T 66: Neutrinos II

Time: Wednesday 15:50–17:20 Location: POT/0251

T 66.1 Wed 15:50 POT/0251

Detection of solar pp-neutrinos with CID in SERAPPIS — •Tim Charissé, Marcel Büchner, Arshak Jafar, Kai Loo, George Parker, Oliver Pilarczyk, and Michael Wurm — Institute of Physics and EC PRISMA+, Johannes-Gutenberg University Mainz, Mainz, Germany

The OSIRIS detector, a pre-detector that monitors the radiopurity of the scintillator for the JUNO experiment, is planned to be used for the measurement of the solar pp-neutrino flux after fulfilling it's initial purpose. This upgrade is called SEarch for RAre PP-neutrinos In Scintillator (SERAPPIS). As these pp-neutrinos originate from the sun it is crucial to obtain the directional information to get a high sensitivity. This directional information is contained in the Cherenkov light which is hard to distinguish from the scintillation signal. While there are experimental efforts like slow scintillators to enhance the sensitivity for Cherenkov light in SERAPPIS, there is also a data-analytical method called Correlated and Integrated Directionality (CID) to obtain the directional information from the data. It uses the angular distribution between the direction of the neutrino and the detected light for the whole data set to gain information over the pp-neutrino flux.

This talk will present the status of the ongoing sensitivity study for CID in SERAPPIS based on Monte Carlo simulations. It is investigated if CID can have a valuable impact on the measurement of the solar pp-neutrino flux.

T 66.2 Wed 16:05 POT/0251

Column Density Determination for the KATRIN Neutrino Mass Measurement — Fabian Block[1], •Christoph Köhler[2], and Sonja Schneidewind[3] for the KATRIN-Collaboration — [1]Karlsruhe Institute of Technology — [2]Technical University of Munich — [3]Westfälische Wilhelms-Universität Münster

The KATRIN experiment aims to model-independently probe the effective electron anti-neutrino mass with a sensitivity of 0.2 eV (90 % CL) by investigating the endpoint region of the tritium beta decay spectrum. To achieve this goal the gas quantity of the windowless gaseous tritium source, characterized by the column density, has to be known with great accuracy.

We present in this talk the principle of measuring the column density with an angular resolved photoelectron source and describe the method to ensure continuous monitoring of the column density during measurement campaigns of KATRIN. The influence of the recent hardware upgrade of the photoelectron source is discussed in light of the column density determination accuracy.

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T 66.3 Wed 16:20 POT/0251

Calorimetric methods for monitoring Atomic hydrogen beam for Project 8 — •Christian Matthé, Felix Wünsch, and Sebastian Böser for the Project 8-Collaboration — Johannes Gutenberg Universität Mainz

The Project 8 collaboration aims to determine the absolute neutrino mass with a sensitivity of 40 meV by measuring the tritium decay spectrum around the endpoint energy. For this level of precision it is necessary to use atomic tritium, since molecular tritium sensitivity is limited by the molecular final state distribution to about 100 meV.

A flux of $\approx 10^{19}$atoms/s from the source will be required to inject a beam with $\approx 10^{15}$atoms/s into the detection volume after cooling and state selection inefficiencies. For monitoring this beam, we have built a detector that uses a wire with a micrometer-scale diameter intersecting the beam on which a small fraction of the beam's hydrogen atoms recombine into molecules. The energy released heats the wire and produces a measurable change in its resistance. Such a detector is suitable for both development work and for minimally disruptive online monitoring in the final experiment.

Additionally, we are working on a calorimetrically estimating the fraction of molecules being split by measuring the surplus power our thermal atom source draws when dissociating hydrogen.

In this talk I will present results from tests of both methods.

T 66.4 Wed 16:35 POT/0251

Modeling of RF signals in large-volume antenna-array CRES detectors — •Florian Thomas and Sebastian Böser for the Project 8-Collaboration — Institut für Physik, Johannes Gutenberg-Universität Mainz

The Project 8 collaboration has established Cyclotron Radiation Emission Spectroscopy (CRES) as a novel frequency-based approach of measuring the tritium beta decay spectrum and determining neutrino mass with the endpoint method. To gather sufficient statistics for its design sensitivity of $m_\beta < 40$ meV the Project 8 experiment needs to be scaled up to a $\mathcal{O}(m^3)$ source volume.

In the large-volume case a possible detection scheme for the radio frequency radiation emitted by the decay electrons is an antenna array with $\mathcal{O}(100)$ independent readout channels. In order to reconstruct the electron tracks comprehensive simulations are required. For this large number of channels, numerical solutions of the electron trajectory, the electromagnetic fields and the antenna response are computationally challenging. In this contribution we present an alternative simulation approach which is based on analytic knowledge about cyclotron radiation and $\mathcal{O}(1000)$ faster than our full numeric baseline approach with a negligible impact on the simulation results.

T 66.5 Wed 16:50 POT/0251

Test setup for de-excitation of Rydberg atoms in KATRIN using THz radiation — •Enrico Ellinger — Bergische Universität Wuppertal

The majority of the background in the neutrino mass experiment KATRIN probably originates from the ionization of Rydberg atoms in the main spectrometer volume. The Rydbergs are formed by natural radioactive decay, followed by sputtering processes on the inner walls of the spectrometer vessel. The neutral Rydberg atoms can migrate through the spectrometer before they are ionized by thermal radiation. The resulting free electrons are eventually accelerated towards the main detector producing the background.

Terahertz radiation can stimulate $\Delta n = \pm 1$ transitions in Rydberg atoms to states from which spontaneous decay to the ground state is faster, significantly reducing the ionization probability. A set of 8 high intense THz sources, targeting subsequent transitions in the vicinity of $n = 30$ can reduce the background by up to 50 %, as shown by earlier simulations.

We developed an experimental test setup that serves as a proof of principle for this new method. The setup mimics the processes in the main spectrometer. The main components are an implanted ^{212}Pb source producing the Rydberg atoms and a 40 mW tuneable Thz source able to target two transitions (256.3 & 284.3 GHz) in Rydberg atoms.

The development of the test setup and first experimental results are presented.

T 66.6 Wed 17:05 POT/0251

Recent developments for an automated krypton assay in xenon at the ppq level — Steffen Form, •Matteo Guida, Robert Hammann, Ying-Ting Lin, Hardy Simgen, and Jonas Westermann — Max-Planck Institut für Kernphysik, Heidelberg, Germany

The beta-decaying isotope ^{85}Kr is one of the main intrinsic background components in liquid xenon (LXe) dark matter detectors. Via purification techniques, a krypton-in-xenon concentration below 100 ppq (parts per quadrillion) can routinely be achieved. The rare gas mass spectrometer (RGMS), at Max-Planck Institut für Kernphysik, provides a measurement of the krypton concentration of an extracted xenon gaseous sample taken directly from the experiment. First, krypton is separated from xenon using a cryogenic gas-solid chromatography system. Then, the amount of krypton is quantified using a mass spectrometer. The system has achieved a detection limit of 8 ppq. A fully automatic rare gas mass spectrometer (Auto-RGMS) is under construction for the krypton assay of future low-background LXe detectors. Without human effort, the automatic operation is going to enable more frequent krypton monitoring and provide more robust results. The plan is to introduce a novel adsorbent for the chromatography system to increase the xenon sample size and further push down the krypton detection limit. The new solutions show a large enhancement in the separation power at a given temperature and in the linearity of the adsorption isotherms. The progress to select a new adsorbent and optimize the working point of Auto-RGMS will be discussed.