# T 18: Methods in Astroparticle Physics I

Time: Monday 16:15–18:15 Location: KS 00.004

T 18.1 Mon 16:15 KS 00.004

**Large-scale TPB Vacuum Evaporation for the LEGEND-1000 Liquid Argon Veto** — •Lorenzo Pietropaoli[1], Konstantin Gusev[1,2], Laszlo Papp[1], Nadezda Rumyantseva[1,2], and Stefan Schönert[1] — [1]Department of Physics, TUM School of Natural Sciences, Technical University of Munich, 85748 Garching b. München, Germany — [2]Dubna, Russia

LEGEND-1000 searches for $0\nu\beta\beta$-decay using HPGe detectors in instrumented LAr. A critical background suppression component is the LAr instrumentation, utilizing scintillating fibers coated with Tetraphenyl Butadiene (TPB) and read out by SiPMs. TPB acts as a wavelength shifter, converting 128 nm VUV scintillation light from LAr to ∼430 nm blue light, which is absorbed by green wavelength-shifting (and scintillating) fibers and guided to SiPMs for detection.

We present the design and status of the new LEGEND-1000 TPB evaporator. Building on the LEGEND-200 experience, the system features a 2.3 m tall vacuum chamber designed for the simultaneous, uniform coating of 9 fiber modules with lengths up to 1.6 m. The setup is under construction and assembly in a dedicated new clean room facility at TUM. This talk covers the technical design, the scaling of the evaporation process, and the current status of the commissioning.

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

T 18.2 Mon 16:30 KS 00.004

**The detection principle and implementation of the Cryogenic Outer Veto for the NUCLEUS experiment** — •Alexandra Schröder for the NUCLEUS-Collaboration — Technische Universität München

Coherent Elastic Neutrino-Nucleus Scattering (CEvNS) is predicted in the Standart model to be a neutral current process with low recoil energies in the order of keV. Its experimental observation requires extremely sensitive detectors, enabling the study of neutrino properties and offering the potential to probe physics beyond the Standard Model. The NUCLEUS experiment is designed to observe CEvNS using cryogenic calorimeters with ultra-low energy thresholds oi the order of a few 10 eV. The final experimental site will be at the Chooz nuclear power plant in France, featuring a relatively low overburden of 3 m water equivalent. As a result, a robust background mitigation strategy is required to achieve the desired sensitivity. The Cryogenic Outer Veto (COV), consisting of kilogram-scale high-purity germanium crystals, constitutes a key component of the NUCLEUS background suppression system. The realization of the COV was a collaboration-wide effort. Prior to the integration of the full COV configuration consisting of six crystals, a single COV crystal was tested and operated within the experiment. The complete six-crystal COV system was integrated in December 2024. In this talk, I will present the design and operating principle of the COV, along with an overview of the upscaling process from a single crystal to the final six-crystal configuration.

T 18.3 Mon 16:45 KS 00.004

**Overview of the Cryogenic Detector and Development of the Cryogenic Inner Veto for the Observation of Coherent Elastic Neutrino Nucleus Scattering (CE$\nu$NS) with NUCLEUS10g** — •Michael Hock — Technische Universität München

The study of Coherent Elastic Neutrino Nucleus Scattering (CE$\nu$NS) offers new opportunities to investigate fundamental neutrino properties and to probe physics beyond the Standard Model. The NUCLEUS experiment aims to precisely measure the CE$\nu$NS cross-section from electron antineutrinos produced at the reactors of the Chooz nuclear power plant in France.

NUCLEUS targets ultra-low recoil energies by employing gram-scale cryogenic calorimeters with energy thresholds on the order of $\mathcal{O}(10\,\text{eV})$. In its first science phase, NUCLEUS 10g will deploy two detector modules, each comprising nine cryogenic target detectors embedded in a Cryogenic Inner Veto.

This contribution presents the current status of the NUCLEUS 10g detector components and reports on the ongoing development of the Cryogenic Inner Veto, which is expected to mitigate the Low Energy Excess (LEE) and therefore may be essential for achieving the required low-background conditions.

T 18.4 Mon 17:00 KS 00.004

**Digital broadband interferometry for mapping lightning at the Pierre Auger Observatory** — Markus Cristinziani[1], •Eric-Teunis de Boone[1], Qader Dorosti[1], Stefan Heidbrink[2], Waldemar Stroh[2], Jens Winter[2], and Michael Ziolkowski[2] — [1]Experimentelle Astroteilchenphysik, Center for Particle Physics Siegen, Universität Siegen — [2]Elektronikentwicklungslabor der Physik, Universität Siegen

Lightning-related phenomena are known to interact with and influence all detector systems of the Pierre Auger Observatory in Argentina. Notably, the Surface Detector has recorded unique signals linked to Terrestrial Gamma Flashes (TGFs) which are rare phenomena related to the initial processes of lightning. Interpreting these signals remains challenging due to the absence of a system capable of providing detailed 3D imaging of lightning propagation.

To address this gap, we are developing BOLT: Broadband Observatory for Lightning and TGFs, a state-of-the-art interferometric lightning mapping array that enhances the Observatory's unique capabilities for precision research including TGFs. It consists of radio detectors that have been previously developed for the Auger Engineering Radio Array (AERA), located at strategic positions within the Auger field.

