

Mott DAQ Speed

December 17, 2014

How to speedup DAQ

- I. Reject low-energy electrons:
 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
 - Add block readout
- FADC has a mode with time readout: Pulse Integral and High Resolution Time Mode
- We took data with this mode ... results are shown next ...

Comparison of:

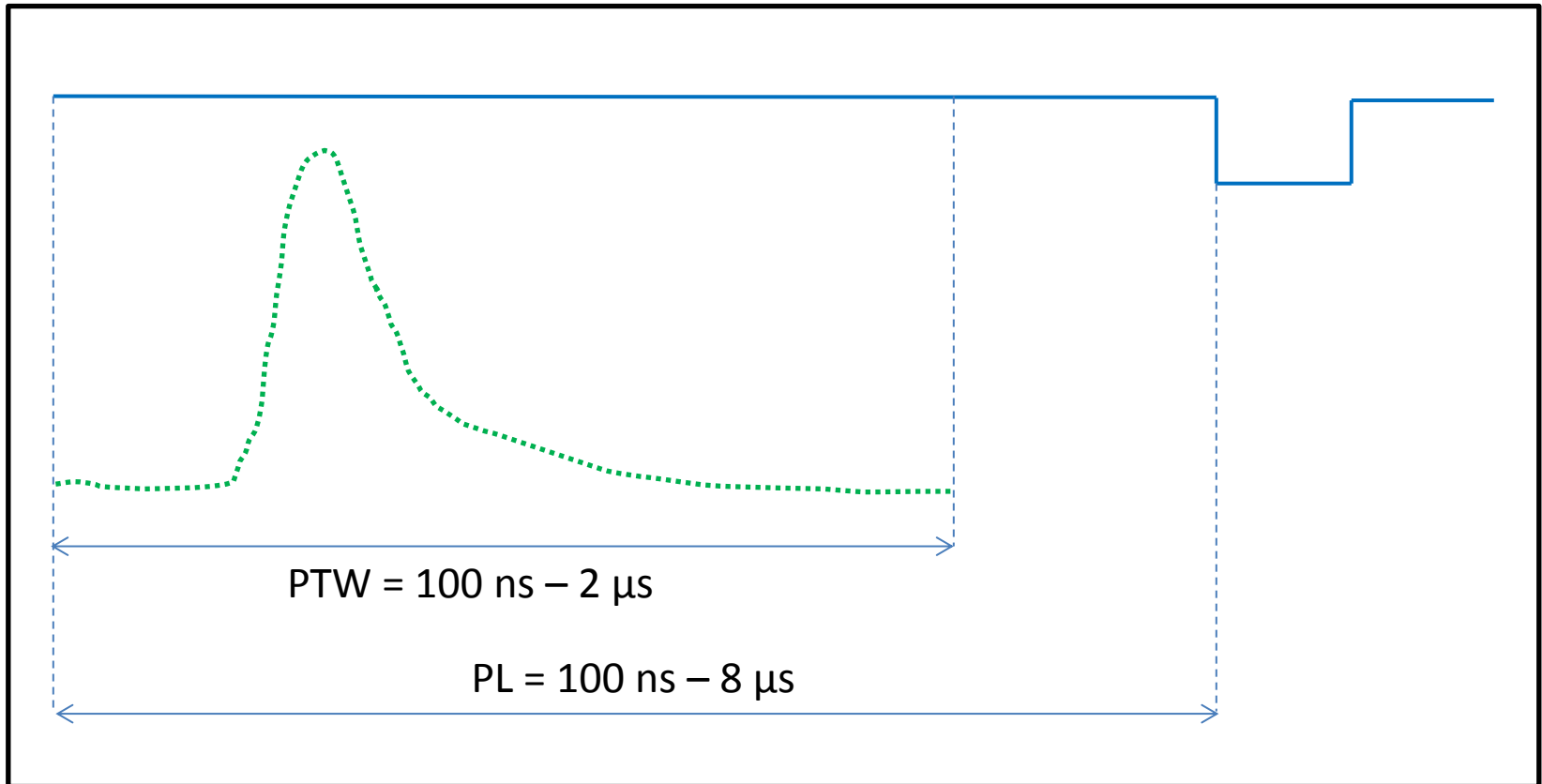
Raw ADC Data Samples Mode

vs.

Pulse Integral and High Resolution Time
Mode

**RAW ADC DATA SAMPLES – RUN
7673**

Raw ADC Data Samples



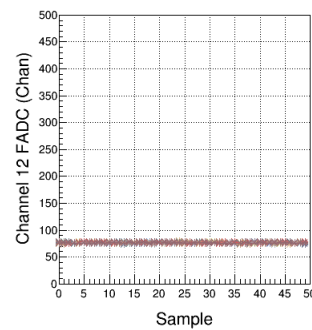
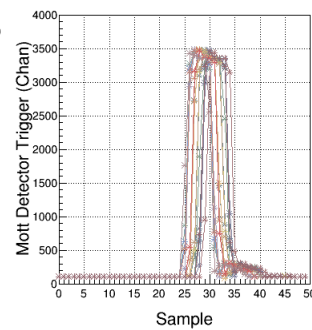
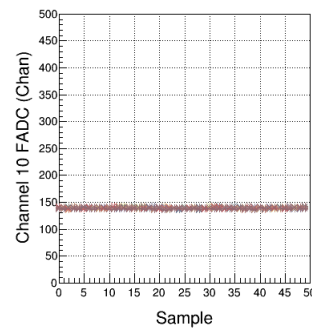
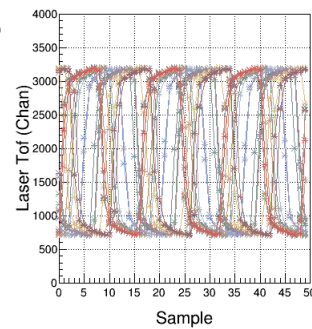
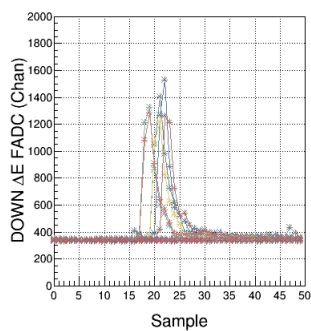
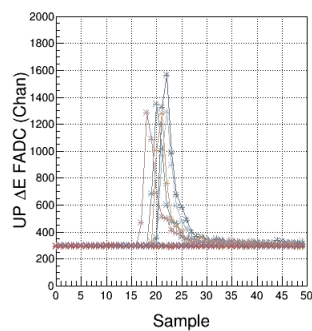
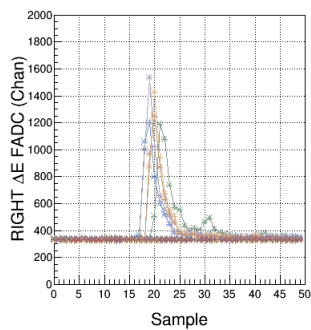
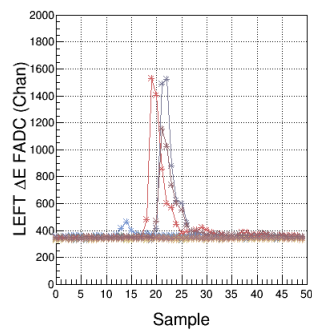
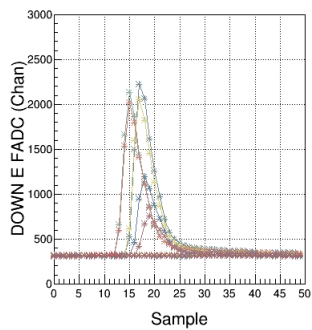
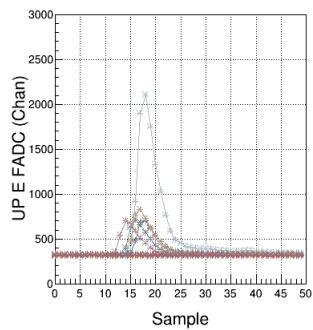
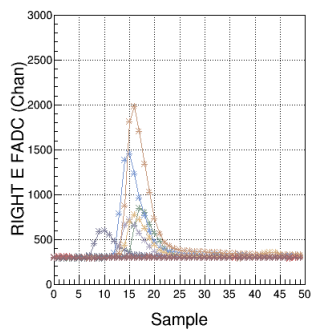
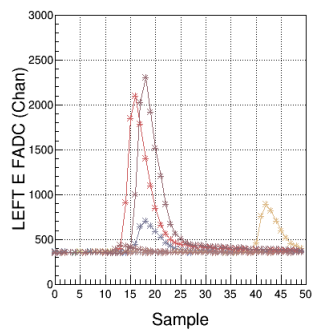
Mott Settings:

- 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})

