

# General Hall C Analysis Procedure in 12 GeV Era

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The general Hall C analysis procedure for experiments in the 12 GeV era is discussed. The procedure outlines the first necessary steps in the data analysis regardless of the nature of the experiment. These include, but are not limited to:

1. *reference time cuts*, 2. *detector time window cuts*, 3. *detector calibrations*. Additional necessary procedures will be added in subsequent sections as updates to this document are made.

## 1 Set Reference Time Cuts

The first step in Hall C Data Analysis is to make sure the *reference time* cuts are set properly, as one needs to make sure the reference times correlated with the trigger are selected. The *reference time* is a copy of the pre-trigger which is distributed to all ADCs/TDCs in all detectors Read-Out Crontrrollers (ROCs)<sup>1</sup>. When the pre-trigger is accepted, all crates read-out detector signals associated with the trigger, including the reference time itself (copy of pre-trigger). The reference time is subtracted from the detector signal later on during the analysis replay. When using the reference time, the Hall C analyzer, *hcana*, choses the first hit in the time window if multiple hits are present per event. In this scenario, the first hit may NOT necessarily be the *good hit*, and the wrong reference time would be chosen resulting in the wrong time being subtracted in the ADC/TDC spectra. By placing a reference time cut, the analyzer then considers the first hit after the cut, which is likely to be a *good hit*.

As an example, consider the H(e,e')p Elastic coincidence run 3377 which had the highest SHMS rate of elastics taken during the E12-10-003 experiment.

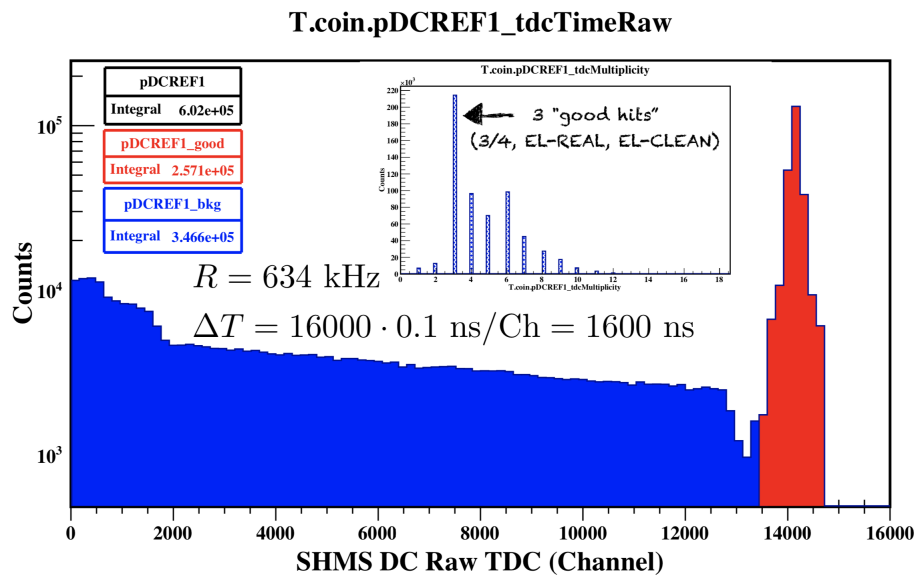


Figure 1: SHMS Reference Time Spectrum for Coincidence Run 3377 of E12-10-003 experiment.

Following the poissonian behavior of physics triggers, the probability that 2 hits (*background* and *good hit*) fall within a certain time window  $\Delta T$  at a given physics rate  $R$  is given by:

$$P(\lambda; k) = e^{-\lambda} \frac{\lambda^k}{k!}, \text{ where } \lambda = R\Delta T \text{ and } k = \# \text{ hits} \quad (1)$$

<sup>1</sup>Refer to [https://hallcweb.jlab.org/DocDB/0010/001028/002/trigger\\_v2.pdf](https://hallcweb.jlab.org/DocDB/0010/001028/002/trigger_v2.pdf) for a detailed discussion on the Hall C trigger

From the multiplicity in Figure 1, the reference time had 3 good hits (3/4, EL-REAL, EL-CLEAN, **read further**). For simplicity of the calculation, **redefine 3 good hits as a single good hit**. Then, from Eq. 1 and Figure 1, the probability of finding 2 hits within the Drift Chamber Time Window is

$$P(\lambda; k) = e^{-R\Delta T} \frac{(R\Delta T)^2}{2!} = 0.1865 \quad (2)$$

From Figure 1, this probability is given by taking the ratio of the **background** to the total number of events and dividing by 3 to normalize to a single good hit, one obtains

$$P_{data} = \frac{1\ 346600}{3\ 602000} = 0.1919 \quad (3)$$

The two results agree to  $\leq 1\%$ . These results indicate that if the reference time had **NOT** been set for this run, then  $\sim 19\%$  of the events would have the **WRONG** reference time and a lower tracking efficiency by  $\sim 19\%$ , hence, **THE IMPORTANCE OF SETTING THE REFERENCE TIMES!**

