

Test of Power Pulsing with the HBU-LED System



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Calice Meeting

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Challenges of Engineering prototype

- Front-end electronics readout
Integrated design of active layer and electronics

induce another problem

- Heat

Power pulsing!!

cooling system?

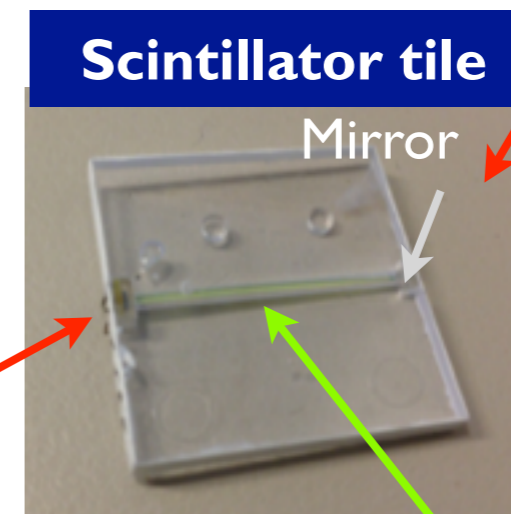
OMG...



SPIROC2b



HBU
(HCAL Base Unit)



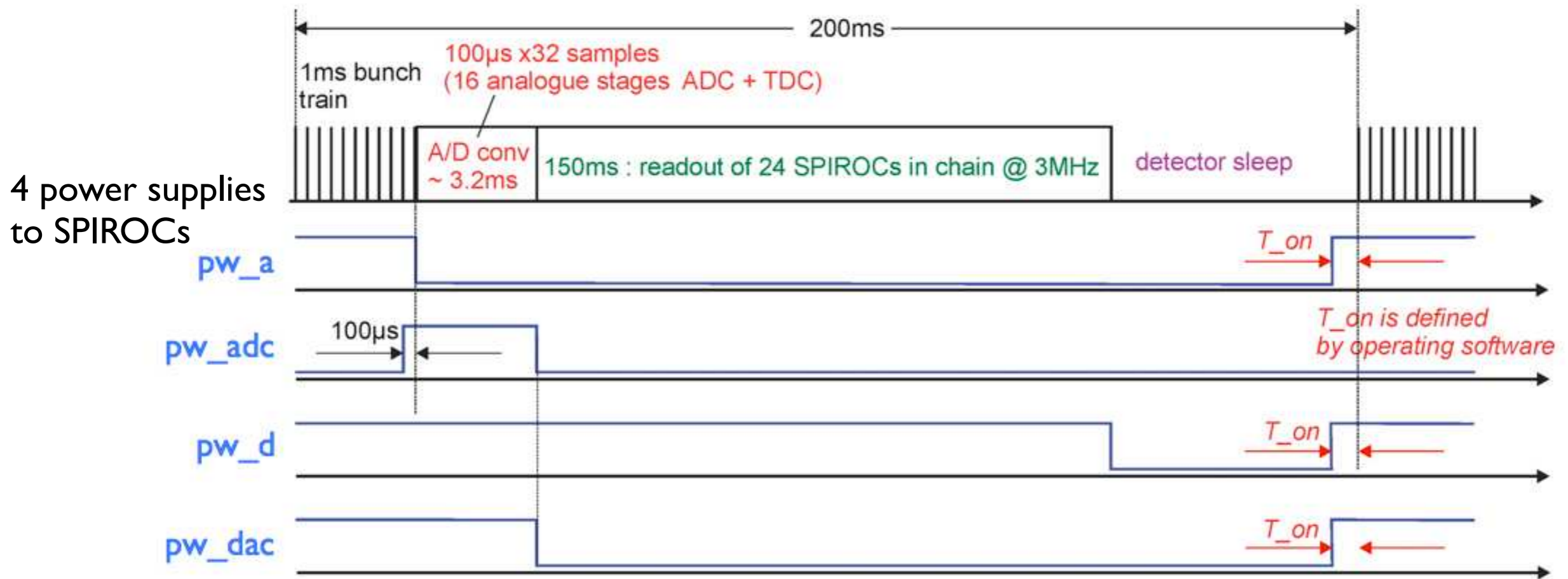
Scintillator tile

Mirror

SiPM

WLS guide

Concept of AHCAL Power pulsing

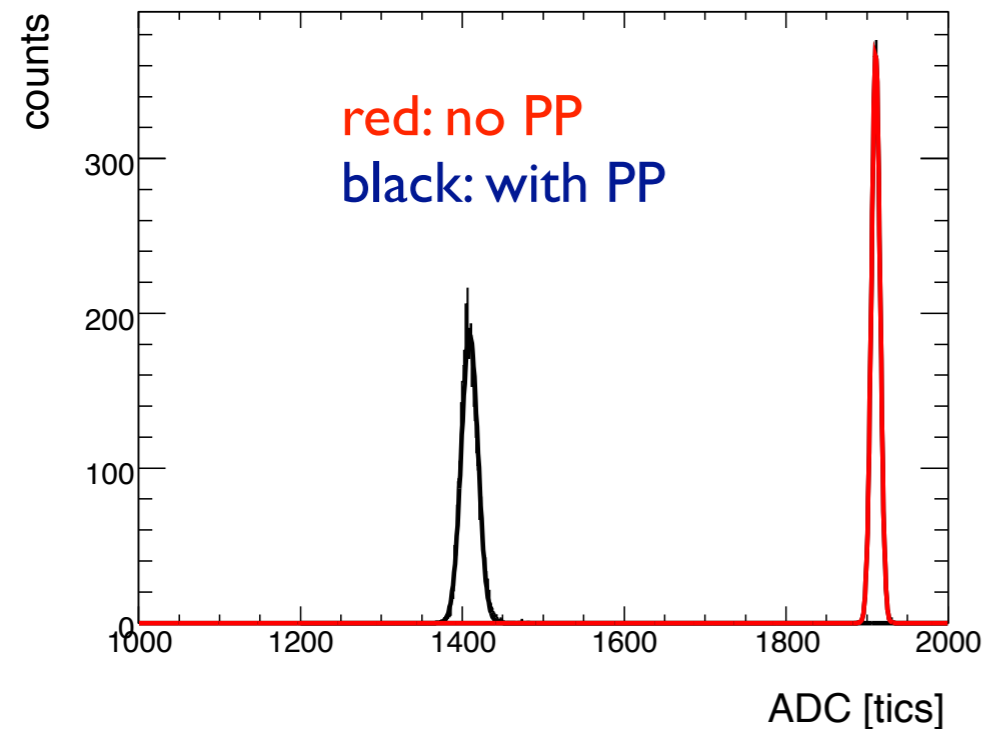


(B. Hermberg, M. Reinecke, M. Terwort (2012))

- ILC beam bunch structure: 1ms beam-on / 199ms off
- Turn off the power not in use
 - The power of SPIROC is delivered by 4 different power supplies
 - pw_a , pw_adc , pw_d , p_dac :
Power control signal for analog/ADC/digital/others part of SPIROCs
- Activation time T_{on} : How short can we make it? / what effect will limit T_{on} ?

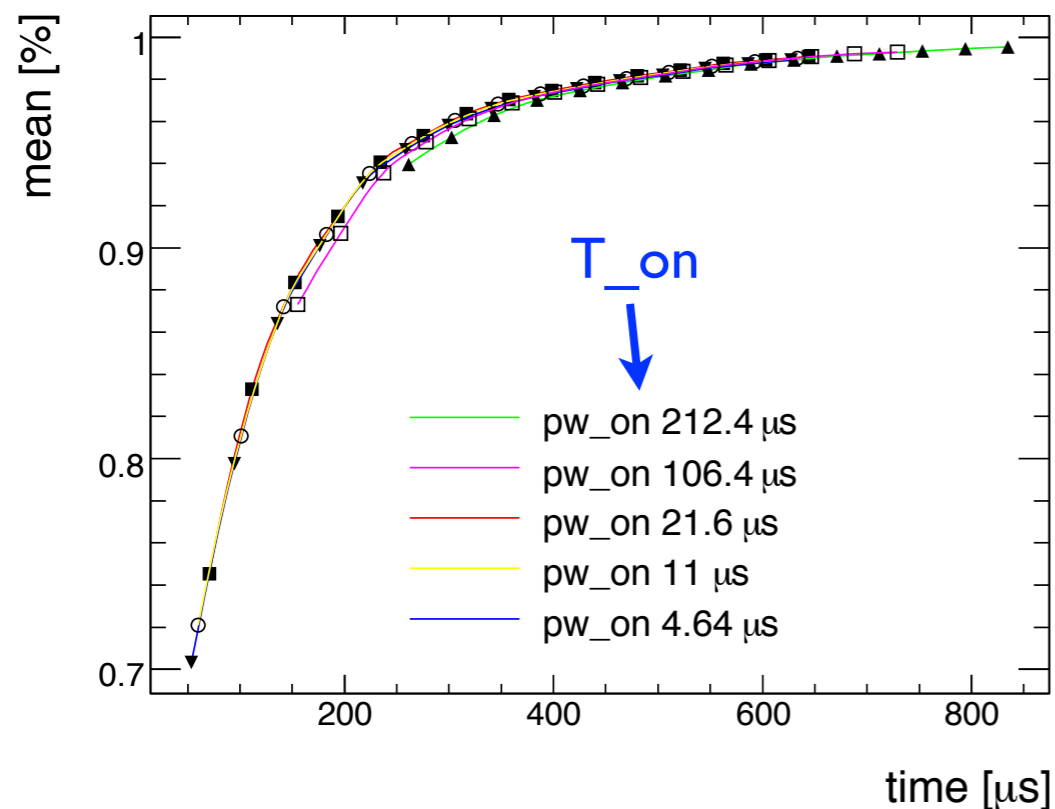
Previous study with charge injection with IHBU

by B. Hermberg



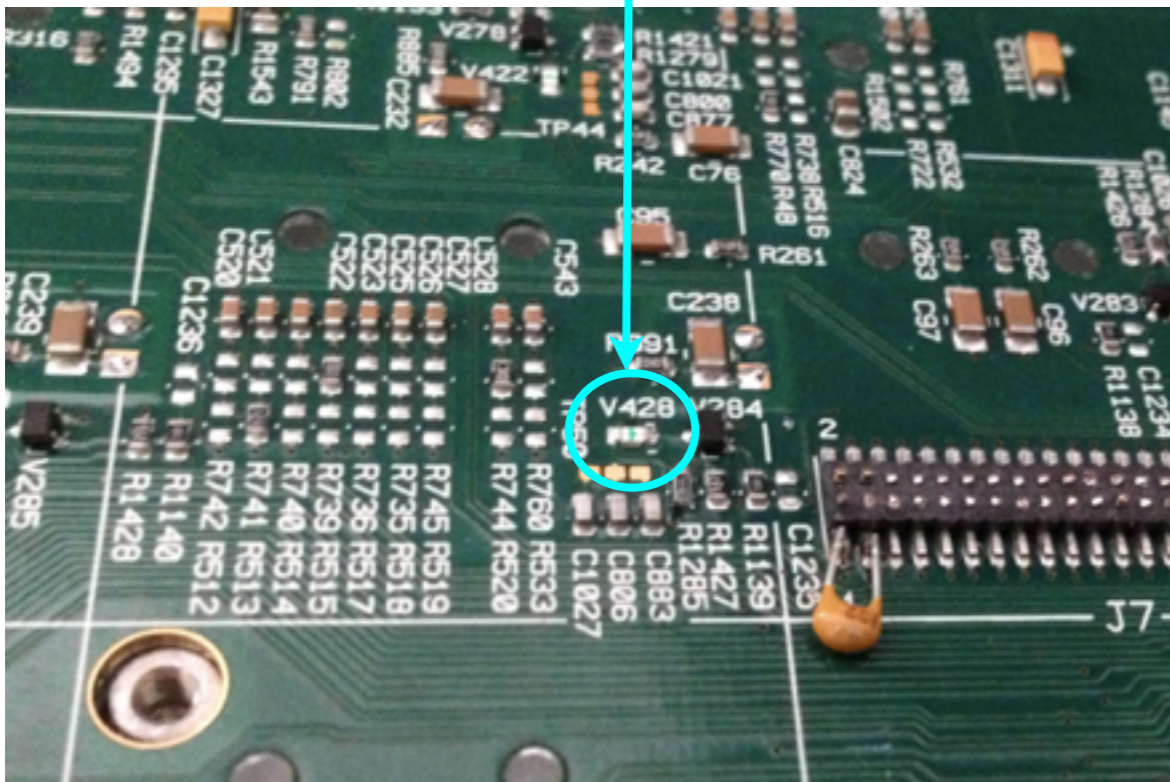
- Shoot charge pulse directly into SPIROCs
Checked the output signal
- Amplitude drops in the beginning
- Need ~ 1 ms to stabilize
Many discussions, but not understood
Measurements with different setup might give clues
- Data quality after 1ms looks nice
Test with more realistic setup

⇒ Scintillator + SiPM system / multi-HBUs !!



Setup

Calibration LED on each channel



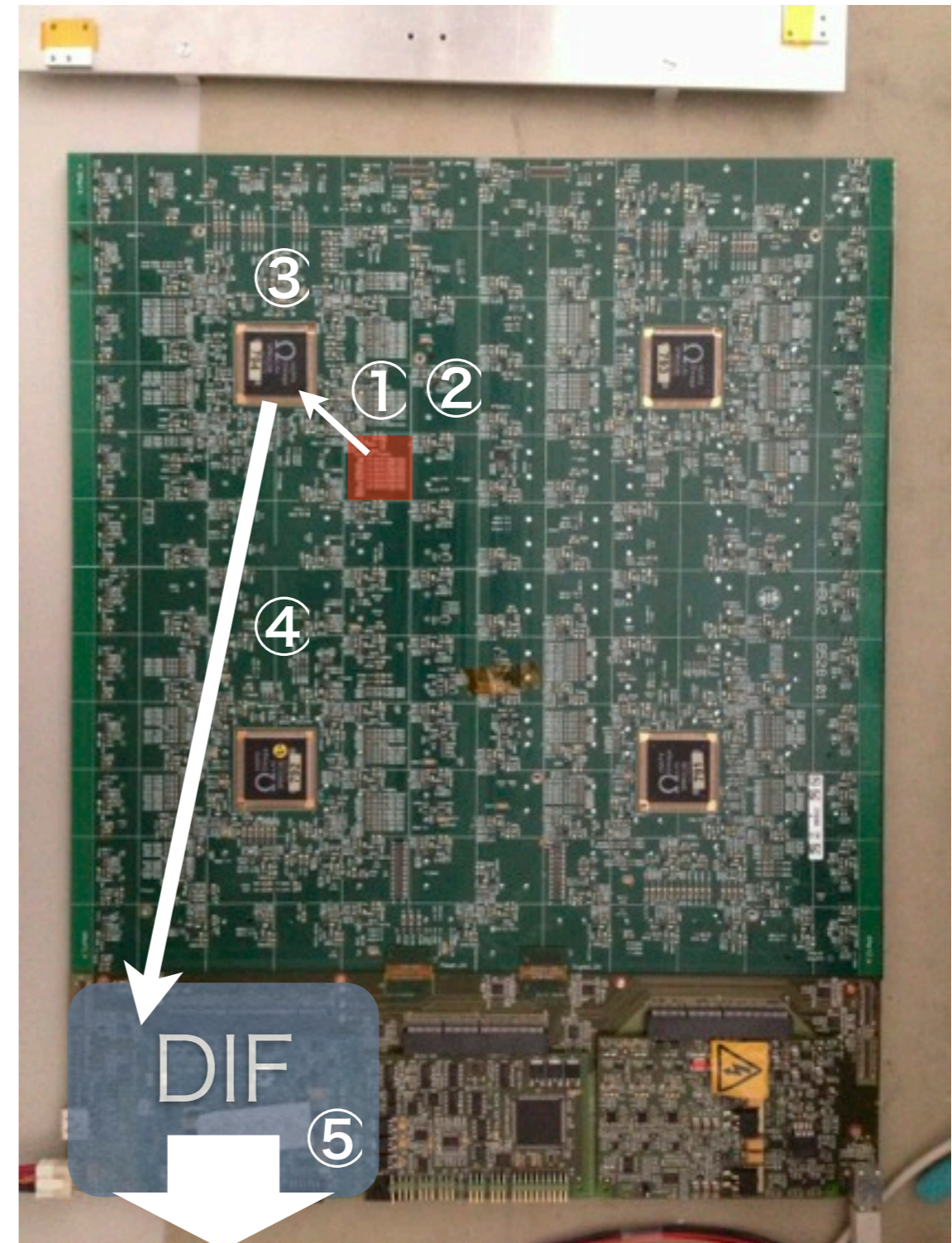
① LED light → Scintillator → SiPM raw signal

② Goes to ASICs via wires (same as charge injection)

③ ASICs process trigger, shaping, digitizing etc.

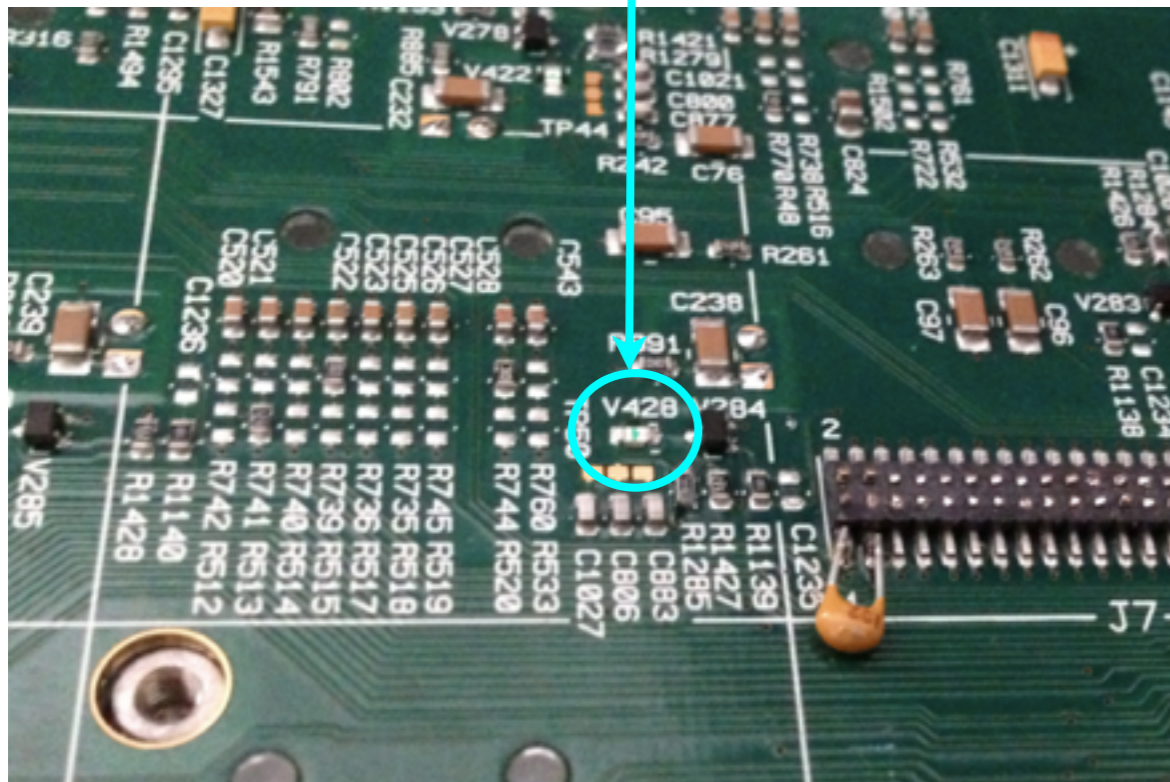
④ Stored in the memory in ASICs

⑤ When one memory of channel becomes full, signals are readout to DIF board then outside

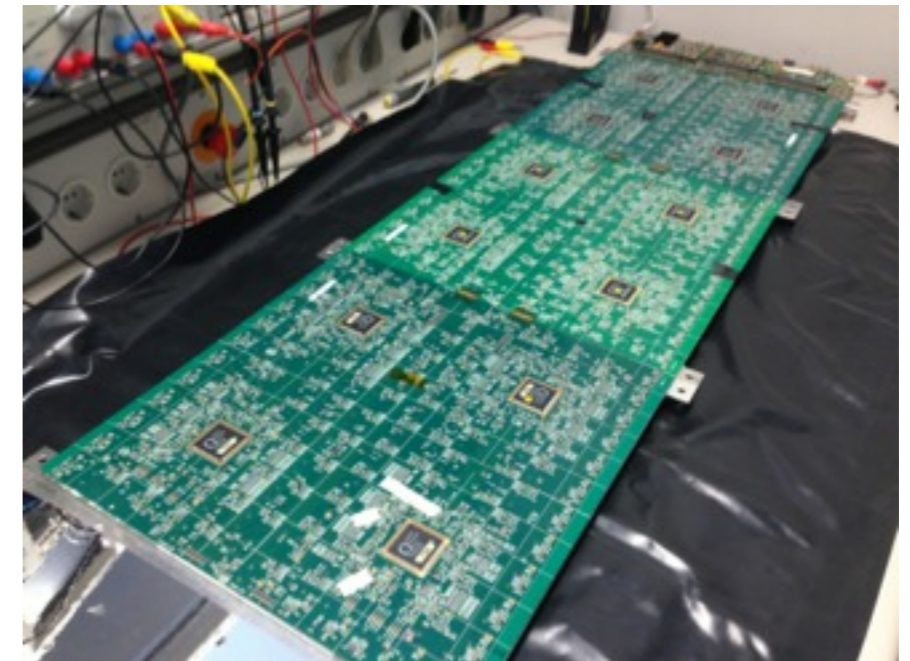


Setup

Calibration LED on each channel



- 1HBU setup
- 3HBU setup
- 6HBU setup (ILD model)



