimation of the primary cosmic ray using only the information gathered from the radio emission.

T 13.5 Mo 17:05 S13

Development of cosmic-ray radio detectors for the IceCube experiment — •Max Renschler[1], Aswathi Balagopal[1], Andreas Haungs[1], Bernd Hoffmann[1], Thomas Huber[1,2], Timo Karg[2], Marko Kossatz[2], Harald Schieler[1], Frank G. Schröder[1,3], Peter Steinmüller[1], Karl-Heinz Sulanke[2], and Andreas Weindl[1] for the IceCube-Collaboration — [1]Karlsruher Institut für Technologie — [2]DESY Zeuthen — [3]University of Delaware

A new hybrid particle and radio detector is currently under development to upgrade the IceTop array of the IceCube experiment facing IceCube-Gen2. Instrumenting the IceTop surface array with radio detectors in combination with conventional particle detectors improves the accuracy of the measurement of Extensive Air Showers (EAS) induced by cosmic rays. Especially the radio technique enables the measurement of highly inclined EAS throughout all the year. This gives rise to the search for PeV gamma rays coming from the galactic center which is visible from the IceCube site all over the year at an inclination of 61°. In addition, we can study in which way a radio array can improve the ability to veto inclined air showers for the purpose of neutrino detection in the ice. The deployment of the first two prototype antennas extending a station of scintillation detectors at IceTop has been scheduled for January 2019. These antennas serve as a test setup for a future deployment of 74 radio antennas inside the IceTop footprint. During this presentation, the proposed IceTop radio array as well as the first deployed prototype antennas will be introduced in detail and first measurement results will be shown.

T 13.6 Mo 17:20 S13

Analyse der Permittivitätsdaten des Pierre-Auger-Observatorium * — •Jannis Pawlowsky — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

Mit dem Auger-Engineering-Radio-Array des Pierre-Auger-Observatoriums wird die von Teilchenschauern ausgehende elektromagnetische Strahlung im Frequenzbereich von 30-80 MHz vermessen. Die emittierten Radiowellen werden dabei nicht nur direkt empfangen, sondern auch das vom Boden reflektierte Signal wird von Antennen registriert. Bei der Reflektion spielen die Bodeneigenschaften eine wichtige Rolle. Neben der Erdzusammensetzung sind Umweltfaktoren wie Temperatur oder Feuchtigkeit entscheidend. Diese beeinflussen die relative Permittivität und somit den Transmissions- und Reflektionskoeffizienten des Bodens. In diesem Vortrag werden die am Pierre-Auger-Observatorium gemessenen Permittivitätsdaten analysiert. Dabei steht insbesondere die Qualität der Datensätze im Vordergrund. Ebenso wird die Verteilung der Werte und die zeitliche Variation angesprochen, wodurch die Korrelation mit Wettereinflüssen aufgezeigt werden kann. Der Effekt auf das gemessene Radiosignal wird diskutiert.

* Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A17PX1).

T 13.7 Mo 17:35 S13

Reconstruction of cosmic ray energies using a single ARIANNA station — •Christoph Welling for the ARIANNA Collaboration — DESY Zeuthen, Zeuthen, Germany

The ARIANNA (Antarctic Ross Ice-Shelf ANtenna Neutrino Array) detector is a pilot-stage antenna array for the detection of ultra-high energy neutrinos using radio signals. Since air showers caused by cosmic rays produce radio emissions similar to those from neutrino-induced showers inside the ice, they present a test case to demonstrate the ability to reconstruct particle shower properties from their radio signals.

An important property of an air shower is its energy. It is usually measured by reconstructing the signal distribution as a function of distance to the shower axis. Since the ARIANNA geometry is optimized fo neutrinos and therefore very sparse, an air shower is only ever detected by a single ARIANNA station, which does not allow us to use methods based on the air shower footprint. We present a novel method that allows us to reconstruct the shower energy based on a single station's measurement. This is achieved by taking the signal's frequency spectrum into account, which is measured in a relatively broad band from 100-500 MHz in ARIANNA.

T 13.8 Mo 17:50 S13

Reconstruction of the electric field using a single ARIANNA station — •Ilse Plaisier — DESY, Zeuthen, Germany

The ARIANNA detector is a pilot detector at the Ross Ice Shelf, for the detection of the radio signals produced after the interactions of high energetic neutrinos in the ice. In order to precisely reconstruct the arrival direction of a neutrino, three ingredients are needed: the arrival direction of the radio signal, the polarization of the signal and the frequency spectrum of the signal. This contribution discusses a fitting method to reconstruct the electric field of the the emitted radio pulses, which then delivers the relevant quantities. So far, the array is not big enough to detect neutrinos. We therefore discuss the application of the fitting procedure to cosmic ray data obtained with ARIANNA. The radio emission caused by cosmic-ray induced air showers is similar to neutrino-induced showers, but with a well-known signal polarization, making it a perfect test case.

T 13.9 Mo 18:05 S13

Seven years of Tunka-Rex operation — •Pavel Bezyazeekov for the Tunka-Rex-Collaboration — Applied Physics Institute, Irkutsk State University

The Tunka Radio Extension (Tunka-Rex) is an antenna array located in the Tunka Valley in Siberia. It measures the radio emission of cosmic-ray air showers with energies up to EeV. It is triggered by the Tunka-133 air-Cherenkov timing array (during nights) and by the Tunka-Grande array of particle detectors (remaining time). The configuration of Tunka-Rex changed over its runtime from 18 to 57 antennas in an area of 1 km^2 and up to 6 satellite antennas extending the total area to 3 km^2. During its lifecycle Tunka-Rex has demonstrated that a cost-effective and full duty-cycle radio detector can reconstruct the energy and shower maximum with a precision comparable to optical detectors. Moreover, it was shown that cosmic-ray setups, which use different detection techniques and are placed in different locations, can be cross-calibrated via their radio extensions. These results are showing the prospects of application of the radio technique for future large-scale experiments for cosmic-ray and neutrino detection. For the time being Tunka-Rex is switching from active measurements to the data analysis and publication of corresponding software and data in the open-access data center with online analysis features. In this report we present the current status of the array and give an overview of the results achieved during these years.