How to Apply TDC Cuts to Trigger

Richard L. Trotta III

November 18, 2019

The procedure for applying TDC cuts to the coincidence trigger for Hall C 12 GeV will be discusses. This will first outline the general mechanics and idea behind the coincidence trigger pseudo-detector system. A general procedure will then be discussed in order to properly apply such cuts. This procedure will mention, but not go into further detail on precursors and postcursors steps. The plan is to have seprate papers for such steps, which can be found in the citations of this paper.

1 Coincidence Trigger Summary

The coincidence trigger is is initially formed from the HMS and SHMS pre-triggers. The HMS and SHMS pre-trigger formation are created through a combination of the hodoscope pre-triggers and the particle detector pre-triggers. For example, the HMS pre-trigger is formed through the combination of hodoscope, cherenkov, and calorimeter pre-triggers in the logic unit. This creates a single arm coincidence pre-trigger that is then fed into a NIM logic unit. The first pre-trigger that arrives opens a coincidence timing window. The second pre-trigger must happen in the coincidence timing window in order for the two events to be considered correlated.

Once the pre-triggers for both spectrometer occur in the timing window a coincidence pre-trigger is formed. There are two subsequent copies of this coincidence pre-trigger. The first is sent to the TDCs (ROC1 and ROC2) and scalers (ROC5 and ROC8). The second copy is sent to a NIM to ECL converter. It should be known that the reference time is also created here which is visable in the TDC spectra at all stages. The converted pre-trigger is copied three (usuallsy more) times for the following purposes; a copy is sent to every TDC module, a copy is sent to the trigger interface (TI) in ROC2 which is the only coincidence mode of the trigger master for any TI, and additional copies may be sent to the HMS readout crate (ROC1) because

the coincidence pre-trigger is common to all crates. The TI allows up to six trigger inputs such as EL-REAL and EL-CLEAN. The TI then outputs the level 1 accepted (L1ACC) pre-triggers to another NIM to ECL converter where they are sent to the TDCs (ROC1 and ROC2) and scalers (ROC5 and ROC8) as well as TDCs (ROC3 and ROC6) located in the hut.

2   Applying Cuts to TDC Spectra

The process of applying cuts to the coincidence time spectrum should only be done only once reference time cuts are properly chosen [1]. After such reference time cuts are chosen the following steps should be performed in order to assure proper coincidence time cuts are applied. The TDC coincidence spectra are the outputs from the L1ACC pre-triggers. The cuts are applied to the raw TDC spectra first. The raw TDC spectra will have the following leaf names corresponding to the TI inputs. . .

<div align="center">

T.coin.(p)hTRIG1_ROC1_tdcTimeRaw
T.coin.(p)hTRIG1_ROC2_tdcTimeRaw
T.coin.(p)hTRIG2_ROC1_tdcTimeRaw
T.coin.(p)hTRIG2_ROC2_tdcTimeRaw
T.coin.(p)hTRIG3_ROC1_tdcTimeRaw
T.coin.(p)hTRIG3_ROC2_tdcTimeRaw
T.coin.(p)hTRIG4_ROC1_tdcTimeRaw
T.coin.(p)hTRIG4_ROC2_tdcTimeRaw
T.coin.(p)hTRIG5_ROC1_tdcTimeRaw
T.coin.(p)hTRIG5_ROC2_tdcTimeRaw
T.coin.(p)hTRIG6_ROC1_tdcTimeRaw
T.coin.(p)hTRIG6_ROC2_tdcTimeRaw

</div>

It should be noted that there are 24 total of such leaves (12 for each spectrometer). The raw spectrum is in units of channels and is converted to nanoseconds during the replay. The conversion is ˜0.1 ns/channel.

The cuts are applied in PARAM/TRIG/ of the main hallc_replay directory. The files in this folder should be familar if the reference time cuts were properly implimented. In the tcoin.param file you will find the reference time cuts as well as the TDC time window cuts that should be adjusted. The section of interest for this file should look like figure 1. The time windows to adjust will depend on the DAQ settings for the run. For example, running with DAQ singles SHMS-3/4 and HMS-EL-REAL would require adjustments on

Figure 1: Example of where TDC time window cuts are applied

pTRIG1_ROC2, hTRIG1_ROC2, pTRIG3_ROC1, and hTRIG3_ROC1. The following DAQ settings correspond to the 6 trigger inputs of the TI

Trigger Input	SHMS DAQ Setting	HMS DAQ Setting
ptrig1	3/4	N/A
ptrig2	EL-REAL	N/A
ptrig3	N/A	EL-REAL
ptrig4	N/A	3/4
ptrig5	3/4	EL-REAL
ptrig6	3/4	3/4

