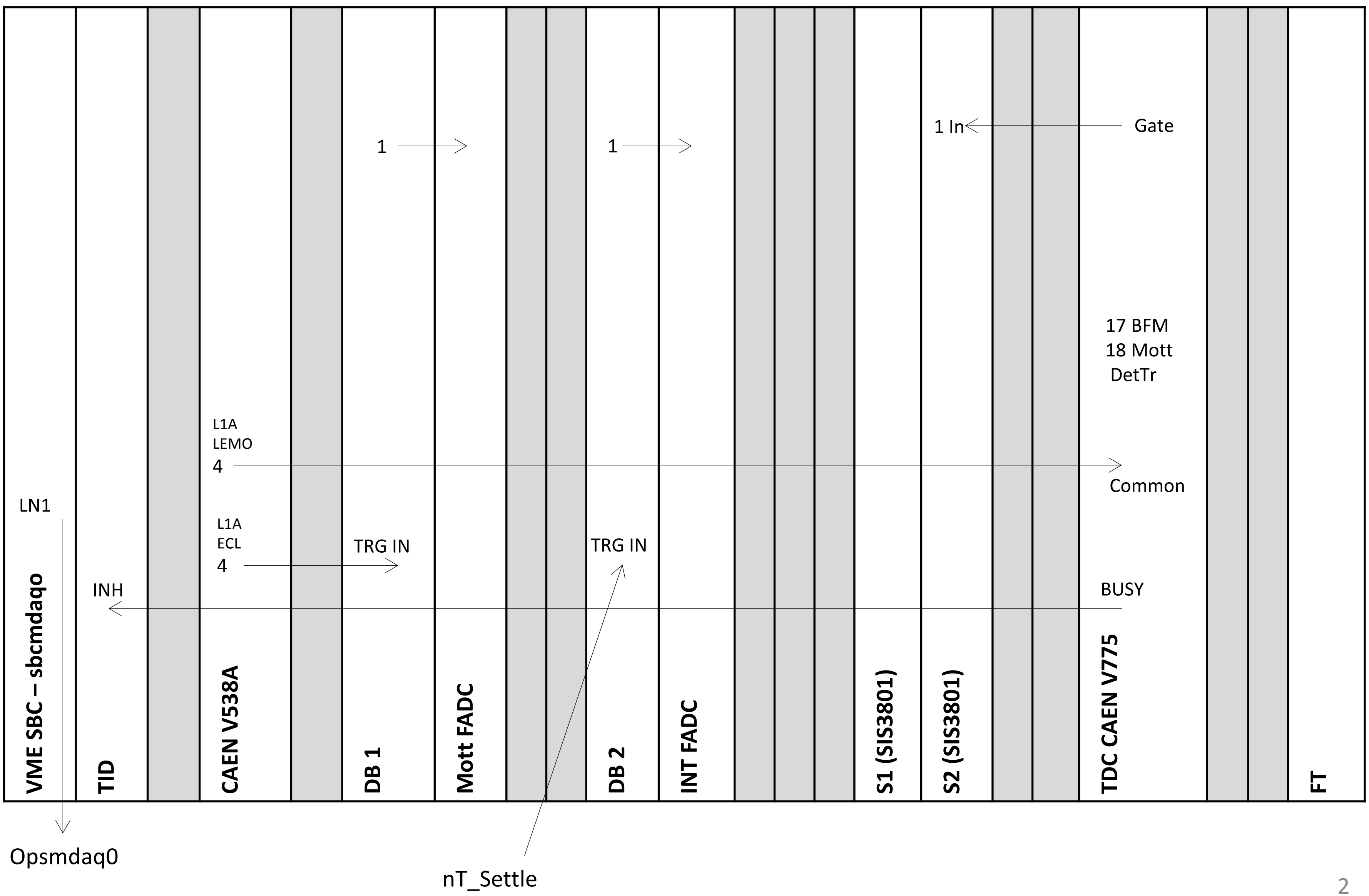
Mott DAQ Speed

February 16, 2015

VME CRATE (VME8200 9U 21Slot - VME64x backplane with no P0 connector)



Data Taking Configurations

Name	Readout	Trigger
Scalers	Scaler S1 (helicity gated), S2 (un-gated)	Delayed nT_Settle
Mott_Sample	Mott FADC (Mode=1), S1, S2, TDC	Mott Detector
Mott_SemiInt	**Mott FADC (Mode=7), S1, S2, TDC**	**Mott Detector**
PEPPo_Int	INT FADC, S1, S2	nT_Settle
SemiIntFast	**Mott FADC (Mode=7), BlockLevel=1**	**Mott Detector**
SemiIntBlock	**Mott FADC (Mode=7), BlockLevel=50**	**Mott Detector**

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
- What about scalers?
- We took data with this mode … results are shown next …

Comparison of:

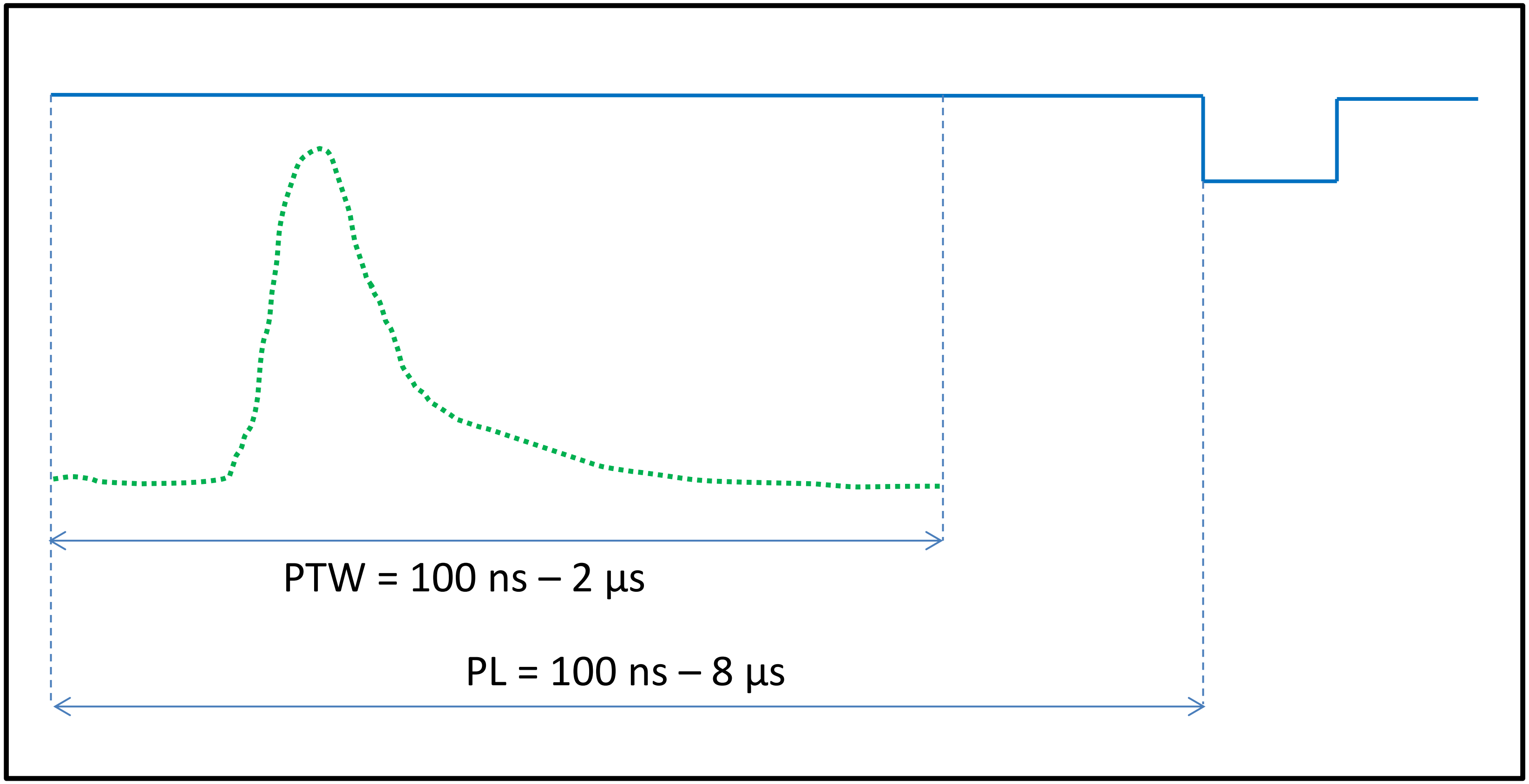
Raw ADC Data Samples Mode

vs.

Pulse Integral and High Resolution Time Mode

RAW ADC DATA SAMPLES – RUN 8222

Raw ADC Data Samples



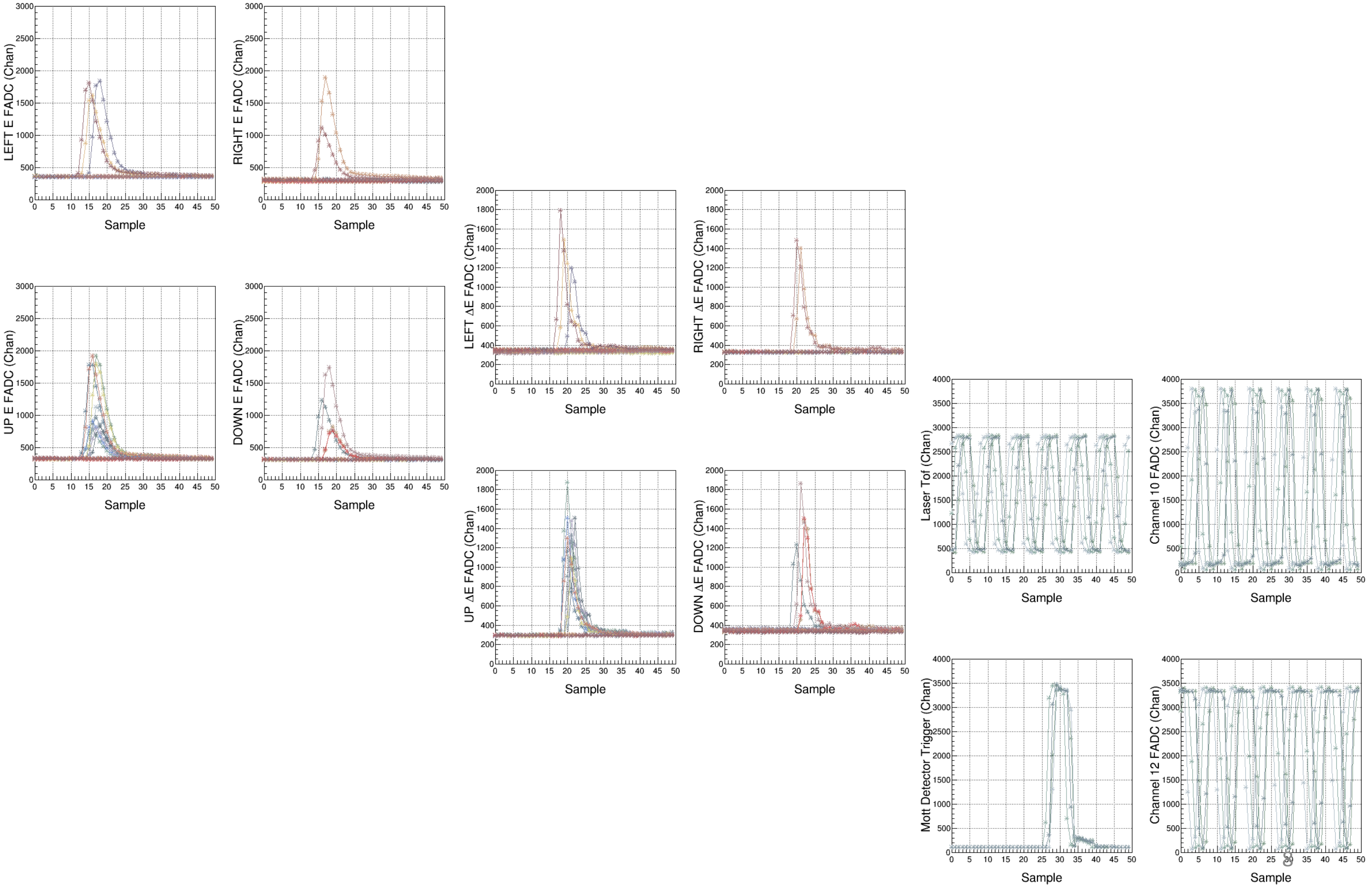
Mott Settings:

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})