In Hall C, each spectrometer has multiple pre-triggers (3/4, STOF, EL-REAL, EL-CLEAN) which may change depending on the nature of the experiment. The base pre-trigger is the 3/4, which requires at least 3 of 4 hodoscope planes to fire. During the commissioning phase of the spectrometers, the reference times was initially defined to be:

$$\text{ref. time} \equiv 3/4 \text{ **OR** STOF **OR** EL-REAL **OR** EL-CLEAN} \quad (4)$$

See December 2017 HC-Log Entry <https://logbooks.jlab.org/entry/3501198>. On January 2018, the STOF trigger was removed from this definition, See HC-Log Entry <https://logbooks.jlab.org/entry/3519686>. Finally, on August 2018, EL-CLEAN was removed from the reference time definition, See HC-Log Entry <https://logbooks.jlab.org/entry/3585301>. It was determined that any pre-trigger that require the 3/4 was un-necessary and redundant to have in the reference time definition, and so they were removed. As of the present day, the reference time definition in Hall C is:

$$\text{ref. time} \equiv 3/4 \text{ **OR** EL-REAL} \quad (5)$$

The list of reference time variables is summarized in Tables 1 and 2.

Ref. Time Name	Physical Location	<i>hcana</i> Leaf Name
hFADC_TREF_ROC1	ROC1::SLOT18::Ch11	T.{spec}.hFADC_TREF_ROC1_adcPulseTimeRaw
hTref1	ROC1::SLOT02::Ch06	T.{spec}.hT1_tdcTimeRaw
hTref2	ROC1::SLOT20::Ch127	T.{spec}.hT2_tdcTimeRaw
hDCREF1	ROC3::SLOT08::Ch15	T.{spec}.hDCREF1_tdcTimeRaw
hDCREF2	ROC3::SLOT16::Ch63	T.{spec}.hDCREF2_tdcTimeRaw
hDCREF3	ROC3::SLOT04::Ch111	T.{spec}.hDCREF3_tdcTimeRaw
hDCREF4	ROC3::SLOT13::Ch95	T.{spec}.hDCREF4_tdcTimeRaw
hDCREF5 <sup>3</sup>	ROC3::SLOT02::Ch127	T.{spec}.hDCREF5_tdcTimeRaw

Table 1: List of HMS Reference Times. Single-Arm DAQ, **spec=hms**, else if Coincidence Mode DAQ, **spec=coin**.

<sup>3</sup>hDCREF5 reference time signal was added on July 2018. Experiments after this date must also check this reference time.

Ref. Time Name	Physical Location	<i>hcana</i> Leaf Name
pFADC_TREF_ROC2	ROC2::SLOT14::Ch11	T.{spec}.pFADC_TREF_ROC2_adcPulseTimeRaw
pTref1	ROC2::SLOT20::Ch15	T.{spec}.pT1_tdcTimeRaw
pTref2	ROC2::SLOT19::Ch31	T.{spec}.pT2_tdcTimeRaw
pDCREF1	ROC6::SLOT06::Ch79	T.{spec}.pDCREF1_tdcTimeRaw
pDCREF2	ROC6::SLOT07::Ch79	T.{spec}.pDCREF2_tdcTimeRaw
pDCREF3	ROC6::SLOT08::Ch79	T.{spec}.pDCREF3_tdcTimeRaw
pDCREF4	ROC6::SLOT09::Ch79	T.{spec}.pDCREF4_tdcTimeRaw
pDCREF5	ROC6::SLOT10::Ch79	T.{spec}.pDCREF5_tdcTimeRaw
pDCREF6	ROC6::SLOT11::Ch47	T.{spec}.pDCREF6_tdcTimeRaw
pDCREF7	ROC6::SLOT12::Ch47	T.{spec}.pDCREF7_tdcTimeRaw
pDCREF8	ROC6::SLOT13::Ch47	T.{spec}.pDCREF8_tdcTimeRaw
pDCREF9	ROC6::SLOT14::Ch15	T.{spec}.pDCREF9_tdcTimeRaw
pDCREF10	ROC6::SLOT15::Ch47	T.{spec}.pDCREF10_tdcTimeRaw

Table 2: List of SHMS Reference Times. Single-Arm DAQ, **spec=shms**, else if Coincidence Mode DAQ, **spec=coin**.

Associated with each physical detector and pseudo-detector (TRIG), are specific reference times from the Tables 1 and 2. The reference times associated with each detector are summarized below.

