T 3: Accelerator neutrino experiments

Time: Monday 16:00–18:00 Location: Tc

T 3.1 Mon 16:00 Tc

Hydrogen-rich Gases for High Pressure Time Projection Chambers at Neutrino Beamlines — •Philip Hamacher-Baumann, Nick Thamm, Thomas Radermacher, and Stefan Roth — RWTH Aachen University - Physics Institute III B, Aachen, Germany

DUNE's near detector complex foresees a magnetized high-pressure gaseous time projection chamber (HPgTPC) as part of its detector suite. The gaseous active volume results in a very low detection threshold with high particle-identification power and large acceptance for tracking, especially for interactions on the gas itself. Neutrino interactions on hydrogen nuclei in the drift gas can be extracted with the transverse kinematic imbalance method to produce intra-nucleon-interaction-free neutrino samples. For design and development of a pressurized TPC, it is essential to quantify and validate electron swarm parameters, such as drift velocity or diffusion, to ensure performance at large detector scales. In this presentation, I will discuss how electron swarm parameters of drift gas mixtures perform at higher than atmospheric pressures. Additionally, a study of a choice of hydrogen-rich gas mixtures for consideration in HPgTPC is presented in addition to measurements in a test chamber. The results are assessed with respect to performance at 10 bar pressure in HPgTPC.

T 3.2 Mon 16:15 Tc

Status of the ESSνSB Target Station — •Tamer Tolba — Institut für Experimentalphysik, Universität Hamburg, Hamburg - Germany

In the quest to discover CP-violation in the leptonic sector, a crucial information has been obtained from reactor experiments demonstrating that the value of the third neutrino-mixing angle, θ_{13}, is higher than its previously defined standard value. In the light of this new finding, an urgent need has arisen to improve the detection sensitivity of the current long-baseline detectors, with a key modification to place the far detectors at the second, rather than the first, oscillation maximum.

The European Spallation Source Neutrino Super Beam (ESSνSB) aims at searching for CP-violation in the leptonic sector, at 5σ significance level in more than 60% of the leptonic Dirac CP violating phase range, and measuring the CP phase angle with high precision by setting the neutrino source-to-detector distance, the baseline, at the second oscillation maximum. Several technological challenges must be precisely studied and simulated before addressing the design of the ESSνSB detector. Among these, the finite element and physics simulations of the target station and the neutrino beam are considered to be highest priority at this phase of the ESSνSB project.

Here I will shed light on the current target station design physics and FEA simulation efforts of the ESSνSB WP4 working group.

T 3.3 Mon 16:30 Tc

A Highly Granular Electromagnetic Calorimeter Concept for the DUNE Near Detector — •Lorenz Emberger[1], Eldwan Brianne[2], and Frank Simon[1] — [1]Max-Planck-Institut für Physik — [2]DESY

The Near Detector (ND) of the Deep Underground Neutrino Experiment (DUNE) will play an important role in the search of CP violation in the neutrino sector. Additionally, as a standalone complex, it will be an excellent laboratory to study a wide range of neutrino interactions and BSM models. The ND design consists of three independent sub-detectors, placed downstream of the neutrino production target. One of these detectors, called ND-GAr, consists of a high pressure gaseous Argon Time Projection Chamber (TPC), surrounded by an electromagnetic calorimeter (ECAL) and a muon system. One key aspect of the ECAL is the reconstruction of neutral particles such as neutral pions and potentially neutrons. Together with the muon system, the ECAL also extends the detector's separation capability of muons and pions. We present a study of the detector system featuring a highly granular electromagnetic calorimeter inspired by the SiPM-on-Tile technology developed by the CALICE collaboration. We will introduce the detector design considerations, as well as the potential physics program. Additionally, we will touch on first ECAL performance evaluations and the separation of muons and pions using a full GEANT4 detector simulation.

