LHRS Analysis for d_2^n

VDC t_0 *Check, Trigger Efficiency* & *Scintillator Studies*

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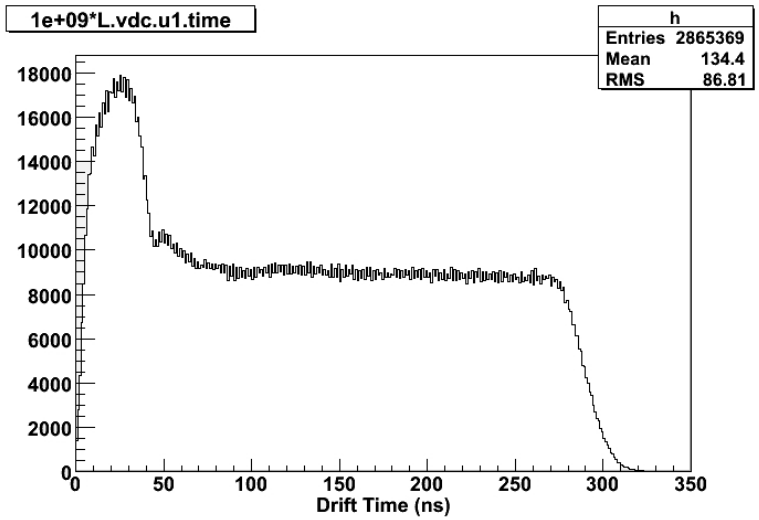
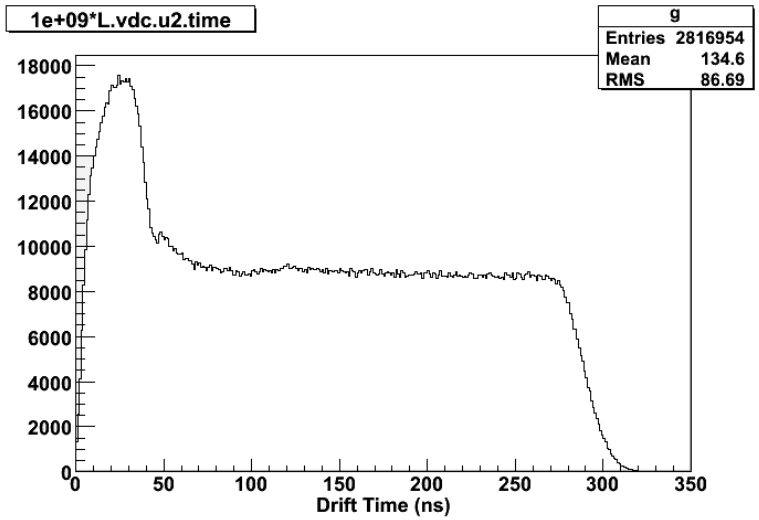
Outline

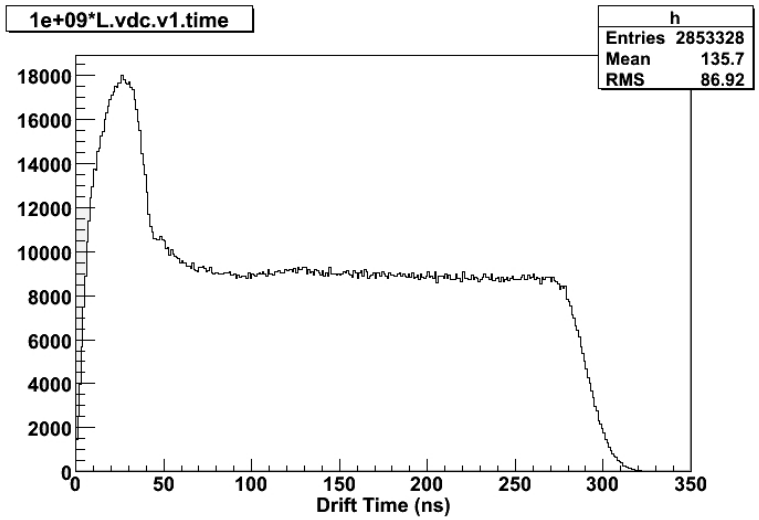
t_0 Check (1)

