T 94: Neutrino physics without accelerators VII

Time: Thursday 16:00–18:35 Location: Ts

Group Report T 94.1 Thu 16:00 Ts

Measurement of *pp* chain and CNO cycle solar neutrinos with Borexino — •Ömer Penek[1,2], Alexandre Goettel[1,2], Sindhujha Kumaran[1,2], Livia Ludhova[1,2], Luca Pelicci[1,2], Giulio Settanta[1], and Apeksha Singhal[1,2] for the Borexino-Collaboration — [1]Forschungszentrum Jülich - Institute for Nuclear Physics, IKP-2, Jülich, Germany — [2]RWTH Aachen University - Physics Institute III B, Aachen, Germany

The Borexino detector, located at the Laboratori Nazionali del Gran Sasso in Italy, is a liquid scintillator detector with a primary goal to measure solar neutrinos. The *pp* fusion chain has been measured in Borexino with an outstanding precision through the detection of *pp*, *pep*, ^{7}Be, and ^{8}B neutrinos in Borexino Phase-II, namely the data-taking period from December 2011 until May 2016. The observation of neutrinos from the CNO cycle has been achieved recently by the Borexino collaboration for the first time since its prediction in the 1930s by Bethe and Weizsäcker. This measurement is challenging due to the high correlation with the ^{210}Bi isotope and the *pep* neutrino signal present in the liquid scintillator. In the so-called Borexino Phase-III, namely the data-taking period from July 2016 until February 2020, the upper limit on the ^{210}Bi rate has been determined through the tagging of alphas from ^{210}Po, which is the decay product of ^{210}Bi. This talk is dedicated to the Borexino solar neutrino analysis with a focus on the observation of CNO neutrinos.

T 94.2 Thu 16:20 Ts

^{210}Bi upper limit for the direct evidence of CNO solar neutrinos with Borexino — •Sindhujha Kumaran[1,2], Alexandre Göttel[1,2], Livia Ludhova[1,2], Luca Pelicci[1,2], Ömer Penek[1,2], Giulio Settanta[1], and Apeksha Singhal[1,2] for the Borexino-Collaboration — [1]Forschungszentrum Jülich - Institute for Nuclear Physics, IKP-2, Jülich, Germany — [2]RWTH Aachen University - Physics Institute III B, Aachen, Germany

Borexino is a liquid scintillator detector located at the Laboratori Nazionale del Gran Sasso, Italy with the main goal to measure solar neutrinos. The experiment recently provided the first direct experimental evidence of CNO-cycle neutrinos in the Sun. The intrinsic ^{210}Bi is an important background for this analysis due to its similar spectral shape to that of CNO neutrinos. ^{210}Bi β^- decays to ^{210}Po, which then α decays to stable ^{206}Pb. Ideally, ^{210}Bi should be in secular equilibrium with ^{210}Po and ^{210}Po can be distinguished through an event-by-event basis via pulse shape discrimination techniques. Until mid-2016, additional ^{210}Po was brought from peripheral sources to the detector's fiducial volume via the convective motions of the scintillator, triggered by seasonal temperature changes. However, the thermal insulation performed in 2015-16 has thermally stabilized the detector, achieving low levels of convection in the innermost region and making it possible to measure ^{210}Bi via ^{210}Po. This talk will present the strategy and the methods used to extract the ^{210}Bi upper limit in Phase-III (Jul 2016- Feb 2020) of the experiment via the analysis of ^{210}Po in the cleanest region of the detector called the Low Polonium Field.

T 94.3 Thu 16:35 Ts

Strategy used in CNO solar neutrinos analysis with the Borexino Experiment — •Apeksha Singhal[1,2], Alexandre Göttel[1,2], Sindhujha Kumaran[1,2], Livia Ludhova[1,2], Luca Pelicci[1,2], Ömer Penek[1,2], and Giulio Settanta[1] for the Borexino-Collaboration — [1]Forschungszentrum Jülich - Institute for Nuclear Physics, IKP-2, Jülich, Germany — [2]RWTH Aachen University - Physics Institute III B, Aachen, Germany

The Borexino Detector, an ultra-pure liquid scintillator located at the Laboratori Nazionali del Gran Sasso, Italy has detected the neutrinos from CNO cycle in the Sun for the first time in history. The challenges faced in the analysis of CNO neutrinos are the low rate of CNO neutrinos and degeneracy of spectral shape of CNO neutrinos to that of Bi-210 background and pep solar neutrinos. This talk describes the optimization of Monte Carlo simulation in order to perform spectral fit of data and determination of constraints like C-11 shift in energy scale and Bi-210 constraint model parameters.

