HK 26: Instrumentation V

Time: Wednesday 13:45–15:30 Location: PHIL A 301

HK 26.1 Wed 13:45 PHIL A 301

Development of a Scintillating Fiber Hodoscope for the Proton Radius Measurement at AMBER — •Karl Eichhorn[1], Jan Michael Friedrich[1], Jarosław Grzyb[2], Igor Konorov[1], Martin J. Losekamm[3], Tim Maehrholz[1], Felix Mindl[1], Stephan Paul[1], Marcin Stolarski[2], and Frowin Wild[1] — [1]TUM School of Natural Sciences - Technical University of Munich, 85748 Garching, Germany — [2]National Centre for Nuclear Research, 02-093 Warsaw, Poland — [3]European Space Agency, ESTEC, 2201 AZ Noordwijk, Netherlands

The AMBER experiment will measure the proton charge radius using elastic muon-proton scattering at the M2 beam line at CERN. Four Scintillating Fiber Hodoscopes (SFHs) will be used in combination with ALPIDE pixel sensors to reconstruct the incoming beam particles, as well as the muons that have been scattered off the active hydrogen target. Each SFH consists of four 9x9 cm^2 large planes of square scintillating fibers, which are read out individually with SiPM arrays. Keeping the material budget to a minimum, they provide precise timing information using custom readout electronics based on the Citiroc 1A ASIC and the AMBER iFTDC. The first SFH detector was built and successfully tested with a high-energy muon beam in 2025. We will present the results of this beam test and provide an outlook on further developments.

We acknowledge funding from BMBF (grant number 05P24WO1) and MNiSW (grant number 2025/WK/03).

HK 26.2 Wed 14:00 PHIL A 301

Heavy-ion tracking detector at R^3B — •Isabelle Brandherm[1], Christoph Caesar[2], Pablo García-Gil[2,3,4], Michael Heil[2], Deniz Savran[2], and Andreas Zilges[1] for the R3B-Collaboration — [1]Institute for Nuclear Physics, University of Cologne, Germany — [2]GSI Helmholtzzentrum, Darmstadt, Germany — [3]Universidad de Vigo, Vigo, Spain — [4]Institute for Nuclear Physics, Technical University of Darmstadt, Germany

The R^3B (Reactions with Relativistic Radioactive Beams) experiment at GSI is a versatile setup that enables kinematically complete measurements. Tracking detectors are used at R^3B to reconstruct the trajectories of charged particles as they pass through the magnetic field of the the GSI Large Acceptance Dipole (GLAD) magnet. This allows the magnetic rigidity of the particles to be determined.

This talk presents the design and performance of a position-sensitive scintillation-fiber detector that will be a part of the tracking system for heavy ions. The detector is constructed from ultra-thin scintillation fibers with a thickness of 200μm. Thin fibers are used to minimize the material budget in the particle trajectory and thus reduce straggling within the detector material. The fibers are read out with silicon photomultipliers, allowing the detector to operate in magnetic fields while maintaining high detection efficiency.

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HK 26.3 Wed 14:15 PHIL A 301

Study of a low-temperature SiPM readout system for 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 several thousands of hours in extracted beam mode, using a 150 μA electron beam with an energy of 155 MeV. In the simplest model of LDM, the electrons might produce the dark photon as a massive vector particle via a Bremsstrahlung-like process in the beam dump, which then decay into dark matter particles. If LDM exists within the targeted parameter space, a fraction of the produced LDM will scatter off electrons in one of the calorimeters' Cherenkov crystals, generating a measurable signal.

Given the low probability of such an event, dark counts can significantly overlay the interesting signal. This presentation will focus on a feasibility study for a readout system consisting of one PMT with additional 5 cooled SiPMs per crystal as a small test setup. Initial measurements with a constant overvoltage and temperature dependent breakdown voltage will be presented. The aim is the reduction of dark counts while maintaining high detector efficiency for different temperatures.

HK 26.4 Wed 14:30 PHIL A 301

Feasibility Study on a Backward Angle Sampling Calorimeter for the P2 Experiment at MESA — Òscar Andújar Sabán[1], Ning Cao[1], Luigi Capozza[1], •Jonas Geisbüsch[1], Ravi Gowdru Manjunata[1], Frank Maas[1,2,3], Antoine Martinet[1], Oliver Noll[1,2], Paul Schöner[1], Christoph Rosner[1], Pierre Vijayan[1], and Sahra Wolff[1] — [1]Helmholtz-Institut Mainz, Mainz, Germany — [2]Institute of Nuclear Physics, Mainz, Germany — [3]PRISMA+ Cluster of Excellence, Mainz, Germany

A sampling calorimeter with SIPM read-out for the detection of high energy particles is under development. Such a calorimeter can be well suited for many experiment applications where space limitations apply. The main focus is on choosing the right material, as well as the right arrangement of active and passive material. Different mechanical options will be explored. The detector prototype design will be prepared by doing detector response simulations to ensure a high energy resolution, as well as a high spatial resolution. A possible application for such a calorimeter is the P2 experiment at the upcoming MESA accelerator in Mainz. The talk will give an update on the progress of this project.