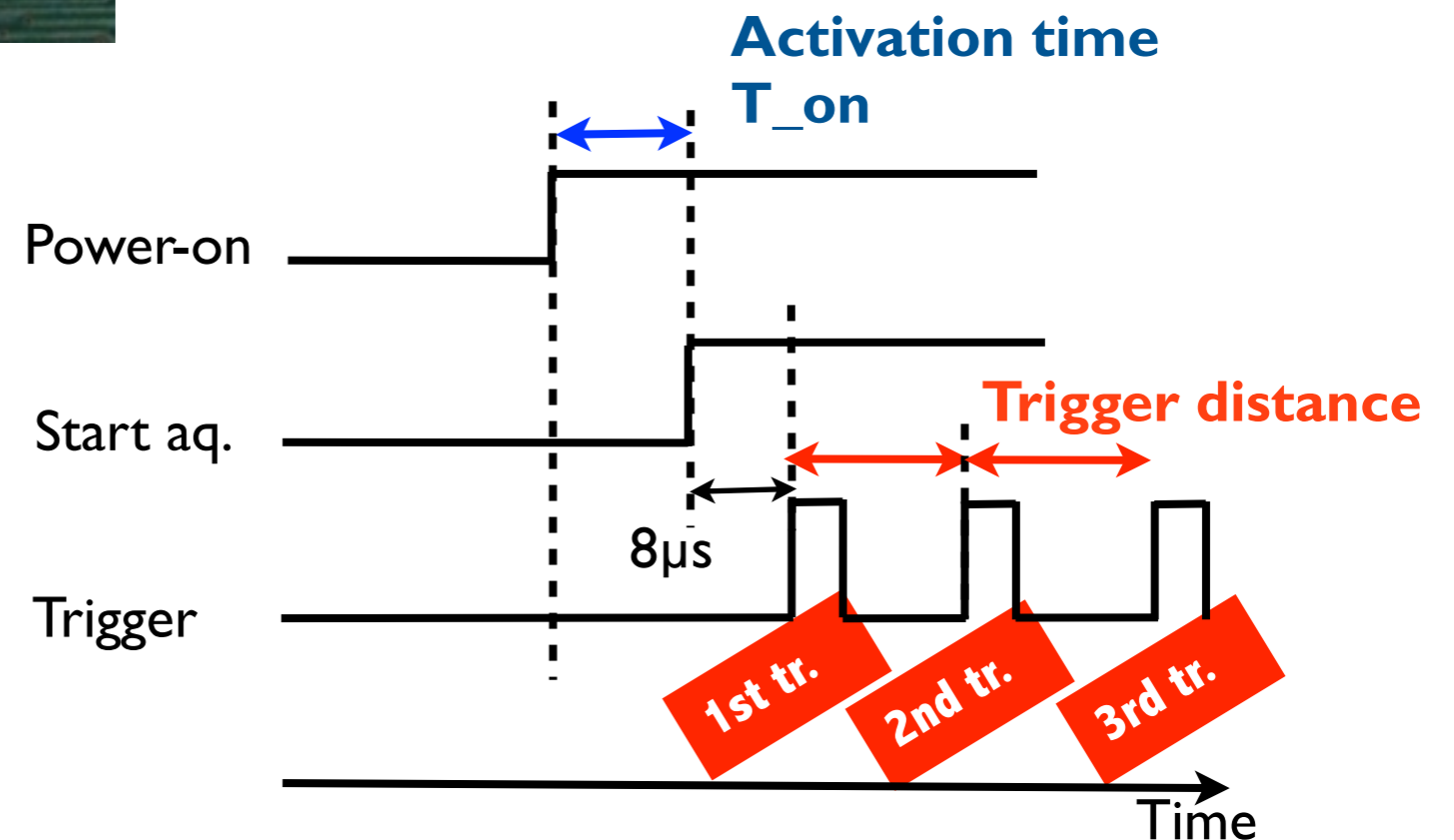
■ Analysis

- Shape
- Amplitude, Gain

■ External trigger mode

Clocked by DIF

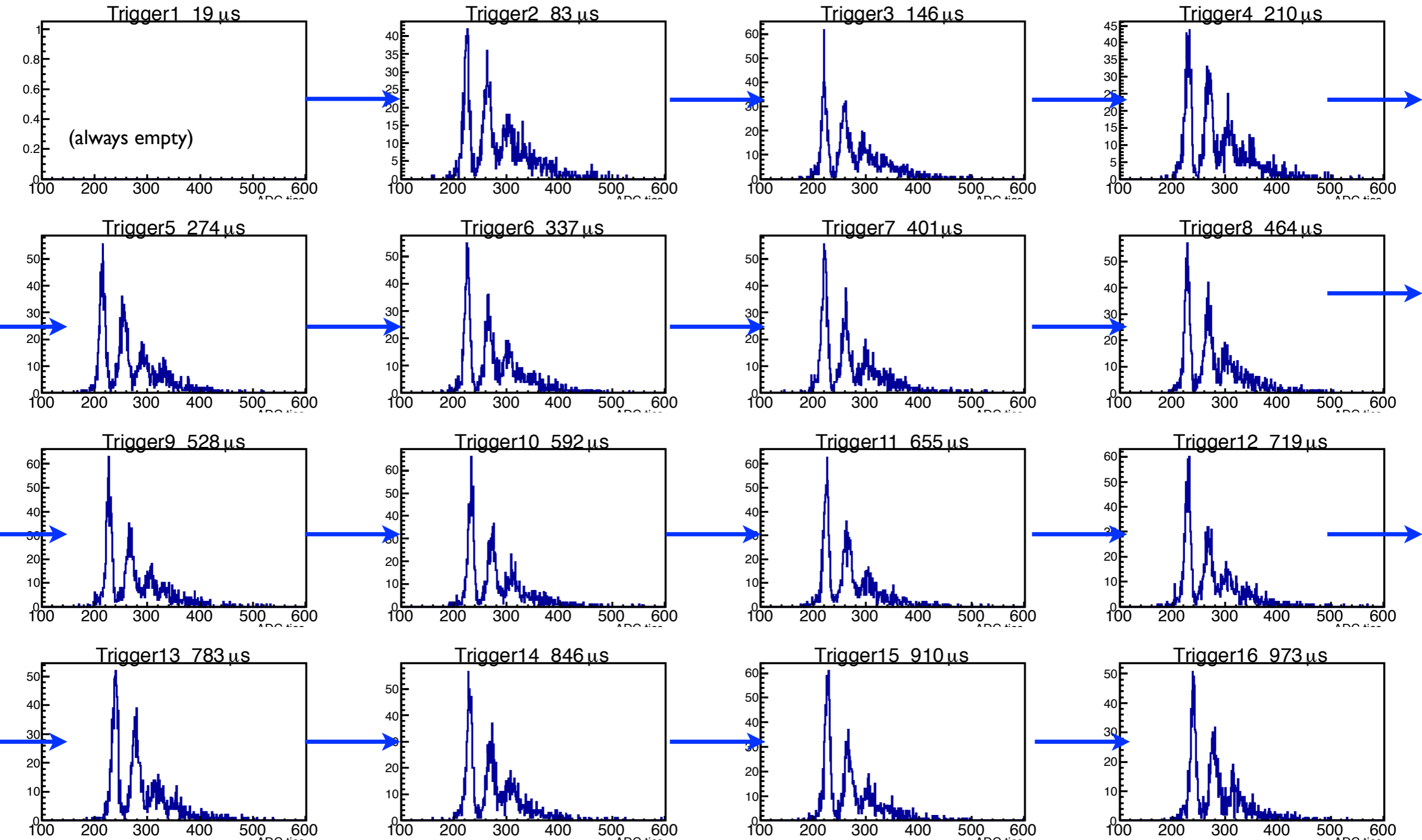
- Varying T_{on} , trigger distance, number of HBUs (1,3)



1HBU - noPP mode

$T_{on}: 11\mu s$
trigger distance: $60\mu s$

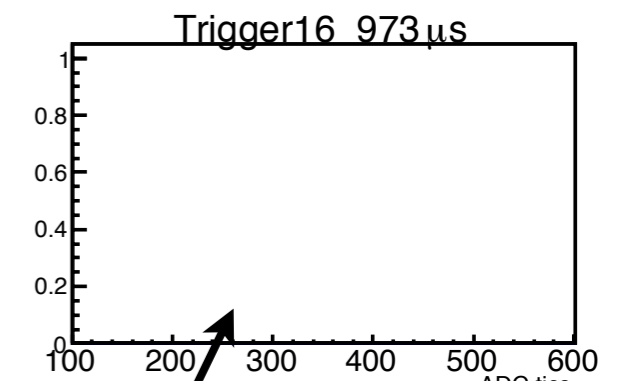
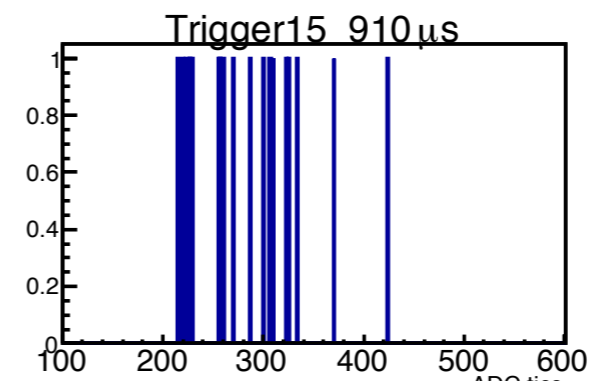
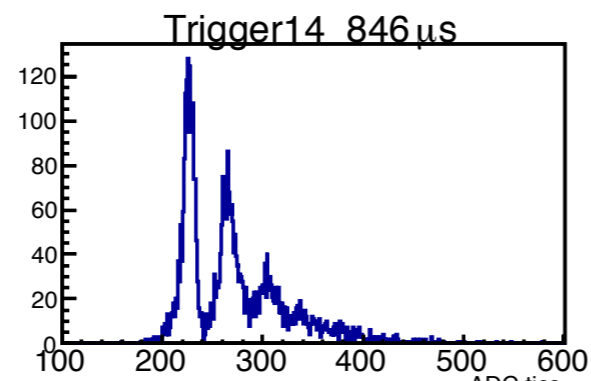
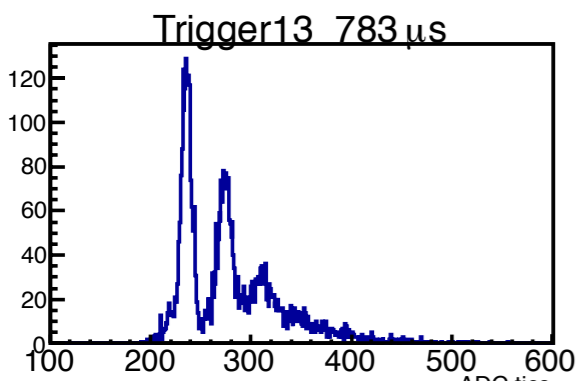
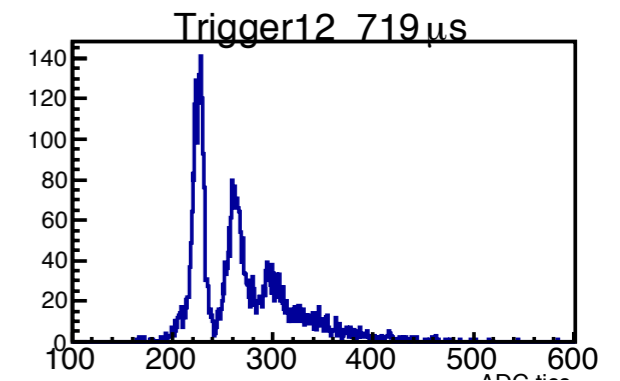
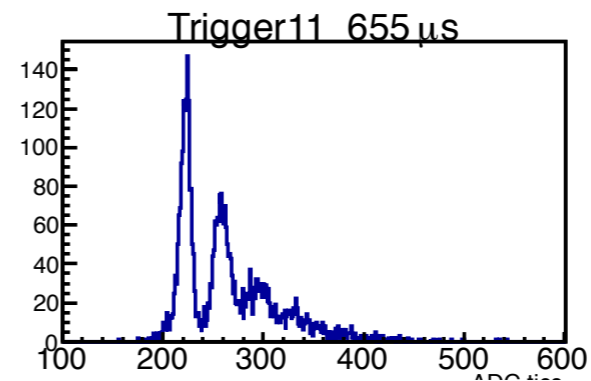
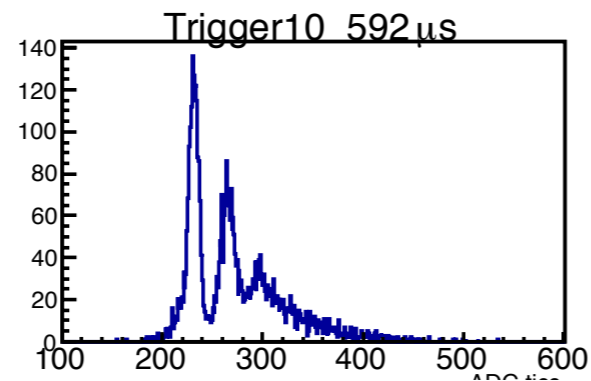
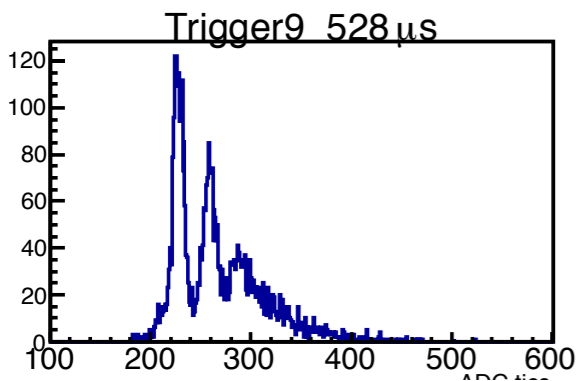
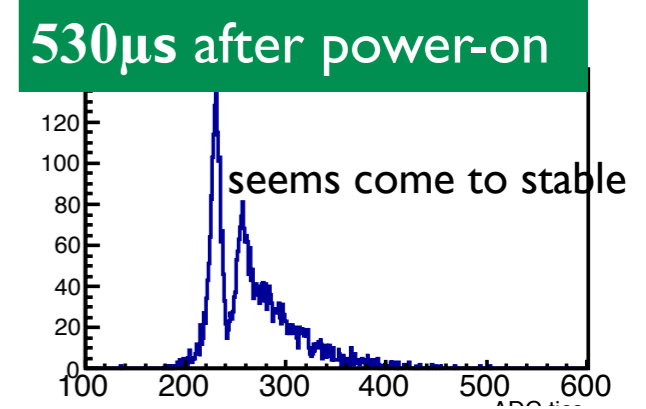
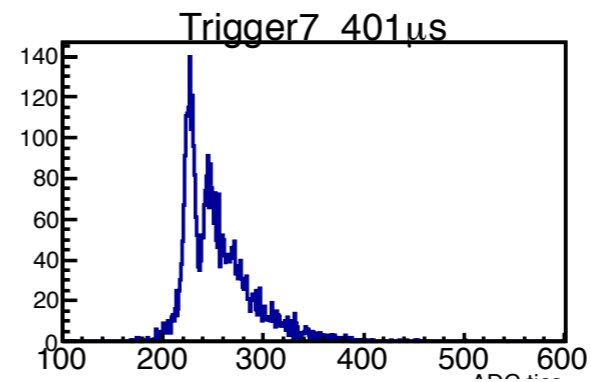
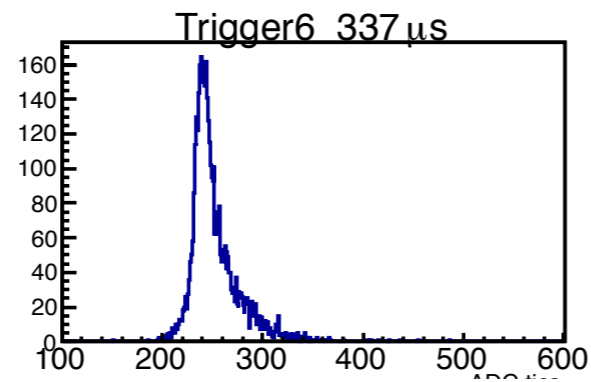
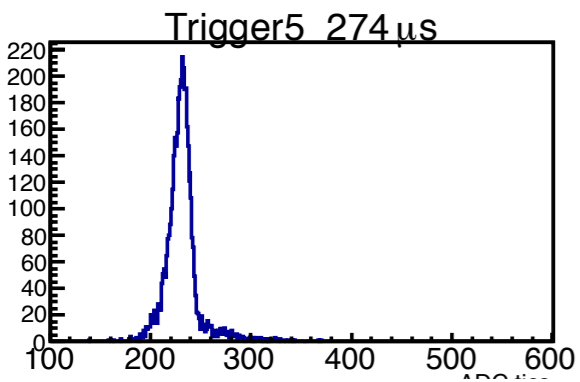
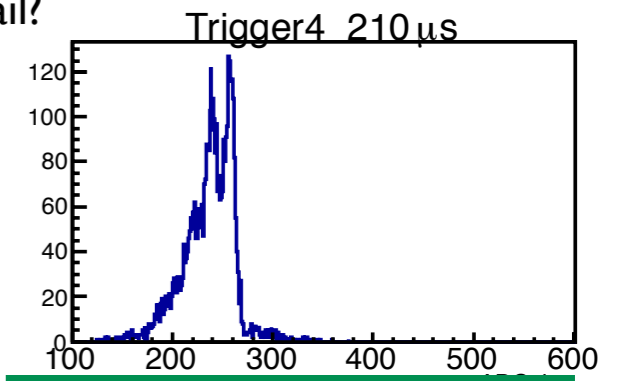
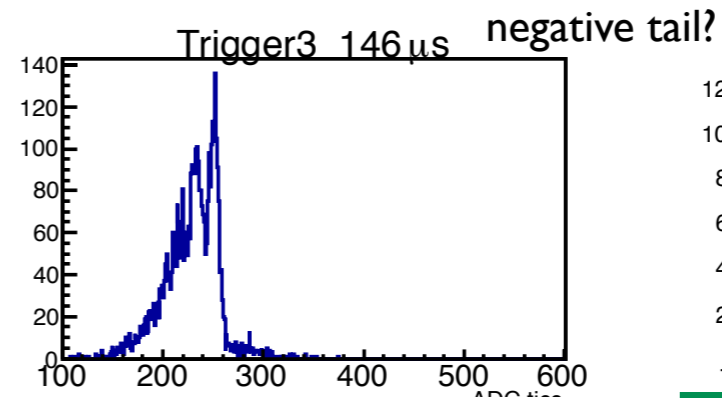
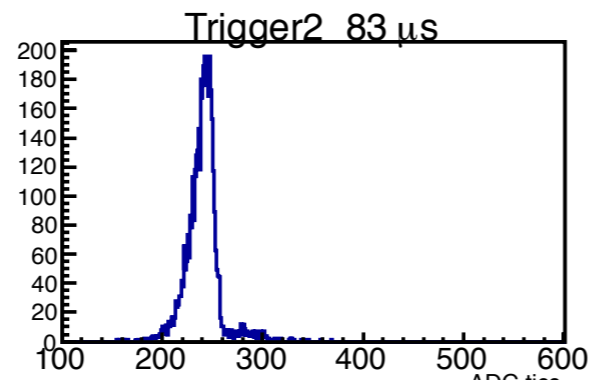
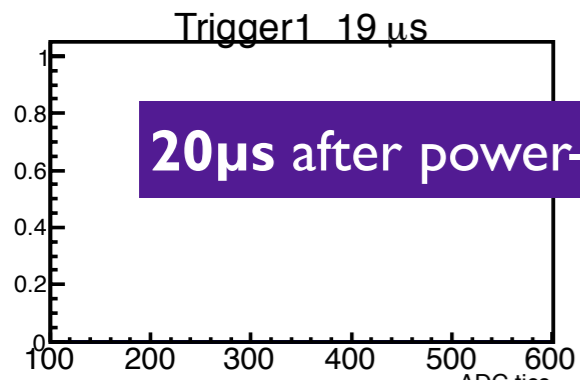
(Chip 213, channel 10)



1HBU - PP mode

$T_{on}: 11\mu s$
trigger distance: $60\mu s$

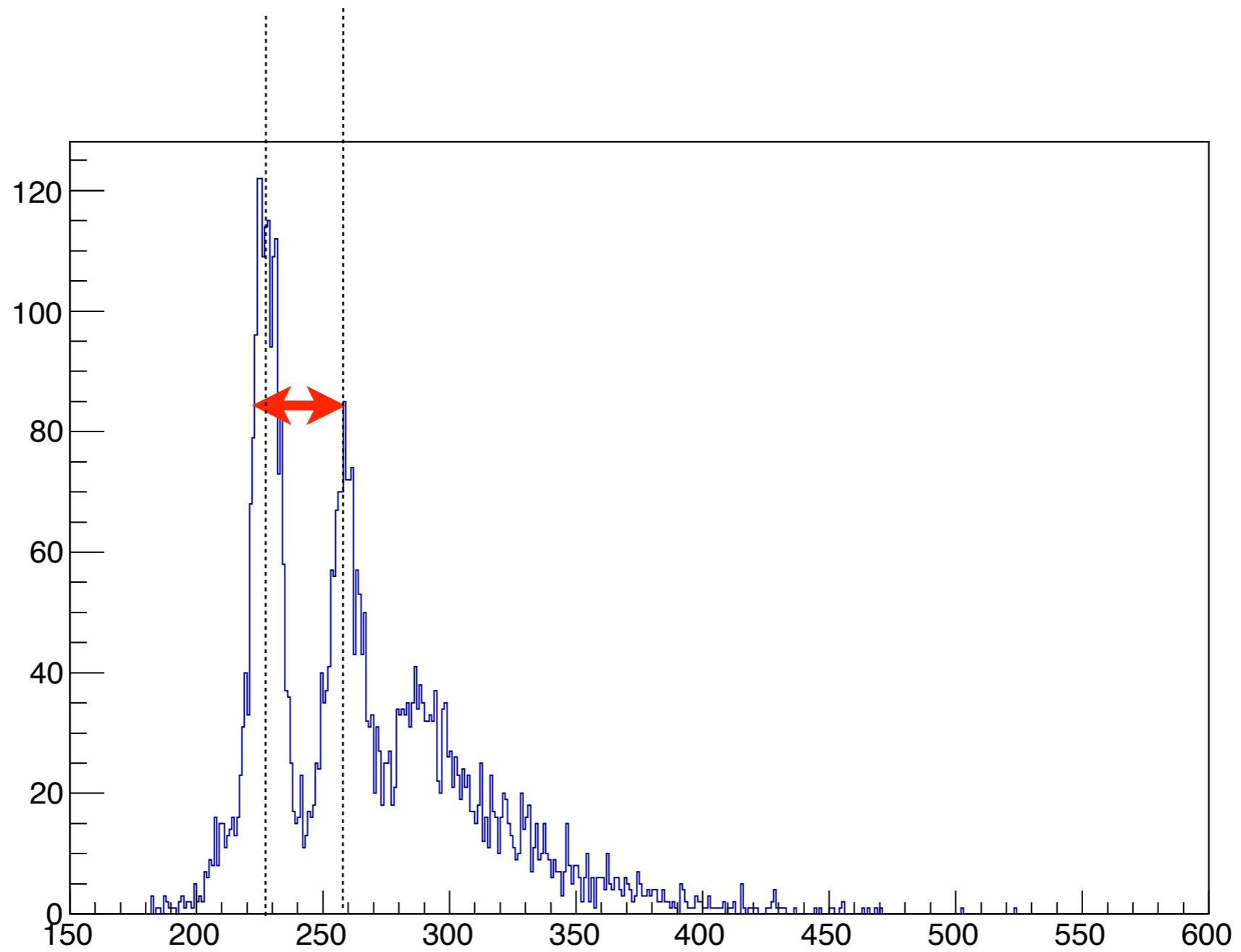
Crazy shortly after power-on,
gradually come to normal



(empty due to bugs of DIFs)

