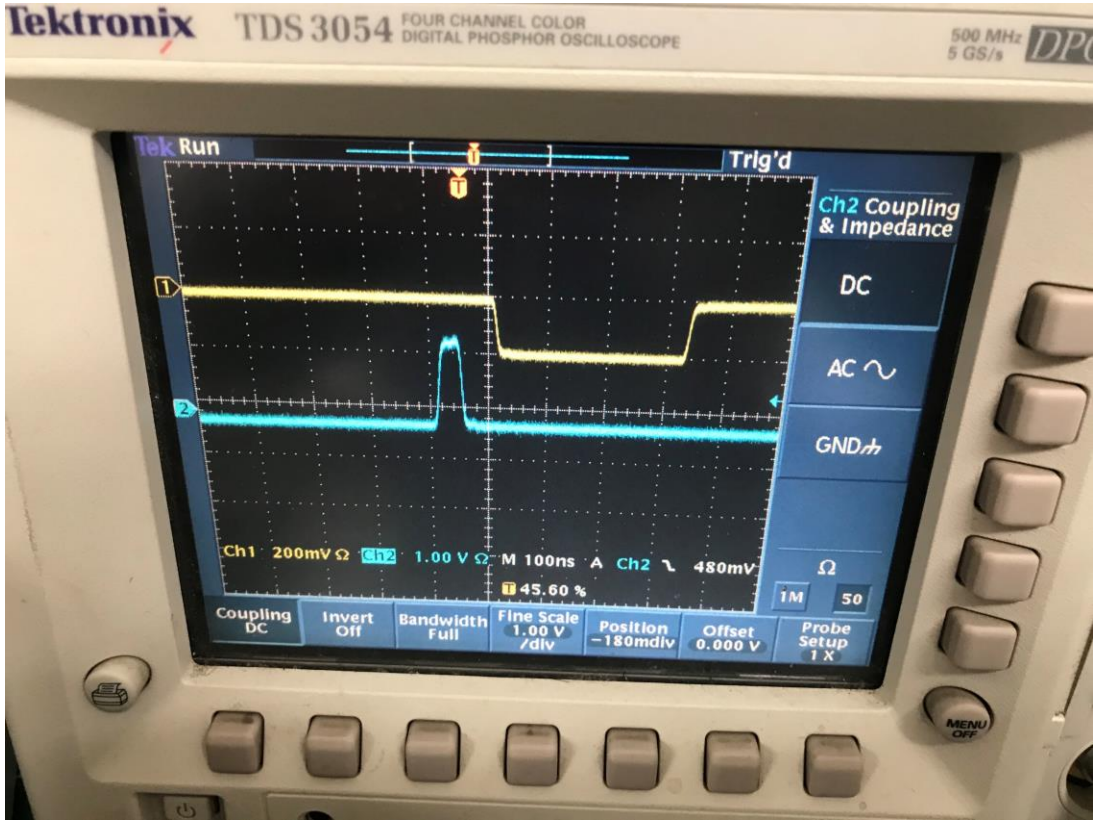
FADC Test

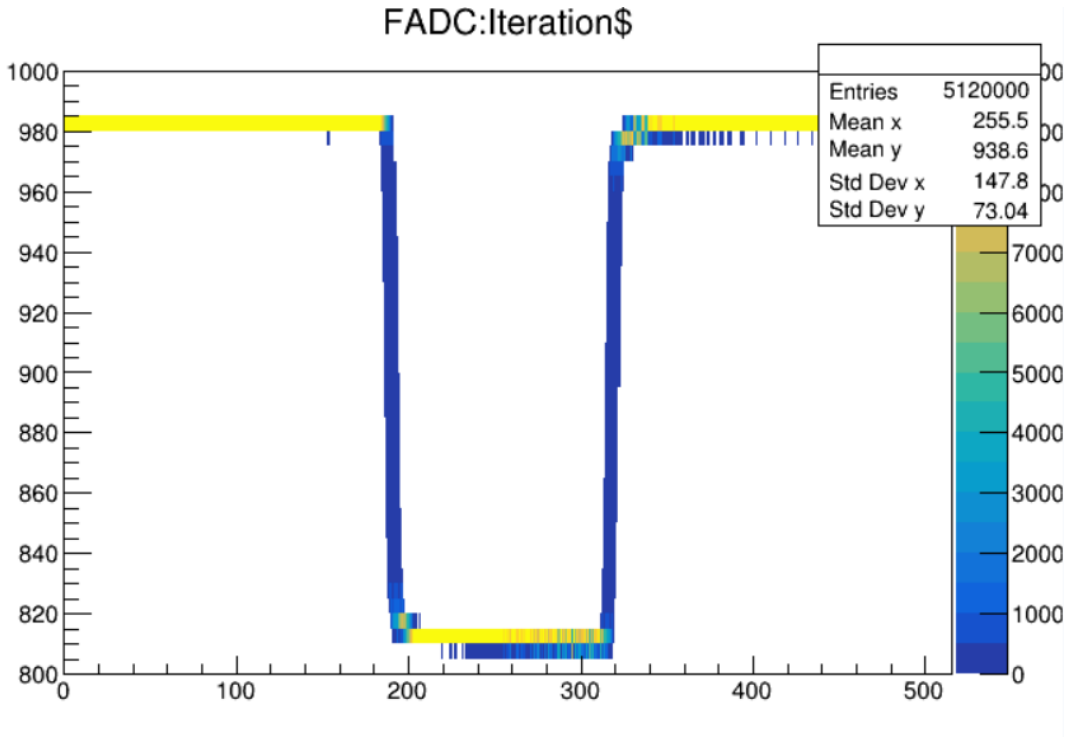
NOTICE FADC400

SPECIFICATIONS

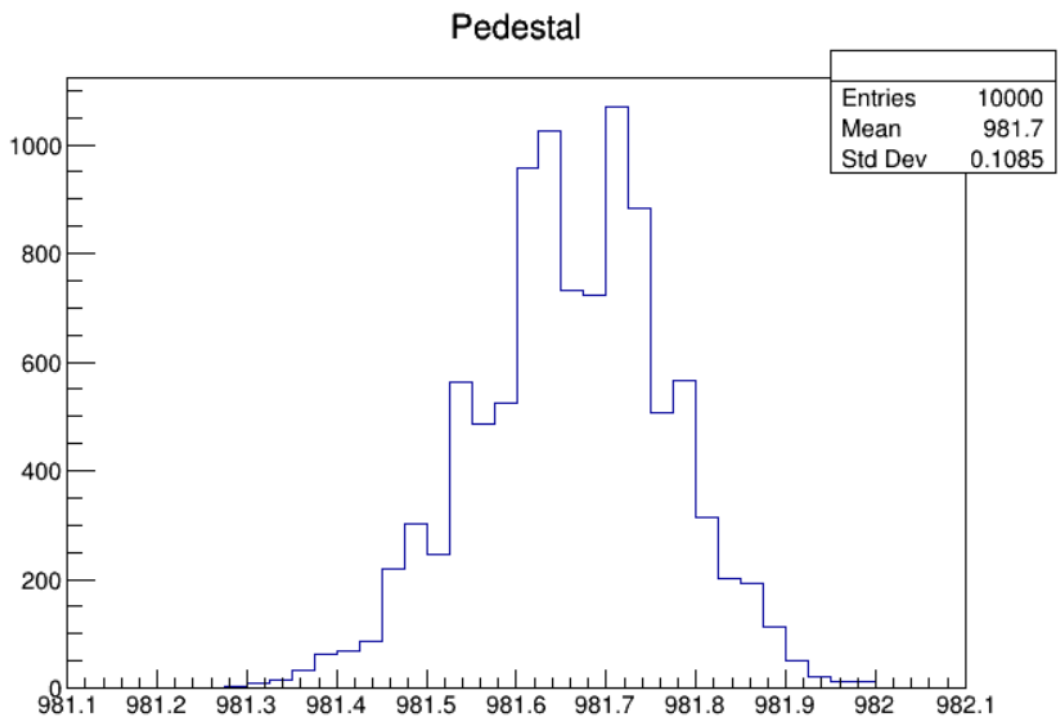
Parameters		Values		
Model Name		FADC64	FADC100	FADC400
General	Dimension	6 U (H) x 1 unit (W)		
Input	No. of Channels	8	8	4
	Connector Type	BNC		
	Impedance	50 Ω		
	Voltage Range	1 V_{P-P}, bipolar		
	Gain	0.7 ~ 10 (programmable)		
ADC	Sampling	64 MS/s	100 MS/s	400 MS/s
	Resolution	12 bits	10 bit	10 bit
Trigger	Input Impedance	1 kΩ		
	Input Level	TTL or LVTTL		
	Output Level	LVTTL		
External Clock	Input	LVDS		
Data Buffer	Buffer Size	256 k samples	256 k samples	1 M samples
Interface	VME	A 32 / D16 single mode read / write		