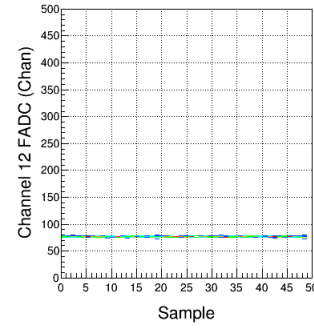
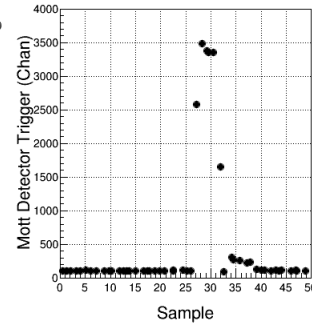
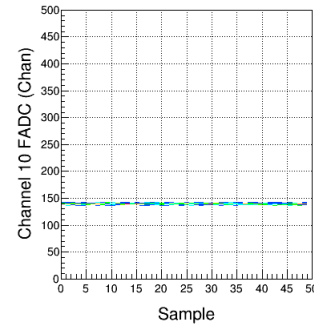
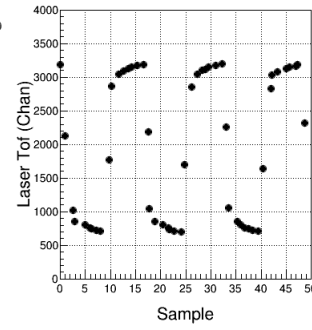
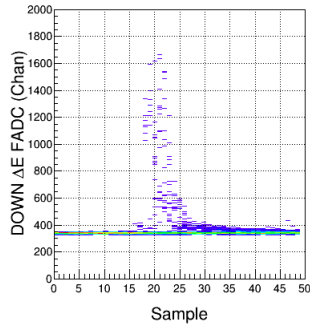
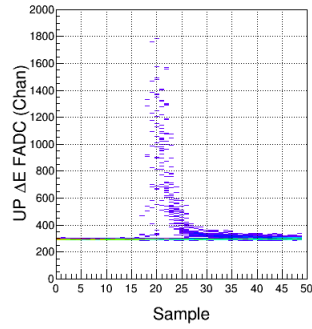
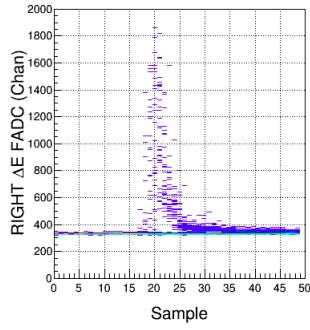
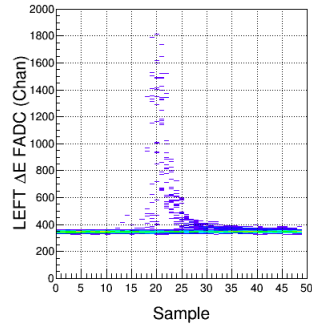
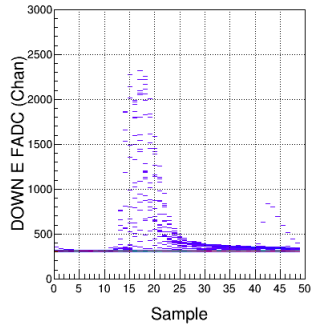
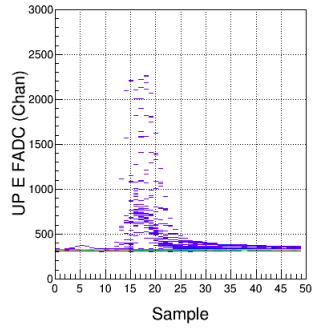
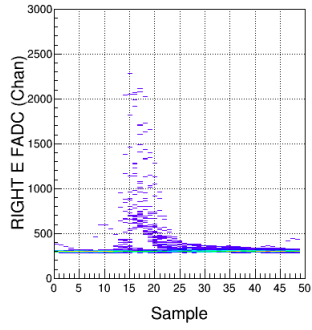
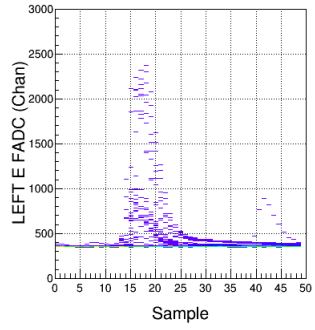
Mott Readout:

- I. 50 samples

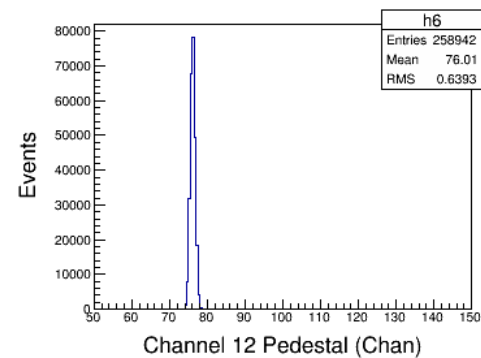
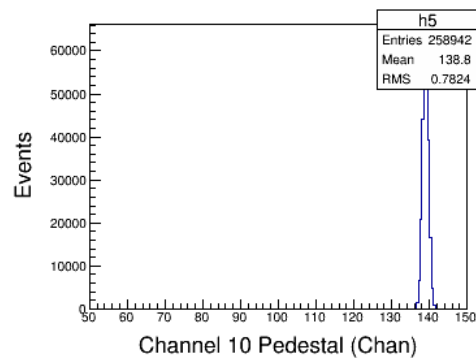
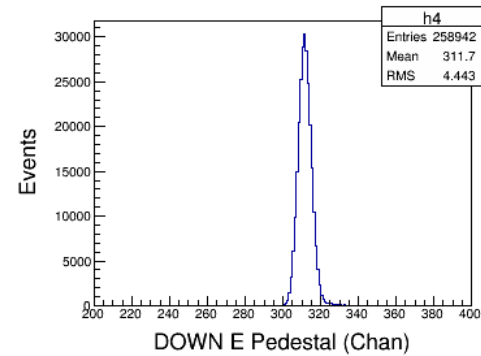
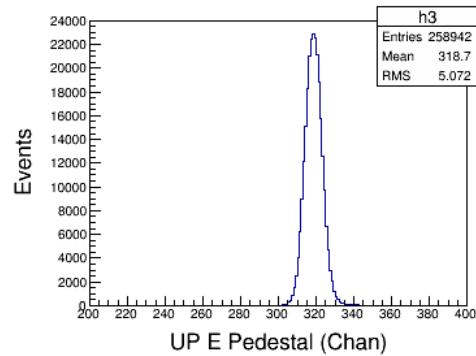
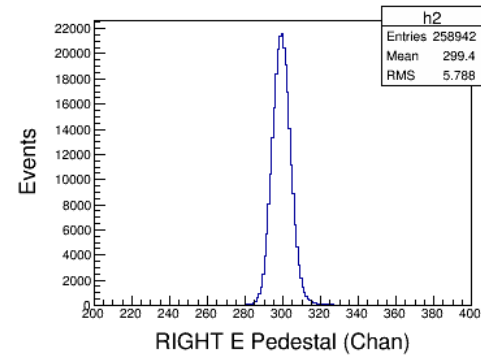
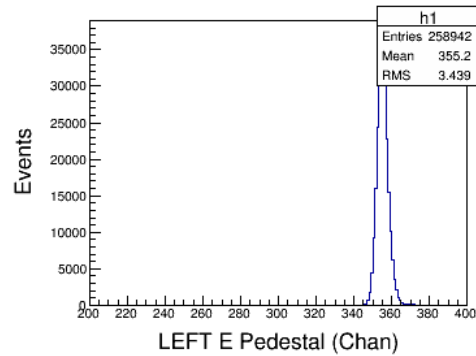
Samples



Samples

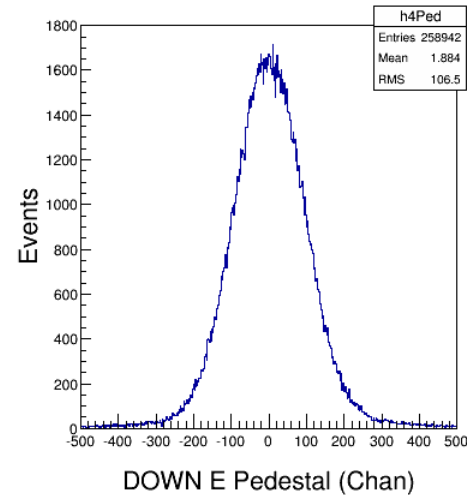
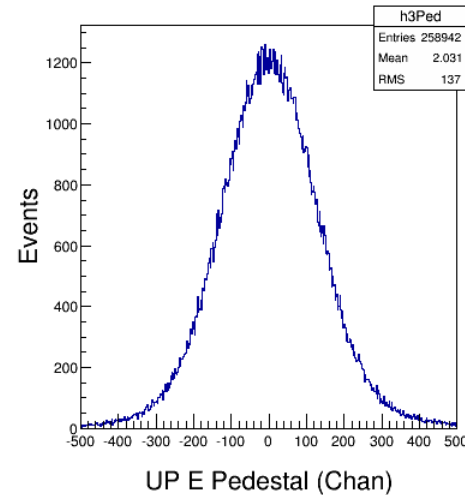
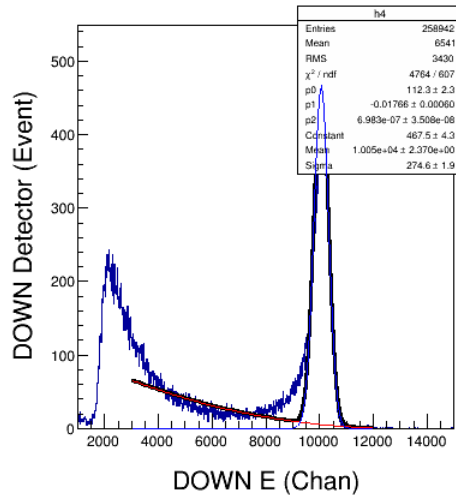
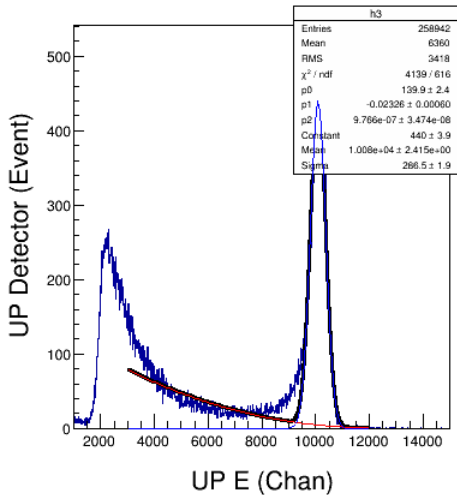
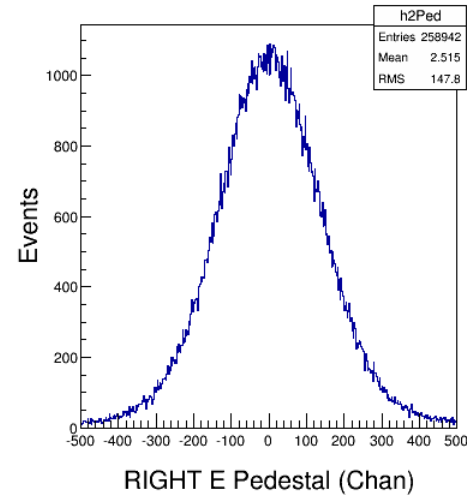
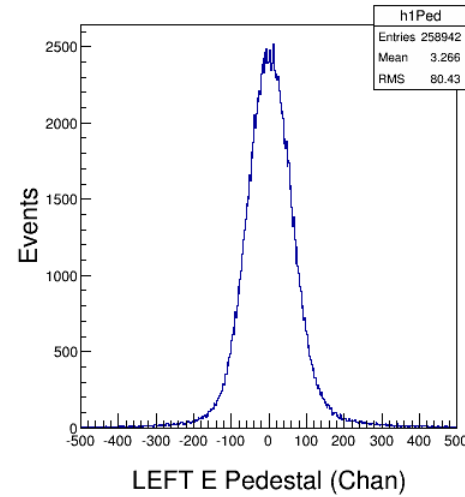
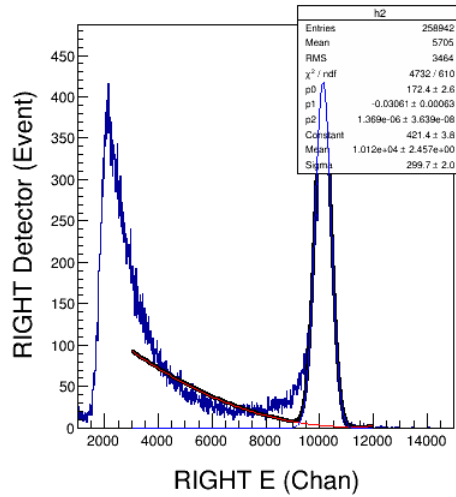
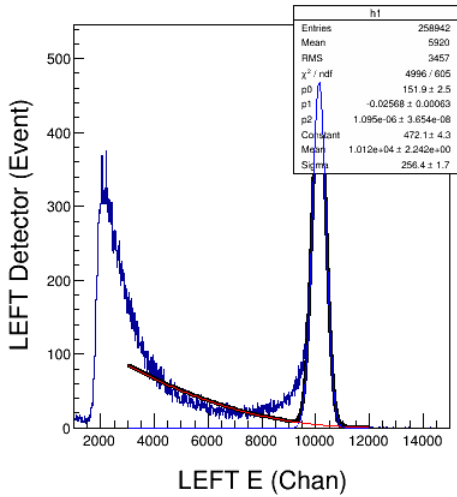


