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

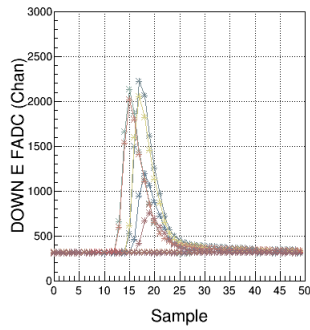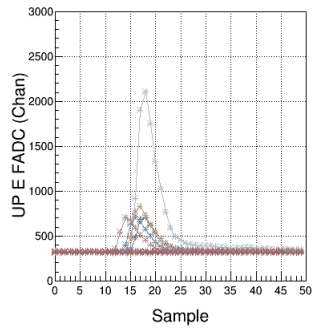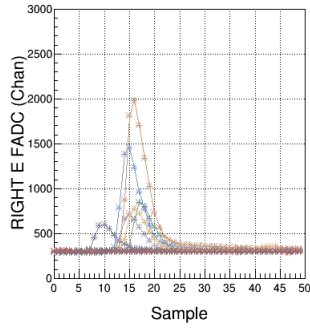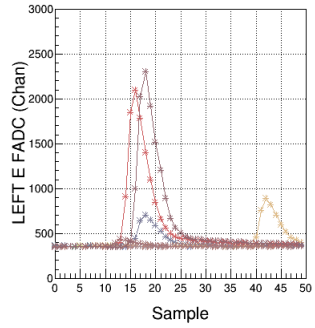# Raw ADC Data Samples

PTW = 100 ns – 2 µs

PL = 100 ns – 8 µs
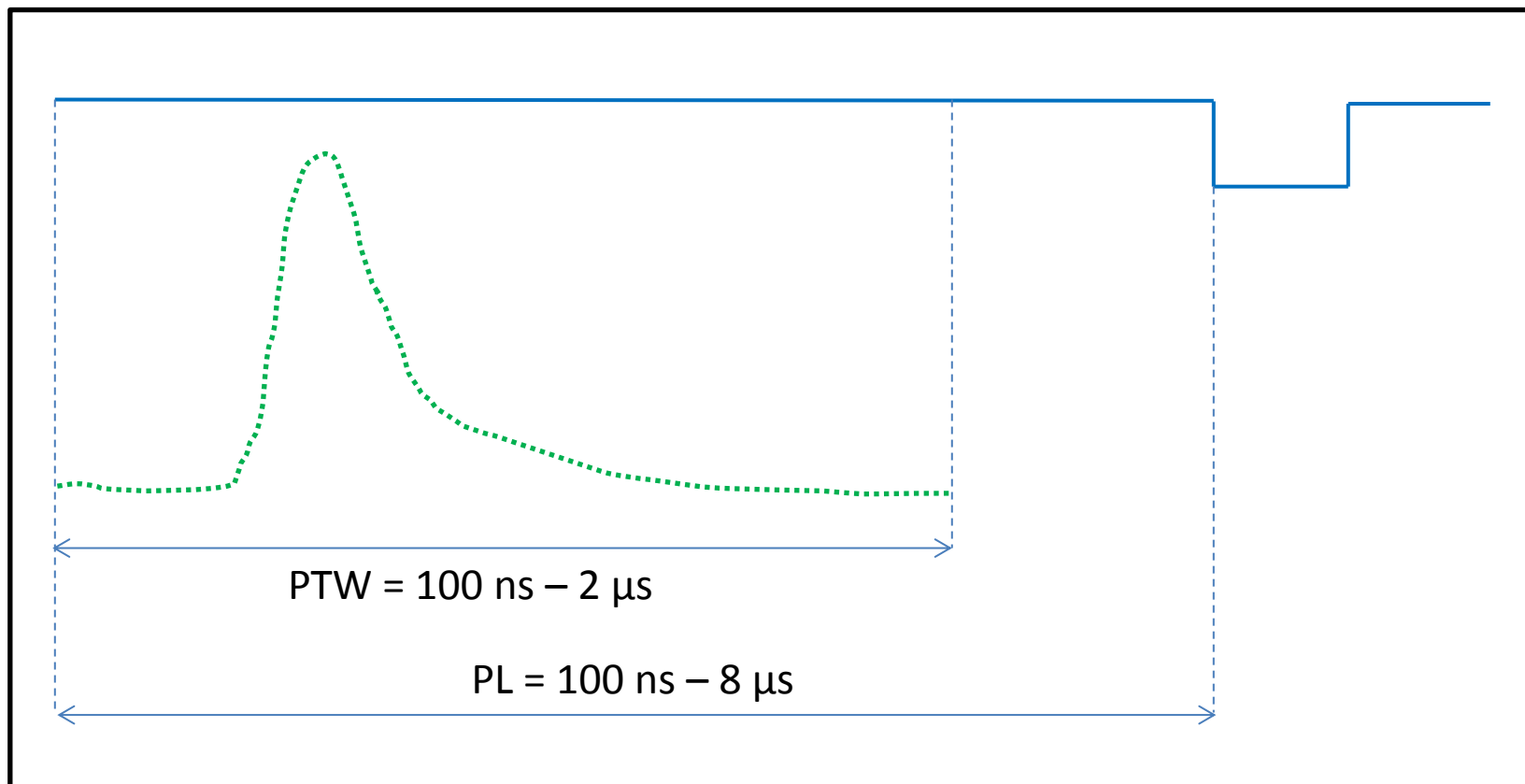
Mott Settings:
I. Programmable Latency (PL) = 60 samples
II. Programmable Trigger Window (PTW) = 50 samples
III. Threshold = 0
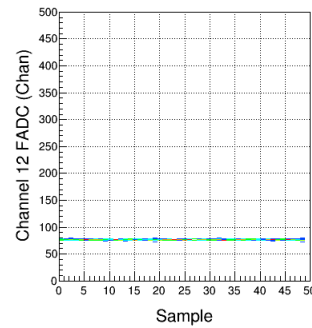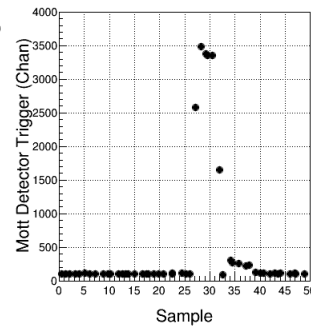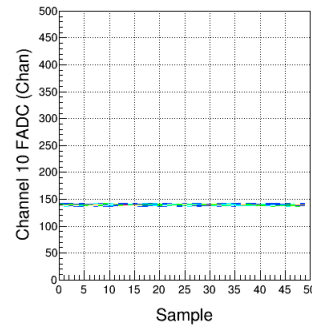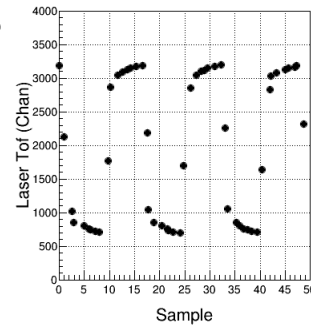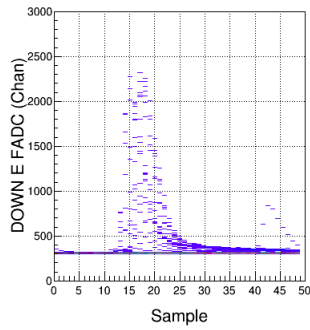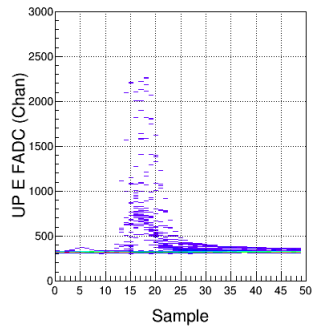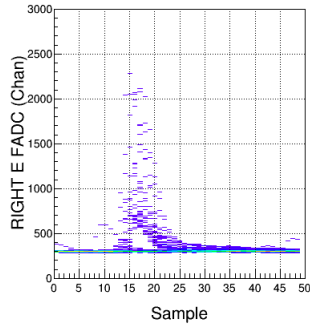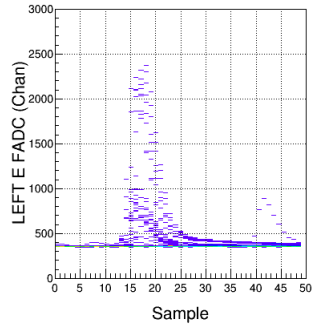IV. Each Sample = 4 ns (250 MHz), 0 – 4096 (2^{12})

Mott Readout:
I. 50 samples

Samples
