T 95: Neutrinos: Myon-Rekonstruktion

Zeit: Donnerstag 16:00–18:35 Raum: H11

Gruppenbericht T 95.1 Do 16:00 H11

Overview and status of the Topological Track Reconstruction for large unsegmented liquid scintillator neutrino detectors — Felix Benckwitz[1], Caren Hagner[1], David Meyhöfer[1], Henning Rebber[1], •Malte Stender[1], Björn Wonsak[1], Sebastian Lorenz[2], Johann Dittmer[3], Mikko Meyer[3], and Kai Zuber[3] — [1]Universität Hamburg, Institut für Experimentalphysik — [2]Johannes Gutenberg-Universität Mainz, Institut für Physik — [3]Technische Universität Dresden, Institut für Kern- und Teilchenphysik

In this contribution we present the Topological Track Reconstruction, which works with minimal hypothesis in contrast to other reconstruction methods in liquid scintillator detectors. The reconstruction yields a 3D density distribution of the emitted scintillation photons enabling the localisation of muon events. This also implies information of the dE/dx of the muons and is therefore able to pin down hadronic showers within the track. These showers produce serious background isotopes. This information enhances the rejection and the study of cosmogenic background events.

The discussed reconstruction provides sharp tracks for GeV events, but even low energy events of a few MeV - traditionally thought as point-like - reveal some topological information. This information can then be used for event discrimination. The possibility to apply the reconstruction to different detector geometries and configurations promises a large field of application. This talk will present the advances of the Topological Track Reconstruction and give an overview about its applications.

T 95.2 Do 16:20 H11

Topological Track Reconstruction in Liquid Scintillator Neutrino Detectors for MeV Events — •Henning Rebber, Caren Hagner, Björn Wonsak, David Meyhöfer, Malte Stender, and Felix Benckwitz for the JUNO-Collaboration — Universität Hamburg

Neutrino detectors like the JUNO experiment in China demand for an unprecedented energy resolution while pushing the fiducial mass of liquid scintillator to ever higher dimensions. This complicates the tasks of event reconstruction and background reduction. For widespread events, like e.g. high energy (∼GeV) muons, current developments in the topological track reconstruction provide a 3D light emission density distribution based on isotropically emitted, unscattered scintillation photons. The method gives access to a particle's differential energy loss dE/dx and can help in the essential task of background rejection.

But also for low energy events in the signal range (∼MeV) - although comparatively point-like - the topological features hold valuable information which can be used for particle discrimination. Electron events can partly be separated from positron and gamma events. The current status of this study is presented. This work is supported by the DFG.

T 95.3 Do 16:35 H11

Studies on multi-muon track reconstruction with the JUNO liquid scintillator neutrino detector — •Axel Müller, Alexander Tietzsch, David Blum, Tobias Heinz, Tobias Sterr, Marc Breisch, and Tobias Lachenmaier for the JUNO-Collaboration — Physikalisches Institut, Universität Tübingen

The Jiangmen Underground Neutrino Observatory (JUNO) is a planned 20 kt liquid scintillator detector with the main goal to determine the neutrino mass hierarchy with neutrinos from nuclear power plants at 53 km baseline. With an expected muon rate of 3 per second, fast and reliable muon tracking is necessary to veto a partial volume along the track. Due to the large dimensions of the detector a fraction of the atmospheric muon events consists of two or more muons traversing the detector. These events cannot be reconstructed with conventional one-particle reconstruction algorithms. In order to reconstruct the tracks of these bundle events, a new approach is developed to expand and combine the single-muon reconstruction algorithms. A description of the reconstruction strategy, examples of its application and first results are presented in this talk.

This work is supported by the Deutsche Forschungsgemeinschaft.

T 95.4 Do 16:50 H11

A new muon tracking for the Borexino experiment — •Michael Nieslony, Johann Martyn, Vsevolod Orekhov, and Michael Wurm for the Borexino-Collaboration — Johannes Gutenberg-Universität Mainz

The Borexino experiment is a liquid scintillator detector located at the Laboratori Nazionali del Gran Sasso (LNGS) in Italy with the primary aim of detecting solar neutrinos. The experiment's exceptional radiopurity levels enabled the spectral measurement of almost the whole pp-fusion-cycle of the sun, including ^{7}Be-, *pp*-, and *pep*-neutrinos. Besides the solar program, a multitude of analyses ranging from the detection of geoneutrinos up to setting the most stringent limit on the lifetime of the electron have been performed.

The rejection of background events is a vital factor for the ongoing success of the experiment. One of the major background sources are cosmic muons, which produce unstable nuclei like ^{11}C along their way through the detector through spallation processes. To efficiently reject those events, a precise knowledge of the muon track is necessary. A new muon tracking based on the first hit times of the emitted Cherenkov and scintillation photons was developed and is presented in this talk. The work was supported by funds of the *Deutsche Forschungsgemeinschaft (DFG)*

T 95.5 Do 17:05 H11

Topological Track Reconstruction with the SNO+ experiment — •Johann Dittmer, Mikko Meyer, and Kai Zuber for the SNOplus-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Deutschland

SNO+ is a large liquid scintillator based experiment that reuses the Sudbury Neutrino Observatory (SNO). Located 2 km underground in a mine near Sudbury the detector consists of a 12 m diameter acrylic vessel which is filled with 780 t of liquid scintillator. Main goal of SNO+ is the search for the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{130}Te. The scintillator is loaded with 0.5 % by weight during the search. It is also possible to measure reactor–, geo–, supernova– and solar neutrinos.