Gain

Peak distance between pedestal and I.p.e



Gain IHBU

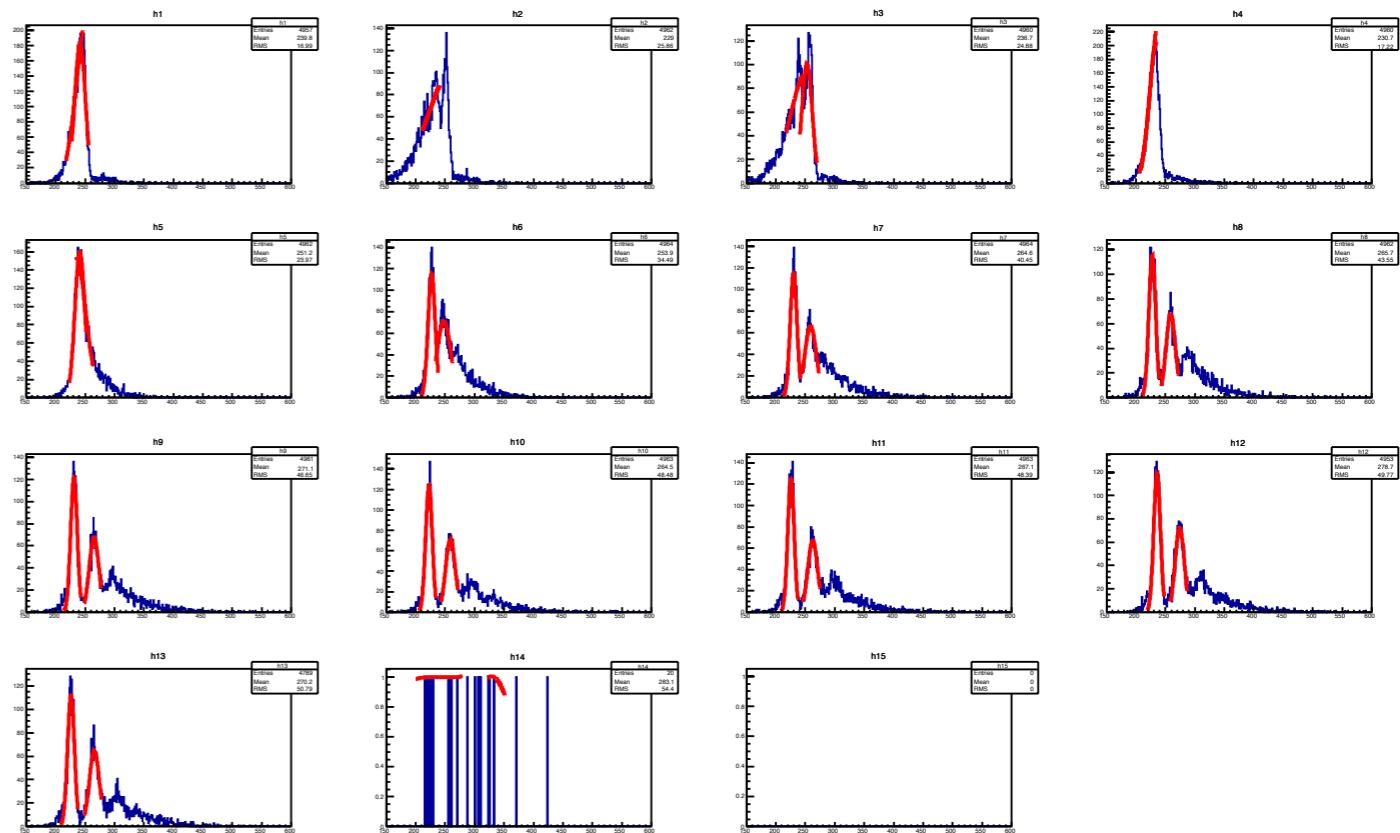
Gain drops
restore with $\tau \sim 1\text{ms}$

(noPP)

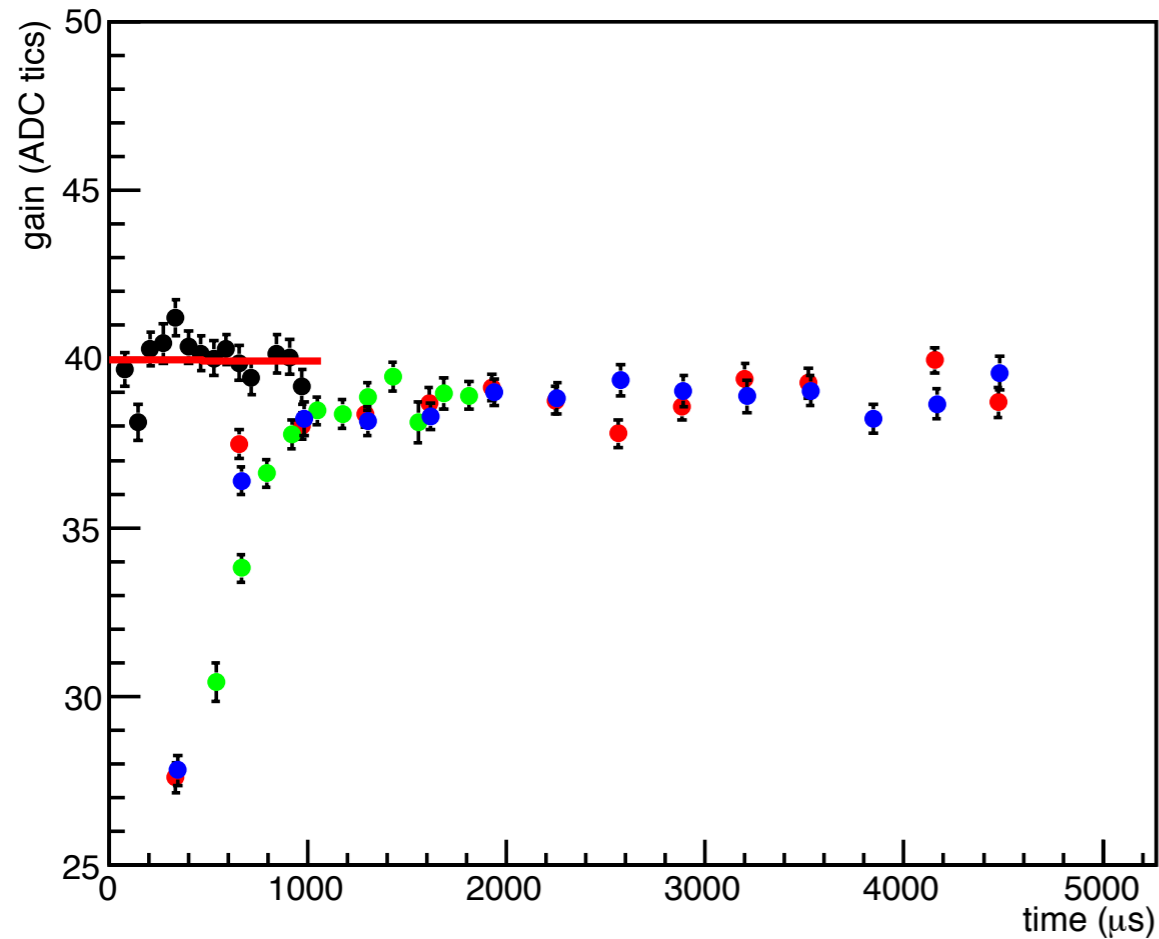
(PP) $T_{\text{on}}: 11\mu\text{s}$, trigger distance $330\mu\text{s}$

(PP) $T_{\text{on}}: 22\mu\text{s}$, trigger distance $63\mu\text{s}$

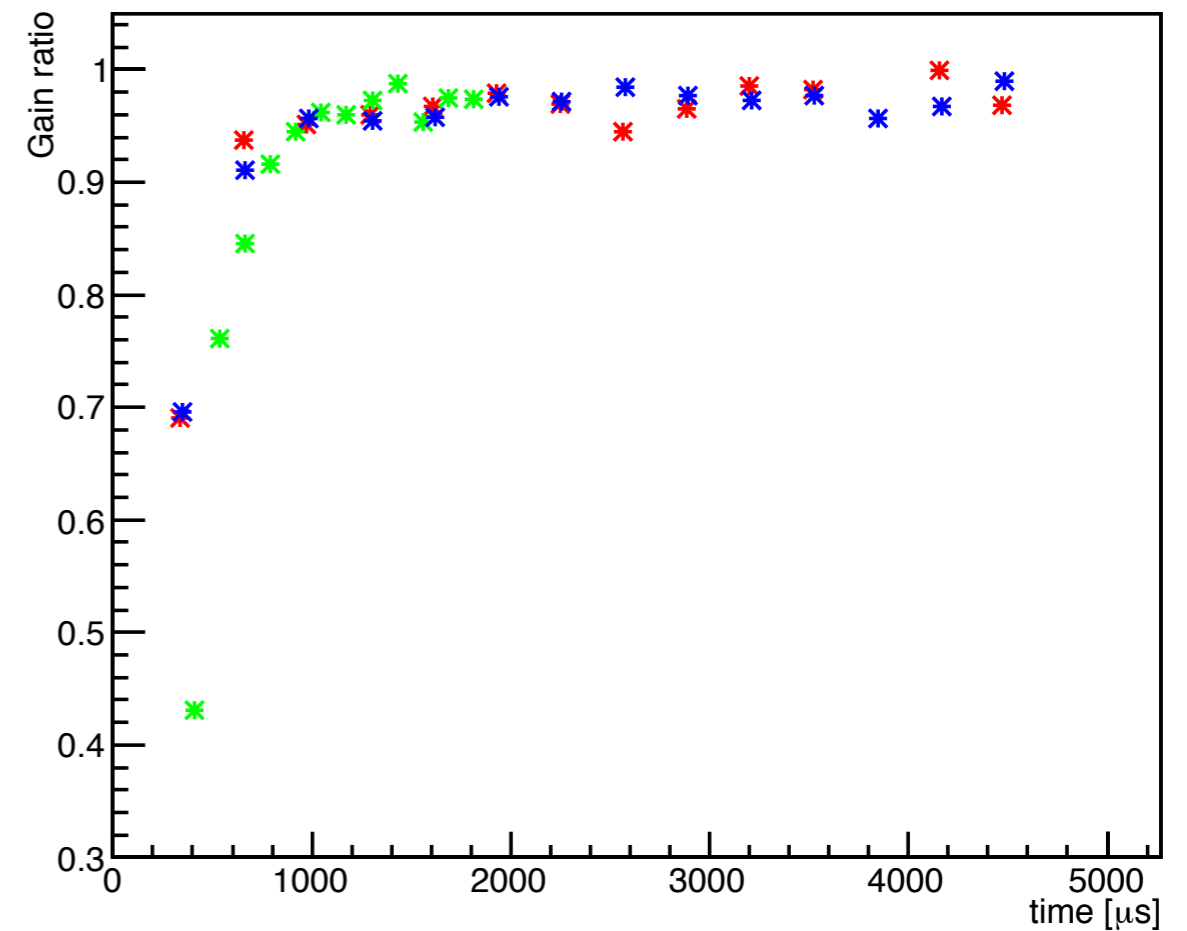
(PP) $T_{\text{on}}: 22\mu\text{s}$, trigger distance $330\mu\text{s}$



Gain



Gain ratio of w/ to w/o PP mode

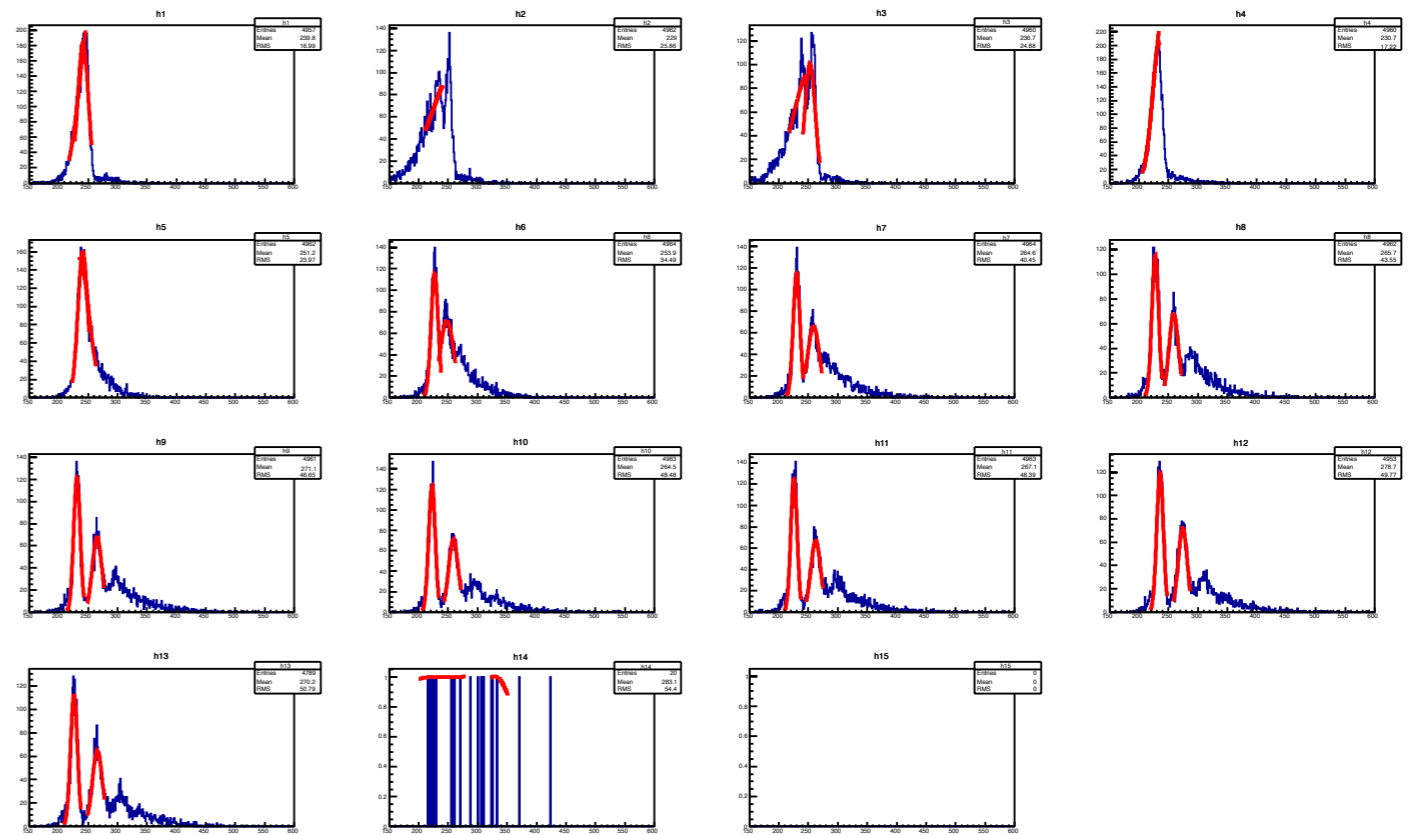


Gain IHBU

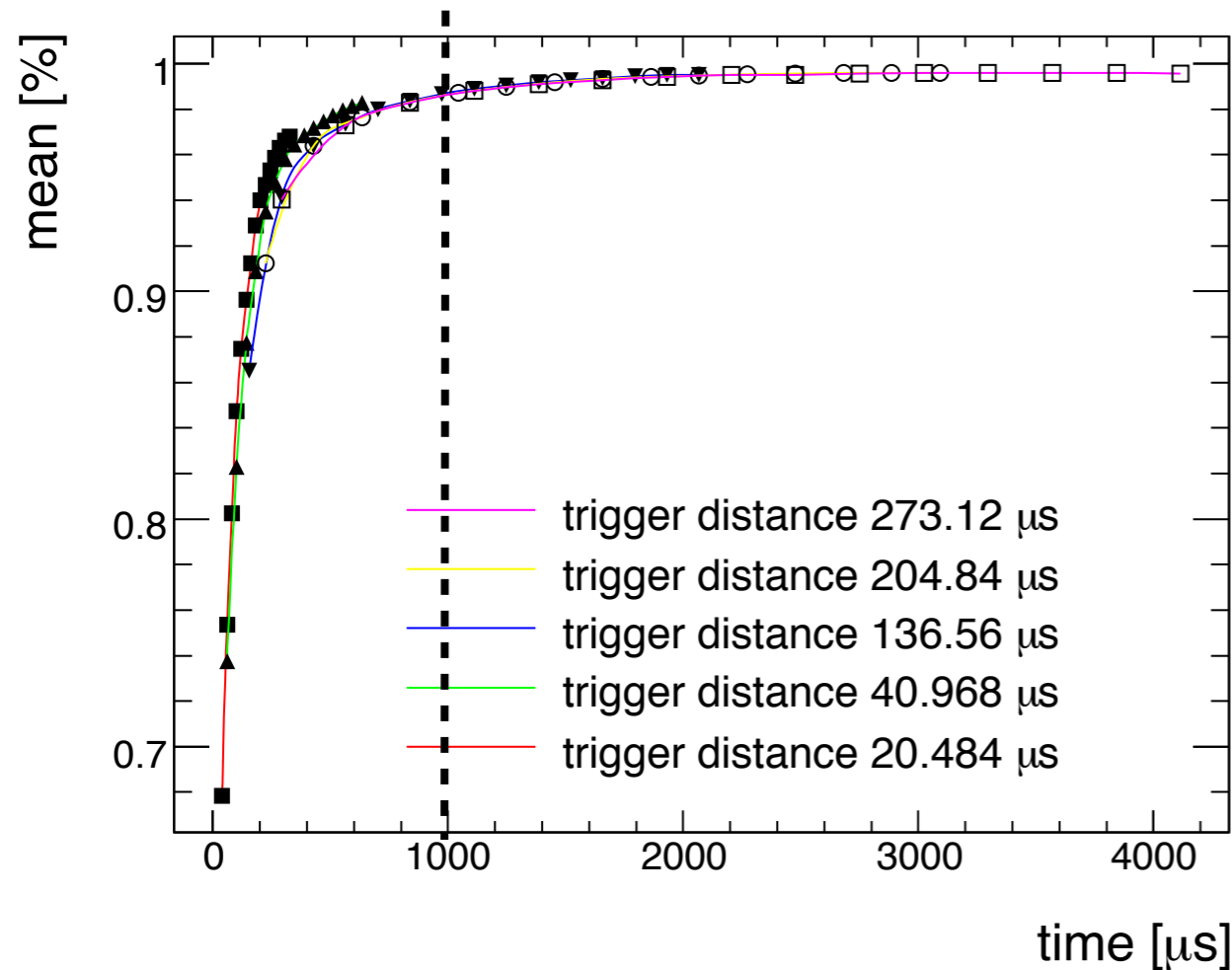
Gain drops
restore with $\tau \sim 1 \text{ms}$

Comparison with charge injection

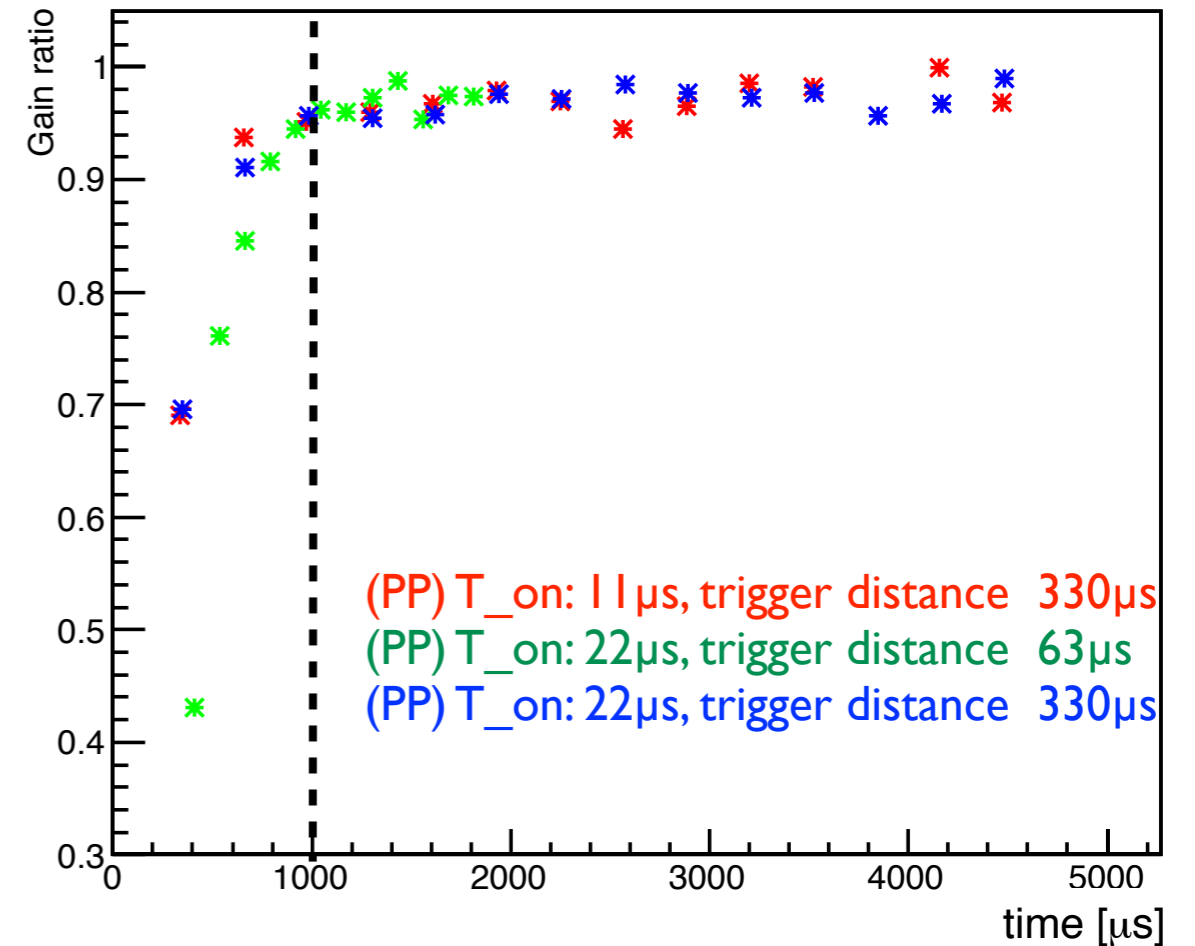
Consistent behavior



Charge injection



LED-SiPM

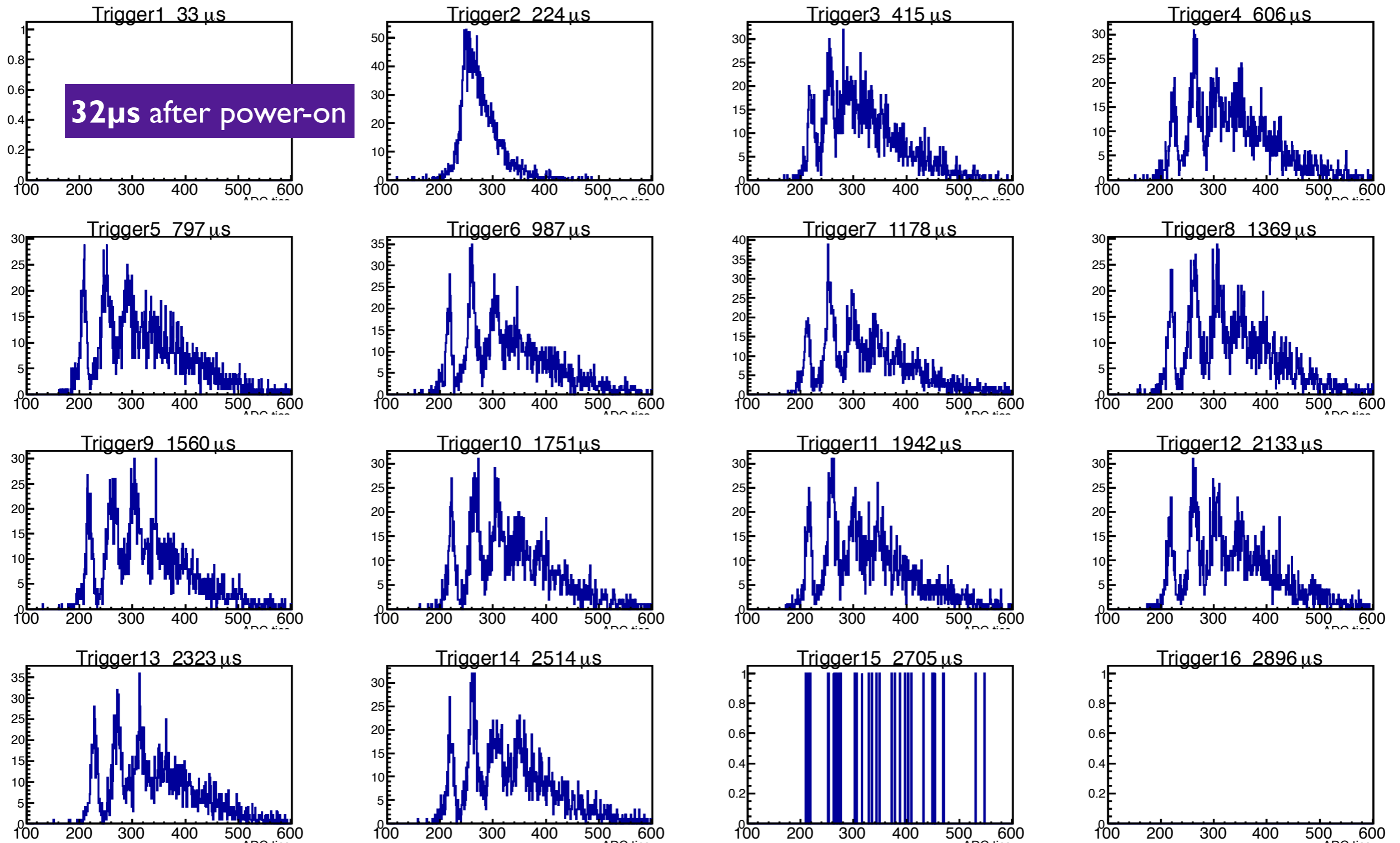


3HBU - PP mode

$T_{on}: 24\mu s$
trigger distance: $190\mu s$

(Chip 213, channel 10)