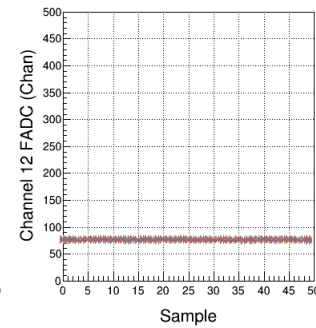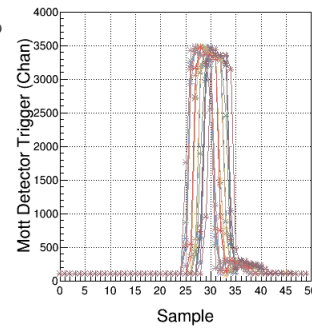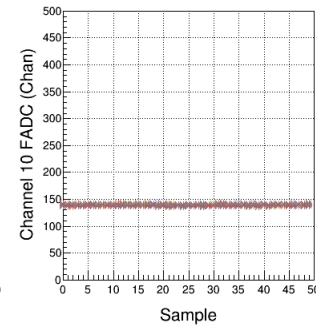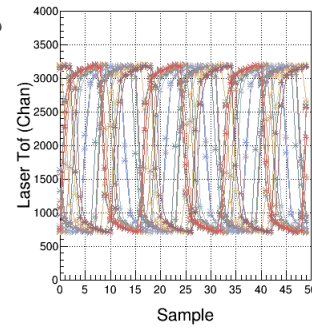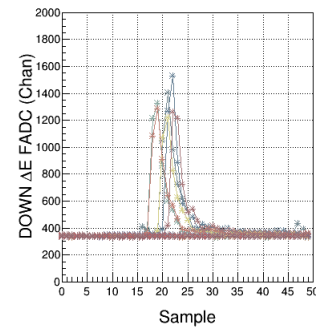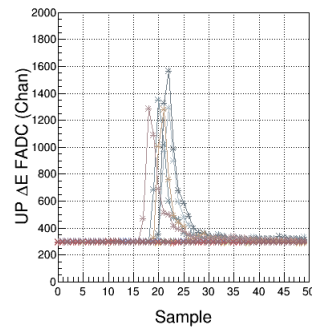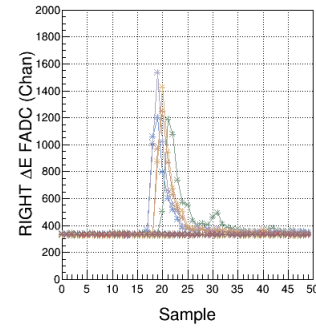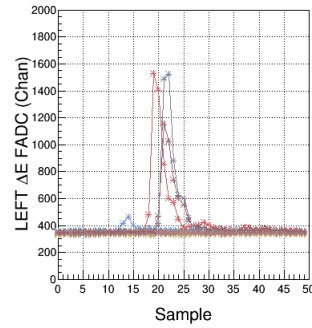
Samples
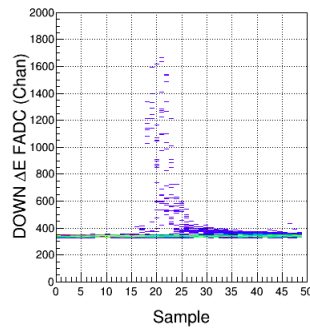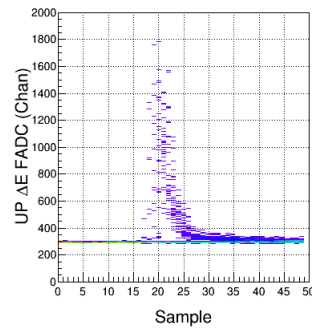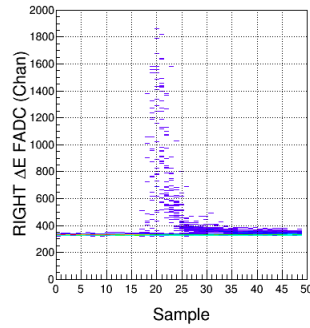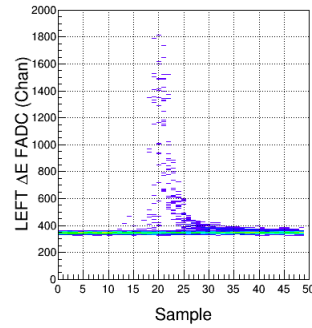
Analysis: Pedestals
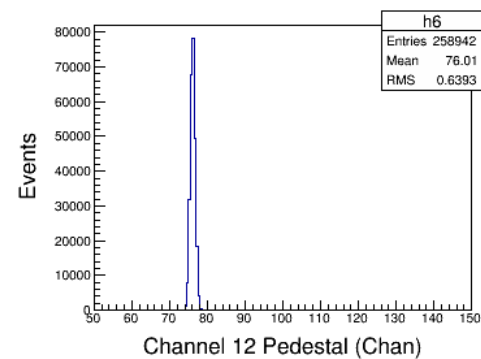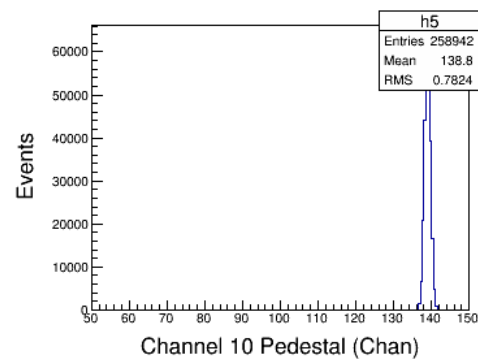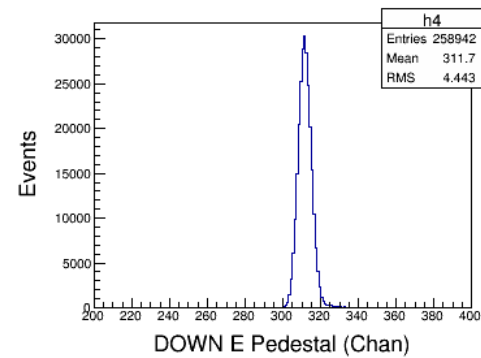
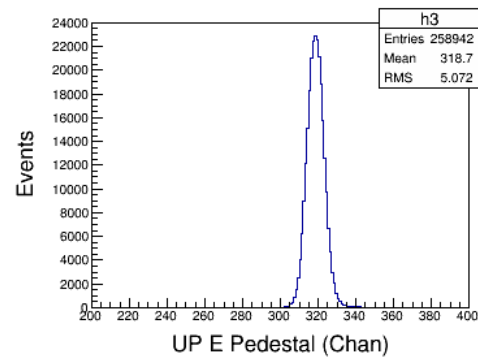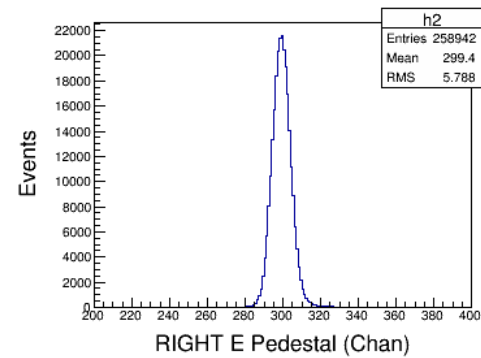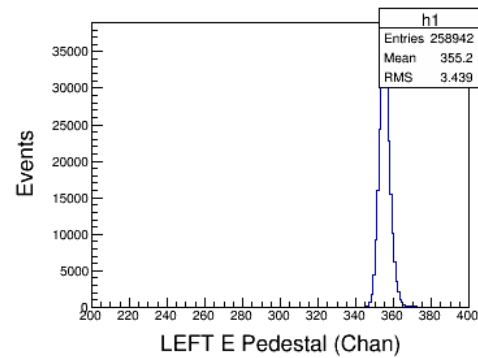# Analysis: Energy

$\sigma_E \sim 2.7\%$
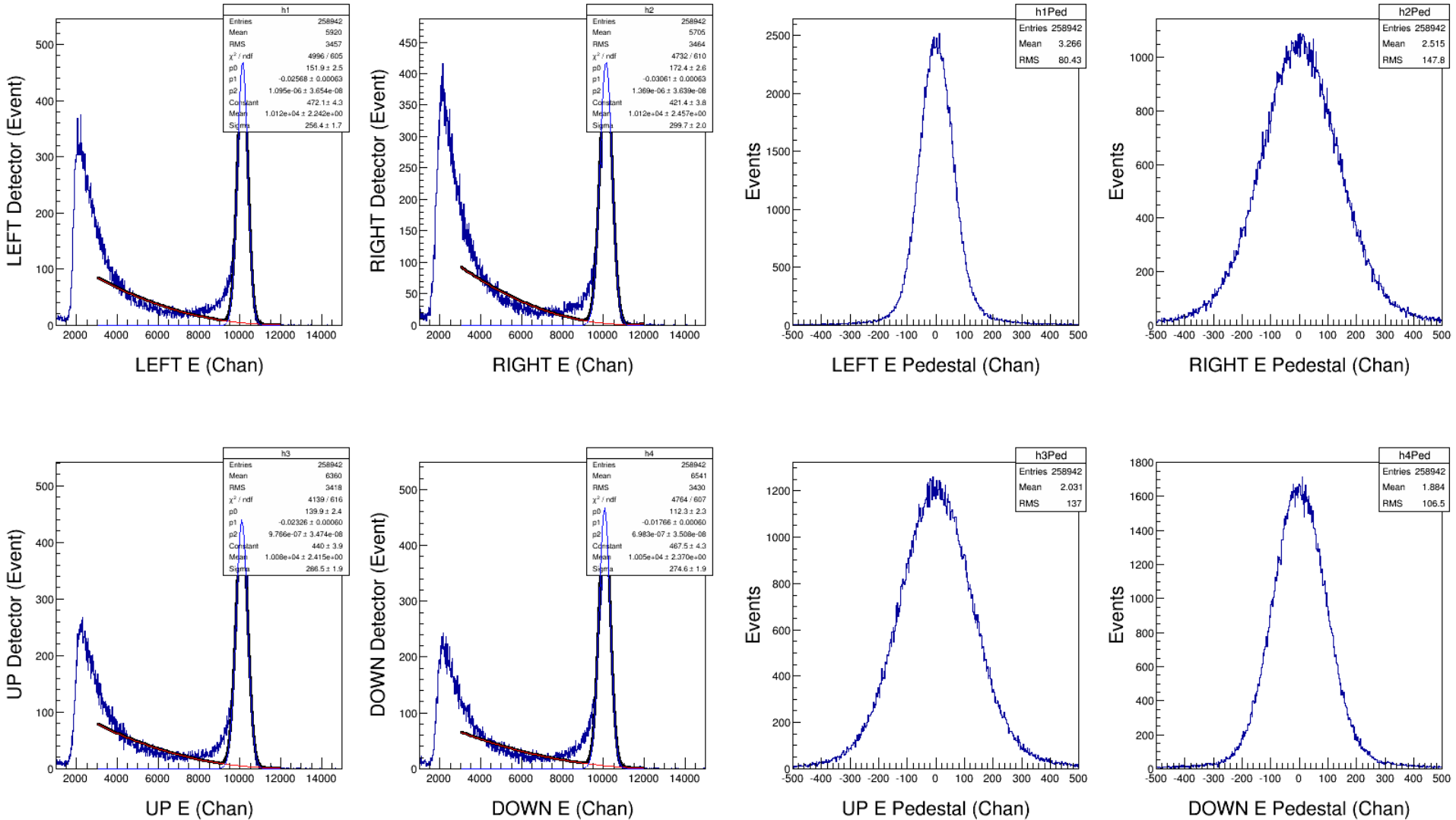
Analysis: Time-of-flight

$\sigma_t \sim 0.2$ ns

PULSE INTEGRAL AND HIGH RESOLUTION TIME – RUN 7672, 7642
