T 20: Neutrinophysik I

Zeit: Montag 16:00–18:05 Raum: Z6 - SR 2.012

Gruppenbericht T 20.1 Mo 16:00 Z6 - SR 2.012
The nEXO experiment — •Michael Wagenpfeil for the nEXO-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

The nEXO experiment will be a multi-tonne LXe TPC to search for the neutrinoless double beta decay in Xe-136 with a target half-life sensitivity of approximately 10^{28} years. This improvement of two orders of magnitude over current experimental half-life limits is realised by using 5000 kg of isotopically enriched xenon, careful material selection and an improved design of the TPC. MC simulations derive a sensitivity to the effective Majorana neutrino mass between 5.7 and 17.7 meV on a 90 % C.L. depending on the nuclear matrix element calculation after 10 years live-time.

In order to realise this goal, it is crucial to achieve an excellent energy resolution which puts strong requirements on the performance of the TPC detector systems for both VUV scintillation photons and secondary charge carriers.

We give an overview of current sensitivity studies as well as the investigation of the charge-detecting anode tiles foreseen for nEXO. We also discuss the progress of the characterisation efforts of VUV-sensitive SiPMs which are planned to be employed as photo detectors covering the inside wall of the TPC.

T 20.2 Mo 16:20 Z6 - SR 2.012
Investigation on the electron drift at the edges of the EXO-200 TPC — •Sebastian Schmidt, Gerrit Wrede, Tobias Ziegler, Jürgen Hössl, Gisela Anton, and Thilo Michel — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg, 91058 Erlangen

The EXO-200 experiment searches for the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{136}Xe using a TPC filled with enriched liquid xenon. An event taking place within the detector leads to the ionization and excitation of Xe-atoms. The created electrons are drifting in an electric field until they either recombine with a Xe-ion or reach the charge detection unit of the system. Deexcitation, as well as recombination, causes the emission of scintillation light which is also detected. This information is combined in order to estimate the energies as well as the positions of the interactions of a primary particle.
In this contribution, the analysis of non-uniformities of the electric field close to the edges of the EXO-200 TPC is presented. This involves the investigation of the standoff distance, describing the shortest distance of a reconstructed interaction vertex to the inner boundary of the TPC. By using charge drift simulations in combination with optimization methods, an improvement of the agreement of MC and data is achieved.

T 20.3 Mo 16:35 Z6 - SR 2.012
Charge-only energy reconstruction with Convolutional Neural Networks for the EXO-200 experiment — •Tobias Ziegler[1], Michael Jewell[2], Sebastian Schmidt[1], Jürgen Hössl[1], Gisela Anton[1], and Thilo Michel[1] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP — [2]Stanford University, California, USA

The EXO-200 experiment searches for the neutrinoless double beta ($0\nu\beta\beta$) decay of ^{136}Xe with a single-phase liquid xenon (LXe) time projection chamber (TPC) filled with enriched LXe. The TPC provides the position (X,Y,Z) of events and the deposited energy in LXe by simultaneously detecting the xenon scintillation light and the amount of secondary electrons. For charge collection, electrons drift in the electric field towards the anode, where they induce currents in a first plane of wires and are collected by a second plane of wires. In this study, we investigate the energy reconstruction of events with single or multiple charge deposits using all available collection wires. We apply Deep Learning methods, esp. Convolutional Neural Networks, to reconstruct the charge-only energy deposition in the EXO-200 experiment and compare its performance to the conventional approach.

T 20.4 Mo 16:50 Z6 - SR 2.012
Multi-Pixel Photon Counters for the detection of liquid xenon scintillation light — •Katharina Witzmann[1], Michael Wagenpfeil[1], Tobias Ziegler[1], Judith Schneider[1], Ako Jamil[2], Jürgen Hössl[1], Gisela Anton[1], and Thilo Michel[1] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP — [2]Yale University, Connecticut, USA

The future nEXO experiment will search for neutrinoless double beta decay with a single-phase time projection chamber, filled with liquid xenon enriched in ^{136}Xe, by detecting scintillation light and secondary electrons. The vacuum ultraviolet (VUV) scintillation light of liquid xenon will be detected with Silicon Photomultipliers (SiPMs) which are also referred to as Multi-Pixel Photon Counters (MPPCs). Important criteria to achieve the desired energy resolution of 1 % at the Q-value (2457.8 keV) are a photon detection efficiency of at least 15 % for the liquid xenon scintillation light and a probability of less than 20 % to obtain correlated avalanches such as cross-talk or after-pulsing. In this contribution we will present results of characterization measurements with commercial MPPCs named VUV3 and VUV4 carried out by the nEXO-collaboration using differing experimental setups.