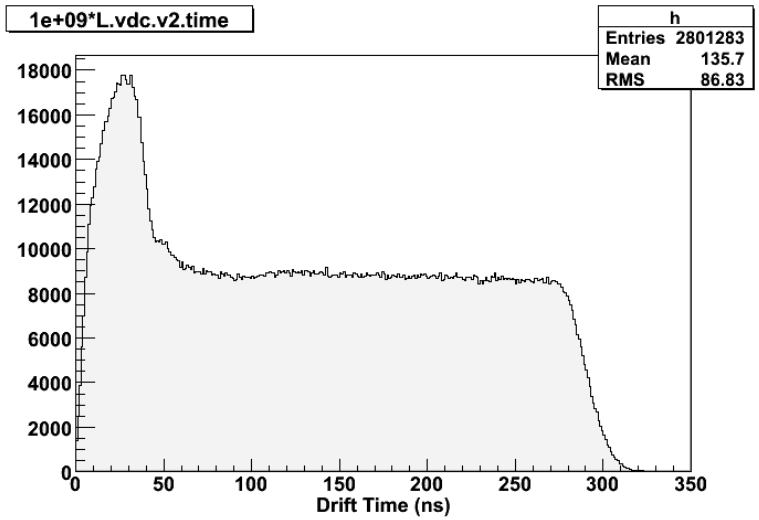
- The t_0 value has to do with minimizing the time difference of the time when drifting e^- pass the hit wire and the time that the particle reaches the VDC
- Essentially a combination of the TDC propagation times
  1. The time for the signal to travel from the hit wire to its corresponding TDC
  2. The time for the trigger signal to propagate from the trigger detector to the TDC (common stop)
- The value of t_0 is identified as the rising edge of the drift time spectrum

t_0 Check (2)


1e+09*L.vdc.u1.time
h
Entries 2865369
Mean 134.4
RMS 86.81
Drift Time (ns)


1e+09*L.vdc.u2.time
g
Entries 2816954
Mean 134.6
RMS 86.69
Drift Time (ns)


1e+09*L.vdc.v1.time
h
Entries 2853328
Mean 135.7
RMS 86.92
Drift Time (ns)


1e+09*L.vdc.v2.time
h
Entries 2801283
Mean 135.7
RMS 86.83
Drift Time (ns)

Trigger Efficiency (1)

Method

- To calculate the trigger efficiency, we first determine good events:
  - *Trigger Cuts – remove pulser, require either a T3 or T4:*
    (DL.edtpl==0)&&(((DL.evtypebits&(1<<3))==(1<<3))
    ||((DL.evtypebits&(1<<4)))==(1<<4)))
  - *VDC Cuts – reconstruction of one cluster in each plane:*
    (L.vdc.u1.nclust==1)&&(L.vdc.v1.nclust==1)
    (L.vdc.u2.nclust==1)&&(L.vdc.v2.nclust==1)
  - *PID Cuts:*
    (L.cer.asum_c> 300)&&(prl_E_P> 0.54) &&(TDC Cuts on the Gas Čerenkov)

Trigger Efficiency (2)

Method

- The efficiency is given as:

$$\varepsilon_{T3} = \frac{N_{T3}}{N_{T3} + N_{T4}}$$

  - N_j = $ps_j \times \text{bit}_j$ for $j = T3, T4$
  - ps_j = prescale for trigger j
  - bit_j = bit pattern for trigger j (from the variable DL.bitj)

- We include the prescales here so as to keep the calculation honest
  - For instance, if all the $T4$'s were prescaled away, this calculation would yield a T3 efficiency of 1, while the $T3$ may only be 50% efficient

Trigger Efficiency (3)

