Mott DAQ Speed

December 18, 2014

How to speedup DAQ

I. Reject low-energy electrons before reaching DAQ:

   1. Increase E-detector hardware threshold

   2. Vetoing dump events

II. Use faster DAQ mode

Increase E-Detector Hardware Threshold

- E-detector discriminator threshold (NIM715) is now at -25 mV
- Change threshold to -50 mV will reduce DAQ rate by a factor of 2

Vetoing Dump Events

- Use laser ToF to veto dump events in NIM754 logic

Use Faster DAQ Mode

- For DAQ to be faster:
  - No Readout of CAEN v775 TDC or SIS3801 Scalers; only FADC readout
  - Use block readout

- FADC has a mode with smaller data size and time readout: Pulse Integral and High Resolution Time Mode

- We took data with this mode … results are shown next …

Comparison of:

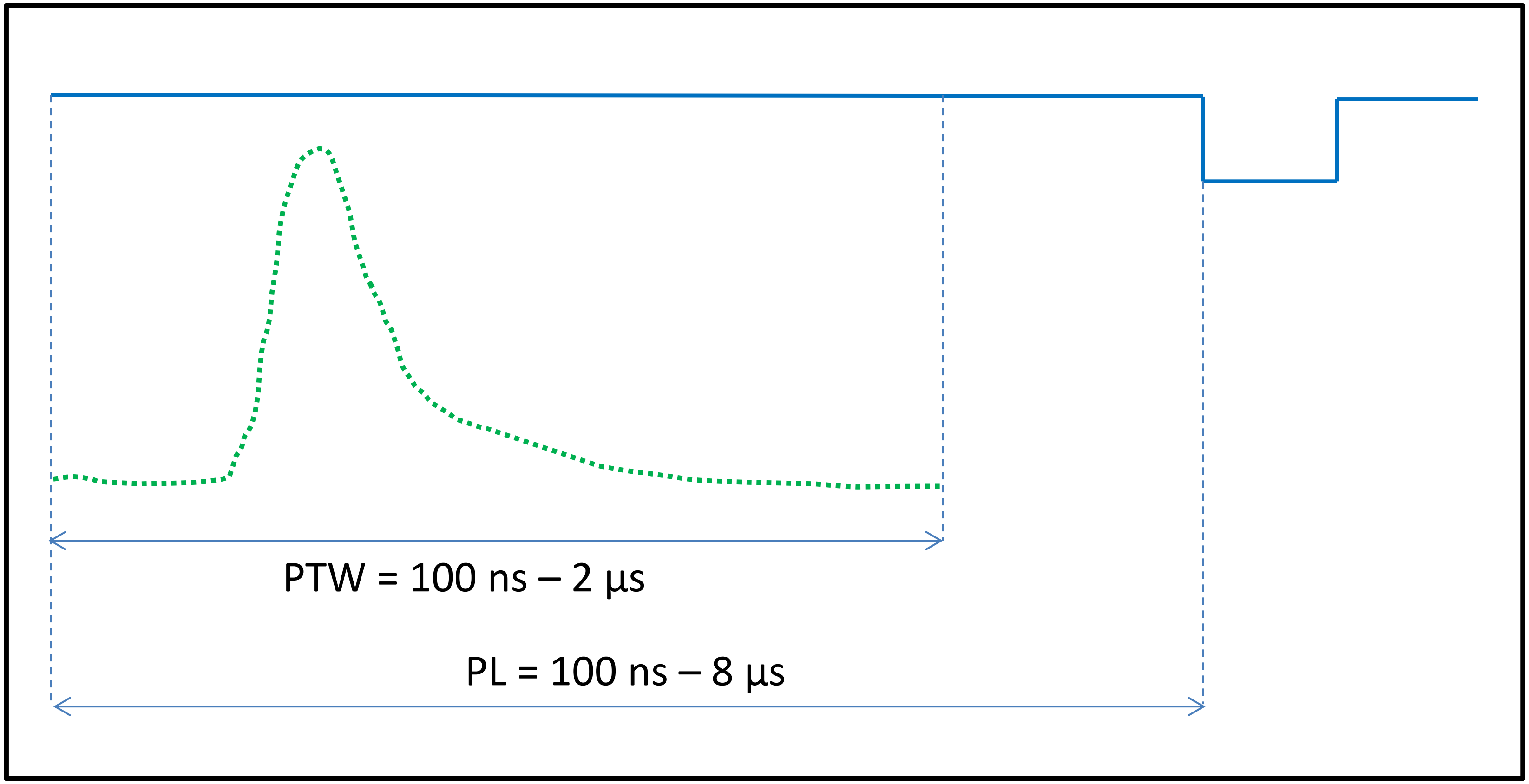
Raw ADC Data Samples Mode

vs.

Pulse Integral and High Resolution Time Mode

RAW ADC DATA SAMPLES – RUN 7673

Raw ADC Data Samples



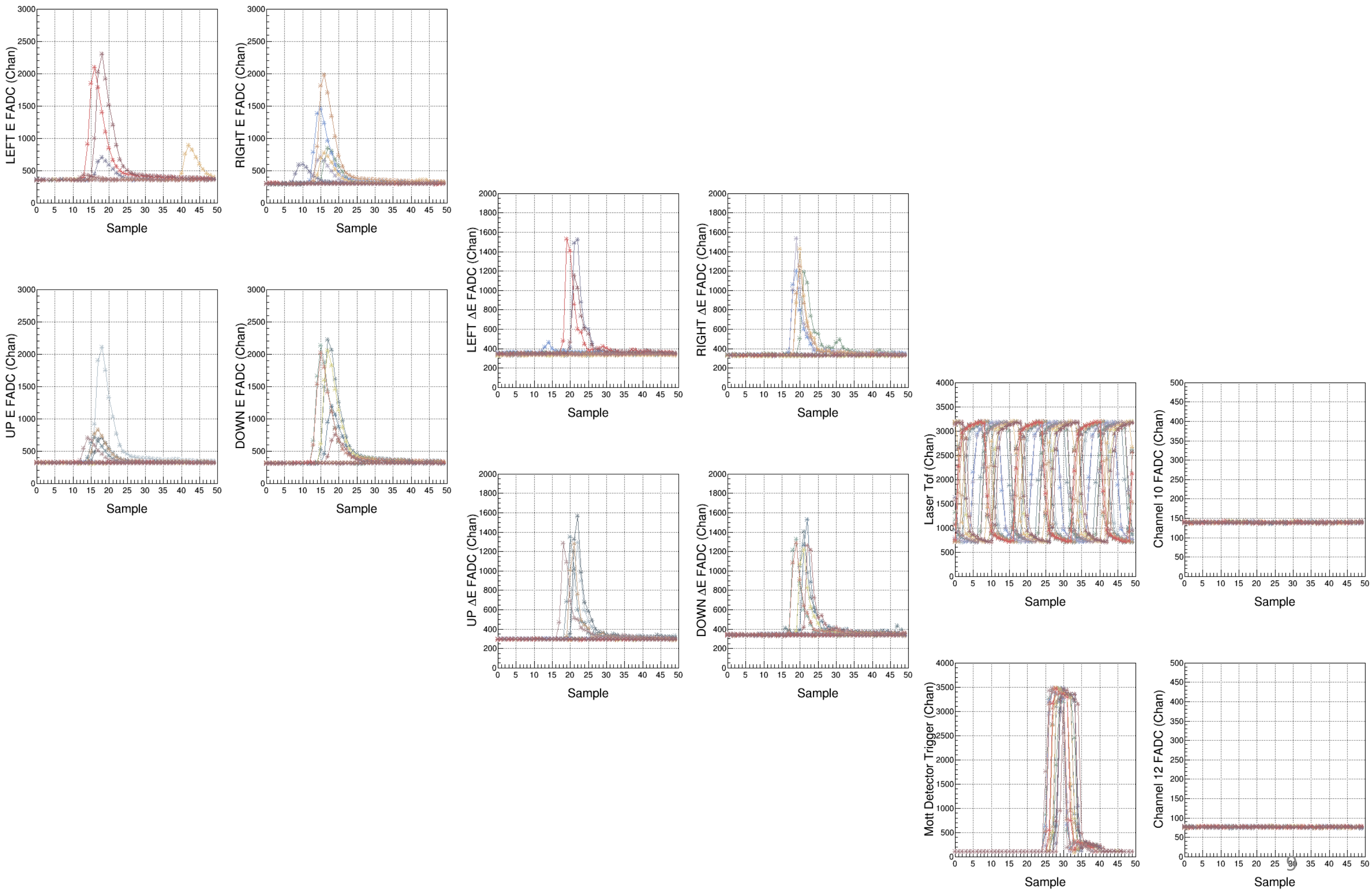
Mott Settings:

I. Programmable Latency (PL) = 60 samples
II. Programmable Trigger Window (PTW) = 50 samples
III. Threshold = 0
IV. Each Sample = 4 ns (250 MHz), 0 – 4096 (2^{12})