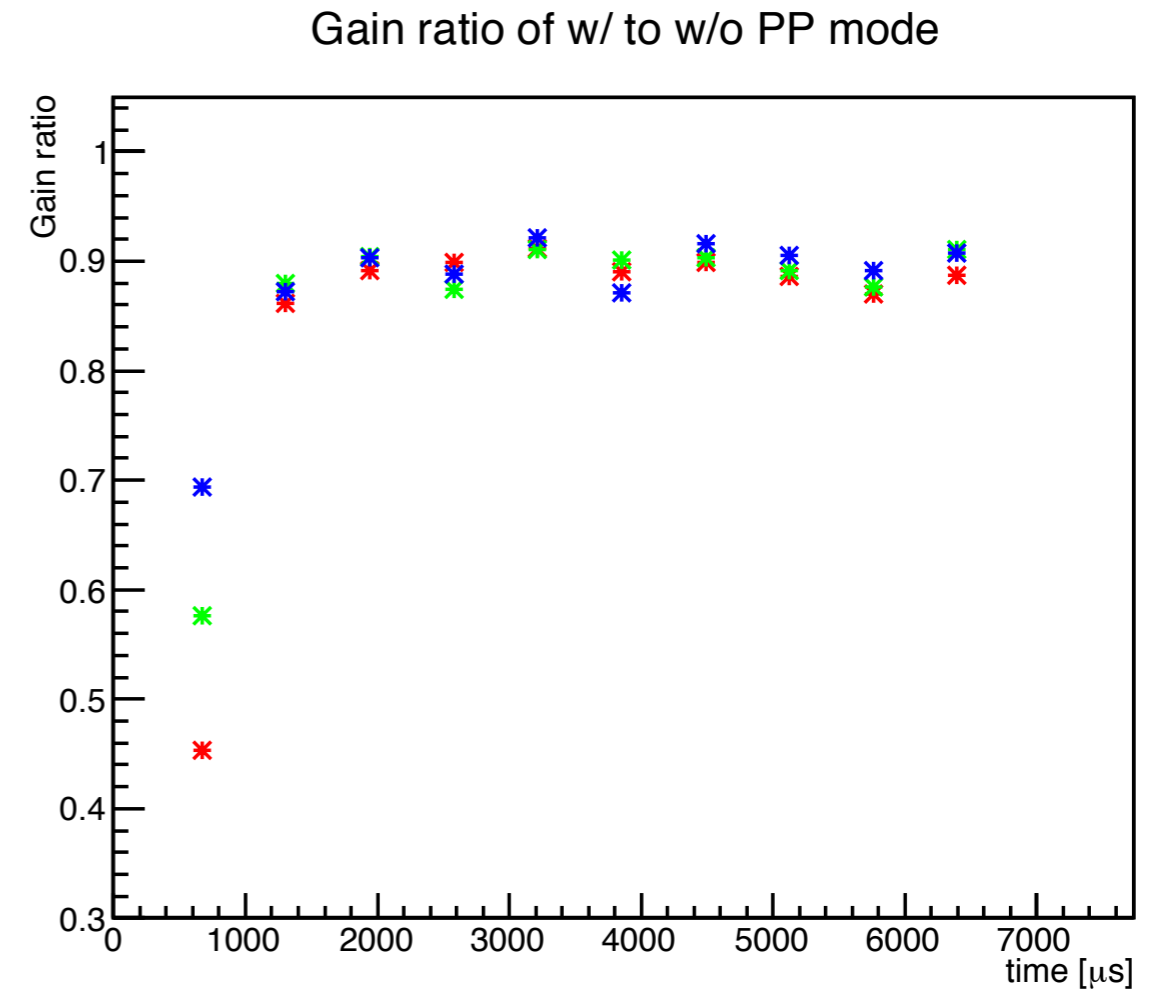
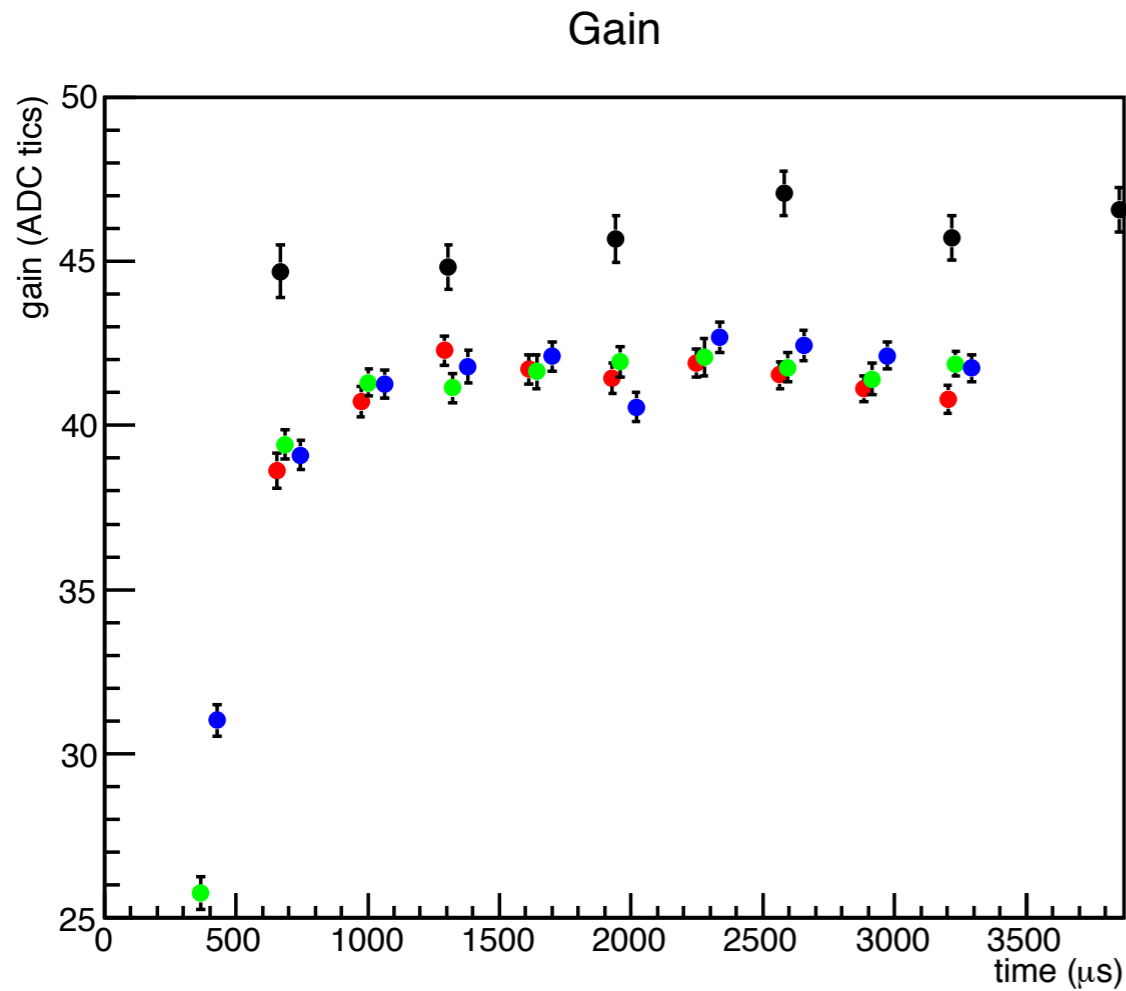
signal quality is fine after the duration



32 μs after power-on

3ms after power-on

Gain 3HBU setup



(noPP)

(PP) T_{on} : 11 μs , trigger distance 330 μs

(PP) T_{on} : 42 μs , trigger distance 330 μs

(PP) T_{on} : 110 μs , trigger distance 330 μs

Saturate with $\sim 2\text{ms}$

NOT restore completely?

More channels should be checked

Discussion

Why does gain drop?

- Not the problem of SiPM
Same effect (quantitatively) in charge injection
Pre-amp gain looks actually drops

- Stabilization time depends on #HBUs
⇒ At least not only the problem of SPIROCs

The power supply to the analog part of the SPIROC (VDDA) is directly checked via oscilloscope.

- 1HBU:
VDDA shows a drop ($\sim 25\text{mV}$) after power-on. $\tau \sim 1\text{ms}$

- 3HBU:
Voltage drop $\sim 100\text{mV}$, $\tau \sim 2\text{ms}$

Clue?

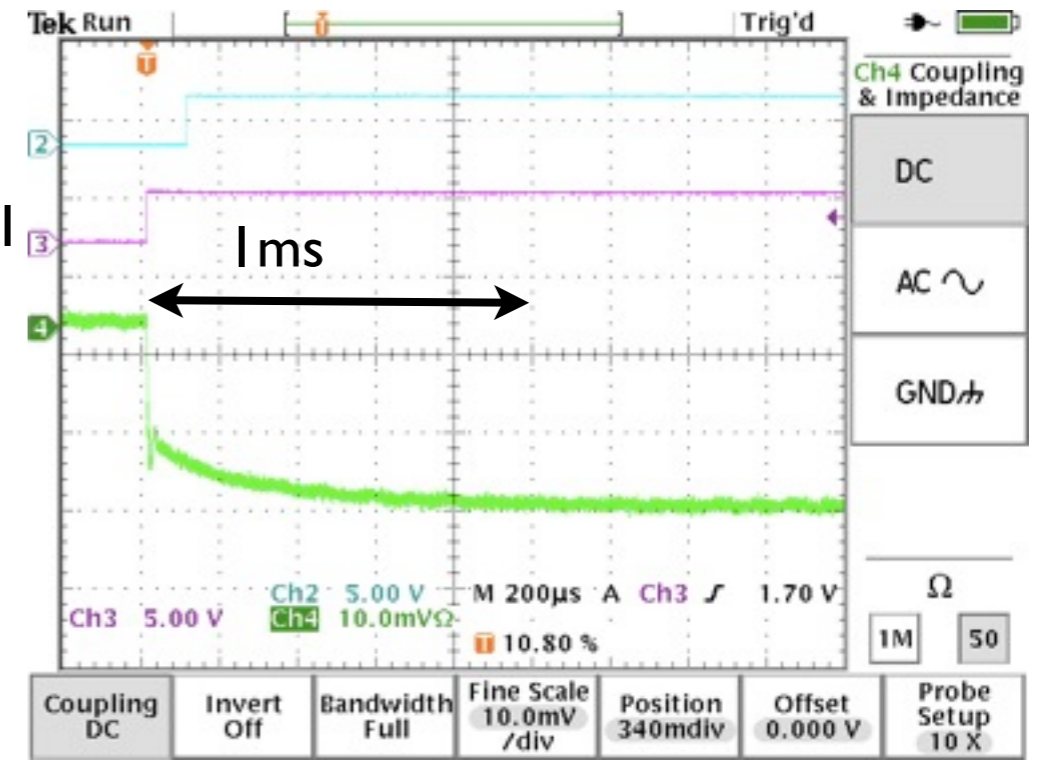
→ VDDA should not affect gain

Start aq.

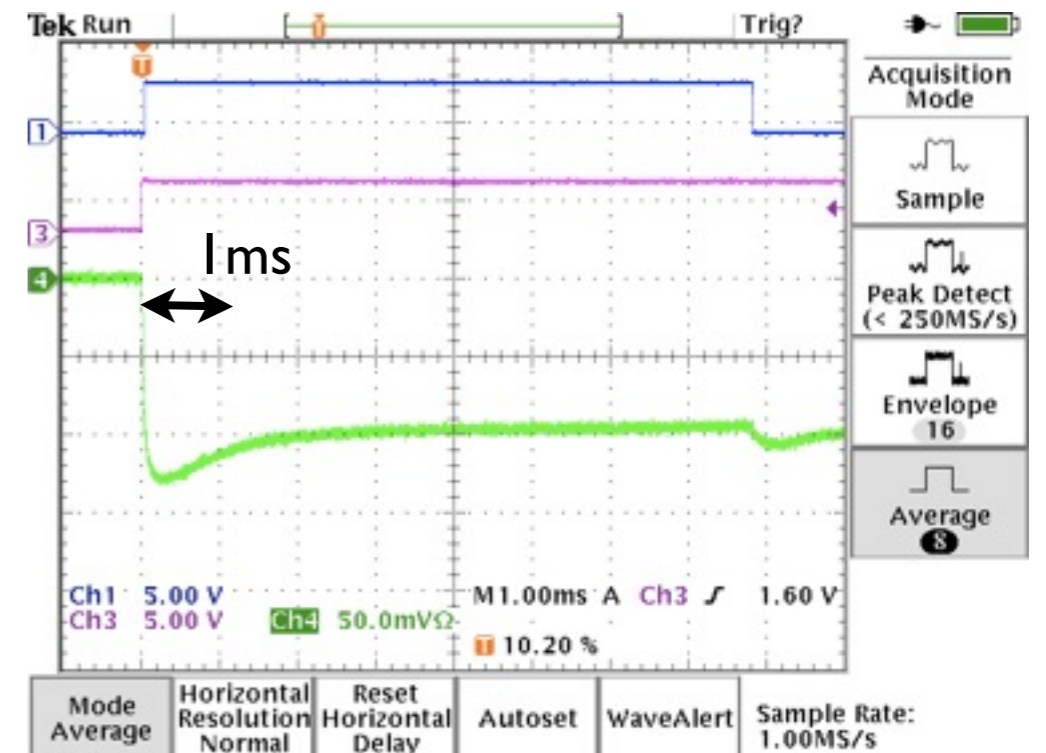
Power control

VDDA

1HBU



3HBU



Summary

- Power pulsing measurement with HBU-LED setup is on going
- Good quality data can be acquired with power pulsing operation after $1\sim 2\text{ms}$, even with 3HBU setup
- Gain drop is confirmed quite consistently with the result of charge injection study
- But the reason is still not clear, need further investigation