Sample Calculation: Run 20676

$$
\begin{aligned}
ps_3 &= ps_4 = 1 \\
N_{T3} &= 12275 \\
N_{T4} &= 4 \\
\varepsilon_{T3} &= \frac{12275}{12275 + 4} \times 100\% = 99.96\%
\end{aligned}
$$

- For comparison: Patricia's calculations yield $\varepsilon_{T3} \sim 99.98\%$ on average

S1 Alignment (1)

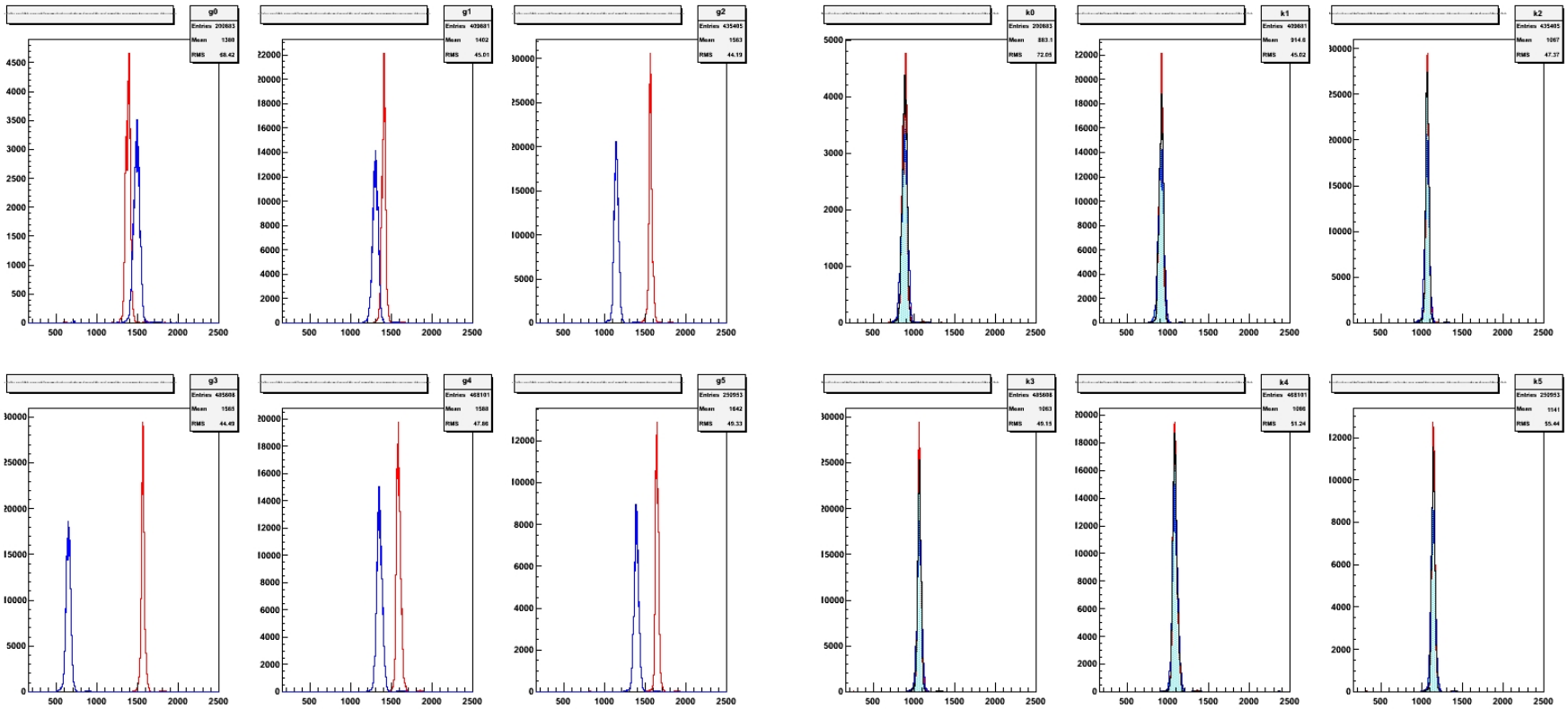
Method: L-R Correction

- Before examining the S2m - S1 time difference, we need to make sure the time averages in S1 are correct
  - We need to determine the proper offsets for the L and R TDC times for each paddle in S1

