T 106: Experimental Techniques in Astroparticle Physics 4

Time: Thursday 16:15–18:30 Location: T-H38

T 106.1 Thu 16:15 T-H38

Automation of the PMT Acceptance Tests for the IceCube Upgrade mDOMs — •Lasse Halve[1], Hannah Erpenbeck[1], Maja Freienhofer[2], Konstantin Mrozik[2], Joëlle Savelberg[1], Johannes Werthebach[2], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]Astroparticle Physics WG Rhode, TU Dortmund University, Germany

The IceCube Upgrade will extend the IceCube Neutrino observatory with seven additional cable-strings of instrumentation. More than 400 multiple-PMT Digital Optical Modules (mDOMs), with 24 3" Photomultiplier Tubes (PMTs) each, will be deployed. We are testing more than 10.000 PMTs for compliance with manufacturer specifications before the integration into the final modules. A dedicated software for steering the test facilities at RWTH Aachen University and TU Dortmund University for a fully automated operation and online analysis has been developed. We present the design principles and specific solutions for full automization of the test procedures and analyses of PMT data.

T 106.2 Thu 16:30 T-H38

First Results of the PMT Acceptance Tests for the IceCube Upgrade mDOMs — •Johannes Werthebach[1], Hannah Erpenbeck[2], Maja Freienhofer[1], Lasse Halve[2], Konstantin Mrozik[1], and Christopher Wiebusch[2] for the IceCube-Collaboration — [1]Astroparticle Physics WG Rhode, TU Dortmund University, Germany — [2]III. Physikalisches Institut B, RWTH Aachen University

For the IceCube Upgrade seven new strings will be deployed in the centre of the IceCube Neutrino Observatory. Each string contains several types of modules and in total more than 400 multiple-PMT Digital Optical Modules (mDOMs), with 24 3" Photomultiplier Tubes (PMTs) each, will be frozen into the glacial ice at the South Pole. Testing these PMTs for compliance with manufacturer specifications is crucial before integration into the final mDOM. Utilizing two test facilities at RWTH Aachen University and TU Dortmund University with fully automated operation allows for mass testing of all PMTs. Here, we present the results of the characterization tests for the first batch of PMTs.

T 106.3 Thu 16:45 T-H38

Acceptance Tests for 10,700 PMTs of the mDOMs of the IceCube Upgrade — •Joëlle Savelberg[1], Hannah Erpenbeck[1], Maja Freienhofer[2], Lasse Halve[1], Konstantin Mrozik[2], Johannes Werthebach[2], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]Experimentelle Physik 5, TU Dortmund University

The currently prepared IceCube Upgrade will add seven new detector-strings to the central region of the IceCube detector, with the goal of improving the photon-detection and lowering the energy threshold. Part of the new instrumentation are more than 400 multi-PMT Digital Optical Modules (mDOMs), each containing 24 3" Photomultiplier Tubes (PMTs) of type Hamamatsu R15458-20. Prior to the assembly of the mDOMs, the 10,700 required PMTs need to be tested for compliance with set specifications. These tests are carried out at dedicated testing facilities at RWTH Aachen University and TU Dortmund University, with setups that have been optimized for large throughput during the production phase. This talk will focus on the design of these setups and development of optimized testing procedures of PMTs in these large quantities.

T 106.4 Thu 17:00 T-H38

Testing the multi-PMT digital optical modules for IceCube Upgrade — •Nora Feigl for the IceCube-Collaboration — DESY Zeuthen

The IceCube Upgrade will enhance IceCube's capabilities at low and high energies. An important part of the Upgrade is the multi PMT approach: the new optical detector module, the multi-PMT digital optical module (mDOM), promises a large sensitive area, homogeneous solid angle coverage and the possibility of multiplicity triggering within a single module.

In the past year the mDOM was tested and characterized to verify the design is up to requirements. During the mDOM Design Verification Test (DVT) phase, all the most basic features of the mDOM mainboard, the PMT bases and the calibration systems for the first DVT modules were tested.

The next step will be the large-scale integrated mDOM Final Acceptance Testing (FAT) to verify the previous measurements and the functionality of all subsystems while undergoing temperature cycles.

In this talk the structure and the current state of the mDOM Testing will be presented. Some results of the Design Verification Tests will be shown as well as a short outlook for the upcoming Final Acceptance Testing.

T 106.5 Thu 17:15 T-H38

LOM - A multi-PMT optical sensor for IceCube-Gen2. — Markus Dittmer, •Berit Schlüter, Alexander Kappes, and Lew Classen for the IceCube-Collaboration — WWU Münster

With a smaller diameter and 4-inch PMTs, the eLongated Optical Module (LOM) combines lessons learned from the development of mDOM and DEgg for IceCube Upgrade with gel pads as a new element for optical coupling. The gel pads are a key component here and offer several advantages over previously used approaches. However, they also pose a challenge for the design of the internal mechanical components and subsequent volume production.

