



Contribution ID: 199

Type: Oral Presentation

A High Pressure TPC with Optical Readout

Wednesday, 31 July 2019 14:54 (18 minutes)

Gas filled Time Projection Chambers (TPCs) can be used to study neutrino interactions at next generation long baseline neutrino oscillation experiments such as DUNE. These detectors have many advantages, particularly their low energy threshold and high angular efficiency. A High Pressure TPC (HPTPC) additionally allows the gas to serve as the neutrino interaction target with good interaction statistics, allowing new cross-section measurements to be made. Such precision probes of neutrino-nuclear interactions are essential to resolve discrepancies within the neutrino Monte Carlo event generators that will be used for experiments including DUNE.

A prototype HPTPC with optical readout has been commissioned in order to assess the feasibility of this technology for neutrino detection, and to perform new measurements of proton and pion scattering on gaseous argon. The TPC is embedded in a pressure vessel allowing gas pressures of up to 5 bar. Cameras are used to image the optical scintillation signal from the avalanche ionisation in the amplification stage. This allows measurement of the track coordinates in the plane perpendicular to the drift field. The charge signal induced by the same ionisation avalanches is read out from the three electrodes of the amplification stage, which are composed of un-segmented meshes.

The HPTPC prototype was operated in a test beam at the CERN PS. Interactions of low momentum protons (≤ 0.5 GeV/c) were measured on different argon mixtures. A dedicated off-axis technique was developed to obtain these lower energy protons from the higher energy T10 test beam.

In this talk we will present the current status of the proton-argon cross-section measurement and give an account of the HPTPC's performance, including results of various calibration measurements. The data analysis is currently ongoing, which includes a combined analysis of the HPTPC and time of flight systems that were employed together during the beam test.

Currently the HPTPC's mesh-based amplification region is being replaced by an ALICE TPC Outer ReadOut Chamber. This chamber will be tested in the high pressure vessel in order to establish the feasibility of using similar chambers for the DUNE near detector HPgTPC.

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Session Classification: Particle Detectors

Track Classification: Particle Detectors