T 14: Neutrinos, Dark Matter II

Time: Monday 16:30–18:00 Location: POT/0361

T 14.1 Mon 16:30 POT/0361

Nuclear Recoil modelling in XENONnT — •Luisa Hötzsch for the XENON-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg

The XENONnT detector is among the most sensitive dark matter experiments, aiming for the direct detection of WIMP dark matter with a multi-tonne xenon target in a dual-phase time projection chamber (TPC). WIMPs are expected to scatter elastically off the xenon nuclei in the target, resulting in a physical recoil of the nucleus. The energy that the recoiling nucleus imparts on neighboring xenon atoms leads to the creation of scintillation light and ionisation electrons, which are the two observables in the detector. A detailed understanding of the processes that govern the translation from deposited nuclear recoil (NR) energy into these two signal channels is therefore of utmost importance for the prediction of the signal shape of a potential WIMP interaction, as well as of NR background sources such as radiogenic neutrons.

In order to calibrate the detector response to NRs for the WIMP search, XENONnT uses neutrons from an external Americium-Beryllium source. In this talk, I will present the modelling and fitting of the liquid xenon response to the NR calibration data for the first WIMP search of the XENONnT detector.

T 14.2 Mon 16:45 POT/0361

Radon removal in the XENONnT experiment via cryogenic distillation — •Henning Schulze Eissing[1], Lutz Althüser[1], Christian Huhmann[1], David Koke[1], Andria Michael[1], Michael Murra[2,1], Philipp Schulte[1], and Christian Weinheimer[1] for the XENON-Collaboration — [1]Institut für Kernphysik, Universität Münster — [2]Columbia University, New York, USA

In order to reduce the dominant component of the electronic recoil background, Rn-222 and its progenies, in the XENONnT experiment a high flux radon removal system has been build by our group (Eur. Phys. J. C 82 (2022) 1104). Rn-222 continuously emanates from detector components and distributes homogeneously within the liquid xenon target due to the half-life of 3.8 days.

Our active radon removal system utilizes the vapor pressure difference between radon and xenon in the form of a cryogenic distillation column. With a xenon flow of 200 slpm the full 8.6 t of xenon are passed through the column within one mean lifetime of Rn-222 resulting in a radon concentration reduction by a factor two. An additional extraction flow of 25 slpm from the xenon gas phase provides a further reduction factor of about two. Combining both methods we achieved a radon activity concentration as low as 1 muBq/kg, the lowest value to date with a xenon-based Dark Matter experiment.

This talk will outline the working principle of the radon removal system and the performance within the XENONnT experiment.

This work is supported by BMBF under contract 05A20PM1 and by DFG within the Research Training Group GRK 2149.

T 14.3 Mon 17:00 POT/0361

Search for Sub-Relativistic Magnetic Monopoles in IceCube — •Silvia Latseva, Annika Wolf, Jakob Böttcher, Christian Dappen, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory at the South Pole is designed to detect high-energy neutrinos. It is also used for searches for exotic particles such as magnetic monopoles, which are predicted by Grand Unified Theories as relics from the very early Universe. A sub-relativistic magnetic monopole could catalyze nucleon decays in matter via the Rubakov-Callan effect. These decays result in small particle showers along the monopole's track with a spacing ranging from centimeters to tens of meters. IceCube detects the Cherenkov light produced in these processes and records potential monopole events by the so-called SLOw Particle (SLOP) trigger. For the separation of signal from background, we have developed an event selection algorithm based on Boosted Decision Trees (BDTs), which are trained on simulated monopole signals and data-driven backgrounds. This talk will give an update on the search for sub-relativistic monopoles in IceCube.

T 14.4 Mon 17:15 POT/0361

Paleo-detectors for Dark Matter — •Alexey Elykov — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

Despite the recent advances in physics, Dark Matter (DM) still eludes detection by modern large-scale experiments and puzzles the minds of physicists. Paleo-detectors represent a drastically different approach to DM detection, which uses ancient samples of natural minerals to search for nm-sized damage tracks produced by DM-induced nuclear recoils, that will accumulate in the minerals for $\sim 1\,\mathrm{Gyr}$, while they reside in the depths of the Earth. Modern, state-of-the-art microscopy techniques can be used to read out these minute tracks with nm resolution, differentiating them from those produced by more energetic radioactive contaminants. Despite their small size the Gyr-scale lifetime of paleo-detectors provides them with enormous exposure, allowing them to probe DM-nucleon cross sections below current limits for DM masses greater than $30\,\mathrm{GeV/c^2}$. For lighter DM particles, with masses $< 10\,\mathrm{GeV/c^2}$, the sensitivity of paleo-detectors reaches many orders of magnitude below the current upper limits. In this talk, the latest research and developments towards the use of mineral-based paleo-detectors will be presented.

T 14.5 Mon 17:30 POT/0361

Construction of the JUNO pre-detector OSIRIS — •Tobias Sterr[1], Cornelius Vollbrecht[2], Oliver Pilarczyk[3], Jessica Eck[1], Tobias Heinz[1], Lukas Bieger[1], Marc Breisch[1], Benedict Kaiser[1], and Tobias Lachenmaier[1] — [1]Eberhard Karls Universität Tübingen, Tübingen, Physikalisches Institut — [2]Nuclear Physics Institute IKP-2 Forschungzentrum Jülich, Jülich, Germany — [3]Institute of Physics and EC PRISMA+, Johannes-Gutenberg University Mainz, Mainz, Germany

The Online Scintillator Internal Radioactivity Investigation System (OSIRIS) is a 20-ton liquid scintillator detector currently under construction at the Jiangmen Underground Neutrino Observatory (JUNO) in Kaiping, China. OSIRIS* main goal is the monitoring of the purity of the liquid scintillator during the filling phase of the JUNO main detector. The construction of OSIRIS was performed between September *22 to January *23 and involved both, Chinese and German personnel. During that time all auxiliary systems (e.g., liquid handling), (digital) infrastructure (e.g., network devices) as well as scientific equipment was installed. This talk will report on the procedures, systems, challenges, and results of this installation work. This work is supported by the Deutsche Forschungsgemeinschaft.

T 14.6 Mon 17:45 POT/0361

Optimisation of Light Concentrators in the OSIRIS Upgrade — •Marcel Büchner — Johannes Gutenberg-University Mainz

OSIRIS as the pre-detector of the JUNO reactor neutrino measurement, is meant to monitor the radio-purity of the scintillator used. When upgraded in the future, it is supposed to either be used as solar neutrino detector or to search for neutrino-less double-Beta decay. To provide a better energy resolution, the photon detection efficiency of OSIRIS needs to be increased. This is achieved by increasing the number of PMTs used along with adding Winston cones as light concentrators in front of them. Previous optimisations have shown that the optimal shape of these light concentrators depends heavily on the exact detector geometry. So the ideal arrangement for the PMTs needs to be found. This talk presents the on going work to optimise the light collection of the OSIRIS upgrade. During first tests an arrangement of 132 PMTs with light concentrators, on an almost equidistant triangular grid has been found, with an optical coverage that is at least 9 times higher then the current OSIRIS detector.