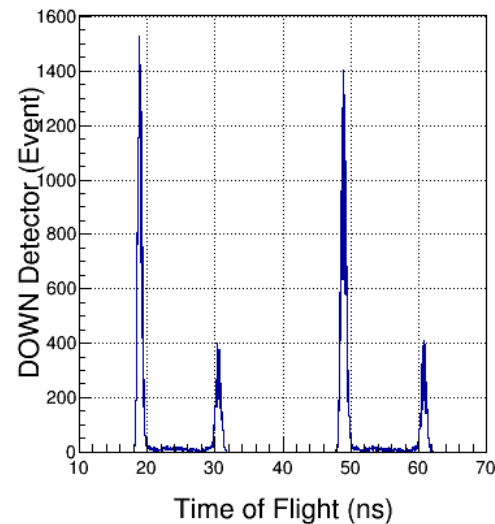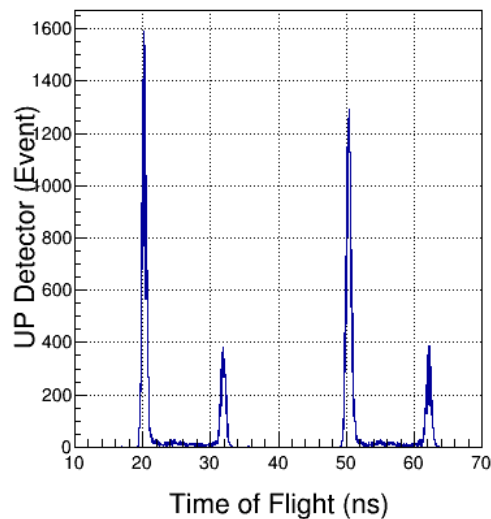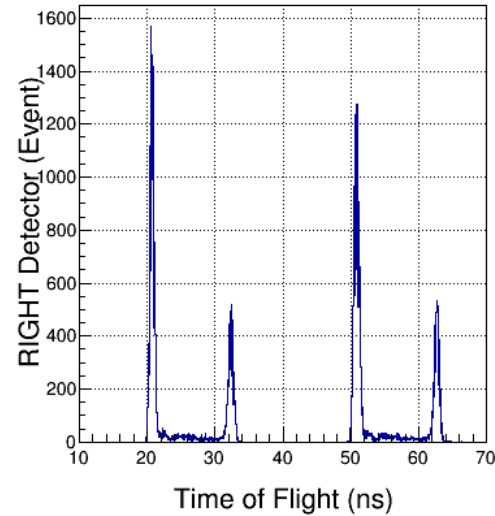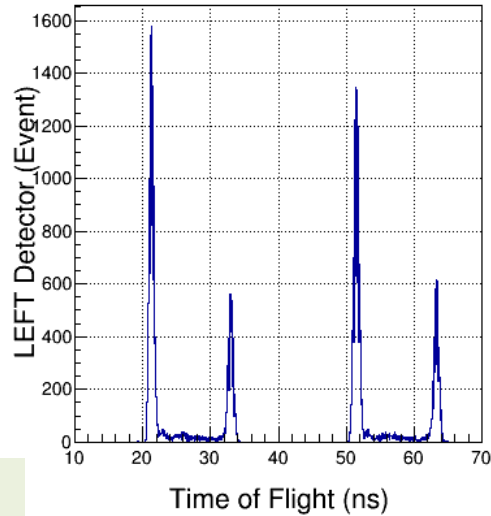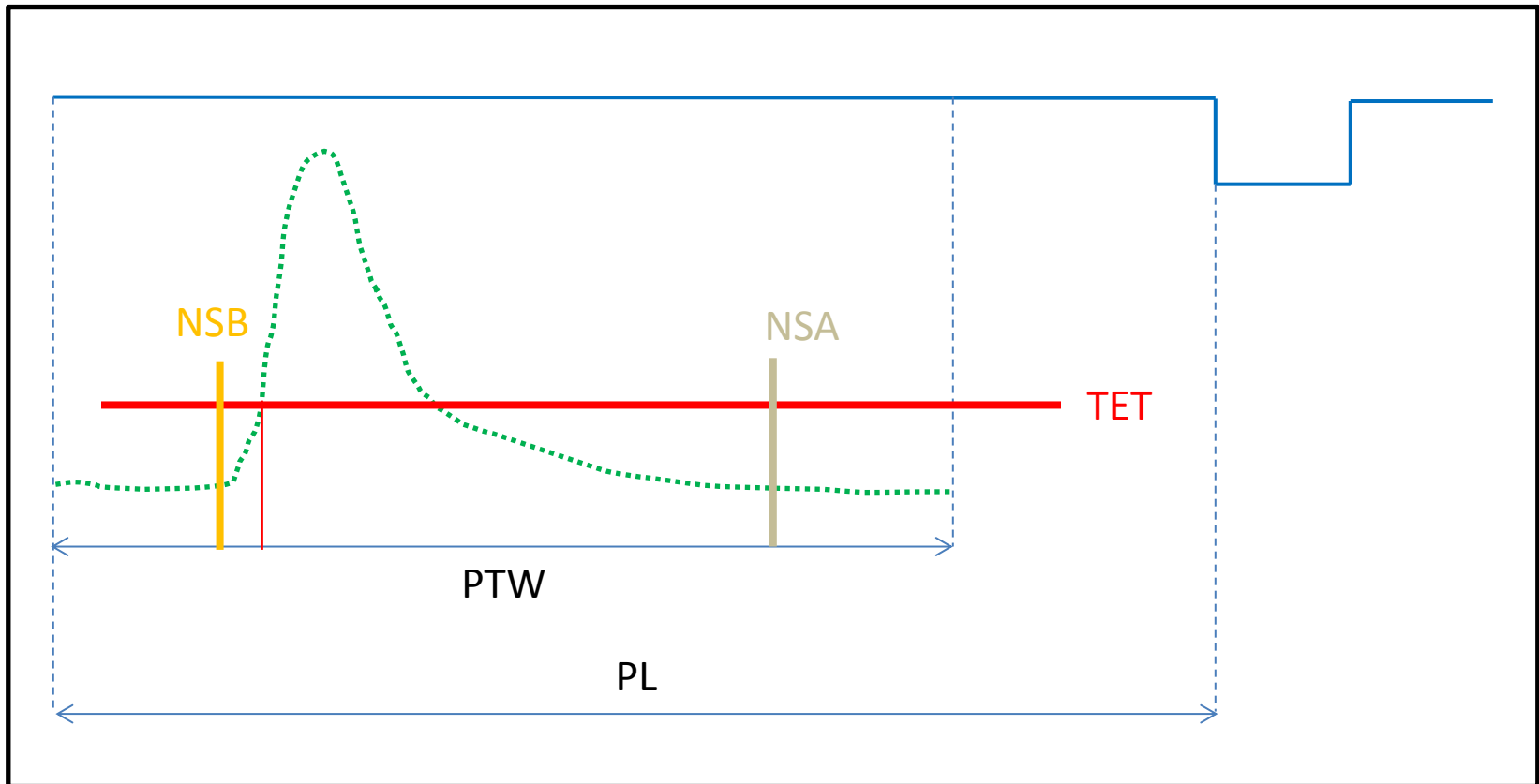
Pulse Integral & High Resolution Time

**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
```
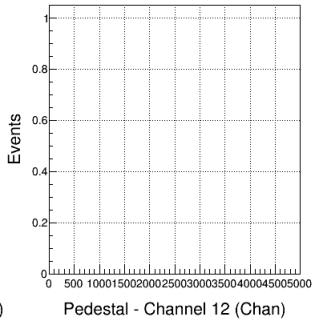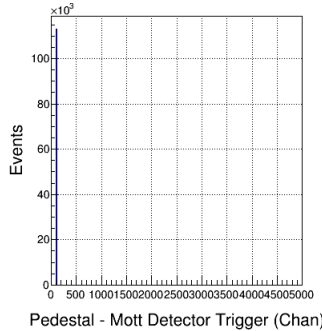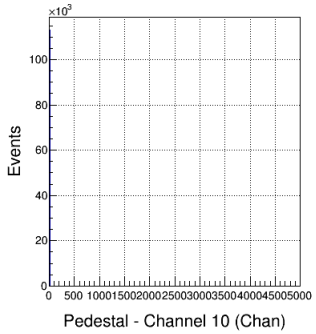
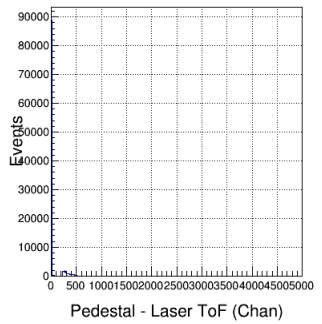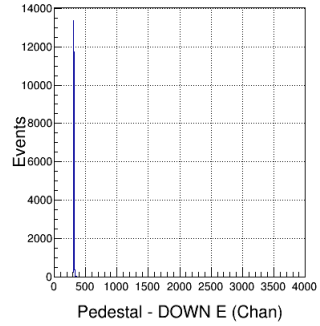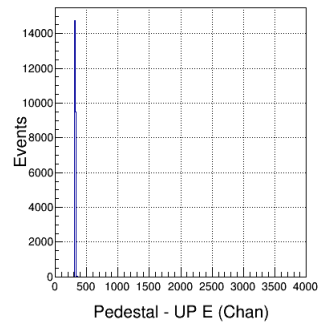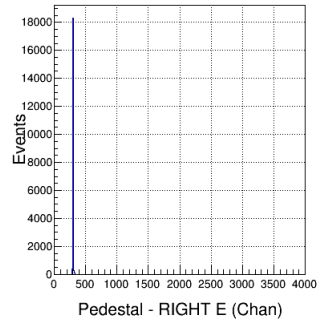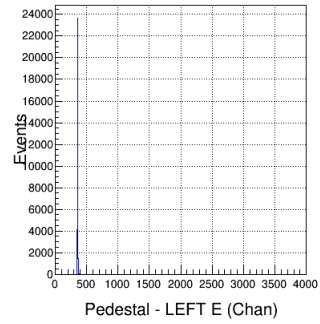# Pulse Integral & High Resolution Time
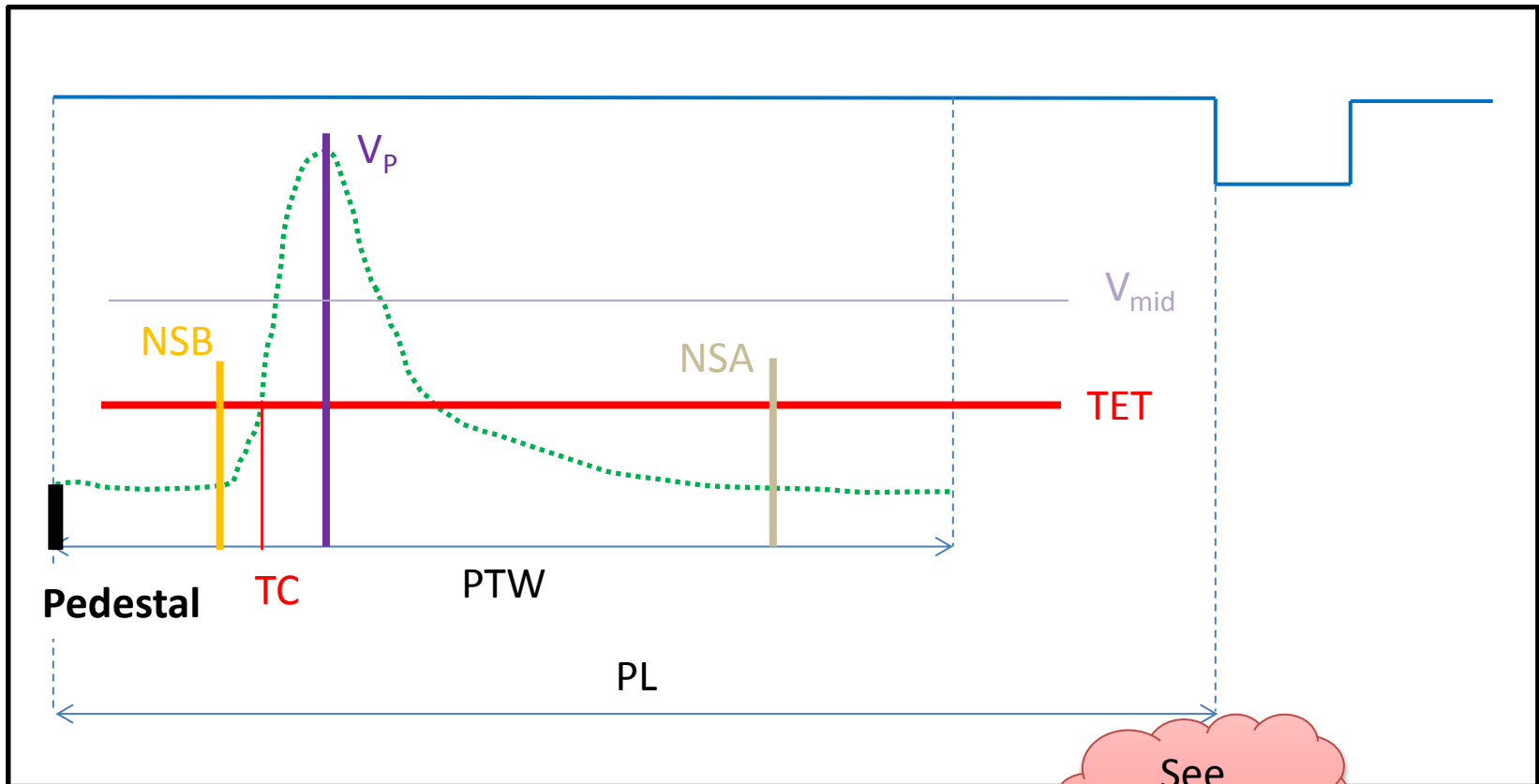
Mott Readout:

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 $V(N1) \leq (V_p\text{-Ped})/2 < V(N2)$
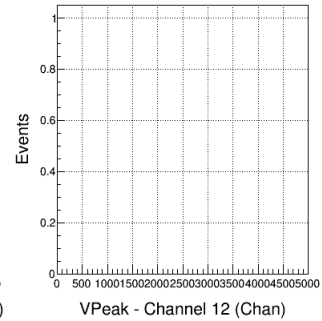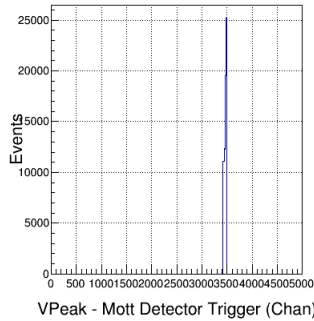V. Pulse Fine Time = $64\,(V_{mid} - V(N1))/(V(N2\text{-}V(N1)))$. From 0 to 63 in steps of 62.5 ps
