T 91: Experimentelle Methoden der Astroteilchenphysik IV

Zeit: Donnerstag 16:30–19:00 Raum: Z6 - SR 2.011

T 91.1 Do 16:30 Z6 - SR 2.011

Characterization tests of the photomultipliers for XENONnT — •Oliver Wack for the XENON collaboration — MPIK, Heidelberg, Germany

For the upgrade of XENON1T to the XENONnT TPC, about 300 additional photomultipliers (PMTs) are required. The Hamamatsu R11410-21 PMT was chosen for XENON1T due to its very low intrinsic radioactivity and high quantum efficiency. Recent investigations on light emission from within the tube led to slight improvements in the design of the new PMTs for XENONnT. In addition to the characterization test performed before, the procedure is improved in order to identify possible vacuum losses at cryogenic temperatures. This includes several cooling cycles to also investigate the stability of the dark-count-rate and effects of light-emission during cryogenic operation. The possible leakage into the tube is identified by a change in the after-pulse spectra before and after cooling.

This talk will also cover the performance of the PMTs during the operation in XENON1T.

T 91.2 Do 16:45 Z6 - SR 2.011

Low-energy calibration of liquid xenon detectors using an Ar-37 internal source — •Daniel Wenz[1], Matteo Alfonsi[1], Christopher Geppert[2], Christopher Hils[1], David Maksimovic[1], Melanie Scheibelhut[1], Pierre Sissol[1], and Uwe Oberlack[1] — [1]Johannes Gutenberg-Universität Institut für Physik — [2]Johannes Gutenberg-Universität Institut für Kernchemie

Liquid xenon time projection chambers (LXeTPC) for Dark Matter search have reached the ton-scale (XENON1T), and due to the excellent self shielding properties of the medium, internal radiation sources have become a standard tool for electronic recoil calibrations. The focus has been on low-energy beta emitters such as tritiated methane or Rn-220, and on Kr83m, which, however, yields two photons in short time sequence. At the low-energy threshold, a well-defined line source is still missing. We present an approach for such a calibration with the MainzTPC, a local LXeTPC developed by the group, together with an Ar-37 source generated at the Mainz TRIGA reactor from Ar-36. Ar-37 decays through electron capture to Cl-37 and allows a calibration of mono-energetic electron recoil events at 0.27 keV and 2.8 keV.

T 91.3 Do 17:00 Z6 - SR 2.011

Optical simulations of the XENON1T experiment and comparison to data — •Lutz Althüser — IKP, Westfälische Wilhelms-Universität Münster

The XENON Dark Matter Project uses a dual-phase xenon time projection chamber (TPC) for a direct detection of weakly interacting massive particles (WIMPs). The current operating step, XENON1T, is the most sensitive direct detection dark matter experiment in the world.

Therefore, the TPC is build to detect low intensity light signals, generated directly by the recoil of incoming scattered particles (S1) or through proportional scintillation (S2) from the electrons generated in the scattering process and drifted into the xenon gas phase. The light collection efficiency (LCE) of these signals depends on the position of the interaction in the active volume and on optical properties of the materials. The resulting LCE map is used as an input parameter for waveform simulations which converts GEANT4 interactions to actual photomultiplier tube (PMT) signals that can be processed with the XENON1T data processor.

A validation of the generated LCE maps with calibration data using simulations as well as the comparison of simulated and measured waveforms will be shown.

This work is supported by BMBF under contract 05A17PM2.

T 91.4 Do 17:15 Z6 - SR 2.011

Radon mitigation for rare-event searches using surface treatments — •Guillaume Eurin, Hardy Simgen, and Florian Joerg — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

In the current state of rare event searches such as direct dark matter detection with the XENON1T detector, radon is a dominating background source. Present in the natural radioactivity decay chains of ^{238}U and ^{232}Th, it is a noble gas that can be emanated from any detector material.

Several strategies have been adopted by low-background experiments in astro-particle physics to tackle this issue. Materials are screened and selected for radio-purity, detector manufacturing is tightly controlled and surface cleaning techniques are explored. A novel solution could be the coating of the surface of materials emanating radon with a thin metallic layer to reduce radon emanation. Investigations have been carried out with industrial partners in order to quantify this reduction and compatibility tests with the operation of a liquid noble gas time projection chamber will be demonstrated in a dedicated setup.

This talk will highlight the promising results already obtained and potential leads for future improvement.

T 91.5 Do 17:30 Z6 - SR 2.011

Investigation of PEN as structural self vetoing material for cryogenic low background experiments — •Felix Fischer for the GERDA-Collaboration — Max-Planck-Institut für Physik, München, Deutschland

Polyethylene Naphthalate (PEN) has recently been shown to scintillate in the deep blue spectrum. It can be produced with high radiopurity which makes it suitable for a wide field of applications in low background experiments like the search for neutrinoless double-beta decay. It is known that some scintillators change in efficiency and behaviour when cooled down to cryogenic temperatures. In order to investigate whether PEN shows similar behaviour, an experiment has been designed and constructed at the Max-Planck-Institute for physics in Munich. First results of PEN properties at cryogenic temperatures will be shown.