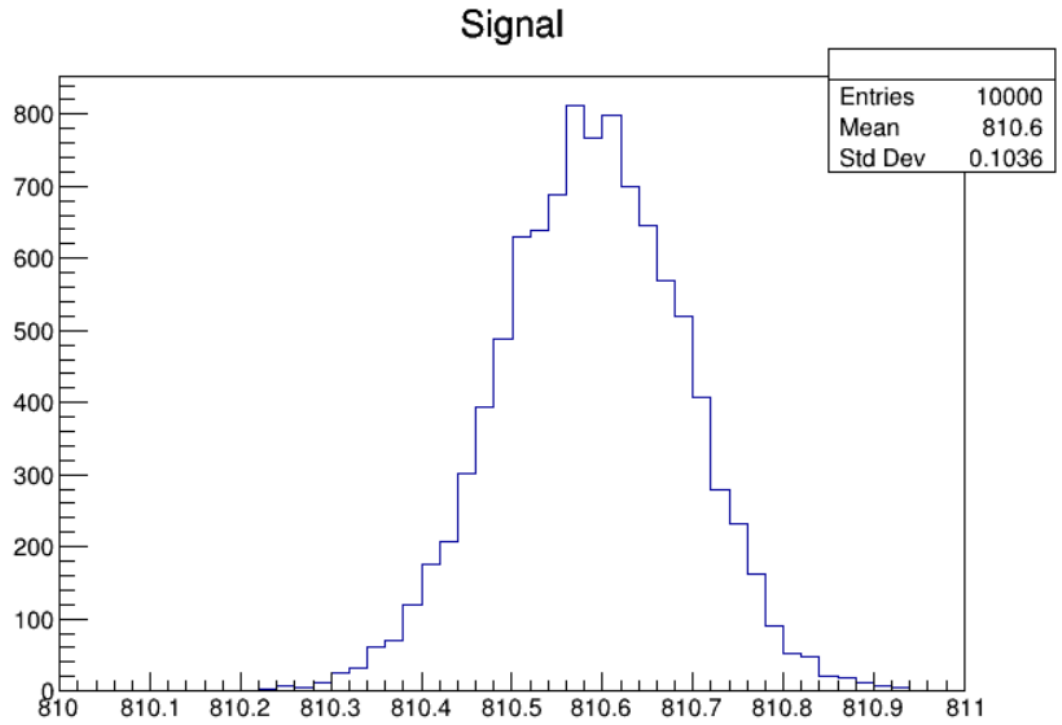
Input Voltage = 200 mV



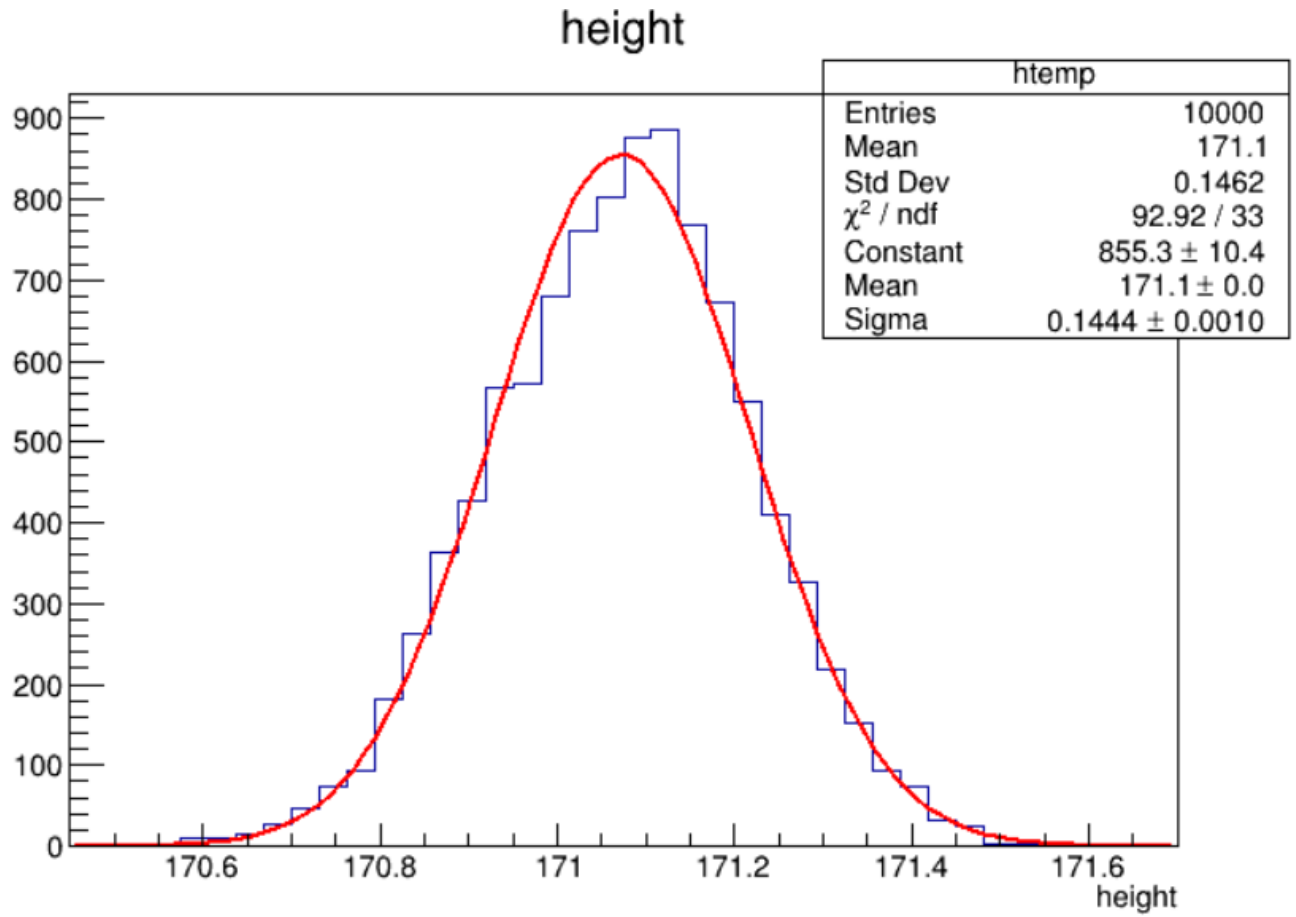


Pedestal and Signal

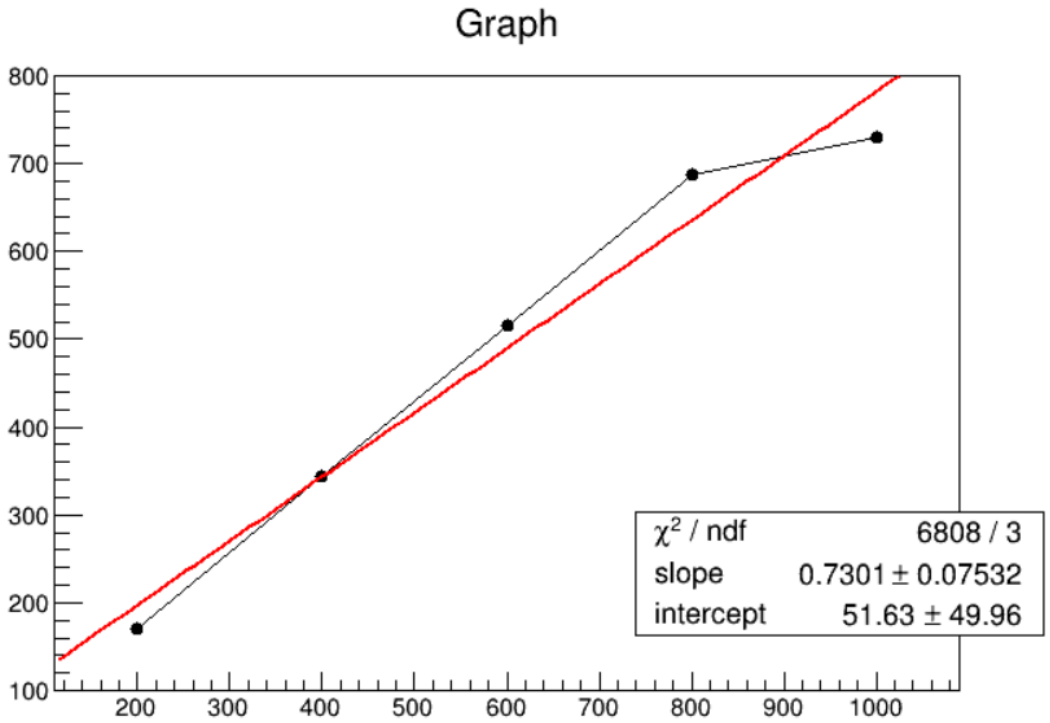


