T 64: Experimentelle Techniken der Astroteilchenphysik 3

Zeit: Dienstag 16:45–19:00 Raum: VSH 18

T 64.1 Di 16:45 VSH 18

Status and Performance of the Wavelength-shifting Optical Module for IceCube Gen2 — •Vincenzo Di Lorenzo, Peter Peiffer, and Sebastian Böser for the IceCube-Collaboration — Johannes Gutenberg-Universität Mainz

The Wavelength-shifting Optical Module (WOM) is a single photon sensor prototype for the next generation of the IceCube experiment. The most prominent features of this sensor are the large sensitivity area, its wavelength shifting properties and the extremely low dark noise rates. These features are stored by shifting the wavelength of abundant UV photons towards the blue, thus guiding and capturing the photons in a tube using two small PMTs. The development of the WOM prototype and its performance will be discussed. In particular, the efficiency of the sensor and the propagation time measurements of the photons inside the optical module will be shown in detail.

T 64.2 Di 17:00 VSH 18

Simulation Studies on the Wavelength-shifting Optical Module for IceCube Gen2 — •Dustin Hebecker for the IceCube-Collaboration — HU-Berlin/DESY

The Wavelength-shifting Optical Module is a single-photon sensor that employs wavelength-shifting and light-guiding techniques to maximize the collection area while minimizing the dark noise rate. The prototype sensor is developed for application in ice-Cherenkov neutrino detectors, such as IceCube-Gen2 or MICA. It is aimed at decreasing the energy threshold as well as increasing the energy resolution and the vetoing capability of the neutrino telescope, when compared to a setup with optical sensors similar to those used in IceCube. The proposed sensor captures photons with wavelengths between 250 nm and 400 nm. The Wavelength-shifting Optical Module has been integrated in the IceCube simulation framework. In this talk the measurements on which the simulation is based followed by the first simulation results will be shown.

T 64.3 Di 17:15 VSH 18

Investigation of tetraphenyl butadiene coatings for wavelength shifting fibers for the liquid argon veto in GERDA — •Julian Kratz for the GERDA-Collaboration — Physik-Department and Excellence Cluster Universe, Technische Universität München, James-Franck-Straße 1, 85748 Garching

Liquid argon is a widely used medium in particle detectors, especially in the field of neutrino physics and dark matter searches. Liquid argon has a high photon yield of approximately 40 000 photons/MeV with the wavelengths of the photons in the vacuum ultraviolet region around 127 nm. The most common way of detecting the scintillation light of liquid argon is to shift it to longer wavelengths, where light detectors are sensitive. The GERDA (GERmanium Detector Array) neutrinoless double beta decay experiment uses liquid argon scintillation light to reject events where particles deposit part of their energy outside the germanium detectors in the surrounding liquid argon. For this purpose wavelength shifting (WLS) fibers with silicon photomultipliers (SiPM) connected to the end are coated with tetraphenyl butadiene (TPB). TPB has been demonstrated to be extremely efficient in converting vacuum ultraviolet photons into visible ones. This work focuses on the TPB coatings applied on WLS fibers for the light yield optimization of the liquid argon veto in GERDA. The work was partly funded by BMBF.

T 64.4 Di 17:30 VSH 18

Characterization of a wavelength shifter coated SiPM — •Patrick Hufschmidt, Jürgen Hössl, Aco Jamil, Lukas Maderer, Judith Schneider, Michael Wagenpfeil, Tobias Ziegler, Gisela Anton, and Thilo Michel — Erlangen Center for Astroparticle Physics, 91058 Erlangen, Germany

Silicon Photomultipliers (SiPMs) are promising candidates for photon counting experiments using next generation nobel gas detectors. Thus they can be an excellent choice for photon detection in experiments for which energy resolution of a signal - derived from scintillation light detection - is crucial. SiPMs offer a high radio purity and single photon resolution which makes them a good choice of photosensors in low background experiments. Since SiPMs are typically not sensitive to wavelengths in the VUV-region, where scintillation light from nobel gases occurs, a wavelength shifter can be applied yielding sufficient quantum efficiency at VUV-wavelengths. We measured internal gain, temperature dependent breakdown voltage, crosstalk probability and photon detection efficiency for xenon scintillation light at cryogenic temperatures for a wavelength shifter coated SiPM. This contribution explains the working principle of a SiPM and their basic characteristics. Futhermore, characterization results are presented.

T 64.5 Di 17:45 VSH 18

Design and comparison of a SiPM based detector module to PMT modules in the MAGIC telescopes — •Alexander Hahn[1], David Fink[1], Daniel Mazin[1,2], Razmik Mirzoyan[1], and Masahiro Teshima[1,2] for the MAGIC-Collaboration — [1]Max-Planck-Institut für Physik, München, Deutschland — [2]Institute for Cosmic Ray Research, Tokyo, Japan

The MAGIC collaboration operates two Imaging Atmospheric Cherenkov Telescopes (IACTs) with 17 m diameter on the Canary Island La Palma. Both telescopes offer the great possibility to operate new light detectors alongside the existing camera equipped with 1039 photomultiplier tubes (PMTs). Within the Otto-Hahn working group of the MPG and the MAGIC collaboration we built a composite light detector module which consists of a large-size assembled matrix of silicon photomultipliers (SiPMs) with the same active area as PMT pixels. The aim is to evaluate their potential use as an alternative photo sensor for existing and future experiments as MAGIC and the Cherenkov Telescope Array (CTA). Special constraints on the design as for example operation at high ambient temperatures and high levels of background light have been addressed. We developed an analog summation circuit to combine the individual SiPM signals while preserving the pulse shape of a single sensor. With a dedicated analysis we perform a detailed comparison of our SiPM module to PMTs with data from regular telescope operations. In this presentation we show the design, our comparison to PMTs and the influences of our finding on the next iteration of prototypes.

