**Triggering on Supernova Burst Neutrinos at DUNE**

**Introduction**

DUNE is a planned, broad band on-axis neutrino oscillation experiment located at Fermilab, Illinois and Sanford Underground Research Facility, South Dakota.

The far detector will consist of 4 liquid argon 10 kt time projection chambers (LArTPCs), 4850 ft underground and 1300 km from the point of neutrino production [1].

LArTPCs are sensitive to low energy electron neutrinos via charged current interaction on Ar with threshold 5.9 MeV for a superallowed transition [2].

A typical supernova (SN) burst from the galactic centre would produce ~3x10^3 neutrino events in the far detector over 10’s of seconds [1].

The detection of such bursts requires a data acquisition system capable of triggering the readout of a data stream of order 1 TB / (sec 10^3) during these 10’s of seconds.

From the SN time profile, many astrophysics observables and the neutrino mass ordering may be measured [1].

**Simulation**

Use the MARLEY event generator [3] to simulate low energy electron neutrino interactions on argon nuclei.

The pre-SN progenitor is 11.2 solar mass, main sequence star [4]. The time profile model is taken from Hudepohli [5].

Overlay signal events with radiological backgrounds, currently the dominant sources are neutrons and radon.

**Hit Clustering**

A hit finder is run to isolate deposits of charge above some threshold. Clustering then groups these hits close in time and channel space.

For triggering, this must be fast.

‘Typical’ electron from a SN neutrino event spans 5 cm x 5 cm around the interaction vertex.

To differentiate the SN neutrinos from background, make simple cuts.

**References:**


**Method in a Nutshell**

Unique signatures of SN burst:

- Events spread out over a long time (exponential cooling of SN with 2-3 second decay time).
- Events typically higher energy than background.

Strategy: keep it very simple.

Count the number of hit-clusters in a 10 second window. Trigger above a threshold number of hit-clusters.

Fake triggers:

Use the background rate from the clustering algorithm, assume it fluctuates in a Gaussian way.

Can map out the burst-trigger rate as a function of the threshold number of hit-clusters.

**Burst Trigger**

Background model: Gaussian with mean equal to the background rate from the hit clustering algorithm and RMS equal to the square root of this mean.

Trigger: Is the number of SN like clusters in the time window greater than some cut?

Signal: Overlay different sized supernova bursts on top of background and calculate the signal efficiency.

Fake triggers: Can vary the fake trigger acceptance to meet DAQ requirements.