Veto against charged Kaons entering the LBNE- LArTPC

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Abstract

Bruce Baller recently pointed out that a charged Kaon, entering the TPC volume and stopping inside after a short travel, can simulate a proton decay if the zero time is not measured directly.

We propose a simple and inexpensive way to tag such events. If implemented this technique can restore the proton decay fiducial volume to nearly the full instrumented TPC volume.

Introduction

Charged particles entering though the cathode plane assemblies (CPA's) on the periphery of the TPC may leave a short track inside. The location of this track in the drift direction is not well measured if the event time is not measured directly. It may look like a genuie short, stopping, track. If the track is generated away from the cathode planes it can indicate a proton decay or supernova neutrino candidate; if it is known to have entered from the outside as a charge track it is useless background. We will show how to tell for sure.

Method

We propose to double up the CPA's on the TPC periphery with a second layer of CPA's , just 10 cm away to the outside. The outer layer will be biased 2.5 kV more negative than the original inner CPA's, i.e. at 152.5 kV rather than 150 kV. This meets the transparency criterion, ensuring that all electrons drift through the inner cathode mesh plane without any losses. The weaker E-field makes the drift field in that space half as strong as the main drift field, hence the electrons will drift half as fast (roughly). For a charged track entering from the outside, its signal within the main fiducial volume will be unchanged. The track segment across the new 10 cm deep space will, however have several distinguishing characteristic:

--all wire signals will be twice as long and half as strong compared to those of the same track just inside the inner CPA;

--the short track segment will have a well defined and well known duration, common to all such segments; it is the drift time across the new space.

--the short segments cut off cleanly in time; there is no straggling ionization beyond the end time

--finally, if the track is not normal to the CPA it will have a kink, which can be calculated as:

tan (alpha 1) / tan (alpha 2) = speed1 / speed 2,

where the alpha's are the angle between the track and the plane normal.

This is very similar (but not identical) to Snell's law of refraction,   for the same reason that light (which is slower) in glass, the drift speed is half that of the drift speed in the main volume, hence gap space has an index of refraction of 2.0.

These characteristics are likely to identify unambiguously and efficiently charged tracks coming into the fiducial volume from outside the TPC.