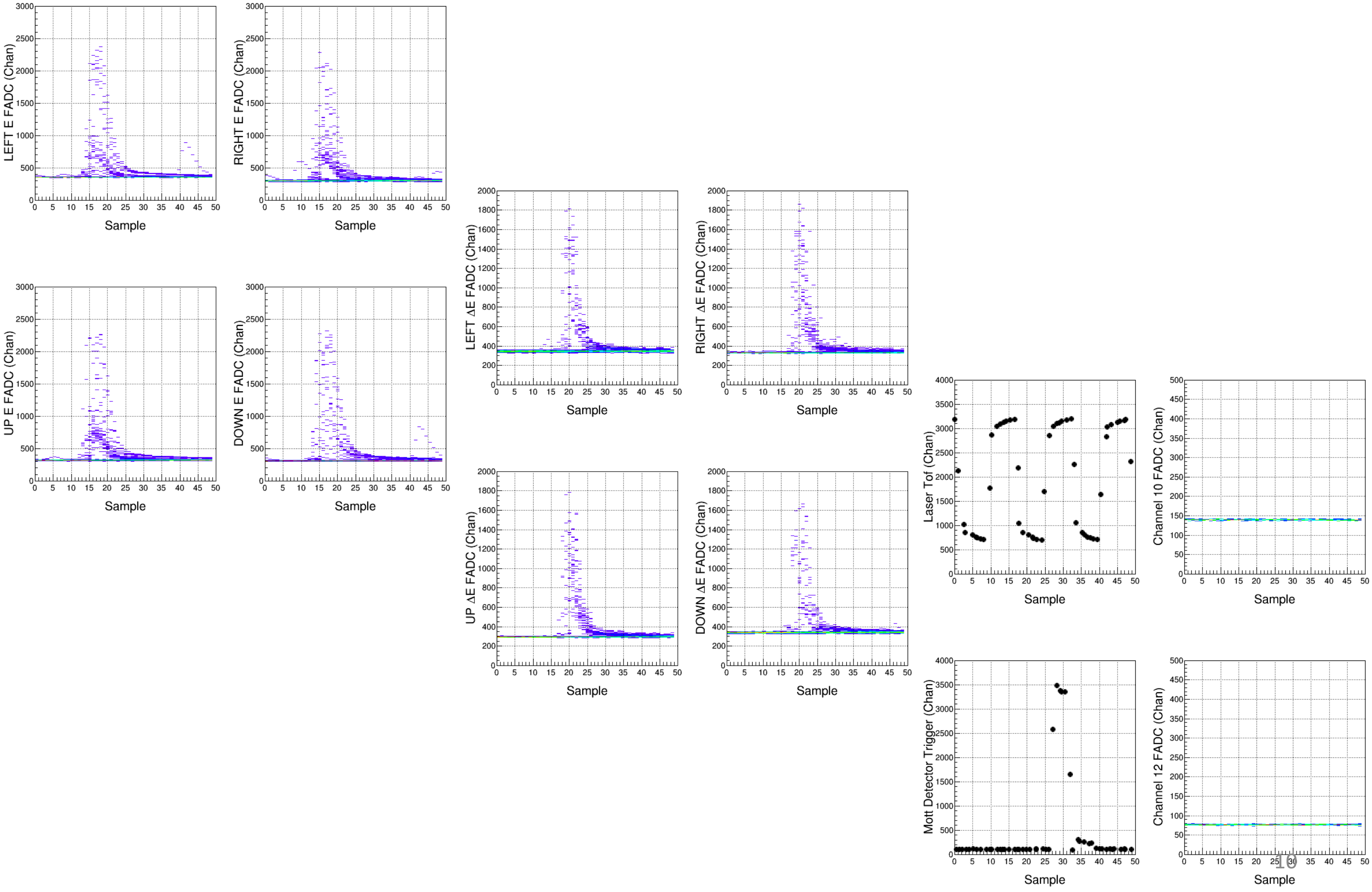
Mott Readout:

I. 50 samples

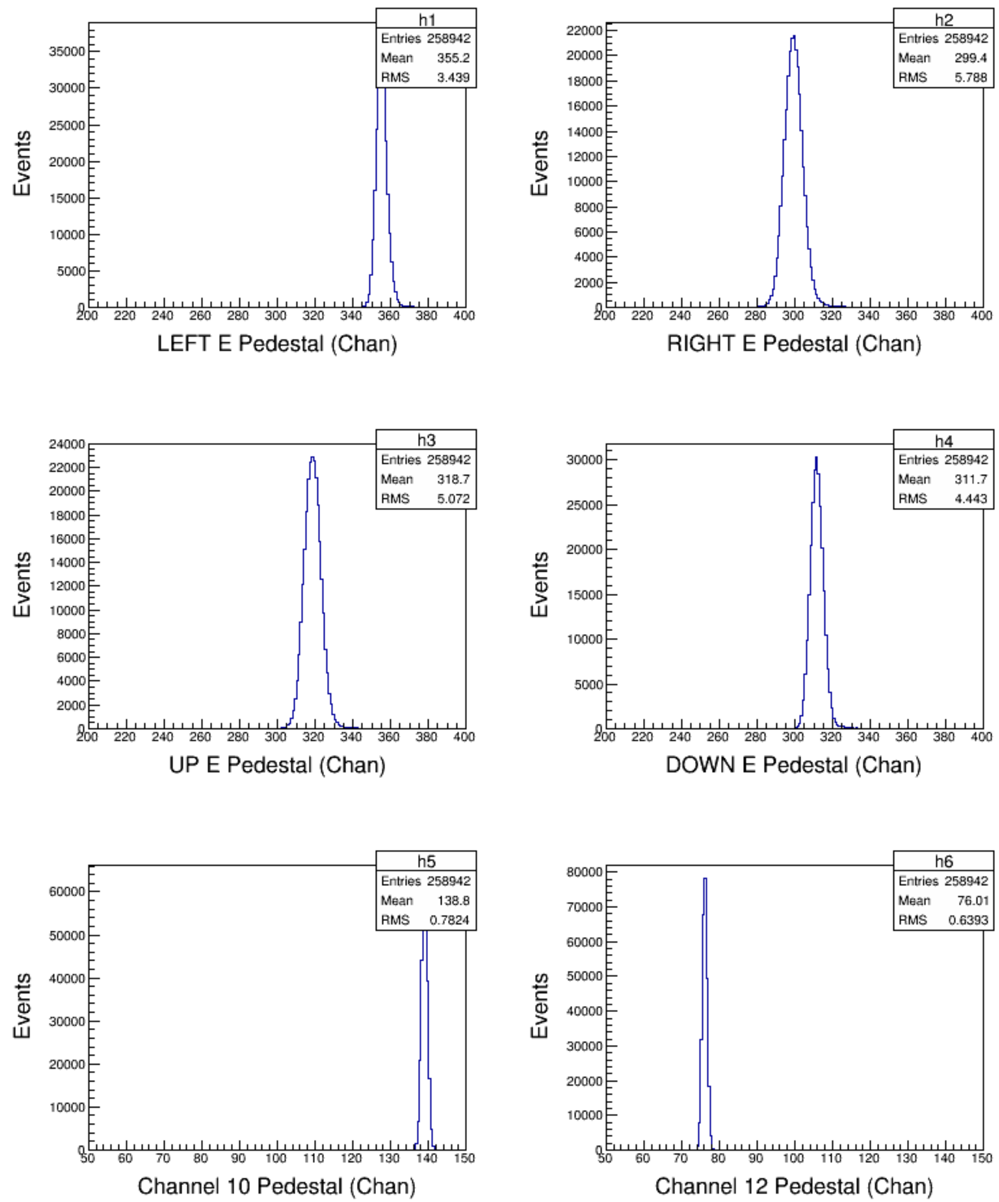
Samples


LEFT E FADC (Chan)
RIGHT E FADC (Chan)
UP E FADC (Chan)
DOWN E FADC (Chan)
LEFT ΔE FADC (Chan)
RIGHT ΔE FADC (Chan)
UP ΔE FADC (Chan)
DOWN ΔE FADC (Chan)
Laser Tof (Chan)
Channel 10 FADC (Chan)
Mott Detector Trigger (Chan)
Channel 12 FADC (Chan)
Sample

Samples

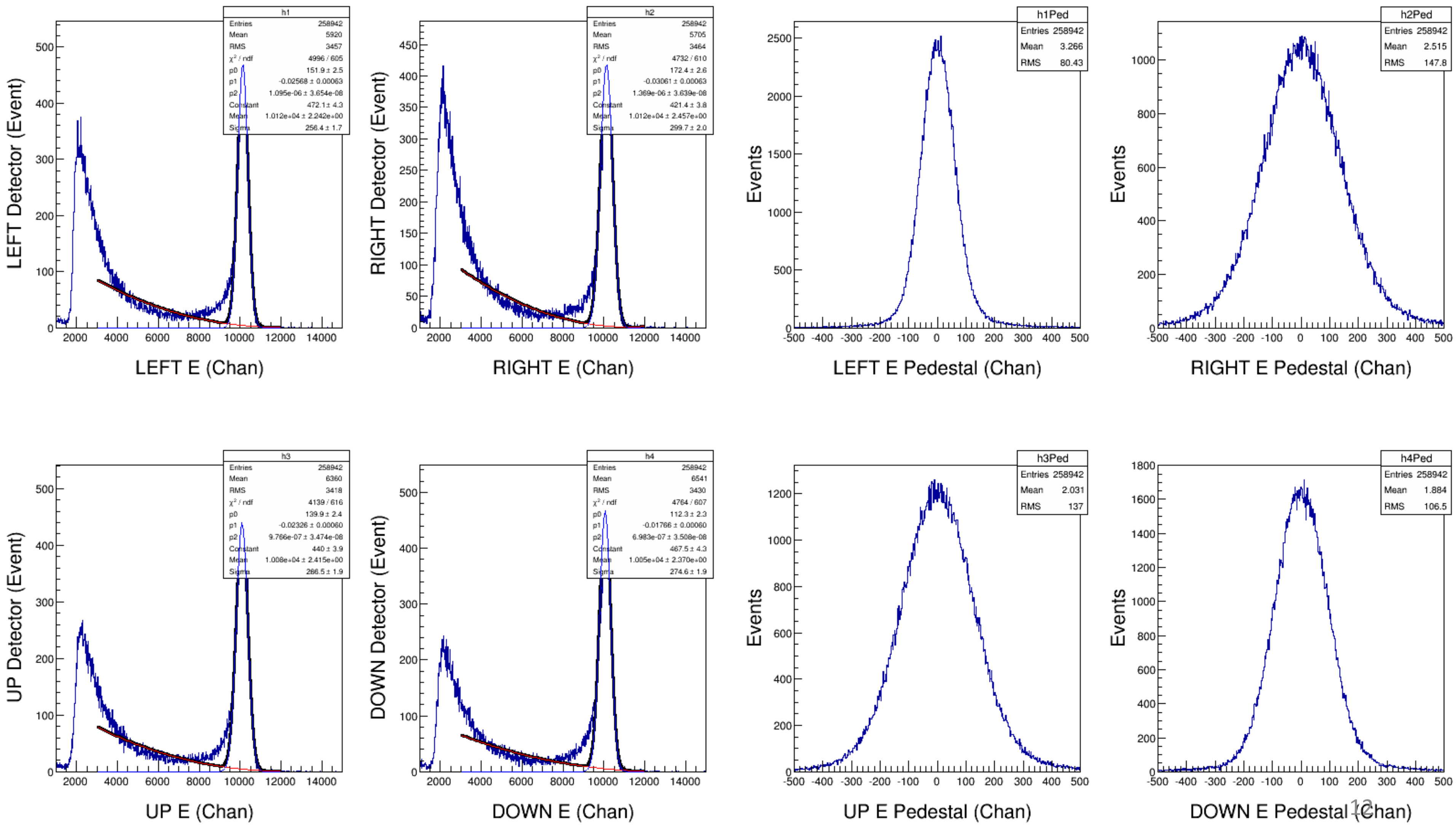

LEFT E FADC (Chan)
RIGHT E FADC (Chan)
UP E FADC (Chan)
DOWN E FADC (Chan)
LEFT ΔE FADC (Chan)
RIGHT ΔE FADC (Chan)
UP ΔE FADC (Chan)
DOWN ΔE FADC (Chan)
Laser Tof (Chan)
Channel 10 FADC (Chan)
Mott Detector Trigger (Chan)
Channel 12 FADC (Chan)
Sample