SPEC	DETEC	Ref. Time Name
HMS	AERO[adc]	hFADC_TREF_ROC1
	CAL[adc]	hFADC_TREF_ROC1
	CER[adc]	hFADC_TREF_ROC1
	DC[tdc]	hDCREF1, hDCREF5
	HODO[adc]	hFADC_TREF_ROC1
	HODO[tdc]	hTref2
	TRIG[adc]	hFADC_TREF_ROC1
	TRIG[tdc]	hTref1
SHMS	AERO[adc]	pFADC_TREF_ROC2
	CAL[adc]	pFADC_TREF_ROC2
	HGCER[adc]	pFADC_TREF_ROC2
	NGCER[adc]	pFADC_TREF_ROC2
	DC[tdc]	pDCREF 1-10
	HODO[adc]	pFADC_TREF_ROC2
	HODO[tdc]	pTref1, pTref2
	TRIG[adc]	pFADC_TREF_ROC2
TRIG[tdc]	pTref2	

Table 3: List of Detector Reference Times, which applies for both Singles and Coin DAQ modes. The table shows which reference times are being subtracted from each detector or pseudo-detector signal.

From the summary Table 3 above, it is important to note that the all detectors in HMS / SHMS use the same ADC reference time signal in their respective spectrometers (indicating all ROCs FADCs appear to be synchronized), however, with respect to the TDCs, each TDC receives a distinct copy of the reference times with the exception of the Drift Chambers in ROC3, as this crate has the capability to synchronize all TDCs it holds.

To determine what values to set the reference time cuts, it is recommended that a multiplicity cut be made on the variable being looked at. The multiplicity of a given variable refers to the total number of adc or tdc hits per event. If the event was a true physics event, most likely the total number of reference time hits will be one. If the reference time was OR'ed from  $n$  pre-triggers, and the pre-triggers are assumed to be almost 100% efficient, then a true physics event will most likely have  $n$  hits. In this case, it is recommended that a multiplicity cut requiring  $n$  hits be made in order to clean the reference time spectrum and better select a reference time cut value. It is easier to look at the multiplicity leaf variable itself, and determine which multiplicity cut to make.

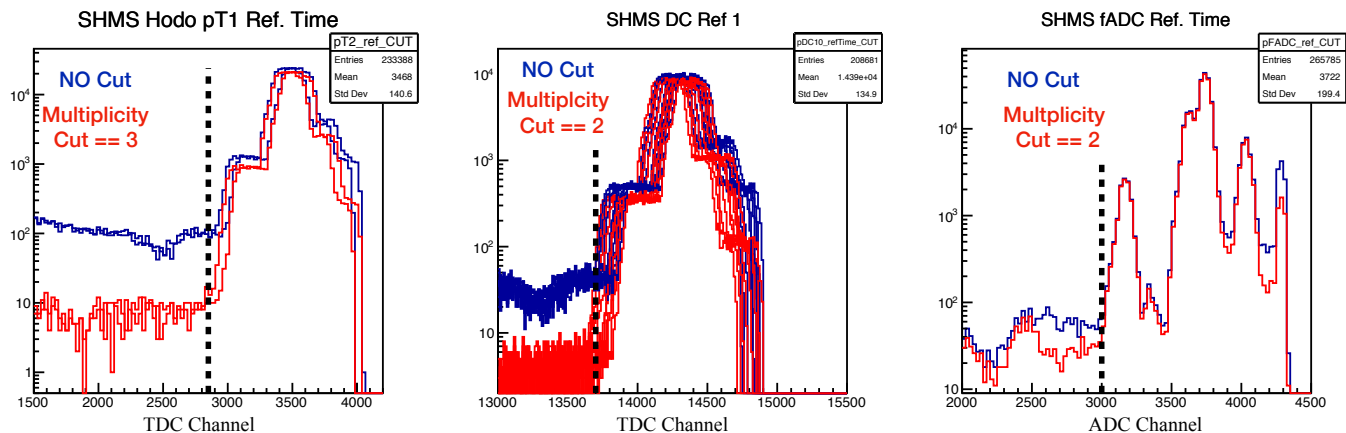


Figure 2: SHMS Reference Time Cuts for Coincidence Run 3289 of E12-10-003 experiment. The conversion from TDC Channel to time is  $\sim 0.1$  ns/Ch. The conversion from ADC Channel to time is  $0.0625$  ns/Ch.

