T 85: Methods in astroparticle physics 4

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

T 85.1 Thu 16:00 Geb. 20.30: 2.067

Intensity interferometry with Fresnel lens telescopes — •Christopher Ingenhütt, Naomi Vogel, Andreas Zmija, Pedro Silva Batista, Stefan Funk, Gisela Anton, Alison Mitchell, and Adrian Zink — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

Intensity interferometry (II) correlates the photon streams of at least two telescopes with varying baselines to determine the angular diameter of stars with high (∼milliarcsecond) resolution. This method is less sensitive to atmospheric effects than similar methods and doesn't set high requirements on the optical imaging capabilities of the individual telescopes. Limiting factors that determine the observable objects are light collection area and possible baselines. We built two telescopes, each using a 1m diameter Fresnel lens focusing the starlight onto a photomultiplier tube. By using widely available standardized aluminium and carbon fiber parts and complementing them with self-designed 3D-printed components, the telescope setup was kept both cheap and lightweight (∼10kg). The lightweight design also enables the telescopes to be repositioned, allowing data acquisition with multiple telescope baselines. We present an overview of the design and assembly process, characterize the telescopes with respect to photon rates from stars as well as from the night sky, and give an outline of potential observation targets.

T 85.2 Thu 16:15 Geb. 20.30: 2.067

Simultaneous two color intensity interferometry measurements at H.E.S.S. — •Naomi Vogel, Andreas Zmija, Gisela Anton, Stefan Funk, Alison Mitchell, and Adrian Zink — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

Intensity interferometry (II) is a method that can achieve high angular resolution astronomical observations in the optical band by correlating photon streams from at least two telescopes with varying baselines. Imaging Atmospheric Cherenkov Telescopes are used for this technique because of their large light collection areas. Our II setup was designed to be mounted to the lid of the Phase I H.E.S.S. telescopes in Namibia. The light beam reflected from the telescope is split into two 10nm interference filters with central wavelengths at 375nm and 470nm. It is detected by photomultiplier tubes whose photo currents are transferred to our workstation via optical fibers for further analysis. Following our first measurement campaign in April 2022, we give a review and an update on the changes of the optical setup and show new results from our measurement campaign in April 2023.

T 85.3 Thu 16:30 Geb. 20.30: 2.067

Interpolating Antenna Calibration Data from Sparse Measurements with Information Field Theory — •Maximilian Straub, Martin Erdmann, and Alex Reuzki for the Pierre-Auger-Collaboration — Physics Institute III A RWTH Aachen

In order to measure radio emissions from cosmic-ray induced air showers, Short Aperiodic Loaded Loop Antennas (SALLAs) are being installed at the Pierre Auger Observatory. The antennas' directional response is being determined using a drone carrying a reference signal. Information Field Theory, a Bayesian method, is used to interpolate the point measurements into a full pattern in both the direction and frequency domain. This allows to incorporate all knowledge on the measurement and learn local correlation structures to fill in the unseen directions and frequencies. Given the Bayesian nature, the resulting map provides a good estimate of the resulting pattern's uncertainties. We apply the approach to simulation data and to measurements conducted in situ at the Pierre Auger Observatory.

T 85.4 Thu 16:45 Geb. 20.30: 2.067

Intrinsic Resolution Limits in Low-Energy Event Reconstruction with IceCube — •Kaustav Dutta and Sebastian Böser — JGU Mainz, Germany

The IceCube Observatory is a cubic-kilometer neutrino telescope built into the deep glacial ice at the South Pole. Low energy extensions to the detector include the existing DeepCore subarray and the upcoming IceCube Upgrade, which will be constructed in the 2025/26 Antarctic Summer season. The IceCube Upgrade will consist of seven new strings of photosensors, characterized by a denser instrumentation than the existing array. The setup will allow us to study neutrino oscillations with greater sensitivity compared to the existing instrumentation, improve neutrino mass hierarchy studies, and test for the PMNS mixing matrix unitarity with high precision. The reconstruction of event information, in particular the direction of an incoming neutrino, is a crucial ingredient to all of these low-energy physics analyses. Here, we focus on identifying the theoretically achievable resolution in directional reconstruction. The factors that limit the physics information in the events, specifically the transverse spread of hadronic shower, in-ice photon scattering, module resolutions and module noise, have been analyzed. These limitations subsequently impose constraints on the achievable resolution. The resolution limits are finally compared with the performances of the state-of-the-art reconstruction algorithms used by the IceCube Collaboration.