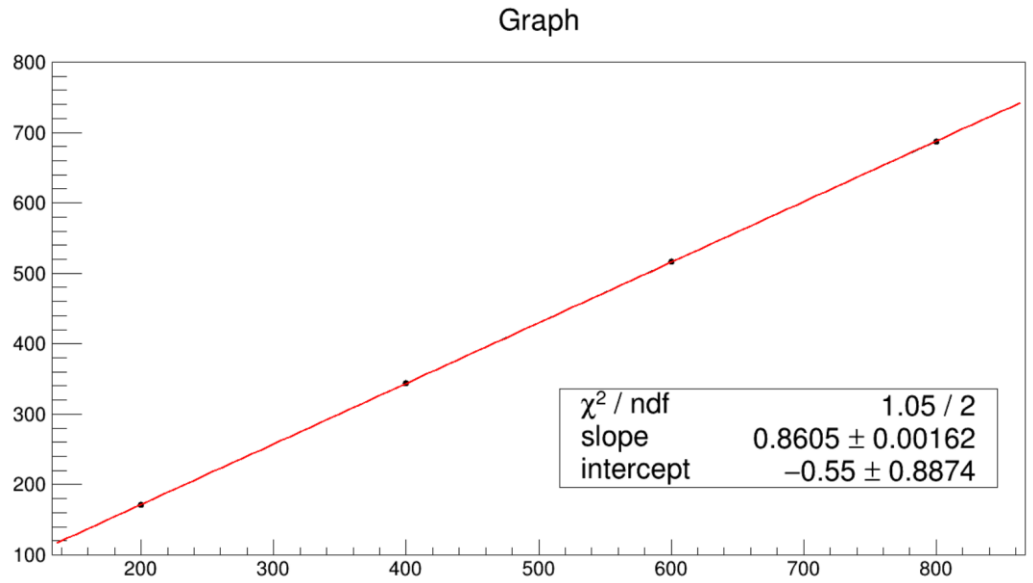


Height


height
htemp
Entries 10000
Mean 171.1
Std Dev 0.1462
χ² / ndf 92.92 / 33
Constant 855.3 ± 10.4
Mean 171.1 ± 0.0
Sigma 0.1444 ± 0.0010
900
800
700
600
500
400
300
200
100
0
170.6
170.8
171
171.2
171.4
171.6
height

Result





FADC의 peak to peak 전압은 1 V이기 때문에, 200 mV ~ 800 mV까지로 fitting을 하였으며 한 channel 은 0.8605 mV에 해당함을 확인할 수 있다.

