

Updates to HCANA for Hodoscope

1. Added additional THcHodoHit::SetCorrectedTimes method
2. ScintillatorPlane::ProcessHits
 - Save the TDC and ADC good reference time used for each plane.
 - Tree variable: $P(H).hod.pl.PosTdcRefTime$, $NegTdcRefTime$, $PosAdcRefTime$, $NegAdcRefTime$
 - Save the TDC and ADC difference between good reference time and time of previous pulse used for each plane.
 - Tree variable: $P(H).hod.pl.PosTdcRefDiffTime$, $NegTdcRefDiffTime$, $PosAdcRefDiffTime$, $NegAdcRefDiffTime$
 - Changed matching of ADC hit to TDC hit.
 - If ADC Raw AMP = 0 , test that hit instead of skipping it.
3. Updated algorithm to find Start Time and focal plane time
4. Add calculation of the difference between the average difference between raw ADC times and TDC times for paddles with “good” hits at both ends.
 - Tree variable $P(H).hod.adctdcoffset$
 - Created hodoscope method GetOffsetTime that can be used by other detectors

Fixed Problem with THcHodoHit SetCorrectedTimes Method

- When both ends of paddle have hits
 - Calculate the time corrected for timewalk and cable lengths , PosCorrTime, NegCorrTime
 - Determines the mean time = TimeAve = (PosCorrTime+NegCorrtime)/2
 - Determines TOF corrected time with both PosTofTime=NegTofTime=TimeAve- Z/30*BetaNominal
 - SetCorrectedTimes(PosCorrTime, NegCorrTime, PosTOFTime, NegTofTime, TimeAve)
 - Sets flag HasCorrectedTime = kTRUE. Use later in THcHodoscope::EstimateFocalPlaneTime to determine if hit has two ends hit and used to determine the focal plane time.
- When only one end of paddle has hit still need to call THcHodoHit SetCorrectedTimes
 - Only want to set either PosCorrTime and NegCorrTime with other time set to default -999
 - Old code:
 - Was using SetCorrectedTimes which was setting flag HasCorrectedTime = kTRUE
 - So hits with only one PMT hit was being included in the focal plane time estimate
 - **New code:**
 - Create new method SetCorrectedTimes(PosCorrTime, NegCorrTime)
 - Sets HasCorrectedTime = kFALSE

With new code, the determination of Start Time does not use paddle with just one good PMT

ScintillatorPlane::ProcessHits Changed method of matching of ADC to TDC hits

ScintillatorPlane::ProcessHits

- Selects first TDC PMT hit within the TDC_min and TDC_max windows.
- Old code
 - If Raw ADC Amp = 0 , then do not use hit.
 - First ADC hit within $ADCTDC_min < TDC_time - ADC_time < ADCTDC_max$
 - If no ADC hit is found then PMT hit is not “good”. Need both ADC and TDC info for “good” PMT hit.
- **New Code**
 - If Raw ADC amp = 0, then use hit and test ADC hit setting ADC Amp =200.
 - Adc Amp=200 sets the timewalk correction to zero.
 - First ADC hit within $ADCTDC_min < TDC_time - ADC_time < ADCTDC_max$ with largest ADC value
 - If none found then selects one with smallest $TDC_time - ADC_time$.
 - So if there is an ADC hit for paddle PMT, then it will set “good” PMT hit if there is TDC PMT hit.

New code ensures that if there is a TDC hit within the selection window and any ADC hit for the paddle PMT , then it will find a “good” hit.

Reminder about the Start Time and focal plane time

- Start Time determined only using Hodoscope.
 - Accounts for the fluctuations in trigger time due different paddles hit, where it hits in paddle, cable lengths etc.
 - Only uses paddles with both ends hit.
- Focal Plane Time is the same as Start Time but uses track information to determine TOF correction.
 - Includes paddles with only end hit.
 - Used in the coincidence time calculation.

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Updated algorithm to find Start Time and focal plane time

- Loops through hits (Note if no hits found after Decode then Start Time = -1000)
 - When hit HasCorrectedTime = kTRUE then fill histogram with hit times PosToFTime and NegToFTime over 0-200ns
- Need to determine the peak time =TPEAK with maximum number of hits.
 - Old code would just determine the peak time from the 0.5ns time bin with the maximum number of hits.
 - **New method** DetermineTimePeak which
 - scans the histogram and gets running sum in 5ns bin.
 - The bin must have at least 3hits and can find multiple peaks.
 - If more than one peak chooses one closest to the fStartTimecenter which is a parameter that can be set.
- Again loop through hits in each plane
 - If HasCorrectedTime = kTRUE and PosToFTime and NegToFTime are within TPEAK +/- tof_tolerance
 - Adds the times to the TimeSum and NTimeSum++
 - If plane has good hit, NumPlanes++
- Set the Start Time = fStartTimecenter
 - Old code: If NTimeSum>0 then Start Time = TimeSum/NTimeSum++
 - **New Code** : If NumPlanes >= 3 then Start Time = TimeSum/NTimeSum++

