T 6: Methods in astroparticle physics 1

Time: Monday 16:00–18:00 Location: Geb. 20.30: 2.067

T 6.1 Mon 16:00 Geb. 20.30: 2.067

Efficiency Measurements of the WOM for the IceCube Upgrade — •Philipp Kern, Sebastian Böser, Yuriy Popovych, John Rack-Helleis, and Bastian Kessler for the IceCube Collaboration-Collaboration — Institut für Physik, JGU Mainz, Deutschland

The IceCube Neutrino Observatory will undergo an Upgrade to increase its sensitivity to neutrino events. One type of Upgrade Module is the Wavelength-shifting Optical Module (WOM), which uses wavelength-shifting technology to detect UV-Cherenkov photons. The main component of the WOM is a quartz tube coated with wavelength-shifting paint. The absorbed and isotropically re-emitted photons are captured inside the tube by total internal reflection and propagate to both ends coupled to Photomultiplier Tubes for detection.

For the deployment in IceCube different properties of the wavelength-shifting tube, such as the attenuation length, the quality of the optical coupling and the paint homogeneity have to be characterized and an efficiency calibration has to be performed for the whole module. For this purpose a custom test stand was built to characterize the WOM, with the possibility to measure the whole surface of the tube over a large wavelength range. This procedure will be done with a single tube used and the complete built WOMs. Here we present results from the characterization and efforts to investigate systematic effects in them.

T 6.2 Mon 16:15 Geb. 20.30: 2.067

Mapping the ice stratigraphy in IceCube & IceCube-Gen2 using camera deployment footage — •Martin Rongen for the IceCube-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen Nürnberg

The IceCube Neutrino Observatory is a cubic-kilometer Cherenkov array deployed in the deep, glacial ice at the geographic South Pole. An important feature of the instrumented ice are undulations of layers of constant optical properties over the footprint of the detector. During detector construction, these layers were mapped using stratigraphy measurements obtained from a stand-alone laser dust logger. While this system is very precise, its cost does not scale to the instrumented volume envisioned for the proposed IceCube-Gen2 Observatory. Here, we explore the possibility of obtaining equivalent stratigraphy data from camera footage recorded during the deployment of IceCube more than a decade ago. If successful, this could be an alternative technique to be considered for IceCube-Gen2.

T 6.3 Mon 16:30 Geb. 20.30: 2.067

Construction of a Prototype of the Wavelength-Shifting Optical Module for the IceCube Upgrade — •Yuriy Popovych[1], Sebastian Böser[1], Ioana Caracas[1], Enrico Ellinger[2], Cloe Girard-Carillo[1], Klaus Helbing[2], Philipp Kern[1], Anna Pollmann[3], John Rack-Helleis[1], Lea Schlickmann[1], and Nick Schmeisser[2] for the IceCube-Collaboration — [1]Johannes Gutenberg-Universität Mainz — [2]Bergische Universität Wuppertal — [3]Chiba University, Japan

The Wavelength-shifting Optical Module (WOM) is one of the sensors to be deployed in the upcoming Upgrade for the IceCube Neutrino Observatory in 2025/26 increasing the sensitivity of low-energy neutrino events. The module consists of a tube coated with wavelength-shifting paint and two Photomultiplier Tubes (PMTs) coupled on both ends. UV-Cherenkov photons are shifted into the visible region, captured inside the tube by total internal reflection and propagated to the PMTs at the end. Besides an increased UV-sensitivity this design ensures a low signal-to-noise ratio by decoupling the photosensitive area and the PMTs. The modules have to withstand the harsh ambient conditions at the South Pole, as well as during transportation - most notably pressures of up to 600 bar during deployment. This talk will give an overview of the construction of the WOM prototype for the IceCube Upgrade and its engineering challenges, as well as reporting on the WOM final acceptance tests and the status of the production for the Upgrade deployment.

T 6.4 Mon 16:45 Geb. 20.30: 2.067

^{42}K mitigation studies in liquid argon for LEGEND-1000 — •Christoph Vogl[1], Viacheslav Belov[1], Tommaso Comellato[1], Maximilian Goldbrunner[1], Konstantin Gusev[1], Brennan Hackett[2], Patrick Krause[1], Andreas Leonhardt[1], Béla Majorovits[2], Susanne Mertens[1], Nadezda Rumyantseva[1], Mario Schwarz[1], Stefan Schönert[1], and Michael Willers[1] — [1]Technical University of Munich, TUM School of Natural Sciences, Department of Physics, James-Franck-Str. 1, 85748 Garching, Germany — [2]Max Planck Institute for Physics, Boltzmannstr. 8, 85748 Garching, Germany

The Legend experiment searches for neutrinoless double beta decay ($0\nu\beta\beta$) of ^{76}Ge using high-purity germanium detectors (HPGe). To reduce background sources at the decay's Q-value ($Q_{\beta\beta} = 2.039$ MeV), the detectors are deployed deep underground in an instrumented liquid argon (LAr) volume. However, commercially available LAr contains the cosmogenically activated isotope ^{42}Ar, whose daughter nucleus ^{42}K is a beta emitter ($Q_\beta = 3.5$ MeV). Beta particles can produce events in the region of interest, mimicking $0\nu\beta\beta$ events. Here, we present measurements on ^{42}K suppression conducted in the LAr cryostat SCARF at TU-Munich. We explore analysis of the event topology in germanium detectors, enclosure of the detectors inside an optically active barrier made of polyethylene naphthalate (PEN), and read-out of the scintillation light produced by LAr and PEN. This research is supported by the DFG through the Excellence Cluster ORIGINS EXC 2094-390783311 and the SFB1258.