This presentation will provide an overview of the proposed LOM design, gel pad studies, and highlight measures taken to ensure consistent quality of the modules under the harsh conditions in the deep ice at the South Pole.

T 106.6 Thu 17:30 T-H38

Reconstruction of simulated muons in a water basin with a multi-PMT optical module — •Francisco Javier Vara Carbonell, Martin Antonio Unland Elorrieta, Markus Dittmer, Lew Classen, and Alexander Kappes for the IceCube-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster, Germany

The IceCube detector, currently the largest neutrino detector in the world, is scheduled to undergo two upgrades that will be accompanied by new and improved optical modules. These new modules include the LOM and the mDOM, which feature a larger number of PMTs in a pressure vessel. Compared to the old modules, they have a larger effective photosensitive area and nearly uniform angular coverage. In addition, the sensitive area is now fragmented, resulting in intrinsic directional sensitivity of each module. The zenith angle resolution of both types of modules for atmospheric muons in water was studied with Geant4 simulations, using machine learning for reconstruction.

T 106.7 Thu 17:45 T-H38

Studien zum Zeitverhalten eines Photomultipliers mit COMSOL Multiphysics — •Janis Averbeck, Markus Dittmer, Martin Antonio Unland Elorrieta, Lew Classen und Alexander Kappes für die IceCube-Kollaboration — WWU Münster, Münster, Deutschland

Zur Detektion der charakteristischen Tscherenkow-Strahlung werden beim IceCube-Neutrinoteleskop Photomultiplier eingesetzt. Die Photonen lösen an der Photomultiplier-Kathode durch den photoelektrischen Effekt Photonen aus, die anschließend in einem elektrischen Feld beschleunigt werden und ein Dynodensystem mit steigendem Potential durchlaufen. Dabei werden bei jeder Dynodenkollision mehrere Sekundärelektronen ausgelöst, die letztlich zu einem messbaren Signal führen. Für den Einsatz in IceCube ist u.a. eine sehr genaue Kenntnis der zeitlichen Verzögerung zwischen Auslösung an der Photokathode und Ankunft des Elektronensignals an der Anode (Transit-Time) erforderlich. Die Transit-Time hängt dabei nicht nur von der Größe der Beschleunigungsspannung, sondern auch vom Entstehungsort der Elektronen auf der kugelförmigen Kathode, der Anfangsenergie der Elektronen sowie deren Geschwindigkeitsvektor ab. Um den Einfluss dieser drei Parameter auf die Transit-Time zu untersuchen wurde damit begonnen, einen Photomultiplier in COMSOL Multiphysics nachzubauen. Der Vortrag präsentiert erste Ergebnisse der Studien.

T 106.8 Thu 18:00 T-H38

Studies of the LED emission profile in the mDOM with

a Geant4 simulation — •Anna-Sophia Tenbruck, Alexander Kappes, Martin Antonio Unland Elorrieta, Lew Classen, and Cristian Jesús Lozano Mariscal for the IceCube-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster

The multi-PMT digital optical modules (mDOMs) used in IceCube Upgrade are not only designed to detect neutrinos at low energies, but are also expected to greatly improve the understanding of the detector by installing calibration devices such as LED flashers. LED flashers are versatile devices successfully used in IceCube to measure the ice properties, sensitivity, and timing of optical modules and their positioning. For this purpose, the emission profile of the LEDs must be accurately characterized after they are installed in an mDOM. To study this, the LEDs were simulated in detail in a Geant4 simulation, and the influence of the other module components on the emission profile as well as systematics resulting from the uncertainties in position and inclination of the LED in the module were investigated.

T 106.9 Thu 18:15 T-H38

The Acoustic Module for the IceCube Upgrade — Jürgen Borowka, •Christoph Günther, Dirk Heinen, Maverick Schönell, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — RWTH Aachen University - Physics Institute III B, Aachen, Germany

One major goal of the IceCube Upgrade is improved calibration by deploying additional calibration devices in the center of IceCube. Amongst these devices are ten stand-alone Acoustic Modules, capable of receiving and sending acoustic signals. Additionally, these signals are detected by compact acoustic sensors inside some of the optical sensor modules. The positions of emitters and receivers are determined by means of trilateration of the acoustic propagation times. With this system we aim for the calibration of the detector's geometry with a precision better than a few 10 cm. In view of the future IceCube-Gen2 detector, this system will provide an important proof of principle for the reliable geometry calibration on distance scales of a few hundred meters. The design of the acoustic modules and the status of the development are presented in this talk.