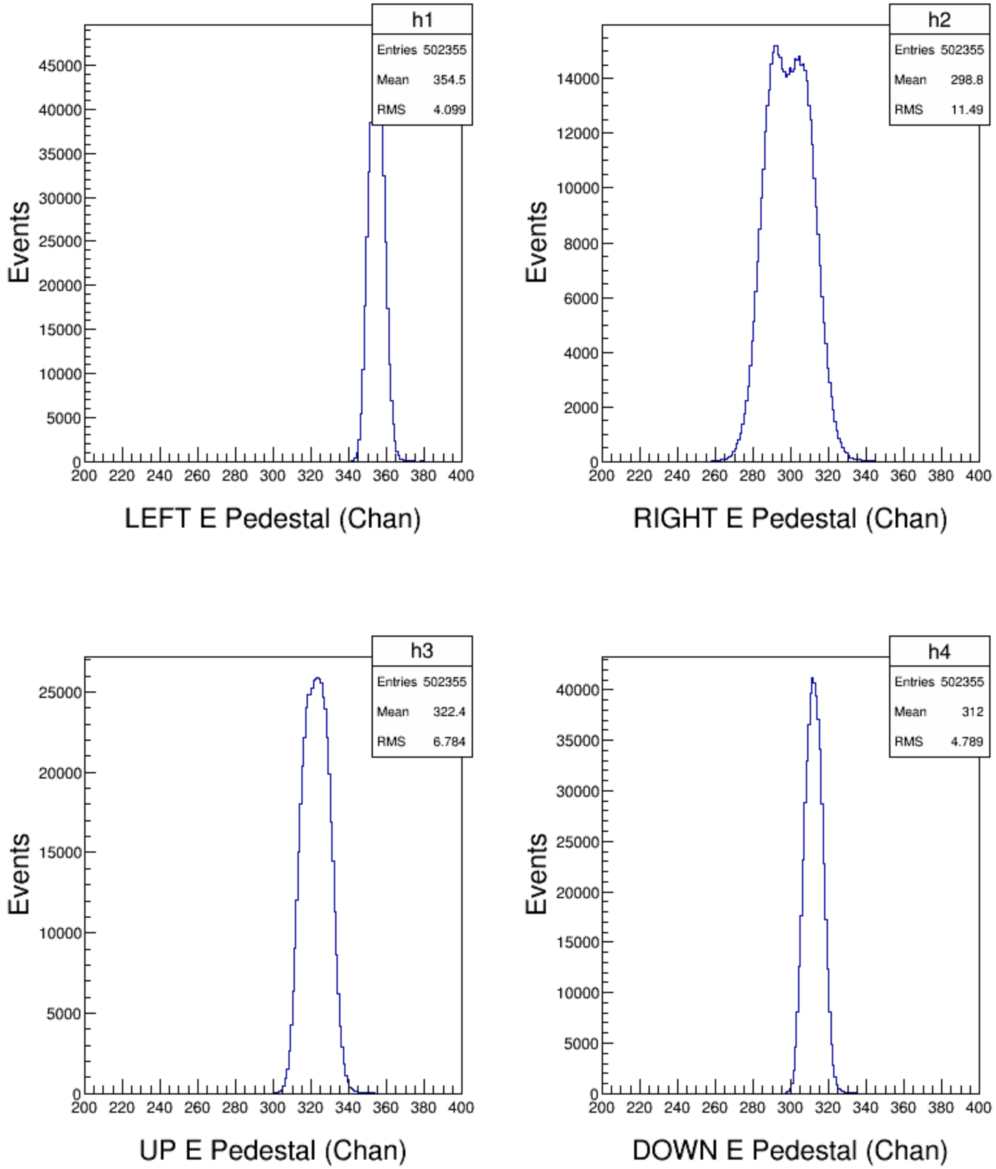
Mott Readout:

I. 50 samples

Samples

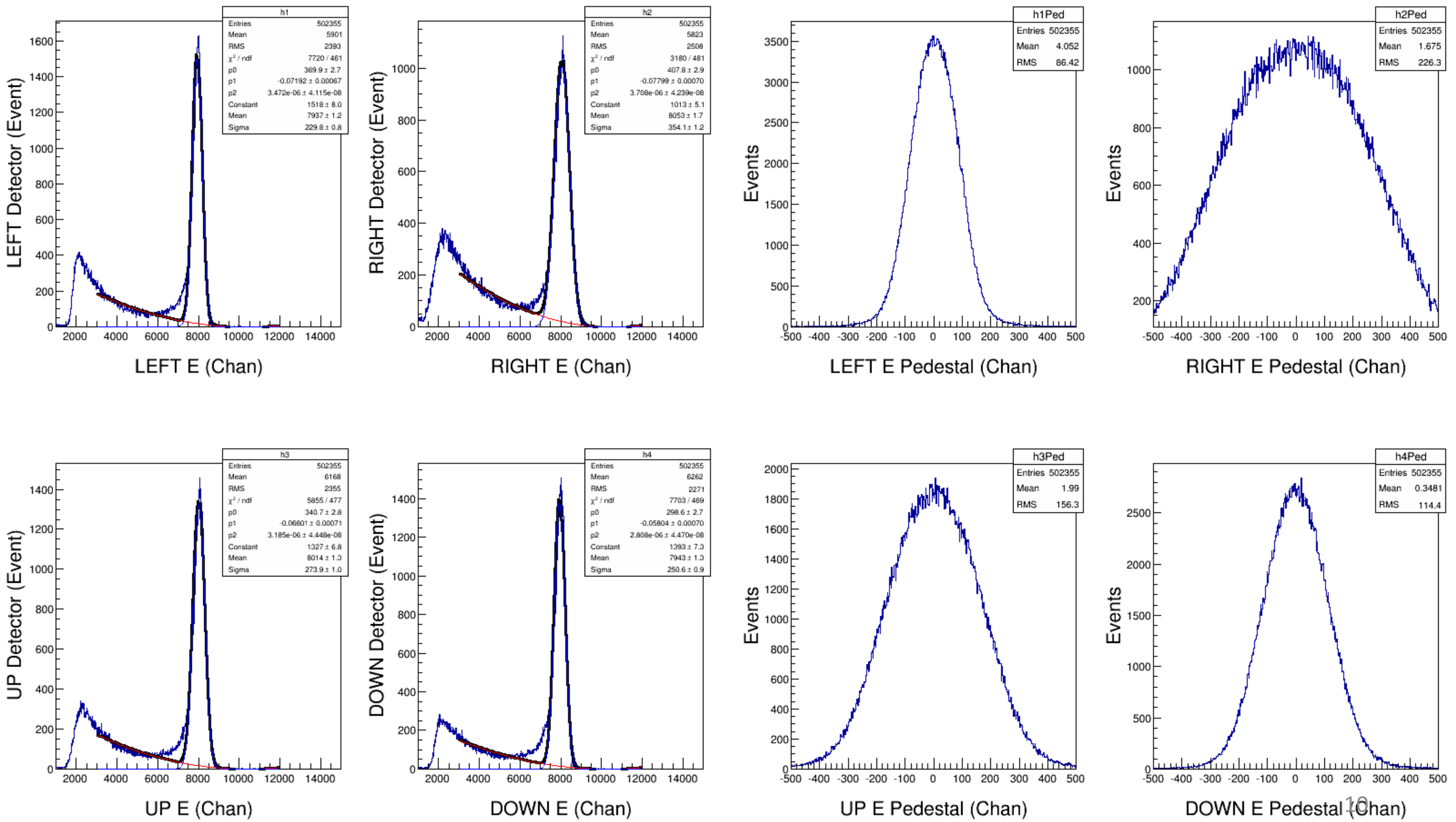

LEFT E FADC (Chan)
RIGHT E FADC (Chan)
UP E FADC (Chan)
DOWN E FADC (Chan)
LEFT ΔE FADC (Chan)
RIGHT ΔE FADC (Chan)
UP ΔE FADC (Chan)
DOWN ΔE FADC (Chan)
Laser Tof (Chan)
Channel 10 FADC (Chan)
Mott Detector Trigger (Chan)
Channel 12 FADC (Chan)
Sample

Analysis: Pedestals

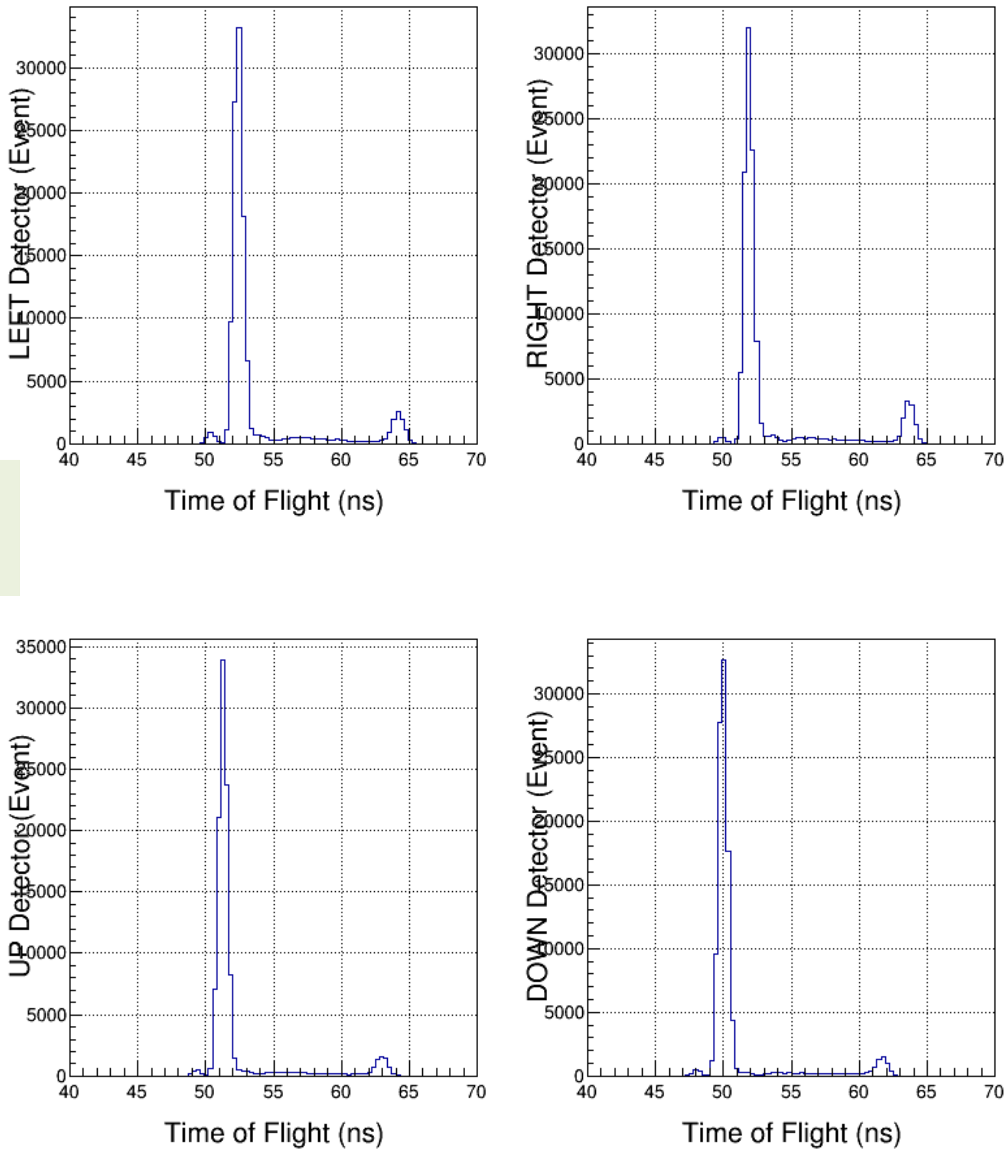


Analysis: Energy

$\sigma_E \sim 3.0\%$



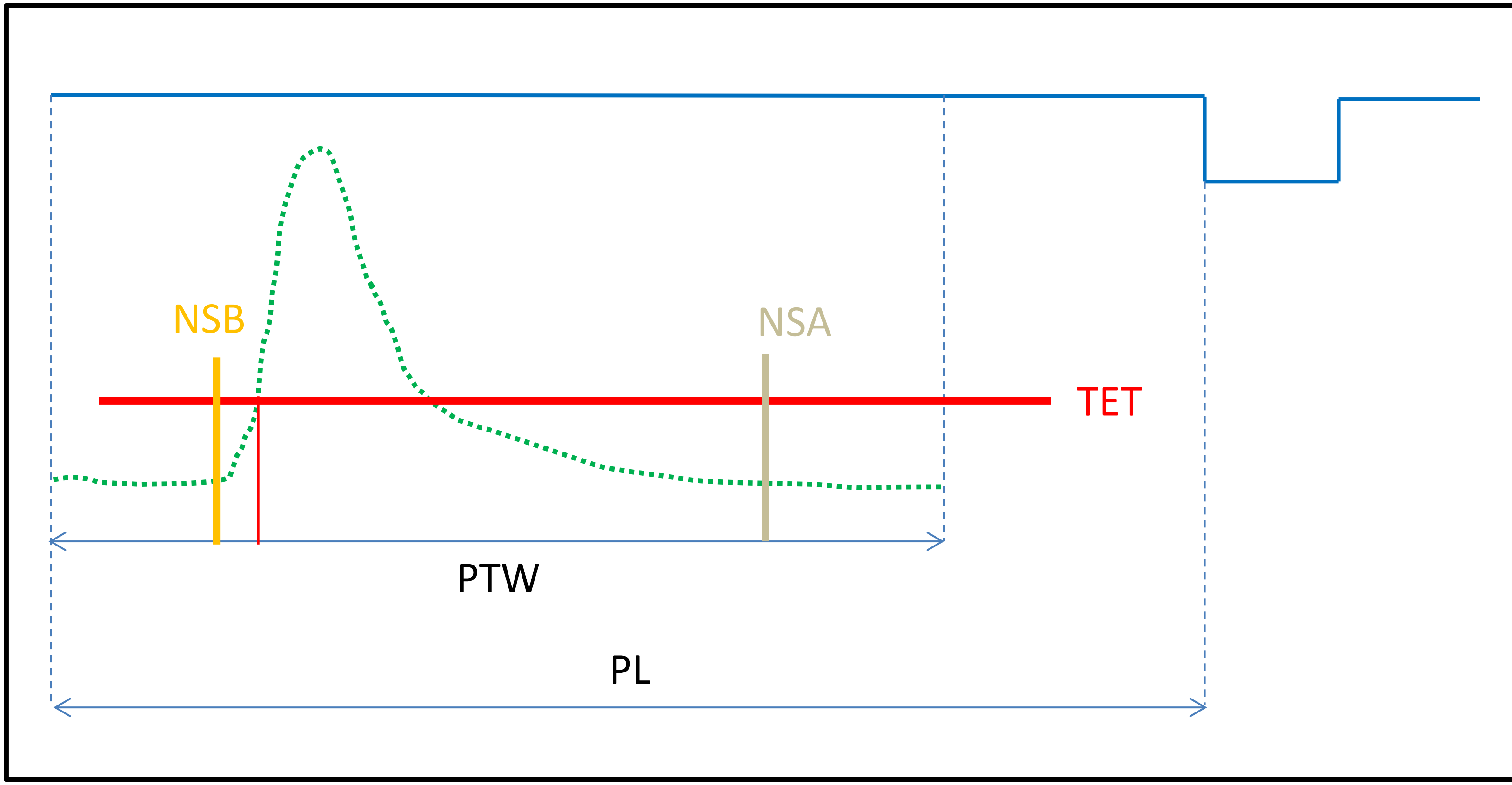
Analysis: Time-of-flight



$\sigma_t \sim 0.3$ ns

PULSE INTEGRAL AND HIGH RESOLUTION TIME – RUNS 8224, 8235

Pulse Integral & High Resolution Time



Mott Settings:

