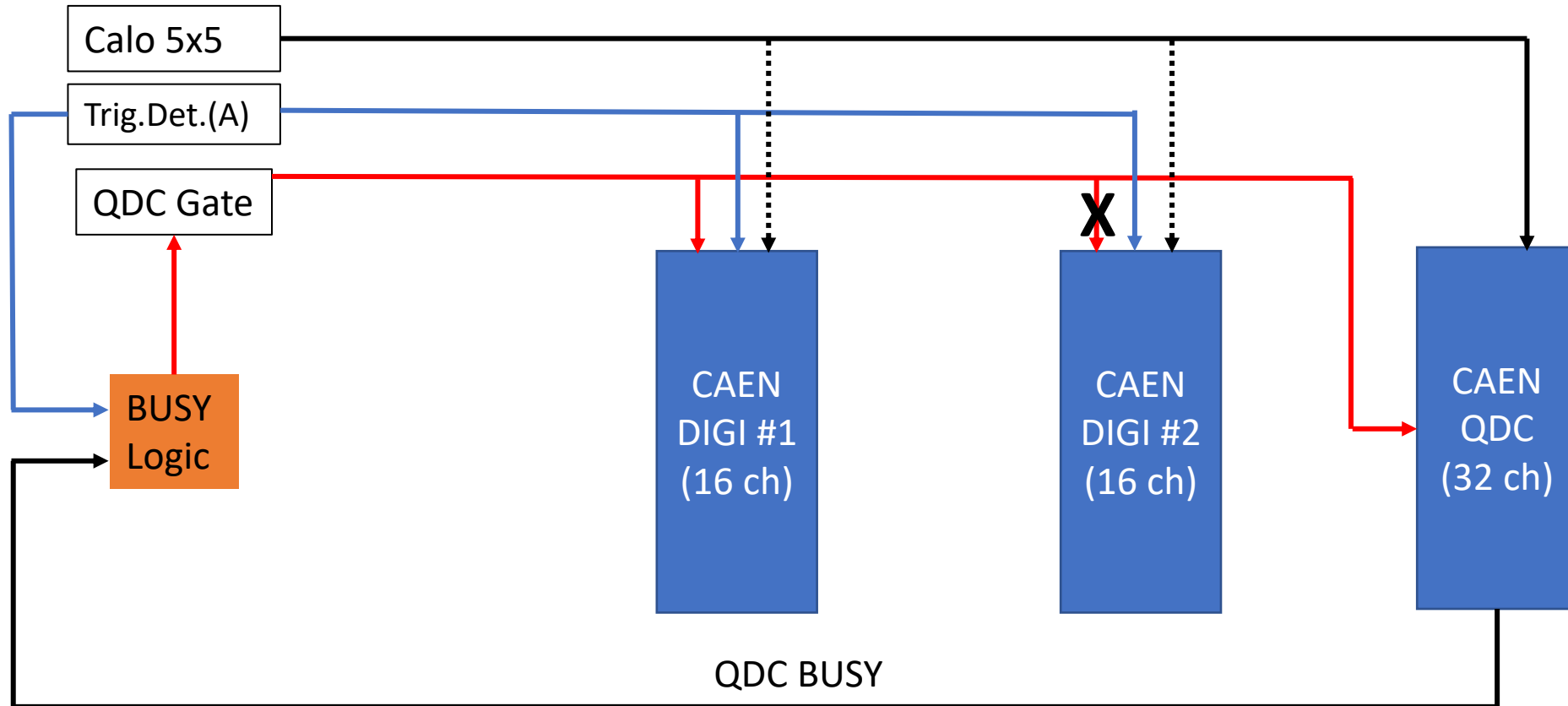


TPEX Fall 2021 DIGI data Decoder Report 01/13/2021:

Ievgen Lavrukhin

Hardware setup.



- QDC Gate is not recorded in DIGI #2
- DIGI #1 time & DIGI #2 time is not synchronized.
- Trig. Det. (A) recorded by DIGI #1 & DIGI #2 has different threshold => # of Events is not the same!

DIGI #1 and DIGI #2 Event Synchronization.

Take a sample of events from DIGI #1 QDC gate signal.

