T 11: Neutrino-Astronomie I

Zeit: Montag 16:00–18:30 Raum: S10

T 11.1 Mo 16:00 S10

STRAW: strings for absorption length in water — •Andreas Gärtner for the STRAW-Collaboration — Technische Universität München

Neutrino astronomy uses large volume detectors to search for astrophysical neutrinos. Detectors such as IceCube at the Geographic South Pole and the Gigaton Volume Detector (GVD) at Lake Baikal instrument up to a cubic kilometer of water or ice for measuring Cherenkov radiation created in neutrino-matter interactions. In the past the utilization of the clear water of the deep sea as Cherenkov medium has had severe difficulties in deploying and maintaining the offshore infrastructure.

Ocean Networks Canada (ONC), an initiative of the University of Victoria, has been creating and maintaining a deep sea infrastructure for scientific instruments off the coast of Canada. One of their network nodes, located on the Pacific abyssal plain of Cascadia Basin, could be an ideal site for a future neutrino telescope.

The Strings for Absorption Length in Water (STRAW) were developed at the Technical University of Munich (TUM) in collaboration with ONC and the University of Alberta. Two strings with optical modules have been deployed at Cascadia Basin in order to measure the optical properties of the water and study the feasibility of a larger installation. We will give a brief overview of the STRAW setup and present first results on the absorption length and background radiation at Cascadia Basin.

T 11.2 Mo 16:15 S10

SkyLLH - A new experiment-independent framework for celestial log-likelihood analyses in multi-messenger astronomy — •Tomas Kontrimas and Martin Wolf for the IceCube-Collaboration — Technische Universität München, Physik-Department, James-Franck-Str. 1, 85748 Garching

Common analysis techniques in multi-messenger astronomy involve hypothesis tests with unbined log-likelihood (LLH) functions using recorded celestial data to identify sources of high-energy cosmic particles in the Universe. We present the new general Python tool "SkyLLH", which provides an experiment-independent framework for constructing log-likelihood functions to perform data analyses with recorded multi-messenger astronomy data. Such data could be data sets from different detectors, e.g. neutrino or gamma-ray event data sets from the IceCube Neutrino Observatory, or the Fermi-LAT, respectively. We highlight the current design goals of SkyLLH, which focus on time-integrated and time-optimized LLH analyses of IceCube data. However, possible future implementations of LLH functions for the Fermi-LAT within the SkyLLH framework will be discussed as well. In addition, we point out future prospects to target SkyLLH as a common analysis tool for the community of multi-messenger astronomy.

T 11.3 Mo 16:30 S10

Geometry calibration of the KM3NeT neutrino telescope using atmospheric muons — •Daniel Guderian and Alexander Kappes — Institut für Kernphysik, Westfälische-Wilhelms-Universität, Münster

The KM3NeT neutrino telescope consists of a network of large volume Cherenkov detectors at the bottom of the Mediterranean Sea destined to look for neutrino interactions in the water. With its two different sites, ORCA and ARCA, currently under construction, specializing in lower and higher neutrino energies, respectively, it aims at studying physics spanning from the determination of the neutrino mass hierarchy to detection of neutrinos from astrophysical objects. With the ongoing deployment of sensors, calibration becomes a highly important task to perform in order to provide the precision necessary for data analysis.

In this talk studies on a method using atmospheric muons for calibration are presented in which the reconstructed muon tracks are used to evaluate the detector geometry. In particular, position and time offset determinations of the photosensors can be achieved applying this technique.

T 11.4 Mo 16:45 S10

Trilateration-based geometry calibration of the IceCube detector — •Frederic Jonske, Christian Haack, Lilly Peters, Shefali Shefali, Martin Rongen, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory detects charged particles by measuring their Cherenkov light using photomultipliers. These photomultipliers have been inserted into the clear antarctic ice at depths between 1450 and 2450 meters. Reconstruction relies on arrival times of light at the position of these sensors. However, their position is currently only known to within a few meters based on deployment data and calibration with light sources. Trilateration of the arrival times of light emitted from LEDs within the sensor modules and received by neighboring sensors can be used to determine the relative sensor positions. In this talk, we discuss an improved determination of the detector geometry using trilateration and recent models of light propagation in ice.

T 11.5 Mo 17:00 S10

Development of acoustic receivers for the IceCube-Upgrade mDOM — •Roxanne Turcotte, Dirk Heinen, Frederic Jonske, Martin Rongen, Shefali Shefali, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — Physikalisches Institut IIIb, RWTH Aachen, Aachen, Germany

The IceCube Neutrino Observatory is a cubic kilometer scale neutrino detector, capable of detecting neutrinos of energies ranging from a few GeV to PeV and above. IceCube-Gen2 is a planned large-scale upgrade to enhance the sensitivity for the highest energy neutrinos. As a first step, the IceCube-Upgrade is being prepared. It involves inclusion of additional sensor strings and calibration devices in the central detector region. IceCube-Gen2 will entail larger spacing of optical sensor modules, for which the current calibration scheme of the geometry by means of trilateration by light becomes challenging. As a promising alternative method, trilateration by acoustic signals is being developed. This system will consist of acoustic receivers incorporated inside the optical sensor modules (mDOM), and stand-alone acoustic emitters. Furthermore, interactions of extremely high energy (EHE) neutrinos, with energies above 1 EeV, are expected to generate a transient acoustic signal strong enough to be detected. We will present the concept, design and tests of the first iteration of the acoustic receivers.