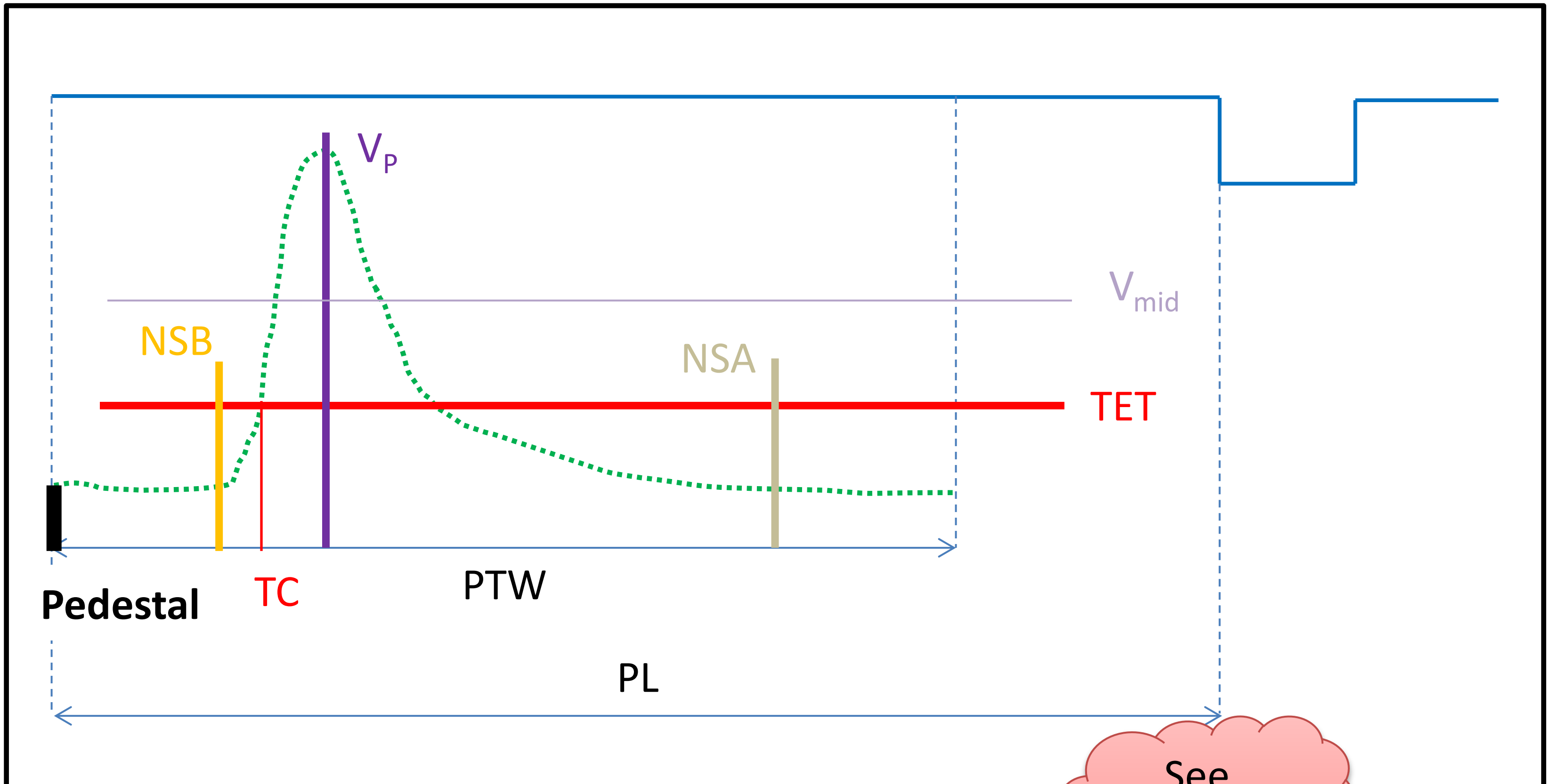
I. PL = 60 samples, PTW = 50 samples, NW = NSB + NSA
II. Programmable Trigger Energy Threshold (TET)
III. Number of pulses (NP) in PTW = 1 (up to 3 pulses)
IV. Number of Samples Before threshold crossing (NSB) = 5
V. Number of Samples After threshold crossing (NSA) = 28

