T 84: Search for Dark Matter IV

Time: Thursday 16:15–18:45 Location: VG 4.102

T 84.1 Thu 16:15 VG 4.102

Status of the DarkMESA Experiment — •Mirco Christmann for the MAGIX-Collaboration — Institute for Nuclear Physics, JGU Mainz, Germany

At the Institute for Nuclear Physics in Mainz the new electron accelerator MESA will be operational shortly. The high-power beam dump of the P2 experiment (150 MeV, 150 μA) is ideally suited for a parasitic dark sector experiment – DarkMESA.

The experiment is designed for the detection of Light Dark Matter (LDM) which in the simplest model couples to a massive vector particle, the dark photon γ. It can potentially be produced in the beam dump by a process analogous to photon Bremsstrahlung and may then decay into Dark Matter (DM) particle pairs $\chi\bar{\chi}$. A fraction of them scatter off electrons or nuclei in the DarkMESA detectors.

This contribution discusses the extension of the simulation framework through the integration of additional models and the current status of the Phase A setup. Beyond the use of a traditional calorimeter, the possibility of utilizing a liquid scintillator for Phase B is under investigation. Initial results obtained in co-operation with the NuDoubt^{++} collaboration are presented.

T 84.2 Thu 16:30 VG 4.102

Light Dark Matter Search with DarkMESA — •Christian Stoss for the MAGIX-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg-University Mainz, Germany

The existence of Dark Matter remains one of the most significant open questions in particle physics. The DarkMESA experiment aims to search for Light Dark Matter (LDM) in an unexplored mass and coupling regime. This parasitic beam dump experiment will be located downstream of the P2 experiment at the new MESA accelerator in Mainz. It is planned to operate for 10,000 hours in extracted beam mode, using a $150\mu A$ electron beam with an energy of $150MeV$.

In the simplest model of LDM, the dark matter particle χ couples to a massive vector particle, the dark photon γ'. In this framework, electrons in the beam dump can produce γ' via a Bremsstrahlung-like process. If kinematically allowed, these dark photons then decay into $\chi\bar{\chi}$ pairs. If LDM exists within the targeted parameter space, a fraction of the produced LDM will scatter off electrons or nuclei in the calorimeter's Cherenkov crystals, generating measurable signals.

This contribution will include a brief overview of the planned experimental stages of DarkMESA as well as a further study for possible improvement of the readout techniques with additional SiPMs at different operating temperatures.

T 84.3 Thu 16:45 VG 4.102

Investigation of hadronic Backgrounds for Lohengrin — •Laney Klipphahn for the Lohengrin-Collaboration — Universität Bonn

The search for dark matter has long been of interest to scientists around the world. Previous searches have so far been unsuccessful in finding proposed DM particles. A promising and not well explored family of DM models contains dark matter particles with masses below $\approx 1\,\mathrm{GeV}$ connected through a portal interaction to the standard model. The Lohengrin experiment at the ELSA electron accelerator in Bonn is a fixed target experiment designed to probe this mass range by searching for dark photons in a dark bremsstrahlung process in the target.

Lohengrin will probe the dark sector by analyzing events with a significant amount of missing momentum in the final state. Hadronic final states comprise a particularly challenging background to the dark photon search, as single nucleons or mesons can be ejected from the target at high angles, evading the detectors that are placed in forward direction. In this talk I will present the results of a MC driven background estimation for the Lohengrin experiment, and its impact on the design and layout of the detector.

T 84.4 Thu 17:00 VG 4.102

Active muon veto of the COSINUS experiment — •Kumrie Shera for the COSINUS-Collaboration — Max-Planck Institute for Physics, Munich, Germany

The Cryogenic Observatory for SIgnatures seen in Next Underground Searches (COSINUS) is a direct dark matter search experiment utilizing sodium iodide (NaI) crystals as cryogenic calorimeters. The cryogenic facility is located in hall B of the Laboratori Nazionali del Gran Sasso (LNGS) in Italy. The NaI cryogenic detectors will be housed in a dry dilution refrigerator positioned at the center of a water tank with a diameter and height of seven meters. The water serves as passive shielding against ambient radiation.

High-energy muons can penetrate the detector's surroundings, generating muon-induced neutrons that may cause nuclear recoils, potentially mimicking a dark matter signal. To actively identify and veto these events, the water tank is equipped with 30 photomultiplier tubes (PMTs), enabling the tank to operate as an active muon veto.

This contribution outlines the installation tests, PMT testing, and the commissioning of the full muon veto system at LNGS.

T 84.5 Thu 17:15 VG 4.102

Pulse Shape Studies on the COSINUS prototypes with BAT — •Sarah Braun for the COSINUS-Collaboration — MPP Munich

The Cryogenic Observatory for SIgnatures seen in Next generation Underground Searches (COSINUS) experiment, located at the Laboratori Nazionali del Gran Sasso (LNGS), Italy, will provide a model-independent cross-check of the DAMA/LIBRA experiment's findings of modulation signals consistent with the expected dark matter signal. It utilizes ultrapure NaI crystals operated at cryogenic temperatures, enabling a dual-channel readout of scintillation and phonon signals to discriminate different particle interactions.