Figure 2 shows the reference times used in the analysis. The multiplicity cut reduces the background, although not completely so a judgement of where to place the cut has to be made. The shapes of the reference times may change depending on the experiment trigger used. To the left of the cut, are the reference times from various sources of background. Once the reference time cut has been determined, the corresponding parameter files must be updated with the cut values. The parameter files to be modified are located at:

```
hallc_replay/PARAM/HMS/GEN/h_reftime_cut.param
hallc_replay/PARAM/SHMS/GEN/p_reftime_cut.param
hallc_replay/PARAM/TRIG/t[daq_mode].param2, [daq_mode]=hms, shms, coin
```

and the parameter files look as follows:

```
; Cut is on reference time per detector.
;Determiend from D2 Heep Coin Run 3377 (and
hdc_tdcrcfcut=-15075.
hhodo_tdcrcfcut=-1600.
hhodo_adcrefcut=-2300.
hcer_adcrefcut=-2300.
hcal_adcrefcut=-2300.

-:--- h_reftime_cut.param Bot L12 Git-Avg_kin
; Cut is on reference time per detector.
;Ref times from run 3288, 3371, 3374, 3377,
pdc_tdcrcfcut=-13550.
phodo_tdcrcfcut=-2800.
phodo_adcrefcut=-2850.
pngcer_adcrefcut=-2850.
phgcer_adcrefcut=-2850.
paero_adcrefcut=-2850.
pcal_adcrefcut=-2850.

-:--- p_reftime_cut.param 55% L13 Git-Avg_kin
t_coin_numAdc = 19
t_coin_numTdc = 113
t_coin_tdcoffset = 300.
t_coin_adc_tdc_offset = 200.
t_coin_trig_tdcchanperns = 0.09766
t_coin_trig_tdcrcfcut=-2800.
t_coin_trig_adcrefcut=-2850.

-:*** t_coin.param Top L1 Git-Avg_kin (Fund
```

Figure 3: HMS (top), SHMS (middle), COIN TRIG[bottom] reference time parameter files. The set cut values have a negative sign as opposed to the histograms in Figure 2. The ADC ref. time is common to the Calorimeter, Cherenkovs and Hodoscopes.

Once the reference time parameter file has been updated, the the data must be replayed so that the correct reference time is selected before moving to the next step in the analysis procedure. In principle, the reference time should be relatively stable,

<sup>2</sup>If the experiment uses the DAQ in single arm mode (separate HMS/SHMS CODA GUI), the TRIG parameter file modified must be `thms.param` or `tshms.param`

but it is worth checking for different kinematics as well as different trigger configurations. It is recommended that for each kinematic setting a single (or combined) run with enough statistics ( $\sim 1$  M events) is selected to set (or check) the reference time cuts.

## 2 Set Detector Time Window Cuts

The next step in the analysis procedure is setting up the detector time window cuts. These are necessary to reduce sources of background that slips into the detector time windows when detecting the physics signals of interest. The time window cut is made on a time difference between the ADC and TDC times on a PMT basis for all the detectors except the Drift Chamber, which cut on the raw drift times for each plane. The time difference is defined in *hcana* as

$$\text{AdcTdcDiffTime} = \text{TdcTime}[\text{ipmt}] - \text{AdcPulseTime}[\text{ipmt}] \quad \text{HODO} \quad (6)$$

$$\text{AdcTdcDiffTime} = \text{HodoStartTime} - \text{AdcPulseTime}[\text{ipmt}] \quad \text{CER, HGCER, NGCER, CAL, AERO} \quad (7)$$

where the `HodoStartTime` is the Hodoscope time projected at the focal plane, and the `TdcTime`, `AdcPulseTime` is the detector (TDC,ADC) pulse time for a given PMT in that detector. If the event is truly a physics event originating from the target, then in principle, the time difference should be a  $\delta$ -function, however due to the finite detector resolutions, it has a finite width and gaussian in shape. Events that are far away from the main peak are clearly out-of-time indicating that the ADC pulse time and TDC Time are NOT correlated with the same event, and a time window cut must be made. With respect to the Drift Chambers, a cut on the raw drift time spectrum to reduce the background from multiple hits. Similarly to the reference time cuts, the detector time window cuts are set via a parameter cut file associated with the detector. The detector variable names used as well as the parameter files used to set the cuts are summarized below.

Detector	<i>hcana</i> Leaf Name	Place-Holders
Hodoscopes	H.hod.[pl].Good[side]AdcTdcDiffTime[ipmt] H.hod.[pl].Good[side]AdcMult[ipmt]	[pl]:1x 1y 2x 2y [side]:Pos Neg
Calorimeter	H.cal.[pl].good[side]AdcTdcDiffTime[ipmt] H.cal.[pl].good[side]AdcMult[ipmt]	[pl]:1pr 2ta 3ta 4ta [side]:Pos Neg
Cherenkov	H.cer.goodAdcTdcDiffTime[ipmt] H.cer.goodAdcMult[ipmt]	
Drift Chamber	H.dc.[pl].rawtdc H.dc.[pl].nhit	[pl]:1u1 1u2 ...2x2 2v1 ...

Table 4: HMS detectors variable names are summarized. The `[ipmt]` index emphasizes the leaf variables are arrays whose indices are the PMTs, but do NOT form part of the leaf name.