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 - Timing
fadc_threshold[9] = 1750;     // CH10 - Timing
fadc_threshold[10]= 1000;     // CH11 - Mott Trigger
fadc_threshold[11]= 1750;     // CH12 - Timing
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
```

Threshold was 100 for Run 8224 (→ CH10 - Timing, CH12 - Timing)

Pulse Integral & High Resolution Time



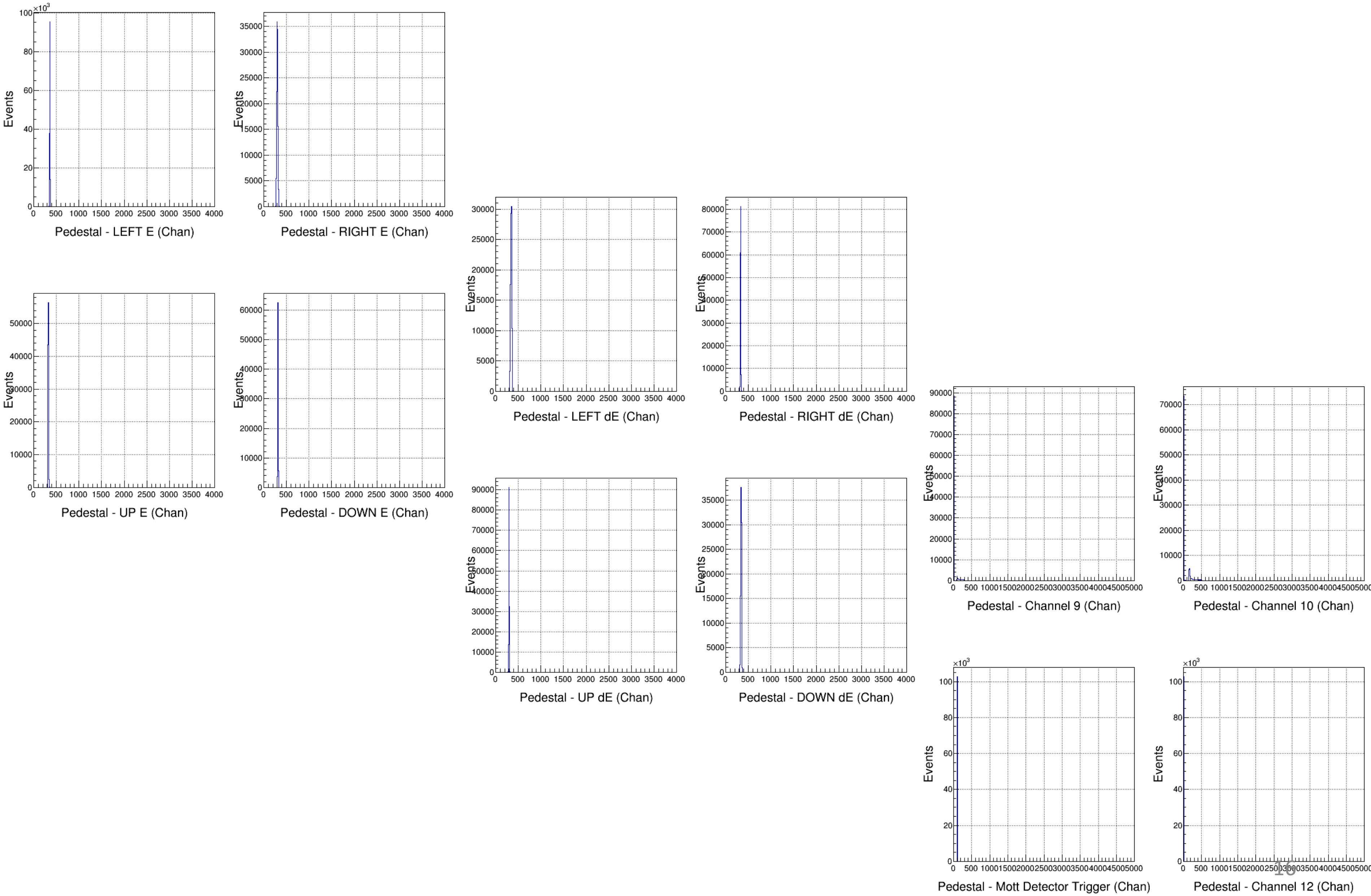
See Note 1

See Note 2

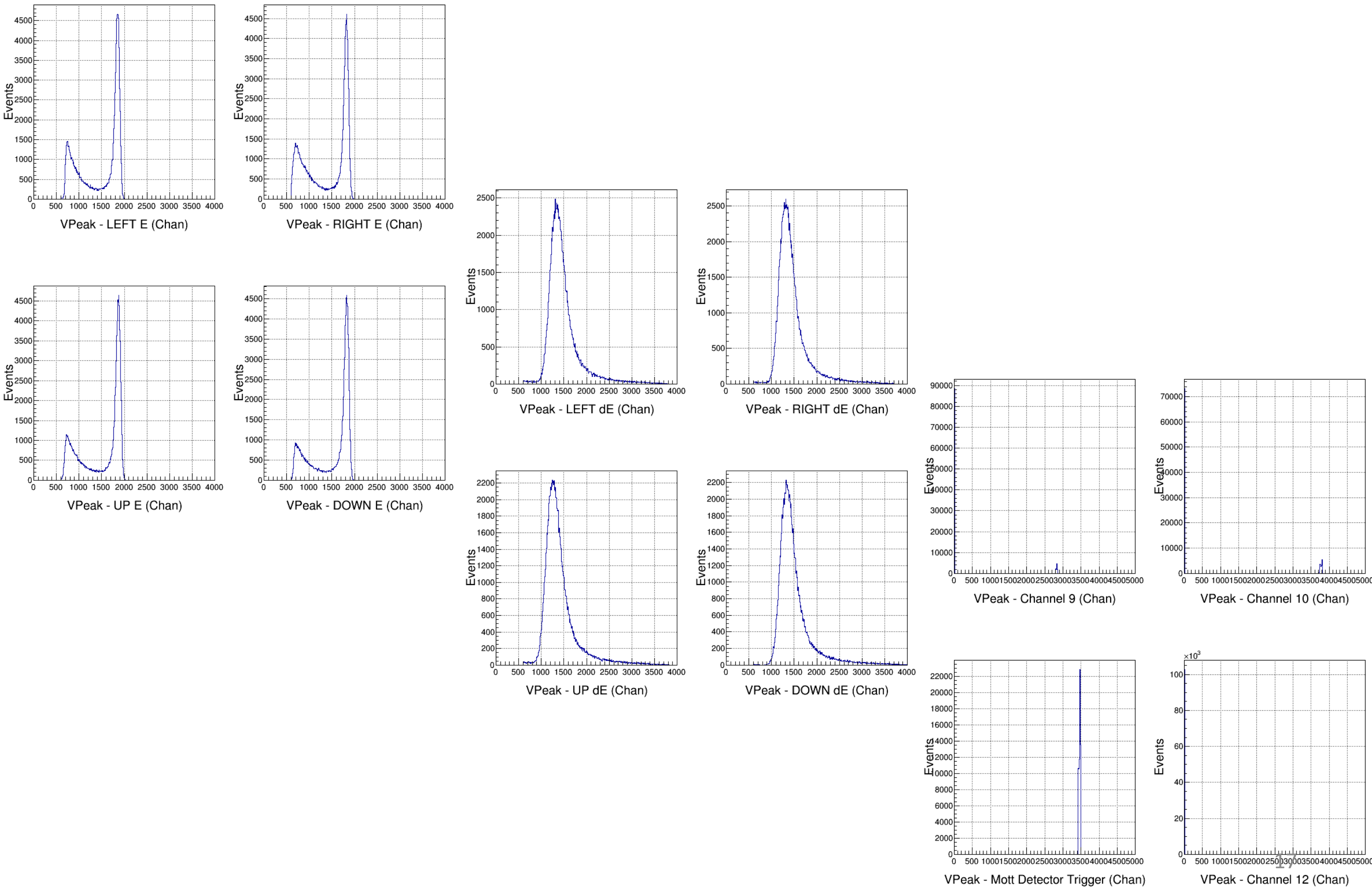
Mott Readout:

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

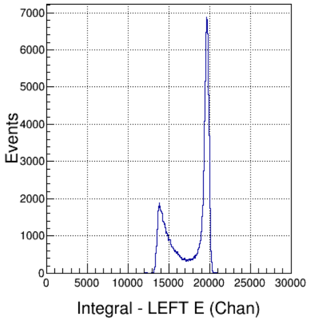
Pulse Pedestal

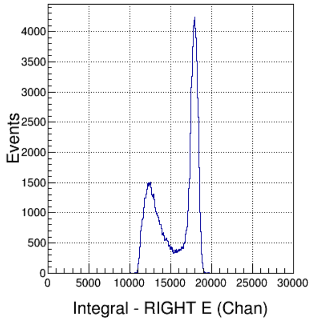


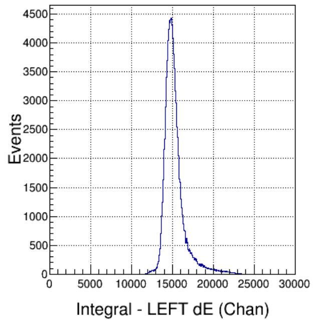
Pulse Peak Value (VP)

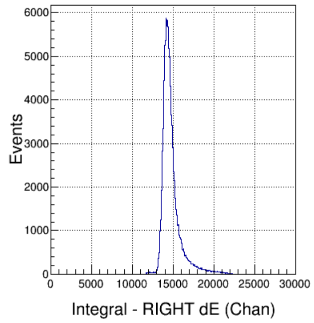


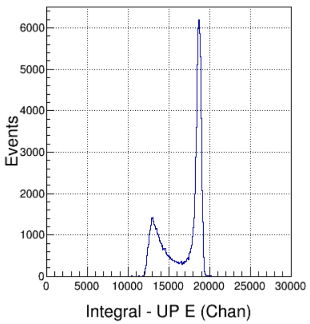
Pulse Integral

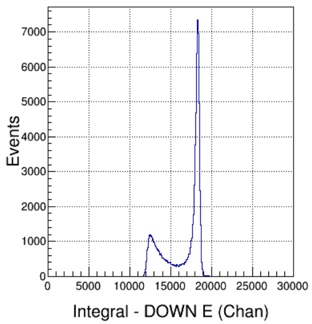


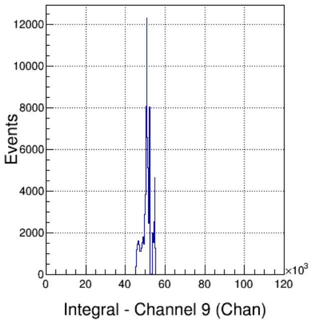


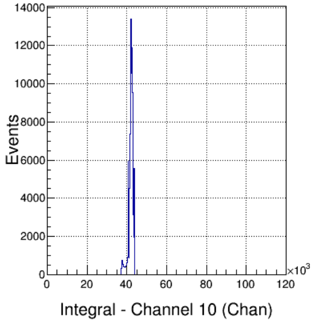


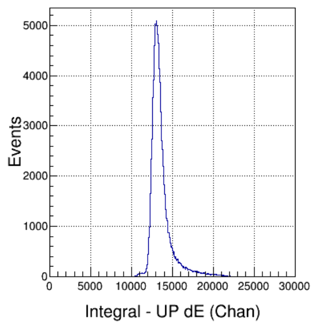


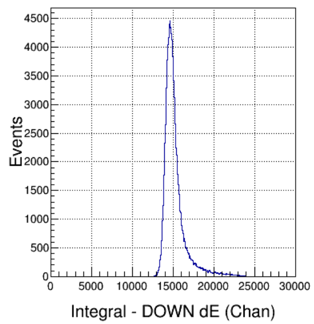


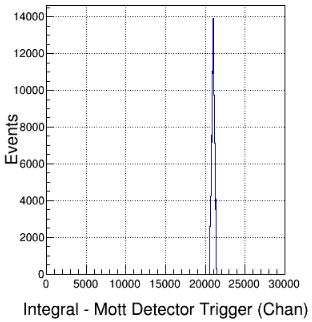