This contribution highlights the recent hardware developments, progress towards selective triggering and precision timing, and first field data, illustrating the growing capability of the system for TGF and lightning studies.

T 18.5 Mon 17:15 KS 00.004

**Performance of a cryogenic heat pump demonstrator for future liquid xenon observatories** — •Philipp Schulte, Lutz Althüser, Robert Braun, Volker Hannen, Christian Huhmann, David Koke, Ying-Ting Lin, Patrick Unkhoff, Daniel Wenz, and Christian Weinheimer — Institut für Kernphysik, Universität Münster

Future liquid xenon (LXe) dark-matter detectors require detector backgrounds about ten times below the solar neutrino-induced background level. Achieving this demands 222Rn concentrations in LXe <0.1 *Bq/kg (less than one 222Rn atom in 160 mol xenon). The ERC project *LowRad* develops high-throughput cryogenic distillation for radon removal, where xenon flow rates of ~1600 kg/h imply heating and cooling powers of O(60) kW at the column reboiler and condenser. To reduce the external cooling demand, a xenon-based cryogenic heat-pump demonstrator has been built and operated. This contribution will present its design and performance, achieving up to ~130 W cooling/heating power at 3.3 bar and 4.3 bar with an electrical input of ~390 W (COP *0.32). Implications for the design and integration of full-scale systems in future LXe observatories such as XLZD will be discussed. Acknowledging support of the ERC AdG *LowRad* (101055063).

T 18.6 Mon 17:30 KS 00.004

**Construction and Deployment of the Wavelength-Shifting Optical Module for the IceCube Upgrade** — •Lea Schlickmann[1], Sebastian Böser[1], Enrico Ellinger[2], Klaus Helbing[2], Kyra Mossel[1], Adam Rifaie[2], and Nick Schmeisser[2] — [1]JGU Mainz University — [2]University of Wuppertal

The Wavelength-shifting Optical Module (WOM) is a novel optical sensor developed to enhance the sensitivity of neutrino detectors to ultraviolet (UV) Cherenkov light. It employs wavelength-shifting and light-guiding technology to efficiently detect UV photons that are otherwise difficult to capture with conventional sensors. Each WOM consists of a quartz tube coated with a wavelength-shifting paint, with a photomultiplier tube (PMT) coupled to each end. UV photons absorbed in the coating are re-emitted at longer wavelengths, captured by total internal reflection inside the tube, and guided to the PMTs for detection.

As part of the IceCube Upgrade, ten WOMs were produced, tested, and deployed in the Antarctic ice during the 2025/26 season. The IceCube Upgrade provides a unique opportunity to evaluate the performance of WOMs under real detector conditions, contributing to the development of future optical sensor technologies. This talk will present an overview of the WOM for the IceCube Upgrade.

T 18.7 Mon 17:45 KS 00.004

**Evaluating Dry Nitrogen Purging to Reduce Water Adsorption in Ultra-High-Vacuum Beam Tubes** — Charlotte Benning, •Hsiang-Chieh Hsu, Tim Kuhlbusch, Achim Stahl, and Jochen Steinmann — III. Physikalisches Institut B, RWTH Aachen

The Einstein Telescope (ET) requires 120 km beam pipes with a diameter of one meter. Additionally, to achieve the design sensitivity of the ET, a residual pressure below $10^{-10}$ mbar is required. Meeting both requirements will make the vacuum cost to about one-third of the total anticipated budget using current production and vacuum technologies. Continuous on-site manufacturing of the beam pipes in the tunnels can lower the cost while requiring novel cleaning method. Laser cleaning is proposed to be used to clean ferritic stainless steel surfaces and remove adsorbed water, eliminating the need for high-temperature and time-consuming bakeout. Therefore, controlling moisture re-adsorption is crucial. This work investigates how the dryness of the purging gas (nitrogen) influences the re-adsorption of water vapor on surfaces after cleaning, to identify the dryness level that keeps water contamination acceptably low.

T 18.8 Mon 18:00 KS 00.004

**Development of a High-Temperature Superconducting magnet** — •Christian von Byern for the AMS-100 at RWTH Aachen-Collaboration — I. Physics Institute B, RWTH Aachen

While AMS-02 is currently operated on board of the International Space Station, the next generation of cosmic particle detector is already planned. AMS-100 is designed for operation at Lagrange Point 2 and will feature a geometric acceptance of $100m^2sr$. With this large acceptance and improved momentum resolution a measurement of cosmic rays up to the PeV scale will be possible and an improvement of a factor 1000 regarding the sensitivity of anti-matter measurements is expected. The magnetic field of the spectrometer will be generated by a High Temperature Superconducting (HTS) solenoid. This coil will include several layers of individual HTS tapes. During operation at 55K it will produce a field of 0.5T at 4.5kA current. To reduce the material budget in terms of mass and interaction length the HTS tapes will be stabilized using few millimetres of aluminium. As an intermediate step a small demonstrator coil is in preparation. In this R&D phase multiple samples, including straight cable samples, bent cable samples as well as coil samples with few windings are prepared and tested. In this talk the development of a soldering process for cable production and measurement results of the different samples will be presented and interpreted.