T 105: Methods in Astroparticle Physics V

Time: Friday 9:00–10:30 Location: KS 00.004

T 105.1 Fri 9:00 KS 00.004

Neutron Detection with Gadolinium-loaded water based liquid scintillator — •Amala Augusthy, Noah Goehlke, Johann Martyn, Philipp Kern, and Michael Wurm — JGU Mainz

ANNIE is an accelerator neutrino experiment at the Booster Neutrino Beam at Fermilab. It is a 26-ton Gadolinium-loaded water Cherenkov detector designed to measure CC interaction cross-sections and neutron multiplicity. In addition, ANNIE serves as a testbed for novel detector technologies amongst which is Water-based Liquid Scintillator (WbLS). WbLS is a novel detection medium that allows the simultaneous detection of scintillation and Cherenkov light. To test the detection capabilities with WbLS, a 366 L cylindrical vessel, filled with Gadolinium (Gd) loaded WbLS, dubbed SANDI was deployed in ANNIE in fall 2024. The energy carried away by final-state neutrons is a major source of systematic uncertainty in long baseline neutrino oscillation experiments, hence it is very important to tag neutrons efficiently. To investigate neutron detection efficiency in Gd-WbLS, an AmBe source was deployed. Extracting the neutron detection efficiency requires a well-tuned Monte Carlo simulation. This talk presents an overview of the ongoing Monte Carlo tuning efforts aimed at quantifying the neutron detection efficiency in Gd-loaded WbLS.

T 105.2 Fri 9:15 KS 00.004

A high-precision nuclear recoil calibration facility at the TU Wien TRIGA reactor — •Andreas Erhart — Technische Universität München, München, Deutschland

Cryogenic calorimeters are a key technology for experiments aiming to measure coherent neutrino-nucleus scattering at the low-energy frontier or to directly search for sub-GeV dark matter particles. A detailed understanding of the detector response at the 100 eV scale is hereby indispensable. The CRAB collaboration has developed a novel, direct and model-independent calibration method based on nuclear recoils induced by the radiative capture of thermal neutrons. Following a successful feasibility study at TU München, where CRAB achieved the first observation of a monoenergetic peak at 112.5 eV from ^{182}W recoils and the observation of two ^{27}Al nuclear recoil peaks at 575 eV and 1145 eV, respectively, the project now enters its high-precision phase.

For this purpose, a dedicated calibration facility has been established at the TU Wien TRIGA reactor, providing a pure, low-intensity thermal neutron beam to the target detectors mounted inside a wet dilution refrigerator. Stable cryostat operation on a month-scale and excellent detector energy resolution below 5 eV have since been demonstrated. These results enable high-statistics calibration measurements of various detector materials such as $CaWO_4$, Al_2O_3, germanium and silicon in the near future, and open the prospect of an extensive associated physics program.

T 105.3 Fri 9:30 KS 00.004

Implementation of a Bi-Po Coincidence Cherenkov Source for Hybrid Calibration in JUNO — •Manuel Böhles[1], Marcel Büchner[1], Tim Charissé[1], Arshak Jafar[1], Meishu Lu[2], Johann Martyn[1], Oliver Pilarczyk[1], Hans Steiger[2], and Michael Wurm[1] — [1]Johannes Gutenberg University Mainz, Institute for Physics, 55128 Mainz, Germany — [2]Technical University of Munich, School of Natural Sciences, 85748 Garching, Germany

Hybrid Cherenkov/scintillation analyses in the JUNO experiment require dedicated calibration tools to improve event identification and background suppression. A precise characterization of Cherenkov light and its separation from scintillation light is essential for enhancing the sensitivity to rare event searches. A compact Cherenkov calibration source based on MeV-scale beta electrons and a delayed coincidence trigger has been designed and realized. The source is loaded with Th-228, providing Bi-Po-212 decay sequences with a well-defined time correlation. The prompt beta decay produces Cherenkov light, while the subsequent alpha decay generates a scintillation signal in a fast plastic scintillator, enabling efficient event tagging. Laboratory tests are underway, and deployment in the OSIRIS pre-detector is planned prior to JUNO calibration campaigns. These measurements will support hybrid Cherenkov/scintillation analyses in JUNO with enhanced sensitivity to solar neutrinos, searches for the Diffuse Supernova Neutrino Background (DSNB), and potential future neutrinoless double beta decay ($0\nu\beta\beta$) studies. The development is funded by the DFG Research Unit "JUNO" (FOR 5519).