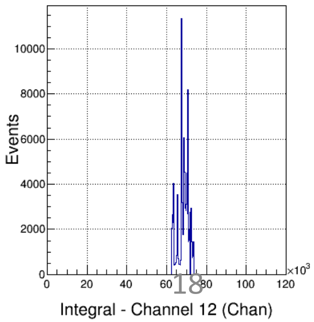




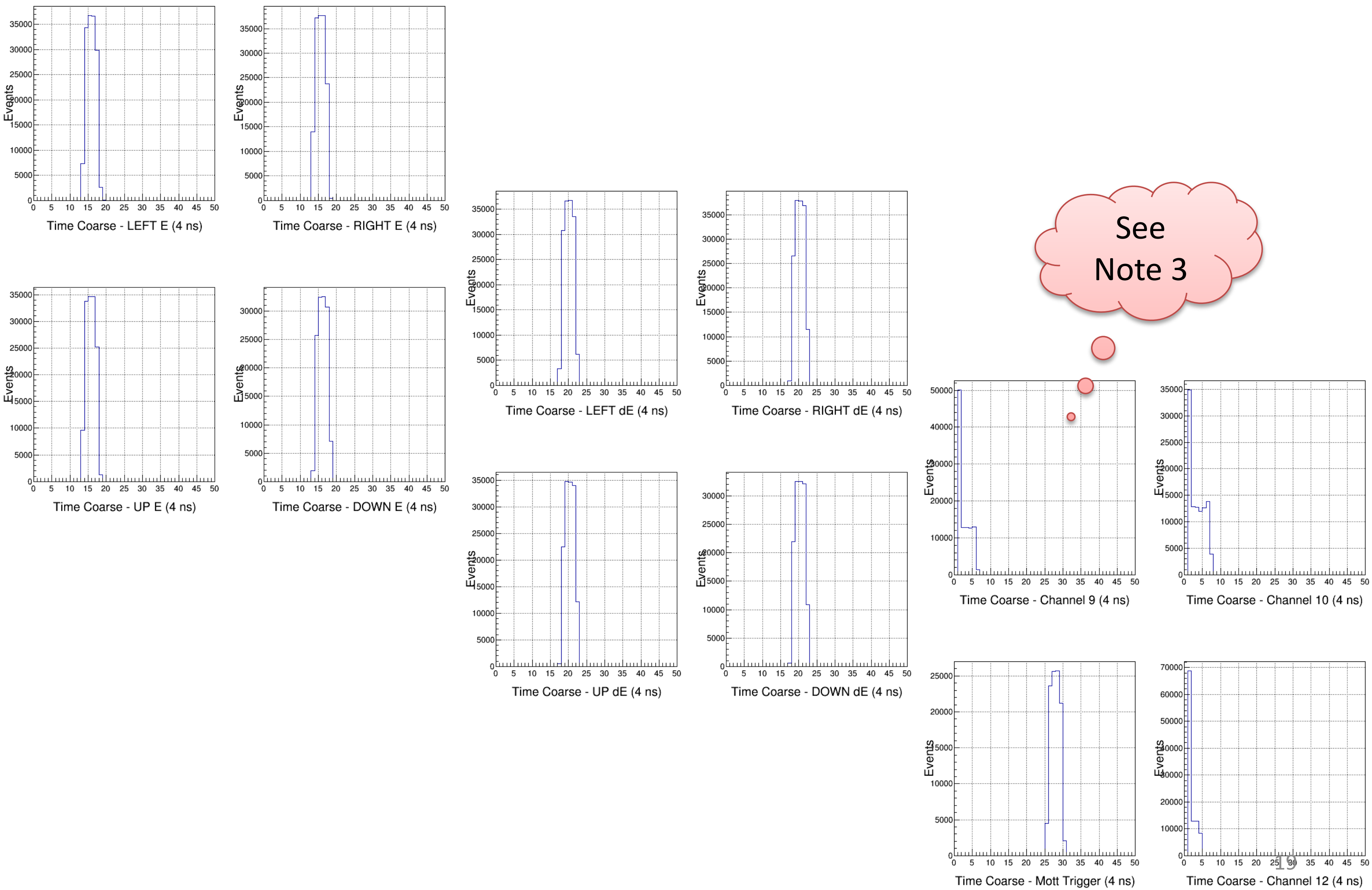




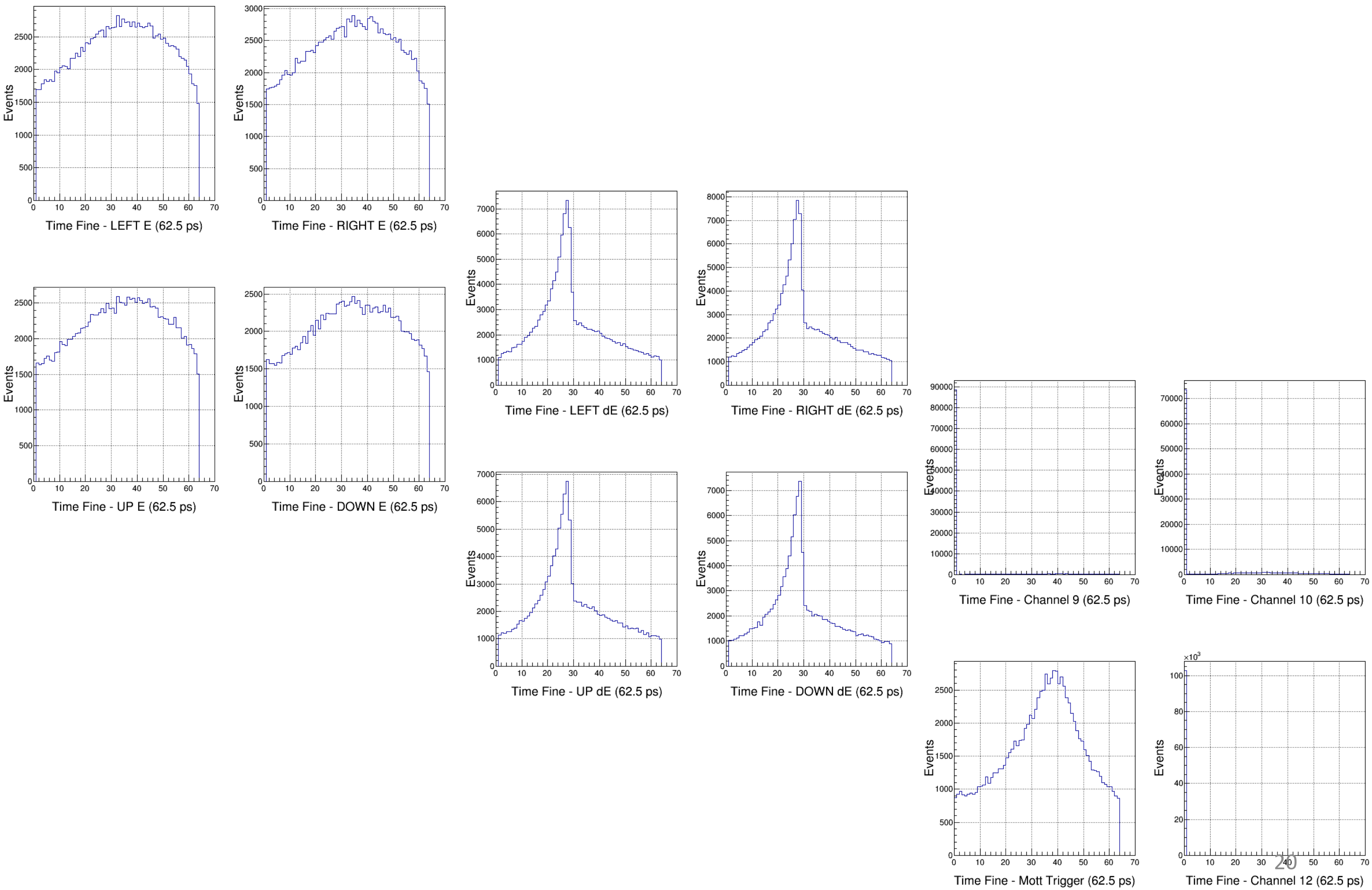




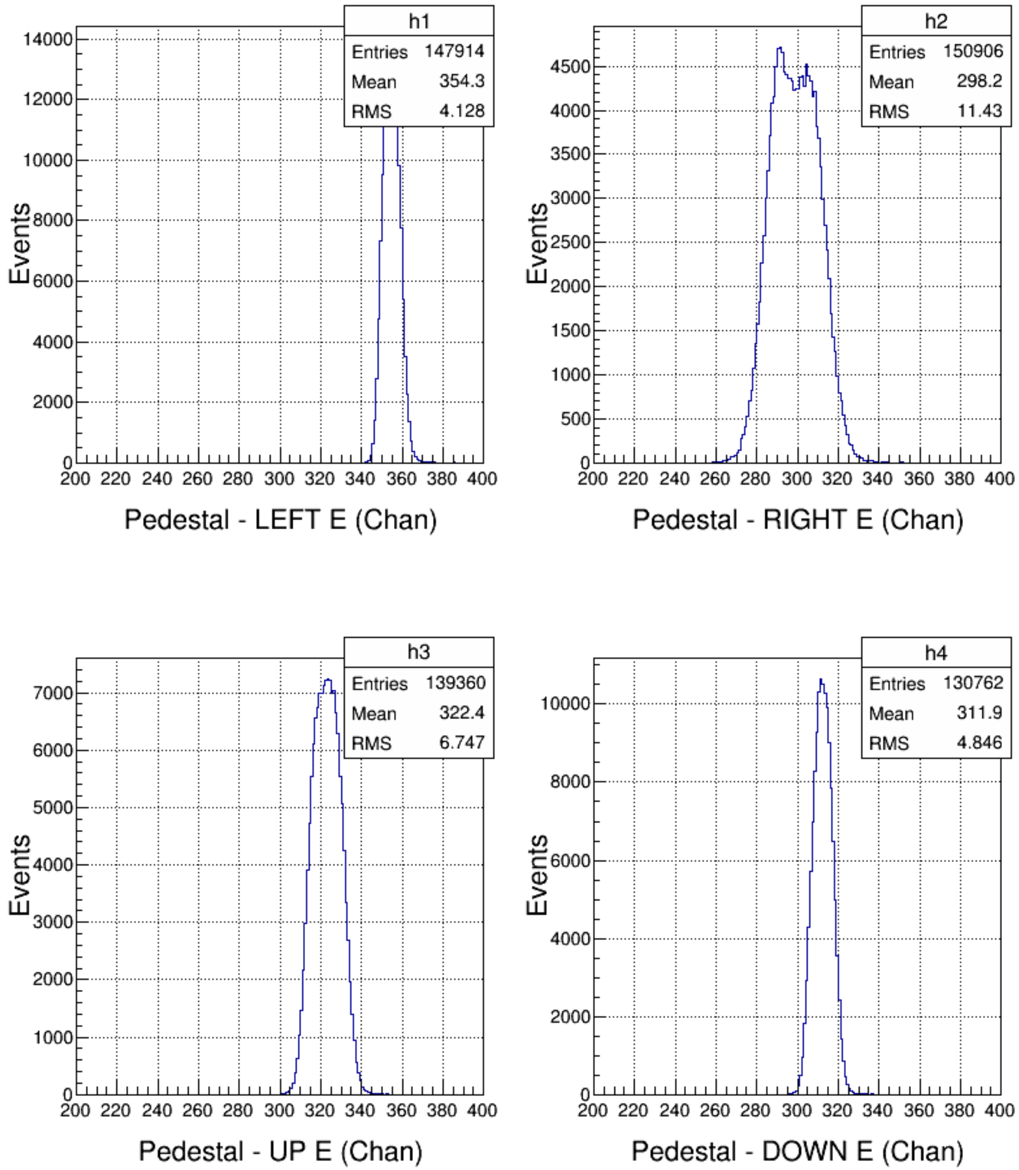
Pulse Coarse Time



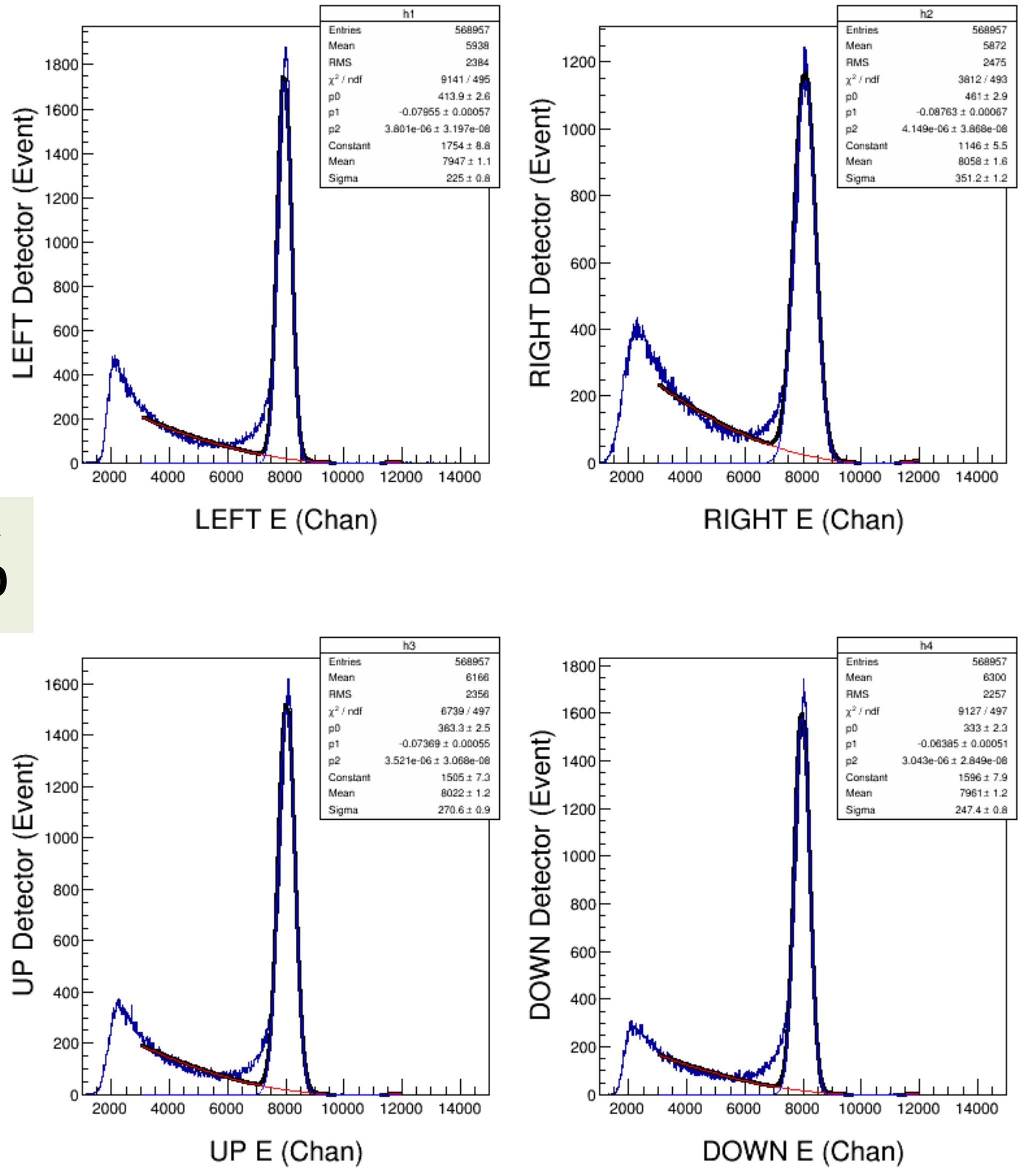
Pulse Fine Time



Analysis: Pedestals



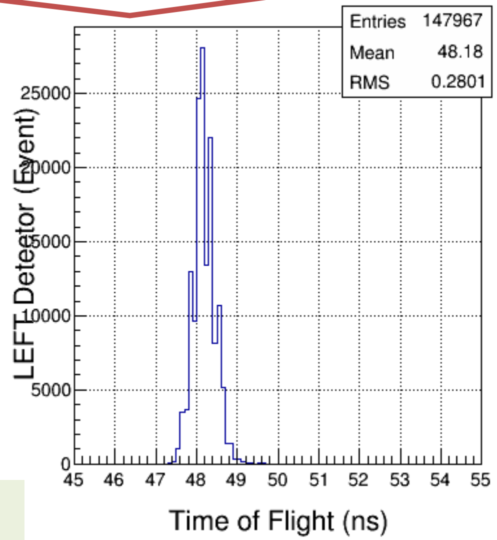
Analysis: Energy

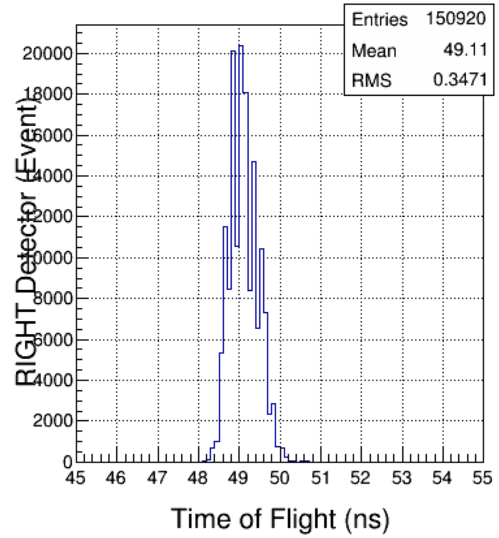


σ_E ~ 3.0%

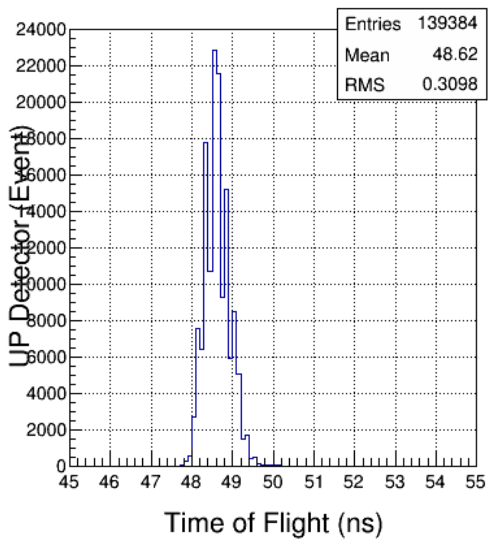
Analysis: Self Timing Peak

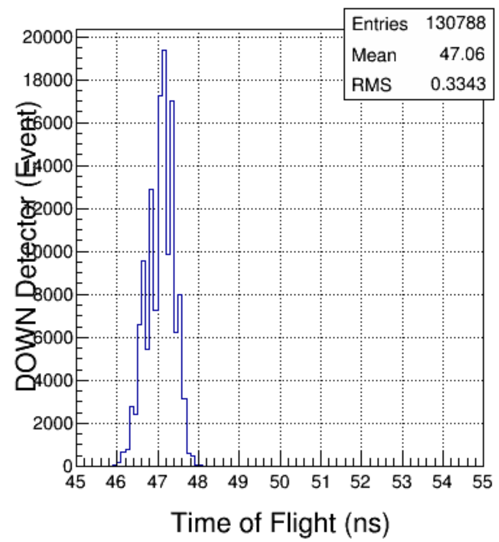
```
T->Draw("(TimeCoarse11*4.0 + TimeFine11*0.0625) - (TimeCoarse1*4.0 + TimeFine1*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse11 >1.0")
```





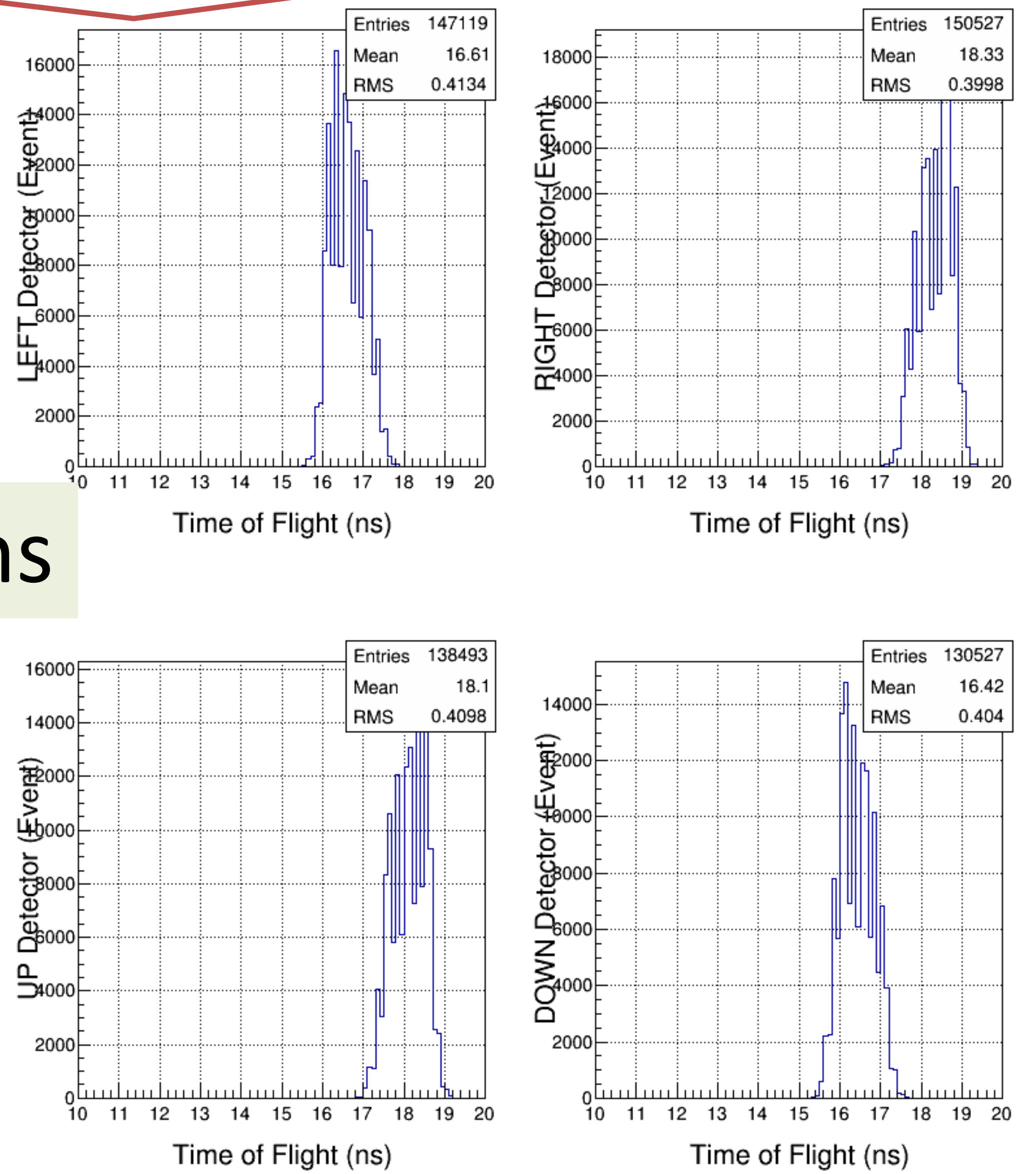
$\sigma_t \sim 0.3$ ns





Analysis: E-dE Timing Peak

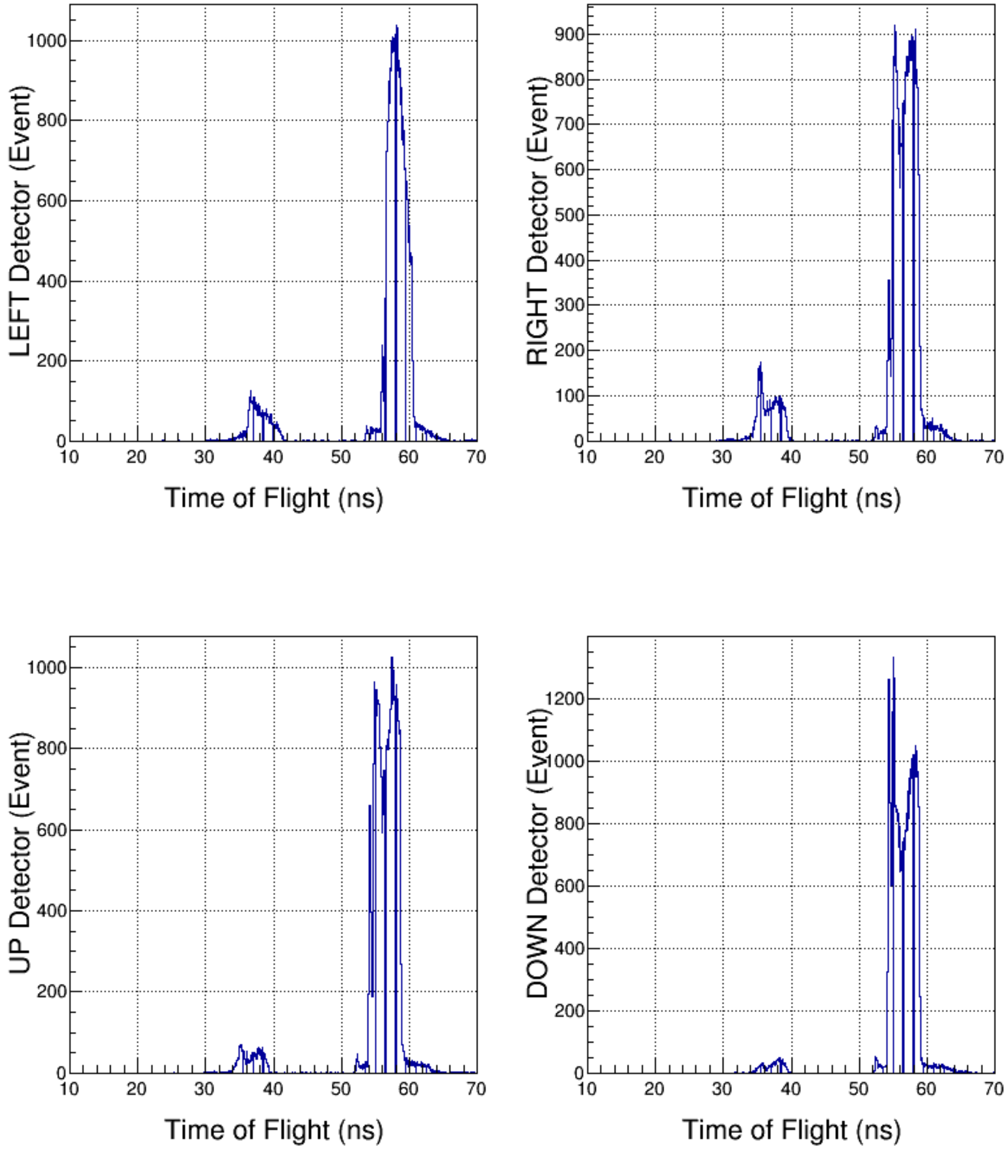
```
T->Draw("(TimeCoarse5*4.0 + TimeFine5*0.0625) - (TimeCoarse1*4.0 + TimeFine1*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse5 >1.0")
```



$\sigma_t \sim 0.40$ ns

Analysis: Time-of-flight

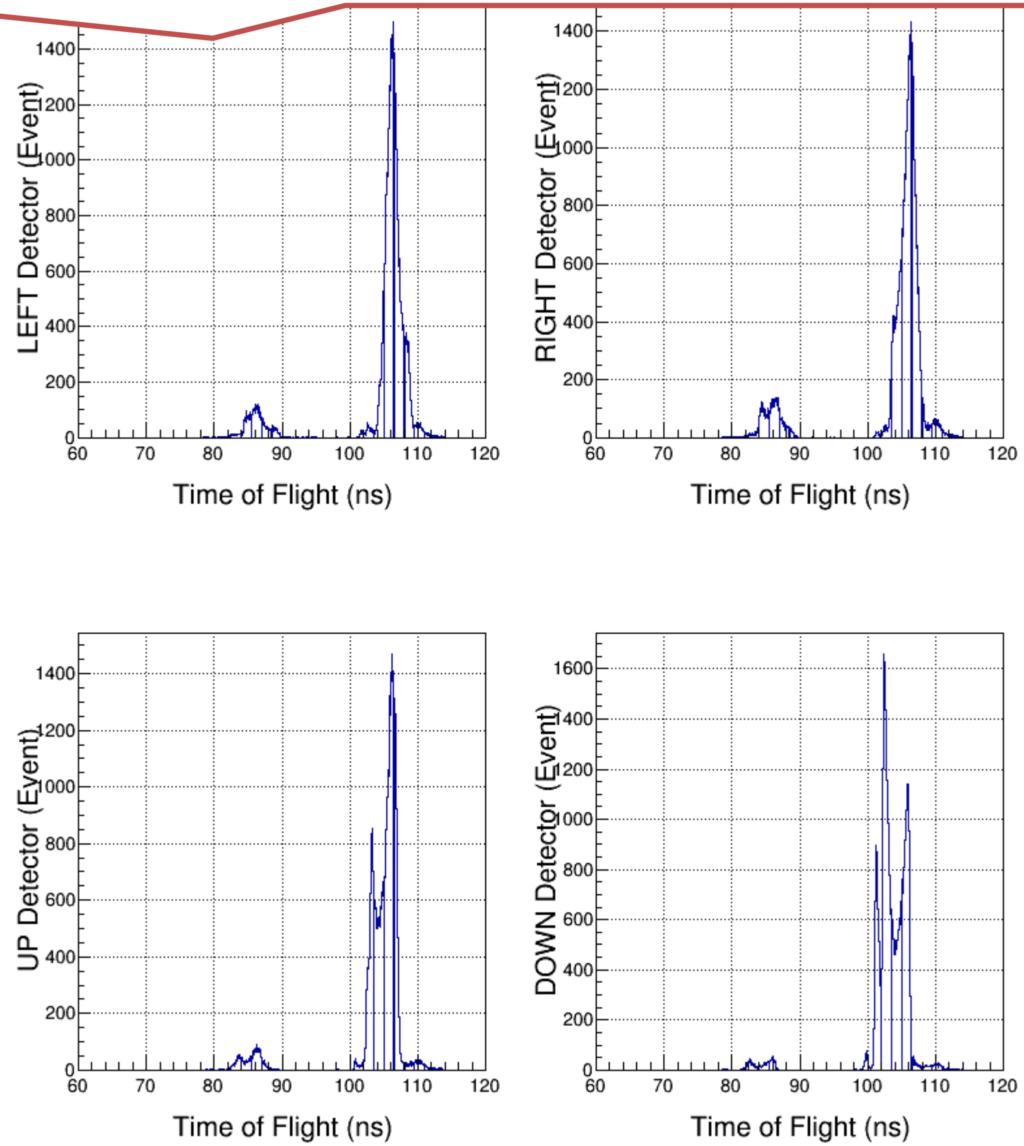
```