Analysis: Pedestals

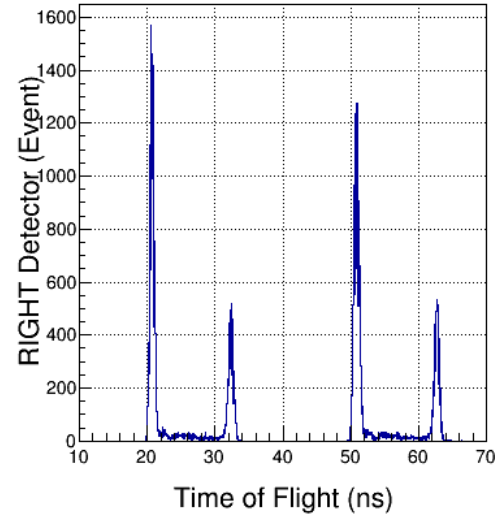
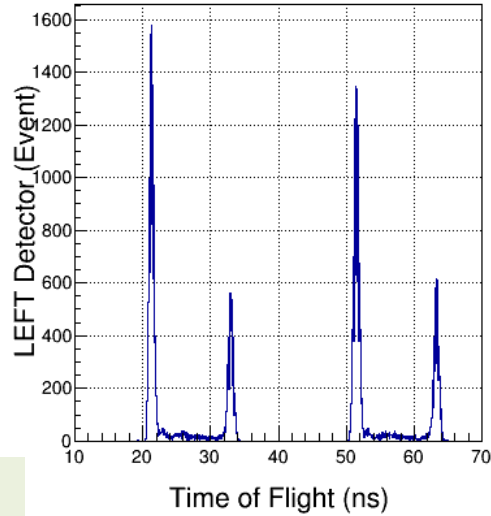


Analysis: Energy

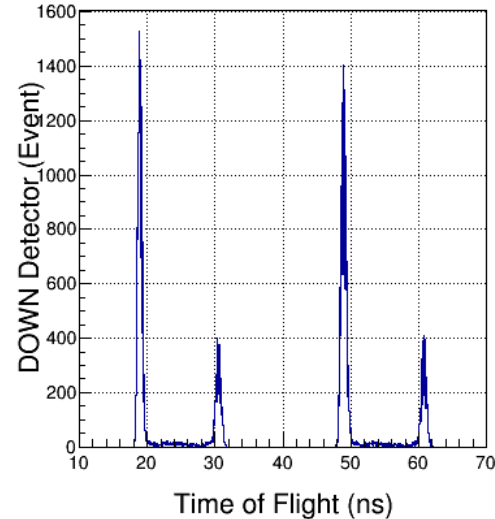
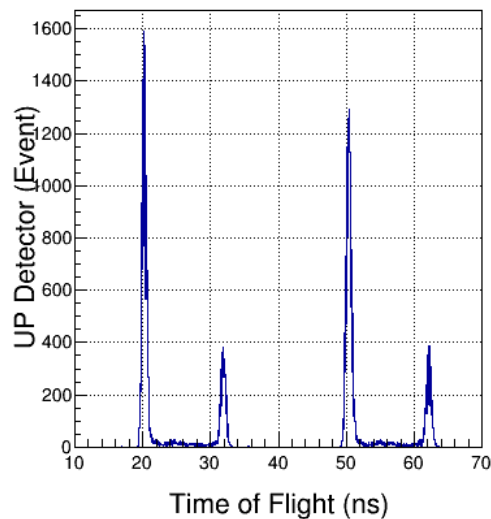
$$\sigma_E \sim 2.7\%$$