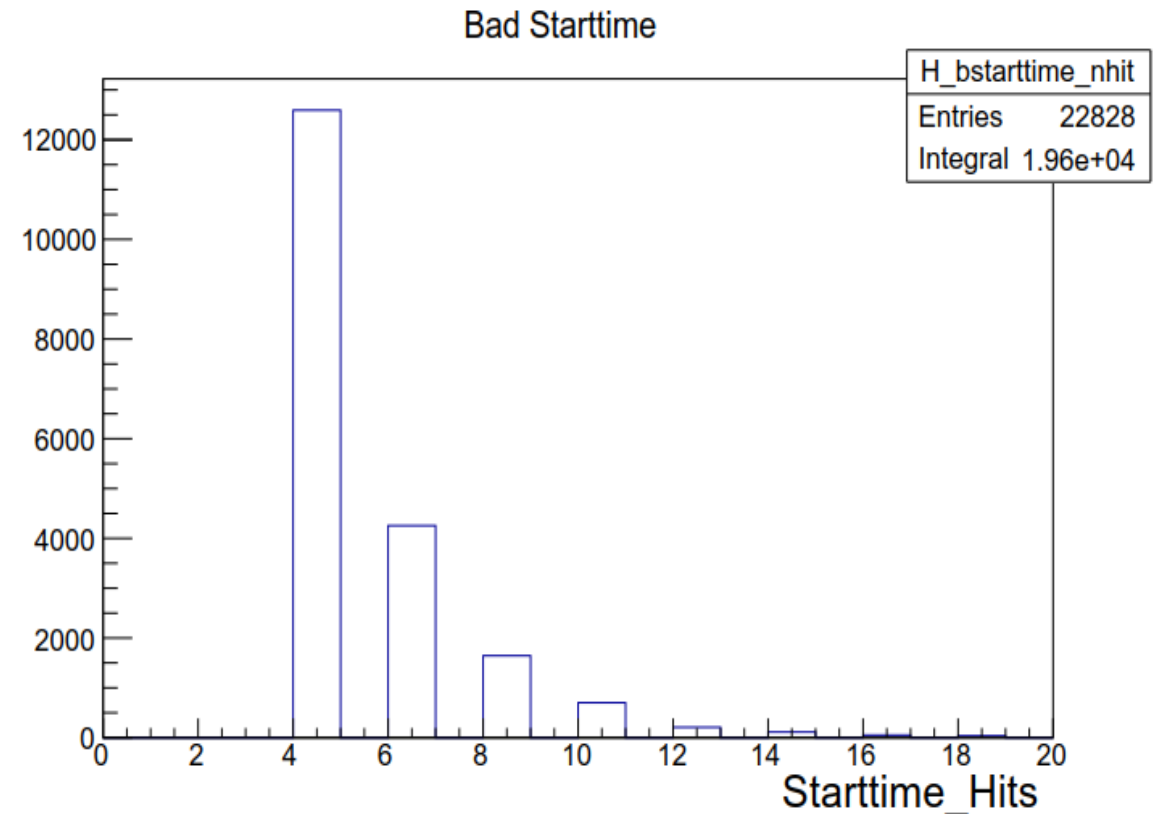
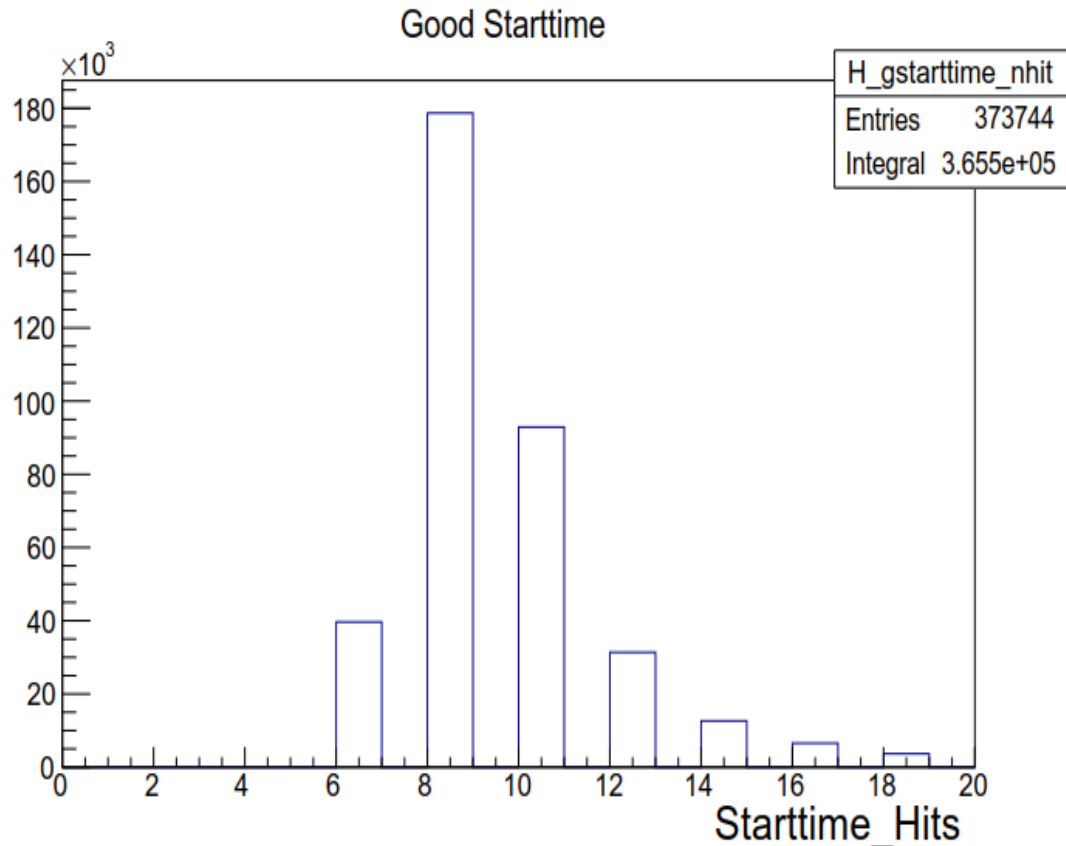
- With new code will have more failures where Start Time = fStartTimecenter
- But is better at ignoring the accidental singles triggers at high rates.
- For focal plane time if NumPlanes < 3
 - If GoodStartTime then fptime=fStartTime otherwise -2000;
 - In THcCoinTime do not calculate CoinTime if fptime=-2000;