T 94.4 Thu 16:50 Ts

Development of an attenuation length monitor for JUNO — •Heike Enzmann, Michael Wurm, Wilfried Depnering, Paul Hackspacher, Oliver Pilarczyk, Artur Meinusch, Kai Loo, Hans Steiger, and Eric Theisen — Johannes Gutenberg - Universität, Institute of Physics, Mainz, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is currently under construction in China. Its 20 kt liquid scintillator (LS) detector is designed to determine the neutrino mass hierarchy via a precision measurement of the survival probabilities of electron antineutrinos in reactor neutrino oscillations. The filling of the detector with LS will commence late in 2021.

Excellent transparency of the LS is required to maximize the collection of scintillation light in order to reach the required measurement precision. Thus, several purity monitors will be installed as part of the filling system to test each batch of LS prior to its insertion into the Central Detector. This talk covers the development and testing of an attenuation length monitor for LS quality control. The monitor will measure the attenuation length using a laser. The measurement will be done over two different lengths of LS to reduce systematic effects. This work is supported by DFG research unit "JUNO" (FOR2319) and the Cluster of Excellence PRISMA+.

T 94.5 Thu 17:05 Ts

The Design of the DAQ-software for OSIRIS — •Kai Loo[1], Runxuan Liu[2,3], and Michael Wurm[1] — [1]Johannes Gutenberg-Universität Mainz, Institute for Physics and EC PRISMA+, Staudingerweg 7, 55128 Mainz — [2]Institut für Kernphysik, Forschungszentrum Jülich, 52428 Jülich — [3]III. Physikalisches Institut B, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (JUNO), under construction in southern China, will determine the neutrino mass hierarchy (MH) by observing neutrinos from nuclear reactors at the distance of 53 km. To reach the desired sensitivity ($> 3\sigma$) for MH, the radiopurity of the different detector components plays a crucial role. To ensure the purity of the 20 kt liquid scintillator (LS) target of JUNO, the Online Scintillator Internal Radioactivity Investigation System (OSIRIS) will be constructed. It will monitor the radiopurity of the LS during its production and the filling phase of the central detector of JUNO. The OSIRIS detector will utilize the novel concept of intelligent-PMT i.e. the necessary electronics will be mounted at the back of the PMT. Each iPMT will then act as an individual self-triggering digitizer. Due to the asynchronous data flow from the iPMT system and of the order of 15 kHz dark count rate per PMT, this chosen approach requires a triggering and physical event building in software level. This talk will report the design, progress and status of the DAQ software for OSIRIS. This work is supported by the DFG Research Unit *JUNO* (FOR2319) and the Cluster of Excellence PRISMA$^+$.

T 94.6 Thu 17:20 Ts

Reconstruction of atmospheric neutrino events with JUNO — •Mariam Rifai[1,2], Giulio Settanta[1], Livia Ludhova[1,2], Alexandre GötteI[1,2], Philipp Kampmann[1], Runxuan liu[1,2], Cornelius Vollbrecht[1,2], and Luca Pelicci[1,2] for the JUNO-Collaboration — [1]Forschungszentrum Jülich GmbH, Nuclear Physics Institute IKP-2, Jülich, Germany — [2]RWTH Aachen University - Physics Institute III B, Aachen, 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 with a target mass of 20 kt. It aims to determine the neutrino mass hierarchy with at least 3σ significance, through a measurement of the oscillation pattern of reactor neutrinos over 53 km baseline.

The sensitivity of JUNO to the mass ordering could be enhanced through the atmospheric neutrino channel. As one of the largest LS detectors, JUNO might be able to measure with high precision the atmospheric neutrino events and their oscillation parameters at MeV-scale as well at GeV-scale. This work represents the current methods used in the reconstruction of atmospheric neutrinos with JUNO.

T 94.7 Thu 17:35 Ts

Instrumentation of the OSIRIS liquid handling system — •Eric Theisen[1], Wilfried Depnering[1], Heike Enzmann[1], Paul

Hackspacher[1], Kai Loo[1], Artur Meinusch[1], Oliver Pilarczyk[1], Hans Steiger[1,2], and Michael Wurm[1] — [1]Johannes Gutenberg-Universität Mainz, Institute of Physics and Cluster of Excellence PRISMA+, Staudingerweg 7, 55128 Mainz — [2]Physik-Department, Technische Universität München (TUM), James-Franck-Straße 1, 85748 Garching bei München