Analysis: Pedestals

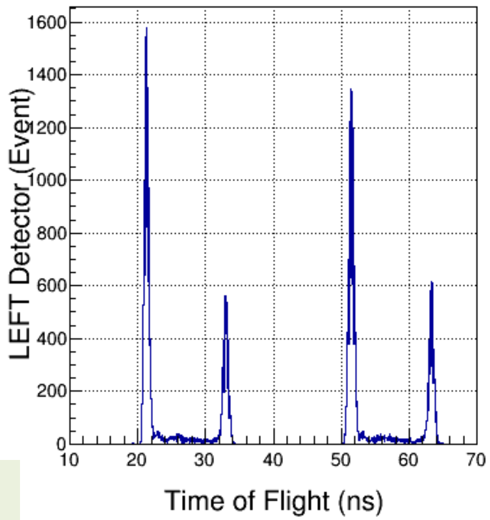


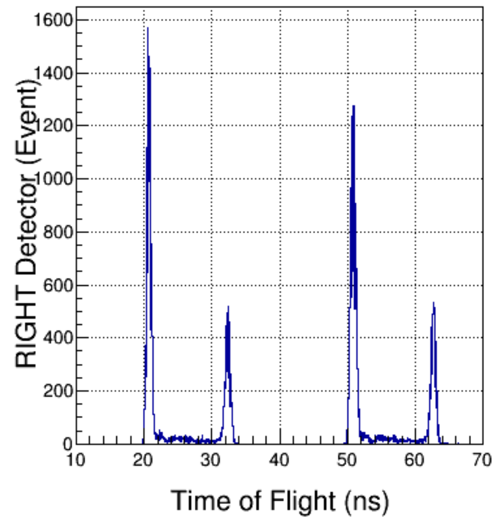
Analysis: Energy

$\sigma_E \sim 2.7\%$

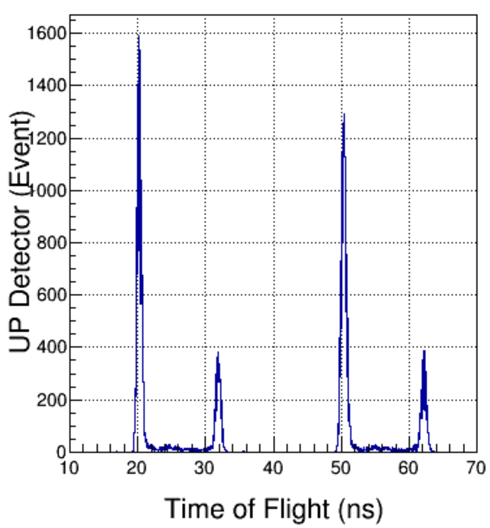


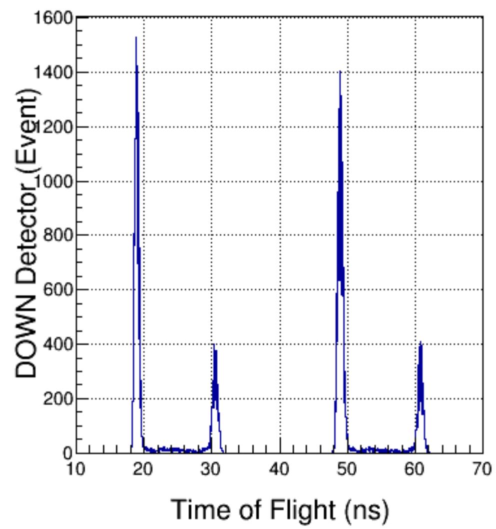
Analysis: Time-of-flight





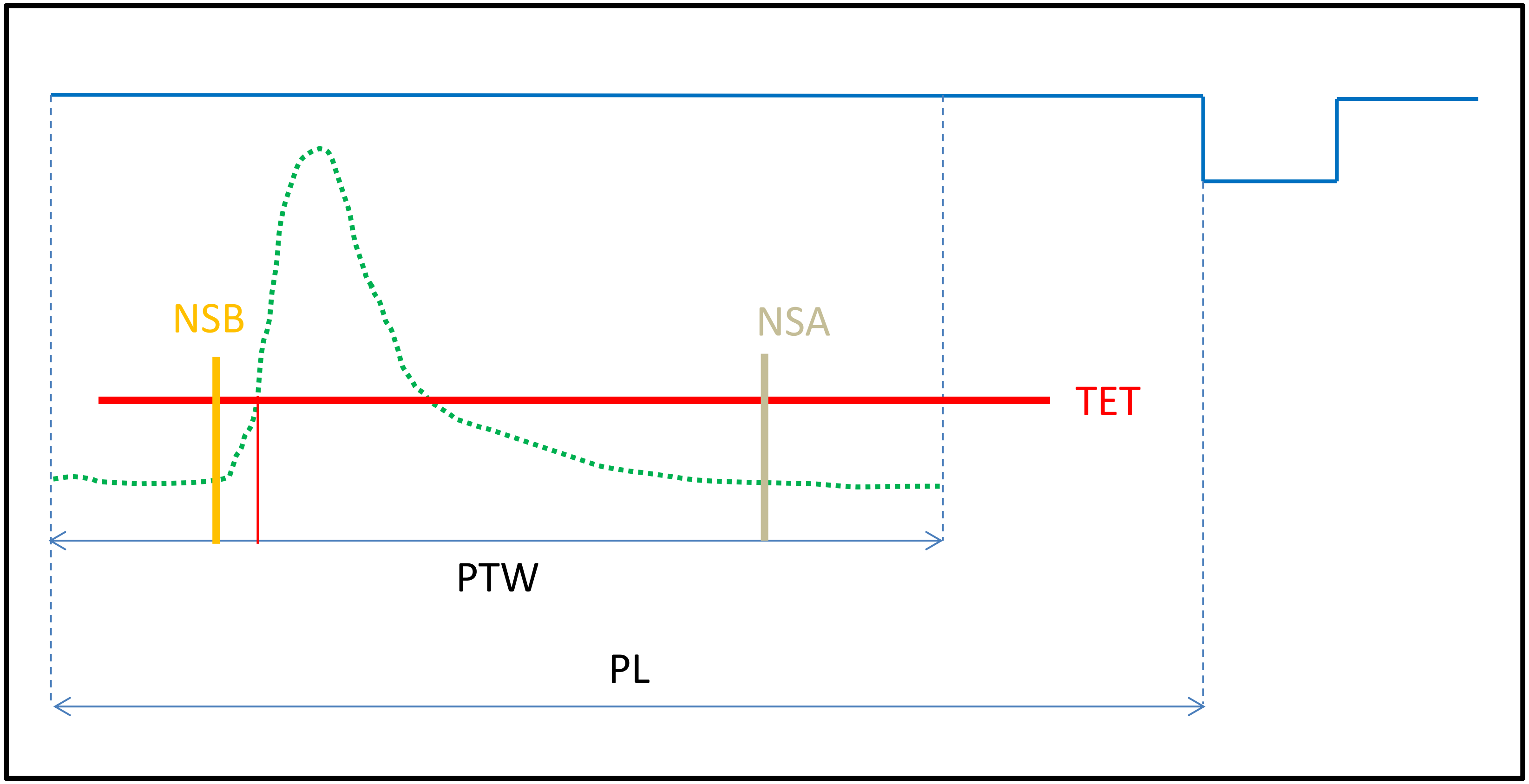
$\sigma_t \sim 0.2$ ns





PULSE INTEGRAL AND HIGH RESOLUTION TIME – RUN 7672, 7642

Pulse Integral & High Resolution Time



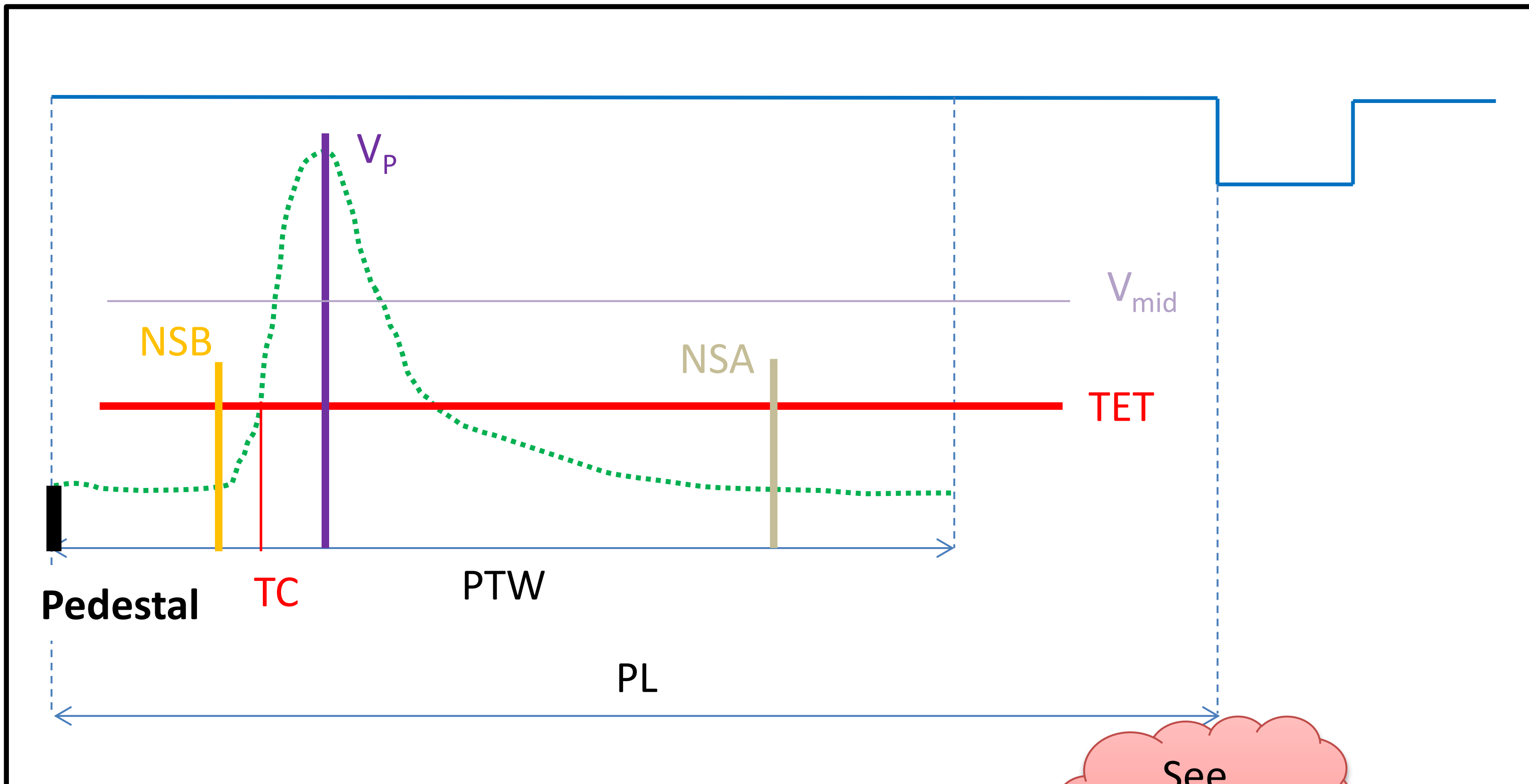
Mott Settings:

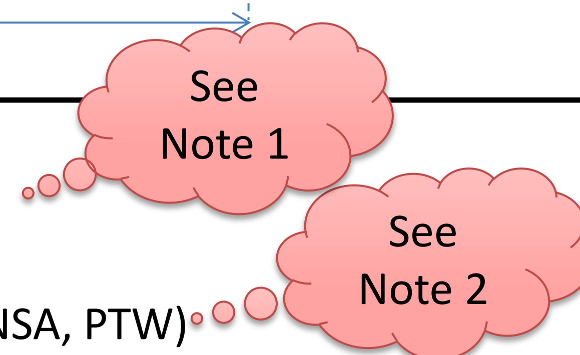
I. PL = 60 samples, PTW = 50 samples, NW = NSB + NSA
II. Programmable Trigger Energy Threshold (TET)
III. Number of pulses (NP) in PTW = 1 (up to 3 pulses)
IV. Number of Samples Before threshold crossing (NSB) = 5
V. Number of Samples After threshold crossing (NSA) = 28

TET

```
fadc_threshold[0] = 600;       // CH1 - E LEFT
fadc_threshold[1] = 600;       // CH2 - E RIGHT
fadc_threshold[2] = 600;       // CH3 - E UP
fadc_threshold[3] = 600;       // CH4 - E DOWN
fadc_threshold[4] = 600;       // CH5 - dE LEFT
fadc_threshold[5] = 600;       // CH6 - dE RIGHT
fadc_threshold[6] = 600;       // CH7 - dE UP
fadc_threshold[7] = 600;       // CH8 - dE DOWN
fadc_threshold[8] = 1750;      // CH9 - BFM
fadc_threshold[9] = 100;       // CH10 - Free
fadc_threshold[10]= 1000;      // CH11 - Mott Trigger
fadc_threshold[11]= 100;       // CH12 - Free
fadc_threshold[12]= 10;        // CH13 - Delayed Helicity
fadc_threshold[13]= 10;        // CH14 - T_Settle
fadc_threshold[14]= 10;        // CH15 - Pat Sync
fadc_threshold[15]= 10;        // CH16 - Pair Sync
```

Pulse Integral & High Resolution Time





Mott Readout:

I. Pedestal = Average of first 4 samples of window

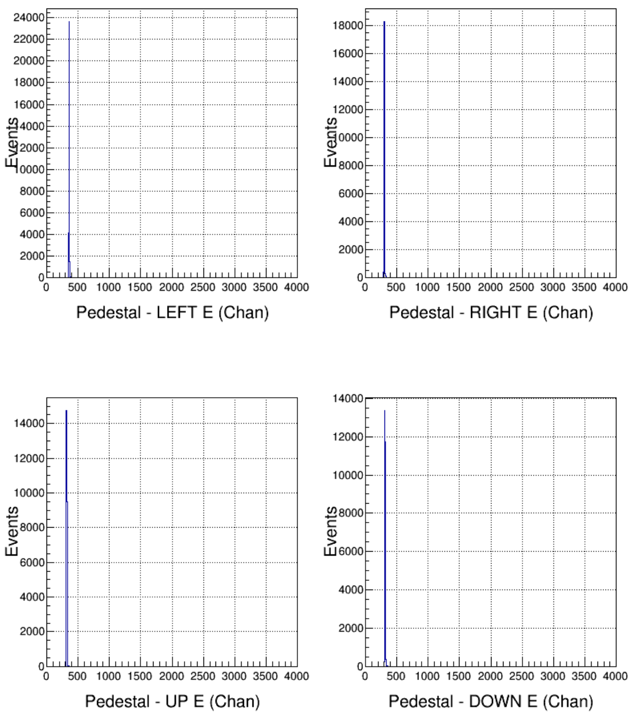
II. Peak Value (V_P)

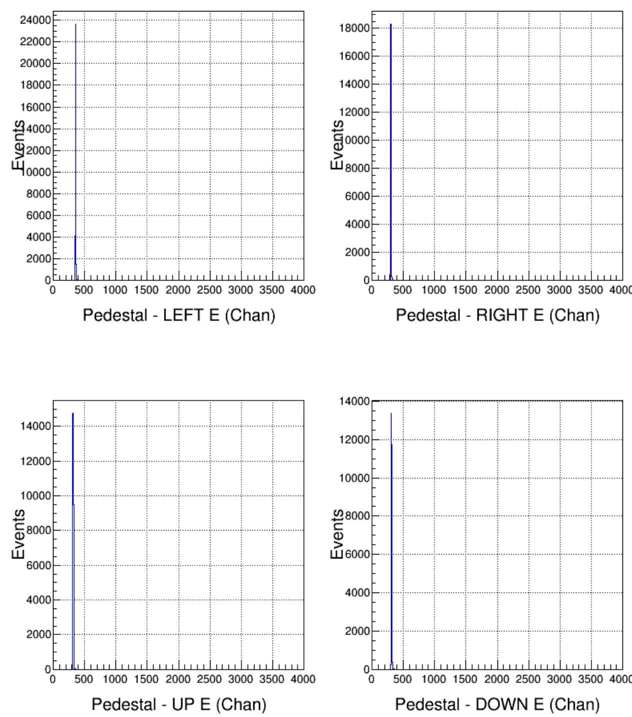
III. Pulse Integral = Sum of raw samples MIN(NSB+NSA, PTW)

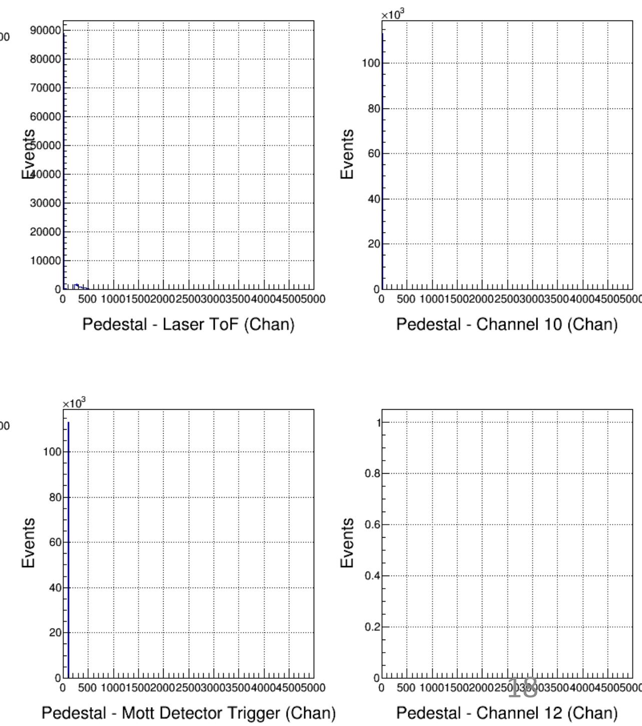
IV. Pulse Coarse Time = Sample number N1 such that $V(N1) \leq (V_p\text{-Ped})/2) < V(N2)$