T 11.6 Mo 17:15 S10

Development of an Emitter for the Acoustic Geometry Calibration of the upcoming IceCube-Upgrade — •Shefali Shefali, Dirk Heinen, Frederic Jonske, Martin Rongen, Roxanne Turcotte, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — Physics Institute 3B, RWTH Aachen University, NRW, Germany

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T 11.7 Mo 17:30 S10

Improving the IceCube-DeepCore event classification — •Leander Fischer for the IceCube-Collaboration — DESY, Zeuthen, Germany

The IceCube Neutrino Observatory is a cubic kilometer in-ice Cherenkov detector located at the Geographic South Pole. DeepCore is a denser sub-array of IceCube that reaches an energy detection threshold of less than 10 GeV and provides data for some of the most precise neutrino oscillation measurements using atmospheric neutrinos. In current studies, muon neutrinos are identified by separating the measured data into two channels: track- and cascade-like events. A possible way to improve the current sensitivity is to split the data into further classes that might result in better reconstruction performance and better control over the systematic uncertainties. An approach for splitting the data using decision tree-based multivariate machine learning algorithms will be presented in this talk.

T 11.8 Mo 17:45 S10

Topological Track Reconstruction in Liquid Scintillator Neutrino Detectors for GeV Events — Caren Hagner, •David Meyhöfer, Henning Rebber, and Björn Wonsak for the JUNO-Collaboration — Institut für Experimentalphysik, Uni Hamburg

In the current era of neutrino physics, detectors tend to be demanding for more target volume and higher energy resolution. The greater volume and more readout channels make event reconstruction and background rejection challenging. An example for this development is JUNO, which is currently being constructed in China. The Topological Track Reconstruction is being tested and enhanced with simulations from said detector. It is able to provide a 3D light emission density distribution, based on isotropically emitted, unscattered scintillation photons. Hence one will obtain the differential energy loss (dE/dx), which can be used for background rejection.

For high energy events in the range of GeV this yields tremendous potential. Especially the impact of decay product signals from ^{9}Li and ^{8}He can be tackled. By determining the differential energy loss (dE/dx) the volume potentially containing background signals can be minimized. This reduces the dead time of the detector. The talk will primary focus on the differential energy loss (dE/dx) algorithm with the Topological Track Reconstruction in the high energy regime.

T 11.9 Mo 18:00 S10

Improving IceCube low energy event reconstruction — •Elisa Lohfink[1], Maicon Hieronymus[1], Sebastian Böser[1], and Elmar Schömer[2] for the IceCube-Collaboration — [1]Institut für Physik, JGU Mainz, Deutschland — [2]Institut für Informatik, JGU Mainz, Deutschland

Within the IceCube Neutrino Observatory and its low-energy extension (DeepCore), neutrinos with energies down to the GeV range can be reconstructed individually. The reconstruction is based on minimizing a six-dimensional likelihood space. Causality induced steep borders in the time-dimension make this likelihood space particularly difficult to evaluate, especially at reconstructed times later than the true event time. Currently, this challenge is overcome using MultiNest, a computationally expensive global nested sampling algorithm. In the new approach investigated here, directed likelihood sampling in the time-dimension is used to circumvent the issues induced by causality borders. This opens the possibility to use different, less costly minimization techniques and thus to significant speed-up of the reconstruction.

T 11.10 Mo 18:15 S10

Simulation of Light Propagation Through Hole Ice for the IceCube Experiment — •Sebastian Fiedlschuster for the IceCube-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP, Erwin-Rommel-Str. 1, 91058 Erlangen

IceCube is a neutrino observatory at Earth's South Pole that uses glacial ice as detector medium where particles from neutrino interactions produce Cherenkov light as they move through the ice, which then is detected by an array of photo detectors deployed within the ice. *Hole ice* is the refrozen water in the drill holes that were needed to deploy the detector modules.

Aiming to improve the detector calibration for the current IceCube detector as well as for the upcoming upgrade, a new method to simulate the propagation of light through the hole ice has been introduced. The new method allows a ray-tracing simulation of light through ice volumes of different optical properties, such as one or several hole-ice cylinders with specific positions, sizes, scattering lengths and absorption lengths. The effect of shadowing cables can be studied by modeling cables as opaque volumes. This talk will outline the simulation method and present current results.