T 105.4 Fri 9:45 KS 00.004

Calibration and Long-term Monitoring for IceCube Upgrade mDOMs without Artificial Light Sources — •Carolin Klein and Summer Blot — DESY, Zeuthen, Germany

Since 2011, the IceCube Neutrino Observatory has yielded important results in neutrino astronomy and neutrino physics. The IceCube Upgrade expands this detector. A higher photomultiplier (PMT) density decreases the energy threshold of the experiment, enabling more detailed studies of atmospheric neutrino oscillations at the GeV scale. Current calibration routines of the multi-PMT digital optical module (mDOM) included in the IceCube Upgrade require artificial light produced by LEDs. In this talk, calibration methods without such light sources are presented, enabling calibration even in the case of an LED dysfunction. The calibration of the PMT gain and mainboard electronics is instead performed using dark noise, mainly induced by radioactive decays in the glass components of the module. The dark noise based methods can also be used in-situ for long-term monitoring of the calibrated properties during detector up-time. A long-term monitoring test stand based on these approaches was setup and operated in a laboratory. The goal is to assess the stability of calibration constants and mDOM performance over time in a well-controlled laboratory environment. In this talk, the first results of these measurements will be presented.

T 105.5 Fri 10:00 KS 00.004

The IceAct PiRATE: A Realtime Snow Accumulation Monitoring and Telescope Calibration System — •Lars Heuermann, Oliver Bosch, Cem Güer, Jan Nicklaus, Andreas Nöll, Jochen Steinmann, Christopher Wiebusch, and Simon Zierke — RWTH Aachen - III. physikalisches Institut B, Aachen, Germany

IceAct is an array of Imaging Air Cherenkov Telescopes located on the ice-surface of the IceCube Neutrino Observatory. It aims to calibrate IceTop and the in-ice detector, improve cosmic-ray composition studies, and potentially enhance IceCube's veto capability for atmospheric neutrinos. The telescope design is optimized to be cost-efficient and to operate reliably in the harsh environmental conditions of the South Pole. This is achieved by a Fresnel-lens-based optics and a camera with 61 SiPMs, resulting in a total field of view of 12 degrees per telescope. For stable operation, it is also important to monitor the changing environmental conditions. The Raspberry Pi-based Real-time snow Accumulation monitoring and Telescope calibration Enhancement (PiRATE) has been developed for this purpose. It features a nanosecond LED light pulser for in-situ camera calibration and a CCD-camera-based snow monitoring system, mounted inside the telescope. The PiRATE is designed to operate at extreme cold temperatures and with minimized emission of electromagnetic interference in the radio band. This talk will present the current status of the PiRATE, report on integration, function, and performance tests, as well as give an outlook on the future deployment at the South Pole.

T 105.6 Fri 10:15 KS 00.004

Optical calibration of the ice stratigraphy logger in the IceCube Upgrade — •Andrei Chubarov, Anna Eimer, and Martin Rongen for the IceCube-Collaboration — Erlangen Center for Astroparticle Physics (ECAP)

The IceCube Neutrino Observatory, deployed in the Antarctic glacier, detects atmospheric and astrophysical neutrinos using Cherenkov radiation from secondary charged particles. Limited knowledge of the ice optical properties is currently the dominant systematic for many analyses. The recently deployed IceCube Upgrade includes several new types of calibration modules, enabling additional measurements of the optical properties of the ice. The LOMlogger is such a device, which measured the backscattered light from a collimated light source to analyse the ice stratigraphy in two Upgrade drill holes. This new data covers 150m below the previously explored ice depths and serves as a technology demonstrator for potential large-scale stratigraphy logging in IceCube-Gen2.

In this talk, laboratory characterizations of the light source employed by the LOMlogger will be presented. This includes the pulsed intensity and the angular profile of the laser beam emitted into the ice.