This contribution focuses on fitting different pulse shape models to the COSINUS detector prototypes, using the Bayesian Analysis Toolkit (BAT) in Julia. Franz Pröbst's model for cryogenic detectors has proven effective when applied to the CRESST experiment detectors. This study explores whether similar success can be achieved with COSINUS prototypes using a remoTES. The overall objective is to understand the detector parameters and their effect on the performance, to guide and accelerate our detector R&D strategy.

T 84.6 Thu 17:30 VG 4.102

Dark matter direct detection with XENONnT experiment — •Giovanni Volta for the XENON-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Understanding the nature of Dark Matter (DM) is one of the open issues in modern physics. In this context, XENON project aims to lead the effort on DM direct detection using ton-scale xenon dual-phase time projection chamber technology, operating in a low background environment. The status of XENONnT experiment, operating at the underground LNGS (L'Aquila, Italy) laboratory, will be shown, along with the most recent DM search results.

T 84.7 Thu 17:45 VG 4.102

Study of spurious clustered electron emission signals in XENONnT — •Alexis Michel and Alexey Elykov — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

In direct search of dark matter, dual-phase xenon time projection chambers (TPCs) like XENONnT are widely used. This kind of detector has a target of liquid xenon (LXe) with a layer of gaseous xenon (GXe) above. Alongside the prompt scintillation signal, interactions in the TPC produce ionization electrons. These are drifted upward as a cloud of electrons by an applied electric field and extracted into the GXe to produce a secondary scintillation signal.

The extraction into the gas is not always complete and electrons can stay behind. What then happens to those electrons is not exactly known yet. Previous experiments often observed a number of spurious signal types, which could be associated with delayed extraction of trapped electrons. One such signal type takes the form of significantly delayed localized bursts of electrons (e-burst).

Understanding the origin of this background is of key importance for low-energy searches that look for particle interaction products down to the single- and few-electron level. Moreover, characterization of the e-burst background could shed light on the microphysics processes at the liquid-gas xenon interface, informing the operation and design of the current and future generation of xenon TPCs.

In this talk I will present the recent results and progress on studies of such signals and their correlation with detector conditions.

T 84.8 Thu 18:00 VG 4.102

.MOTION, a liquid xenon time projection chamber platform for high voltage development in dark matter detectors — •Yanina Biondi, Alexander Jansen, Steffen Lichter, Michael Schrank, Karin Vogt, and Yanina Biondi — Institute For Astroparticle Physics, Karlsruhe Institute of Technology

MOTION is a time projection chamber with 80 kg of liquid xenon (LXe), serving as a testing platform for high-voltage (HV) delivery of around -200 kV and stability in LXe for next-generation dark matter detectors. The objective of this detector is to study the breakdown voltage of liquid xenon, which might depend on different factors such as surface area of the conductor and the purity of the liquid xenon, among others. The detector also serves as a platform to study spurious electron emission from electrodes, as well as the development of high voltage feedthroughs made out exclusively of radiopure materials. This project is supported by the Young Investigator Group Preparation Program of the Karlsruhe Institute of Technology.

T 84.9 Thu 18:15 VG 4.102

Design and Commissioning of the MainzTPC2 — •Constantin Szyszka, Alexander Deisting, Christopher Hils, Peter György, Kaveh Kooshkjalali, and Uwe Oberlack — Institut für Physik & Exzellenzcluster PRISMA^{+}, Johannes Gutenberg-Universität Mainz

The MainzTPC is an experimental dual-phase xenon time projection chamber (TPC) dedicated to studying scintillation and ionization processes in liquid xenon for low-energy electronic and nuclear recoils. Its design has been optimized for use as the primary target in Compton and neutron scattering experiments to measure recoil energies in liquid xenon down to 1 keV.

To address known instabilities in the liquid level of the MainzTPC, we observed the liquid-gas interface using commercially available cameras and aim to improve the level meters and level control based on these observations. Additionally, the MainzTPC is being redesigned to accommodate an array of silicon photomultipliers (SiPMs) instead of the top photomultiplier tube (PMT) and eight avalanche photodiodes (APDs) to improve position resolution in x and y. Both of these changes require a complete redesign of the TPC and its infrastructure. We report on the status of this work.

T 84.10 Thu 18:30 VG 4.102

Simulation and Prototyping of the MainzTPC2 — •Peter Gyorgy, Alexander Deisting, Christopher Hils, Kaveh Kooshkjalali, Uwe Oberlack, and Constantin Szyszka — Johannes Gutenberg-Universität Mainz, Institut für Physik & Exzellenzcluster PRISMA+

The MainzTPC, a small-scale dual-phase xenon time projection chamber, is being redesigned. This upgrade includes the replacement of the top photomultiplier tube (PMT) with a silicon photomultiplier (SiPM) array to gain significantly improved spatial resolution in event reconstruction.

The goal is to achieve a deeper understanding of xenon scintillation and ionization yields at low energies, and to attempt to observe the elusive Migdal effect — a hybrid nuclear- electron- recoil signal that could prove key to extend to lower dark matter masses the sensitivity of large dual-phase time projection chambers, such as XENONnT or XLZD.

The prototyping process requires extensive modeling and simulations in GEANT4, exploring various design configurations. It must consider optical physics, neutron and gamma scattering, and long-term radioactive exposure. This presentation will summarize results from this simulation process.