T 85.5 Thu 17:00 Geb. 20.30: 2.067

Use of Moyal and Lambert functions for reconstruction and simulation of PMT signals — •Oleg Kalekin for the ANTARES-KM3NET-ERLANGEN-Collaboration — ECAP, FAU Erlangen-Nürnberg

Photomultiplier Tubes (PMTs) are widely used in astrophysical experiments as photodetectors. Signals from PMTs have Gaussian like rising edge and exponential like falling edge. Such signals can be fitted with a modified Moyal function with decoupled parameters for rising and falling edges. The solution for the inverse modified Moyal function can be found using a Lambert function. A method for the fast calculation of the Lambert function has been proposed recently by Darko Veberic. Therefore, the analytical Moyal and its inverse functions can be used for simulations of PMT signals including deriving of trigger time or Time-over-Threshold parameters.

T 85.6 Thu 17:15 Geb. 20.30: 2.067

Improving the Signal Extraction and Gain Calibration for the IceAct Telescopes — •Lukas Brusa, Jonas Häussler, Johanna Hermannsgabner, Lars Heuermann, Lea Schlickmann, and Christopher Wiebusch for the IceCube-Collaboration — RWTH Aachen, Aachen, Germany

IceAct is a surface detector array of Imaging Air Cherenkov Telescopes located at the South Pole as part of the IceCube Neutrino Observatory. The telescopes feature a camera with 61 SiPM-based pixels and are optimized for air-shower measurements in harsh environments. Physics goals are improved cosmic ray studies, the cross calibration of IceCube and IceTop by a hybrid measurement of air-showers, and an improved atmospheric neutrino veto. First step in the analysis of the recorded data is the gain calibration of the pixels and the signal extraction. When extracting photon hit information for a single pixel, the measured signal (waveform) is cross-correlated with the noise-free signal expectation. This increases the signal-to-noise ratio leading to an improved gain calibration. This talk will give an overview of the new signal extraction algorithm, present an updated gain calibration and compare the data between experiment and simulation.

T 85.7 Thu 17:30 Geb. 20.30: 2.067

Status of the IceAct Telescopes above the IceCube Neutrino Observatory — •Lars Heuermann, Lukas Brusa, Jonas Häussler, Andreas Nöll, Lea Schlickmann, Rosa van Monsjou, and Christopher Wiebusch for the IceCube-Collaboration — RWTH Aachen - III. physikalisches Institut B, Aachen, Germany

IceAct is an array of Imaging Air Cherenkov Telescopes on the ice surface above the IceCube Neutrino Observatory. Each telescope features a SiPM-based 61-pixel camera and Fresnel lens-based optics, resulting in a 12-degree field of view. The design is optimized to be operated in harsh environments, particularly at the South Pole. Since 2019, two telescopes have been taking data in a stereoscopic setup, 200m apart. In the future, this setup will be expanded to a station comprising seven of these telescopes in a so-called flys eye configuration, increasing the field of view to 36 degrees. For this purpose, the first additional telescope was shipped to the South Pole in October 2023. In this talk we will review the status of the installation, recent analysis results, and report on the ongoing upgrade.

T 85.8 Thu 17:45 Geb. 20.30: 2.067

Measurement-based performance comparison of SiPM and PMT pixels in the MAGIC IACT camera — •Alexander Hahn[1], Razmik Mirzoyan[1], Antonios Dettlaff[1], David Fink[1], Daniel Mazin[1,2] und Masahiro Teshima[1,2] — [1]Max Planck Institute for Physics, Garching, Germany — [2]Institute for Cosmic Ray Research, The University of Tokyo, Kashiwa City, Japan

All the major Imaging Atmospheric Cherenkov Telescopes (IACTs) in operation, including MAGIC, H.E.S.S., VERITAS, and CTA's LSTs and MSTs, utilize photomultiplier tubes (PMTs) as low light level (LLL) detectors. It has been shown that smaller IACTs, such as FACT and ASTRI, can utilize Silicon photomultipliers (SiPMs) instead. However, whether SiPMs can effectively replace PMTs as light detectors in larger-scale IACTs remains an unresolved question primarily investigated through simulations. We have built several SiPM-based prototype detector modules at the Max Planck Institute for Physics to address this question. Our SiPM detector modules have been installed for several years in one of the two MAGIC cameras and were operated in parallel. This allows us to directly compare the performances of SiPM and PMT-based pixels without added assumptions. Here, we present a multi-year in situ study that covers detector calibration, long-term stability, detection efficiencies, and signal-to-noise ratio comparisons between the two detector types.