V. Pulse Fine Time = $64\ (V_{mid} - V(N1))/(V(N2)-V(N1))$. From 0 to 63 in steps of 62.5 ps

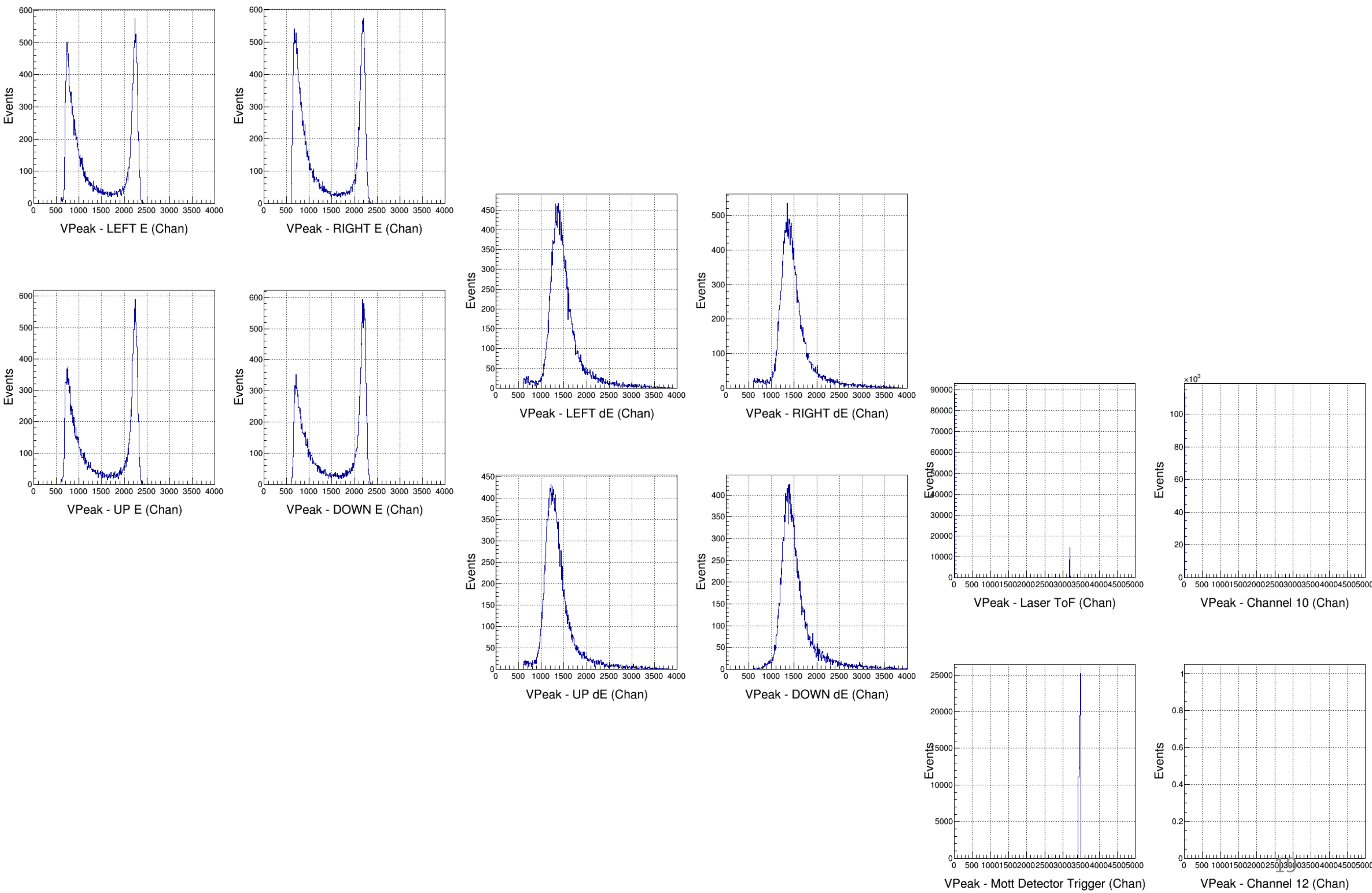
Pulse Pedestal



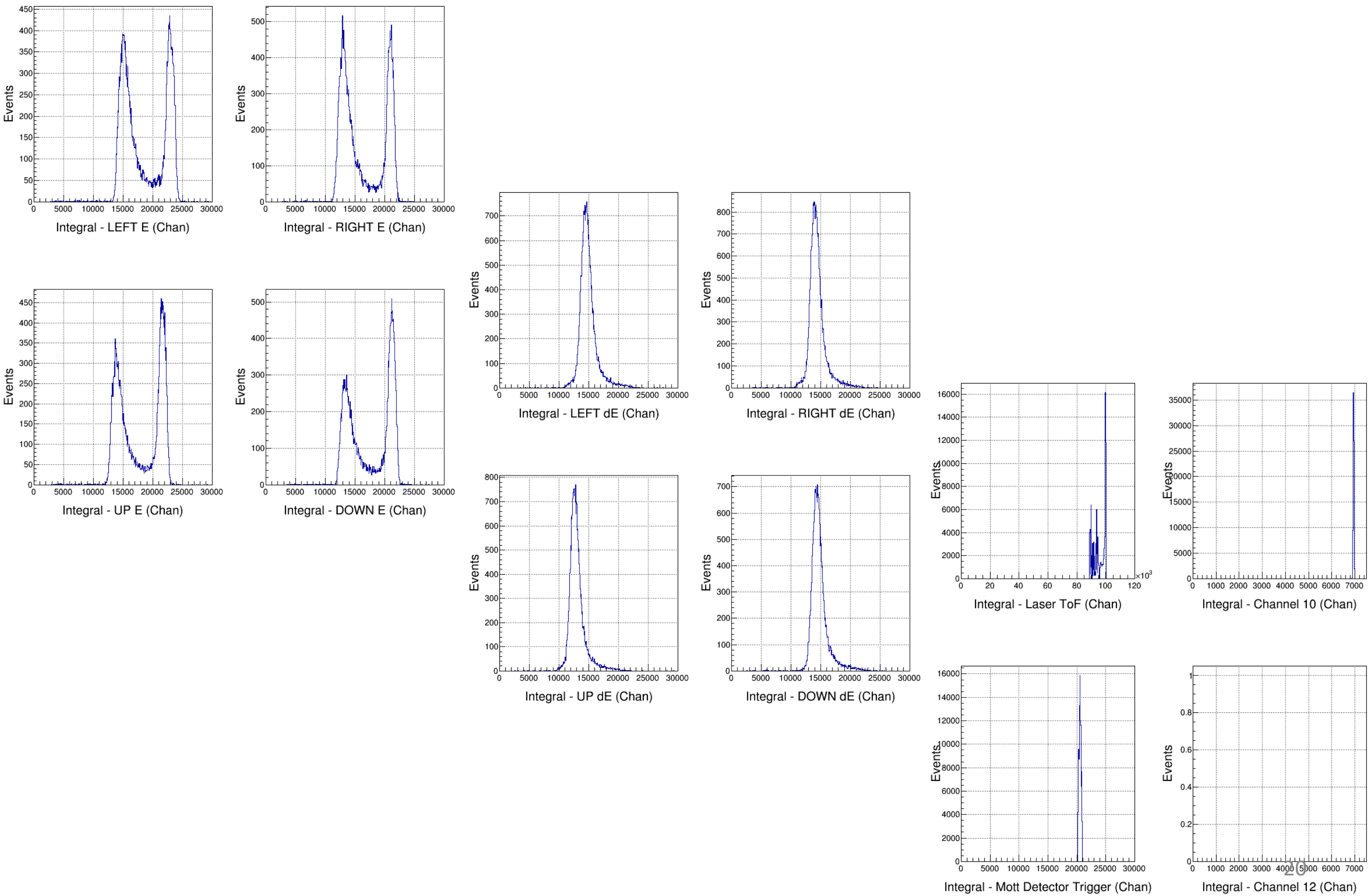




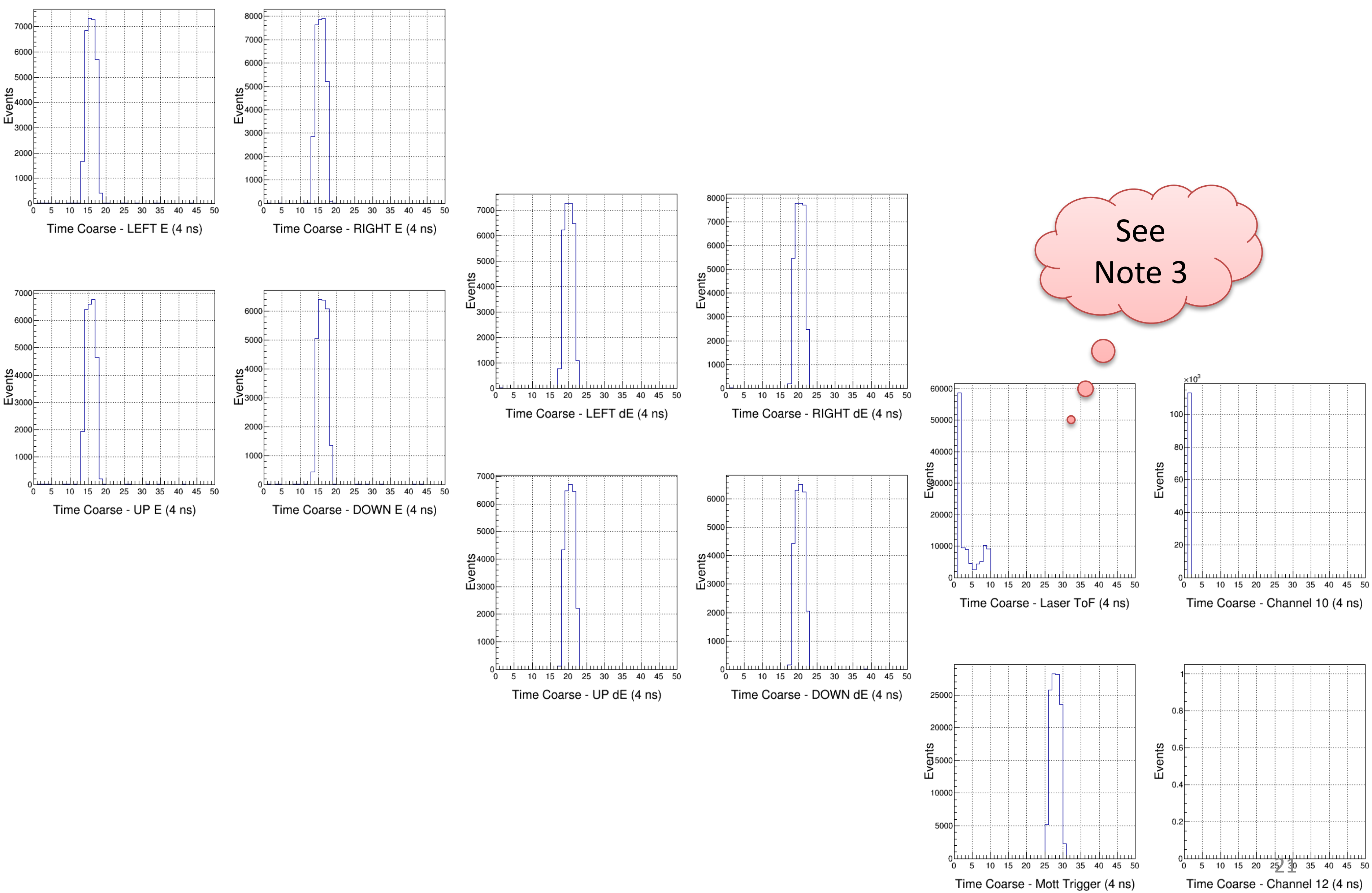
Pulse Peak Value (VP)