HK 26.5 Wed 14:45 PHIL A 301

A new Liquid Scintillator Veto System for Rare Event Searches — •Michail Kontogoulas for the MAGIX-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University Mainz, Germany

In the ongoing search for light dark matter, the DarkMESA and NuDoubt^{++} experiments have combined their efforts to probe a new region of parameter space. DarkMESA is a forthcoming electron beam dump experiment to be located in the new MESA accelerator facility in Mainz, designed to detect light dark matter particles using a PbF_2 crystal calorimeter. The NuDoubt^{++} experiment will utilize an opaque liquid scintillator detector to investigate the double beta decay ($2\beta^+$) and the neutrinoless double beta decay ($0\nu\beta\beta$). Due to the expected rarity of these interactions, exceptional background rejection is crucial for identifying potential events. Therefore, both experiments plan to use passive and active shielding layers against background radiation. This contribution will focus on the development of a liquid scintillator veto prototype for use in both experiments. The prototype will feature a hexagonal geometry with an active volume of approximately 0.351 m^3, filled with a linear alkylbenzene (LAB) scintillator, doped with 0.2wt.% Gadolinium for enhanced neutron tagging. The scintillator will be read out by seven 5-inch PMTs mounted on the top surface of the volume. A comparative analysis will be presented, comparing simulation results with initial tests of the prototype to evaluate veto efficiency, with particular emphasis on neutron rejection, given their significance as a background in dark matter searches.

HK 26.6 Wed 15:00 PHIL A 301

Construction of the crystal Zero Degree Detector for BESIII — •Frederic Stieler, Achim Denig, Peter Drexler, Werner Lauth, Max Lellmann, Jan Muskalla, Jannik Petersen, Saskia Plura, Christoph Florian Redmer, Yasemin Schelhaas, and Hang Zhou — Institute for Nuclear Physics, Johannes Gutenberg University Mainz, Germany

The crystal Zero Degree Detector (cZDD) is an addition to the BESIII experiment in China. In order to measure hadronic cross sections with the Initial State Radiation (ISR) method for a more precise calculation of the hadronic vacuum polarization contribution to the anomalous magnetic moment of the muon, ISR photons have to be detected. Since these photons are mostly emitted at small angles in relation to the colliding particles, the cZDD will measure these photons at angles of about 1.5 mrad to 10.4 mrad, which are not covered yet by the already existing detectors at BESIII.

Following its installation at BESIII, first commissioning data have been taken. The detector is now being used to perform relative-luminosity measurements, allowing an evaluation of its performance

and stability under real experimental conditions.

This contribution discusses the current status of the cZDD, covering its installation, commissioning, and the first results of the relative-luminosity measurements.

HK 26.7 Wed 15:15 PHIL A 301

Studies of Cosmogenic Backgrounds in a Shielded Crystal Calorimeter for DarkMESA — •Shumit Mitra — Institute for Nuclear Physics, Johannes Gutenberg University Mainz, Germany

DarkMESA is a planned electron beam-dump experiment at the MESA accelerator facility in Mainz, designed to search for light dark matter particles mediated by a hypothetical dark photon γ' using a compact crystal calorimeter. Due to the extremely low expected interaction rates of beyond-the-Standard-Model processes, efficient background suppression is essential. DarkMESA therefore relies on a combination of passive and active shielding to mitigate cosmogenic and beam-related backgrounds. This contribution presents the development and characterization of a prototype calorimeter composed of 5×5 $PbWO_4$ crystals of dimensions $2 \times 2 \times 20\,cm^3$ with single-sided SiPM readout per crystal. The calorimeter is hermetically surrounded by inner and outer plastic scintillator veto layers and passive lead shielding. The detector performance with respect to cosmogenic muon- and gamma-induced backgrounds in the relevant energy range around 5 MeV and above is discussed and compared to detailed simulations. First results from long-term background measurements with the full detector setup are presented. Possible contributions from cosmogenic neutrons are briefly addressed. Finally, an outlook on the implications of these studies for a $PbWO_4$-based DarkMESA detector is given.