- timestamp changed from `uint32_t` => `uint64_t`

```
Process Event 440000
Process Event 450000
# of Gates Received by DIGI[0]= 111016
# of Gates Received by DIGI[1]= 0
GATE: DIGI[0] => event = 0, gate_time = 761003572, gate_time_diff = 0, gate_charge = 8010
GATE: DIGI[0] => event = 1, gate_time = 762545706, gate_time_diff = 1542134, gate_charge = 7997
GATE: DIGI[0] => event = 2, gate_time = 763093364, gate_time_diff = 2089792, gate_charge = 8013
GATE: DIGI[0] => event = 3, gate_time = 763413461, gate_time_diff = 2409889, gate_charge = 7956
GATE: DIGI[0] => event = 4, gate_time = 780574222, gate_time_diff = 19570650, gate_charge = 7977
GATE: DIGI[0] => event = 5, gate_time = 796644855, gate_time_diff = 35641283, gate_charge = 7989
GATE: DIGI[0] => event = 6, gate_time = 800091845, gate_time_diff = 39088273, gate_charge = 8003
GATE: DIGI[0] => event = 7, gate_time = 800178278, gate_time_diff = 39174706, gate_charge = 7966
GATE: DIGI[0] => event = 8, gate_time = 801066056, gate_time_diff = 40062484, gate_charge = 7992
GATE: DIGI[0] => event = 9, gate_time = 801325357, gate_time_diff = 40321785, gate_charge = 7988
# of Analog Triggers Received by DIGI[0]= 143848
# of Analog Triggers Received by DIGI[1]= 144446
```

Using Time Differences to find the corresponding subset in DIGI #1 and DIGI #2 "Trig.Det.(A)" signals

```
First Hit Candidate: DIGI[0] =>
event = 253, t_0 = 761003559, t_diff = 0
event = 254, t_1 = 762545693, t_diff = 1542134
event = 255, t_2 = 763093351, t_diff = 2089792
event = 256, t_3 = 763413449, t_diff = 2409890
event = 257, t_4 = 780574209, t_diff = 19570650
event = 260, t_5 = 796644842, t_diff = 35641283
event = 261, t_6 = 800091832, t_diff = 39088273
event = 262, t_7 = 800178266, t_diff = 39174707
event = 263, t_8 = 801066043, t_diff = 40062484
event = 264, t_9 = 801325344, t_diff = 40321785
DIGI[0] found a complete hit pattern in analog trigger set
First Hit Candidate: DIGI[0] =>
event = 26338, t_0 = 89054788746, t_diff = 0
event = 26339, t_1 = 89056330880, t_diff = 1542134
Reached the end of the run.... Stopping search ....
```

