T 56: Methods in astroparticle physics 3

Time: Wednesday 16:00–18:00 Location: Geb. 20.30: 2.067

T 56.1 Wed 16:00 Geb. 20.30: 2.067

Design of a co-deployed stratigraphy logger for the IceCube Upgrade and IceCube Gen2 — •Anna Eimer and Martin Rongen for the IceCube-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

A precise understanding of the optical properties of the instrumented Antarctic ice sheet is crucial to the performance of the IceCube Neutrino Observatory and its planned successor, IceCube-Gen2.

The ice optical properties are driven by impurities deposited with the snow that formed the ice and thus layers of constant optical properties form a stratigraphy. Due to the underlying bedrock, these layers undulate over the large lateral footprints of these detectors.

Within IceCube, the layer undulations have originally been mapped using stratigraphy measurements by a stand-alone laser dust logger. It required a dedicated deployment setup, as it was not located on the main sensor cables. This resulted in significantly increased costs.

In this talk, I will summarize the modeling of ice layer undulations and describe a newly started project to replace the stand-alone dust logger. It consists of a light source that can be co-deployed with the photosensor modules and operated during the deployment of the detector. The newly developed device is planned to be tested during the deployment of the IceCube Upgrade in 2025/26, so to ensure success during IceCube-Gen2.

T 56.2 Wed 16:15 Geb. 20.30: 2.067

Design and Construction of the Acoustic Module for the IceCube Upgrade — •Andreas Nöll, Jan Audehm, Charlotte Benning, Jürgen Borowka, Pierre Dierichs, Mia Giang Do, Oliver Gries, Christoph Günther, Dirk Heinen, Adam Rifaie, Joëlle Savelberg, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory is a cubic kilometer size detector located at the geographic South Pole, consisting of 5160 Digital Optical Modules (DOMs). In the Antarctic summer 2025/26 more than 700 new modules will be installed as part of the IceCube Upgrade. These include ten Acoustic Modules (AMs), capable of transmitting and receiving acoustic signals between 5 and 30kHz. Additionally, up to 30 acoustic receivers will be located in new DOMs. Goal of these devices is improving the geometry calibration based on multilateration of the measured acoustic propagation times. This talk presents the design and construction of AMs, including the acoustic transducer and its internal electronics.

T 56.3 Wed 16:30 Geb. 20.30: 2.067

Calibration and Characterization of the Acoustic Module for the IceCube Upgrade — •Pierre Dierichs, Jan Audehm, Charlotte Benning, Jürgen Borowka, Mia Giang Do, Oliver Gries, Christoph Günther, Dirk Heinen, Andreas Nöll, Adam Rifaie, Joëlle Savelberg, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

The IceCube Neutrino Observatory detects high-energy neutrinos from astrophysical sources. One factor limiting the angular resolution is the imprecise knowledge of the detector geometry. A planned extension of the detector, called the IceCube Upgrade, will address this issue. It consists of over 700 additional modules, comprising optical modules and calibration devices, in the central region. These calibration devices include ten Acoustic Modules, each capable of sending and receiving acoustic signals. Their deployment enables the calibration of the detector geometry via multilateration of transit times of these signals. We present the tests to characterize the Acoustic Modules, performed in the laboratory, a swimming pool, and a lake.

T 56.4 Wed 16:45 Geb. 20.30: 2.067

The LED calibration system of the IceCube Upgrade — •Martin Rongen for the IceCube-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen Nürnberg

The IceCube Neutrino Observatory, instrumenting about $1\,\mathrm{km}^3$ of deep, glacial ice at the geographic South Pole, is due to be enhanced with the IceCube Upgrade. The IceCube Upgrade will be deployed during the 2025/26 Antarctic Summer season, consisting of seven new columns of photo sensors. It targets neutrino oscillations and improvements to the calibration of the optical properties of the instrumented ice, thereby improving the angular and energy resolution of archival and new neutrino events. For this purpose, the Upgrade will include a host of new calibration devices. These include several thousand pulsed LEDs incorporated into the photosensor modules. The array of LEDs and photo sensors will allow us to improve our knowledge on the light propagation in the instrumented ice. Here, we describe the design and production of this LED system as well as testing prior to integration into the sensor modules.