T 20.5 Mo 17:05 Z6 - SR 2.012
Characterisation of a VUV-sensitive Silicon Photomultiplier for the nEXO experiment — •Judith Schneider[1], Tobias Ziegler[1], Michael Wagenpfeil[1], Patrick Hufschmidt[1], Ako Jamil[2], Katharina Witzmann[1], Naomi Vogel[1], Jürgen Hössl[1], Gisela Anton[1], and Thilo Michel[1] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP — [2]Yale University

For the future nEXO experiment, about 4 m^2 of SiPMs will be used for the detection of the LXe VUV (vacuum ultraviolet) scintillation light at 178 nm in order to search for the neutrinoless double beta ($0\nu\beta\beta$) decay of ^{136}Xe. Most commercially available SiPMs are not sensitive to UV light. Besides that, SiPMs are suffering from correlated avalanches such as crosstalk and afterpulsing. In order to achieve an energy resolution of about 1 % (σ) at the Q-value of the $0\nu\beta\beta$ decay of ^{136}Xe at 2457.8 keV, a photon detection efficiency (PDE) of at least 15 % at 178 nm and a correlated avalanche probability of less than 20 % are required. We present the characterisation of a device capable of detecting VUV light. This includes measurements in the absence of light as well as using Xe scintillation light. We compare the results with the requirements of the nEXO experiment at −100 °C.

T 20.6 Mo 17:20 Z6 - SR 2.012
CONUS - A new experiment to measure COherent Neutrino nUcleus Scattering at reactor site — •Thomas Rink for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik (MPIK), Heidelberg, Deutschland

The recent discovery of coherent elastic neutrino nucleus scattering (CEνNS) by the neutrino beam experiment COHERENT opened up a new and high statistics path in neutrino detection. The reaction's coherent nature allows a strong enhancement of the corresponding cross section and makes it the strongest among all known neutrino interactions. Nevertheless, its detection in the fully coherent regime with reactor antineutrinos has been impossible so far due to very low nuclear recoil energies and their corresponding quenching, i.e. energy dissipation in the conversion of nuclear recoils into detectable signals. With the latest generation of Germanium detectors exhibiting lowest detection thresholds, around 300 eV, such attempts become feasible. The CONUS experiment established at MPIK Heidelberg aims at detecting this interaction with a high signal-to-background ratio by combining ultra-low threshold and high-purity Germanium detectors, an advanced shield design and highest possible antineutrino fluxes on the Earth's surface. For this, CONUS uses four such low threshold detectors with a total mass up to 4 kg and is going to be operated at the nuclear power plant in Brokdorf, Germany. This talk introduces the design, realization and current status of the CONUS experiment and gives an overview of phenomenological and theoretical questions that can be addressed utilizing CEνNS.

T 20.7 Mo 17:35 Z6 - SR 2.012
Anti- and Coincidence Methods for CONUS — •Tobias Schierhuber for the CONUS-Collaboration — Max-Plank-Institut für Kernphysik, Heidelberg, Deutschland

The upcoming experiment CONUS is utilizing next generation Germanium detectors to measure coherent elastic neutrino nucleus scattering (CEνNS) and is located inside the commercial nuclear power plant in Brokdorf, Germany, at shallow depth (up to 45 m water equivalent). This means the muon flux from cosmic radiation is only reduced by a factor of ~ 5. Therefore many steps are necessary to ensure low background results. One such step is active background suppression in order to remove unwanted components and obtain the best signal to background ratio possible.

This talk will give an introduction into two currently used background suppression methods: first, a cosmic-ray suppression system based on plastic scintillators to remove residual muon-induced signals and second, an anti-coincidence method applied between the four Germanium detectors, which are used in the CONUS experiment. Both systems are useful tools to study signal and background components by operating them in coincidence as well as anti-coincidence mode. Furthermore the underlying framework for the data acquisition, a custom solution using the Lynx DAQ will be presented.

T 20.8 Mo 17:50 Z6 - SR 2.012

Commissioning of the CONUS Experiment — •Janina Hakenmüller for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The CONUS experiment is looking for **CO**herent elastic **N**eutrino n**U**cleus **S**cattering with low-threshold high-purity Germanium (Ge) point contact detectors with a total mass of ∼4 kg. The experiment is set up at the nuclear power plant of Brokdorf, Germany, where a high antineutrino flux with energies within the coherent regime is provided. To measure a signal detectors with a sufficiently low energy threshold are required to be able to detect the tiny recoils of the nuclei hit by the antineutrinos. Moreover, the background has to be suppressed as much as possible to make the signal clearly visible. For CONUS, located at the shallow depth of maximal 45 meters of water equivalent (m w.e.), this is achieved with a shell-like passive shield and an active muon veto system. During the commissioning in the underground laboratory at Heidelberg (15 m w.e.) the detectors and the shield have been characterized and thoroughly tested. In the talk, the achieved background level is discussed and the remaining background contributions are examined. Monte Carlo simulations with the Geant4-based framework MaGe are employed to disentangle the cosmic-ray muon-induced contributions, background from the shield and intrinsic contaminations of the detectors. Special attention is payed to the neutron-induced background, as fast neutrons can mimic the signal. Moreover, detector characteristics like the dead layer thickness, depletion voltage and longterm stability are presented.