T 64.6 Di 18:00 VSH 18

SiPM performance in the Scintillator Upgrade of the Pierre Auger Observatory — •Julian Kemp, Thomas Bretz, Thomas Hebbeker, Lukas Middendorf, Christine Peters, and Johannes Schumacher for the Pierre Auger-Collaboration — III. Physikalisches Institut A, RWTH Aachen University

The Pierre Auger Observatory successfully measures cosmic-ray air-showers at the highest energies by detecting both the fluorescence light produced in the atmosphere and the particle density of the shower at the ground. Nevertheless, this procedure does not allow for a precise measurement of the muon to electron ratio of a single shower. As this quantity is connected to the mass of the primary particle, it allows for a cosmic-ray mass composition measurement. To improve the ability of separating muons from the electromagnetic component, scintillator based detectors will be added to each surface detector station. The basic design consists of several scintillator bars feeding the produced light into a bundle of wavelength shifting fibers. The light can be detected by either photomultiplier tubes (PMTs) or by silicon photomultipliers (SiPMs). The latter benefit from their high photon detection efficiency and robustness. Three prototype devices based on SiPMs have successfully been installed at the Pierre Auger Observatory in September 2016. Their performance is studied.

T 64.7 Di 18:15 VSH 18

Silicon Photomultipliers (SiPM) in a Liquid Xenon Time Projection Chamber (TPC) — •Christopher Hils[1], Matteo Alfonsi[1], Andrea Brogna[2], Daniel Wenz[1], and Uwe Oberlack[1,2] — [1]Johannes Gutenberg-Universität Mainz — [2]PRISMA Detektor Labor, Johannes Gutenberg-Universität Mainz

SiPMs are solid state light sensors with single photon count capabilities. With properties similar to the commonly used photomultiplier tubes (PMTs), they provide a higher granularity, they are operated at a much lower bias voltage and have possibly a smaller cost per area. A low background experiment like a liquid xenon TPC also benefits from their much smaller mass and dimensions. Xenon is scintillating in the VUV regime at 178nm, but most commercially available SiPMs are not sensitive at this wavelength. To increase sensitivity the SiPMs have to undergo a special treatment, in which the inactive entrance layer on top of the SiPM is thinned. We designed and built a test stand to observe the operational stability and to measure the sensitivity, crosstalk and afterpulse properties of VUV-sensitive SiPMs in liquid xenon. We use a 241Am source immersed in liquid xenon to provide scintillation light and are able to examine three SiPM samples and a 1" PMT for reference simultaneously.

T 64.8 Di 18:30 VSH 18

Quantum efficiency measurements of the mDOM PMTs for Iceube-Gen2 — •Raffaela Busse, Lew Classen, and Alexander Kappes for the IceCube-Collaboration — Institut fur Kernphysik, Westfälische Wilhelms-Universität Münster

A significant sensitivity gain for IceCube-Gen2 is anticipated to come from new optical sensor designs. One candidate is the Multi-PMT Digital Optical Module (mDOM), which incorporates 24 3" photomultipliers (PMTs). This design features a.o. an increased effective area and information on the photon arrival direction. To exploit its full potential, a detailed understanding of the PMTs is crucial. Therefore, the properties of all PMT components have to be investigated thoroughly. This talk focuses on the optical properties of the glass and the photocathode, in particular on the quantum efficiency and the wavelength- and angular dependencies. The talk presents measurements of these aspects with a test stand that has been designed and set up in the framework of a master thesis.

T 64.9 Di 18:45 VSH 18

Untersuchungen zu Dunkelraten bei Photomultipliern mit der Photokathode auf Hochspannung — •Florian Trittmaack[1], Saskia Schmiemann[2], Lew Classen[1] und Alexander Kappes[1] für die IceCube-Kollaboration — [1]Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Deutschland — [2]Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster, Deutschland

Eine wesentliche Steigerung der Sensitivität von IceCube-Gen2 wird von neuen Designs für die optischen Sensoren erwartet. Eines der favorisierten Designs ist das Multi-PMT Optical Module (mDOM), das 24 3" Photomultiplier in einen 14"-Druckkörper integriert. Für die Rekonstruktion von Ereignissen ist dabei eine stabile und möglichst geringe Dunkelrate der Photomultipler wichtig, insbesondere da das Eis am Südpol optisch nahezu untergrundfrei ist. Dies hat sich bei Photomultipliern, die wie beim mDOM aufgrund der Elektronik mit negativer Hochspannung an der Photokathode betrieben werden, notorisch als schwierig herausgestellt. Der Vortrag präsentiert Untersuchungen, die diesen Aspekt und mögliche Ursachen genauer beleuchten.