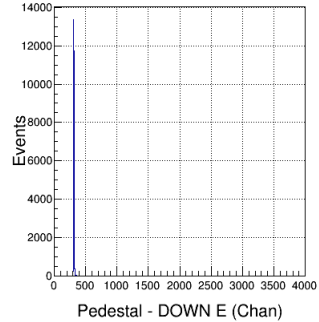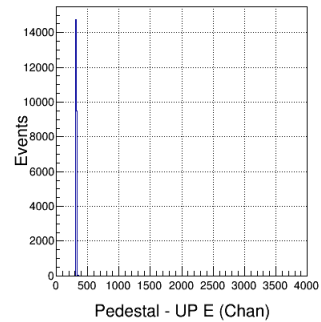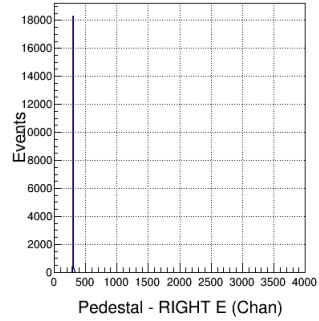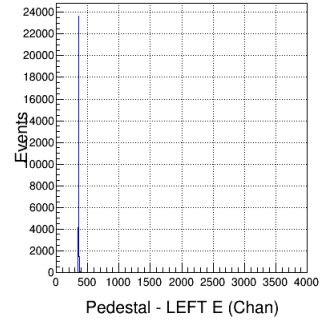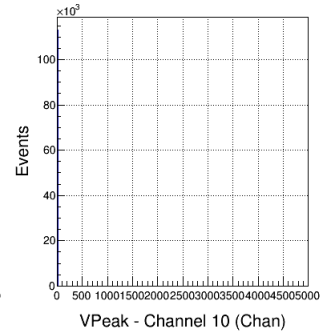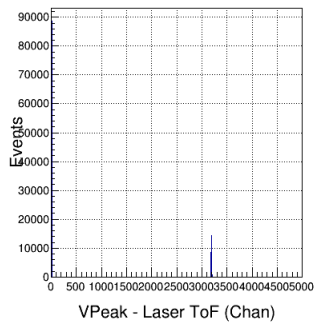
Pulse Pedestal

Pulse Peak Value (VP)
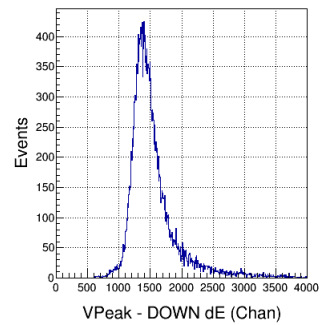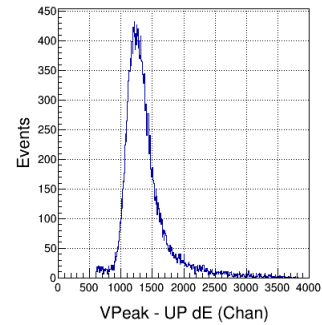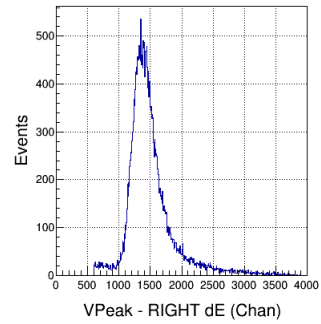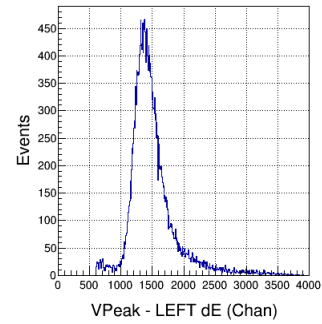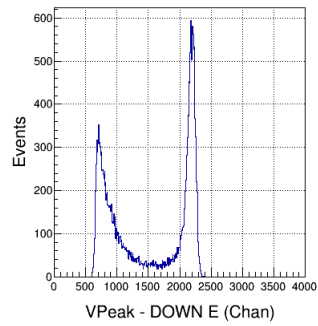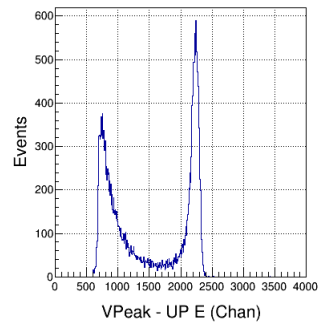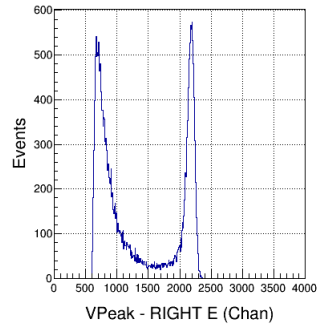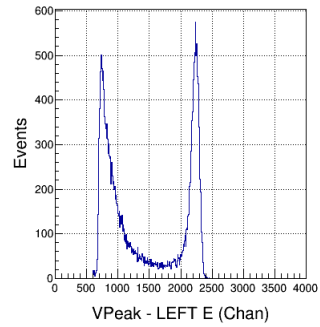
Pulse Integral
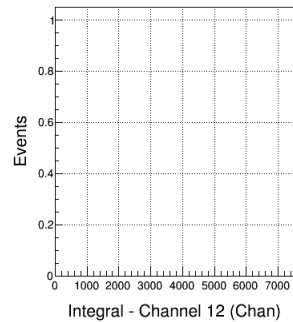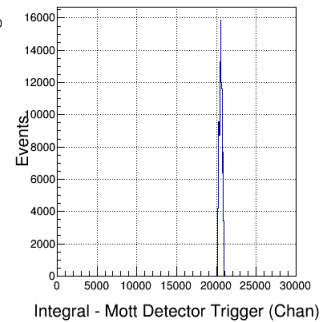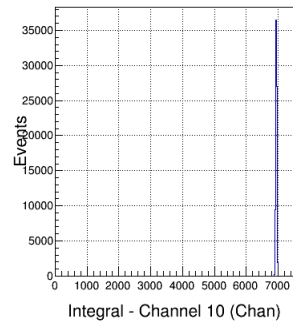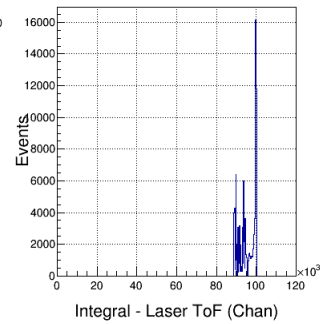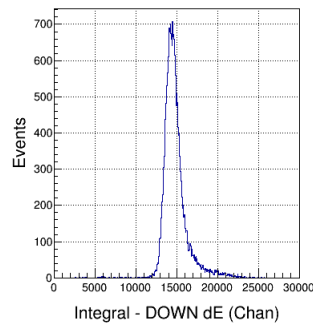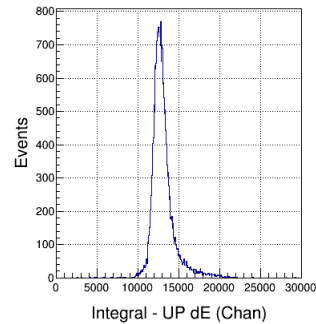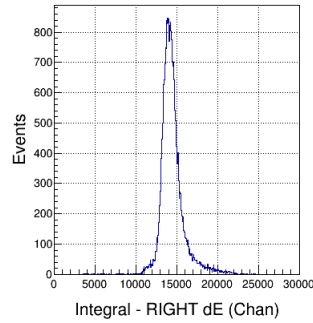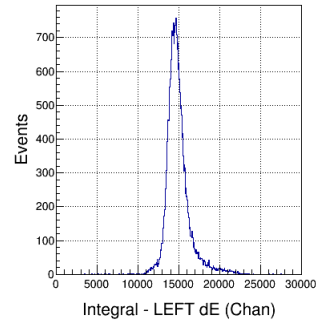