NIM amp test

NIM Amp

Specifications

Fixed Gain of 10 (typ), non-inverting

Dynamic range 0V ~ -2V for low current

Rise time < 2.5 nsec

Delay < 2.5 nsec

Bias control -100mV ～ +30mV

impedance

1 input 50Ω, in DC

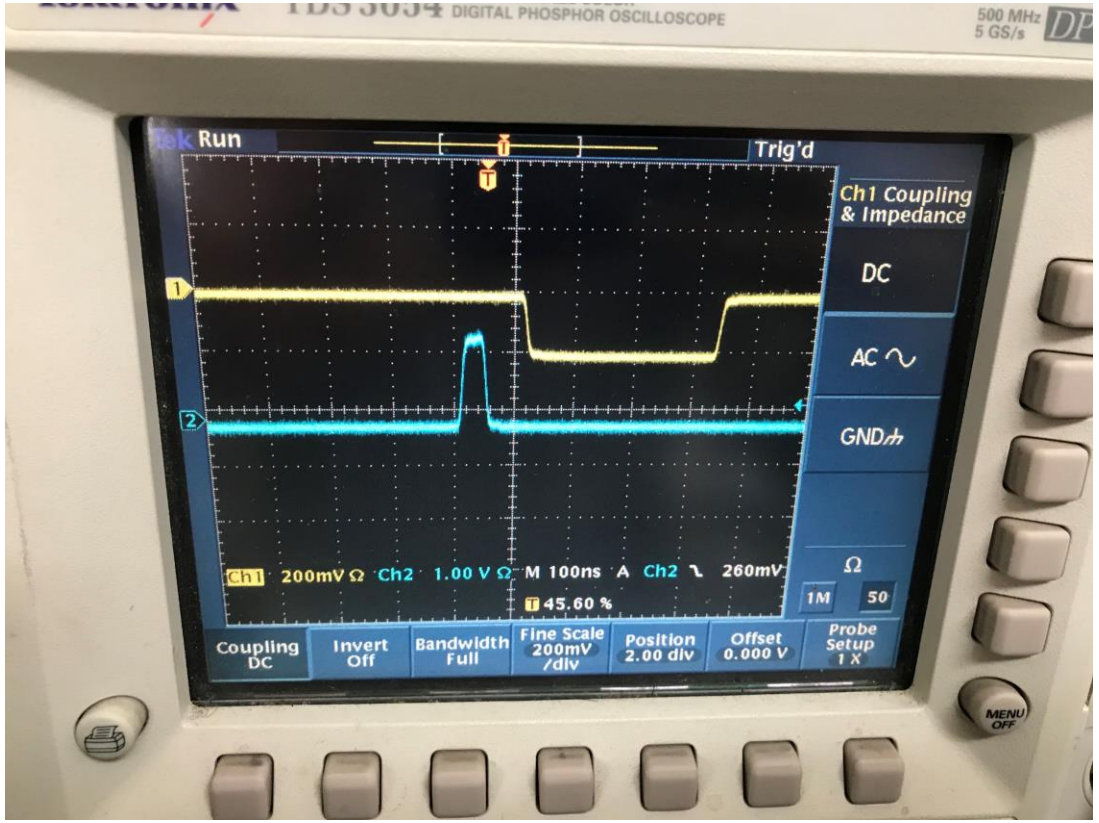
2 output 50Ω, in DC