Detector	<i>hcana</i> Leaf Name	Place-Holders
Hodoscopes	P.hod.[pl].Good[side]AdcTdcDiffTime[ipmt] P.hod.[pl].Good[side]AdcMult[ipmt]	[pl]:1x 1y 2x 2y [side]:Pos Neg
Pre-Shower	P.cal.pr.good[side]AdcTdcDiffTime P.cal.pr.good[side]AdcMult[ipmt]	[side]:Pos Neg
Calorimeter	P.cal.fly.goodAdcTdcDiffTime[ipmt] P.cal.fly.goodAdcMult[ipmt]	
Cherenkov	P.[det].goodAdcTdcDiffTime[ipmt] P.[det].goodAdcMult[ipmt]	[det]:hgcer ngcer
Drift Chamber	P.dc.[pl].rawtdc P.dc.[pl].nhit	[pl]:1u1 1u2 ...2x2 2v1 ...

Table 5: SHMS detectors variable names are summarized. The `[ipmt]` index emphasizes the leaf variables are arrays whose indices are the PMTs, but do NOT form part of the leaf name.



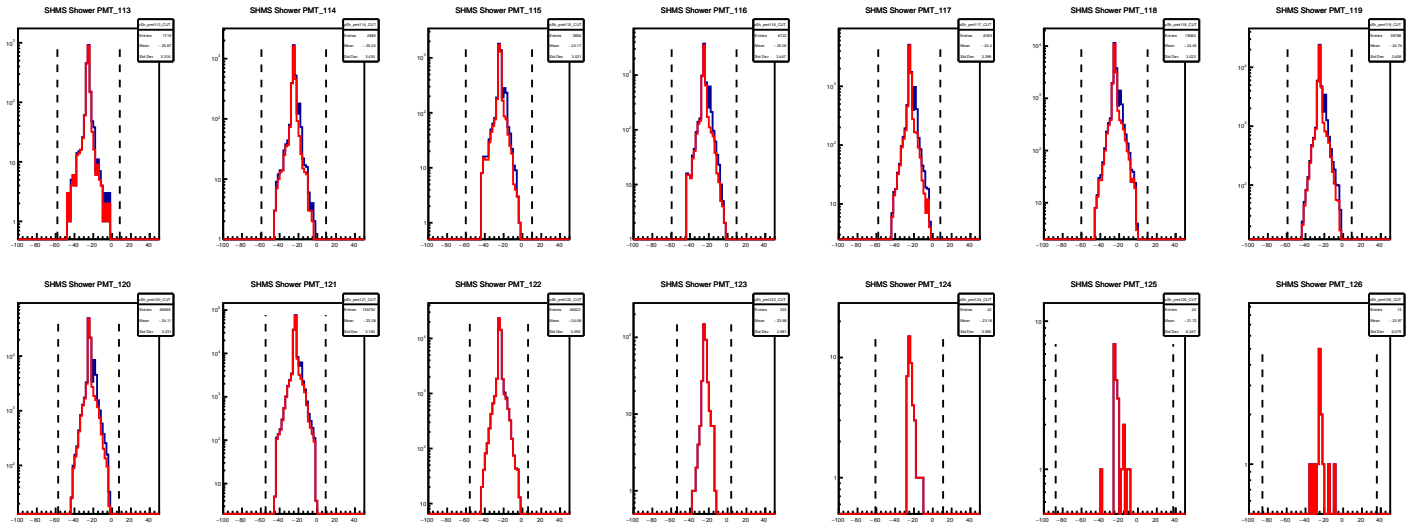


Figure 6: SHMS Calorimeter Row9 Channels Time Difference. Coincidence Run 3289 of E12-10-003 experiment.