Analysis: Time-of-flight

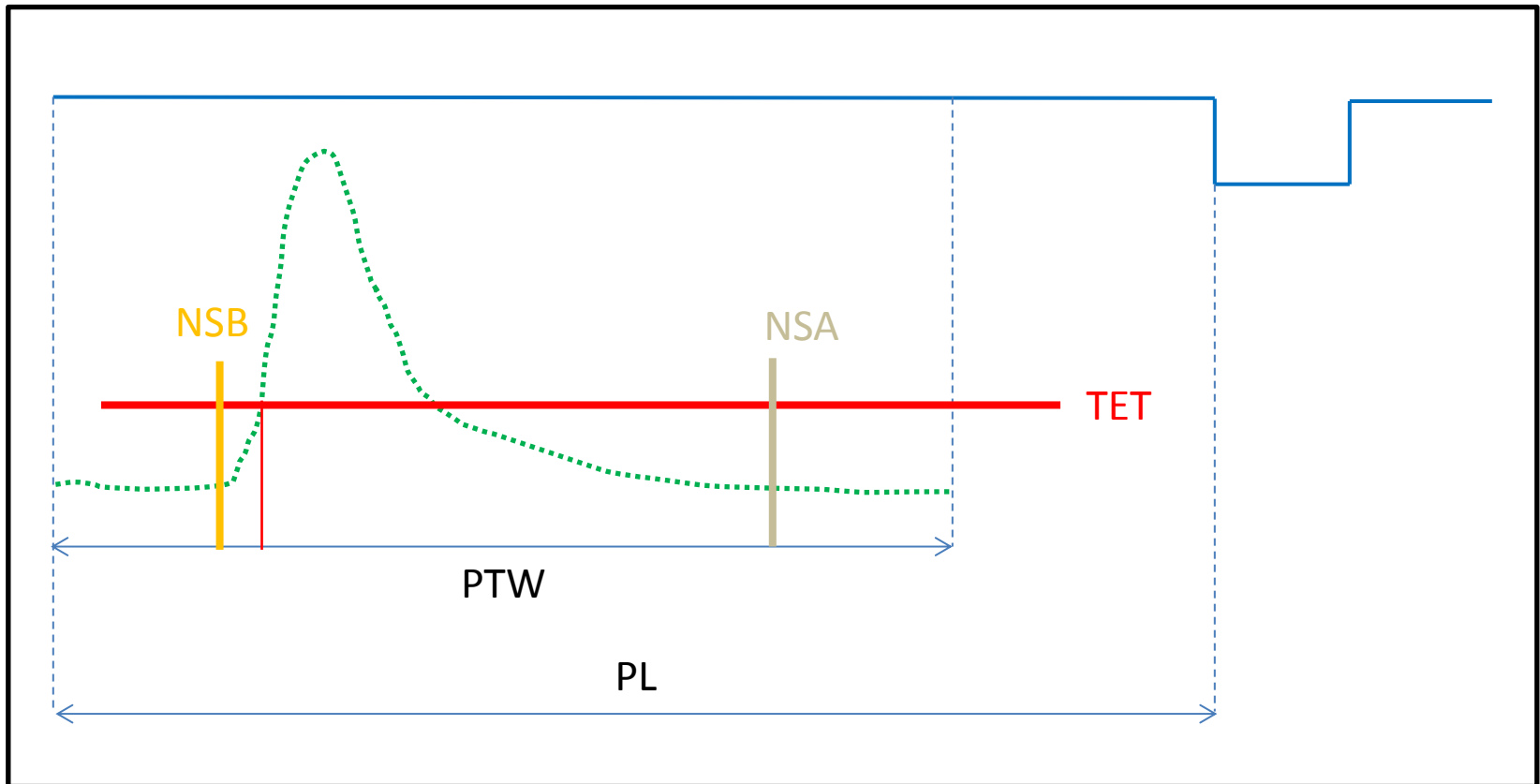


$$\sigma_t \sim 0.2 \text{ ns}$$



**PULSE INTEGRAL AND HIGH
RESOLUTION TIME – RUN 7672, 7642**

Pulse Integral & High Resolution Time



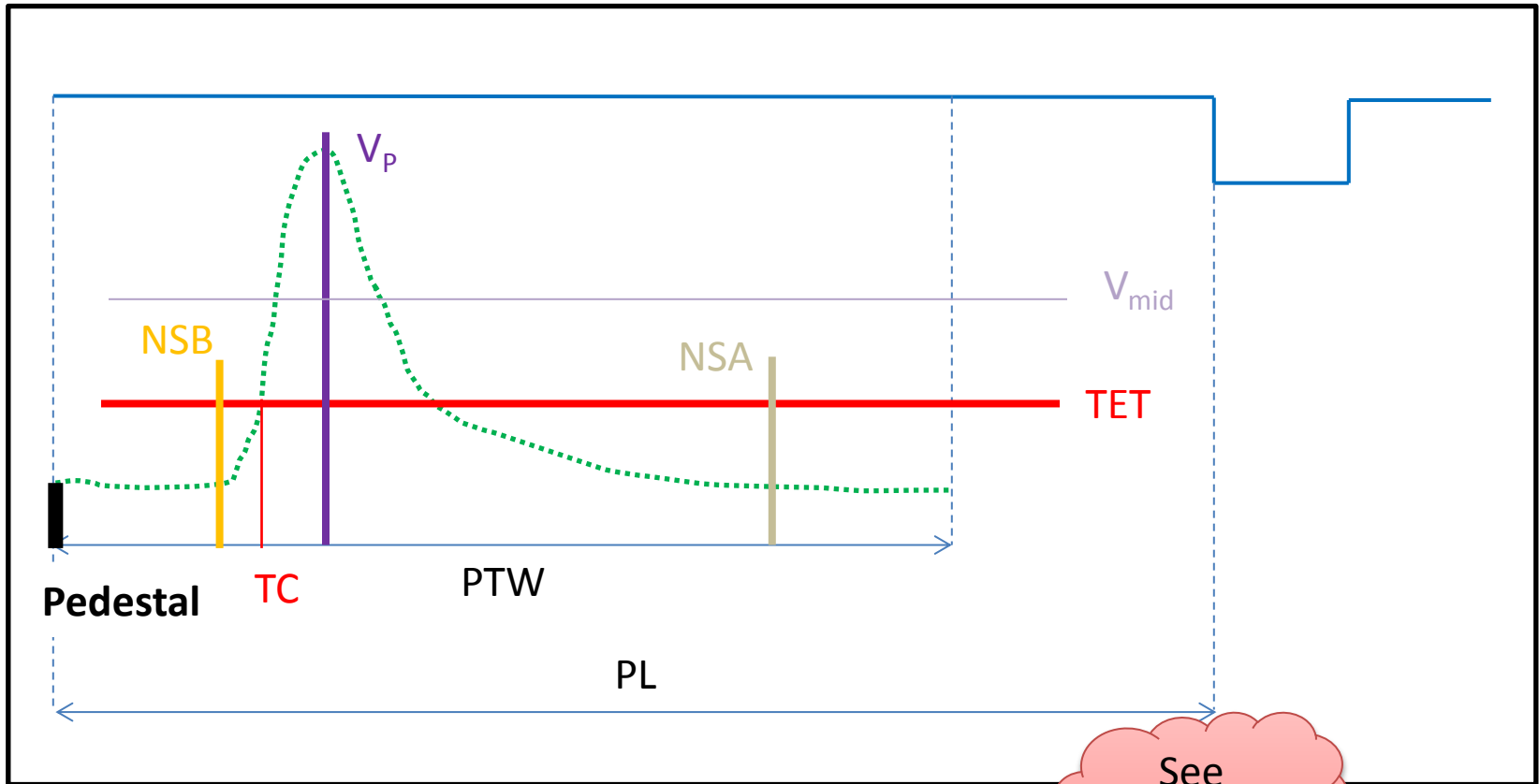
Mott Settings:

- 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



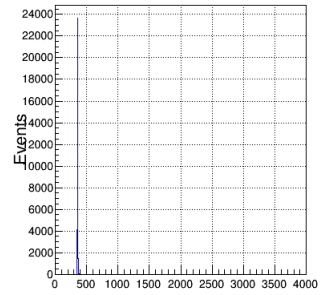
Mott Readout:

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

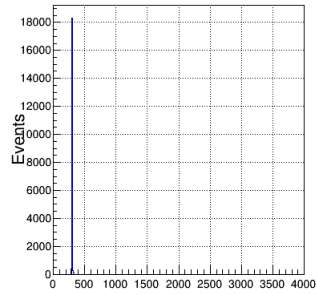
See
Note 1

See
Note 2

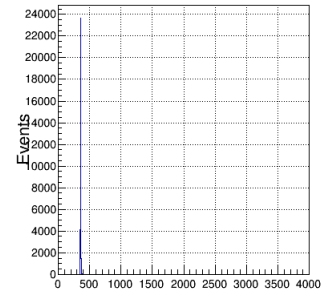
Pulse Pedestal



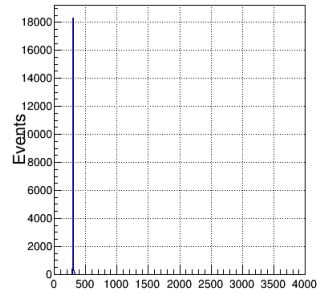
Pedestal - LEFT E (Chan)



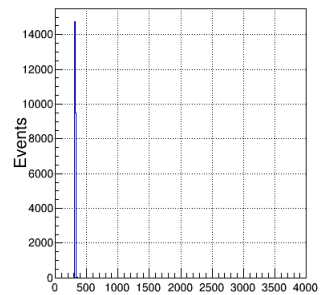
Pedestal - RIGHT E (Chan)



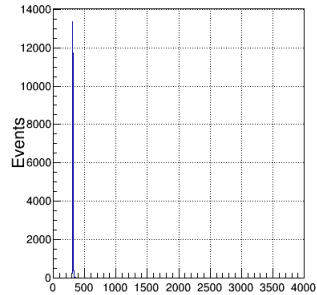
Pedestal - LEFT E (Chan)



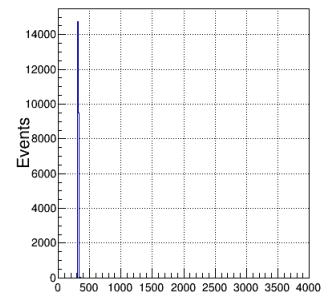
Pedestal - RIGHT E (Chan)



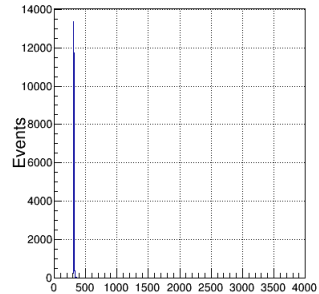
Pedestal - UP E (Chan)



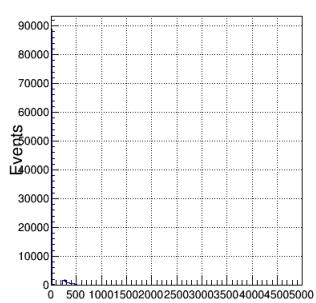
Pedestal - DOWN E (Chan)



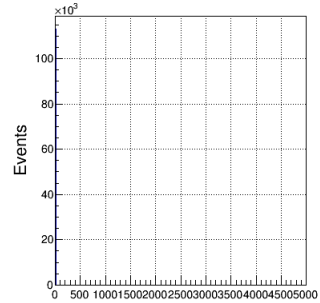
Pedestal - UP E (Chan)



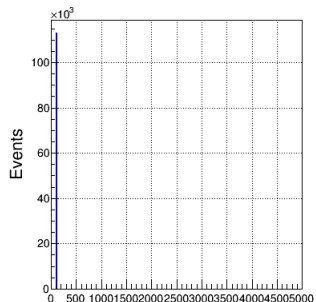
Pedestal - DOWN E (Chan)



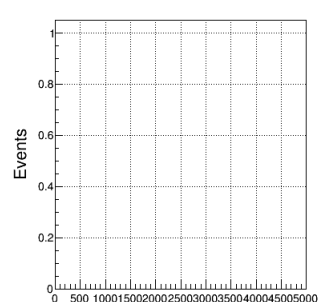
Pedestal - Laser ToF (Chan)



Pedestal - Channel 10 (Chan)

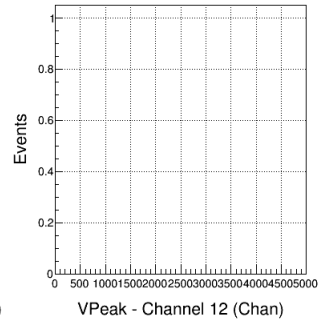
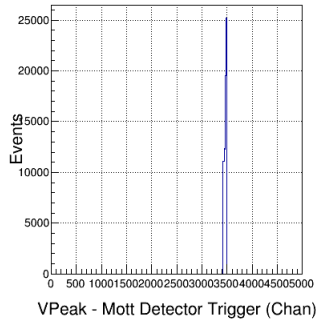
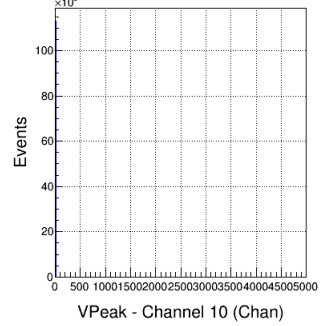
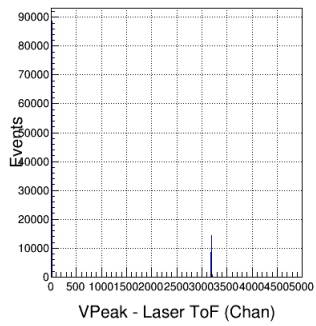
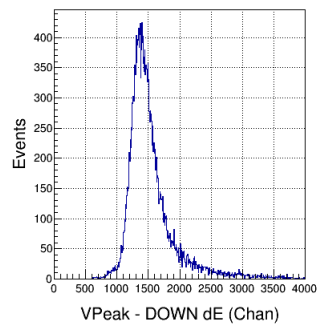
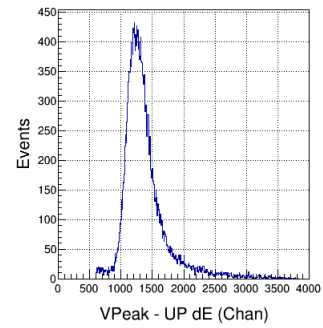
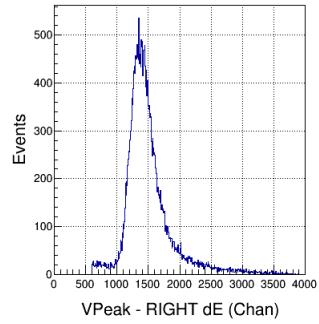
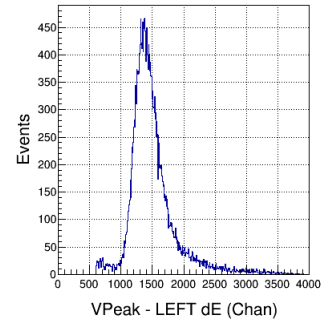
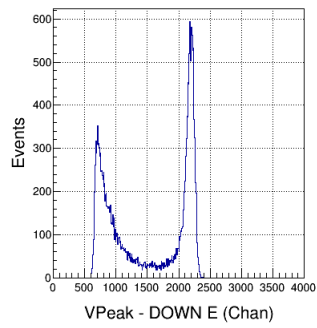
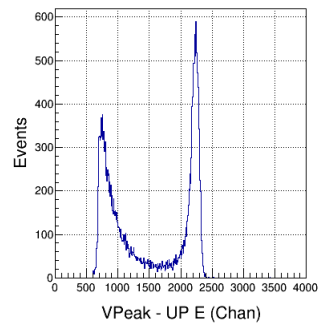
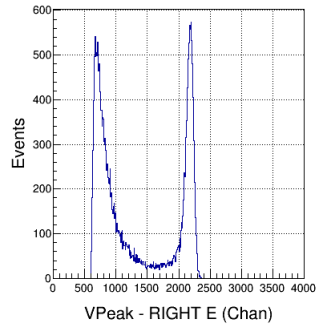
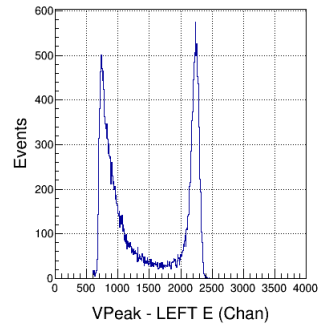


