T 37: Neutrino Astronomy II

Time: Tuesday 16:15–18:30 Location: KS H C

T 37.1 Tue 16:15 KS H C

Title: Characterization and calibration of photomultiplier tubes for the Pacific Ocean Neutrino Experiment — •Josef Pflanz for the P-ONE-Collaboration — Technische Universität München, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) is a planned cubic-kilometer scale neutrino telescope, designed for high-precision neutrino source searches and long-baseline astrophysical observations. The first detector line is currently under development and will consist of 20 modules, equipped with photomultiplier tubes (PMTs). The Hamamatsu R14374 PMT was selected for this first deployment due to its low transit-time spread, high stability, and overall performance quality. In this talk, I will present the characterization and validation procedures carried out on these PMTs. In particular, I will focus on measurements of quantum efficiency, photon detection efficiency, and the linearity of the PMT response when coupled to P-ONE's dedicated front-end electronics. These results provide essential input for the detector's Monte Carlo simulations and establish a robust framework for future large-scale PMT characterization for the full P-ONE array. The talk will highlight the measurement techniques, calibration methods, and results obtained from a subset of the PMTs.

T 37.2 Tue 16:30 KS H C

Construction and testing of the first string for the Pacific Ocean Neutrino Experiment — •Laura Winter for the P-ONE-Collaboration — Technical University of Munich, TUM School of Natural Sciences, Department of Physics, James-Franck-Straße 1, D-85748 Garching bei München, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) is a next-generation multi-cubic-kilometer neutrino telescope under construction in the Northeast Pacific Ocean off the coast of Vancouver Island, Canada. The first construction phase comprises the initial detector string, which is currently under construction and testing, with deployment planned for summer 2026. The line consists of 20 optical and calibration modules designed for the detection of Cherenkov light. Each module features a modular multi-photomultiplier tube (PMT) design with 16 PMTs per module, optically and mechanically coupled to the glass using individual silicone gel pads. The first line will also be used to test biofouling mitigation strategies using both polished glass hemispheres and hemispheres treated with a special anti-biofouling coating. Module integration onto the detector line is currently being performed at TRIUMF (Tri-University Meson Facility) in Vancouver. This contribution presents the optical module production process, the line integration process, and first results from system-level testing of the full string.

T 37.3 Tue 16:45 KS H C

Development of a High-Resolution Muon Calibration Sample for the IceCube Upgrade — •Simon Pick — DESY, Zeuthen

The IceCube Upgrade will deploy nearly 800 new optical sensors in a closely spaced region within the IceCube DeepCore volume, enabling an unprecedented view of atmospheric muons and neutrinos. This dense instrumentation may offer the opportunity to identify muon tracks with exceptionally high angular precision through direct detection. Such events could serve as powerful calibration sources for detector response and angular reconstruction algorithms.

In this contribution, I will present ongoing work toward the development of a high-resolution muon calibration sample. This includes progress on characterizing muon-induced sensor responses through laboratory measurements and simulation, with a particular focus on the development of a new dedicated calibration stand. More broadly, I will provide an overview of the current status and outline the next steps toward the sample development and studies of potential improvements in reconstruction performance.

T 37.4 Tue 17:00 KS H C

Wavelength Division Multiplexing for the Pacific Ocean Neutrino Experiment — •Lea Ginzkey for the P-ONE-Collaboration — Technical University of Munich

The Pacific Ocean Neutrino Experiment (P-ONE) aims to detect high-energy astrophysical neutrinos by instrumenting more than one cubic kilometer of deep ocean water in the Northeast Pacific, off the coast of Vancouver Island (Canada). With the first detector line nearing deployment, planning for the next stages of P-ONE is already underway.

To decrease both cable production complexity and overall cost, we aim to reduce the number of fibers per module while maintaining DAQ redundancy. Wavelength Division Multiplexing (WDM) enables the simultaneous transmission of multiple independent optical channels through a single fiber, offering a promising path towards more efficient deep-sea readout architectures.

The current status of WDM tests for P-ONE will be presented, providing an outlook on how WDM could support the next generation of large-volume oceanic neutrino detectors.

T 37.5 Tue 17:15 KS H C

Production, Installation & Detector Operations of a Calibration Device for the IceCube Upgrade — •Leonhard Eidenschink, Andrii Terliuk, and Patrick Schaile for the IceCube-Collaboration — Technical University of Munich

The Precision Optical Calibration Module (POCAM) is an isotropic, multi-wavelength, self-monitoring optical calibration device. The IceCube Upgrade, an extension of the IceCube detector located at the geographic South Pole, includes seven new strings equipped with more than 700 modules, 22 of which are POCAM devices. All produced POCAMs underwent extensive calibration of their optical properties at our testing facility at Technical University of Munich (TUM). The purpose of POCAM is to emit a well-characterized isotropic light pulse that allows for calibration of both the optical medium and the detector modules. In addition to the routine calibration operations planned after full deployment, a series of special operations were carried out during the installation. This talk provides an overview of the device production, installation in the IceCube Upgrade, and the special calibration operations performed, along with their first data.