T 56.5 Wed 17:00 Geb. 20.30: 2.067

Absolute calibration of the light source for the end-to-end calibration of the Fluorescence Detector of the Pierre Auger Observatory — •Julian Rautenberg and Baobiao Yue for the Pierre-Auger-Collaboration — Bergische Universität Wuppertal, Wuppertal, Germany

The accurate reconstruction of the cosmic ray energy by the Fluorescence Detector (FD) is a most crucial part of the hybrid detection used at the Pierre Auger Observatory. Therefore, the absolute calibration of the FD is vitally important, since it determines the energy scale of the Observatory. However, the previous calibration method was difficult to carry out and required a lot of manpower. To address this issue, a new calibration system, the XY-Scanner, was designed and is currently operating. The system consists of a light source, which scans across the front of each FD telescope with frequent isotropic light pulses. To calibrate the FD with this source, precise measurements of the emitted intensity and the angular profile of the photons in each pulse are needed. A calibration bench was designed for this purpose, which includes measurements from a calibrated photo-diode and a PMT. With the addition of rotation and translation stages, the angular and distance-dependent profiles of the light source are also measured. The current uncertainty of the absolute source calibration is less than 4%. The focus of this contribution is on the setup, operation, and analysis of data on this bench.

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T 56.6 Wed 17:15 Geb. 20.30: 2.067

Relative Calibration of the Fluorescence Detector of the Pierre Auger Observatory using the Night Sky Background — •Hendrik Pfau for the Pierre-Auger-Collaboration — Karlsruher Institut für Technologie, Karlsruhe, Germany

The Fluorescence Detector of the Pierre Auger Observatory is used for a calorimetric measurement of the primary energy of cosmic rays. Precise calibration of the Fluorescence Detector is important for accurate energy measurements. Currently, the relative calibration performed every night is monitoring the response of the camera, but changes of the optical efficiency of the mirror and the aperture (e.g. due to accumulation of dust) are not measured. In this presentation we will discuss how the night sky background can be used for a relative calibration of the telescopes. In particular the border regions of neighboring telescopes, which measure the same night sky, are studied to determine the relative calibration of telescopes and to measure its dependence on the elevation angle viewed by the pixel.

T 56.7 Wed 17:30 Geb. 20.30: 2.067

Development of a high temperature superconducting cable for applications in space — •Laurenz Klein, Daniel Louis, Irfan Özen, Dominik Pridöhl, Stefan Schael, Thorsten Siedenburg, Christian von Byern, and Michael Wlochal — Physics Institute I B, RWTH Aachen University

While AMS-02 is currently operated on board of the International Space Station, AMS-100, a next generation particle detector is already planned. For a substantial improvement on AMS-02's geometrical acceptance and rigidity range, the AMS-100 particle detectors are placed inside a High Temperature Superconductor (HTS) solenoid core and it is foreseen to operate at L2. For a magnetic field of 0.5T generated by a current of 10kA, the cables will contain multiple HTS tape layers. To keep the magnet transparent for particles, the HTS tapes are stabilized in aluminium profiles with a thickness of only a few millimeters. Suitable cables are currently under development at RWTH Aachen. Starting with short samples with lengths up to a meter, a cable design is tested that is scalable to the 5 km length of the AMS-100 cable. In this talk, electromagnetic HTS simulation and measurement results of different samples and designs will be presented and discussed.

T 56.8 Wed 17:45 Geb. 20.30: 2.067

Time Resolution of the AMS-100 Time-of-Flight Detector at Cryogenic Temperatures — •Jule Deiters, Chanhoon Chung, Waclaw Karpinski, Thomas Kirn, Daniel Louis, Stefan Schael, and Michael Wlochal — I. Physikalisches Institut B, RWTH Aachen University

The next generation magnetic spectrometer in space, AMS-100, is designed with a geometrical acceptance of 100 m^2sr for a ten year operation at Sun-Earth Lagrange Point 2. The purpose of AMS-100 is to improve the sensitivity for the observation of new phenomena in cosmic rays by at least a factor of 1000 compared to AMS-02.

The AMS-100 detector consists of a high temperature superconducting solenoid, an electromagnetic calorimeter, a tracking system made out of silicon and scintillating fibre modules, and a Time-of-Flight (ToF) system based on fast plastic scintillators read out by silicon photomultipliers (SiPMs).

The ToF system at Lagrange Point 2 will be operated at temperatures between 50 K and 200 K, so the detectors and scintillators need to be tested at cryogenic temperatures.

At room temperature, ToF-prototypes with (6 x 25 x 90) mm^3 EJ-228 scintillators from Eljen Technology read out by either Hamamatsu S14161-6050HS or Broadcom AFBR-S4N66C013 SiPMs yield time resolutions of (38.45 $\pm$ 0.19) ps and (42.88 $\pm$ 0.98) ps, respectively.

Time resolution measurements with the ToF-prototypes in the temperature range of 243 K to 77 K will be discussed.