T 91.6 Do 17:45 Z6 - SR 2.011

Improved liquid argon scintillation light readout for Gerda Phase II — •Patrick Krause[1], Maria Fomina[1,2], Konstantin Gusev[1,3], Jozsef Janicsko[2], Oskar Moras[1], Vlad Samoil[1], Stefan Schönert[1], Egor Shevchik[2], Christoph Wiesinger[1], and Marisa Zengerle[1] — [1]Physik-Department and Excellence Cluster, Technische Universität München, Garching, Germany — [2]Joint Institute for Nuclear Research, Dubna, Russia — [3]now at Leibniz-Institut für Kristallzüchtung, Berlin, Germany

Liquid Argon (LAr) scintillates upon interaction with ionizing radiation. In this process light with a wavelength of 128 nm is emitted. With the help of so-called wave length shifting (WLS) fibers and silicon photomultipliers (SiPMs) this property is exploited in Gerda's active background suppression strategy to reject events with coincident energy deposition in the germanium detectors and the surrounding LAr. An improved version of the WLS fiber-modules and the SiPM-readout has been developed. This talk will report the changes, challenges and improvements compared to the previous design.

This work has been supported by the German Federal Ministry for Education and Research (BMBF) Verbundforschung 05A17W02 and the German Research Foundation (DFG) via the SFB1258.

T 91.7 Do 18:00 Z6 - SR 2.011

Characterization of surface cleaning procedures for liquid noble gas detectors — •Pablo Herrero Gómez — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

Adequate surface cleaning procedures of materials constituting fiducial volumes are crucial in many liquid noble gas detectors used in direct dark matter or $0\nu\beta\beta$ decay searches. On one hand, surface cleaning reduces residual lubricants from the production processes as well as potential background sources like radon daughters plated out on the detector's materials. On the other hand, inappropriate cleaning procedures might have a negative effect on the gas purity of noble gas detector due to outgassing. In this talk I introduce strategies to probe standard surface cleaning procedures for their applicability in liquid noble gas detectors. With dedicated experimental setups, various possibilities for background mitigation, so as outgassing minimization, can be investigated and mutual influences between each other can be studied.

T 91.8 Do 18:15 Z6 - SR 2.011

Performance of a custom designed prototype inverted coaxial HPGe detector for Legend — •Tommaso Comellato, Matteo Agostini, Andrea Lazzaro, Christoph Wiesinger, and Stefan

Schönert — Technische Universität München, Garching, Germany

Initially, the newly formed Legend collaboration plans to operate up to 200 kg of enriched germanium detectors in the upgraded Gerda infrastructure at Lngs, Italy. The science goal is to search for the neutrinoless double beta decay of ^{76}Ge. In the current Gerda and Majorana Demonstrator experiments, enriched HPGe detectors with excellent pulse shape discrimination (PSD) properties are being operated. Their masses are however typically below one kilogram. To reduce backgrounds from close by parts as cables and holders, larger mass detectors without compromising the PSD performance are required for Legend. A novel detector geometry, referred to as inverted coaxial, is now the baseline design of Legend HPGe detectors. A custom designed inverted coaxial detector with 1.6 kg mass was produced in collaboration with Baltic Scientific Instruments and the Helmholtz Research Center Rossendorf, and is currently comprehensively characterized at TUM. In this talk I will present the latest results about the performance of this detector including the charge collection, signal shape properties and pulse shape discrimination performance.

This work has been supported by the German Federal Ministry for Education and Research (BMBF) Verbundforschung 05A17W02 and the German Research Foundation (DFG) via the SFB1258.

T 91.9 Do 18:30 Z6 - SR 2.011

Extraction of Stopping Muons in IceCube Using Machine Learning — •Tobias Hoinka, Mathis Börner, Mirco Hünnefeld, Joshua Luckey, Max Meier, Thorben Menne, Felix Neubürger, Jan Soedingrekso, and Jan Spinne — TU Dortmund

IceCube is a neutrino observatory located at the South Pole, consisting of digital optical modules that detect Cherenkov light emitted from charged particles traversing the Antarctic ice sheet. The most dominant source of background in the search for neutrinos are atmospheric muons produced in interactions of cosmic rays in the upper atmosphere. At a trigger rate of about 3000 Hz, they also provide a valuable source of information about cosmic rays. A special subset of atmospheric muon events are muon events that contain only muon tracks that end within the detector volume. These stopping muons exhibit features that have interesting implications for both cosmic-ray physics and calibration purposes. In order to extract a sample of stopping muons of high purity, a supervised machine learning approach is used.

In this talk, an overview of the employed methods is given. The properties of the extracted sample are discussed and an unfolding of the muon range spectrum is presented.

T 91.10 Do 18:45 Z6 - SR 2.011

Studies on the time-over-threshold readout of the multi-PMT optical module — •Daniel Guderian and Alexander Kappes — Institut für Kernphysik, Westfälische Wilhelmsuniversität Münster

The multi-PMT Digital Optical Module is a promising candidate for the optical sensors in the planned upgrade of the IceCube detector. It offers, amongst other properties, superior directional sensitivity and larger effective volume when compared to the current sensors. Due to tight energy budget restrictions in a multi-PMT design a power-efficient multi-level time-over-threshold (ToT) readout will be utilized. Studies on optimizing the threshold levels have been carried out using a simulation of the ToT sampling of input signals and the subsequent deconvolution of pulses. The studies include the generation and reconstruction of single photoelectron pulses as well as the directional reconstruction of real high-energy IceCube events with complex PMT signals applying a ToT algorithm. Results characterizing an optimized setup will be presented.