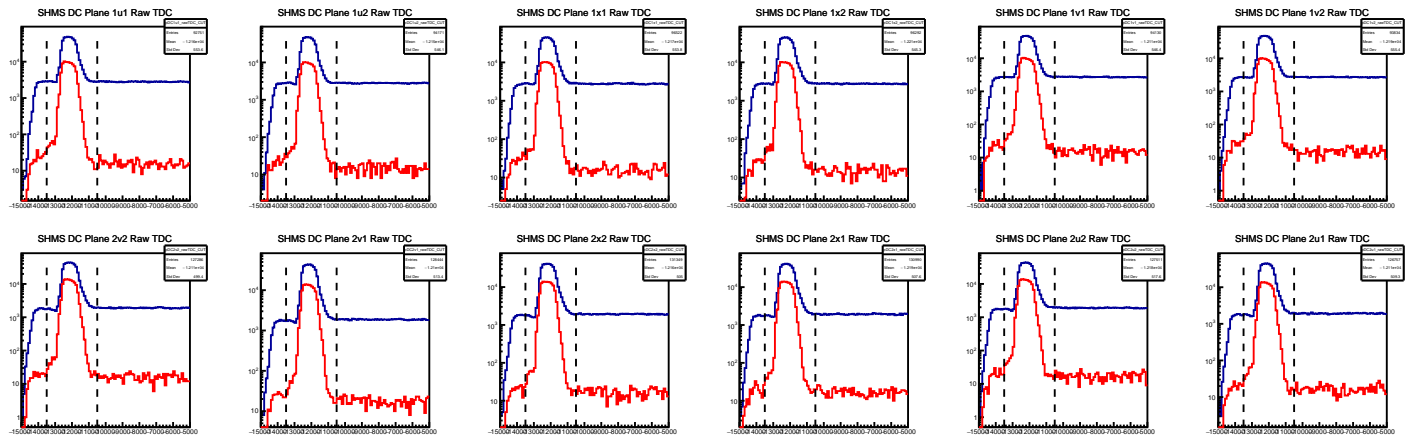


Figure 7: SHMS Drift Chambers Raw TDC Time. Coincidence Run 3289 of E12-10-003 experiment.

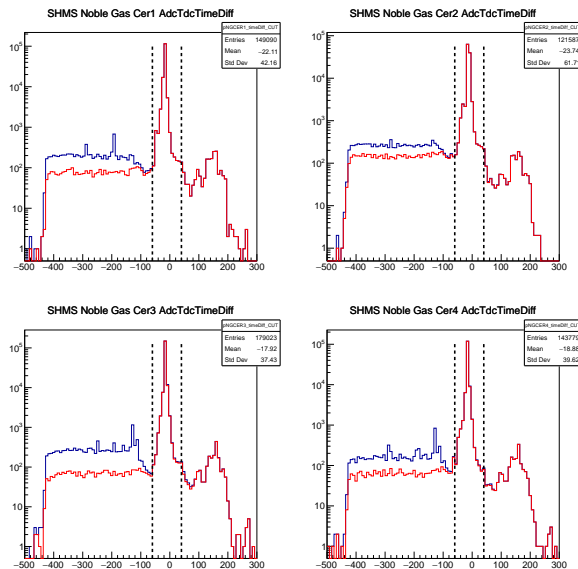


Figure 8: SHMS Noble Gas Cherenkov Time Difference. Coincidence Run 3289 of E12-10-003 experiment.

From the plots shown above, the **red histograms**, have a multiplicity cut, and the **blue histograms** have no multiplicity cut. A main peak is clearly distinguishable in all plots. Once the detector time window cuts have been determined, they are set in the detector cuts parameter files located at:

```
hallc_replay/PARAM/HMS/{DETEC}/h{detec}_cuts.param  
hallc_replay/PARAM/SHMS/{DETEC}/p{detec}_cuts.param  
hallc_replay/PARAM/TRIG/t{spec}.param
```

where `DETEC (HMS): CAL, CER, DC, HODO, AERO`, `DETEC (SHMS): CAL, HGCER, NGCER, DC, HODO, AERO`, and `spec: hms, shms, coin`. For the aerogel, no examples were shown, but in principle, in terms of setting the time window cuts should be similar procedure. For examples of how the parameter file to be modified looks like for all the detectors, see [Appendix A](#).



## 3 Detector Calibrations

After selecting the right reference times and setting proper detector time window cuts, detector calibrations can be started. Ideally, one would use specific runs for calibrations in which most of the focal plane is illuminated. Sometimes, a magnet de-focused run is used, however, one has to be careful as some calibrations actually depend on the reconstructed quantities at the target (Calorimeter), and hence knowledge of the reconstruction spectrometer optics. In this case, it is recommended to use single-arm runs over coincidence runs, as the latter will be more constrained. In this section, I will point to more detailed documentation on the Hall C Document Database (DocDB), as well as the document with the instructions to run the calibration.

### 3.1 Hodoscopes

The hodoscopes Calibration code and README files with the instructions on how to do the calibration is found on:

[https://github.com/JeffersonLab/hallc\\_replay/tree/master/CALIBRATION/hms\\_hodo\\_calib](https://github.com/JeffersonLab/hallc_replay/tree/master/CALIBRATION/hms_hodo_calib)  
[https://github.com/JeffersonLab/hallc\\_replay/tree/master/CALIBRATION/shms\\_hodo\\_calib](https://github.com/JeffersonLab/hallc_replay/tree/master/CALIBRATION/shms_hodo_calib)

Additional documentation on the Hodoscope calibration can be found on the Hall C Document DataBase:

[https://hallcweb.jlab.org/DocDB/0009/000970/001/hodo\\_calib.pdf](https://hallcweb.jlab.org/DocDB/0009/000970/001/hodo_calib.pdf)

