T 69: Experimentelle Methoden der Astroteilchenphysik III

Zeit: Mittwoch 16:30–19:00 Raum: Z6 - SR 2.013

T 69.1 Mi 16:30 Z6 - SR 2.013

IceAct, SiPM based Imaging Air Cherenkov Telescopes for IceCube — •Merlin Schaufel, Jan Auffenberg, Pascal Backes, Thomas Bretz, Giang Do, Erik Ganster, Jan Paul Koschinsky, Leif Rädel, Martin Rongen, Anna Sauret, Johannes Schumacher, Aatif Waza, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut, RWTH Aachen University

The development of cost effective and compact Silicon Photomultipliers (SiPM) based Imaging Air Cherenkov Telescopes enables new measurements using a hybrid configuration with ground based detectors. IceAct is a proposed surface array of such telescopes above IceCube. During January 2018, a new version of an IceAct telescope demonstrator featuring 61 SiPM pixels and improved optics was installed in the center of the IceTop surface detector at the geographic South Pole. Combining information from the telescope and IceCube, it is possible to test the performance in primary particle discrimination, energy calibration and veto capabilities.

We present the status of the project and the prospects of the upcoming data taking season during the antarctic winter.

T 69.2 Mi 16:45 Z6 - SR 2.013

In situ performance of the IceAct Imaging Air Cherenkov Telescope at the South Pole — •Erik Ganster, Jan Auffenberg, Pascal Backes, Thomas Bretz, Giang Do, Jan Paul Koschinsky, Leif Rädel, Martin Rongen, Anna Sauret, Merlin Schaufel, Johannes Schumacher, Aatif Waza, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut, RWTH Aachen University

The IceAct Imaging Air Cherenkov Telescopes are proposed surface detectors extending the IceCube Neutrino Observatory. By observing cosmic ray air showers in the atmosphere with a SiPM based camera, IceAct is capable to veto atmospheric muons and neutrinos, which are a background in cosmic neutrino searches. In December 2015 a 7-pixel demonstrator telescope has been installed at the South Pole and operated in coincidence with IceCube. We present the first analysis of coincident events with the IceCube in-ice detector and the IceTop surface detector and conclude on the performance of the telescope.

T 69.3 Mi 17:00 Z6 - SR 2.013

Prospects on improving the IceCube composition measurements of Cosmic Rays with IceAct — •Pascal Backes, Jan Auffenberg, Thomas Bretz, Giang Do, Erik Ganster, Jan Paul Koschinsky, Leif Rädel, Martin Rongen, Anna Sauret, Merlin Schaufel, Johannes Schumacher, Aatif Waza, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

One main goal of IceCube is improved composition measurements of Cosmic Rays above the knee. IceAct is a planned surface detector consisting of compact Imaging Air Cherenkov Telescopes each equipped with a 61 pixel SiPM camera. Operating in coincidence with the surface detector IceTop and the IceCube in-ice detector, IceAct can provide additional information on the longitudinal profile of air showers. By simulating the response of IceAct to air showers, we study how well IceAct can measure this profile and separate different cosmic ray primaries.

T 69.4 Mi 17:15 Z6 - SR 2.013

HAWC's Eye - Implementing hybrid detection by combining a compact Imaging Air-Cherenkov Telescope with the HAWC Gamma-Ray Observatory — •Merlin Schaufel, Thomas Bretz, and Johannes Schumacher — III. Physikalisches Institut, RWTH Aachen University

Combining the techniques of Imaging Air-Cherenkov Telescopes (IACT) with ground based array detectors promise different advantages and new measurements using the complementary shower informations. We developed a compact Silicon Photomultiplier (SiPM) based telescope which was operated in coincidence with the HAWC Gamma-Ray Observatory during July 2017. Performance parameters including the effective area, zenith angle depended trigger response or the effective trigger threshold, usually only accessible by simulation, were directly measured using real air-shower data. Benefiting from the HAWC shower-core reconstruction, a direct measurement of the Cherenkov light density on ground was carried out for the high altitude of 4100 m.

We present the results of this study and discuss possible improvements for energy resolution and the gamma-hadron separation using a hybrid detector.

T 69.5 Mi 17:30 Z6 - SR 2.013

IceScint: A surface scintillation detector array as Enhancement of IceCube — •Thomas Huber for the IceCube-Gen2-Collaboration — Institut für Kernphysik (IKP), Karlsruher Institut für Technologie (KIT) and Deutsches Elektronen-Synchrotron, (DESY)

To increase the amount of detected high-energy neutrinos of cosmic origin IceCube-Gen2 is under development.

An Enhancement of the present surface array at IceCube (IceTop) by scintillation detectors is foreseen. A scintillator array can be used to increase the veto capabilities for cosmogenic neutrinos and enables an improvement in cosmic-ray reconstruction. This Enhancement and its research and development is in progress for a large-scale surface array of IceCube-Gen2.

2 Prototype stations with 7 scintillators showcasing technological advances for the next generation in cosmic ray detection have been developed for deployment at the South Pole in January 2018. For the readout of the scintillators, SiPMs *(Sillicon Photomultiplier)* are in use. These solid-state photosensors are similar in detection efficiency compared to classical photomultiplier tubes and have considerable advantages.

The detector design, the operation status and first measurements will be presented in this talk.

T 69.6 Mi 17:45 Z6 - SR 2.013

PEN as a Scintillator, Characterisation of Light Output Properties — •Thomas Kraetzschmar — MPI für Physik, München

Polyethylene Naphthalene (PEN) presently attracts the interest of various groups as a cheap, radio pure scintillating material with various potential fields of applications, spanning from low background experiments to high energy physics calorimeters and potential use in education. In this work, the light output of this scintillator was investigated. Several samples of PEN have been molded at different institutes, and characterized for their light output. The measurements conducted include photo spectral analysis and light yield measurements with SiPMs.The measurements and analysis are presented. Results for different molding parameters are presented.