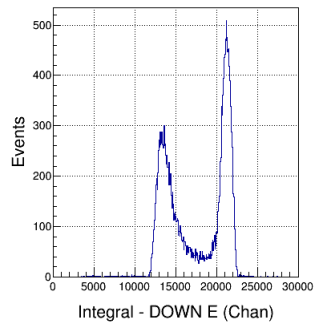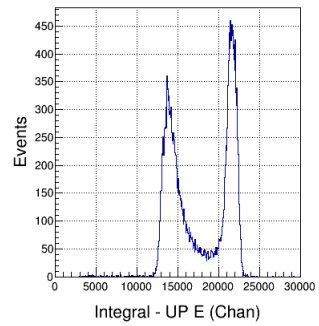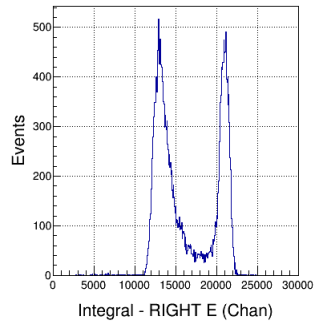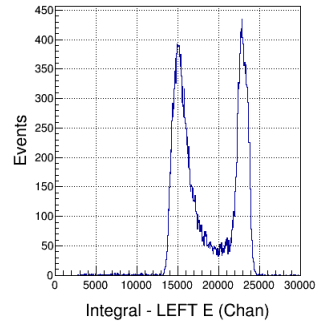
Pulse Coarse Time

Pulse Fine Time

Time Fine - LEFT E (62.5 ps)

Time Fine - RIGHT E (62.5 ps)

Time Fine - UP E (62.5 ps)

Time Fine - DOWN E (62.5 ps)

Time Fine - LEFT dE (62.5 ps)

Time Fine - RIGHT dE (62.5 ps)

Time Fine - UP dE (62.5 ps)

Time Fine - DOWN dE (62.5 ps)

Time Fine - Laser ToF (62.5 ps)

Time Fine - Channel 10 (62.5 ps)

Time Fine - Mott Trigger (62.5 ps)

Time Fine - Channel 12 (62.5 ps)
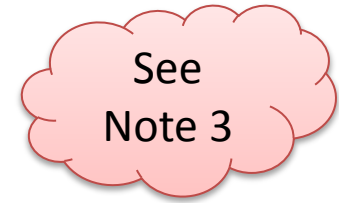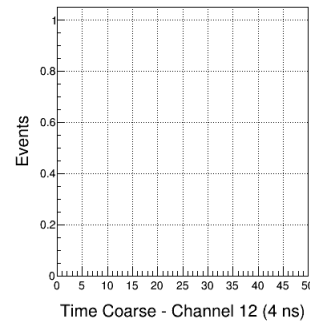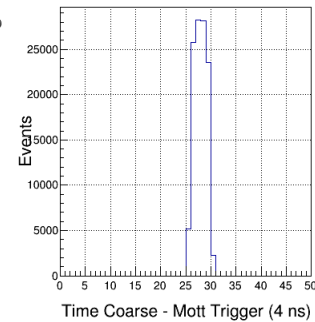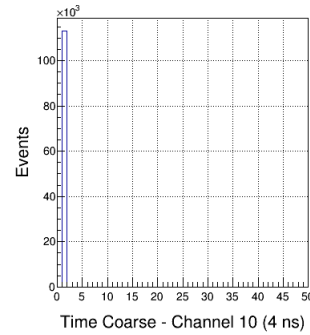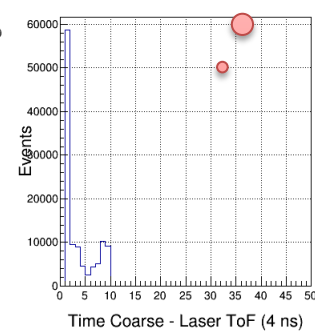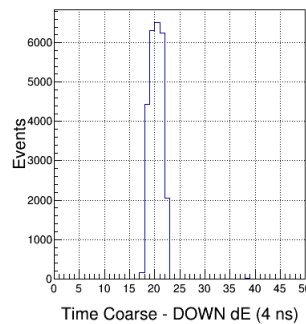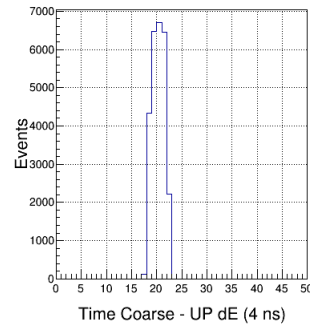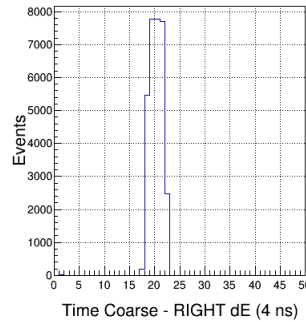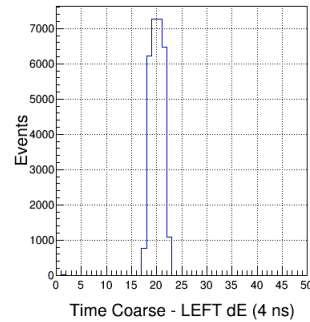