### 3.2 Drift Chambers

The Drift Chambers Calibration code and README files with the instructions on how to do the calibration is found on:

[https://github.com/JeffersonLab/hallc\\_replay/tree/master/CALIBRATION/dc\\_calib/scripts](https://github.com/JeffersonLab/hallc_replay/tree/master/CALIBRATION/dc_calib/scripts)

Additional documentation on the Drift Chamber calibration can be found on the Hall C Document DataBase:

[https://hallcweb.jlab.org/DocDB/0008/000863/003/HallC-Software-Workshop\\_pdf.pdf](https://hallcweb.jlab.org/DocDB/0008/000863/003/HallC-Software-Workshop_pdf.pdf)  
<https://hallcweb.jlab.org/DocDB/0008/000842/003/report.pdf>

### 3.3 Calorimeters

The Calorimeter Calibration code and README (howto.txt) files with the instructions on how to do the calibration is found on:

[https://github.com/JeffersonLab/hallc\\_replay/tree/master/CALIBRATION/hms\\_cal\\_calib](https://github.com/JeffersonLab/hallc_replay/tree/master/CALIBRATION/hms_cal_calib)  
[https://github.com/JeffersonLab/hallc\\_replay/tree/master/CALIBRATION/shms\\_cal\\_calib](https://github.com/JeffersonLab/hallc_replay/tree/master/CALIBRATION/shms_cal_calib)

Additional documentation on the Calorimeter can be found on the Hall C Document DataBase:

<https://hallcweb.jlab.org/DocDB/0008/000809/001/NIMarticleOverview.pdf>

### 3.4 Cherenkovs

The Cherenkovs Calibration code and README files with instructions on how to do the calibration is found on:

[https://github.com/JeffersonLab/hallc\\_replay/tree/master/CALIBRATION/hms\\_cer\\_calib](https://github.com/JeffersonLab/hallc_replay/tree/master/CALIBRATION/hms_cer_calib)  
[https://github.com/JeffersonLab/hallc\\_replay/tree/master/CALIBRATION/shms\\_hgcer\\_calib](https://github.com/JeffersonLab/hallc_replay/tree/master/CALIBRATION/shms_hgcer_calib)

Additional documentation on the Cherenkovs can be found on the Hall C Document DataBase:

[https://hallcweb.jlab.org/DocDB/0008/000893/001/HGC\\_Calibration.pdf](https://hallcweb.jlab.org/DocDB/0008/000893/001/HGC_Calibration.pdf)

## Appendix A Examples of Cut Parameter Files

The values in the parameter files are read in as arrays starting with index zero from left to right. For example, `hhodo_PosAdcTimeWindowMin[0]=-61.`, `hhodo_PosAdcTimeWindowMin[1]=-64.`

```
; Determined by Coin run 3288/3289
hdc_tdc_min_win = -14000.00, -14000.00, -14000.00, -14000.00, -14000.00, -14000.00, -14000.00, -14000.00, -14000.00, -14000.00, -14000.00, -14000.00
hdc_tdc_max_win = -11000.00, -11900.00, -11800.00, -11800.00, -10600.00, -11800.00, -10800.00, -11600.00, -11800.00, -11800.00, -10600.00, -11800.00
[]
-:--- hdc_cuts.param 34% L12 Git-Avg kin (Fundamental)
```

Figure 9: HMS DC TimeWindow cut parameter file.

```
;Time Window Cuts set from Run 3377
;
;          1y          2x          2y
hhodo_PosAdcTimeWindowMin = -61, -64, -61, -65
-58.59, -61.57, -60.98, -63.01
-58.08, -59.98, -60.71, -59.81
-58.14, -61.00, -59.83, -60.09
-58.27, -61.00, -60.98, -61.18
-57.89, -59.51, -60.11, -60.81
-:--- hhodo_cuts.param 46% L83 Git-Avg kin (Fundamental)
```

Figure 10: HMS Hodo TimeWindow cut parameter file.

```
; HMS Cherenkov Parameter File Containing TimeWindow Min/Max Cuts
hcer_adcTimeWindowMin = 80., 90.
hcer_adcTimeWindowMax = 105., 110.
-:--- hcer_cuts.param 63% L25 Git-Avg kin (Fundamental)
```

Figure 11: HMS Cherenkov TimeWindow cut parameter file.

```
;Determined from Run 3289
hcal_pos_AdcTimeWindowMin = -1.4e+02,-1.4e+02,-94,-90,-85,-85,-88,-85,-88,-95,-1.2e+02,-93,-98
-90.28,-96.54,-83.63,-82.16,-127.40,-106.08,-85.81,-94.72,-92.85,-85.41,-86.93,-90.08,-87.29
-92.97,-111.21,-94.81,-99.14,-99.47,-88.64,-82.46,-84.82,-120.49,-93.59,-94.82,-96.37,-94.61
-84.21,-89.51,-127.78,-86.68,-94.48,-87.92,-98.40,-100.97,-99.62,-87.97,-91.54,-95.07,-89.83
[]
-:--- hcal_cuts.param 53% L48 Git-Avg kin (Fundamental)
```