Monitor the StartTime

- Added tree variables to monitor the histogram that determines the TPEAK for StartTime and Focal Plane Time
 - Use “FpTime” instead of “StartTime” in tree name for Focal Plane Time.
- P.hod.TimeHist_StartTime_NumPeaks is the number of peaks found.
 - The “best” peak is peak that has the peak position closest to the StartTimeCenter parameter.
 - With rate the possibility of two good events with times within the SCIN_TDC_MIN and SCIN_TDC_MAX window increases.
- P.hod.TimeHist_StartTime_Peak is the mean of the 5ns bin in ns for the “best” peak.
- P.hod.TimeHist_StartTime_Sigma is the rms of the 5ns bin in ns for the “best” peak.
- P.hod.TimeHist_StartTime_Hits is the number of PMT hits in the 5ns bin of the “best” peak.

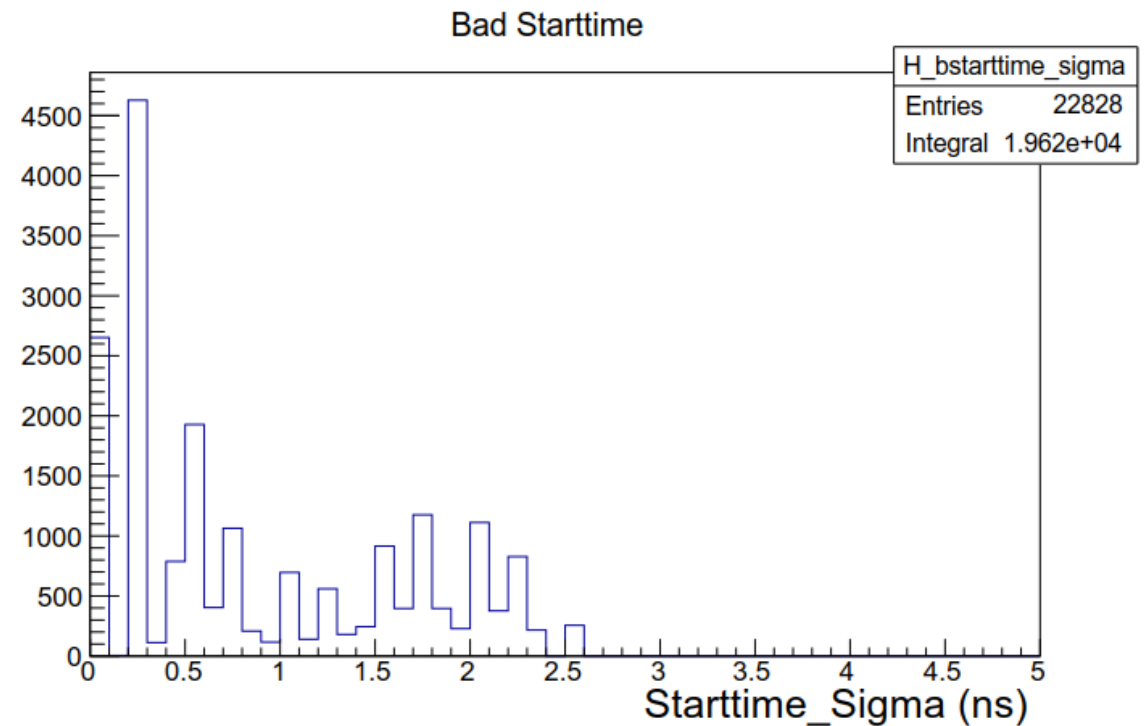
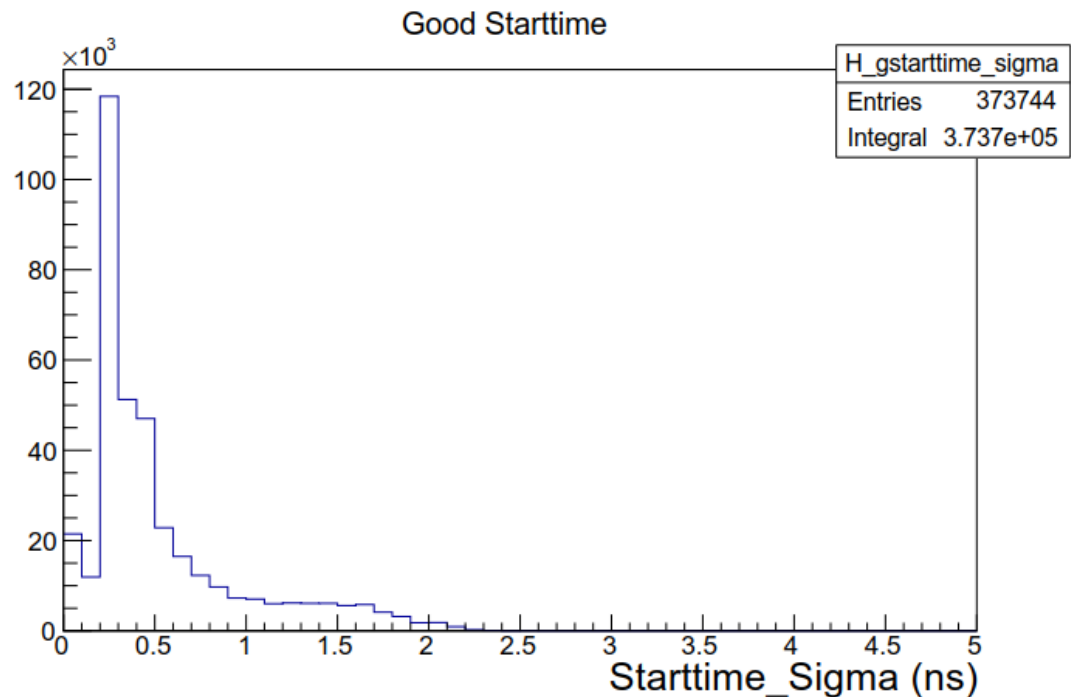
Compare Starttime Hits for “good” to “bad” Starttime

- If HCANA does not find a StartTime, then it sets P.hod.goodstarttime==0 and P.hod.starttime=p_start_time_center
- Look at coincidence run 5371, Hodo 3of4 rate about 600kHz.
- When HCANA finds a “good” starttime then Starttime_hits peaks at 8
