T 118: Dark Matter II

Time: Thursday 15:50–17:20 Location: POT/0006

T 118.1 Thu 15:50 POT/0006

R&D of large-scale electrodes for future generation TPCs — •Vera Hiu-Sze Wu, Alexey Elykov, and Francesco Toschi — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

The DARk matter Wimp search with liquid xenoN (DARWIN) observatory is a future dark matter detector aiming at reaching the sensitivity for WIMPs at the neutrino floor and covering the mass range from 5 GeV/c2 to above 10 TeV/c2 [1]. The observatory uses the technology of a dual-phase time projection chamber (TPC) with a 40 t active volume of liquid xenon (LXe) [1].

The electrodes of the TPC are the vital components for 3D position reconstruction of the signal, benefiting the event selection processes. When designing the electrodes, we have to calculate and optimize the electrostatic. At the same time, the mechanical stability, the feasibility of manufacturing and treatment, as well as to minimization of spark and electron emission has to be ensured. Here we present our investigations of hexagonal mesh electrodes, including mechanical stability and handling as well as the first test of local high-voltage field emission.

[1] J. Aalbers et al., J. Cosmol. Astropart. Phys., 11, 017 (2016)

T 118.2 Thu 16:05 POT/0006

A high resolution scanning set-up for defect detection on electrodes — •Alexander Deisting[1], Jan Lommler[1], Shumit Mitra[1], Uwe Oberlack[1,2], Fabian Piermaier[2], Quirin Weitzel[2], and Daniel Wenz[1] — [1]Institut für Physik & Exzellenzcluster PRISMA+, Universität Mainz — [2]PRISMA Detector Laboratory, Universität Mainz

Achieving as low backgrounds as possible is key when operating time projection chambers (TPCs) for dark matter searches. One source of background signals is the (field) emission of electrons from the electrodes inside the detector. For dual phase TPCs, similar to XENONnT, these electrodes are meshes or grids with wire diameters of $200 - 300\,\mu$m, operated at a high voltage (HV) $\gg 1\,$kV.

The scanning set-up at the PRISMA Detector Laboratory features a high resolution camera mounted to a gantry robot system. The camera's resolution of $1.4 \times 1.4\,\mu\text{m}^2$ provides detailed images of electrode wires. A 3D confocal microscope with a resolution better than $1\,\mu$m is used for studies on the μm scale. We will present results of mesh-scans.

The high resolution images uncover an abundance of microscopic "defects" but they do not show whether a found spot will enhance electron emission and thus the background signals in the TPC or not. To asses the defects' nature we extended the set-up with an overview camera and a HV supply. An electrode wire in a gas may emit electrons, resulting in a corona discharge, which the overview camera records. We present the set-up and report on our progress of matching regions of corona discharges with defects uncovered in the high resolution scan.

T 118.3 Thu 16:20 POT/0006

Understanding xenon scintillation properties — •Robert Hammann, Dominick Cichon, Luisa Hötzsch, Florian Jörg, Teresa Marrodán Undagoitia, and Mona Piotter — Max-Planck-Institut für Kernphysik

Xenon in gaseous and liquid form is a commonly used detector target material for rare-event searches like the direct detection of dark matter. The material has a number of beneficial properties for this application, one being that it is an excellent scintillator. Most xenon-based detectors rely on measuring the scintillation light component emitted in the vacuum ultraviolet range, however, light is also emitted in a wide spectrum of longer wavelengths. Exploring this parameter space could enable the construction of even more sensitive detectors in the future.

In this contribution, we present first measurements with a dedicated setup to extend our knowledge of the scintillation response in gaseous xenon to infrared light, which is so far not exploited in the field. In order to assess the usefulness of this wavelength range for rare-event searches, it is essential to characterize its response. We report measurements of the scintillation light yield for varying levels of electromagnetic impurities and as a function of the xenon gas pressure.