Outlook

- Further analysis on gain / pedestal
- 6HBU setups measurement are ongoing

Acknowledgement

Many thanks for Katja, Mathias, Ali, Coralie, Oskar



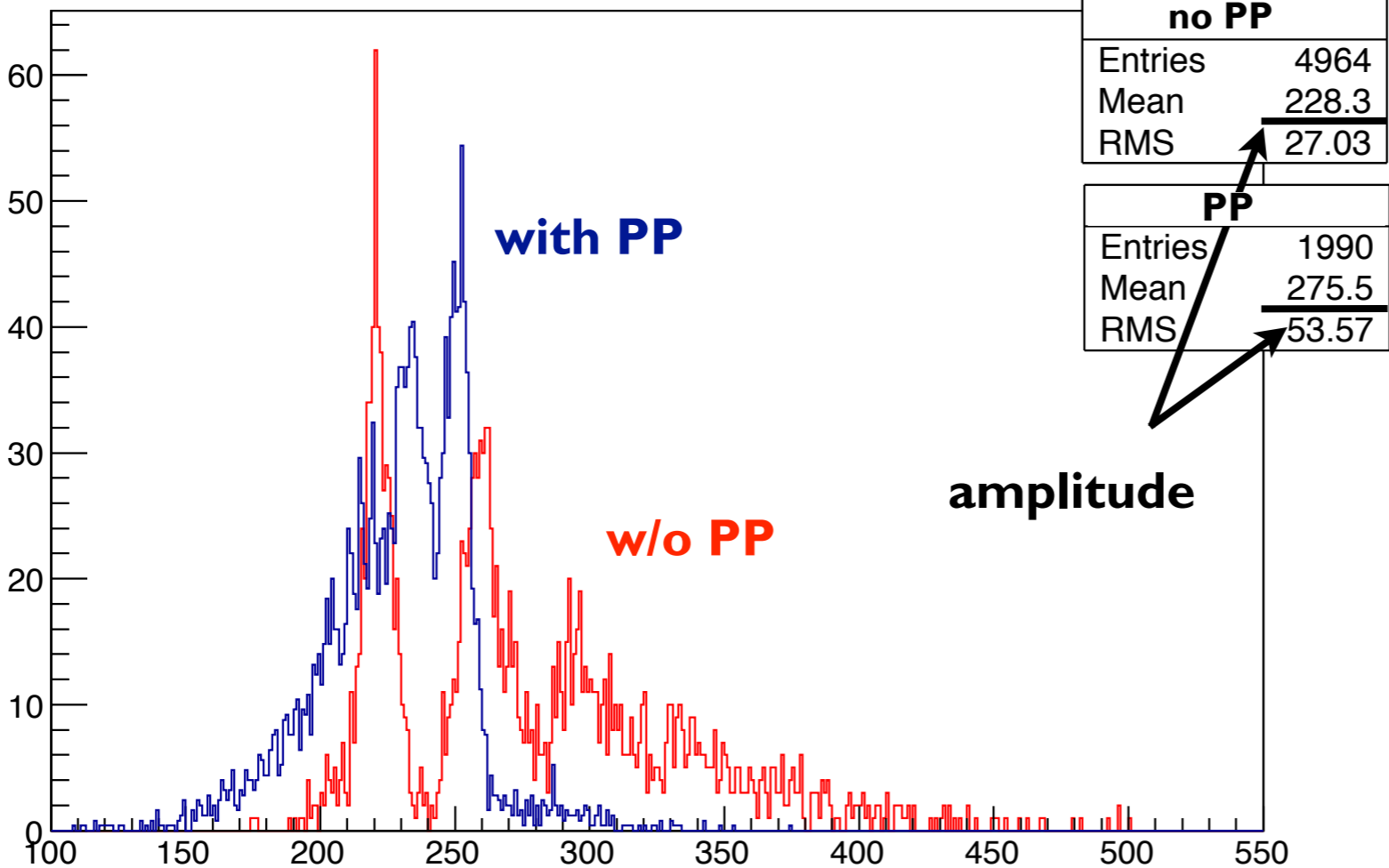
Thank you for the attention





Backup

Amplitude

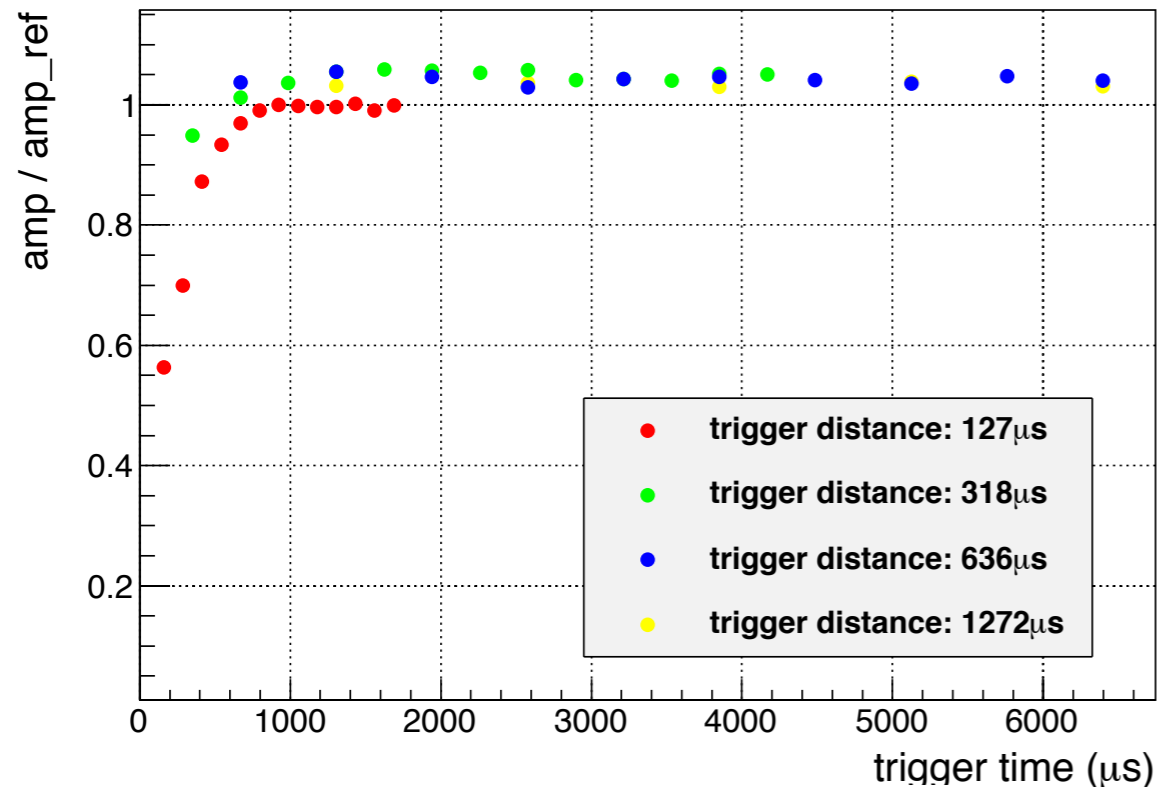


Compare the amplitude between w/ and w/o PP

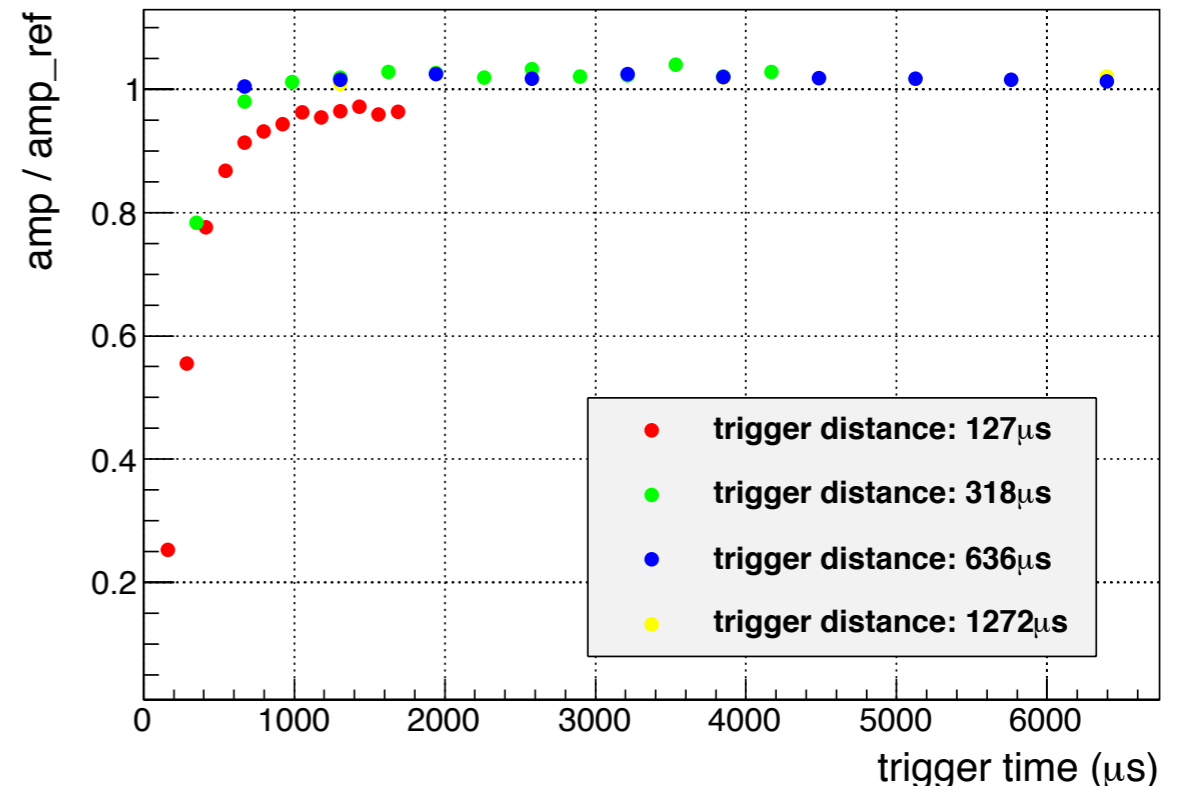
1HBU amplitude curve

Ratio of amp. w/ PP to w/o PP

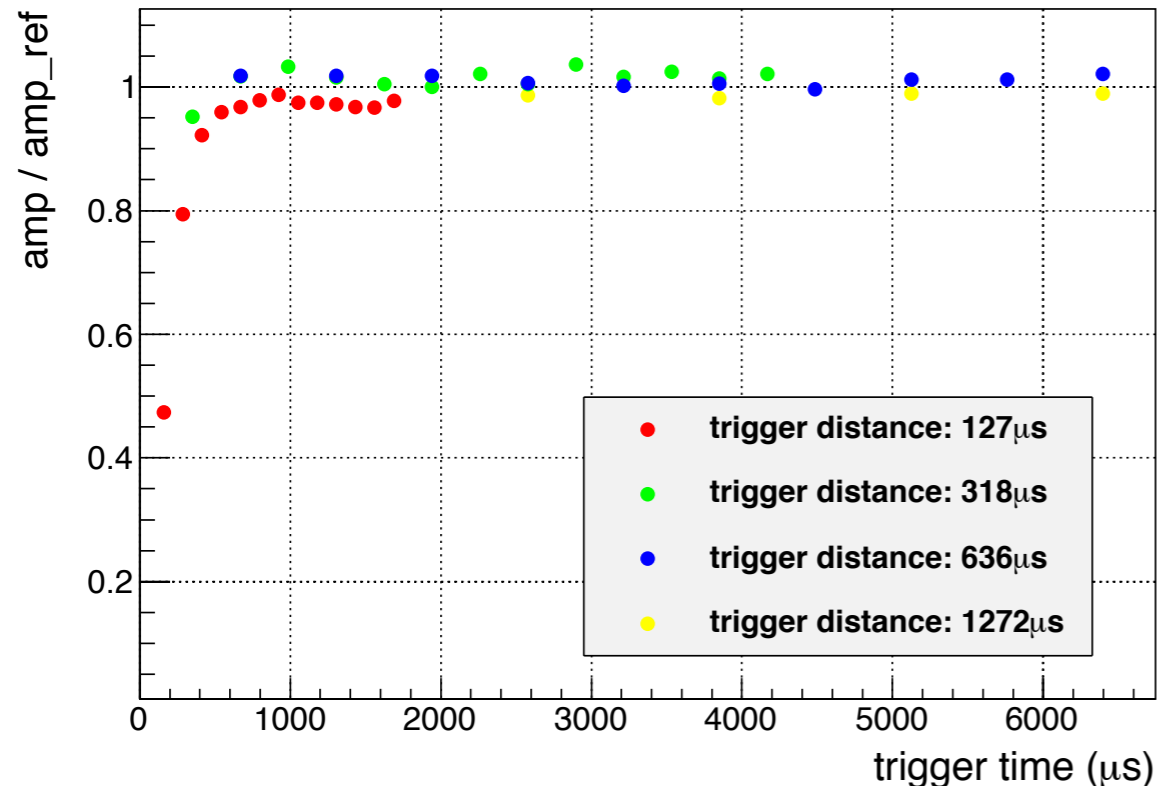
chip:213 chn10



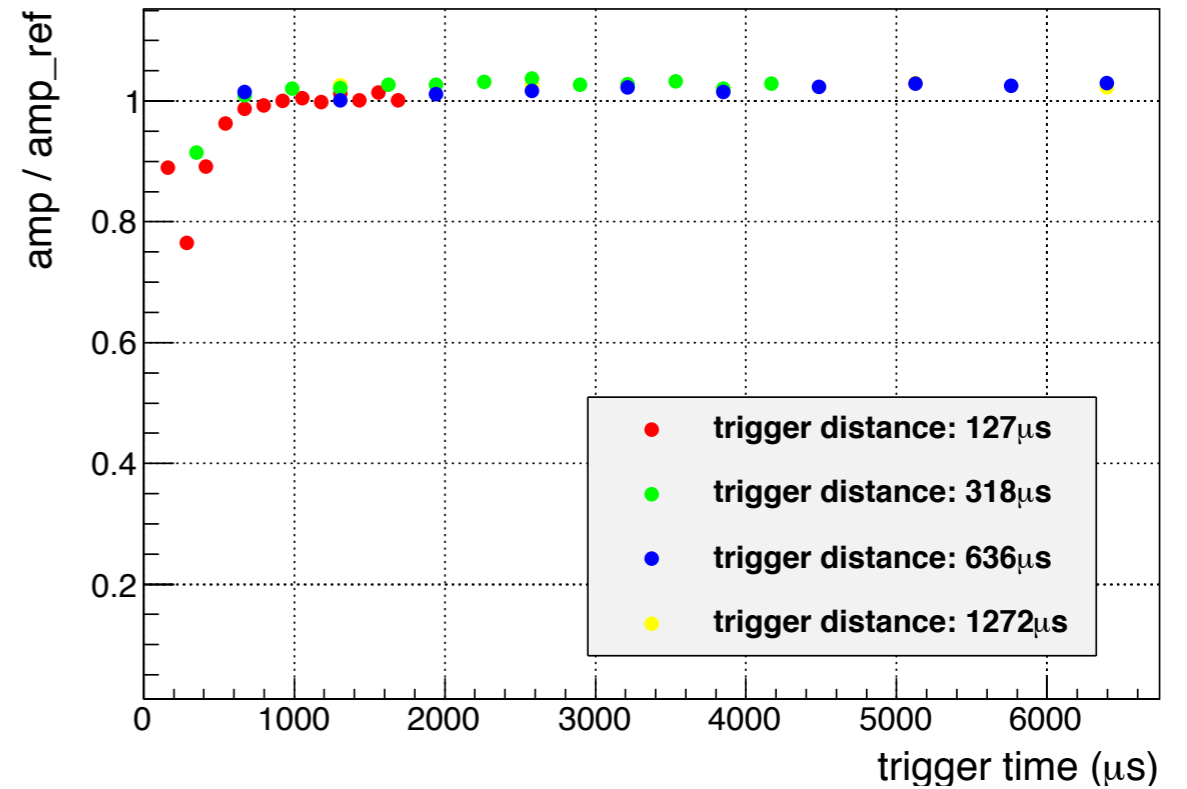
chip:214 chn7



chip:215 chn10



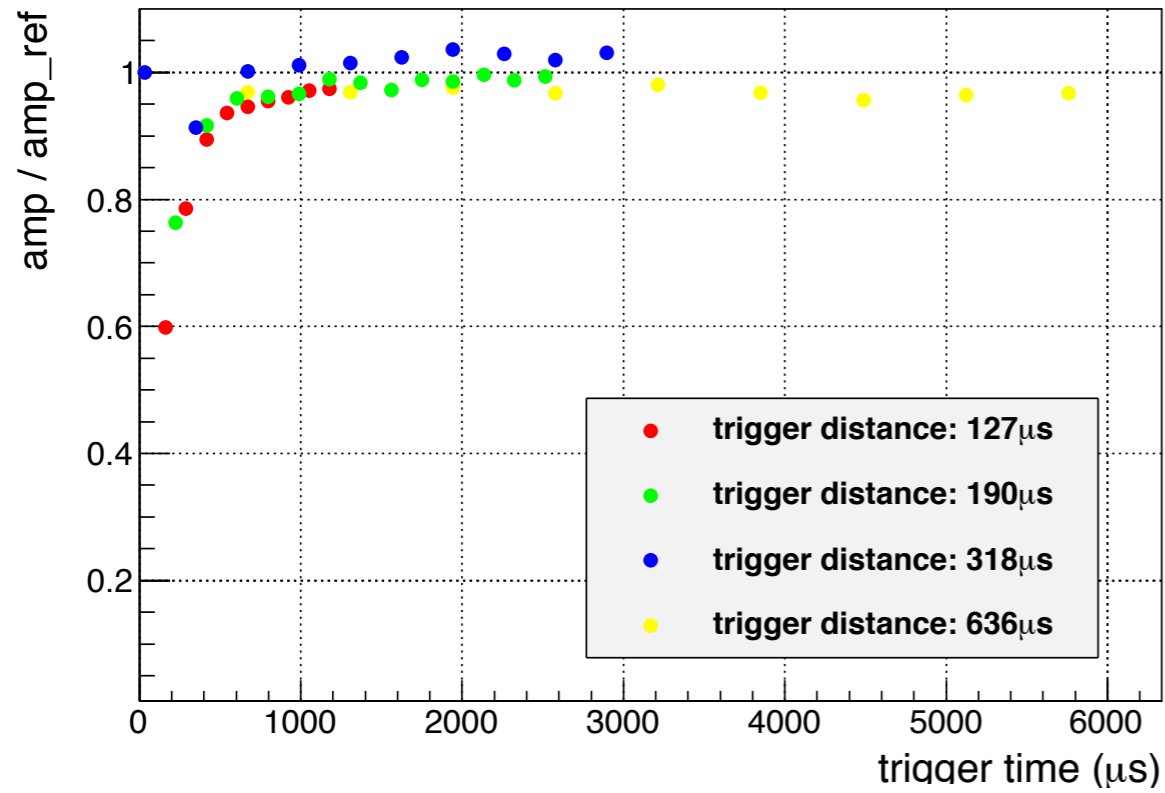
chip:216 chn9



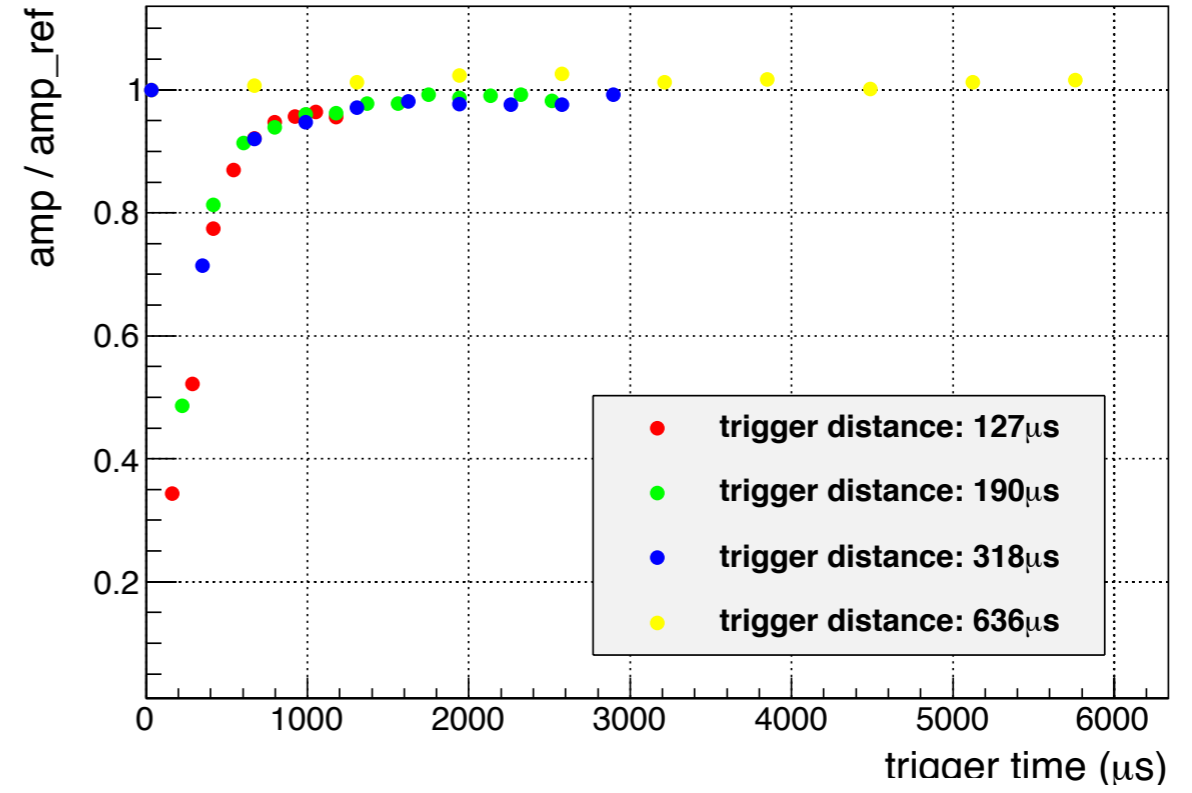
3HBU amplitude curve

Need more time to stabilized ($>2\text{ms}$)

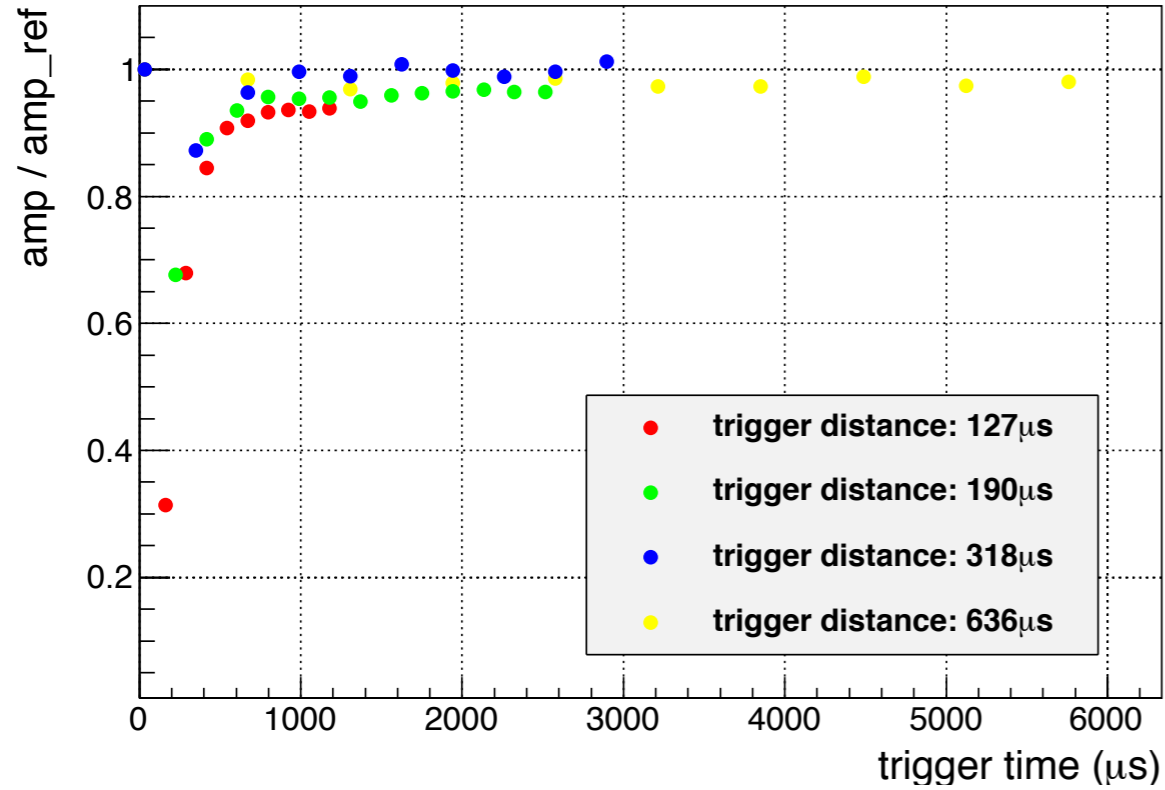
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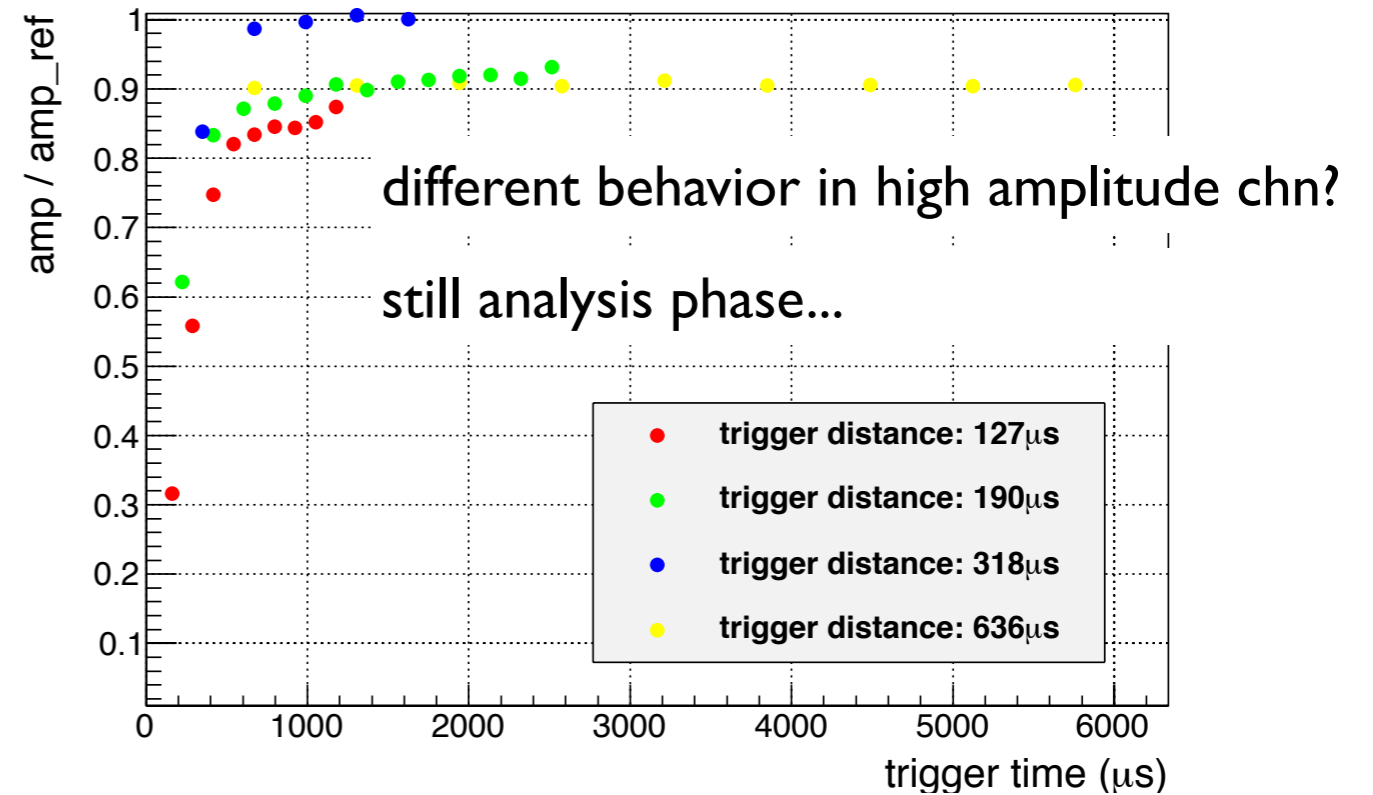
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chip:215 chn10



chip:216 chn9

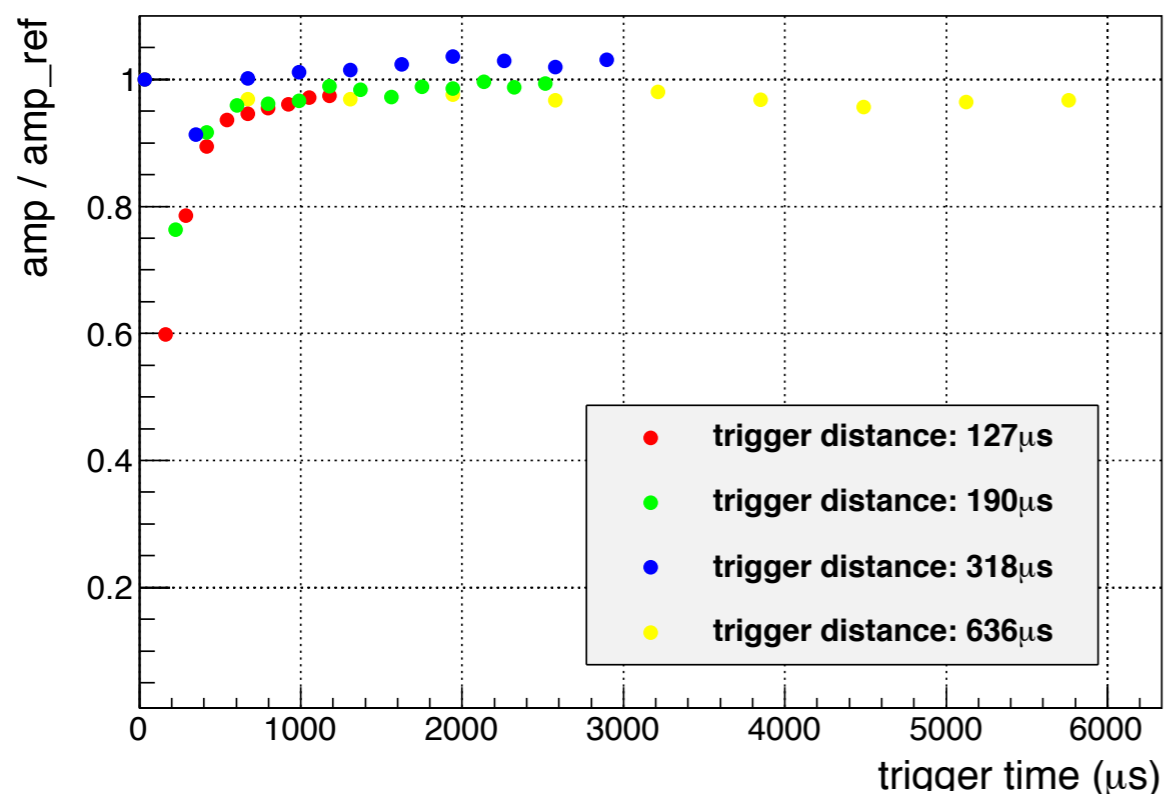


Comparison with IHBU

Need more time to stabilized (~2ms)