T 69.7 Mi 18:00 Z6 - SR 2.013

Characterization of SiPMs for cosmic-ray air-shower detectors for the IceCube upgrade — •Marie Oehler[1], Andreas Haungs[1], Thomas Huber[1,2], Max Renschler[1], Harald Schieler[1], Bernd Hofmann[1], and Andreas Weindl[1] for the IceCube-Gen2-Collaboration — [1]KIT, Karlsruhe, Germany — [2]DESY, Zeuthen, Germany

IceCube is a cubic-kilometer neutrino detector installed in the ice at the geographic South Pole. To increase the amount of detected extragalactic neutrinos the upgrade IceCube-Gen2 is under development. Among others, a large surface scintillation detector array is proposed.

First prototype stations consisting of seven detectors each, will be installed in January 2018 at the South Pole. These recently developed detectors use scintillators, wavelength shifting optical fibers and a photosensor. Silicon Photomultipliers (SiPMs) by Hamamatsu are used as sensors because they are mechanically robust and do not require high voltage compared to classical photomultipliers. Before mounting the SiPMs in the detectors, characterization measurements were made to ensure their suitability and performance for the prototype station. In addition, in order to improve these scintillation detectors, comparison studies between SiPMs of other companies were performed. In this talk the photo-sensor calibration setup, the results of the calibration measurements and the comparison studies will be shown.

T 69.8 Mi 18:15 Z6 - SR 2.013

A study of SiPMs as light detectors for the use in imag-

ing atmospheric Cherenkov telescopes — •Alexander Hahn[1], David Fink[1], Daniel Mazin[2], Razmik Mirzoyan[1], and Masahiro Teshima[2] for the MAGIC-Collaboration — [1]Max-Planck-Institut für Physik, München, Deutschland — [2]Institute for Cosmic Ray Research, the University of Tokyo, Tokyo, Japan

MAGIC is a stereoscopic system of two identical Imaging Atmospheric Cherenkov Telescopes (IACTs) with mirrors of 17 m diameter operated by the MAGIC collaboration on the Canary of Island La Palma. Each of the telescope cameras is equipped with 1039 pixels, based on photomultiplier tubes (PMTs). We developed several prototype detector modules using silicon photomultipliers (SiPMs) as light detectors. The three detector modules consist of assembled matrices based on $6 \times 6\text{mm}^2$ SiPMs from Excelitas, SensL and Hamamatsu correspondingly. Our aim is to develop a SiPM-based pixel with the same active area as the PMT-based one, and to investigate the possible use of SiPMs as new photo sensors for existing and future large size IACTs. An active summation of the individual SiPM outputs to a combined signal of the assembled matrix was achieved while preserving the fast pulse shape. Special design constraints e.g. the operation at ambient temperature and a high level of background light have been addressed and are compared among our different prototypes. In this talk, we will present the features of our design and compare the SiPM-based modules to the existing PMT ones.

T 69.9 Mi 18:30 Z6 - SR 2.013

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

Liquid Xenon Time Projection Chambers (LXeTPC) are used in rare event searches for Dark Matter or neutrinoless double beta decay, or in applications as Compton telescope or camera, where the noble medium offers a combination of scintillation light and ionization that can be used to build large, uniform 3D position sensitive detectors. SiPMs are compact solid state light sensors with single photon count capabilities superior to the commonly used photomultiplier tubes (PMTs). Additionally they provide a high granularity, require comparatively low bias voltage, require less volume and induce less mass into the TPC due to their compact dimensions and, potentially, have a smaller cost per area. Most commercially available SiPMs are not sensitive to the scintillation light of xenon in the VUV regime at 178nm, so a special treatment is neccesary, in which the inactive entrance layer on top of the SiPM is thinned. We operate a test stand to observe the operational stability and to measure the sensitivity, crosstalk and afterpulse properties of three VUV-sensitive SiPM samples in liquid xenon. A 1" PMT is operated simultaneously for reference while scintillation light is provided by a ^{241}Am source immersed in liquid xenon.

T 69.10 Mi 18:45 Z6 - SR 2.013

Extending the Linear Dynamic Range of Silicon Photomultipliers — •Julian Kemp, Thomas Bretz, Thomas Hebbeker, Lukas Middendorf, Christine Peters, and Johannes Schumacher — III. Physikalisches Institut A, RWTH Aachen

Silicon photomultipliers (SiPMs) are replacing conventional photomultiplier tubes in many applications. They have similar or higher photon detection efficiencies, are very robust and do not suffer from aging. SiPMs are cell structured devices consisting of some hundred up to some ten thousand avalanche photodiodes operated in Geiger mode (G-APDs). When detecting a single photon, a cell discharges and produces a well defined output pulse. While recharging, the cell's gain and photon detection efficiency are reduced. Thus, for long lasting bright light pulses, one cell can be hit multiple times, each hit producing a reduced response. The SiPM response to large light fluxes is therefore non-linear and also depends on the temporal distribution of the incident photons. As expected from semiconductor devices, SiPMs are manufactured with great precision. Thus, the variation in the response of different cells and also between different SiPMs of the same type is small. This allows for a precise simulation of the SiPM behavior also for bright incident photon pulses. Making use of this high precision, an algorithm has been developed to recover signals in the highly non-linear regime of the SiPM. It allows to significantly increase the usable dynamic range of SiPMs. The working principle of the algorithm will be presented as well as first measurements to prove its usability.