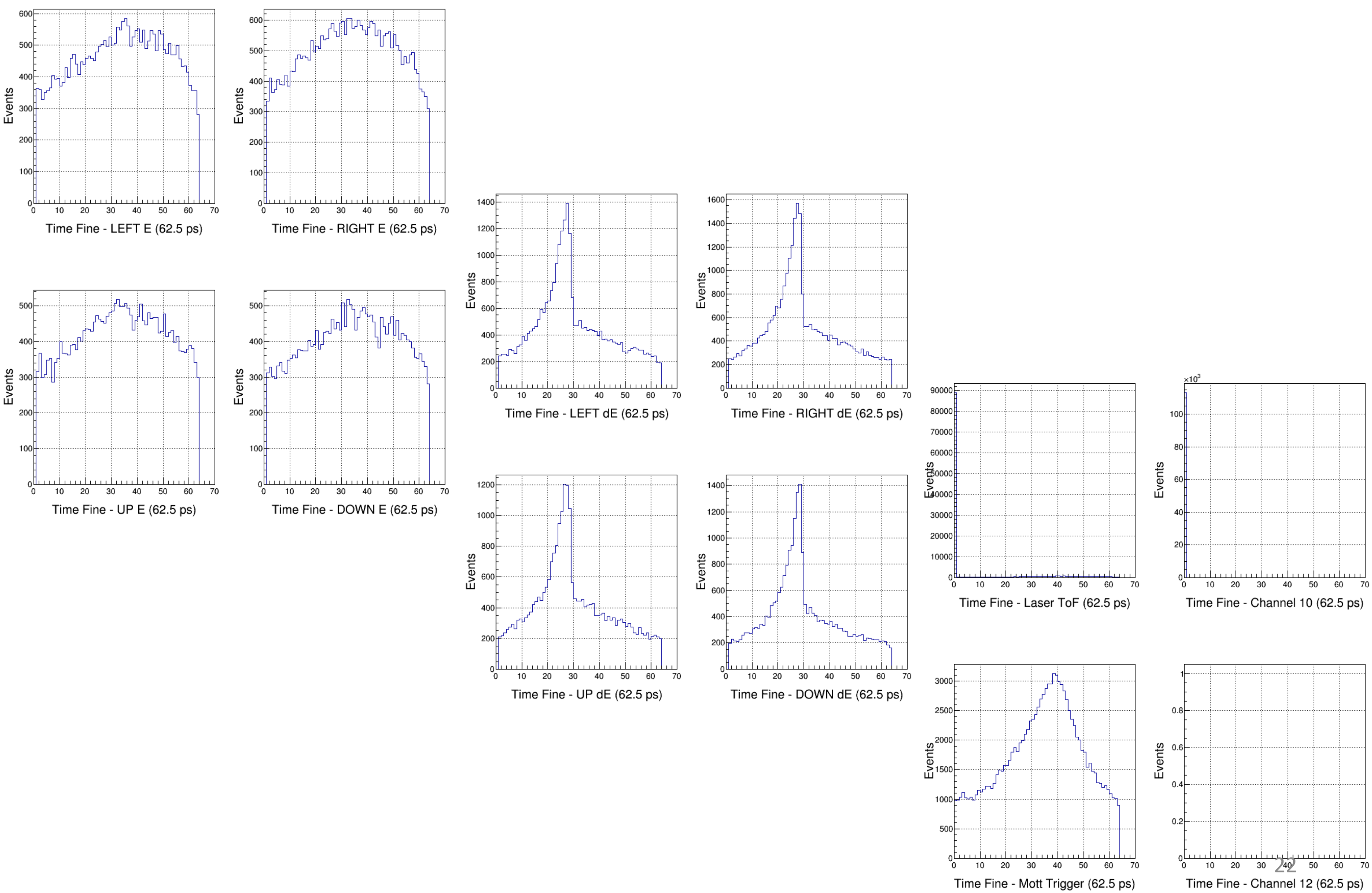
Pulse Integral



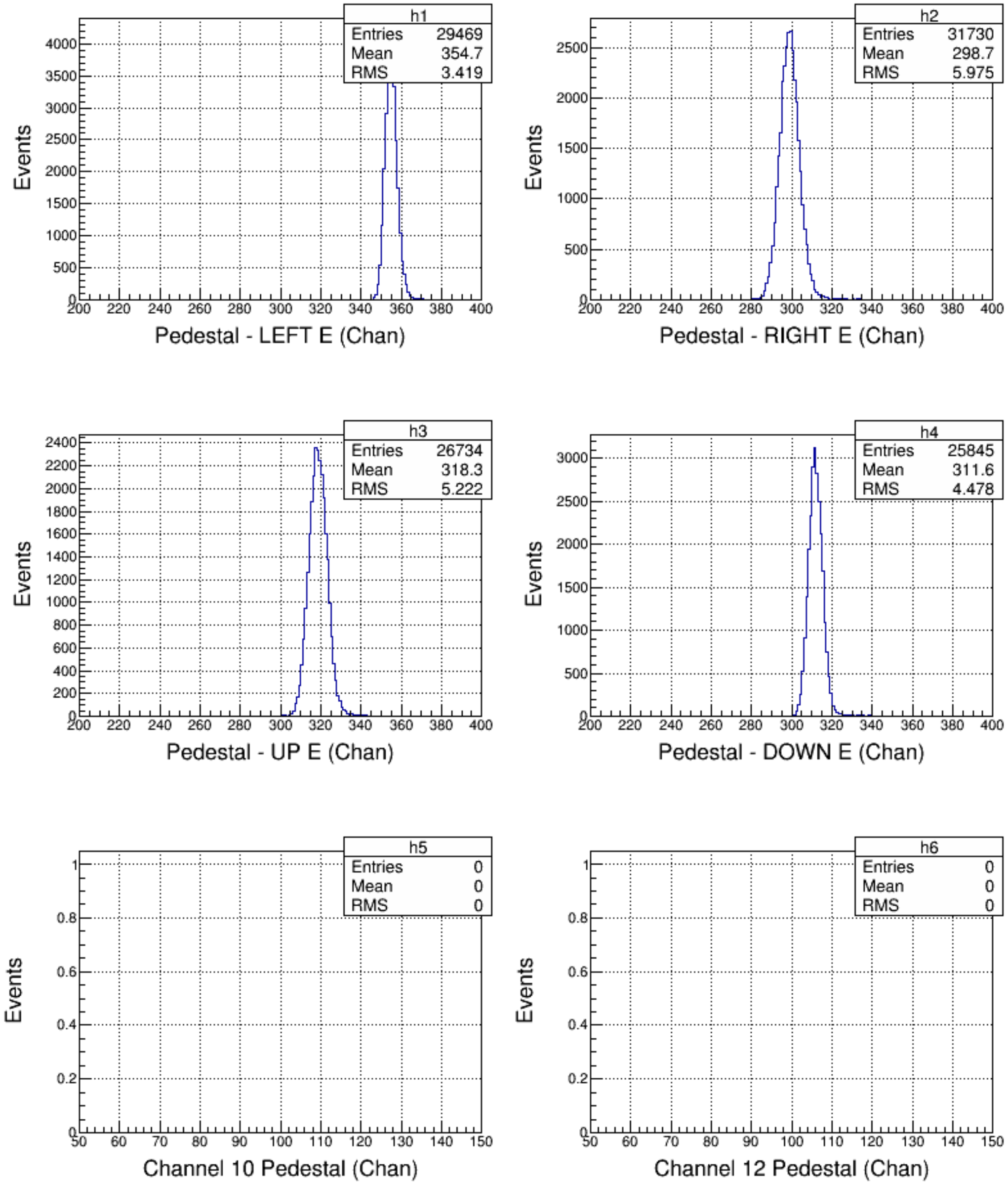
Pulse Coarse Time



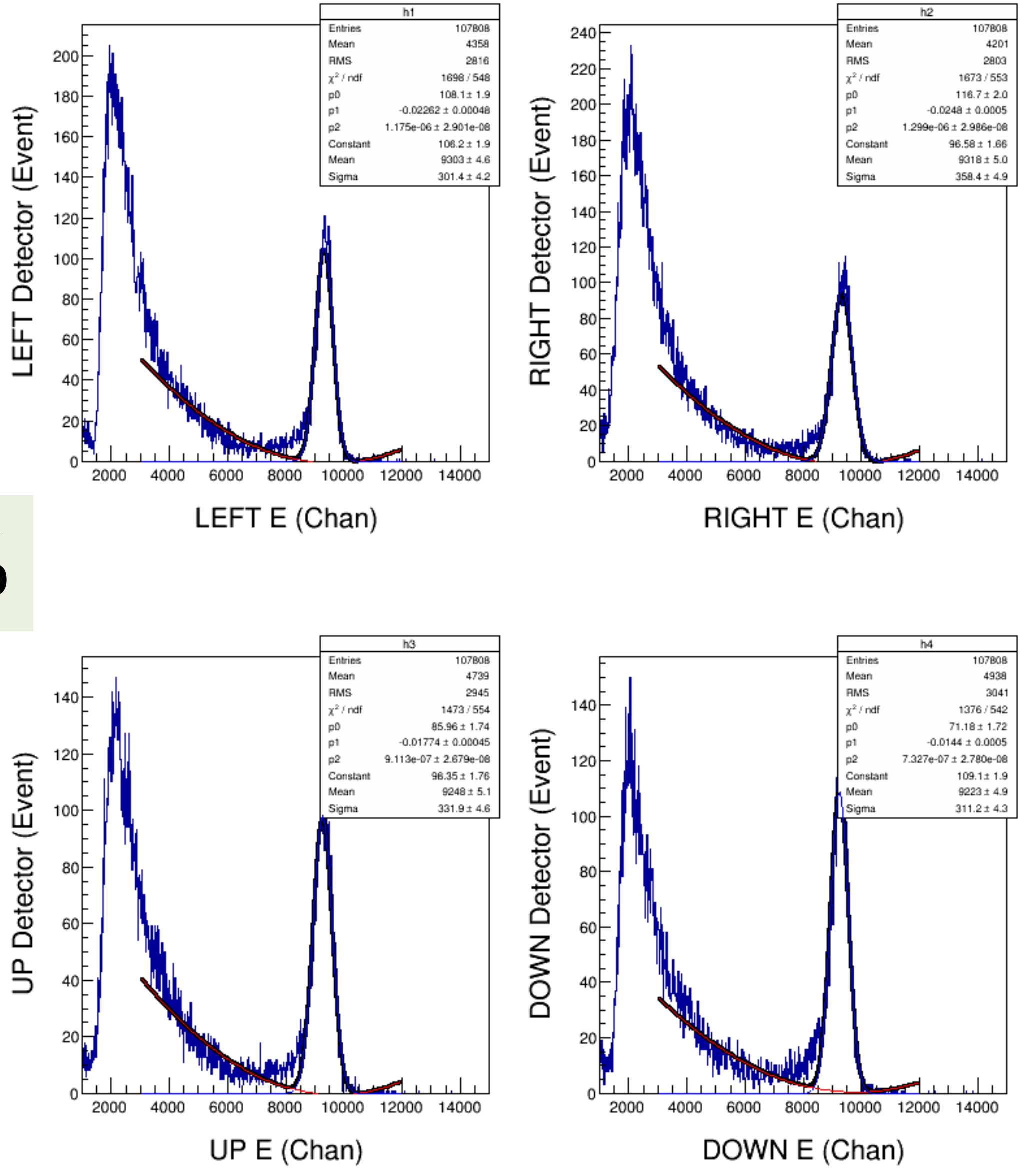
Pulse Fine Time



Analysis: Pedestals



Analysis: Energy



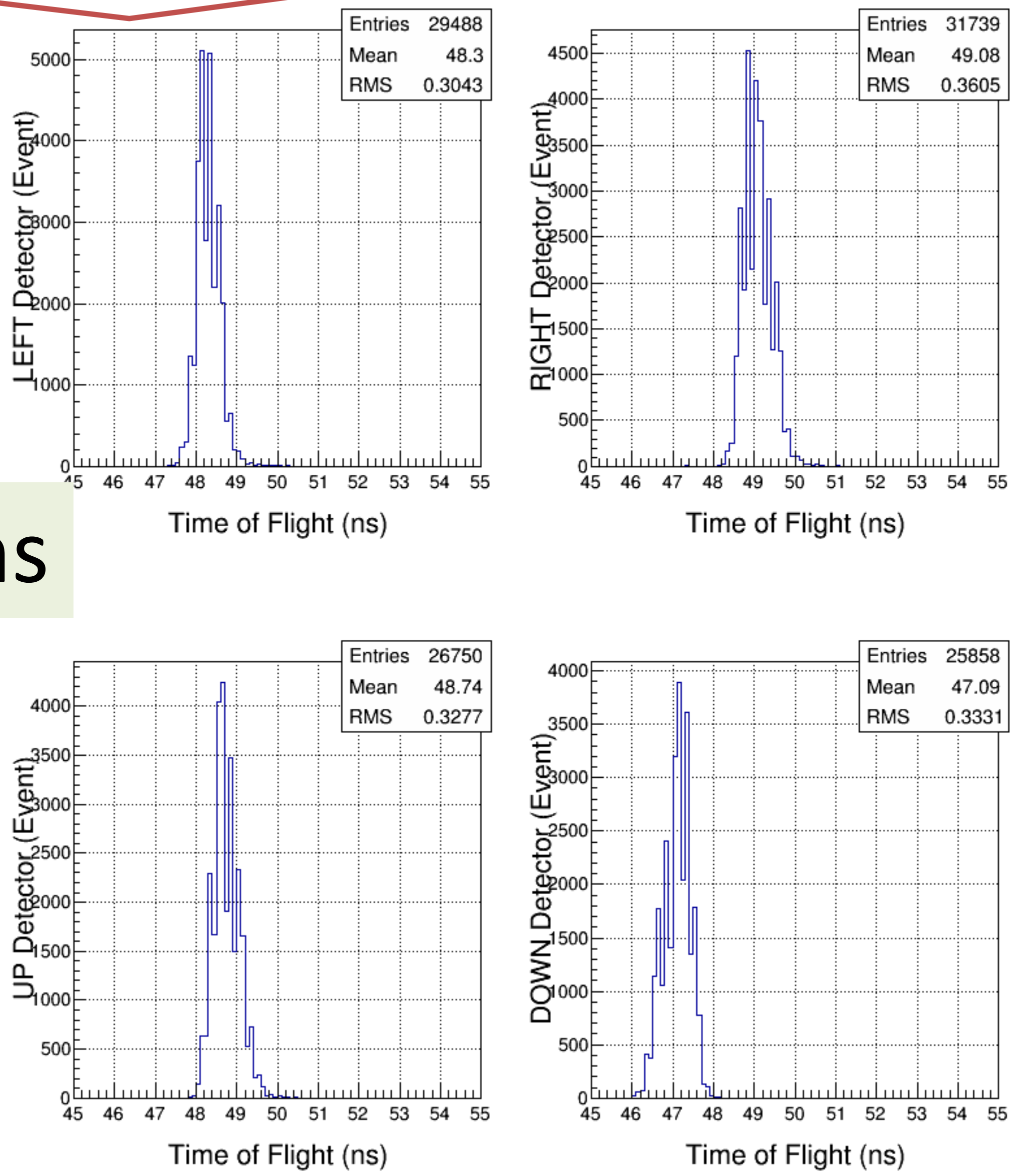
- Energy from run 7642
- Pedestal from run 7672

