Summary of TDR trigger studies

J. Soto

Outline

We have been asked to provide the variables that we want to store on the header of each event, in order to trigger.

Now we have 8 bytes (64 bits) dedicated to store this. It could be more.

This must be driven by the physics: Mainly, supernova and proton decay trigger.

FD2 TDR

SNB-triggering:

First a clustering algorithm was developed. For this, an optical hit is defined as a peak in the digitized signal arriving in one of the optical channels that is above 1.5 PE. A cluster is defined as a collection of hits that present certain correlations in time and space, such that they are believed to have all been caused by the same underlying neutrino event inside the detector. The parameters explored to optimize the clustering algorithm are:

- Maximum cluster duration – the maximum time difference between the earliest and the latest hit in the cluster.
- Maximum time difference between consecutive hits.
- Maximum spatial distance between neighboring optical channels detecting the hits.
- Minimum hit multiplicity – the minimum number of hits required to classify a collection of hits as a cluster.

As an orientation, the optimal parameters were around 300 ns for the maximum cluster duration, 200 ns for the maximum hit time differences, 250 cm for the maximum hit spatial distances, and 10 for the minimum hit multiplicity.

https://docs.dunescience.org/cgi-bin/private/RetrieveFile?docid=26589&filename=main-new.pdf&version=7

Dual-Phase TDR

NDK event time/triggering:

As discussed in Section 5.1, event t_0 reconstruction for non-beam events via the PD system is particularly important to fiducialize nucleon decay candidates in DUNE. Proton decay signal events with a $p \to K^+\bar{\nu}$ final state have been simulated with GENIE [45] throughout the DP TPC active volume, and their optical clusters were reconstructed using the full simulation and reconstruction chain. NDK events should deposit approximately 400 MeV visible energy in the LAr. The same reconstruction algorithm has also been applied to the simulated radiological backgrounds. In a first cluster reconstruction step, three parameters are optimized to group optical hits into separate clusters:

Maximum cluster duration: maximum time difference among all PMT hits in the cluster.

Maximum hit time distance: maximum time difference between successive PMT hits in the cluster. By definition, this quantity is smaller than, or equal to, the maximum cluster duration.

Maximum hit distance: maximum spatial distance between neighbouring PMT hits in the cluster.

In general, several t_0 candidate clusters will be reconstructed per event, induced by the NDK signal, by radiological activity, and by PMT dark counts. If more than one choice exists, event t_0 information is associated to the t_0 candidate cluster of highest charge. For events where at least

https://docs.dunescience.org/cgi-bin/private/RetrieveFile?docid=15415&filename=DUNE-FD-TDR-vol4-DP.pdf&version=2

Summary

Trigger studies are based on hit clustering: grouping hits by looking at time and space correlations:

- The spatial correlation is done by looking at the XArapuca position (given by the channel number), which is implicit in the data.
- The time correlation is done by looking at the hit tick (or hit timestamp), this has to be provided by Daphne.

To implement the SNB trigger as it is defined in the TDR, we need as minimum:

Time-stamp of each hit above 1.5PE inside the waveform.

It would be desirable to have also amplitude, charge and duration of each hit. However we would need to estimate **the number of hits that we expect per waveform**, to be sure we have enough space for that.

Header is 8 bytes -> only 4 shorts, i.e. it seems quite limited: Is this header fixed or can be adjusted? (i.e. defining the number of entries in a hit list)

Since the space is very limited, we could think on a low resolution scale to save it: Instead of storing the amplitude in ADC (16 bits?), we can convert it to 2 or 3 bits scale, to have information of the range of amplitudes, rather than the precise number.

Same for the timestamp, the time resolution needed for the trigger is above 100ns, we could reduce the sampling in order to have space for more hits. (for example using 7 bits in 16us -> 125ns sampling).

In this configuration, having 10 bits per hit (7 bits for timestamp, 3 bits for amplitude), we would have space for up to 6 hits per waveform. The other 4 bits could store the number of hits in the waveform (in case there are more that do not fit in the list).

Opinions? Let’s open the discussion.