T 83: Methods in Astroparticle Physics IV

Time: Thursday 16:15–18:00 Location: KS 00.004

T 83.1 Thu 16:15 KS 00.004

The Monte Carlo simulation of JUNO's pre-detector OSIRIS — •Lukas Bieger, Dhanushka Bandara, Silvia Cengia, Jessica Eck, Adrian Keiderling, Florian Kirsch, Tobias Lachenmaier, Anurag Sharma, and Tobias Sterr — Eberhard Karls Universität Tübingen

The Jiangmen Underground Neutrino Observatory (JUNO) is a multi-purpose neutrino experiment with a 20 kt liquid scintillator detector located in southern China. Its primary objective is to determine the neutrino mass ordering by measuring the oscillated energy spectrum of electron antineutrinos from nearby nuclear power plants with unprecedented energy resolution. The scintillator filling of JUNO was completed in August 2025 and JUNO started data-taking. The Online Scintillator Internal Radioactivity Investigation System (OSIRIS) monitored the radiopurity of the liquid scintillator during the filling, ensuring that the required contamination upper limits were met. OSIRIS is an 18 t liquid scintillator detector, instrumented with 64 20-inch PMTs to detect the light produced by events in the detector's sensitive volume. A precise Monte Carlo simulation is essential for understanding the detector's performance and for optimizing analysis methods. This talk will present the comprehensive simulation framework developed for OSIRIS, with particular emphasis on the MC tuning strategy employed to improve the accuracy of the simulation, as well as on its validation using calibration data, which demonstrates good agreement between simulation and measurements.

T 83.2 Thu 16:30 KS 00.004

Validation of Simulation Data for the IceAct Telescopes — •Cem Gür, Lars Heuermann, Lars Marten, Sönke Schwirn, and Christopher Wiebusch — III. Physikalisches Institut B - RWTH Aachen University

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TITLE: Validation of Simulation Data for the IceAct Telescopes

ABSTRACT: IceAct is a surface array of Imaging Air-Cherenkov Telescopes stationed at the South Pole as part of the IceCube Neutrino Observatory. Each telescope features a 61 SiPM pixel based camera with a Fresnel lens imaging on to it, resulting in a field-of-view of 12 degrees. The main goals of IceAct include the calibration of the IceTop surface array and the in-ice detector, as well as improving cosmic-ray composition studies. An agreement and understanding of the measured data and simulation is vital to reconstruct relevant parameters of cosmic-ray-induced extensive air showers for IceAct. Detailed comparisons allow the investigation of possible mismatches, their causes, and impact on reconstruction performance. In this talk we present three years of measured data to validate the IceAct simulation.

T 83.3 Thu 16:45 KS 00.004

Simulations of Particle Transmission and Electric Fields for the Munich Electrostatic Storage Ring (ESR) — •Nils Doll, Chiara Brandenstein, Peter Fierlinger, Adil W. Muggo, Dario Rückwarth, Wolfgang Schott, Vitus Schuster, Hans Th. J. Steiger, Konstantin Walter, and Florian Zötl — School of Natural Sciences, Physics-Department, Technical University of Munich, 85748 Garching, Germany

Stored ions or ionic molecules in a non-relativistic electrostatic storage ring can serve as a versatile platform for various fundamental experiments. Through precise control of beam dynamics and polarization, searches for electric dipole moments (EDMs) or axion-like particles (ALPs) become feasible in a rather unique and novel setting. Recent progress on the implementation of such a device is being discussed. COMSOL Multiphysics was used for a detailed field-based analysis of beam propagation, capturing emittance growth, phase-space evolution and nonlinear effects from realistic electrode geometries. A comparative simulation study of ion beam stability in an electrostatic storage ring is presented, focusing on the influence of fringe fields, space-charge effects, and radio-frequency (RF) systems for energy and trajectory control of barium and copper ions.

T 83.4 Thu 17:00 KS 00.004

DPG Abstract: Clustering algorithm for event reconstruction in LiquidO detectors — •Susanna Wakely and Kitzia Hernandez for the NuDoubt-Collaboration — Johannes Gutenberg University, Mainz

LiquidO is an innovative technology that uses opaque liquid scintillators for particle detection. A LiquidO scintillator combines a short scattering length and a long absorption length to stochastically confine optical photons close to their creation point. The result is balls of light where energy is deposited in the detector, with different particles producing different characteristic topologies of light balls. A fine array of wavelength-shifting fibres collects and transports the scintillation light for readout by SiPMs. A LiquidO detector will have unprecedented position resolution compared to current transparent scintillators and be capable of particle identification via event topology.

This talk will outline the development of a clustering algorithm, based on the Cambridge-Aachen jet clustering algorithm, for particle identification in LiquidO detectors. This work is done in the context of the CLOUD and NuDoubt++ experiments.