Figure 12: HMS Calorimeter TimeWindow cut parameter file.

```
;Determined from run 3288/3289
pdc_tdc_min_win = -13200.00, -13200.00, -13200.00, -13200.00, -13200.00, -13200.00, -13200.00, -13200.00, -13200.00, -13200.00, -13200.00, -13200.00, -13200.00
pdc_tdc_max_win = -10500.00, -10500.00, -10500.00, -10500.00, -10500.00, -10500.00, -10500.00, -10500.00, -10500.00, -10500.00, -10500.00, -10500.00, -10500.00
-:--- pdc_cuts.param 39% L9 Git-Avg kin (Fundamental)
```

Figure 13: SHMS DC TimeWindow cut parameter file.

```
;Time Windows set based on run 3377
;          1y          2x          2y
phodo_PosAdcTimeWindowMin = -57, -35, -29, -79
-54.26, -37.68, -27.42, -79.25
-52.41, -31.94, -25.25, -22.69
-53.67, -29.91, -22.76, -22.41
-51.35, -30.42, -24.16, -20.55
-47.85, -30.59, -26.15, -19.89
-:--- phodo_cuts.param 8% L24 Git-Avg kin (Fundamental)
```

Figure 14: SHMS Hodo TimeWindow cut parameter file.

```
;Determined from run 3288/3289
phgcer_adcTimeWindowMin = -80, -80.00, -80.00, -80.00
phgcer_adcTimeWindowMax = 40.00, 40.00, 40.00, 40.00
; NPE Threshold for "good" hit (for measuring effic.)
-:--- phgcer_cuts.param 73% L26 Git-Avg kin (Fundamental)
```

Figure 15: SHMS HG Cherenkov TimeWindow cut parameter file.

```

;Determined from run 3288/3289
pngcer_adcTimeWindowMin = -60, -60.00, -60.00, -60.00
pngcer_adcTimeWindowMax = 40.00, 40.00, 40.00, 40.00

;NPE Threshold for "good" hit (for measureing effic.)
pngcer_npe_thresh = 0.5
----- pngcer_cuts.param Bot L22 Git-Avg kin (Fundamental)

```

Figure 16: SHMS NG Cherenkov TimeWindow cut parameter file.

```

;Determined from run 3288/3289
pcal_pos_AdctimewindowMin = -1e+02, -1e+02, -1e+02, -1e+02, -1e+02, -1e+02, -1e+02, -80, -1e+02, -1e+02, -1e+02, -1e+02, -1e+02, -1e+02
pcal_pos_AdctimewindowMax = 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00

pcal_neg_AdctimewindowMin = -100.00, -100.00, -100.00, -100.00, -80.00, -100.00, -100.00, -100.00, -100.00, -100.00, -100.00, -100.00, -100.00, -100.00
pcal_neg_AdctimewindowMax = 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00, 20.00
----- pcal_cuts.param 8% L16 Git-Avg kin (Fundamental)

```

Figure 17: SHMS PreShower TimeWindow cut parameter file.

```

;Determined from run SHMS Defocused Run 1791
pcal_arr_AdctimewindowMin = -52,-54.84,-54.53,-53.21,-44.73,-47.93,-42.67,-40.83,-42.02,-44.00,-56.05,-52.46,-68.90,-47.62
-50.67,-69.07,-50.83,-47.19,-44.07,-47.72,-46.00,-42.32,-44.32,-42.73,-42.69,-44.41,-41.39,-48.56
-42.09,-45.31,-44.07,-49.53,-41.38,-41.84,-43.20,-40.87,-40.89,-42.29,-42.42,-39.00,-38.26,-39.75
-38.62,-39.71,-44.89,-46.88,-49.14,-54.41,-49.51,-44.70,-44.25,-46.26,-45.92,-45.27,-41.69,-41.22
-42.71,-43.73,-40.79,-42.16,-41.86,-43.12,-56.66,-54.71,-48.19,-41.09,-43.23,-45.24,-39.94,-40.02
-37.67,-41.30,-40.84,-36.41,-39.32,-35.37,-40.68,-40.21,-43.66,-57.48,-42.52,-41.08,-42.89,-40.21
-42.69,-40.19,-41.61,-40.10,-40.27,-39.60,-38.06,-32.75,-32.39,-41.60,-42.54,-48.94,-43.94,-40.64
----- pcal_cuts.param 32% L49 Git-Avg kin (Fundamental)

```

Figure 18: SHMS Calorimeter TimeWindow cut parameter file.