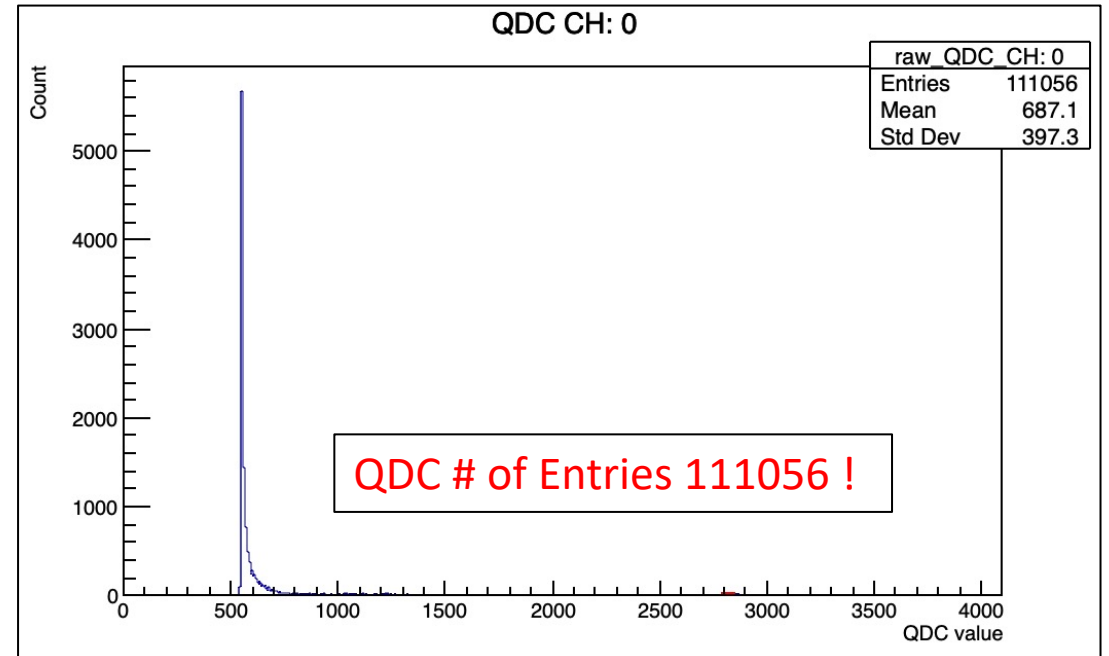
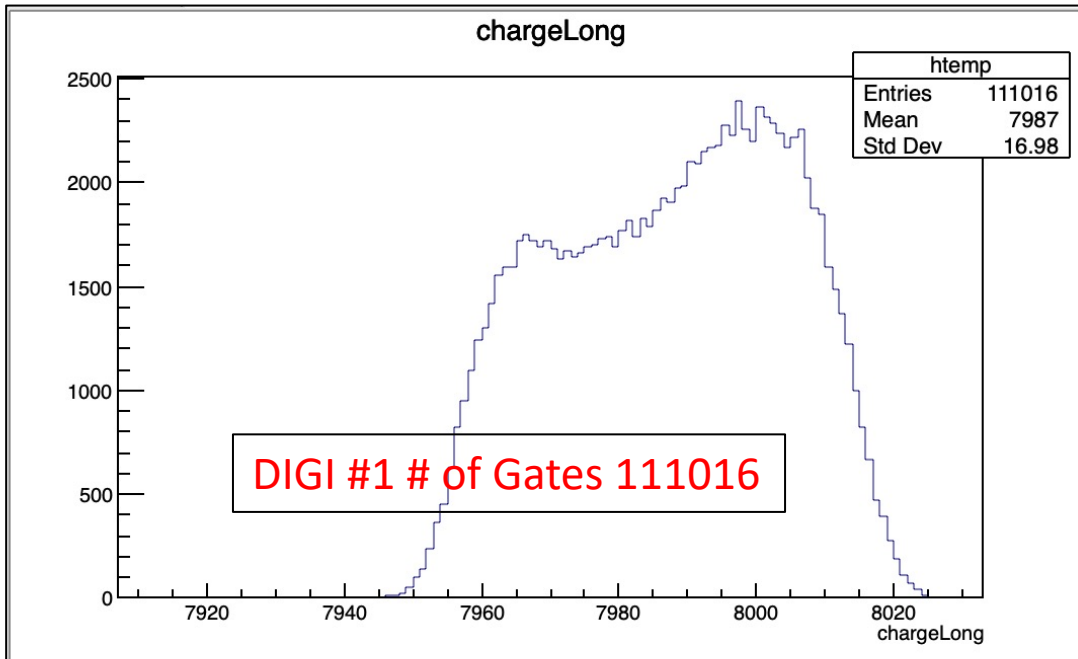
```
First Hit Candidate: DIGI[1] =>
event = 254, t_0 = 760993187, t_diff = 0
event = 255, t_1 = 762535319, t_diff = 1542132
event = 256, t_2 = 763082975, t_diff = 2089788
event = 257, t_3 = 763403073, t_diff = 2409886
event = 258, t_4 = 780563801, t_diff = 19570614
event = 261, t_5 = 796634403, t_diff = 35641216
event = 262, t_6 = 800081386, t_diff = 39088199
event = 263, t_7 = 800167820, t_diff = 39174633
event = 264, t_8 = 801055595, t_diff = 40062408
event = 265, t_9 = 801314896, t_diff = 40321709
DIGI[1] found a complete hit pattern in analog trigger set
First Hit Candidate: DIGI[1] =>
event = 26461, t_0 = 89054609794, t_diff = 0
event = 26462, t_1 = 89056151925, t_diff = 1542131
Reached the end of the run.... Stopping search ....
```