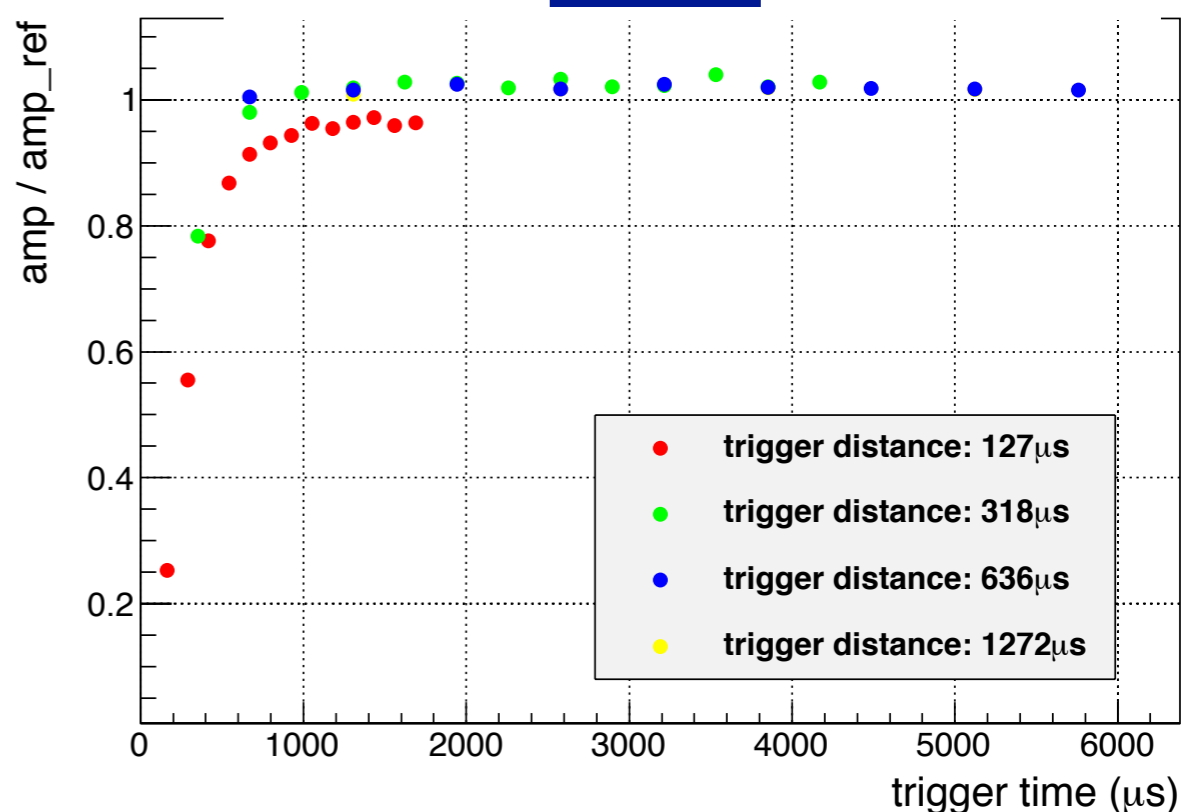
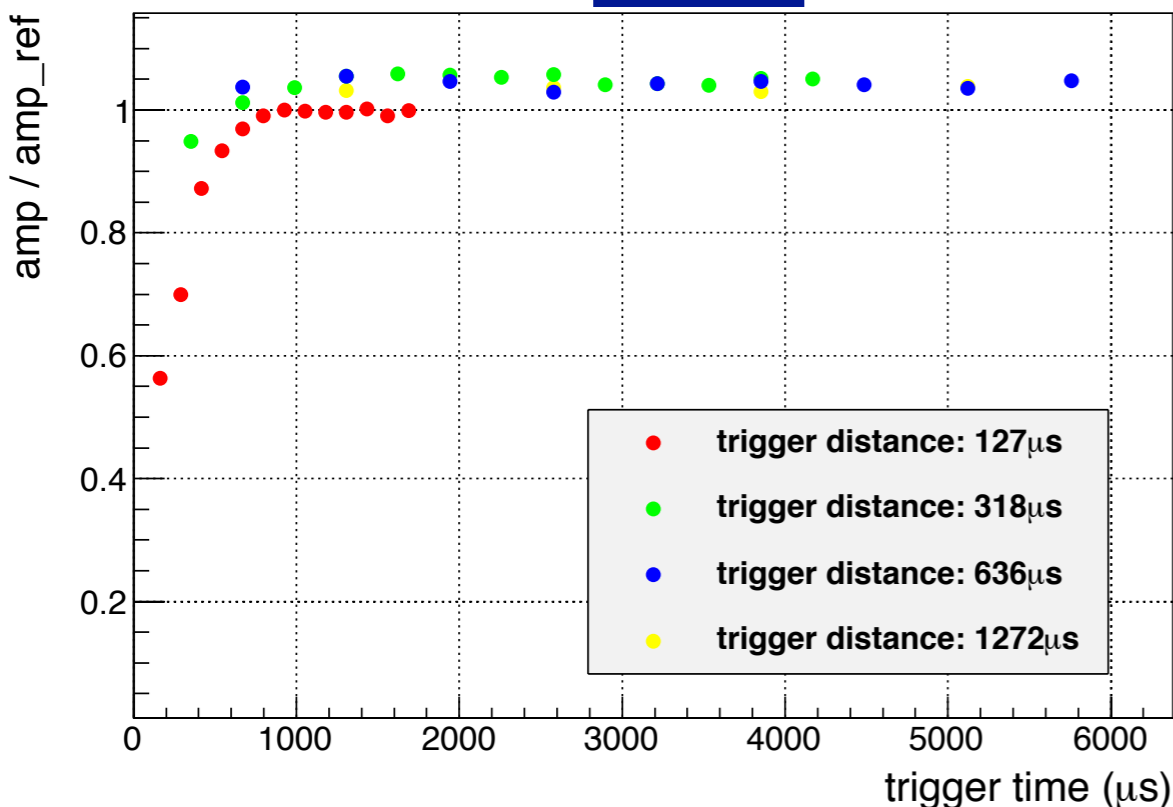
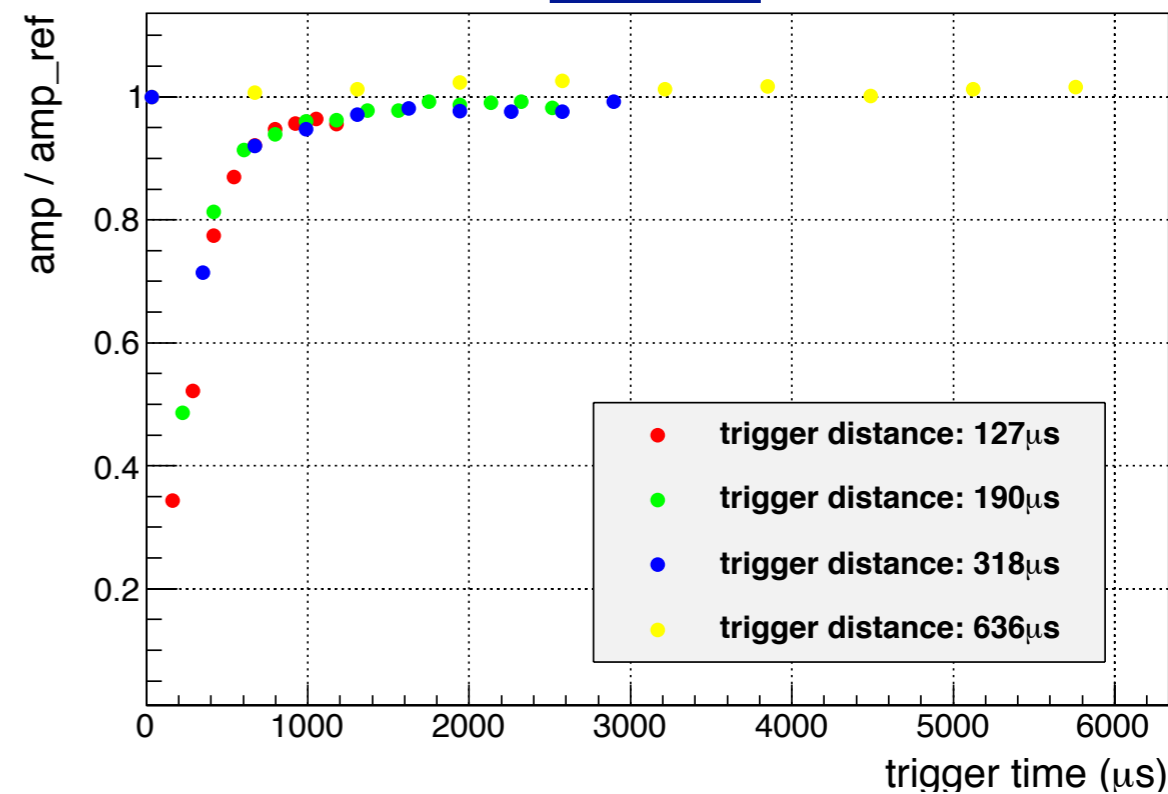
chip:213 chn10

3HBU

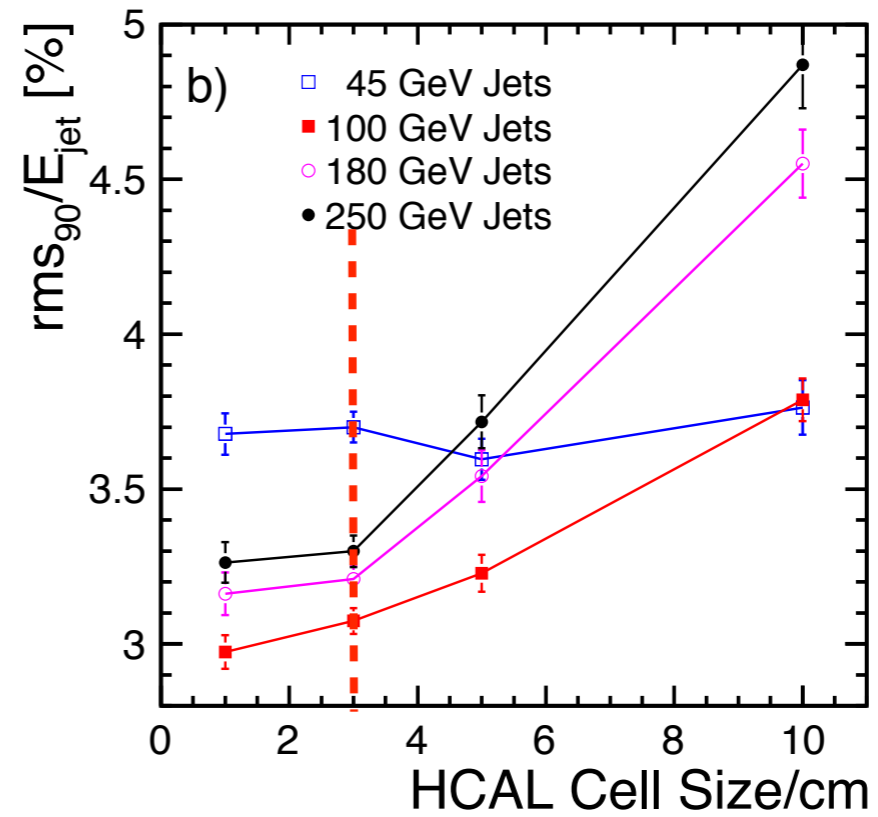
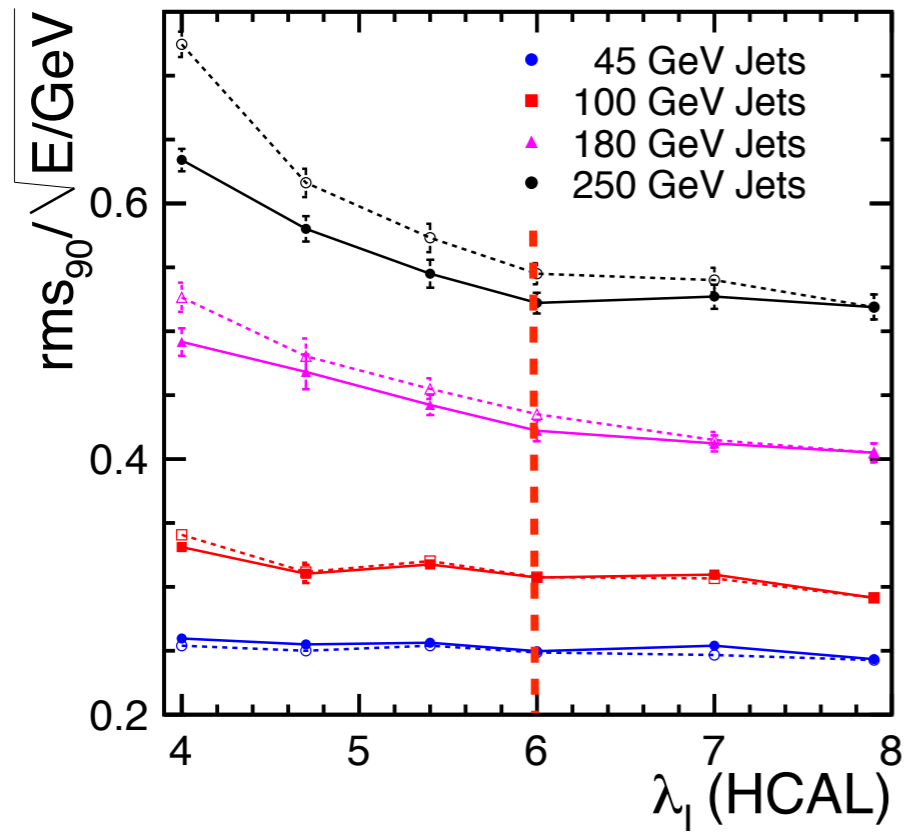


chip:214 chn7

3HBU



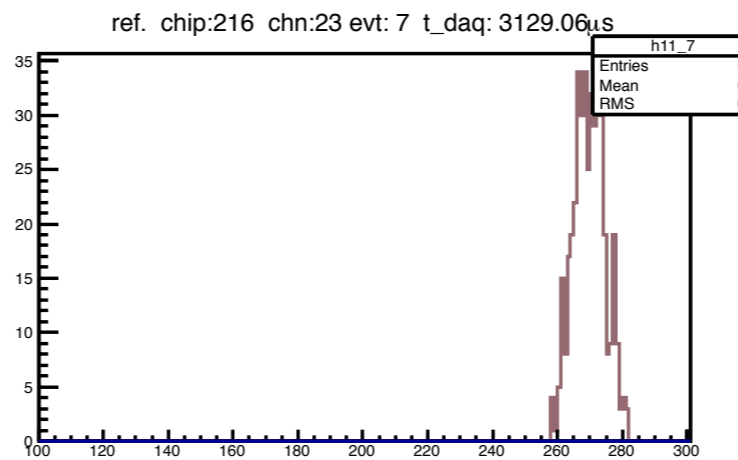
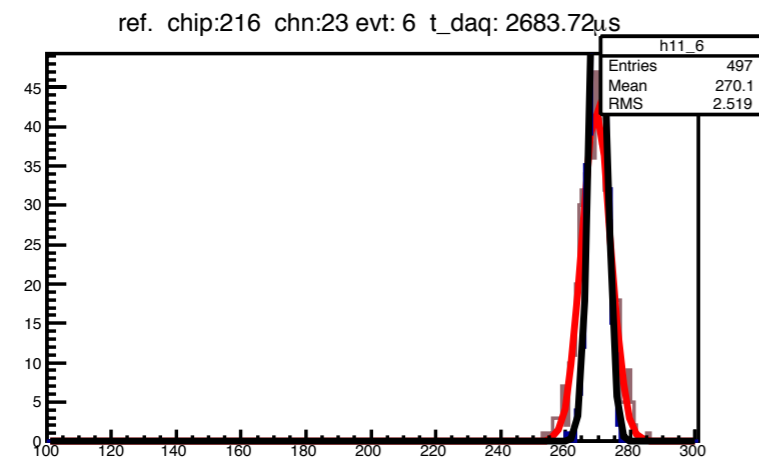
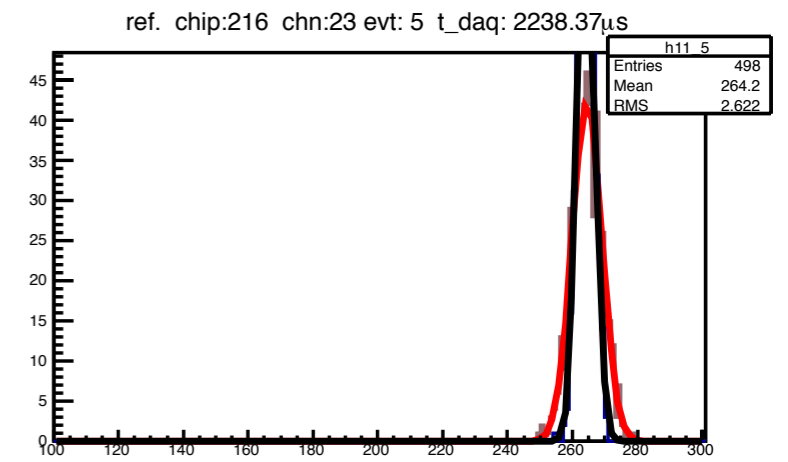
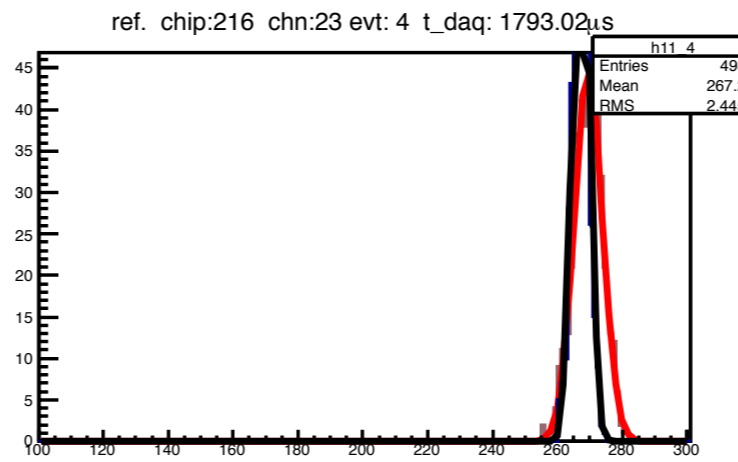
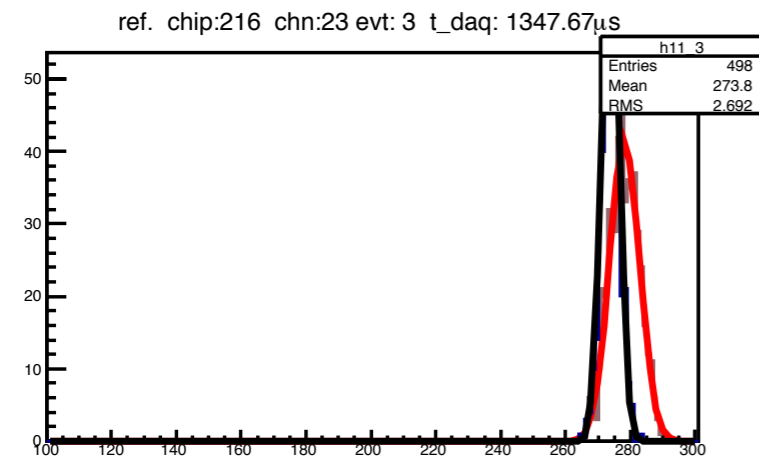
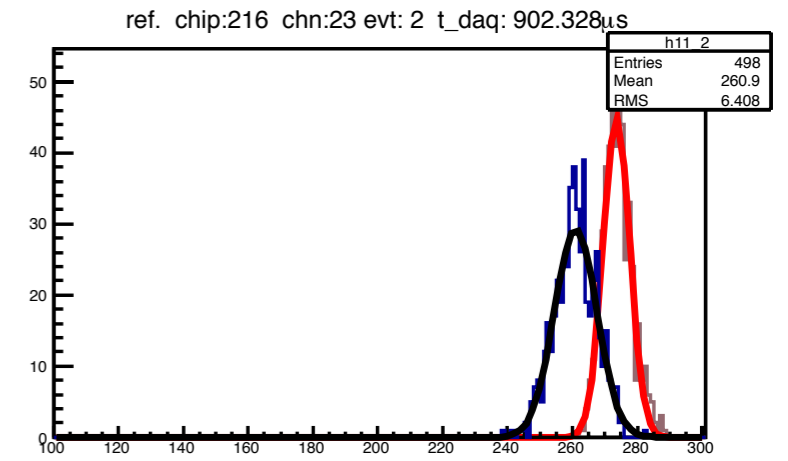
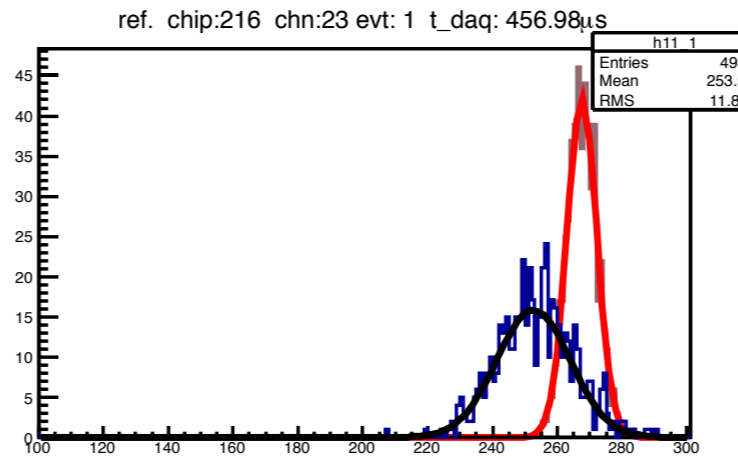
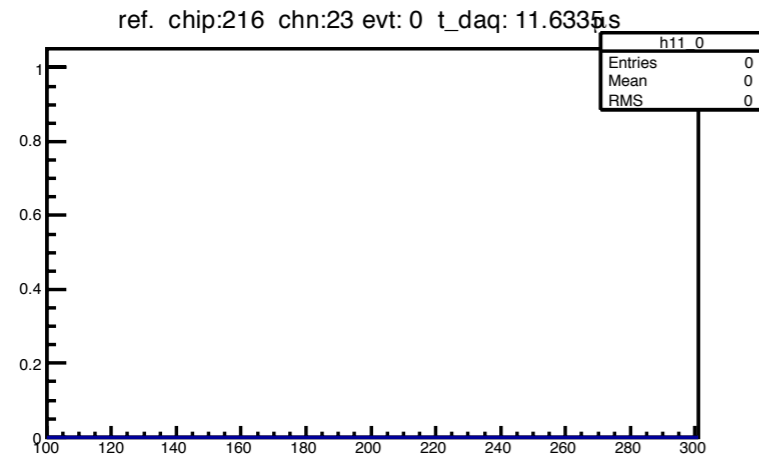
Geometrical Optimization in terms of PFA