This talk deals with the evaluation of expected background for $0\nu\beta\beta$ search coming from solar neutrinos detected via elastic neutrino–electron scattering (ES) and solar neutrino capture (ν–capture).

Furthermore, first results from the so–called topological track reconstruction developed in Hamburg will be presented. This method already demonstrated potential to discriminate background processes and might be an interesting tool for the analysis of solar neutrinos and the $0\nu\beta\beta$ search.

T 95.6 Do 17:20 H11

Potential of the application of the Topological Track Reconstruction to ANNIE — •Felix Benckwitz, Caren Hagner, David Meyhöfer, Henning Rebber, Malte Stender, and Björn Wonsak — Universität Hamburg, Institut für Experimentalphysik

Neutron tagging is an important technique to reduce the background in proton decay searches and precision measurements of neutrino oscillations in water Cherenkov detectors. Therefore, the neutron yield per neutrino energy is a vital input for MC simulations to accurately calculate the background rejection. The measurement of the neutron yield as a function of the transferred momentum for charged current and neutral current neutrino interactions is the goal of the Accelerator Neutrino Neutron Interaction Experiment (ANNIE). In order to achieve this goal, ANNIE deploys a 26 t gadolinium-doped water Cherenkov detector at the Fermilab Booster Neutrino Beam. To meet the vertex reconstruction requirements in a small detector volume, ANNIE, besides conventional PMTs, makes use of Large Area Picosecond Photo Detectors (LAPPDs), which yield a spatial resolution of ~ 1 mm and a time resolution of ~ 50 ps. These characteristics, as well as the instantaneous Cherenkov light make ANNIE a perfect testing field for the Topological Track Reconstruction, which uses the temporarily and spatially detected photon hits to reconstruct the spatial number density of emitted photons. The potential of the Topological Track Reconstruction using Cherenkov light, as well as LAPPDs and its advantages over currently used reconstruction methods are discussed.

T 95.7 Do 17:35 H11

Study of the event reconstruction for the COBRA coplanar grid quad CdZnTe detectors — •Yingjie Chu for the COBRA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

The COBRA experiment aims to measure neutrino-less double beta decay using CdZnTe detectors with a coplanar grid design. Recently the detector system was upgraded with nine 6/, $/mathrmcm^3$ coplanar grid quad CdZnTe detectors to the extended demonstrator (XDEM). The XDEM detectors employ four independent coplanar grid electrode pairs on a single crystal surrounded by an instrumented guard-ring electrode. The purpose of this large volume combined with coplanar grid quad design is to improve the detection efficiency as well as maintain the good energy resolution. Signals can be read out from each grid and be processed separately. A reconstruction of the deposited energy based on the sum of the anode signal amplitudes from four grid pairs could be achieved. Furthermore, the spectral performance as a function of the interaction depth could also be measured.

This talk focuses on the event reconstruction method for XDEM detectors. First results of an improved energy reconstruction and interaction depth determination are presented. In order to improve the energy resolution, further corrections due to the contributions of electron trapping and charge sharing effects on the signals are reported.

T 95.8 Do 17:50 H11

An improved muon track reconstruction for IceCube and IceCube-Gen2 — •Federica Bradascio — federica.bradascio@desy.de

IceCube is a cubic-kilometer Cherenkov telescope operating at the South Pole. Its goal is to detect astrophysical neutrinos and identify their sources. High-energy muon neutrinos are identified through the secondary muons produced via charge current interactions with the ice. The muon tracks are reconstructed using a maximum likelihood method which models the arrival times of Cherenkov photons registered by the photomultipliers. This work aims to improve the muon angular resolution of IceCube and its planned extension, IceCube-Gen2, to the sub-degree range. The current muon reconstruction assumes continuous energy loss along the muon track, and does not account for photomultiplier-related effects such as prepulses and afterpulses. In the reconstruction scheme presented here, the expected arrival time distribution has been modified to parameterize the stochastic muon energy losses.

T 95.9 Do 18:05 H11

Improving the Sensitivity of Measurements in IceCube to Neutrino Oscillation Parameters — •Alexander Trettin for the IceCube-Collaboration — DESY, Zeuthen

One of the applications of the IceCube Neutrino Observatory is the measurement of the neutrino mass splittings and mixing angles using atmospheric neutrinos. These measurements use the DeepCore subarray of IceCube, which has an energy threshold of just under 10 GeV. One of the algorithms used for directional reconstruction in neutrino oscillation studies relies on the arrival time pattern of minimally scattered photons. This talk presents a simple yet effective way to minimize the impact of scattering in ice and increase the efficiency of this approach. Discussed improvements are expected to result in about 10% increase of the sensitivity to oscillation parameters in future studies.

T 95.10 Do 18:20 H11

Impact of uncertainties in the detector geometry of IceCube on event reconstruction — •Lilly Peters, Frederic Jonske, Martin Rongen, Jöran Stettner, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

Neutrinos travel through the universe nearly undisturbed, keep their directional information and provide the possibility to study the unknown sources of high-energy cosmic rays. In 2017, the IceCube Neutrino Observatory has identified, for the first time, a potential astrophysical neutrino source, the Blazar TXS 0506+056. The ability to reliably trace back a neutrino to an astrophysical source requires a precisely reconstructed direction. One source of systematic uncertainties is the actual position of the optical sensors of the detector. Those positions can be estimated from calibration light sources and deployment data taken during the construction of the detector. In this talk, the influence of geometrical uncertainties of the IceCube detector array on directional reconstructions of high-energy neutrinos will be analyzed.