Use the timing of the first event as a reference time (events with < time are ignored) to synchronize DIGI #1 and DIGI #2 events

```
The time of the first event for DIGI[0] is 761003559
The time of the first event for DIGI[1] is 760993187
# Number of Entries in Raw DIGI tree = 1757439
Gate Event = 0 => DIGI time = 761003572 Events Time = 0
RAW Tree: Event = 2204, ch = 28, time = 760993187, t_diff = 0, chargeShort = 478, chargeLong = 462
RAW Tree: Event = 2205, ch = 0, time = 761003590, t_diff = 31, chargeShort = 5097, chargeLong = 6217
RAW Tree: Event = 2206, ch = 1, time = 761003590, t_diff = 31, chargeShort = 2674, chargeLong = 3133
RAW Tree: Event = 2207, ch = 2, time = 761003591, t_diff = 32, chargeShort = 531, chargeLong = 623
RAW Tree: Event = 2208, ch = 5, time = 761003591, t_diff = 32, chargeShort = 1124, chargeLong = 1302
RAW Tree: Event = 2209, ch = 14, time = 761003559, t_diff = 0, chargeShort = 476, chargeLong = 461
RAW Tree: Event = 2210, ch = 15, time = 761003572, t_diff = 13, chargeShort = 2278, chargeLong = 8010
Gate Event = 1 => DIGI time = 762545706 Events Time = 1542134
RAW Tree: Event = 2225, ch = 15, time = 762545706, t_diff = 1542147, chargeShort = 2264, chargeLong = 7997
Gate Event = 2 => DIGI time = 763093364 Events Time = 2089792
RAW Tree: Event = 2226, ch = 0, time = 763093383, t_diff = 2089824, chargeShort = 3556, chargeLong = 4241
RAW Tree: Event = 2227, ch = 1, time = 763093382, t_diff = 2089823, chargeShort = 1871, chargeLong = 2181
RAW Tree: Event = 2228, ch = 5, time = 763093382, t_diff = 2089823, chargeShort = 4247, chargeLong = 5142
RAW Tree: Event = 2229, ch = 6, time = 763093383, t_diff = 2089824, chargeShort = 1268, chargeLong = 1547
RAW Tree: Event = 2230, ch = 10, time = 763093383, t_diff = 2089824, chargeShort = 632, chargeLong = 736
RAW Tree: Event = 2231, ch = 11, time = 763093384, t_diff = 2089825, chargeShort = 677, chargeLong = 803
RAW Tree: Event = 2233, ch = 15, time = 763093364, t_diff = 2089805, chargeShort = 2277, chargeLong = 8013
Gate Event = 3 => DIGI time = 763413461 Events Time = 2409889
```

DIGI #1#2 & QDC Event Synchronization.

- Assumption => # of events with “QDC Gate” in DIGI is the same as # of events in QDC.
- Run “gainscan_5GeV_11252021_1758.dat”:



DIGI #1#2 & QDC Event Synchronization.

- We have DIGI events
with Gate signal only:

⇒ NO CALO

⇒ NO Trig.Det.(A)