Pedestal - Mott Detector Trigger (Chan)

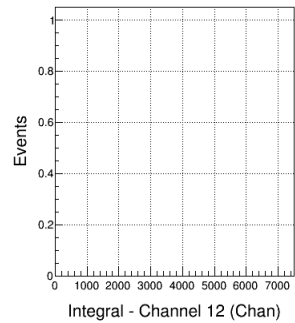
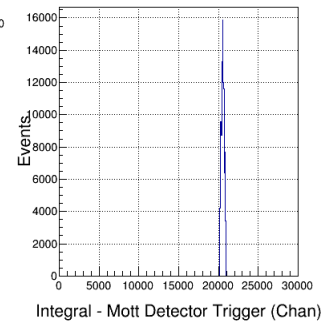
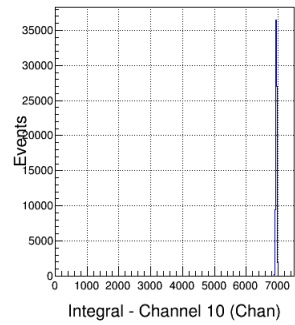
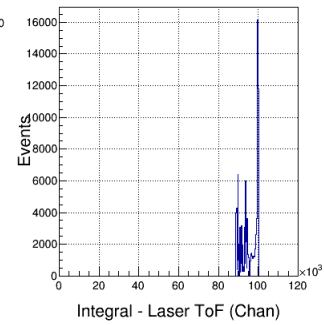
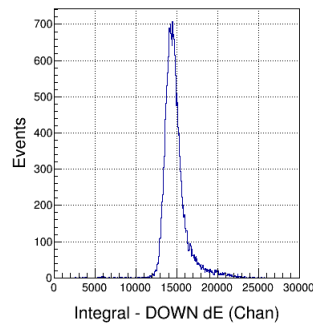
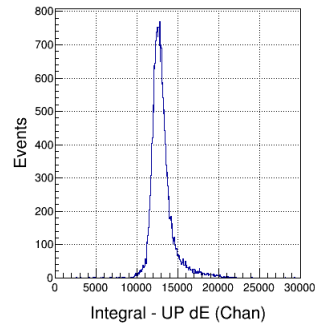
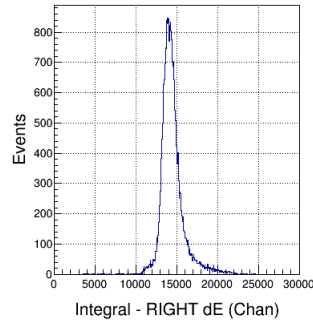
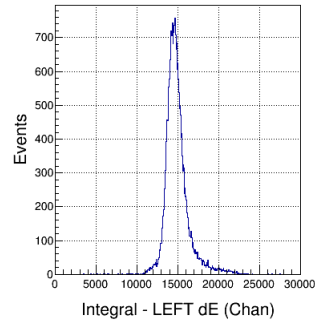
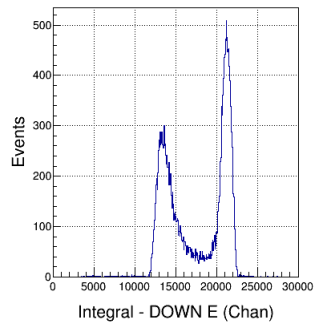
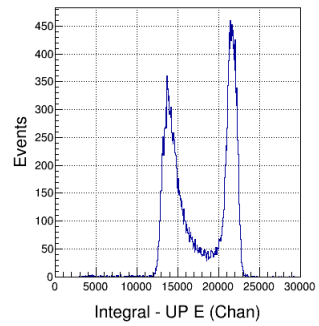
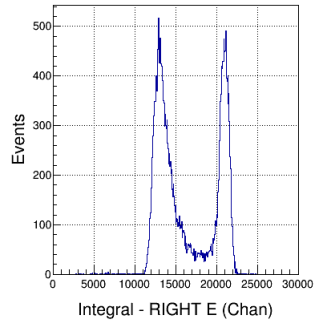
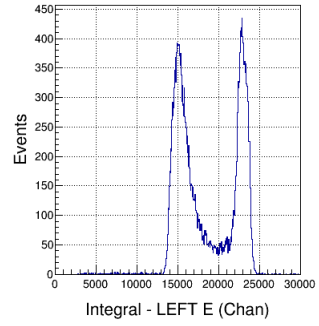


Pedestal - Channel 12 (Chan)

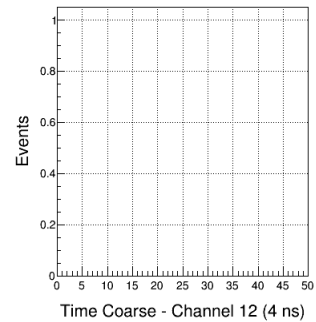
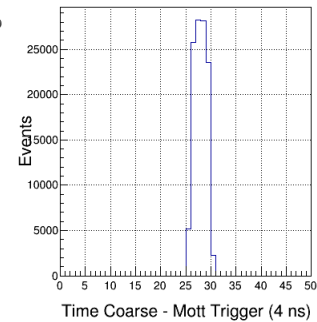
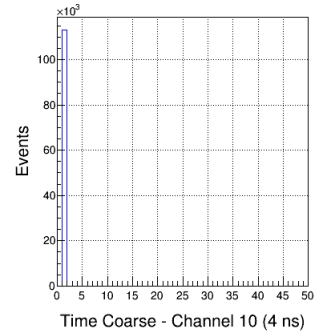
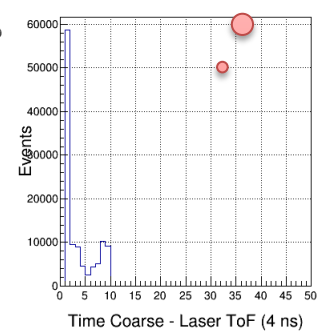
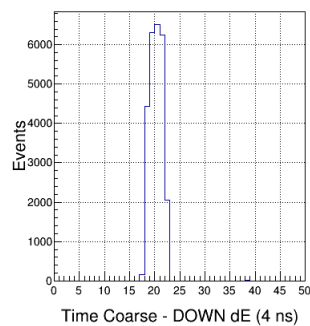
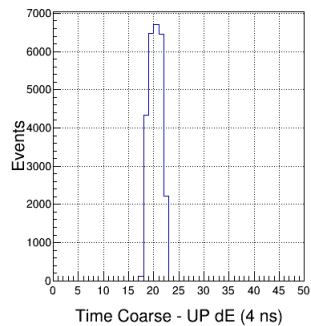
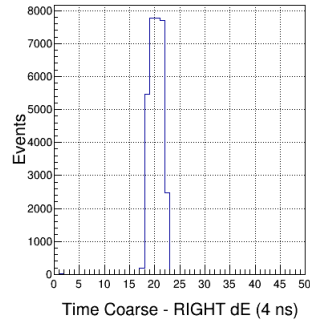
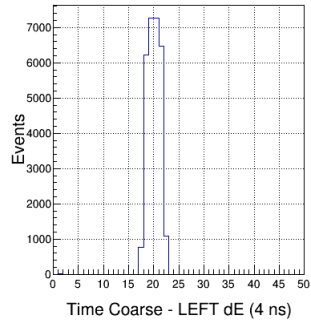
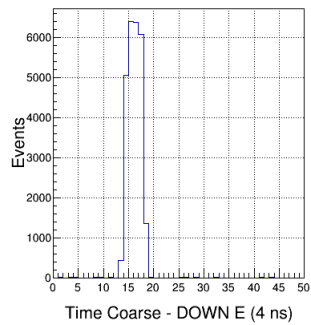
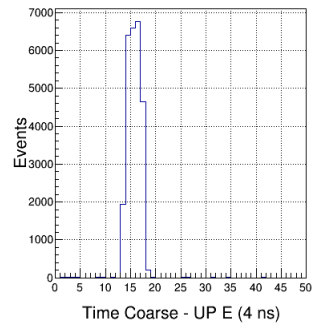
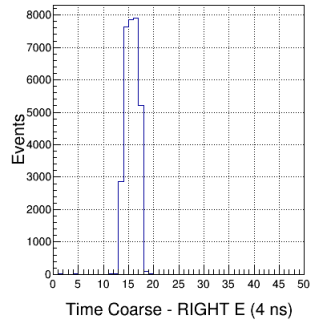
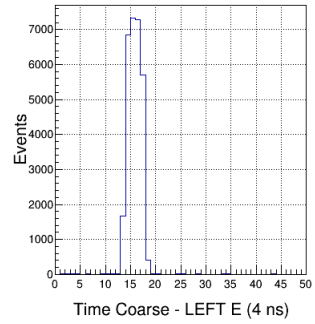
Pulse Peak Value (VP)