T 37.6 Tue 17:30 KS H C

Calculation of the neutrino flavour ratios for astrophysical dense environments — •Tilman Eckstein[1,2], Vladimir Kiselev[1,2], Jonas Hellrung[1,2], and Julia Becker Tjus[1,2,3] — [1]Theoretical Physics IV, Plasma Astroparticle Physics, Faculty for Physics and Astronomy, Ruhr University Bochum, 44780 Bochum, Germany — [2]Ruhr Astroparticle and Plasma Physics Center (RAPP Center), Germany — [3]Department of Space, Earth and Environment, Chalmers University of Technology, 412 96 Gothenburg, Sweden

Neutrinos are elementary particles that are characterised in particular by their weak interaction. This allows them to travel enormous distances almost unhindered and still be detected on Earth. Dense astrophysical environments, such as compact obscured nuclei (CONs), are potential sites where high-energy neutrinos may be produced.

In this work, the event generator SIBYLL 2.3d was used to simulate pp collisions under extreme astrophysical conditions, as they might occur in such dense environments. A special feature of the resulting particle showers is that different decay channels lead to characteristically different neutrino flavour compositions. These flavour ratios were calculated using the numerical tool MCEq.

After their creation, neutrinos are subject to the quantum mechanical phenomenon of neutrino oscillation, which causes their flavour composition to change as they propagate over distance. Finally, the numerical tool NuSQuIDS was used to determine the theoretical flavour ratios after propagation from these potential astrophysical source regions to Earth.

T 37.7 Tue 17:45 KS H C

Tau neutrino appearance with KM3NeT/ORCA — •Sebastian Weissbrod for the KM3NET-ERLANGEN-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP, Erlangen, Germany

KM3NeT/ORCA is a water-Cherenkov neutrino telescope currently under construction in the Mediterranean Sea. Due to its modular design, based on strings of Digital Optical Modules (DOMs), data taking is possible already during the construction phase. In the last year, the KM3NeT collaboration has presented a multitude of physics results obtained with a 433 kt-yr data-set recorded with the six-string ORCA6 sub-array. Among these results is the analysis of tau neutrino appearance in the atmospheric neutrino flux through neutrino oscillations, providing insight into the tau neutrino cross section, as well as

probing non-unitary neutrino mixing.

The analysis is based on the minimization of a binned log-likelihood ratio comparing model predictions with observed event counts. The detector response is estimated using detailed Monte Carlo simulations that are specific to the present detector geometry.

A new analysis is currently in preparation, harnessing the further deployment of more strings, providing an expanded detector sub-array and increasing the exposure to up to 1.7 Mt-yr. This update introduces new challenges, such as the characterization of the larger data-set and the transition to a new software framework for the statistical calculations. In my talk I will be presenting preliminary insights on atmospheric tau neutrino appearance using the expanded data-set.

T 37.8 Tue 18:00 KS H C

Integration of the NEUT Neutrino Interaction Model into the KM3NeT/ORCA Simulation Framework and Evaluation of Its Impact on Oscillation Analyses — •Frederik Andersen, Thomas Eberl, and Rodrigo Gracia-Ruiz for the KM3NET-ERLANGEN-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

The KM3NeT/ORCA neutrino telescope is currently under construction in the Mediterranean Sea. It is optimised to detect atmospheric neutrinos with energies up to 100 GeV. To this end a three dimensional grid of photomultiplier tubes detects Cherenkov radiation induced by particles that result from neutrino interactions with seawater. The data recorded by the experiment is analysed by comparing to detailed Monte-Carlo simulations which implement state-of-the-art knowledge on secondary particle production and detection processes. As a first step, so-called neutrino event generator codes employ different approximations to simulate the distribution of final-state particles produced in neutrino interactions. Differences in neutrino generators can introduce biases in the interpretation of the experimental data, and lead to tensions in measurements performed by different experiments. In this talk we will present our results how using different neutrino event generators impacts KM3NeT/ORCA's scientific results by implementing an alternative simulation pipeline using NEUT, the neutrino event generator developed by Super-Kamiokande, and compare its results to the default KM3NeT pipeline employing GENIE as event generator.

T 37.9 Tue 18:15 KS H C

KM3NeT/ARCA All-Sky Diffuse Analysis using PyForward-Folding — •Anke Mosbrugger and Oliver Janik — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

KM3NeT/ARCA is a cubic-kilometer water-Cherenkov neutrino detector under construction in the Mediterranean Sea. Its primary goal is to detect high-energy neutrinos from both galactic and extragalactic sources. This talk presents methods to improve the search for the astrophysical neutrino flux using ARCA21, the construction phase with 21 detection lines in operation.

Studies of the astrophysical neutrino flux commonly use a binned, forward-folding likelihood method. Our analysis is carried out with the new open-source tool PyForwardFolding (PyFF). PyFF supports the full analysis chain following event selection, including flux weighting, binning, and handling of systematics. PyFF also enables combined analyses across different detector configurations and between experiments, such as KM3NeT and IceCube. This is especially relevant for searches along the Galactic Plane and for identifying potential Galactic neutrino sources.