S1 Alignment (2)

Results: Before & After

- Left: Before the correction; Right: After the correction – light blue shows time average formed from corrected raw variables
- All variables shown are raw variables



S2-S1 Time Difference (1)

Method: Calculating the Time Averages

- Now with the S2m paddles aligned (from last meeting) and the S1 L-R correction determined, we can now look at the time difference between the S2m and S1 paddles
  - We consider the time averages of each paddle:

$$t^i_{s2m,cor} = \frac{1}{2}\left(t^i_{L,raw} - \delta^i_{s2m,LR} + t^i_{R,raw}\right) - \Delta^i$$

$$t^j_{s1,raw} = \frac{1}{2}\left(t^j_{L,raw} - \delta^j_{s1,L} + t^j_{R,raw} - \delta^j_{s1,R}\right)$$

  - Δ^i contains the correction needed so that paddle i aligns to the reference paddle ($i_{\text{ref}} = 7$)
  - The various δ's are the L-R corrections. S1 has a slightly different form, as they were chosen so that the S2m - S1 time differences are positive, for convenience

S2-S1 Time Difference (2)

Results: S2m - S1 Time Difference

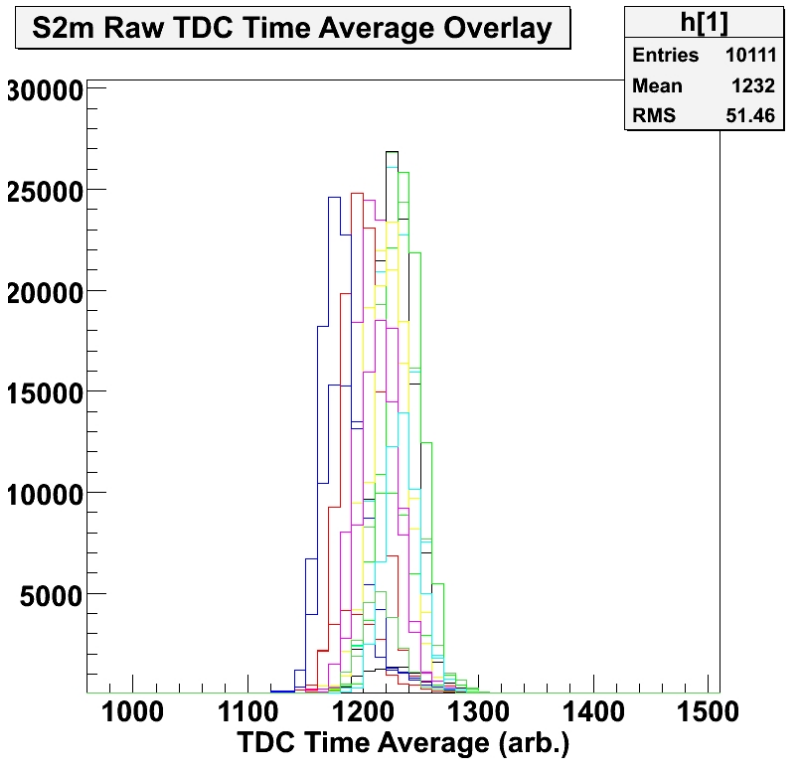
- Going paddle-to-paddle in S1, we do see a noticable offset
  - This can be fixed
- However, going paddle-to-paddle in S2m – we see some values (for a given S1 paddle) are in disagreement by as much as ~ 1 ns (!)