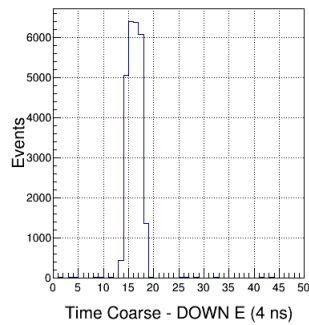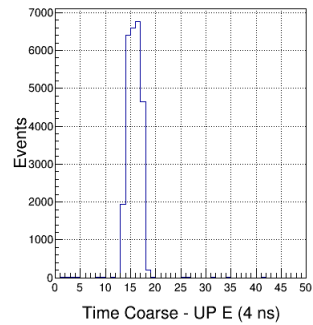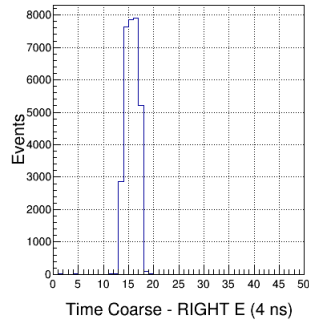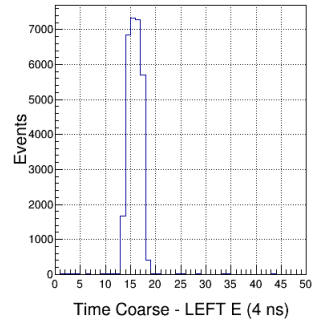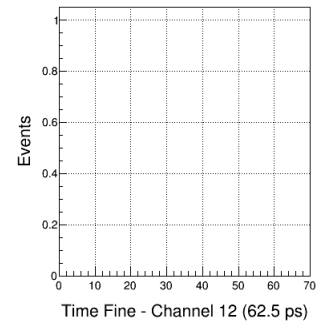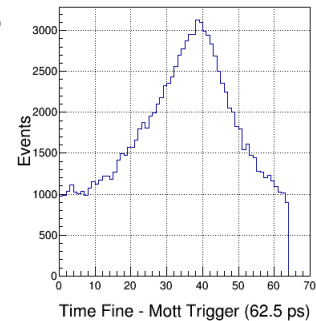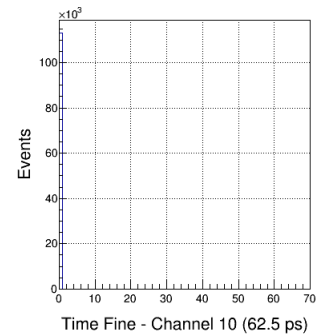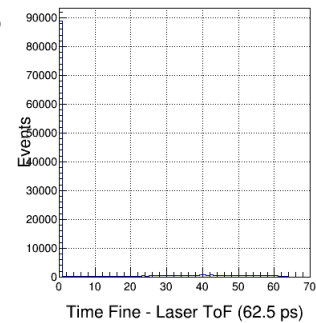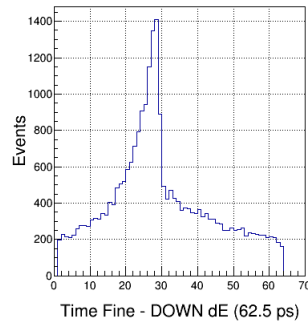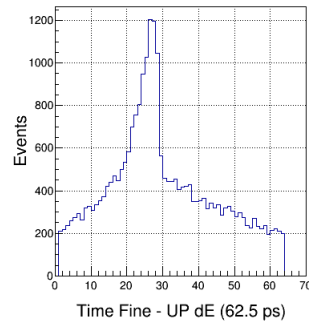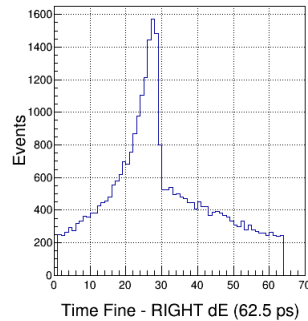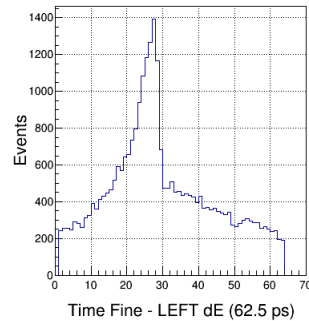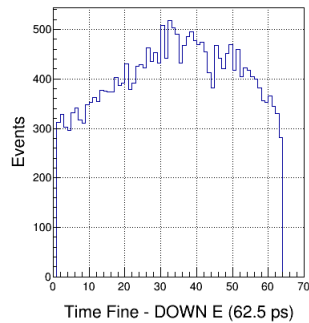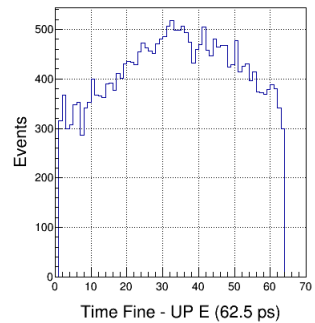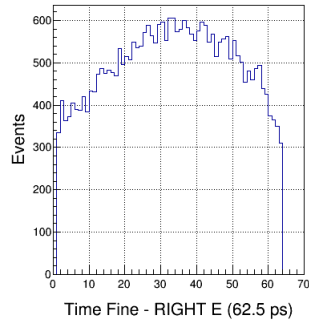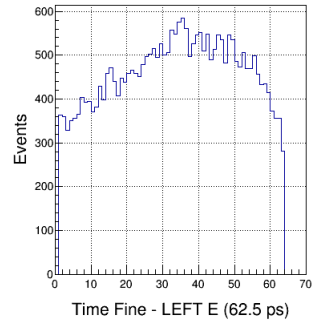
Analysis: Pedestals
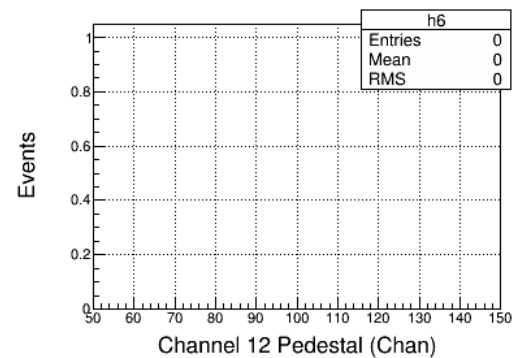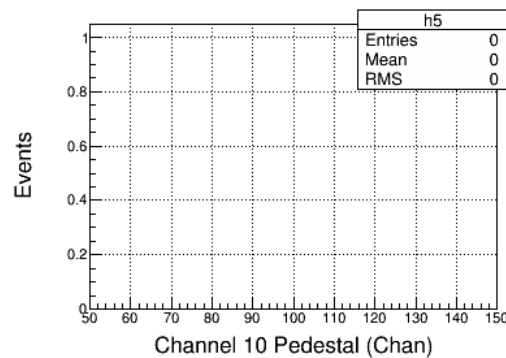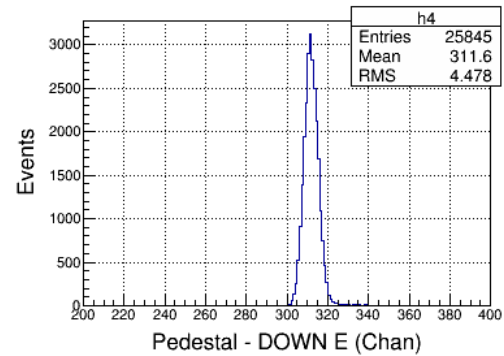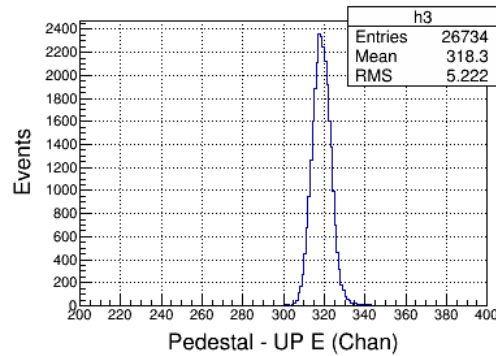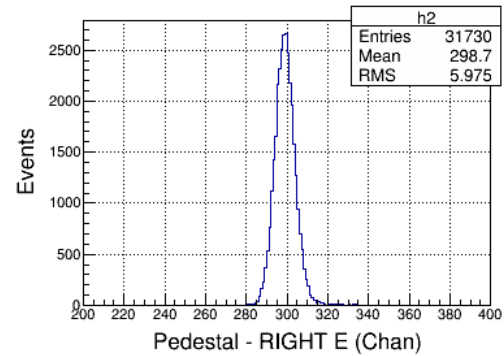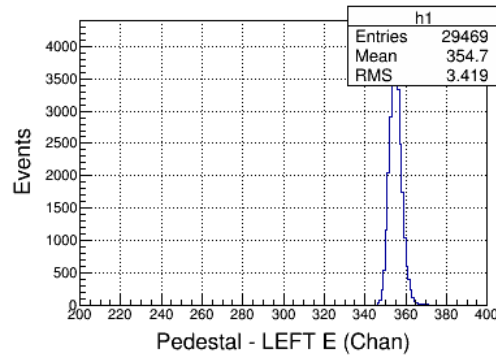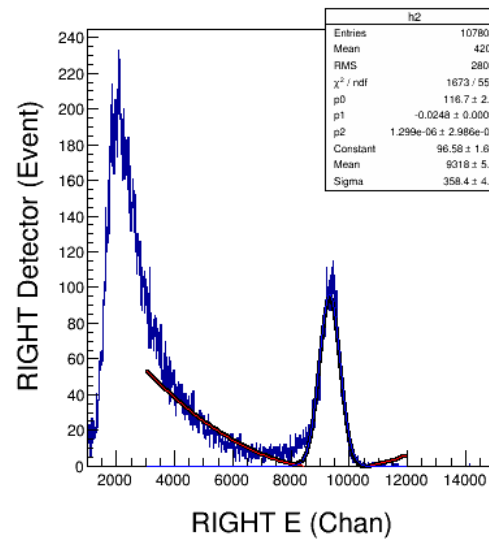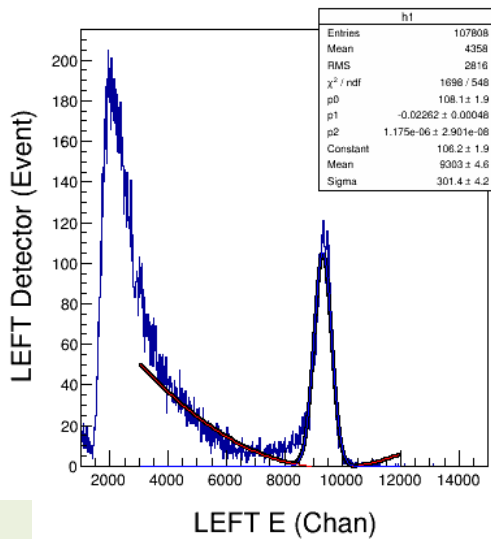