The first step in applying cuts is to remove all cuts that are currently being applied to the raw spectra. This means setting the minimum to zero and opening the maximum to an arbitrarily large number (usually 10,000 is used). This will allow one to see the entire raw spectrum including background (see figure 1 left).This figure shows the SHMS spectrum which was set to 3/4. It is difficult to see much of anything in the raw, but if looking at the replayed spectrum (figure 1 right) there are some peaks hidden behind the large background. The idea is to subtract the background surrounding the peaks in order to clean the spectrum up a bit. Applying cuts to the raw spectrum to subtract these backgrounds will clean up these peaks after another replay is run. The raw spectrum cuts should be around the large peak (using logarithmic scale is helpful). The peak for figure 1 (left) seems to be between 5750 and 6750 so this was chosen as the time window minimum and

Table 1: Example of TDC coincidence raw (left) and timing (right) spectrum without cuts applied for pTRIG1_ROC2. This is for run 6749 which was a physics run so the trigger inputs were ptrig1,ptrig3, and ptrig5.
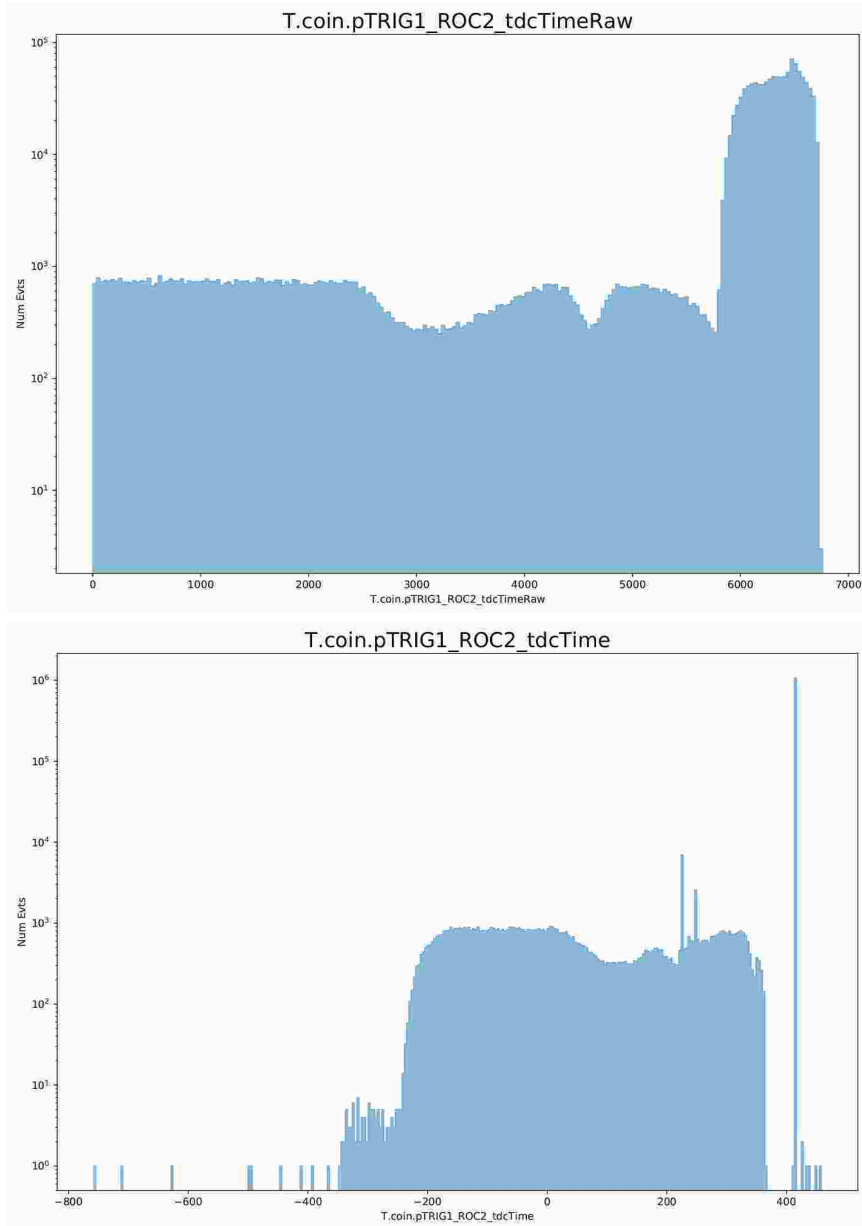
maximum. These values should be changed accordingly in the tcoin.param file. The cut spectra can be seen in figure 2. The figures show a comparison before and after the cuts. It is important to note that the cuts applied to the raw spectrum do not cut into the large peak, doing so can result in lost events. It is usually better to start with larger cuts and work in. Figure 2 (right) is the final spectrum after the cuts. There are discernible peaks in the spectrum now which correspond to the scintillator events and reference time.

Table 2: Example of TDC coincidence coincidence raw (left) and timing (right) spectrum with cuts applied (orange) vs without cuts (blue) for pTRIG1_ROC2's raw spectrum. This is for run 6749 which was a physics run so the trigger inputs were ptrig1,ptrig3, and ptrig5. The cuts applied to the raw spectrum are at 5750 for the minimum and 6750 for the maximum.