Pulse Integral

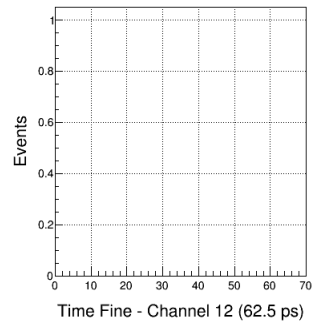
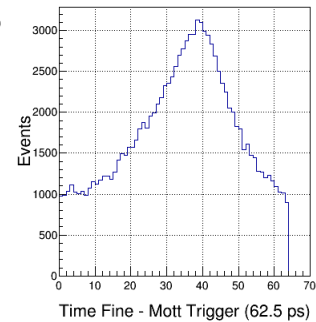
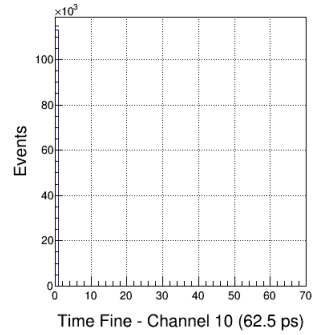
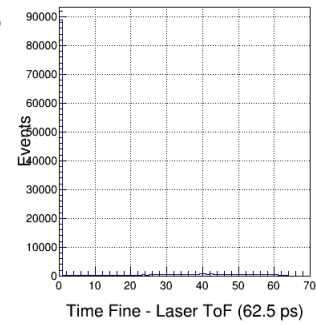
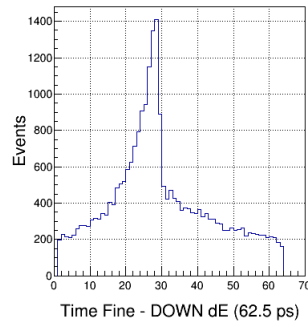
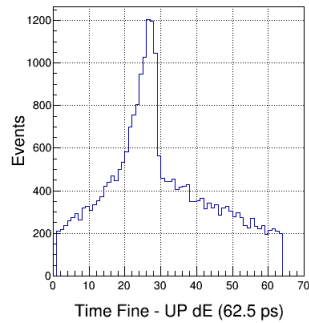
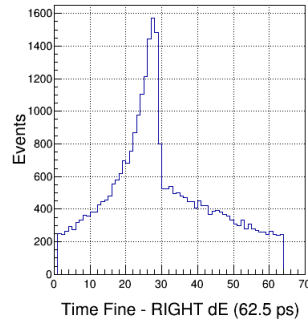
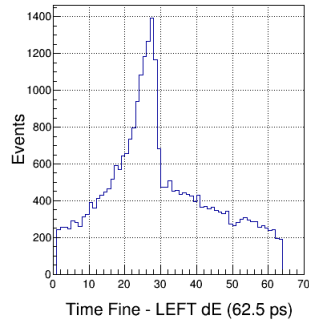
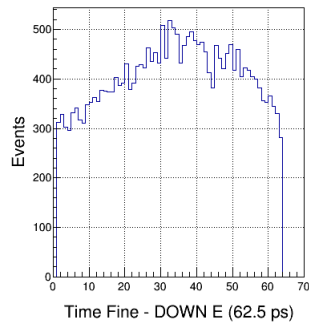
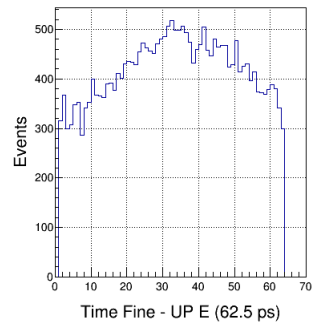
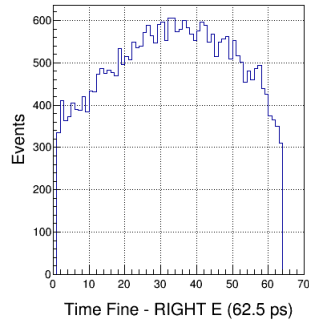
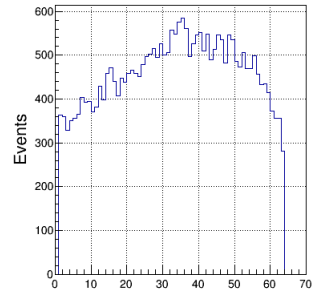


Pulse Coarse Time

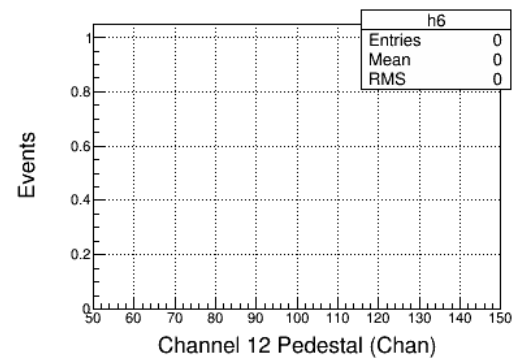
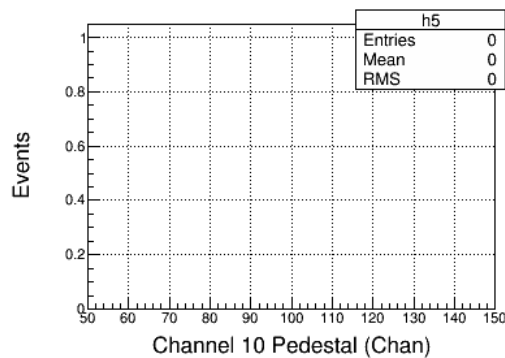
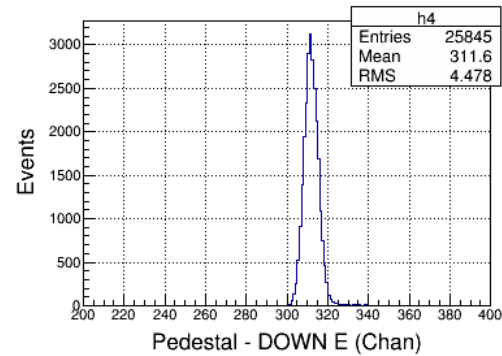
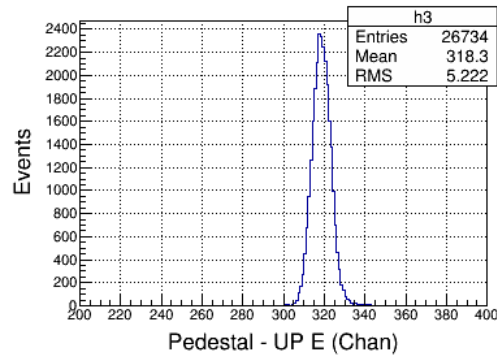
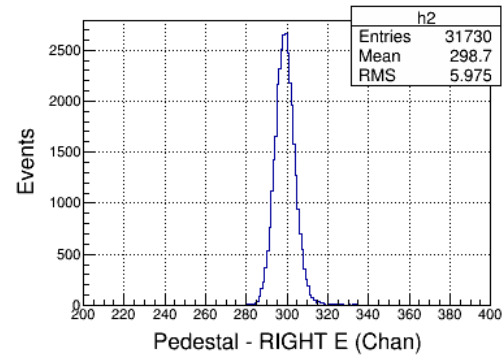
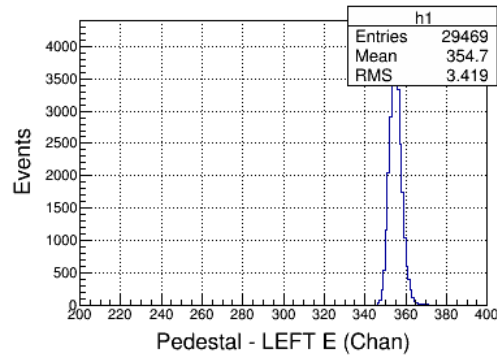


See Note 3

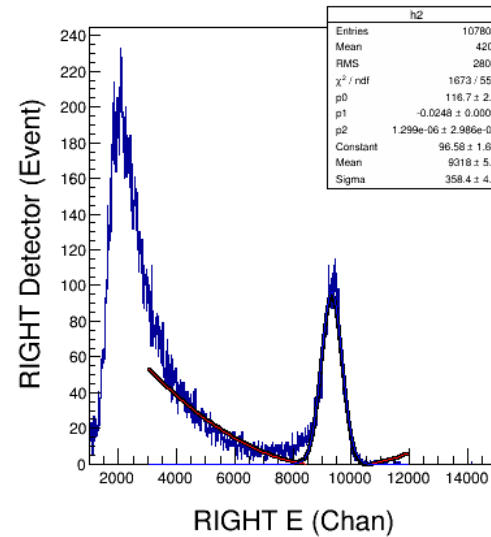
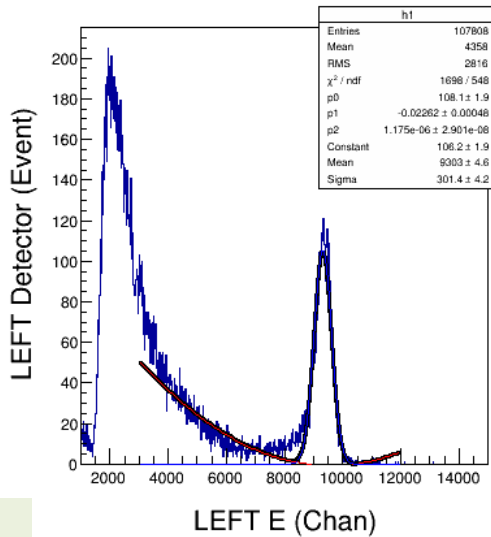
Pulse Fine Time



Analysis: Pedestals



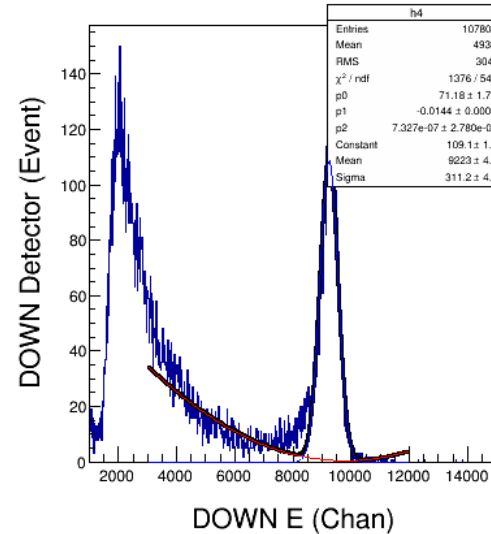
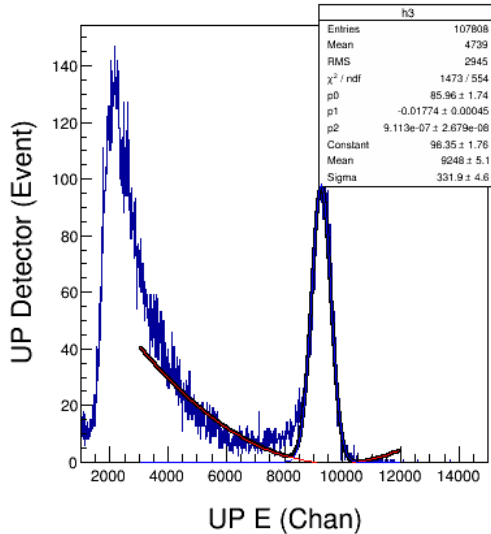
Analysis: Energy