$\sigma_E \sim 3.2\%$

The increase partially due to average pedestals being subtracted. New data will have this fixed

Analysis: Self Timing Peak

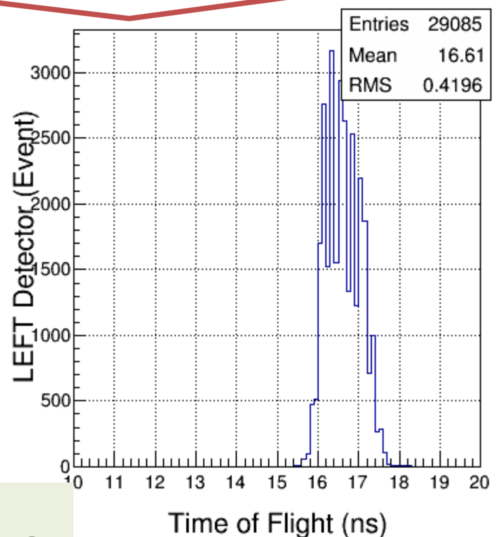
T->Draw("(TimeCoarse11*4.0 + TimeFine11*0.0625) - (TimeCoarse1*4.0 + TimeFine1*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse11 >1.0")

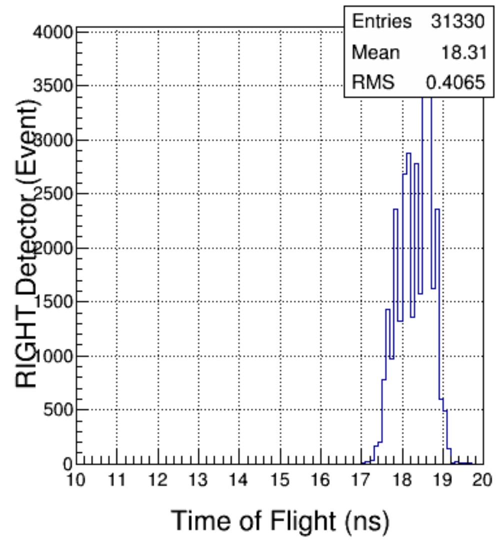


$\sigma_t \sim 0.33$ ns

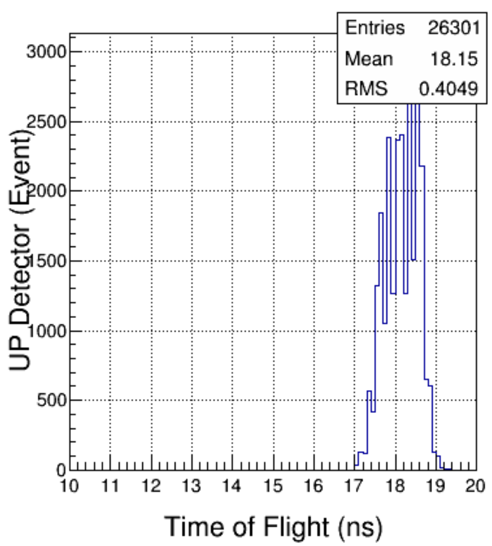
Analysis: E-dE Timing Peak

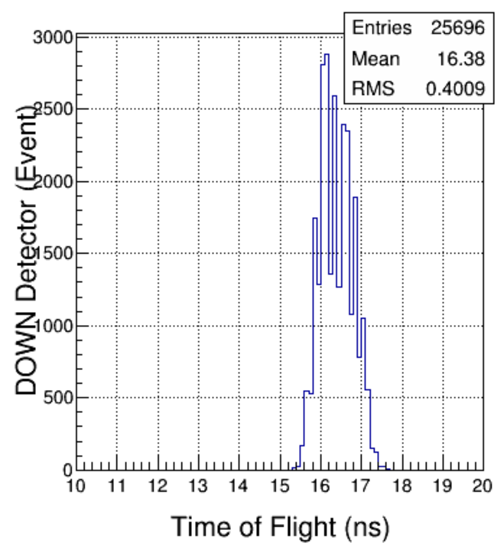
T->Draw("(TimeCoarse5*4.0 + TimeFine5*0.0625) - (TimeCoarse1*4.0 + TimeFine1*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse5 >1.0")