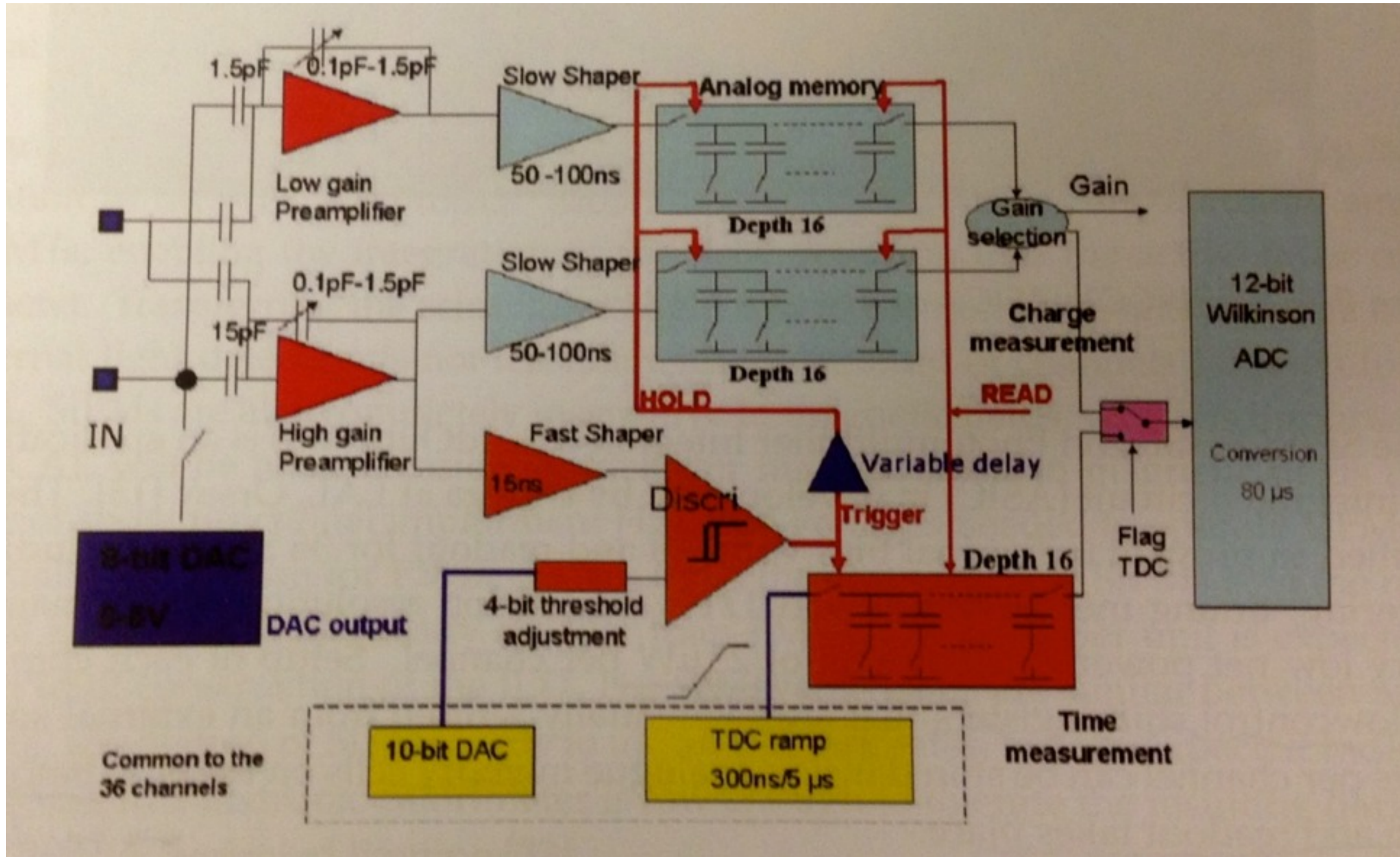
Pedestal

ADC dist. of channels without scintillator/SiPM attached

red: no PP
blue: with PP

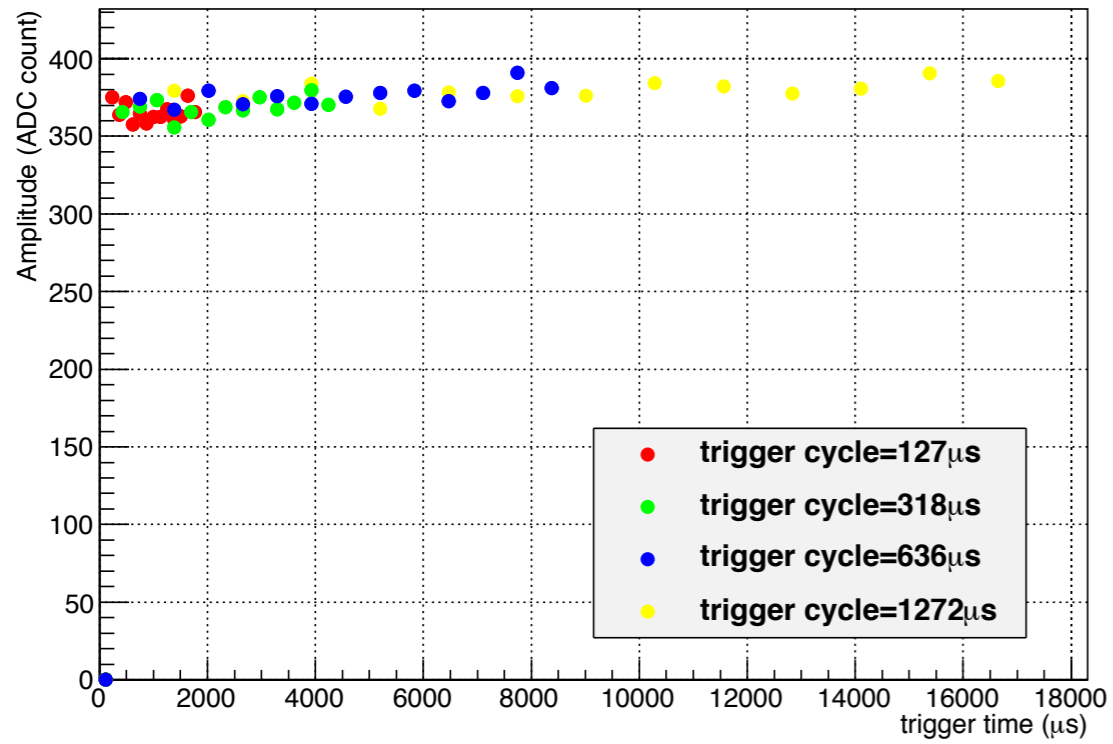


SPIROC2b

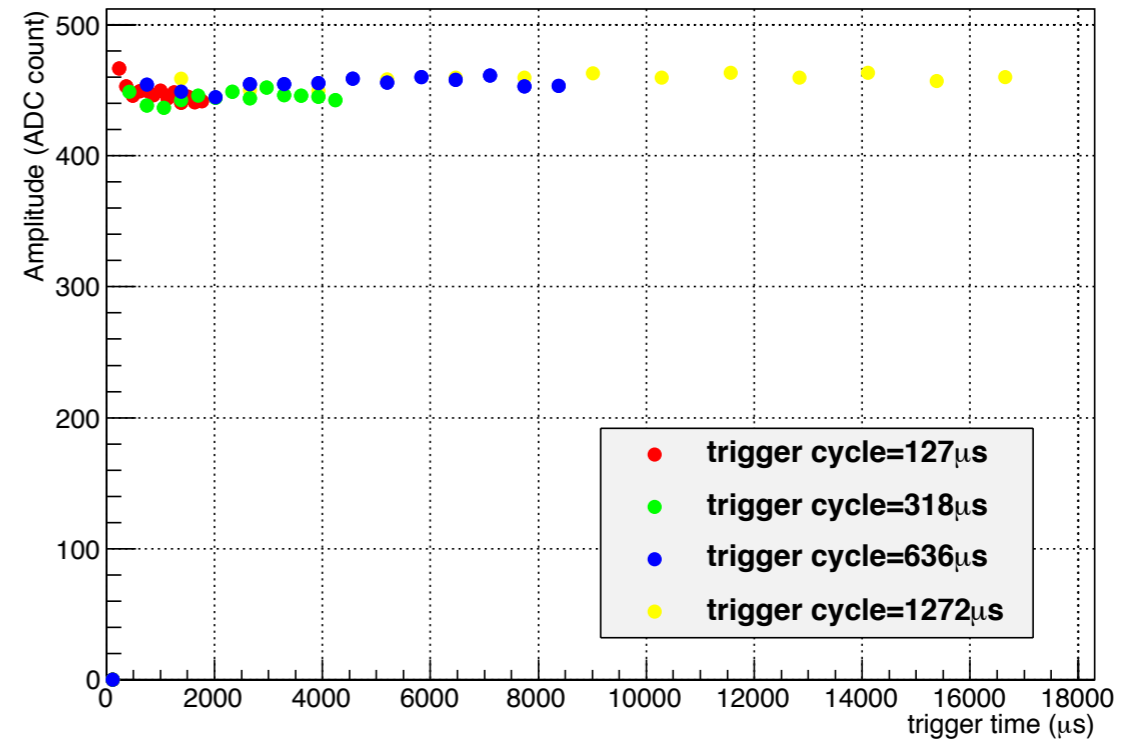


IHBU noPP

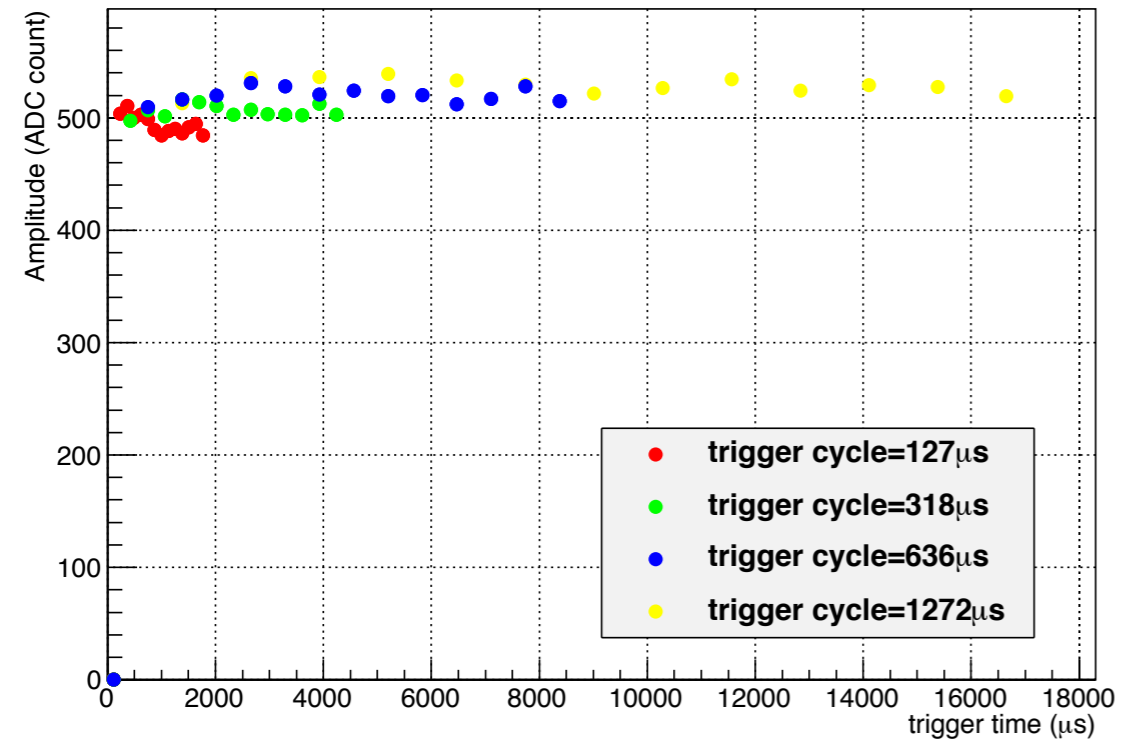
chip:213 chn10



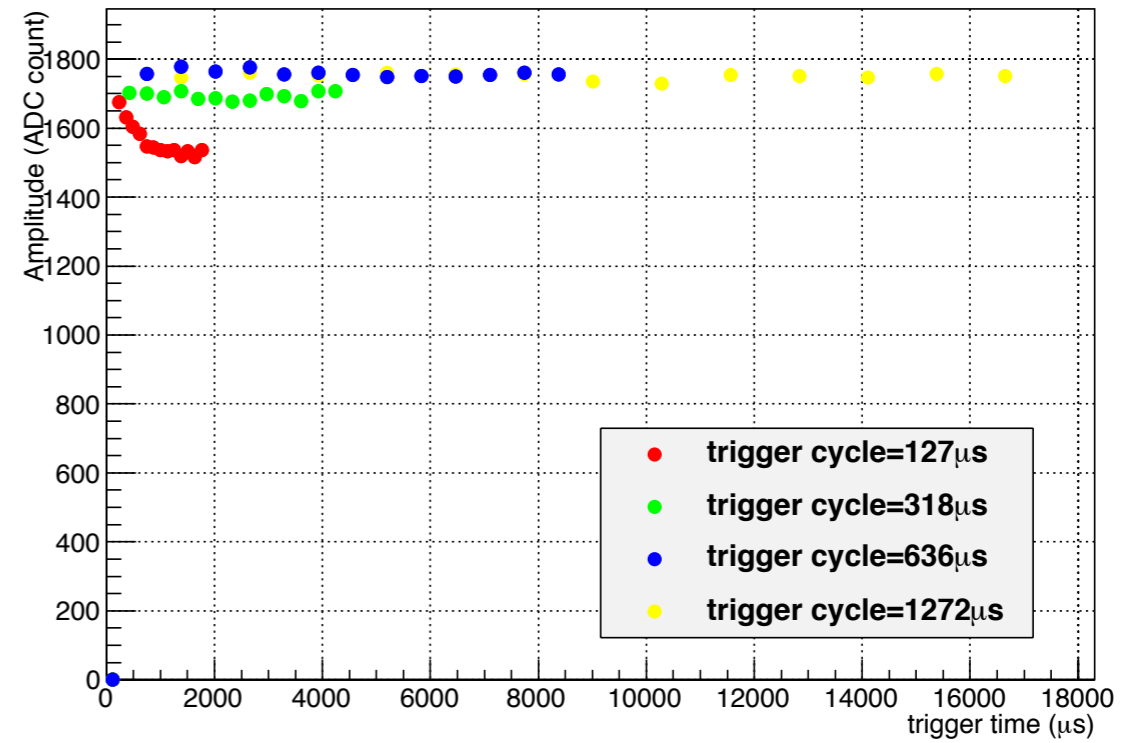
chip:214 chn7



chip:215 chn10

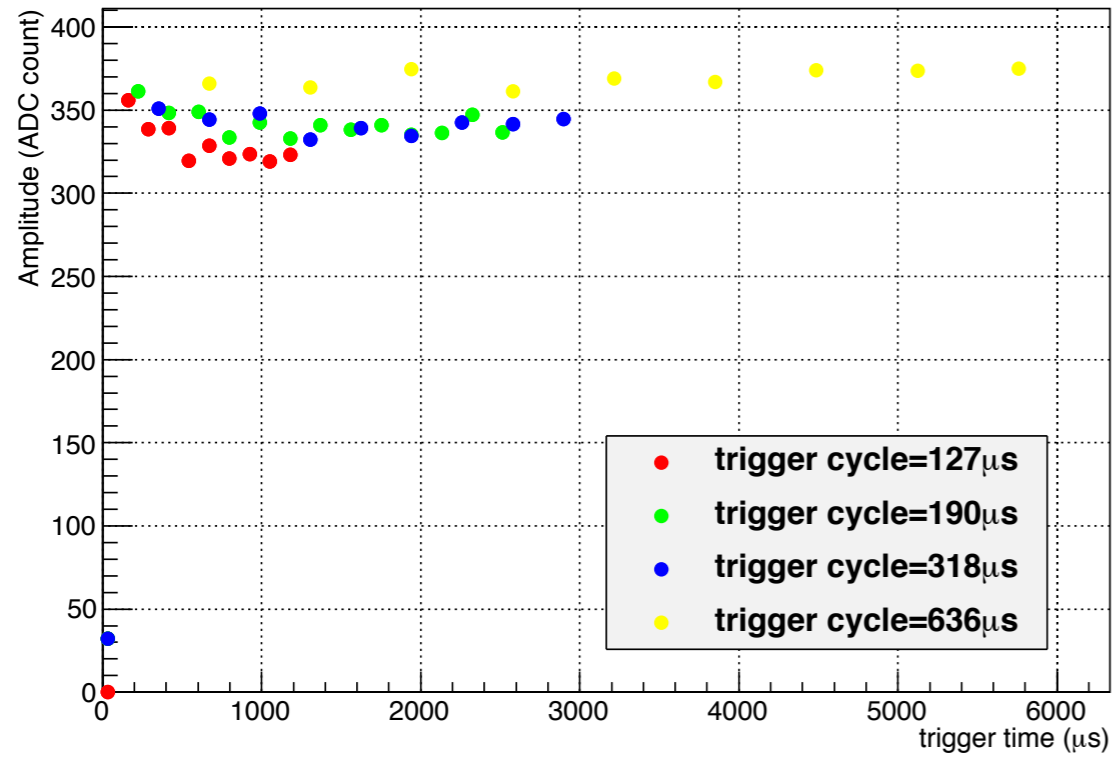


chip:216 chn9

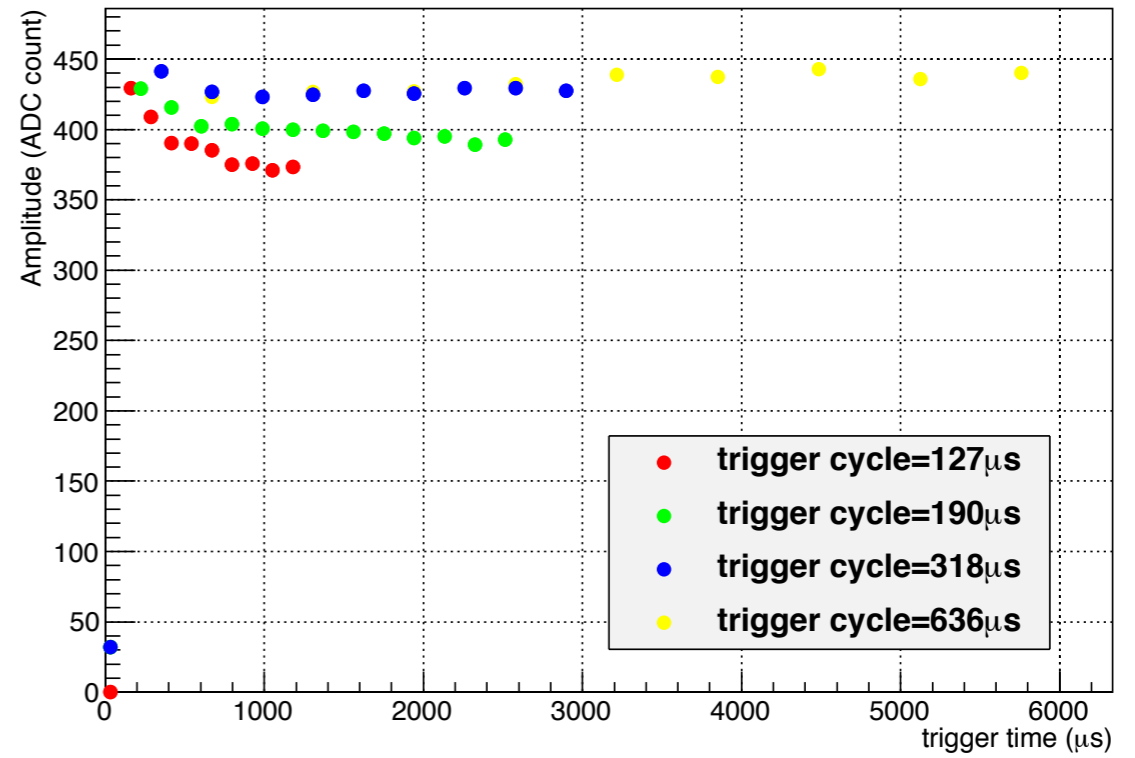


3HBU noPP amplitude curve

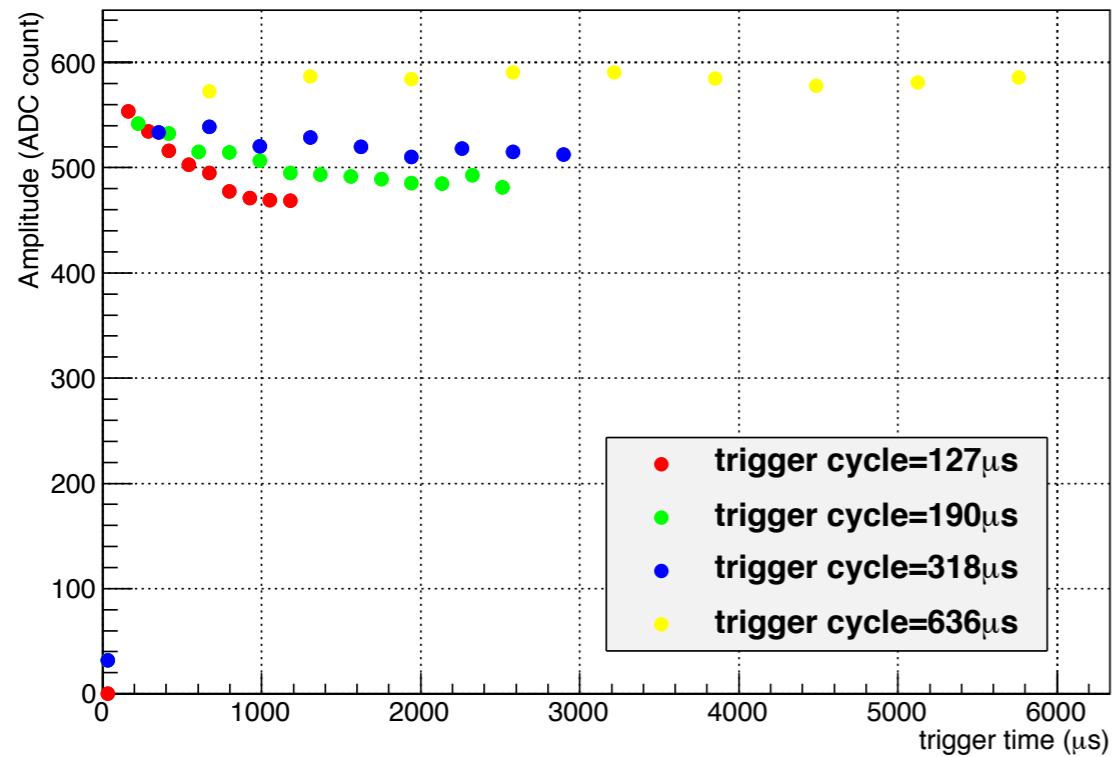
chip:213 chn10



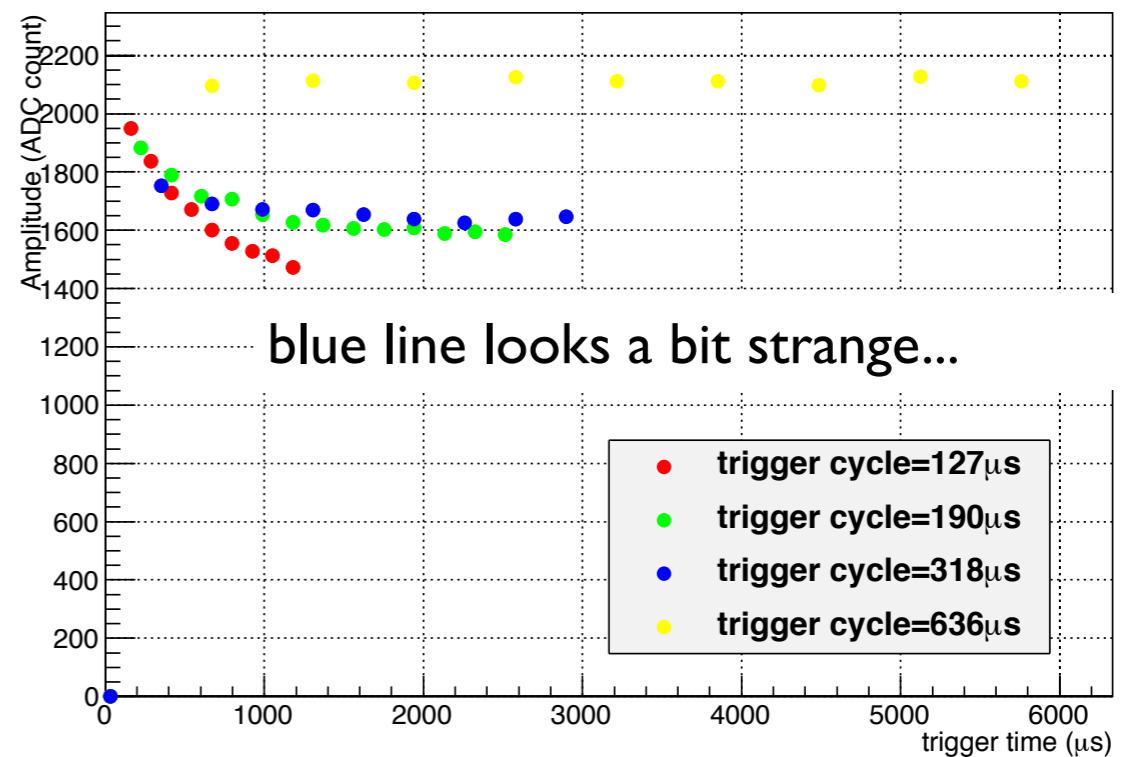
chip:214 chn7



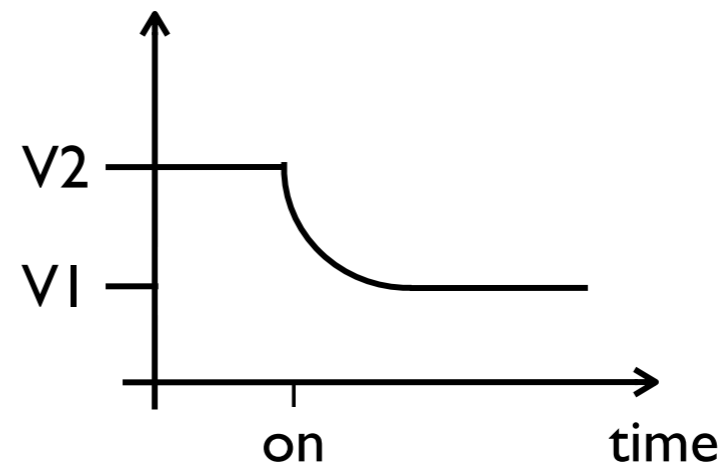
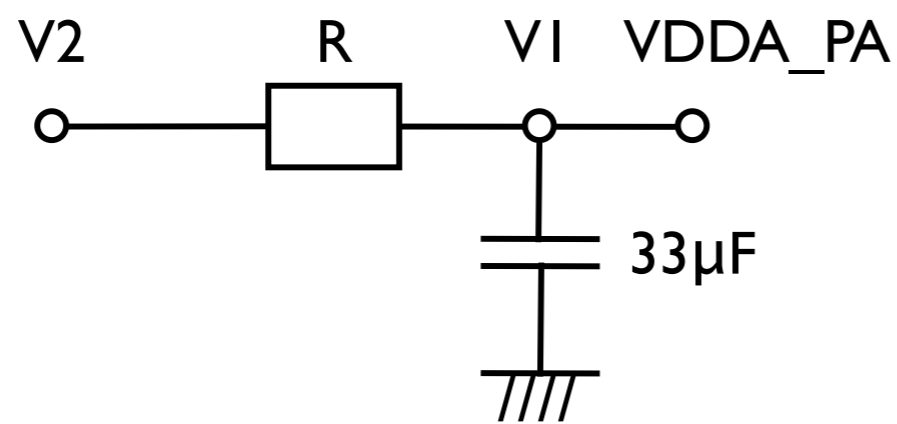
chip:215 chn10



chip:216 chn9



RC component between VDDA - Preamp

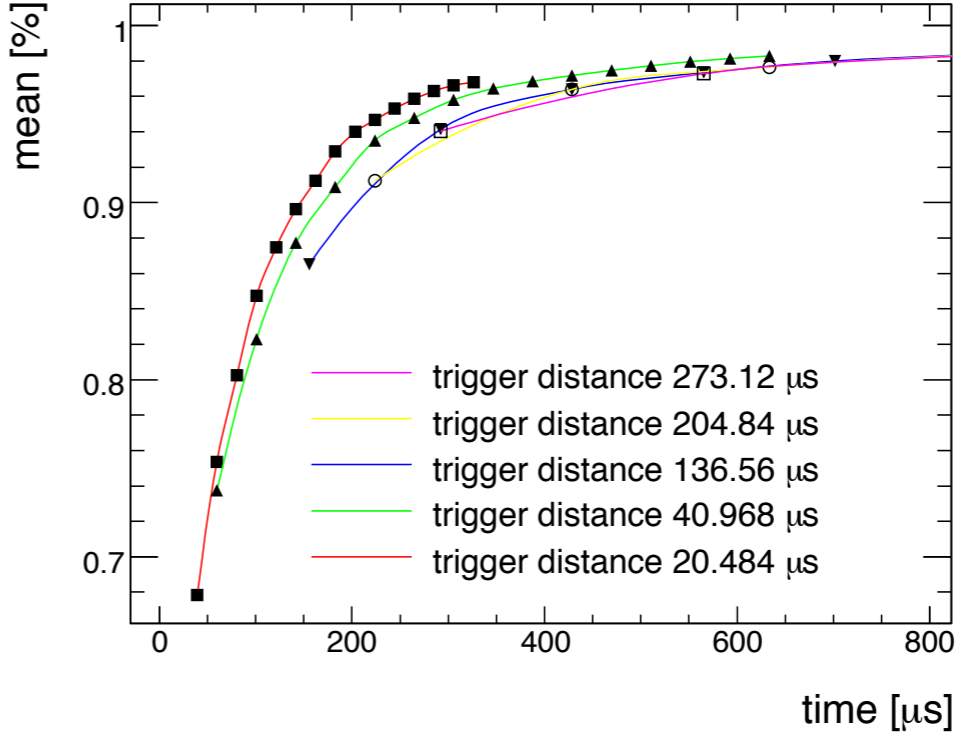
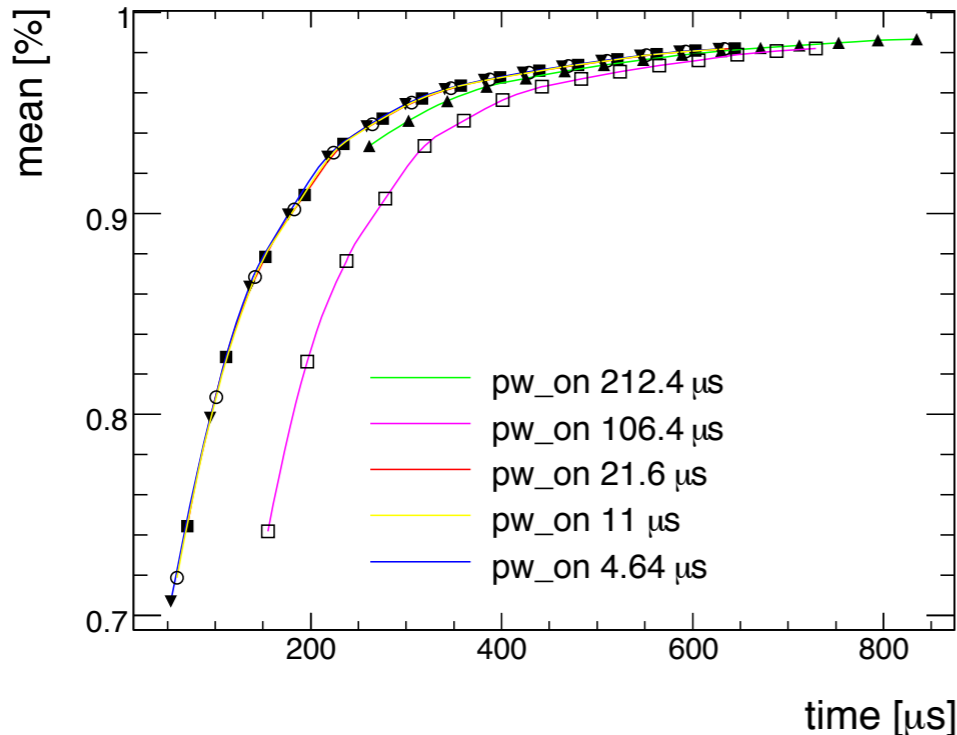