T 6.5 Mon 17:00 Geb. 20.30: 2.067

Crystallized polyethylene naphthalate as wavelength shifting reflector for LEGEND-1000 — •Maximilian Goldrunner[1], Brennan Hackett[2], Andreas Leonhardt[1], and Stefan Schönert[1] for the LEGEND-Collaboration — [1]Technical University of Munich, TUM School of Natural Sciences, Garching, Germany — [2]Max Planck Institute for Physics, Garching, Germany

The future LEGEND-1000 experiment will search for the neutrinoless double-beta decay of Ge-76. For background suppression, 1,000 kg of high-purity germanium detectors will be employed in a liquid argon (LAr) volume. Particles traversing the LAr induce scintillation light with a wavelength peaking at 128nm. The scintillation light is converted to visible wavelength by wavelength shifters. To improve the background suppression in LEGEND-1000, optically inactive surfaces are covered with wavelength-shifting reflectors (WLSR) that also reflect the scintillation light to the LAr instrumentation. Polyethylene naphthalate (PEN) is a wavelength-shifting polymer already used in the precursor experiment LEGEND-200. PEN thin films can be crystallized to act as a WLSR without a separate reflector. In this work, we studied the crystallization of amorphous PEN by heating, characterized for reflectivity and wavelength-shifting efficiency, to find the optimal configuration. We present the first measurement under the relevant LAr conditions, namely for excitation with LAr scintillation light and at LAr temperature. We compare it with amorphous PEN and the TPB-based WLSR of LEGEND-200. The DFG supports this research through the Excellence Cluster ORIGINS and the SFB1258.

T 6.6 Mon 17:15 Geb. 20.30: 2.067

Reflectivity measurements of PTFE with VUV light in liquid xenon — •Robert Braun, Johanna Jakob, Lutz Althueser, and Christian Weinheimer — Institute for Nuclear Physics, University of Münster, Germany

Rare event searches as performed with liquid xenon detectors demand a precise knowledge of the employed materials. Measurements of optical properties at the xenon scintillation wavelength in the vacuum UV (VUV) regime are required for accurate simulations and detector characterization. With the Reflectivity Setup in Münster, the angular dependent reflection properties of a sample under VUV light can be studied in a gaseous (GXe) or liquid xenon (LXe) environment.

Polytetrafluorethylen (PTFE) is used to encapsulate the active volume of all large scale LXe dark matter experiments. Among these experiments are the XENON1T and XENONnT experiments from which PTFE samples of the detector walls were studied in vacuum, GXe and LXe using this setup. This talk will report about the reflectivity measurements of the PTFE depending on its surface treatment and the surrounding material.

T 6.7 Mon 17:30 Geb. 20.30: 2.067

Development of a Bi-solvent Liquid Scintillator with Slow Light Emission — •Hans Steiger[1,2], M. Böhles[2], M. R. Stock[1], U. Fahrendholz[1], M. Lu[1], L. Oberauer[1], J. Firsching[1], M. Eisenhuth[2], and M. Wurm[2] — [1]Physik-Department, Technische Universität München, James-Franck-Str. 1, 85748 Garching, Germany — [2]Johannes Gutenberg University Mainz, Cluster of Excellence PRISMA+, Staudingerweg 9, 55128 Mainz, Germany

One of the most promising approaches for the next generation of neutrino experiments is the realization of large hybrid Cherenkov/scintillation detectors made possible by recent innovations in photodetection technology and liquid scintillator chemistry. The development of a potentially suitable future detector liquid with particularly slow light emission is discussed in the present talk. This cocktail is compared with respect to its fundamental characteristics (scintillation efficiency, transparency, and time profile of light emission) with liquid scintillators currently used in large-scale neutrino detectors. In addition, the optimization of the admixture of wavelength shifters for a scintillator with particularly high light emission is presented. Furthermore, the pulse-shape discrimination capabilities of the novel medium was studied using a pulsed particle accelerator driven neutron source. Beyond that, purification methods based on column chromatography and fractional vacuum distillation for the co-solvent DIN (Diisopropylnaphthalene) are discussed. This work is supported by the Clusters of Excellence PRISMA+ and ORIGINS and the Collaborative Research Center 1258.

T 6.8 Mon 17:45 Geb. 20.30: 2.067

DISCO: A hybrid Cherenkov Scintillation detection experiment for WbLS — •Amala Augusthy[1], Manuel Böhles[1], Noah Goehlke[1], Daniele Guffanti[2], Benedict Kaiser[3], Tobias Lachenmaier[3], and Michael Wurm[1] — [1]JGU Mainz, Institute for Physics and EC PRISMA+ — [2]University of Milano-Bicocca & INFN Milano-Bicocca — [3]Institute of Physics, University of Tübingen

Water based liquid scintillator (WbLS) is a novel detection medium capable of separating Cherenkov and scintillation components of a signal. The ability to separate the two light components will enable one to construct large low-threshold detectors with directional reconstruction capabilities. DISCO is a lab-scale experiment built to demonstrate such a separation and characterize WbLS. It uses muons as test particles to characterize detection media. It comprises of three main components: an external muon tracker, a test cell, and a light detection system. The test cell can be filled with water, liquid scintillator, or WbLS. The light detection system consists of 16 fast 1-inch PMTs with sub-nanosecond resolution. There is also a provision to include a LAPPD in the near future. This talk discusses the experimental set-up of DISCO and a preliminary tracking algorithm to evaluate the hit patterns produced by the muons on the PMTs. This project is supported by the DFG Graduate School GRK 2796: Particle Detectors.