- When HCANA does not “good” starttime, then Starttime_hits peaks at 4
 - Typically particle passes through two planes (so they are close in time giving a peak of 4 hits)
 - HODO 3of4 trigger formed because of random coincidence with 3rd plane which is out of time by more than 5ns.



Compare Starttime Sigma for “good” to “bad” Starttime

- If HCANA does not find a StartTime, then it sets P.hod.goodstarttime==0 and P.hod.starttime=p_start_time_center
- Look at coincidence run 5371, Hodo 3of4 rate about 600kHz.
- When HCANA finds a “good” starttime then Starttime_sigma has large peak at 0.2ns
- When HCANA does not “good” starttime, then Starttime_sigma has a relatively smaller peak at 0.2ns
 - Wider spread in sigma



Compare Starttime Peak for “good” to “bad” Starttime

- If HCANA does not find a StartTime, then it sets P.hod.goodstarttime==0 and P.hod.starttime=p_start_time_center
- Look at coincidence run 5371, Hodo 3of4 rate about 600kHz.
- Hodo 3of4 trigger has usually S1X set the timing with peak at around 54ns
 - When S2Y sets the timing, then peak is at about 38ns
 - When S2X sets the timing, then peak is at about 64ns
- The “bad” starttime shows more random HODO 3of4