T->Draw("(TimeCoarse1*4.0 + TimeFine1*0.0625) - (TimeCoarse9*4.0 + TimeFine9*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse9 >1.0")
```



Use CH1-CH4

Analysis: Time-of-flight

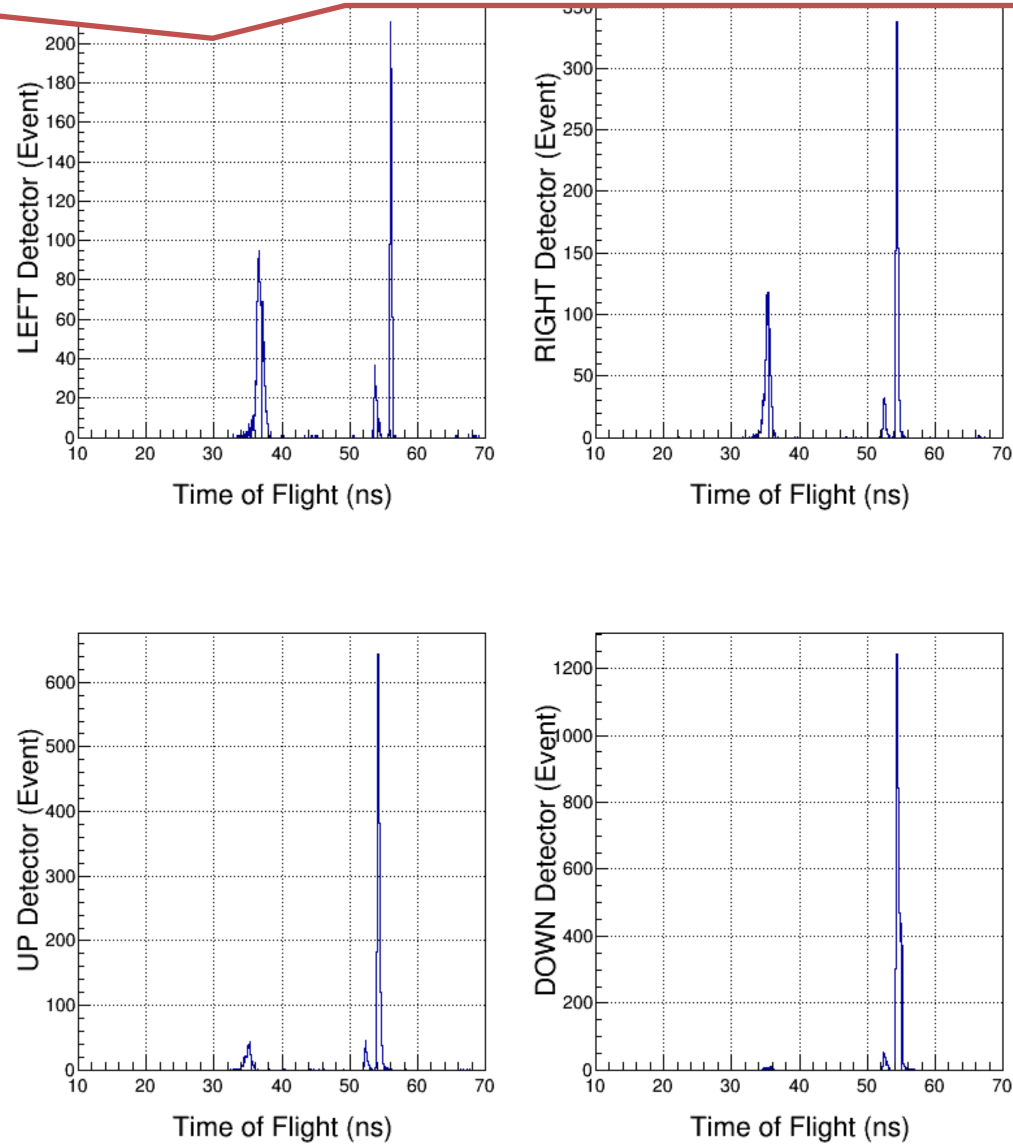
```
T->Draw("(TimeCoarse11*4.0 + TimeFine11*0.0625) - (TimeCoarse9*4.0 + TimeFine9*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse9 >1.0 ")
```



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")

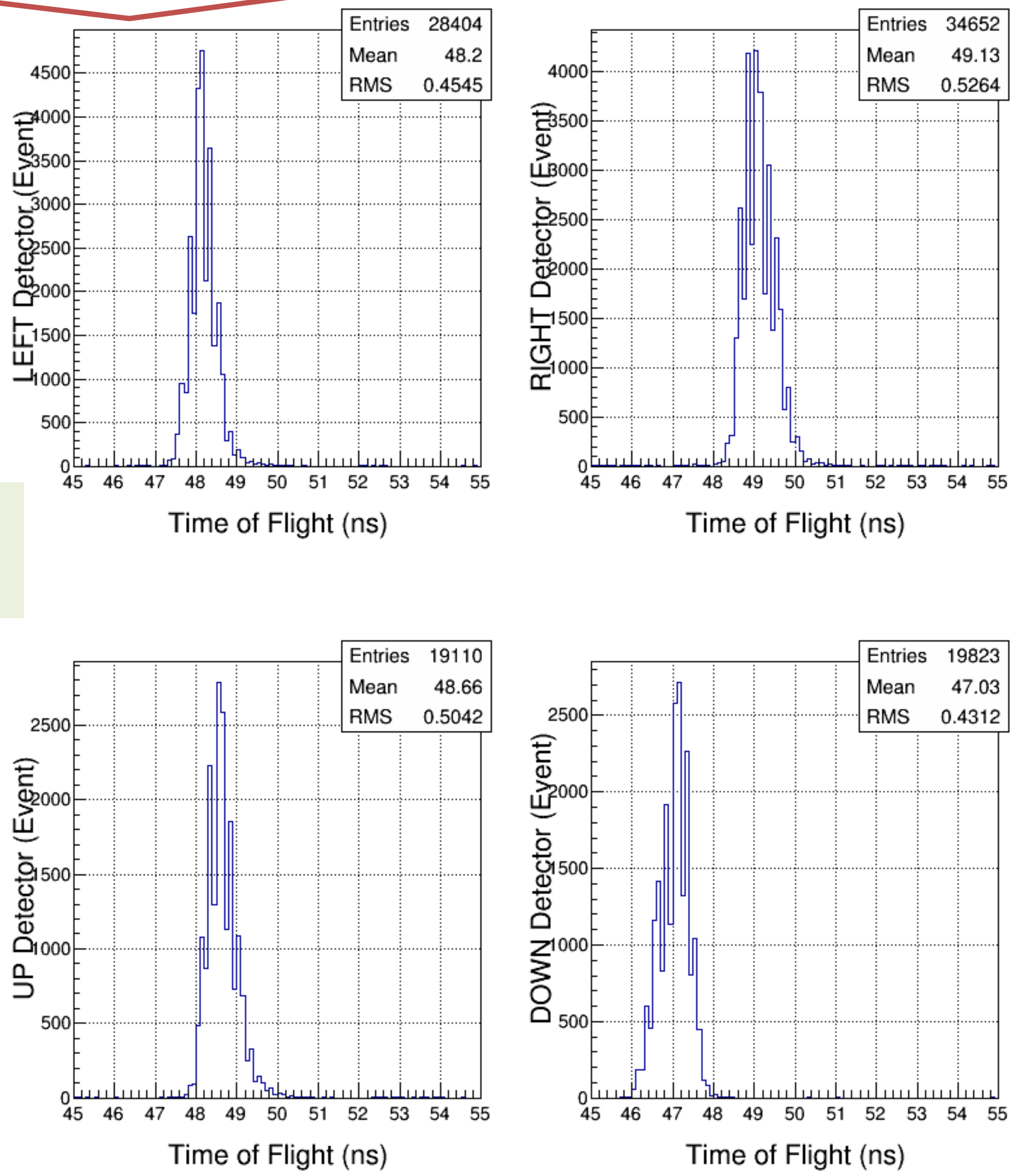


Use CH11

Analysis: Self Timing Peak - 8235

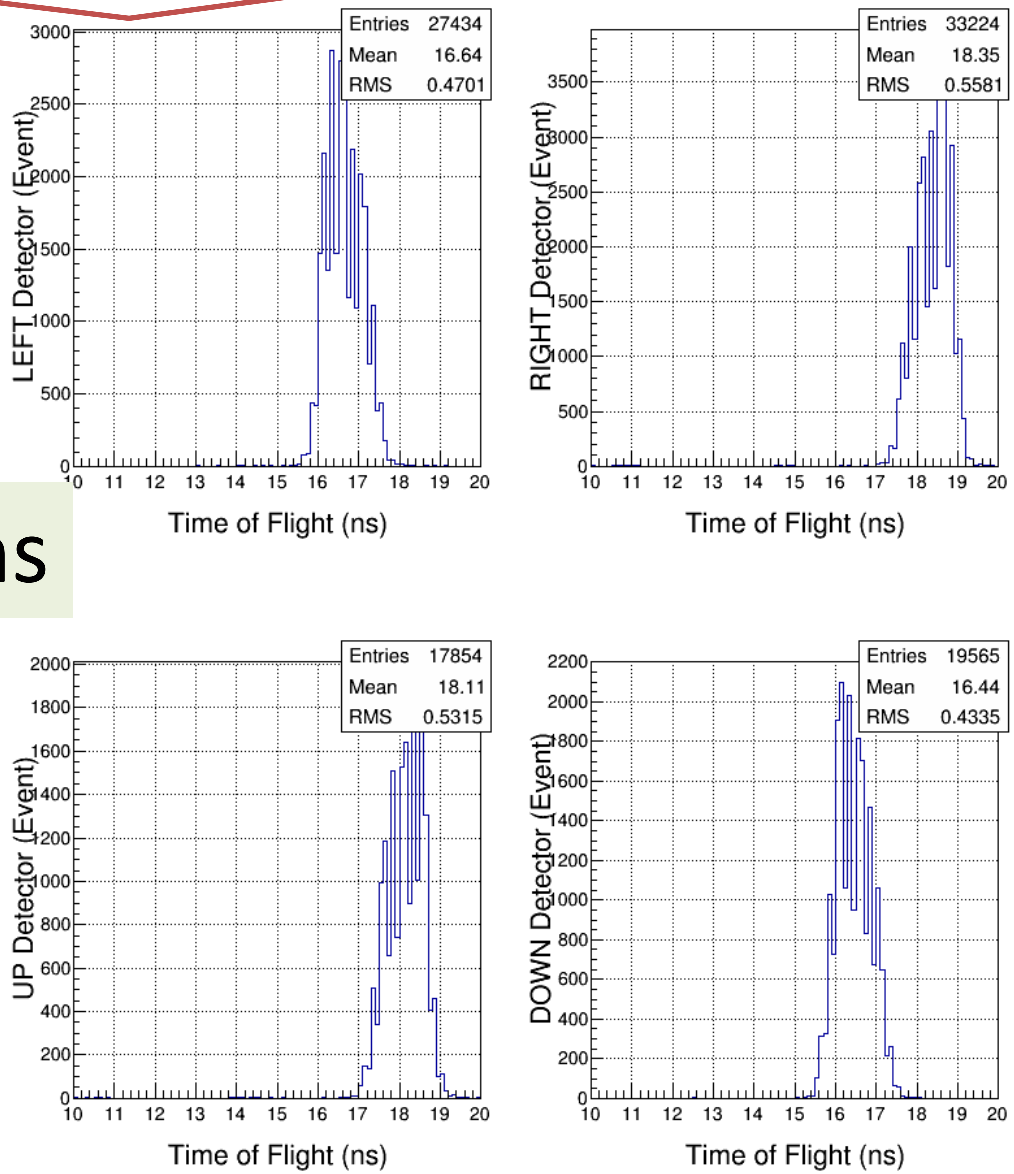
```
T->Draw("(TimeCoarse11*4.0 + TimeFine11*0.0625) - (TimeCoarse1*4.0 + TimeFine1*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse11 >1.0")
```

$\sigma_t \sim 0.5$ ns



Analysis: E-dE Timing Peak - 8235

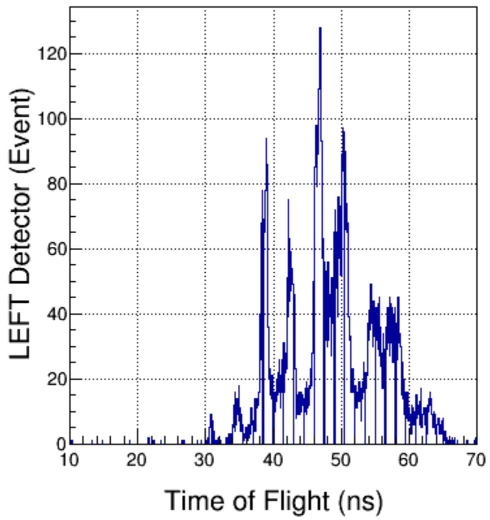
```
T->Draw("(TimeCoarse5*4.0 + TimeFine5*0.0625) - (TimeCoarse1*4.0 + TimeFine1*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse5 >1.0")
```

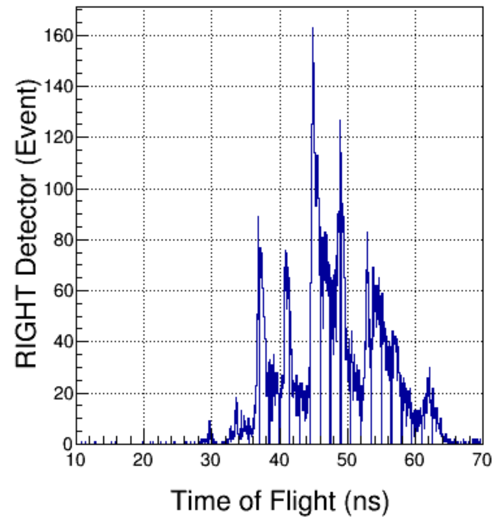


$\sigma_t \sim 0.50$ ns

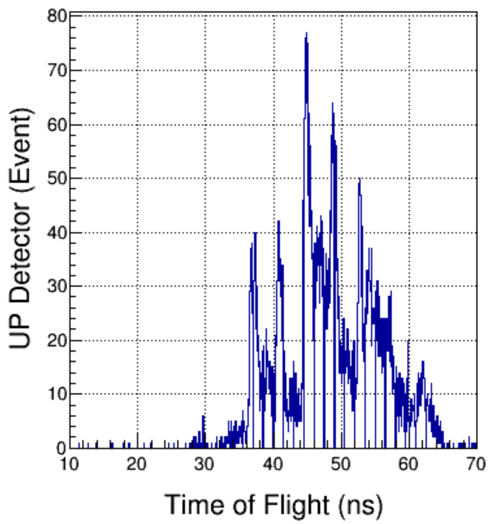