Analysis: Energy

- Energy from run 7642
- Pedestal from run 7672

$\sigma_E \sim 3.2\%$
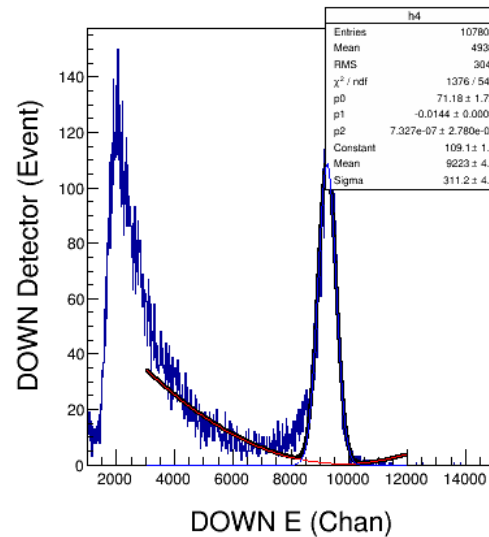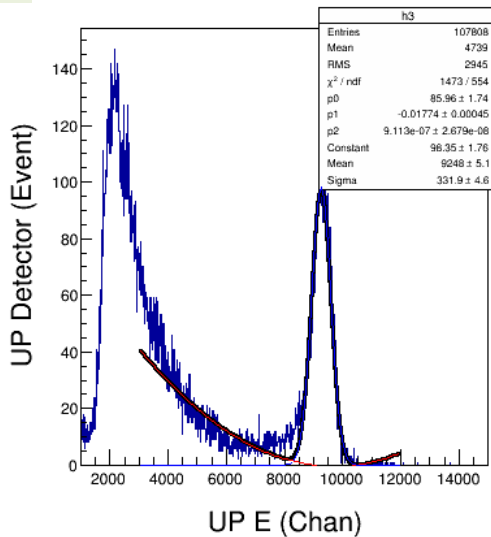
The increase partially due to average pedestals being subtracted. New data will have this fixed

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

	Entries	29488
	Mean	48.3
	RMS	0.3043

	Entries	31739
	Mean	49.08
	RMS	0.3605

	Entries	26750
	Mean	48.74
	RMS	0.3277

	Entries	25858
	Mean	47.09
	RMS	0.3331

LEFT Detector (Event) — Time of Flight (ns)

RIGHT Detector (Event) — Time of Flight (ns)

UP Detector (Event) — Time of Flight (ns)
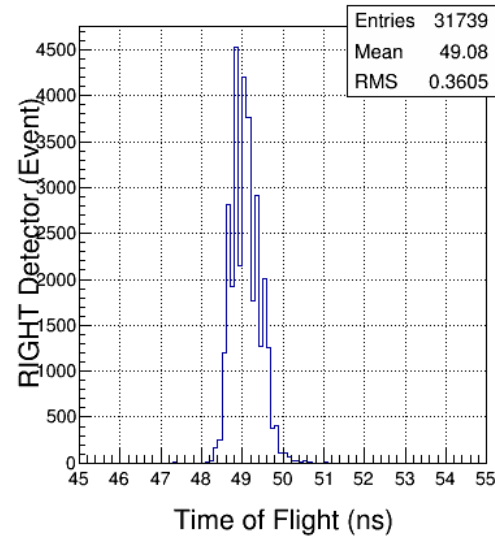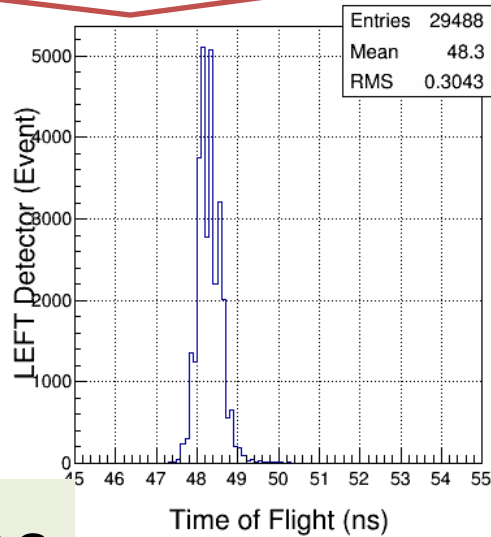
DOWN Detector (Event) — Time of Flight (ns)
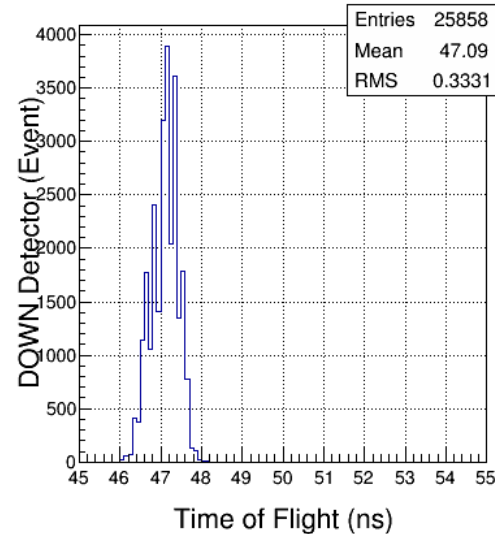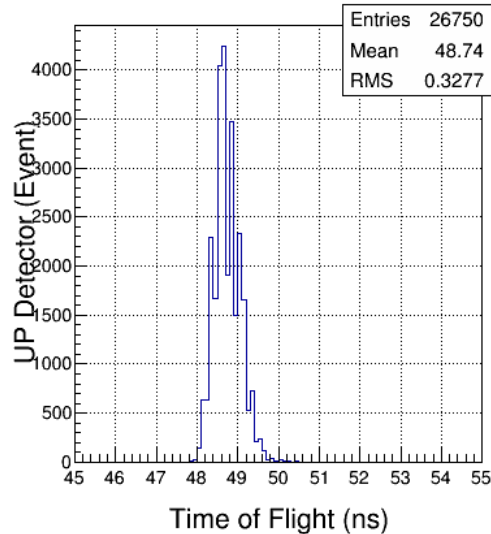
Analysis: E-dE Timing Peak

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