The CLOUD collaboration is designing a 5-10 ton LiquidO ultra-near reactor anti-neutrino detector. The NuDoubt++ experiment will be the first double-beta-plus ($\beta\beta$++}) decay experiment. It is expected to make the first 5σ observation of the $2\nu\beta\beta$++ decay, and discover or improve the half-life limit of the $0\nu\beta\beta$++ process by 3 orders of magnitude.

T 83.5 Thu 17:15 KS 00.004

A new optical model for LEGEND-200 with the remage simulation stack — •Manuel Huber, Rosanna Deckert, Luigi Pertoldi, and Stefan Schönert — Department of Physics, TUM School of Natural Sciences, Technical University of Munich, 85748 Garching b. München, Germany

To reach ultra-low backgrounds for the detection of the neutrinoless double-beta decay of ^{76}Ge, the Large Enriched Germanium Experiment for Neutrinoless $\beta\beta$ Decay (LEGEND) operates germanium detectors in scintillating liquid argon. A quantitative model of the complex optical instrumentation of the liquid argon is crucial for developing optimal methods to discriminate signal from background. I will present the development of a Monte Carlo model for the number of detected photons in the light readout channels deployed in the currently running stage of the experimental program, LEGEND-200. It is facilitated by the new Monte Carlo simulation stack `remage`, based on Geant4 and our Python-based package ecosystem around `pyg4ometry`, that I will present. To demonstrate the applicability of the new model, comparisons of the simulated detector response with LEGEND-200 characterization data will be presented.

We acknowledge support from the DFG under Germany's Excellence Strategy – EXC 2094 (ORIGINS) and through the Sonderforschungsbereich SFB 1258. We acknowledge support by the BMFTR Verbundprojekt 05A2023 (LEGEND).

T 83.6 Thu 17:30 KS 00.004

Development of an Optimized Liquid Argon Anti-Coincidence Classifier for LEGEND-200 — •Nele Sierig, Rosanna Deckert, Niko Lay, and Stefan Schönert for the LEGEND-Collaboration — Department of Physics, TUM School of Natural Sciences, Technical University of Munich, 85748 Garching b. München, Germany

The LEGEND-200 experiment searches for neutrinoless double beta decay of ^{76}Ge using up to 200 kg of high-purity germanium detectors immersed in instrumented liquid argon (LAr). To ensure ultra-low backgrounds, the experiment is operated deep underground at the Laboratori Nazionali del Gran Sasso. The LAr not only provides shielding and cooling, but also enhances active background suppression through an optical instrumentation system that detects scintillation light emitted upon interactions by ionizing radiation.

In this talk, I will present a novel LAr classifier, developed to tag and reject backgrounds efficiently. Our methodology integrates spatial and temporal information from the LAr scintillation light and utilizes detector-type-specific models. This development is essential for meeting the ambitious background goals and maximizing the overall sensitivity of LEGEND-200.

We acknowledge support from the DFG under Germany's Excellence Strategy – EXC 2094 (ORIGINS) and through the Sonderforschungsbereich SFB 1258. We acknowledge support by the BMFTR Verbund-

projekt 05A2023 (LEGEND).

T 83.7 Thu 17:45 KS 00.004

Quantitative Study of Cherenkov-Scintillation Separation for Background Suppression in Large Scale Neutrino Detectors — •Meishu Lu[1], Manuel Böhles[2], Lothar Oberauer[1], Michael Wurm[2], and Stefan Schönert[1] — [1]School of Natural Sciences, Technical University of Munich, 85748 Garching, Germany — [2]Institute for Physics, Johannes Gutenberg University Mainz, 55128 Mainz, Germany

The first physics results from the Jiangmen Underground Neutrino Observatory (JUNO) demonstrate the potential of next-generation large liquid-scintillator detectors. Beyond precision oscillation measurements, improved event reconstruction and background suppression are required for rare-event searches such as the diffuse supernova neutrino background (DSNB) and neutrinoless double-beta decay ($0\nu\beta\beta$). Separation of Cherenkov and scintillation light provides additional timing and topological information and has been firstly demonstrated by the Borexino collaboration. Building on previous tabletop studies at TUM, we present a new investigation of key factors affecting the separation ability, including emission spectra and photon-sensor quantum efficiency. These results indicate the potential of hybrid detection for future large-scale detectors and upgrades. We acknowledge support from the Deutsche Forschungsgemeinschaft under Germany's Excellence Strategy EXC 2094 - 390783311 and EXC 2118 - 390831469 and through the Sonderforschungsbereich SFB 1258 "Neutrinos and Dark Matter in Astro- and Particle Physics", as well as the DFG Forschungsgruppen FOR 2319 - 268668443 and FOR 5519 - 498394246.