The Jiangmen Underground Neutrino Observatory (JUNO) located in southern China is currently beeing contructed for future investigations of the neutrino mass hierarchy. It will observe anti-neutrinos created in nuclear reactors in a distance of about 50 km. In order to achieve the desired sensitivity, it is important to monitor precisely the radioactivity of JUNO's liquid scintillator target. For this purpose the 20-ton predetector OSIRIS (Online Scintillator Internal Radioactivity Investigation System) has been devised to monitor the radiopurity of the liquid scintillator before the filling of the JUNO main detector. To ensure a smooth operation of OSIRIS, numerous sensors of different types will provide precise knowledge of the filling levels, gas pressures and temperatures in each vessel of the liquid handling system. In this talk the concept for the OSIRIS liquid handling instrumentation and the sensor system design will be reported. This work has been supported by the DFG Research Unit "JUNO" (FOR2319) and the Cluster of Excellence PRISMA+.

T 94.8 Thu 17:50 Ts

A liquid organic TPC for monitoring nuclear waste repositories — Malte Göttsche[1], Thomas Radermacher[2], Stefan Roth[2], and •Georg Schwefer[1] — [1]RWTH Aachen University - AICES Graduate School, Aachen, Germany — [2]RWTH Aachen University - Physics Institute III B, Aachen, Germany

In neutrino physics, the low energy region below 5 MeV is of great interest, e.g. for the investigation of solar neutrinos and geo-neutrinos. This energy regime is also crucial for the newly envisioned application of monitoring underground repositories of radioactive waste by measuring the antineutrino emissions produced by β-decaying isotopes present in the waste. To this end, we are investigating a detector design using a time projection chamber (TPC) based on a room-temperature organic liquid for precision measurements of low energy neutrinos. In this presentation, the results from first simulation studies on the reconstruction of low-energy antineutrinos in a liquid organic TPC and on the expected signal rates from nuclear waste repositories are discussed.

T 94.9 Thu 18:05 Ts

Current Status of the TRISTAN Project — •Daniel Siegmann for the KATRIN-Collaboration — Max-Planck Institute for Physics, Munich, Germany

The TRISTAN (TRitium Invetigations of STerile to Active Neutrino mixing) project aims to search for the signature of a keV sterile neutrino in the tritium beta decay spectra by upgrading the detector system of the KATRIN experiment. This extension of the experiment will be performed after its neutrino mass survey.

To reach a high sensitivity to the sterile neutrino mixing angle the strong activity of the KATRIN tritium source is required. The resulting high electron rate is one of the greatest challenges for the TRISTAN project. It will be approached by distributing the rate among 3500 pixels, resulting in count rates of 100 kcps per pixel. To resolve the kink-like signature of the keV sterile neutrino signal the detector needs to maintain an excellent energy resolution of 300 eV (FWHM) at 20 keV and a low energy threshold.

This year the first TRISTAN detector module was integrated into the Monitor Spectrometer of the KATRIN Experiment to investigate the overall detector performance and validate its design. The outcomes of this milestone as well as the upcoming steps for TRISTAN Project will be presented in this talk.

This work is supported by the Max Planck society and the TU Munich ("Chair for Dark Matter, Susanne Mertens").

T 94.10 Thu 18:20 Ts

Upgrade of the PoLiDe-setup for ortho-positronium lifetime and formation probability measurements in liquid scintillators — •Ulrike Fahrendholz[1], Lothar Oberauer[1], Hans Theodor Josef Steiger[1,2], Matthias Raphael Stock[1], Oliver Dötterl[1], Mario Schwarz[1], Konstantin Schweizer[1], David Dörflinger[1], and Ludwig Wallner[1] — [1]Physik-Department, Technische Universität München (TUM), James-Franck-Str. 1, 85748 Garching bei München — [2]Cluster of Excellence PRISMA+, Johannes Gutenberg-Universität (JGU) Mainz, Staudingerweg 9, 55099 Mainz

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillator (LS) multi-purpose neutrino detector built in a dedicated underground laboratory in Jiangmen (China). The main detection channel for determination of the neutrino mass ordering is the Inverse Beta Decay (IBD), where a neutron and a positron are produced. The positron*s direction and energy are resolved by measuring its scintillation light followed by the two 511 keV gammas resulting from the annihilation with an electron. Formation ortho-positronium delays the annihilation signal, leading to an overall distorted pulse shape in the detector. For better understanding of this process, the existing setup for Positronium Lifetime Determination (PoLiDe) has been upgraded to achieve more accurate values for the lifetime and formation probability of ortho-positronium in the LS. This work is supported by the DFG Research Unit *JUNO* (FOR2319) and the Maier-Leibnitz-Laboratorium (MLL).