σ_t ~ 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")
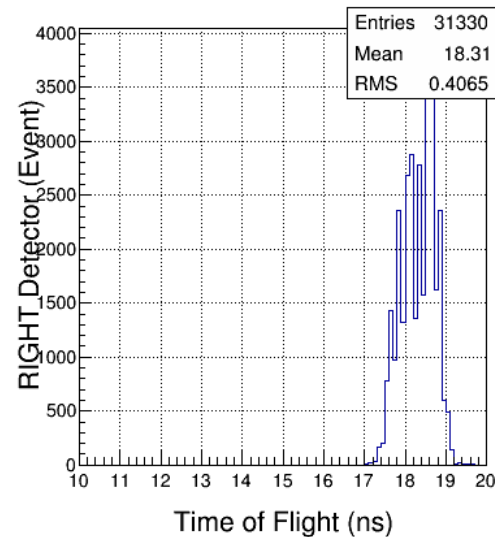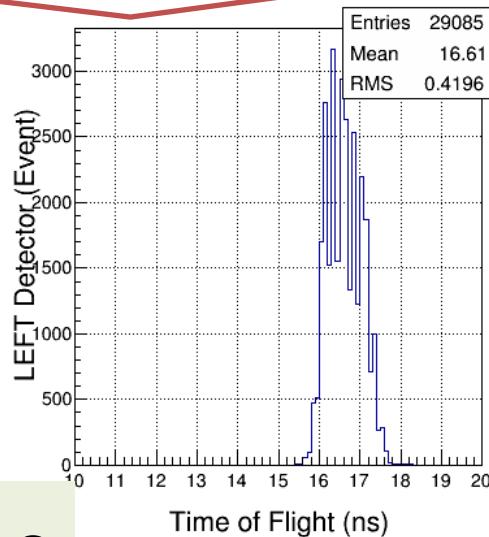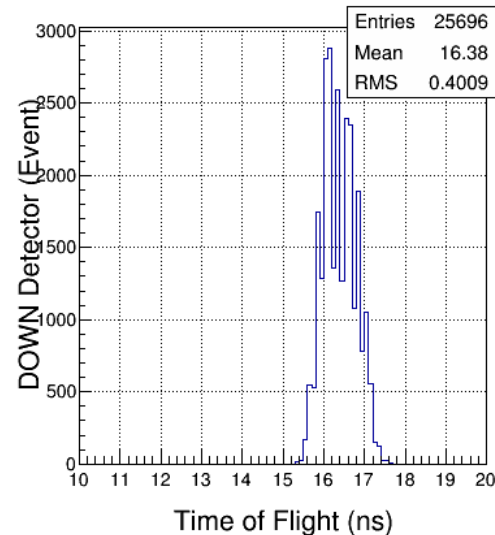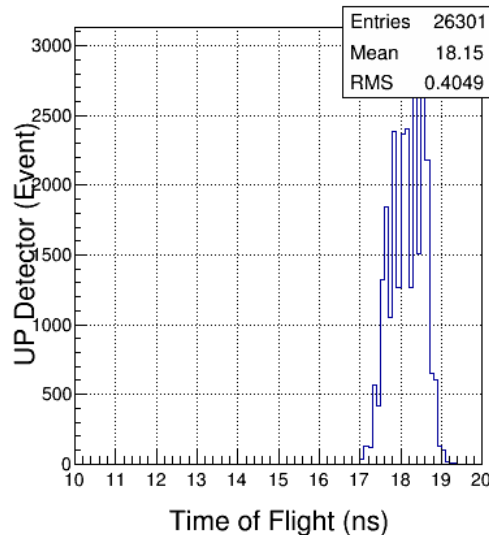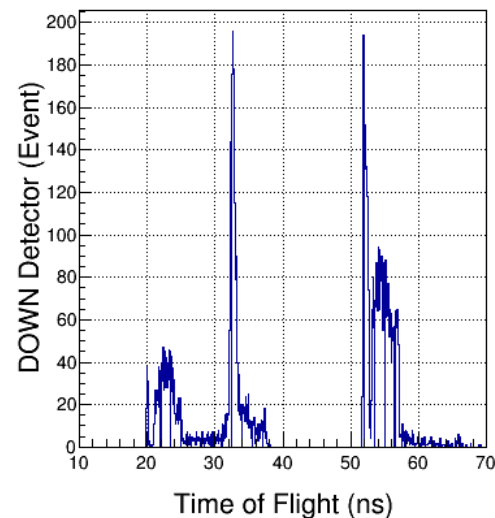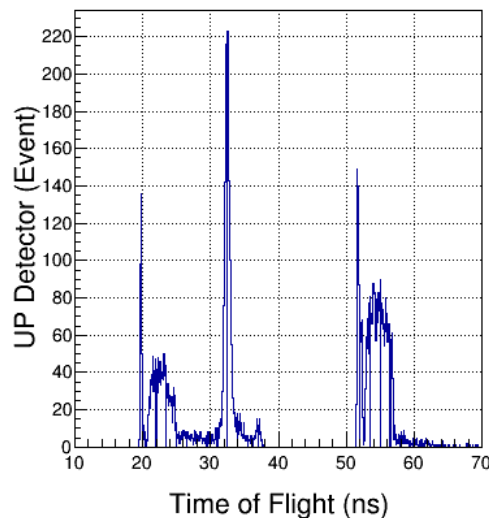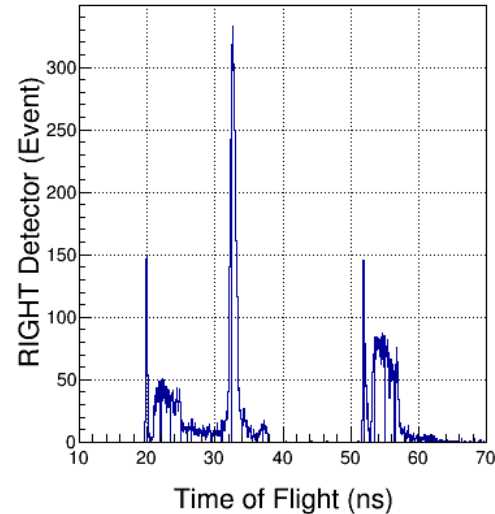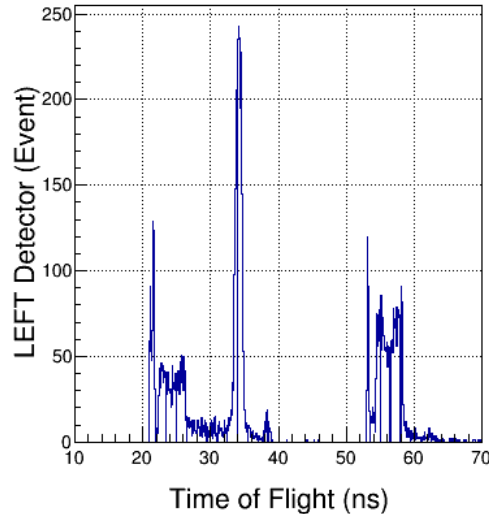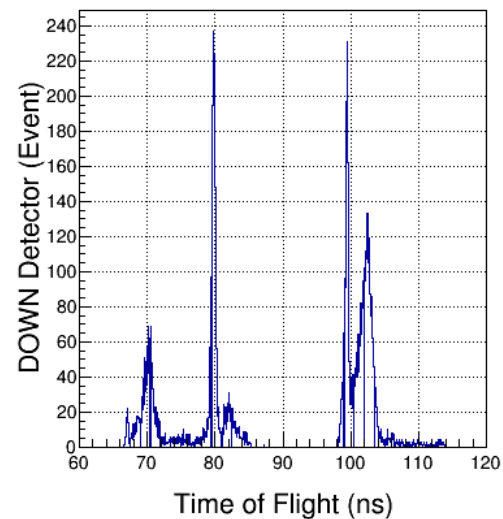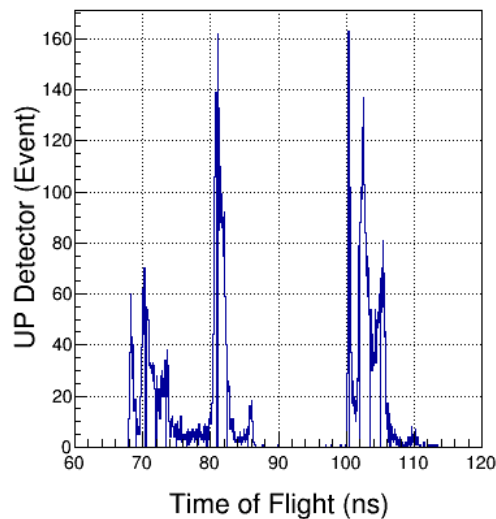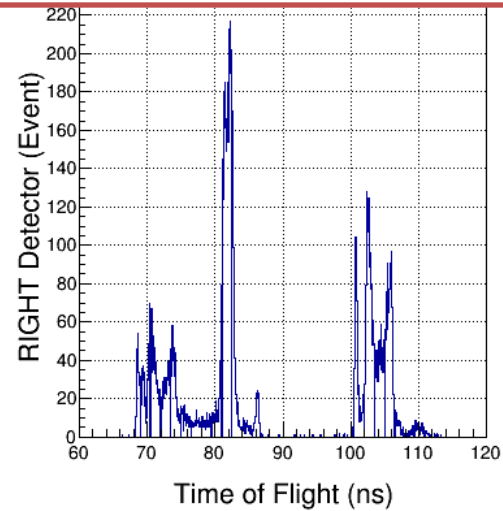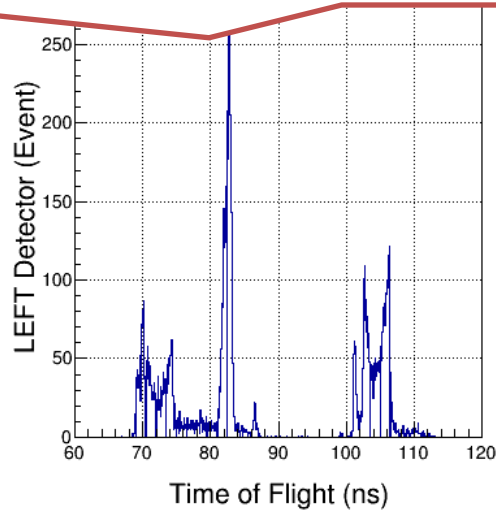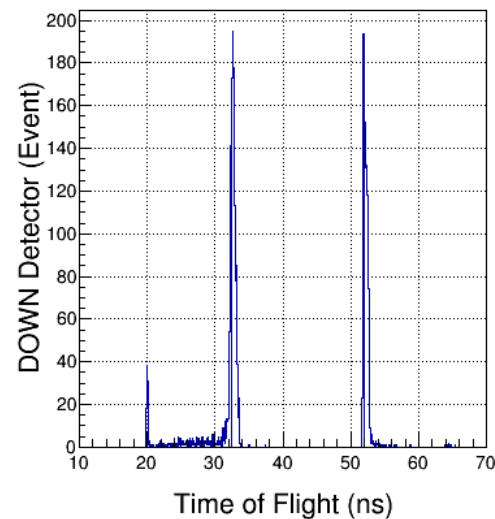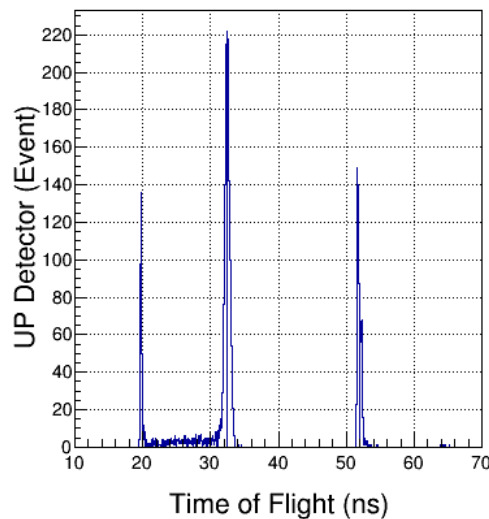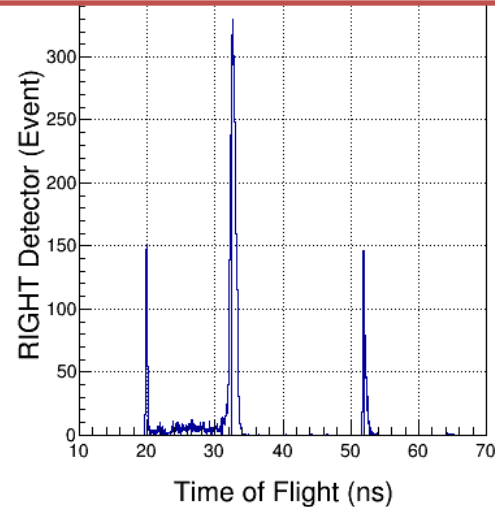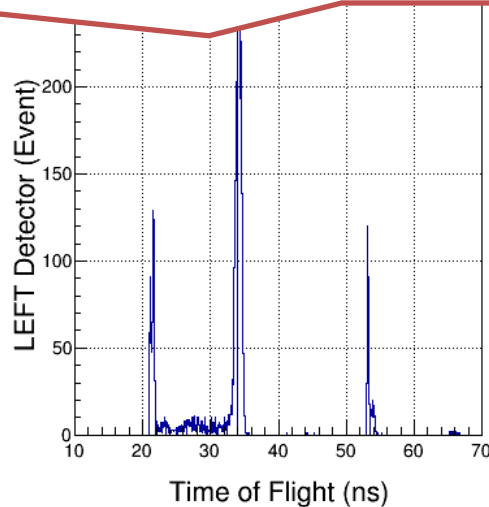

Use CH11

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

bad

good

PTW

PL
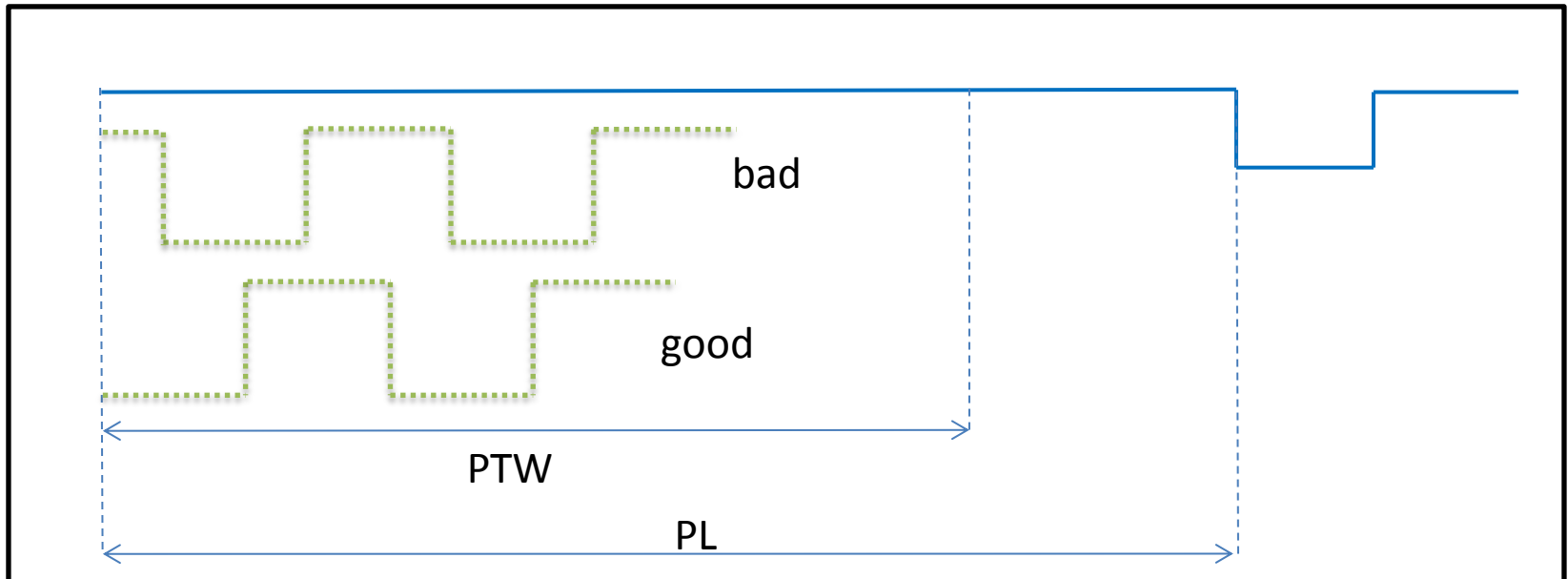
Conclusions – so far …

- 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 …