$$\tau = R \cdot C$$

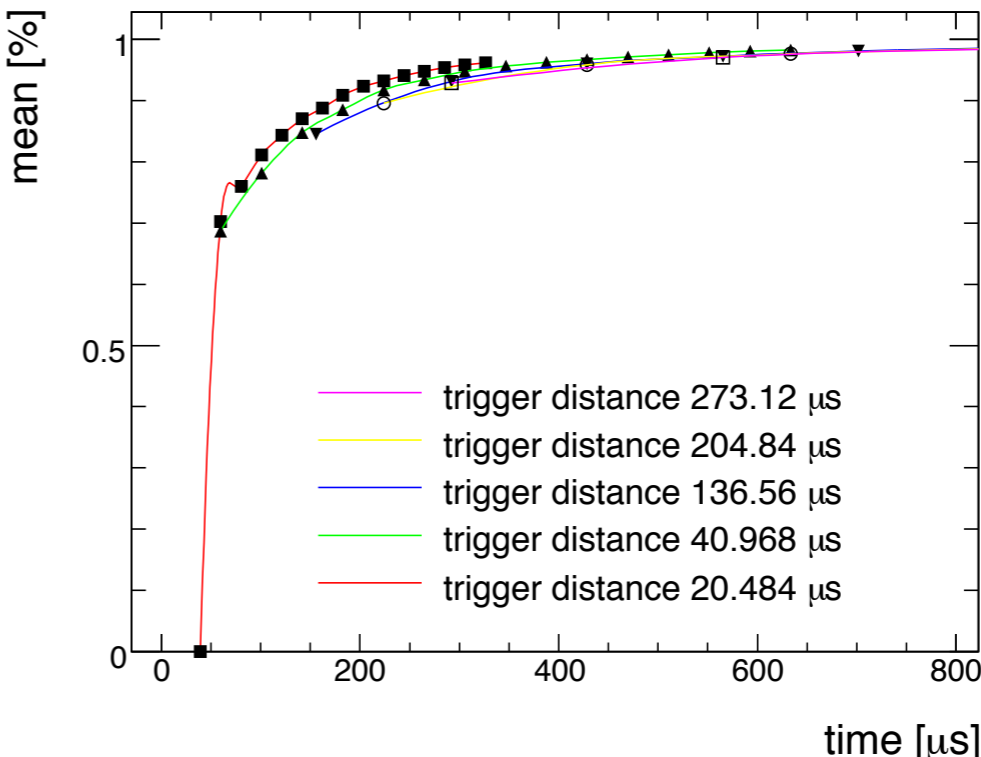
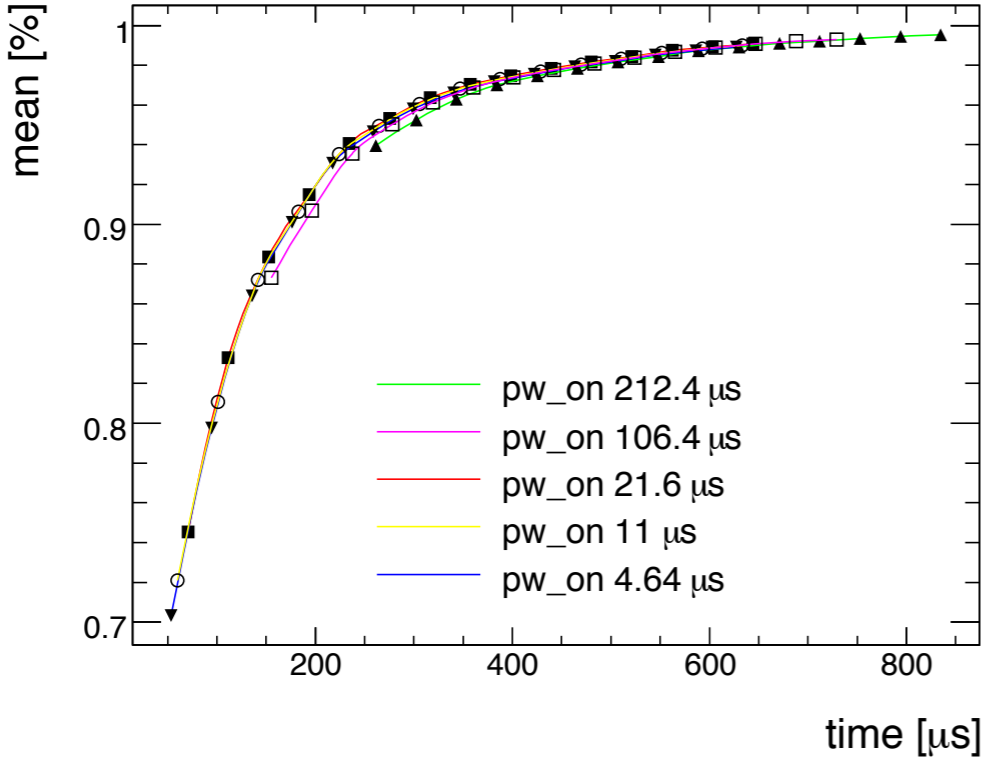
$$V1 = V2 \text{ (off)}$$
$$V1 = V2 - 0.2V \text{ (on)}$$

Gain drops in charge injection study

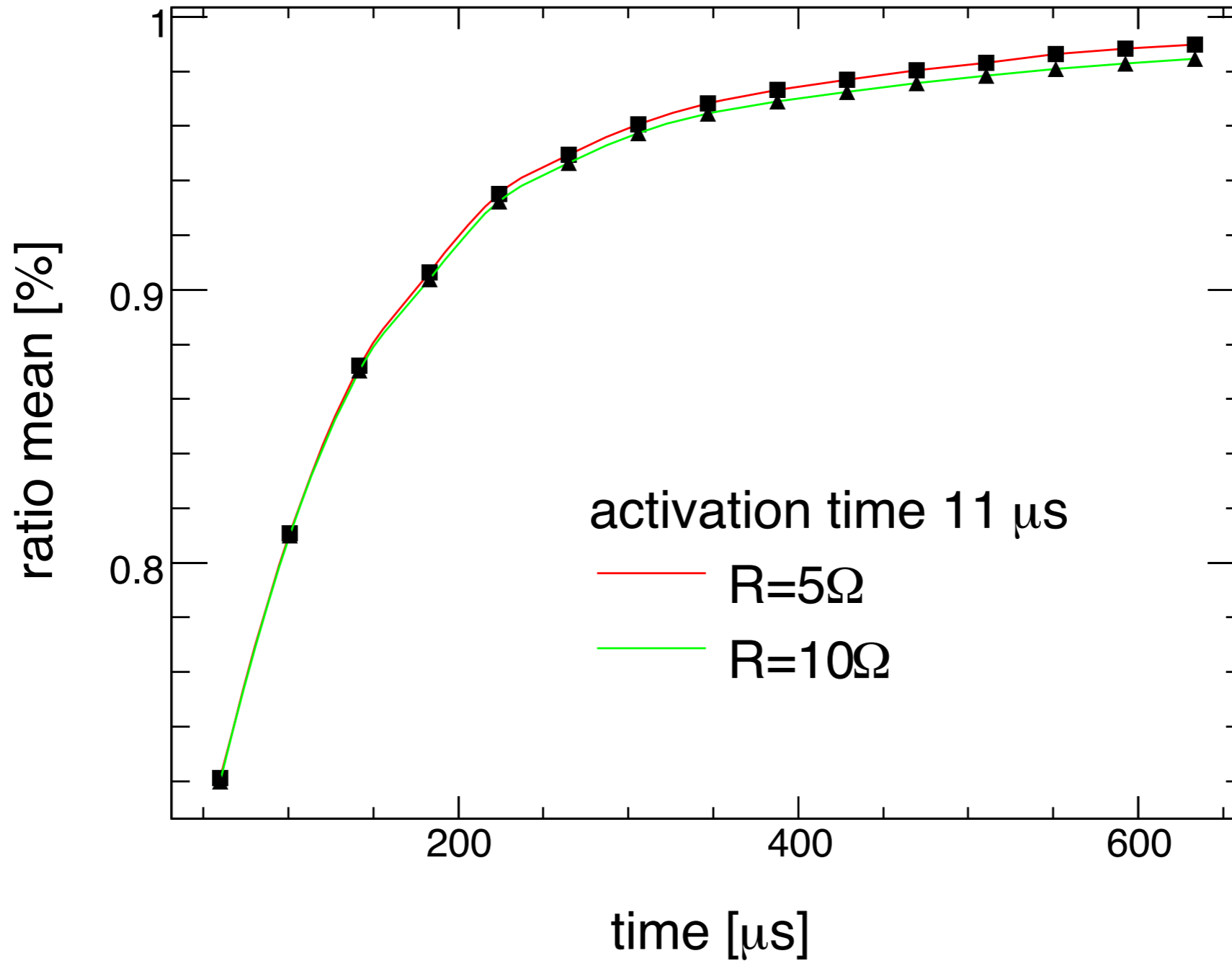
10Ω



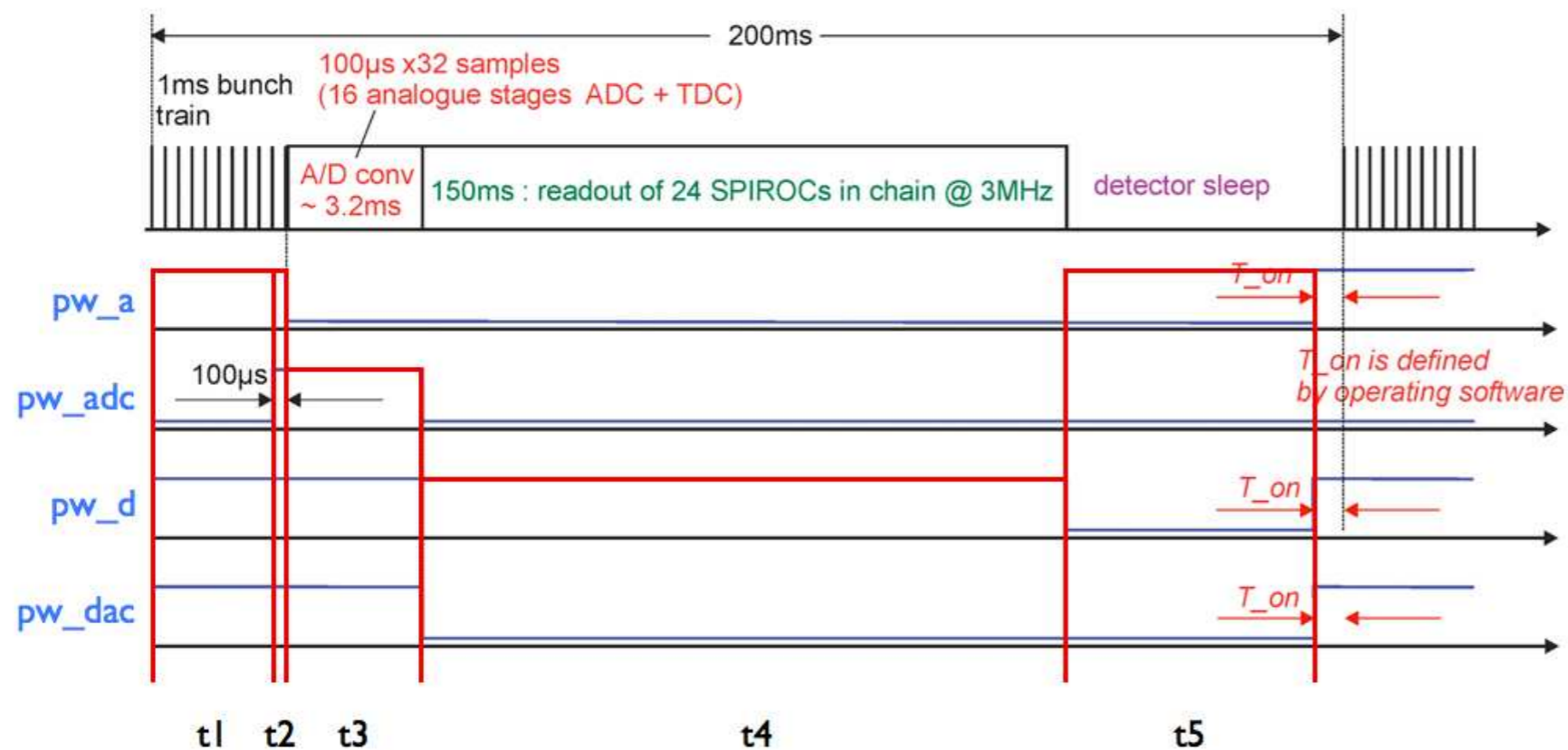
5Ω



Gain drops in charge injection study



Power consumption estimation in current chip design



time window	I_{VDDA} [mA]	I_{VDDD} [mA]	time [ms]
t1	498.47	30.33	0.9
t2	519.47	37.56	0.1
t3	245.20	36.79	3.2
t4	0.71	29.31	150
t5	0.56	0.01	45.8

TABLE 1: Table with the different currents and times.

Power	P_{VDDA} [mW]	P_{VDDD} [mW]	P [mW]
P1	7.40	0.45	-
P2	0.86	0.06	-
P3	12.95	1.94	-
P4	1.76	72.54	-
P5	0.42	$7.56 \cdot 10^{-3}$	-
P_{VDAC}	-	-	0.05
P_{VRef}	-	-	1.89
ΣP	100.32 mW		

TABLE 2: Table with the different power consumptions.