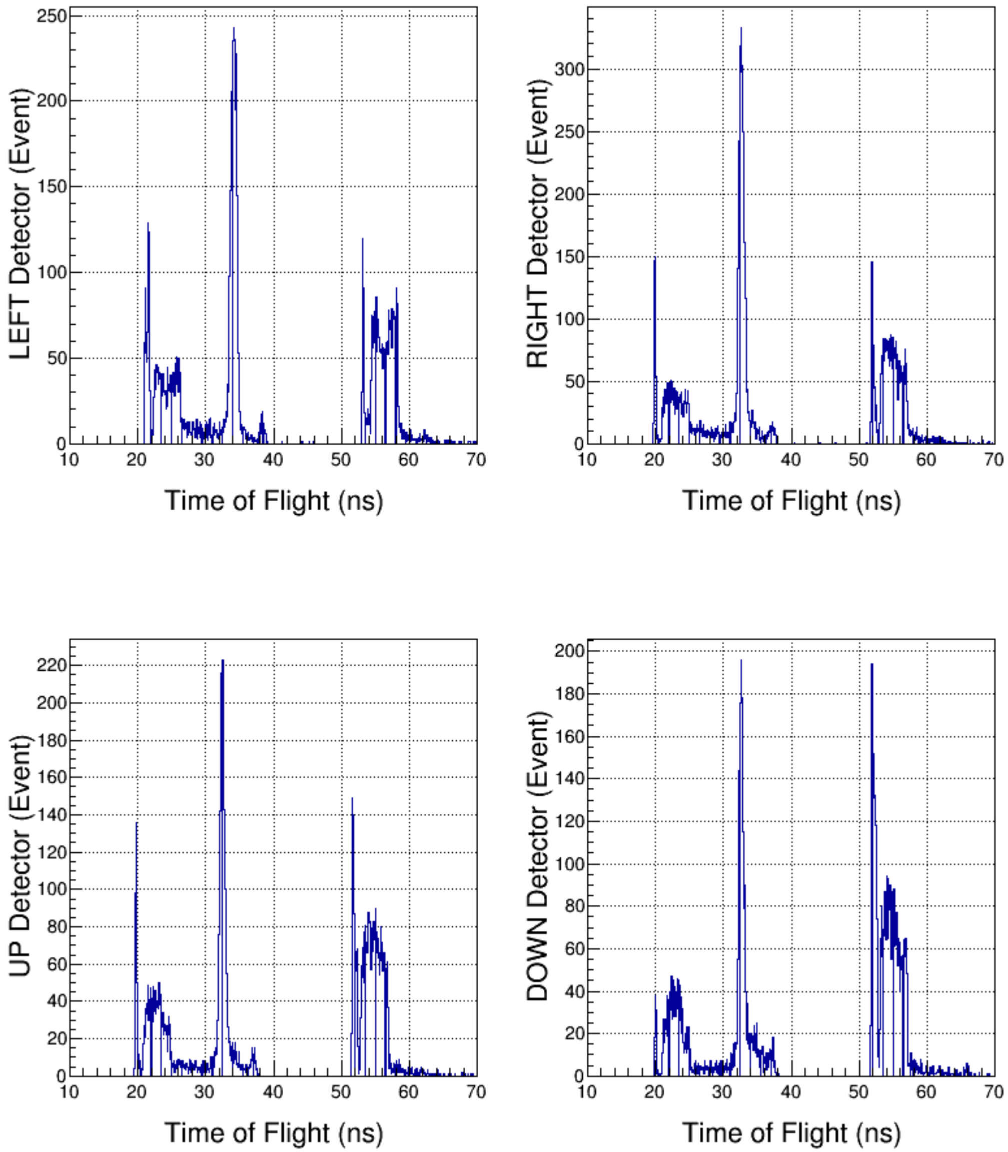
$\sigma_t \sim 0.40$ ns





Analysis: Time-of-flight

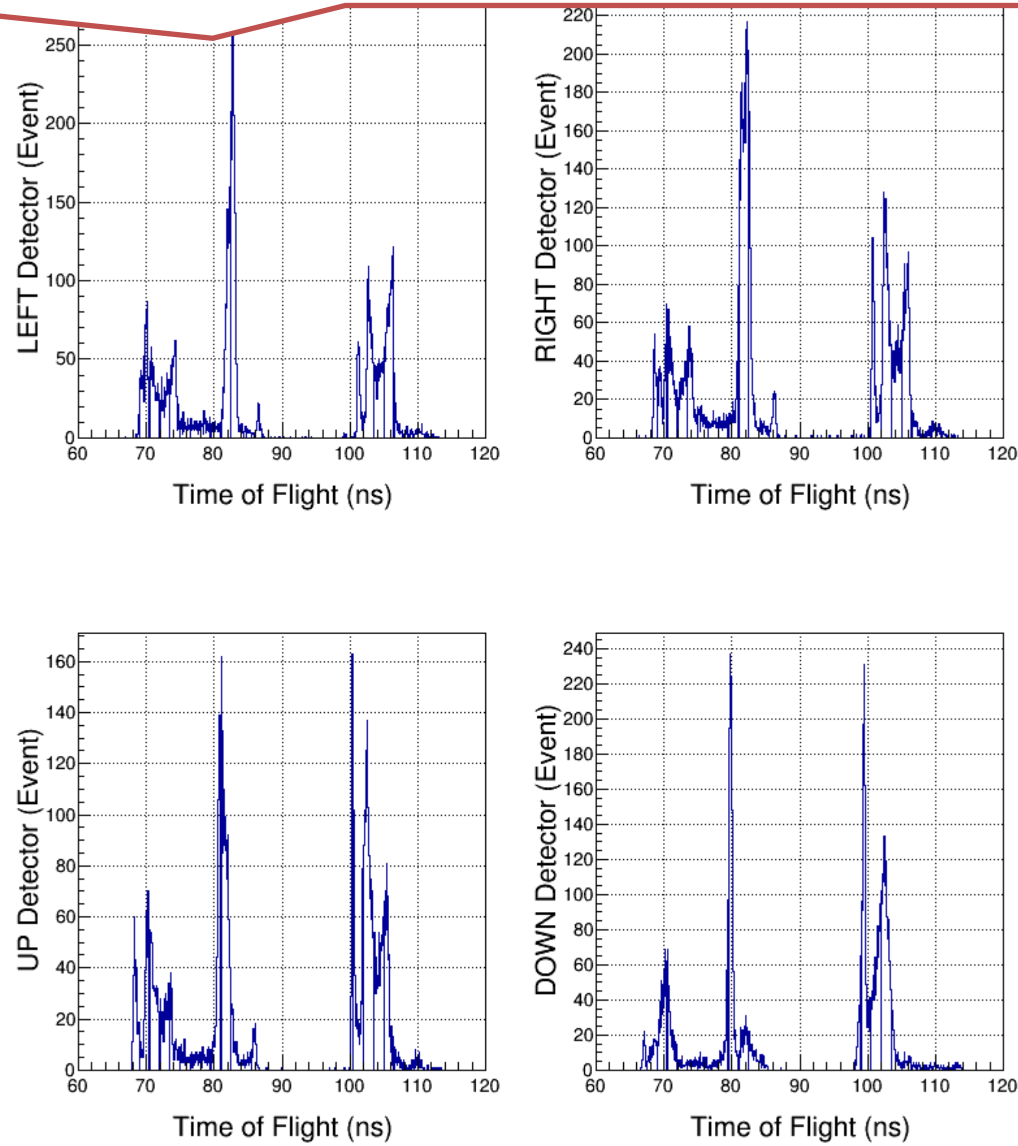
```
T->Draw("(TimeCoarse1*4.0 + TimeFine1*0.0625) - (TimeCoarse9*4.0 + TimeFine9*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse9 >1.0")
```



Use CH1-CH4

Analysis: Time-of-flight

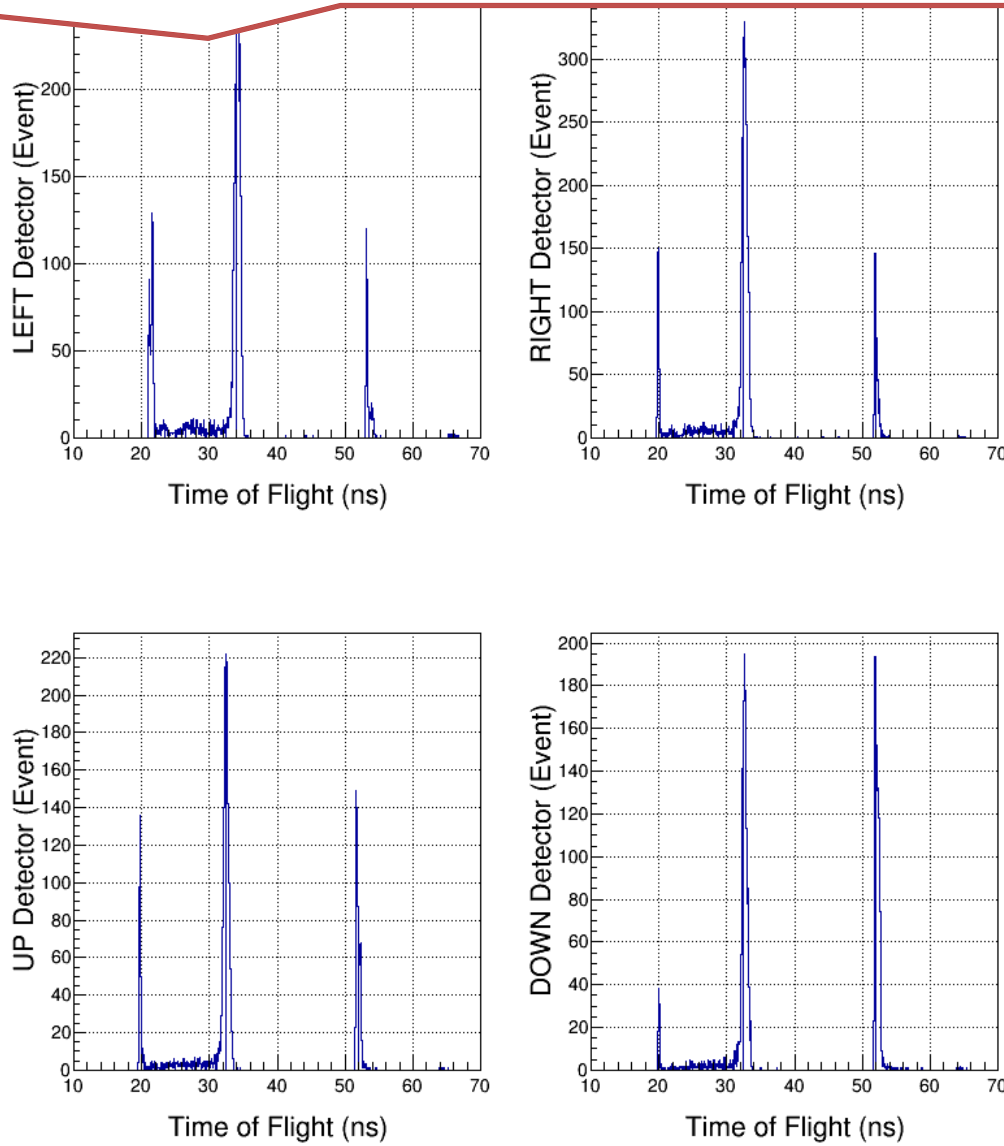
```
T->Draw("(TimeCoarse11*4.0 + TimeFine11*0.0625) - (TimeCoarse9*4.0 + TimeFine9*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse9 >1.0 ")
```



Use CH11

Analysis: Time-of-flight

```
T->Draw("(TimeCoarse11*4.0 + TimeFine11*0.0625) - (TimeCoarse9*4.0 + TimeFine9*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse9 >1.0 &&VPeak9>0.0")
```



Use CH11

Notes

Note 1

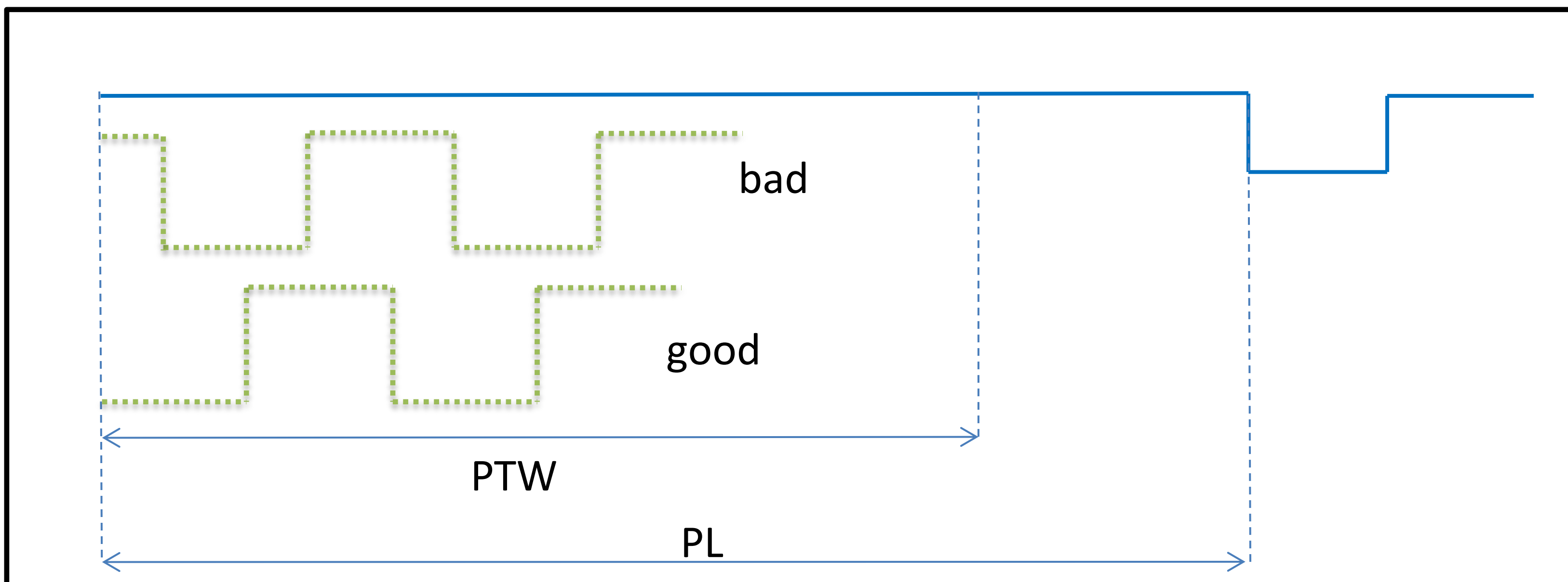
➢ If first sample above threshold then:
course time =1, fine time = 0, ped = 0, and VPeak = 0

Note 2

➢ MIN(NSB+NSA, PTW): Make sure NSB+NSA is less than PTW. Otherwise from CODA readout, cannot tell how many samples were summed; this is needed for pedestal subtraction.

Note 3

➢ How FADC deal with a periodic square wave. Solution: add same signal to another channel delayed by ½ period



Conclusions – so far …

- Pulse Integral and High Resolution Time Mode has good energy and time resolutions. Must have:
  - Correct FADC parameters: Threshold, NSB, NSA
  - Add a second laser ToF signal delayed by ½ period

- What about scalers? Working with B. Moffit (DAQ Group) for a solution

- A new CODA Configuration was created with this mode (no CAEN v775 TDC and no SIS3801 Scalers) with block readout. Still must test for speed …