Analysis: Time-of-flight - 8235

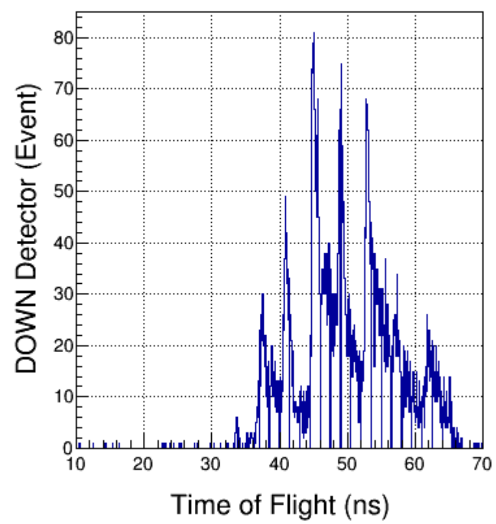
T->Draw("(TimeCoarse1*4.0 + TimeFine1*0.0625) - (TimeCoarse9*4.0 + TimeFine9*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse9 >1.0")





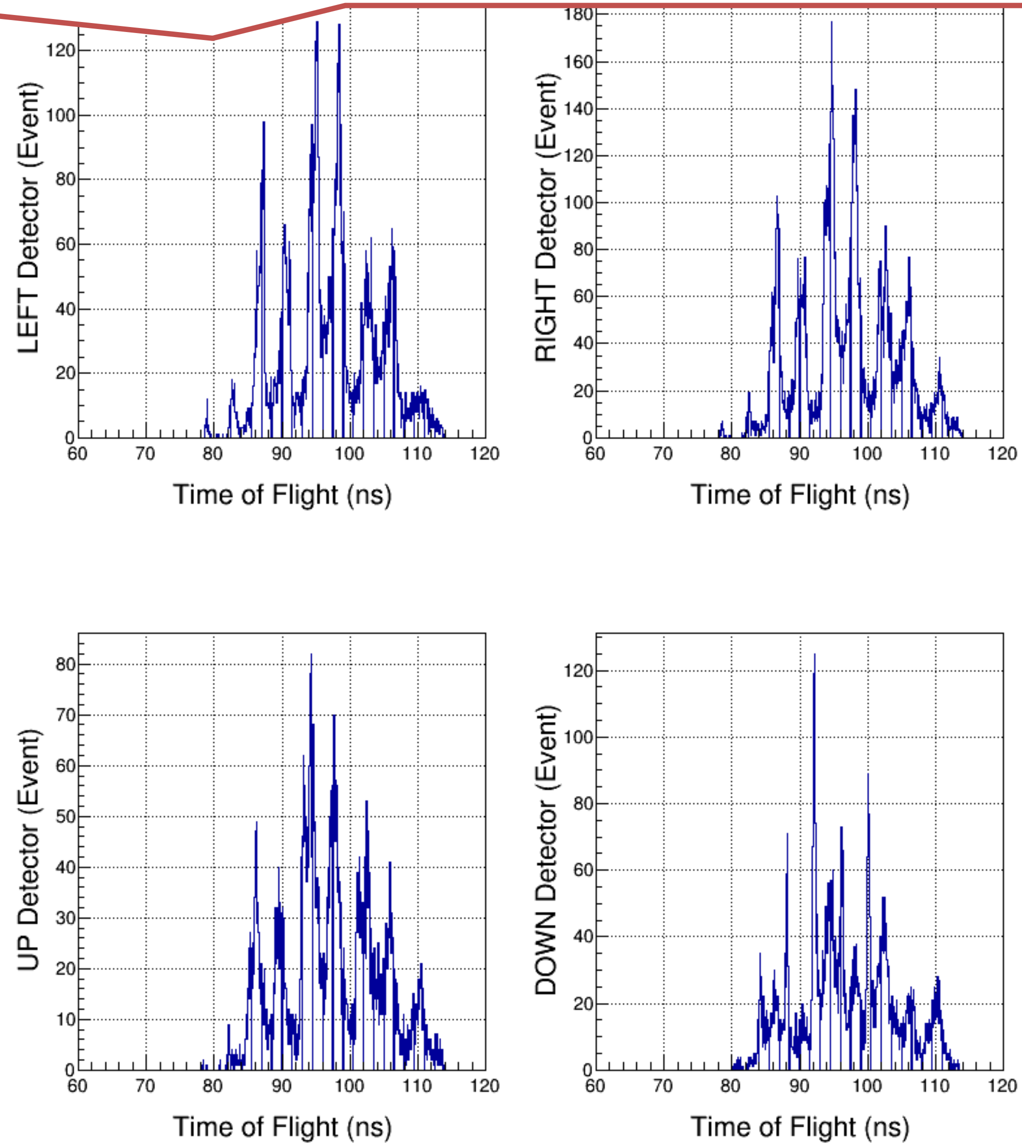
Use CH1-CH4





Analysis: Time-of-flight - 8235

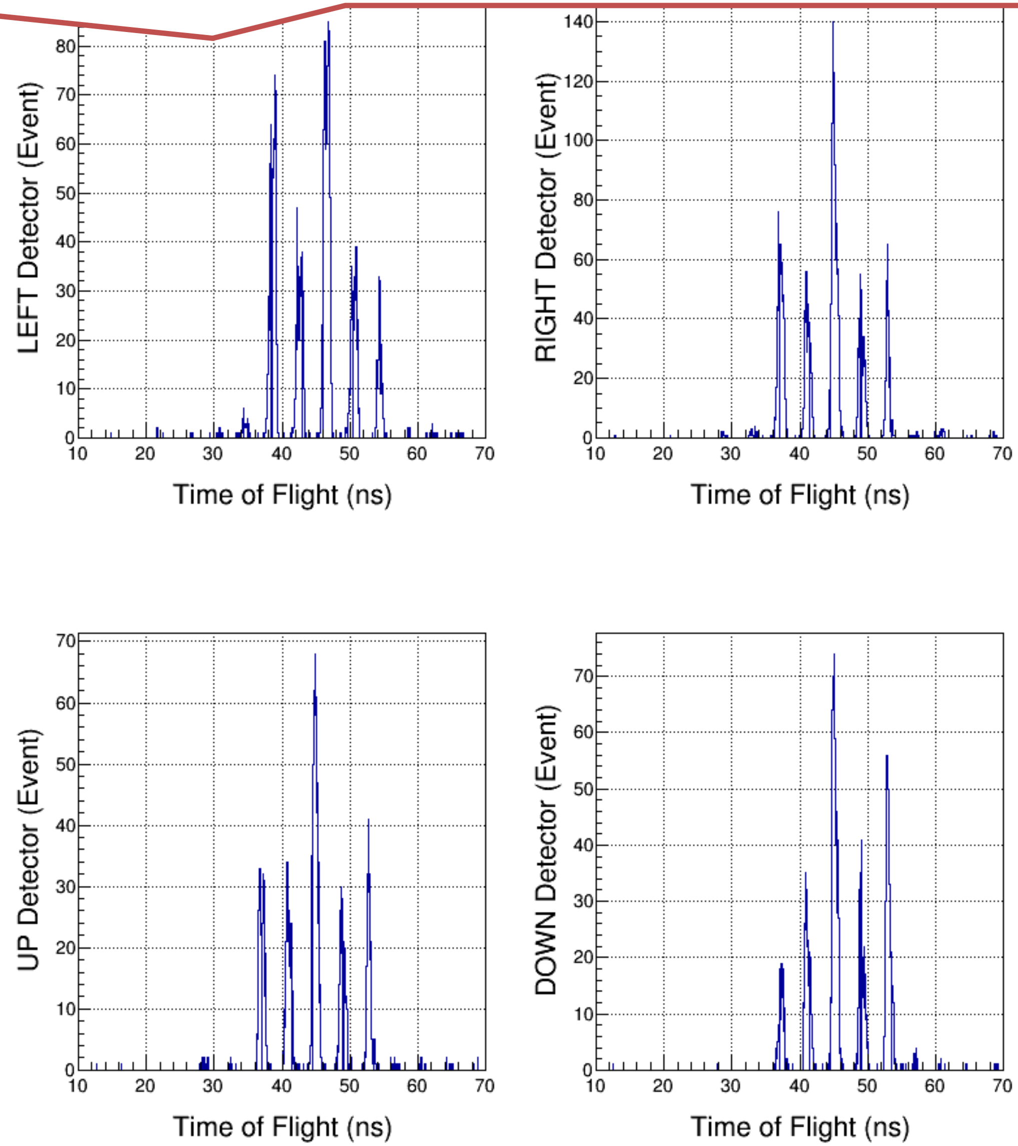
```
T->Draw("(TimeCoarse11*4.0 + TimeFine11*0.0625) - (TimeCoarse9*4.0 + TimeFine9*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse9 >1.0 ")
```



Use CH11

Analysis: Time-of-flight - 8235

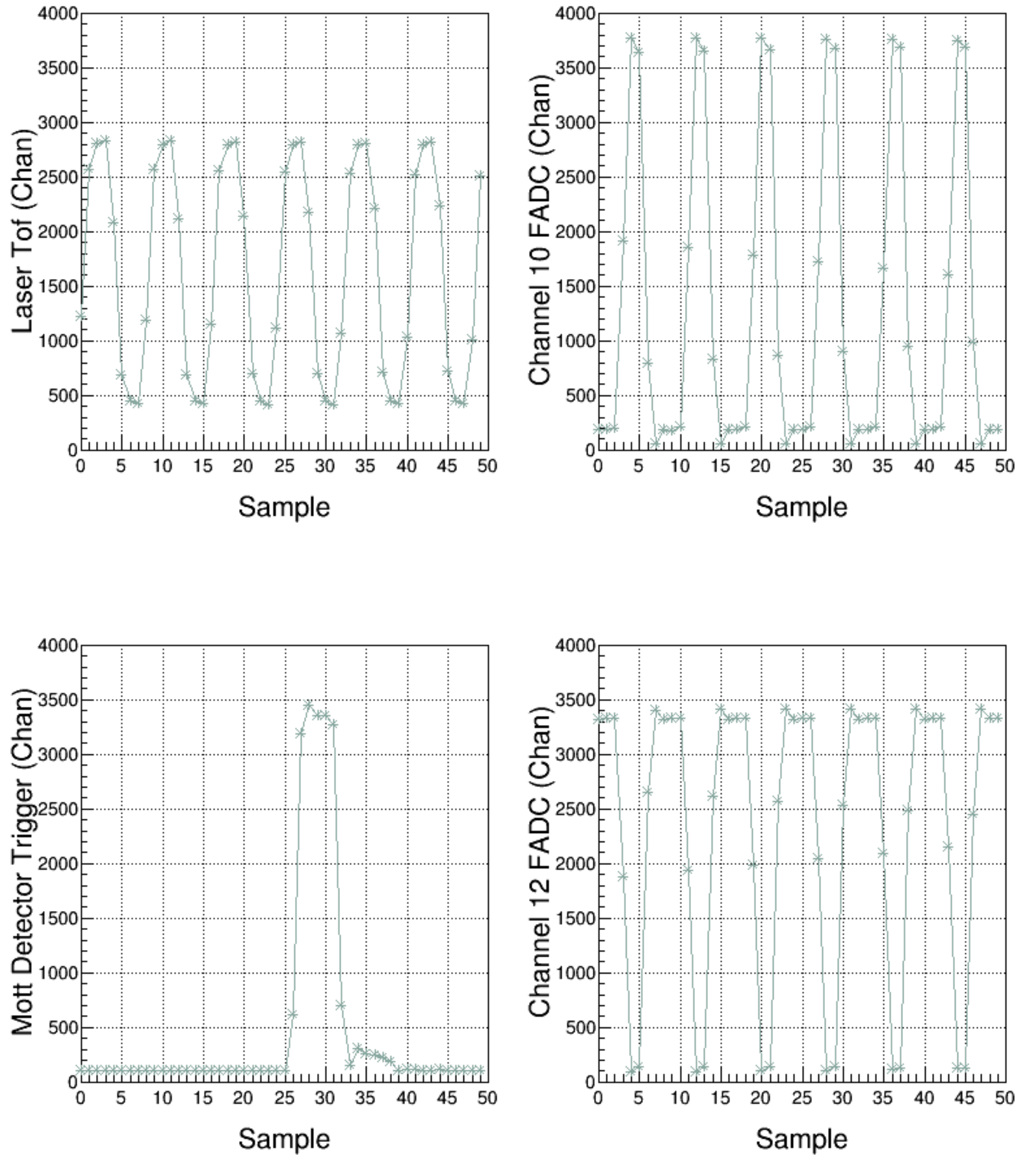
T->Draw("(TimeCoarse11*4.0 + TimeFine11*0.0625) - (TimeCoarse9*4.0 + TimeFine9*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse9 >1.0 &&VPeak9>0.0")



Use CH11

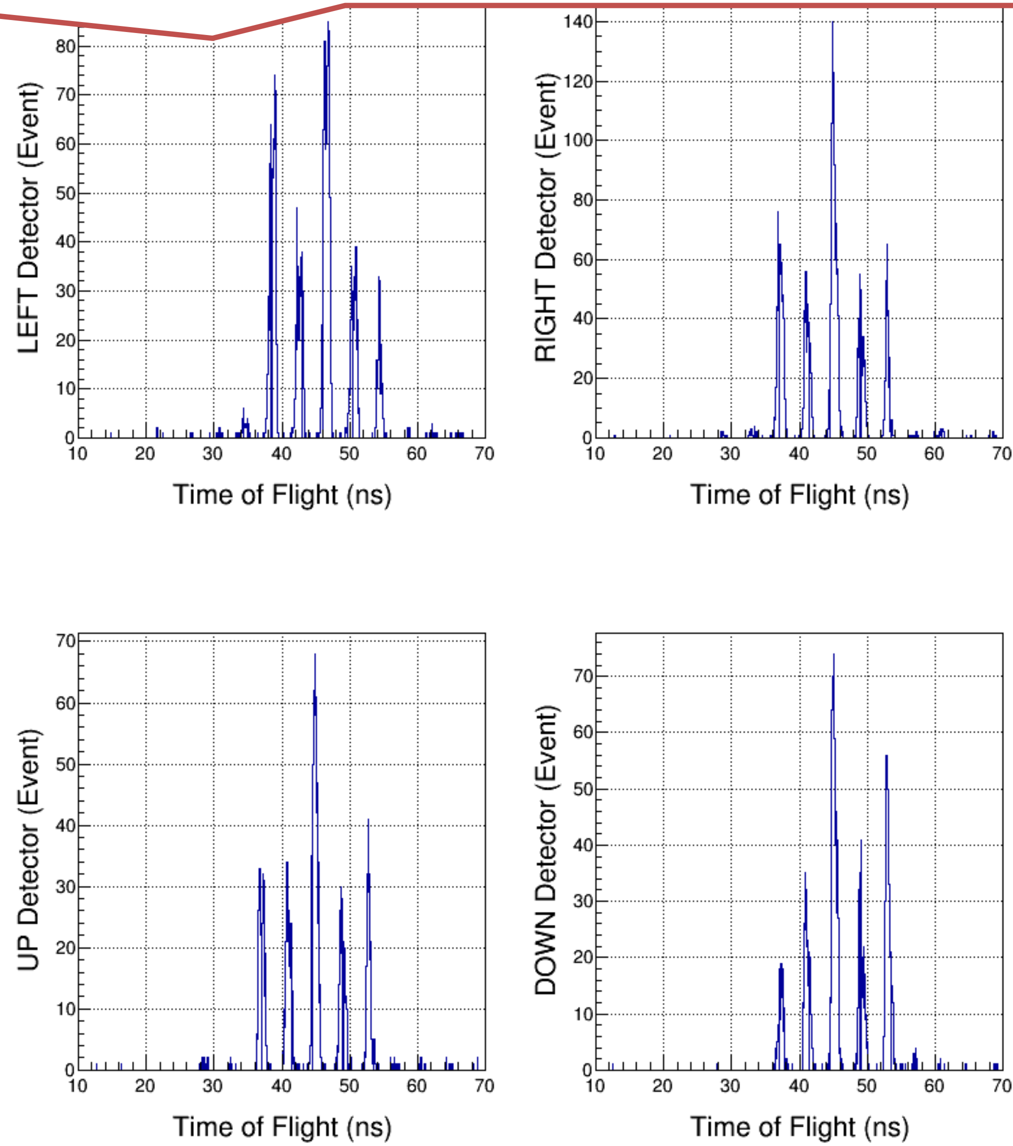
Three Timing Signals

- Added two more laser timing signals to FADC.
- From Disc 708, OUT signal was connected to FADC Ch10 and OUT_bar was connected to Ch12.
- Original laser timing signal is still connected to Ch9.



Analysis: Time-of-flight - 8235