Scintillating Plane Time Differences		
S1 Paddle	S2m Paddle	dt (TDC Channels)
0	0	355.54
	1	336.37
	2	328.31
1	3	295.17
	4	293.04
	5	292.66
2	5	147.95
	6	161.38
	7	165.72
3	8	161.72
	9	145.29
	10	163.64
4	10	115.94
	11	113.18
	12	137.47
5	13	84.21
	14	82.61
	15	78.92

S2-S1 Time Difference (3)

Results: S2m - S1 Time Difference

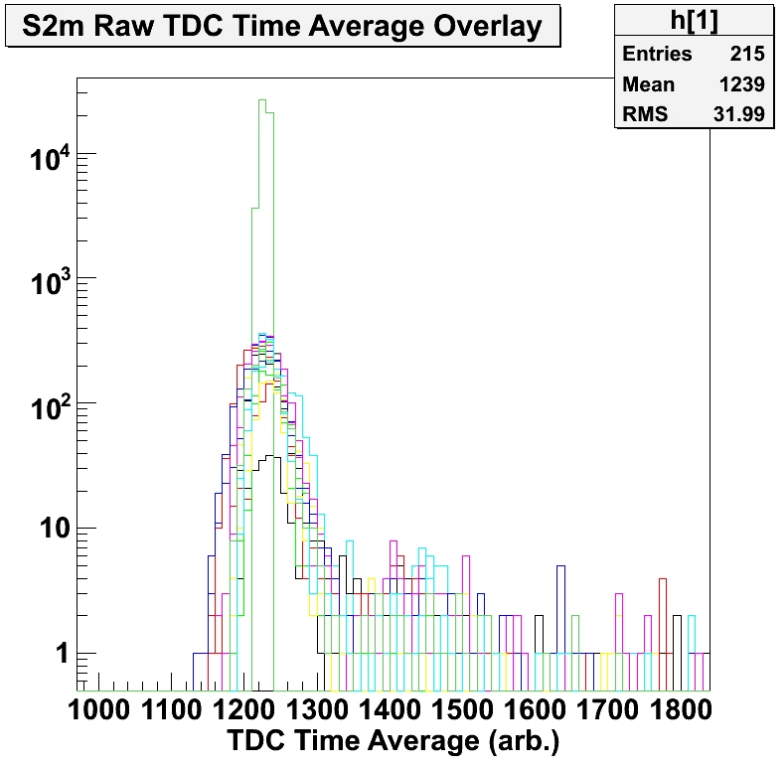
- Such a result suggests that the S2m paddles aren't actually lined up. . .
- A close look shows the S2m times are not aligned
  - Checked the cuts – did not require paddle overlap, and that the reference paddle takes the timing. . .



S2-S1 Time Difference (4)

Results: S2m - S1 Time Difference

- Using the proper cuts
- Note: Large green peak is the reference paddle 7 – it has two less cuts than all other paddles



S2-S1 Time Difference (5)

Results: S2m - S1 Time Difference

- Trying the calculation again. . .
- Nothing really changes

Scintillating Plane Time Differences		
S1 Paddle	S2m Paddle	dt (TDC Channels)
0	0	355.86
	1	340.75
	2	327.92
1	3	299.12
	4	298.74
	5	296.71
2	5	159.30
	6	182.56
	7	165.29
3	8	168.72
	9	156.61
	10	163.53
4	10	112.05
	11	116.81
	12	132.97
5	13	91.39
	14	87.55
	15	85.26

Summary

- VDC:
  - t_0 looks good – no correction needed
- Trigger Study:
  - Have a good handle on the method
  - Sample calculation is in agreement with previous work by Patricia
- Scintillator Study:
  - S1 L-R correction has been implemented
  - S2m - S1 time difference looks normal on first glance (paddle-to-paddle in S1)
    - Strange behavior in going paddle-to-paddle in S2m

What's Next?

- Trigger Study:
  - Determine how to get the prescale factors for each run out of the ROOTfile
  - Do a run-by-run analysis of the T3 trigger efficiency for the major (production) kinematics
    - The code for this is ready to go
- Scintillator Study:
  - Fairly puzzled. . . the S2m time average is aligned, yet the time difference with S1 isn't consistent?