- Energy from run 7642
- Pedestal from run 7672

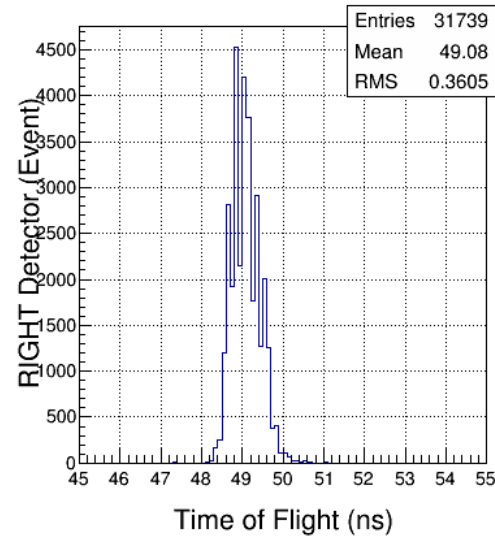
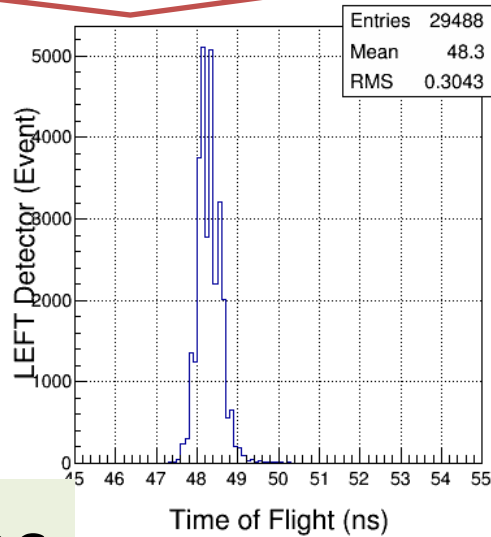
$\sigma_E \sim 3.2\%$

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

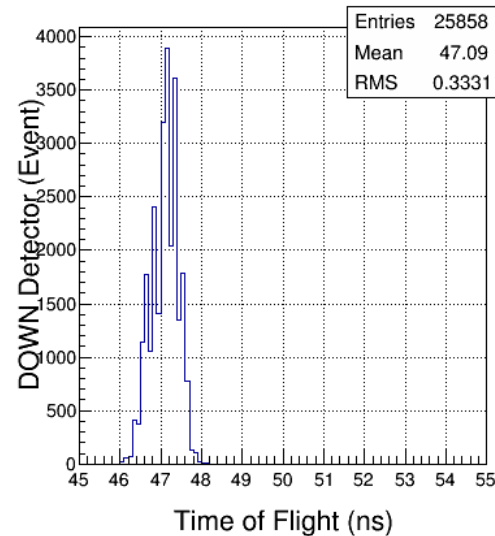
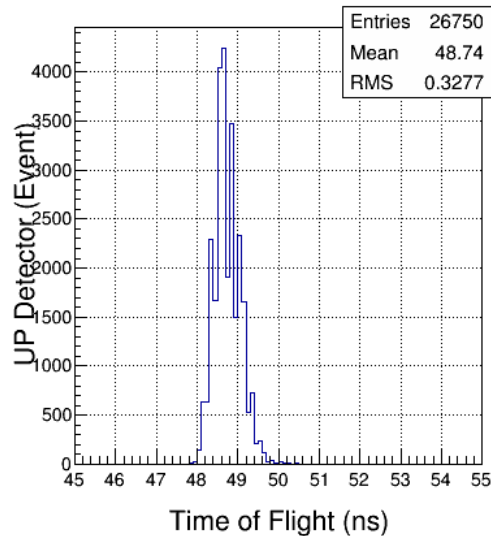


Analysis: Self Timing Peak

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

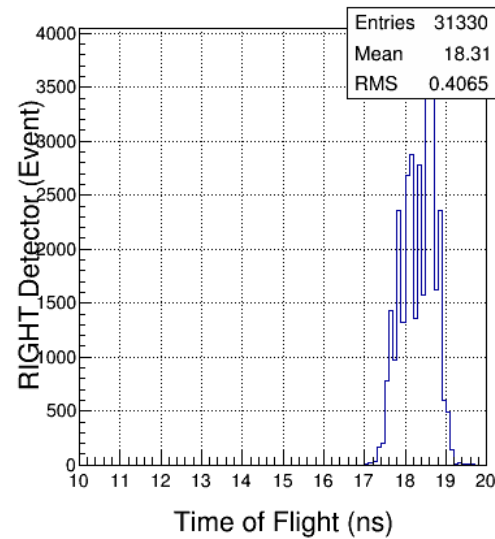
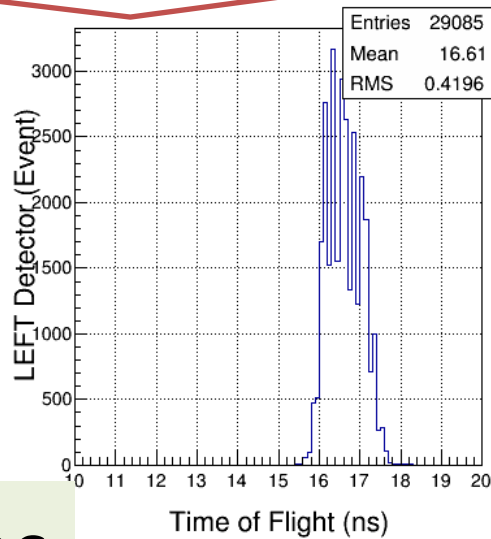


$$\sigma_t \sim 0.33 \text{ ns}$$

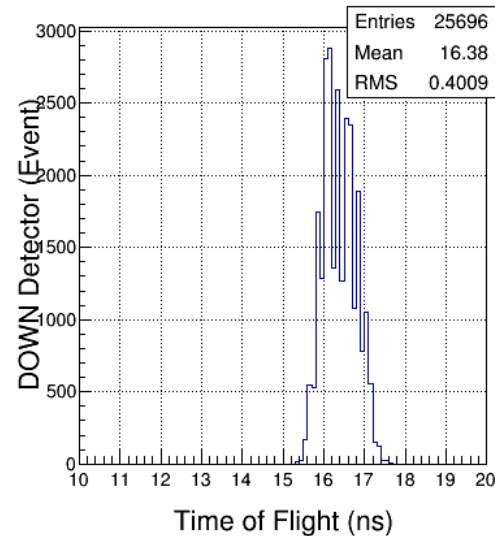
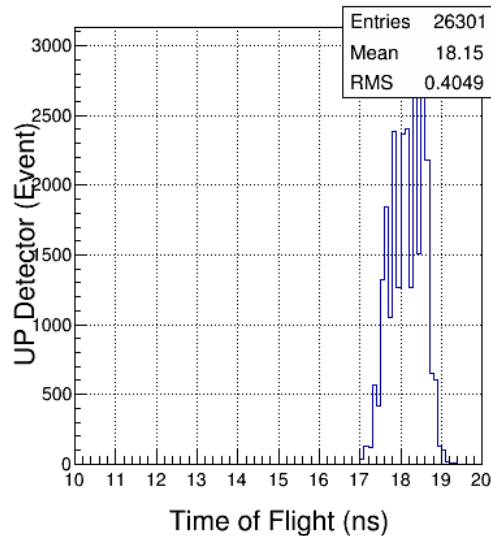


Analysis: E-dE Timing Peak

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

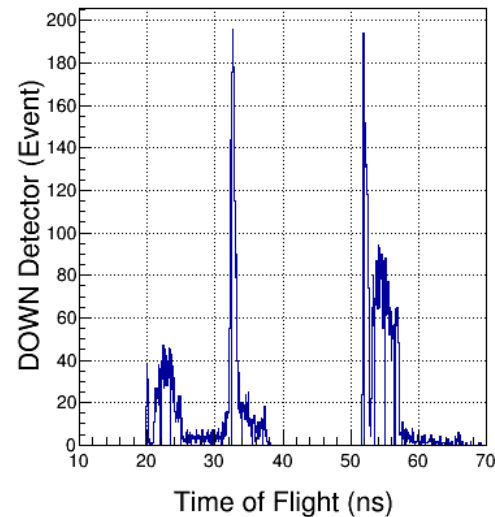
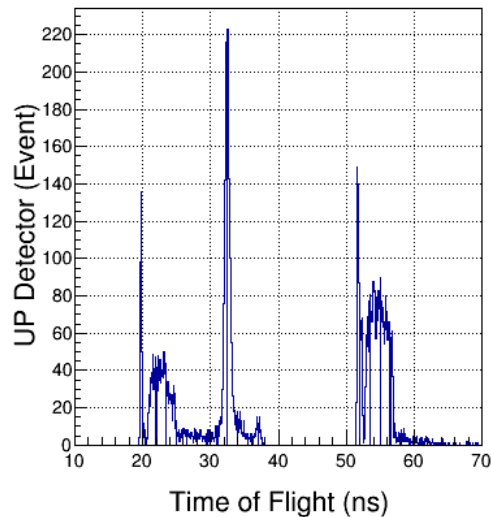
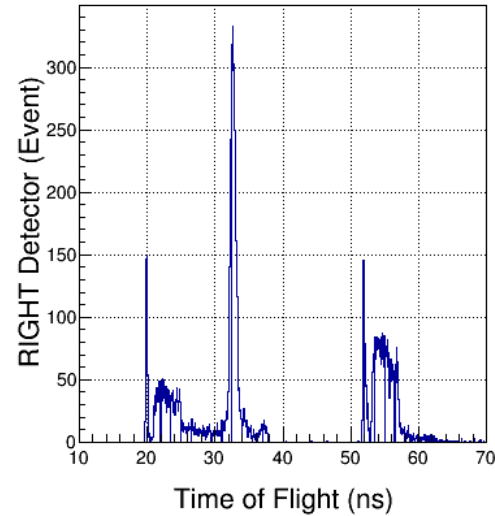
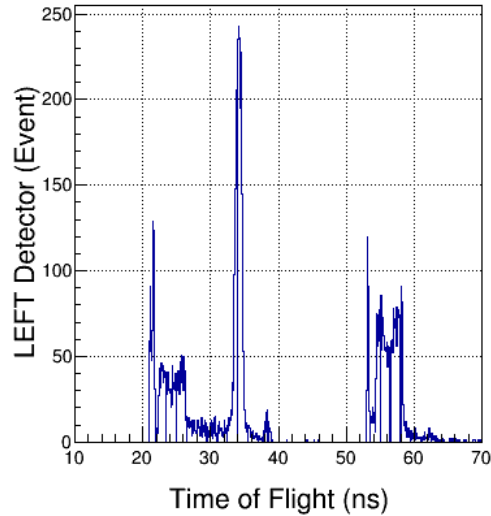