- Makes no sense to me.
- Need to check the code again.
- DIGI Event Selection:
[-100 ns, +100 ns]

```
The time of the first event for DIGI[0] is 761003559
The time of the first event for DIGI[1] is 760993187
# Number of Entries in Raw DIGI tree = 1757439
Gate Event = 0 => DIGI time = 761003572 Events Time = 0
  RAW Tree: Event = 2204, ch = 28, time = 760993187, t_diff = 0, chargeShort = 478, chargeLong = 462
  RAW Tree: Event = 2205, ch = 0, time = 761003590, t_diff = 31, chargeShort = 5097, chargeLong = 6217
  RAW Tree: Event = 2206, ch = 1, time = 761003590, t_diff = 31, chargeShort = 2674, chargeLong = 3133
  RAW Tree: Event = 2207, ch = 2, time = 761003591, t_diff = 32, chargeShort = 531, chargeLong = 623
  RAW Tree: Event = 2208, ch = 5, time = 761003591, t_diff = 32, chargeShort = 1124, chargeLong = 1302
  RAW Tree: Event = 2209, ch = 14, time = 761003559, t_diff = 0, chargeShort = 476, chargeLong = 461
  RAW Tree: Event = 2210, ch = 15, time = 761003572, t_diff = 13, chargeShort = 2278, chargeLong = 8010
Gate Event = 1 => DIGI time = 762545706 Events Time = 1542134
  RAW Tree: Event = 2225, ch = 15, time = 762545706, t_diff = 1542147, chargeShort = 2264, chargeLong = 7997
Gate Event = 2 => DIGI time = 763093364 Events Time = 2089792
  RAW Tree: Event = 2226, ch = 0, time = 763093383, t_diff = 2089824, chargeShort = 3556, chargeLong = 4241
  RAW Tree: Event = 2227, ch = 1, time = 763093382, t_diff = 2089823, chargeShort = 1871, chargeLong = 2181
  RAW Tree: Event = 2228, ch = 5, time = 763093382, t_diff = 2089823, chargeShort = 4247, chargeLong = 5142
  RAW Tree: Event = 2229, ch = 6, time = 763093383, t_diff = 2089824, chargeShort = 1268, chargeLong = 1547
  RAW Tree: Event = 2230, ch = 10, time = 763093383, t_diff = 2089824, chargeShort = 632, chargeLong = 736
  RAW Tree: Event = 2231, ch = 11, time = 763093384, t_diff = 2089825, chargeShort = 677, chargeLong = 803
  RAW Tree: Event = 2233, ch = 15, time = 763093364, t_diff = 2089805, chargeShort = 2277, chargeLong = 8013
Gate Event = 3 => DIGI time = 763413461 Events Time = 2409889
  RAW Tree: Event = 2235, ch = 0, time = 763413480, t_diff = 2409921, chargeShort = 4940, chargeLong = 6060
  RAW Tree: Event = 2236, ch = 1, time = 763413480, t_diff = 2409921, chargeShort = 2524, chargeLong = 2940
  RAW Tree: Event = 2237, ch = 2, time = 763413481, t_diff = 2409922, chargeShort = 483, chargeLong = 566
  RAW Tree: Event = 2238, ch = 5, time = 763413480, t_diff = 2409921, chargeShort = 1924, chargeLong = 2244
  RAW Tree: Event = 2239, ch = 6, time = 763413481, t_diff = 2409922, chargeShort = 973, chargeLong = 1142
  RAW Tree: Event = 2240, ch = 7, time = 763413481, t_diff = 2409922, chargeShort = 384, chargeLong = 439
  RAW Tree: Event = 2241, ch = 8, time = 763413482, t_diff = 2409923, chargeShort = 488, chargeLong = 589
  RAW Tree: Event = 2242, ch = 10, time = 763413482, t_diff = 2409923, chargeShort = 390, chargeLong = 450
  RAW Tree: Event = 2243, ch = 14, time = 763413449, t_diff = 2409890, chargeShort = 527, chargeLong = 552
  RAW Tree: Event = 2244, ch = 15, time = 763413461, t_diff = 2409902, chargeShort = 2223, chargeLong = 7956
  RAW Tree: Event = 2245, ch = 18, time = 763403106, t_diff = 2409919, chargeShort = 822, chargeLong = 955
Gate Event = 4 => DIGI time = 780574222 Events Time = 19570650
  RAW Tree: Event = 2255, ch = 0, time = 780574240, t_diff = 19570681, chargeShort = 4805, chargeLong = 5884
  RAW Tree: Event = 2256, ch = 1, time = 780574241, t_diff = 19570682, chargeShort = 1489, chargeLong = 1712
  RAW Tree: Event = 2257, ch = 5, time = 780574241, t_diff = 19570682, chargeShort = 1999, chargeLong = 2309
  RAW Tree: Event = 2258, ch = 6, time = 780574242, t_diff = 19570683, chargeShort = 473, chargeLong = 557
  RAW Tree: Event = 2260, ch = 15, time = 780574222, t_diff = 19570663, chargeShort = 2244, chargeLong = 7977
```

- Main Github: https://github.mit.edu/tpex-desy/TPEX_Decoder_2021
 - QDC decoder is ready (showed it last year).
 - DIGI decoder is not merged.
- My Fork (more updated): https://github.mit.edu/lavrukhin-1/TPEX_Decoder_2021
 - QDC decoder version is the same as main.
 - DIGI decoder is in progress....
 - Any ideal are appreciated....

Thank you!