```
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 CH10 or Ch12

Notes

Note 1

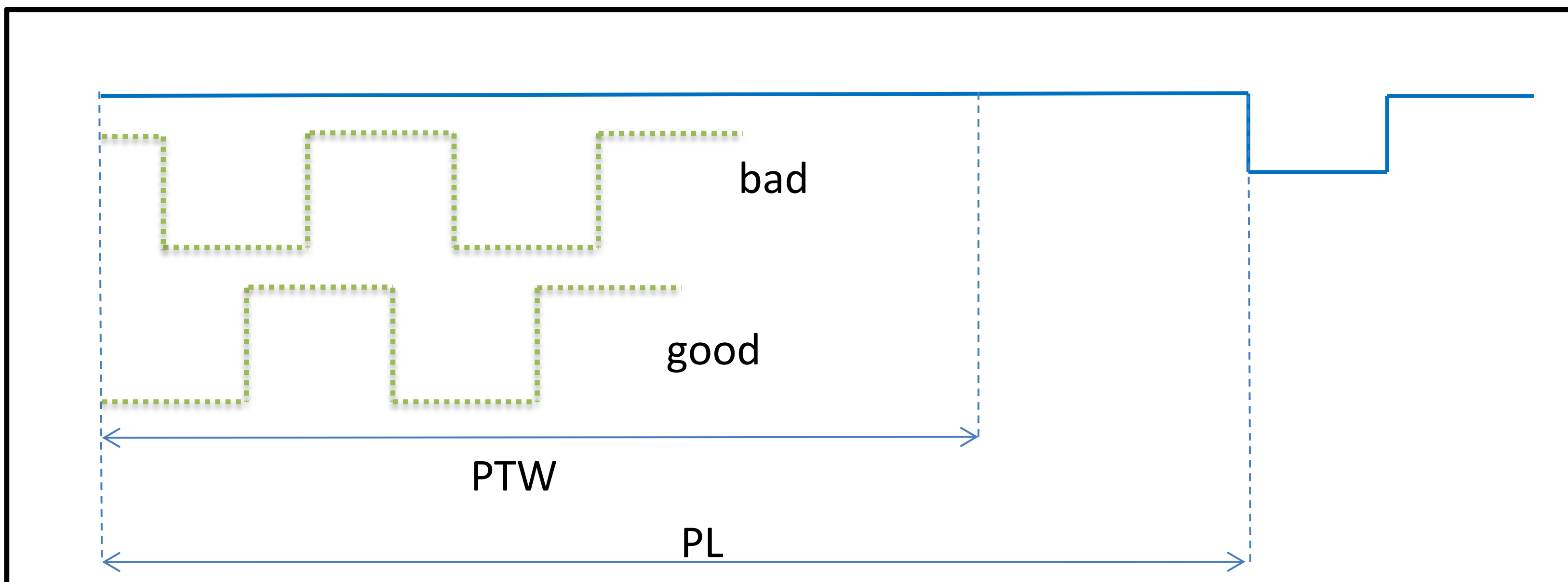
- If first sample above threshold then:
  course time =1, fine time = 0, ped = 0, and VPeak = 0

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. Possible Solutions:
  I. Use signal and signal_bar – Run 8235 (**do not know if it works; still analyzing**)
  I. 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
  - How to deal with a periodic signal?
- Again, what about scalers?
- A new CODA Configuration was created with this mode (no CAEN v775 TDC and no SIS3801 Scalers) with block readout. Next …

Conclusions – so far …

- Measure deadtime with 2.2 uA on 1 um gold foil:

I. Run 8225: Mott_SemiInt configuration (FADC+TDC+Scalers), Deadtime = 28% at 5.1 kHz.

II. Run 8227: SemiIntFast configuration (only readout of FADC, Blocklevel = 1) , Deadtime = 17% at 5.1 kHz.

III. Run 8228: SemiIntBlock configuration (only readout of FADC, Blocklevel = 50) , Deadtime = 1% at 5.1 kHz.

Learn how to
unblock and analyze