T 118.4 Thu 16:35 POT/0006

The CRESST-III Dark Matter Search: Status and Outlook — •Christian Strandhagen for the CRESST-Collaboration — Eberhard-Karls-Universität Tübingen, D-72076 Tübingen

The CRESST experiment (Cryogenic Rare Event Search with Superconducting Thermometers) operates an array of cryogenic detectors using different target materials in a well-shielded setup at the LNGS (Laboratori Nazionali del Gran Sasso) underground laboratory in Italy to search for nuclear recoils induced by scattering of dark matter particles in the detectors. With detection thresholds for nuclear recoils as low as 10 eV, CRESST is among the leading experiments in the search for low mass dark matter particles. The most recent measurement campaign, which started in summer 2020, was focused on investigating the origin of an unexplained event population at very low energies ("low energy excess") which is limiting the sensitivity of the experiment in the low mass region. We present the status of CRESST-III and report on observations of the low energy excess and dark matter results. Finally we show our plans for the coming years including the upgrade of the readout electronics.

T 118.5 Thu 16:50 POT/0006

A low-threshold diamond cryogenic detector for sub-GeV Dark Matter searches — •Anna Bertolini[1], Gode Angloher[1], Antonio Bento[1,2], Lucia Canonica[1], Nahuel Ferreiro Iachellini[1], Dominik Fuchs[1], Abhijit Garai[1], Dieter Hauff[1], Athoy Nilima[1], Michele Mancuso[1], Federica Petricca[1], Franz Probst[1], Francesca Pucci[1], Ahmed Abdelhameed[1], Elia Bertoldo[1,3], and Johannes Rothe[1,4] — [1]Max-Planck-Institut für Physik, München, Germany — [2]LIBPhys-UC, Departamento de Fisica, Universidade de Coimbra, Coimbra, Portuga — [3]Institut de Física d'Altes Energies (IFAE), Barcelona Institute of Science and Technology (BIST), Bellaterra (Barcelona) — [4]Physik-Department and Excellence Cluster Universe, Technische Universität München, D-85748 Garching, Germany

Recently the sub-GeV dark matter (DM) mass region has started to be probed. To explore this region, detectors with a low energy threshold are required. Recent developments in the production of diamond crystals allow for high-quality large-mass diamonds that can be used as DM detectors. Thanks to their superior cryogenic properties, diamond detectors can reach an energy threshold in the eV range. In this contribution the realization of the first low-threshold cryogenic detector that uses diamond as absorber for astroparticle physics applications will be reported. Two diamond samples instrumented with a W-TES have been tested, showing transitions at about 25 mK. The performance of the diamond detectors will be presented highlighting the best performing one, reaching an energy threshold of 16.8 eV.

T 118.6 Thu 17:05 POT/0006

ELOISE - Reliable Background Simulation at Sub-keV Energies — •Holger Kluck — Institut für Hochenergiephysik der Österreichischen Akademie der Wissenschaften, 1050 Wien, Österreich

$CaWO_4$ is a well-known target material for experiments searching for rare events like coherent elastic neutrino-nucleus scattering (CEνNS) with NUCLEUS or hypothetical dark matter-nucleus scattering with CRESST. Pushing the detection threshold down to sub-keV energies, experiments encounter new phenomena like an exponential rise of observed events towards lowest energies of yet unknown origin. This highlights the need for verified and reliable simulations of radioactive background components at sub-keV energies, e.g. based on the widely used Geant4 toolkit.

The ELOISE project aims to tackle this issue for electromagnetic particle interactions in $CaWO_4$ in a two-stage approach: First by a systematic evaluation of the current accuracy by comparing benchmark simulations with data from extended literature research and dedicated measurements. Second, if needed, ELOISE intend to develop bespoken simulation code for $CaWO_4$ to improve the accuracy at the sub-keV energy regime. Currently, ELOISE conduct a dedicated measurement of electronic energy loss in $CaWO_4$ via ionization.

In this contribution, I will first motivate the problem and outline the scope of ELOISE. Afterwards, I will report first results of ELOISE's reference measurements. Finally, I will discuss our preliminary findings and its implication for rare event searches with $CaWO_4$.