$$\sigma_t \sim 0.40 \text{ ns}$$



Analysis: Time-of-flight

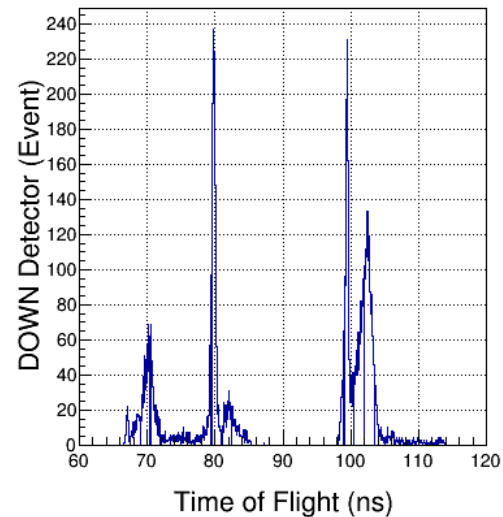
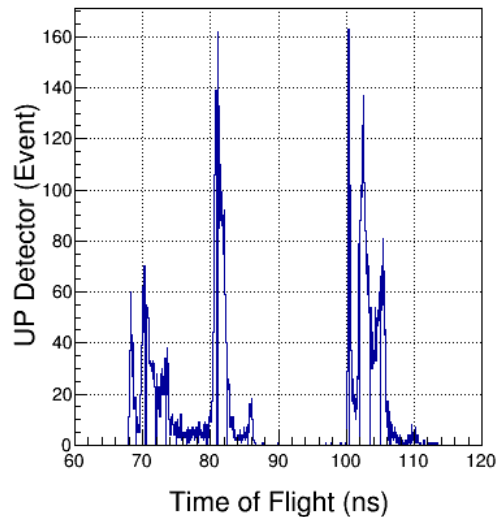
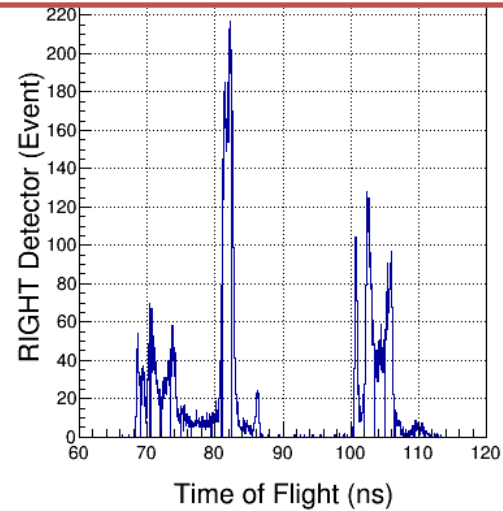
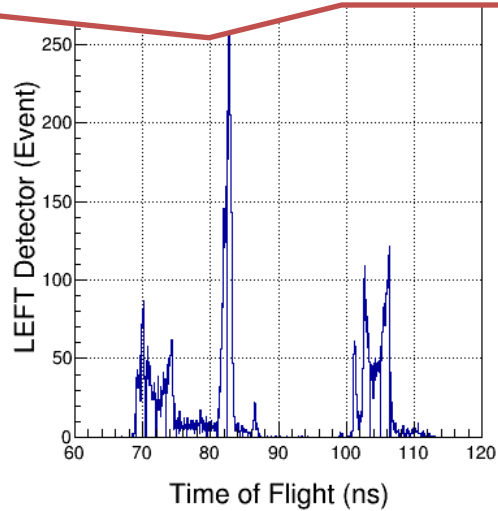
```
T->Draw("(TimeCoarse1*4.0 + TimeFine1*0.0625) - (TimeCoarse9*4.0 + TimeFine9*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse9 >1.0")
```



Use CH1-CH4

Analysis: Time-of-flight

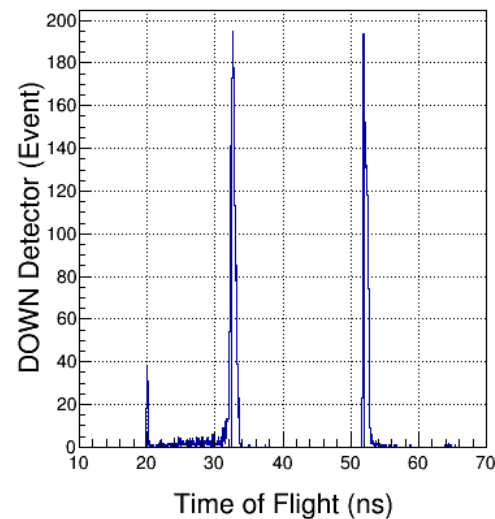
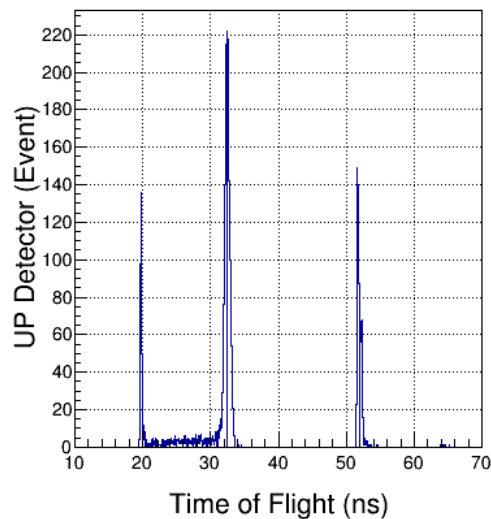
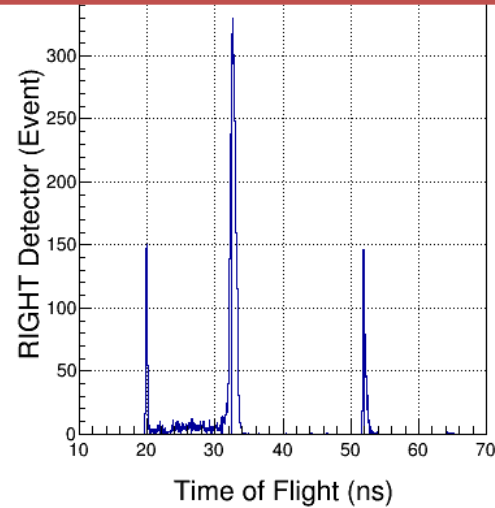
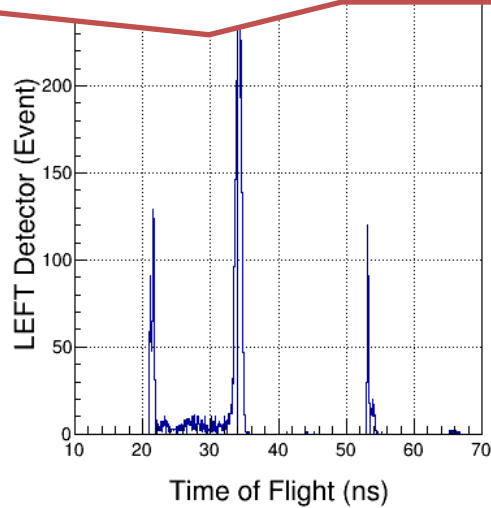
```
T->Draw("(TimeCoarse11*4.0 + TimeFine11*0.0625) - (TimeCoarse9*4.0 + TimeFine9*0.0625) >> h1", "TimeCoarse1>1.0 &&TimeCoarse9 >1.0 ")
```



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

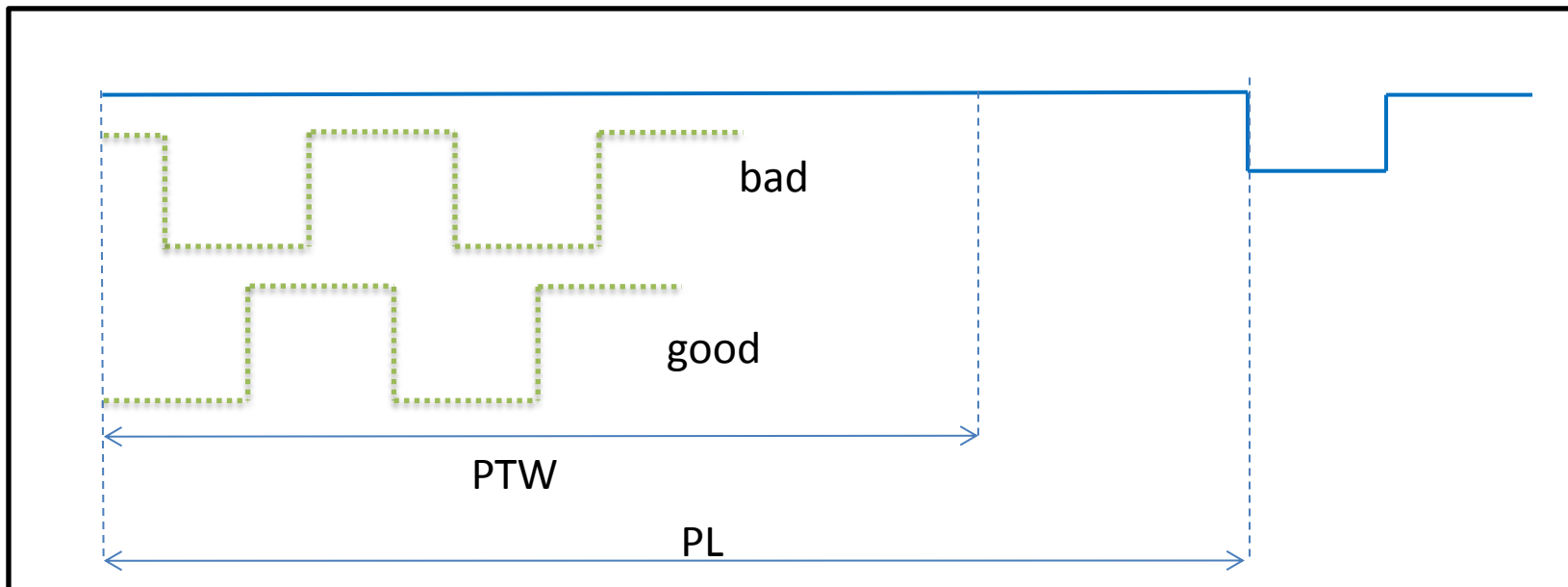
- I. If first sample above threshold then:
course time = 1, fine time = 0, and ped = 0

Note 2

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

Note 3

- I. How FADC deal with a periodic square wave. Solution: add same signal to another channel delayed by $\frac{1}{2}$ 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 $\frac{1}{2}$ period
- What about scalers?
- 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 ...