T 3.4 Mon 16:45 Tc

Scintillator material studies to reconstruct neutrons at the ECAL of DUNE Near Detector — •Asma Hadef, Antoine Laudrain, Volker Büscher, Lucia Masetti, and Sebastian Ritter — Johannes Gutenberg Universität, Mainz, Germany

The Deep Underground Neutrino Experiment (DUNE) seeks to revolutionize our understanding of neutrinos and their role in the universe. The DUNE near detector (ND) is located near the neutrino source and is a crucial part of a precision measurement of the CP violating phase. It needs to measure neutrino interactions with high detection efficiency, superior identification of charged and neutral particles and precise energy reconstruction. The electromagnetic calorimeter (ECAL) of the ND should be in particular sensitive to neutrons with energies of hundreds of MeV that interact inside the plastic scintillator or nearby. By precisely measuring the time and position of a neutron-induced hit, it is possible to determine the neutron kinetic energy via time of flight. In this talk, an experimental setup to study the scintillator material to identify neutron interaction with respect to the background by using pulse shape discrimination (PSD) with plastic scintillators and silicon photomultipliers (SiPMs) will be presented.

T 3.5 Mon 17:00 Tc

Dual Cherenkov/Scintillation Reconstruction in Water-based Liquid Scintillator — •Daniele Guffanti, Manuel Böhles, Nils Brast, Hans Steiger, and Michael Wurm — Institute of Physics and Excellence Cluster PRISMA, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany

One of the most intriguing possibilities for the next generation of neutrino experiments consists in large hybrid Cherenkov/Scintillation detectors, made possible by recent innovations in photodetection technologies and liquid scintillator chemistry such as Water-based Liquid Scintillators and Slow Scintillators. Being able to exploit both Cherenkov and Scintillation photons can bring significant improvements to the sensitivity of an experiment, enhancing energy and track reconstruction. This possibility is particularly interesting for hadronic interactions, which can be studied on an extracted beamline with a ton-scale experiment.

T 3.6 Mon 17:15 Tc

The ANNIE experiment — •Michael Nieslony, David Maksimovic, Daniele Guffanti, and Michael Wurm for the ANNIE-Collaboration — Johannes Gutenberg University, Mainz, Germany

The Accelerator Neutrino Neutron Interaction Experiment (ANNIE) is a Gadolinium doped water Cherenkov detector located in the Booster Neutrino Beam at Fermilab with the primary goal of measuring the final state neutron multiplicity of neutrino-nucleus interactions. ANNIE will make use of pioneering photodetectors called Large Area Picosecond Photodetectors (LAPPDs) with less than 100 picosecond time resolution to enhance its reconstruction capabilities and demonstrate the feasibility of this technology as a new tool in high energy physics. This talk will present an overview of recently taken ANNIE beam commissioning and calibration data and outline the framework for the upcoming neutron multiplicity analysis. Furthermore, additional future R&D efforts involving the use of the novel detection medium of water-based Liquid Scintillators will be briefly highlighted.

T 3.7 Mon 17:30 Tc

The T2K Near Detector Upgrade — Philip Hamacher-Baumann, Paula Nehm, Paolina Noll, Thomas Radermacher, Stefan Roth, David Smyczek, and •Nick Thamm — RWTH Aachen University - Physics Institute III B, Aachen, Germany

The Tokai to Kamioka (T2K) long baseline neutrino oscillation experiment is entering the next phase (T2K-II) with increased beam power of up to 1.3 MW. To match the reduced statistical uncertainty an upgrade of the near detector (ND280) is planned to increase the detector acceptance and therefore reduce the systematic uncertainties. In the upstream part a 3D fine-grained scintillator target, a time-of-flight system and two time projection chambers (TPCs) will be installed. These new High Angle TPCs (HATs) will cover the phase space of neutrino scattering with the final state lepton scattered at a large angle. Improved momentum resolution and particle identification will be achieved by using resistive bulk micromegas technology. Installation is scheduled for the year 2021 with first data taking starting in 2022. In this talk first tests of a prototype HAT including gas monitoring chambers will be presented.

T 3.8 Mon 17:45 Tc

Pattern Recognition Algorithm for the High Angle TPCs of the T2K Near Detector Upgrade — Philip Hamacher-Baumann, •Paula Nehm, Paolina Noll, Thomas Radermacher, Stefan Roth, David Smyczek, and Nick Thamm — RWTH Aachen University - Physics Institute III B, Aachen, Germany

The T2K near detector upgrade includes the addition of two High Angle Time projection chambers (HATs). They will increase the selection efficiency of leptons for scattering angles larger than ca. 40 degrees by achieving a full polar angle coverage for muons produced in CC events. For these HATs the reconstruction algorithm needs to be reworked. As a first step the pattern recognition algorithm of the already installed time projection chambers of the T2K near detector has been adapted for the new HATs. This as well as the readjustment of the parameters of the algorithm to the new geometry will be presented.