T 99: Methods in Astroparticle Physics IV

Time: Friday 9:00–10:30 Location: VG 3.101

T 99.1 Fri 9:00 VG 3.101

Comissioning a first atomic tritium source — •Leonard Hasselmann, Daniel Kurz, and Caroline Rodenbeck for the Atomic Tritium at TLK-Collaboration — KIT-IAP, Karlsruhe, Germany

The Karlsruhe Tritium Neutrino mass (KATRIN) experiment will Research a sensitivity below $0.3\,\mathrm{eV/c^2}$. In order to increase the sensitivity on the neutrino mass a new high resolution differential measurement method is required. The maximum effective resolution which can be achieved is not limited only by the detector, but also by molecular effects in the source gas constraining it to ~1 eV FWHM for T_2. Thus, future ultimate neutrino experiments need to use differential detectors combined with atomic tritium sources. Therefore, we move forward with the development of atomic tritium sources.

At the Tritium Laboratory Karlsruhe, a system to demonstrate the production of atomic tritium is currently being comissioned. A commercially available cracking system is used for hydrogen dissociation. For beam diagnostics, a quadrupole mass spectrometer equipped with a cross beam ion source is used.

In this talk, results from the comissioning of the system with non-radioactive gases like protium and deuterium are shown.

This work is supported by the Helmholtz Association and by the Ministry for Education and Research BMBF (grant numbers 05A23PMA, 05A23PX2, 05A23VK2, and 05A23WO6)

T 99.2 Fri 9:15 VG 3.101

Reduction of the molecular background in an atomic tritium setup using different shroud configurations — •Daniel Kurz, Leonard Hasselmann, and Caroline Rodenbeck for the Atomic Tritium at TLK-Collaboration — KIT-IAP, Karlsruhe, Germany

The investigation of the tritium β-decay spectrum at its endpoint is a direct way to measure the neutrino mass. Using molecular tritium reduces the achievable sensitivity by a broadening due to rotational and vibrational excitations of the $^3\mathrm{HeT}^+$ daughter molecule. The use of atomic tritium overcomes this fundamental limitation.

After a commissioning phase with inactive hydrogen, the "Beam for an Atomic Tritium Experiment" setup at Tritium Laboratory Karlsruhe is going to demonstrate the production of atomic tritium. To dissociate the hydrogen molecules, a commercially available dissociation device, the tectra H-flux atomic hydrogen source, is used. Investigating the beam composition is done by a HIDEN DLS10 quadrupole mass spectrometer (QMS) equipped with a cross-beam ion source.

Previous results show that recombination by wall contacts produces a major molecular background. To prevent recombined molecules from reaching the QMS beam shaping skimmers and a shroud are indispensable. The latter is an actively pumped tube around the QMS. In this, two opposite holes act as a skimmer trimming the beam to the size of the QMS entrance aperture. Molecules recombined inside the QMS are pumped away.

This talk presents the results investigating the reduction of the molecular background using different shroud configurations.

T 99.3 Fri 9:30 VG 3.101

Enhancing the energy resolution of MAC-E filters using a Transverse Energy Compensator (TEC) — •Richard Salomon, Kevin Gauda, Kyrill Blümer, Christian Gönner, Volker Hannen, and Christian Weinheimer — Universität Münster - Institut für Kernphysik, Münster, Deutschland

Precise electron spectroscopy with energy resolutions on the eV-scale is currently possible using magnetic adiabatic collimation with an electrostatic filter. Such a MAC-E filter is currently in use at the Karlsruhe Tritium Neutrino (KATRIN) experiment, where an energy resolution of 2.7 eV is achieved in the standard measurement configuration.

This talk focuses on a novel method to improve the energy resolution of MAC-E filters. It can be shown that accelerating electrons in a Wideröe-type drift tube with a polynomial voltage ramp in a high magnetic field creates an angular-dependent energy gain compensating the missing longitudinal energy component in the analyzing plane. In the KATRIN example, a Transverse Energy Compensator (TEC) can lead to an improvement by up to an order of magnitude, while other configurations might benefit even more. If combined with a time-of-flight measurement, it is possible to obtain a differential spectrum measurement with a sub-eV energy resolution, which is necessary to probe the inverted neutrino mass ordering.

This idea by Christian Weinheimer has been submitted as a provisional patent application under the number 10 2024 126 381 by the University of Münster. This work is supported by BMBF ErUM-Pro 05A23PMA.

T 99.4 Fri 9:45 VG 3.101

Position Reconstruction in a Scintillating CeBr3 Crystal for the ComPol CubeSat Using Neural Networks — •Jonas Schlegel — TUM, Muenchen, Deutschland

Compact objects such as Black Hole Binaries represent extreme astrophysical environments with many unresolved questions. Their small size makes them unsuitable for imaging techniques. Precise X-ray spectra and polarization measurements are crucial for understanding their dynamics and geometry. The CubeSat mission ComPol targets the binary system Cygnus X-1, which includes a rotating black hole and a companion star. After In-Orbit Verification (IOV) on the ISS, it will operate in Low Earth Orbit (LEO), performing spectroscopy and polarimetry in the 20-200 keV hard X-ray range.

Polarimetry is based on Compton scattering kinematics in a two-layer detector system. The prototype uses Silicon Drift Detectors (SDD) to determine the recoiling electron's energy and position, while a CeBr3 scintillator records photon energy via a Silicon Photomultipliers (SiPM) matrix. The core objective is to reconstruct absorbed X-ray events in the calorimeter.

A barium source is used for detector calibration, with scans performed in the X-Y and Y-Z planes. Neural networks achieve position resolutions of 2.4-4.3 mm in the x and y plane and 2.8 mm for the z plane. Edge effects are corrected with position- and energy-dependent shifts. Data from the LARIX X-ray facility validate the expected ϕ-distribution for unpolarized X-rays, demonstrating the success of the position reconstruction methods.

T 99.5 Fri 10:00 VG 3.101

Reconstruction of atmospheric neutrino events in JUNO — •Milo Charavet, Rosmarie Wirth, Mikhail Smirnov, Caren Hagner, and Daniel Bick — Hamburg University, Hamburg, Germany

The ordering of the neutrino masses is one of the fundamental open questions in the field of neutrino physics. The Jiangmen Underground Neutrino Observatory (JUNO) is a multipurpose liquid scintillator-based experiment (LS) with a target mass of 20 kt. It aims to determine the neutrino mass ordering (NMO) with at least 3σ significance, through a measurement of the oscillation pattern of reactor neutrinos over 53 km baseline. While reactor neutrinos are the main source of sensitivity to NMO at JUNO, atmospheric neutrino oscillation can provide independent sensitivity, and enhance its overall sensitivity in the combined analysis. As one of the largest LS detectors, JUNO might be able to measure with high precision the atmospheric neutrino events and their oscillation parameters. However, accurately reconstructing atmospheric neutrinos in such a large liquid scintillator detector is a significant challenge. This talk presents reconstruction methods to analyze these atmospheric neutrino events.

T 99.6 Fri 10:15 VG 3.101

Development of a high temperature superconducting magnet for applications in space — •Christian von Byern[1], Laurenz Klein[1], Daniel Louis[1], Niklas Moldrickx[2], Irfan Özen[1], Dominik Pridöhl[1,2], Ben Rüsse[2], Stefan Schael[1], Thorsten Siedenburg[1], Myrto Theodorou[1], and Michael Wlochal[1] — [1]I. Physics Institute B, RWTH Aachen, Germany — [2]Institute of Structural Mechanics and Lightweight Design, RWTH Aachen, Germany

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 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 measurement results of the different samples will be presented and interpreted.