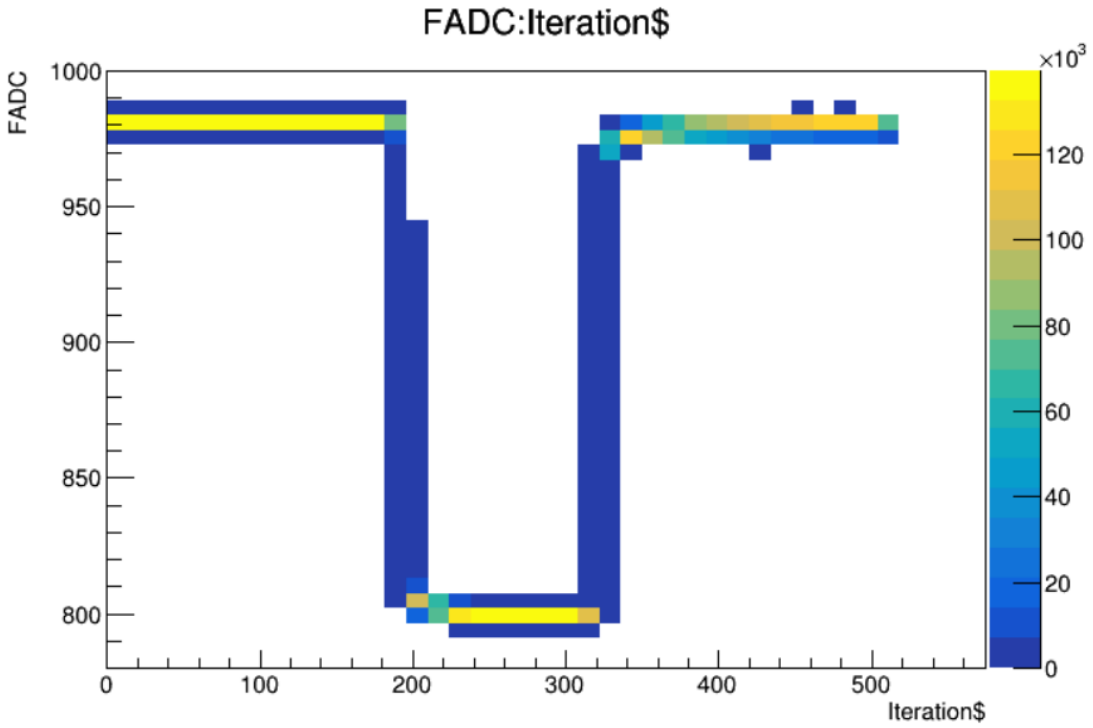
Note

Dev. is AD8009, 1GHz, Current Feedback.

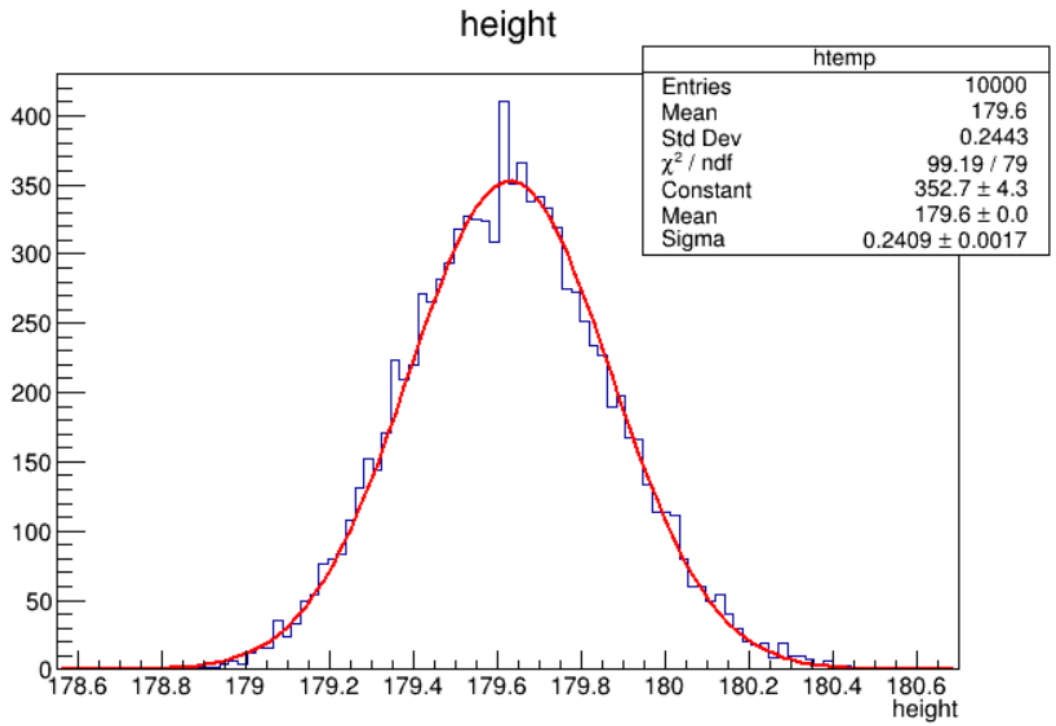
2-outputs are divided by the resisters and not included Buffer circuit, in case 1 output, other output be terminated, no Emitter Follower.

Input voltage = 20 mV, channel 7



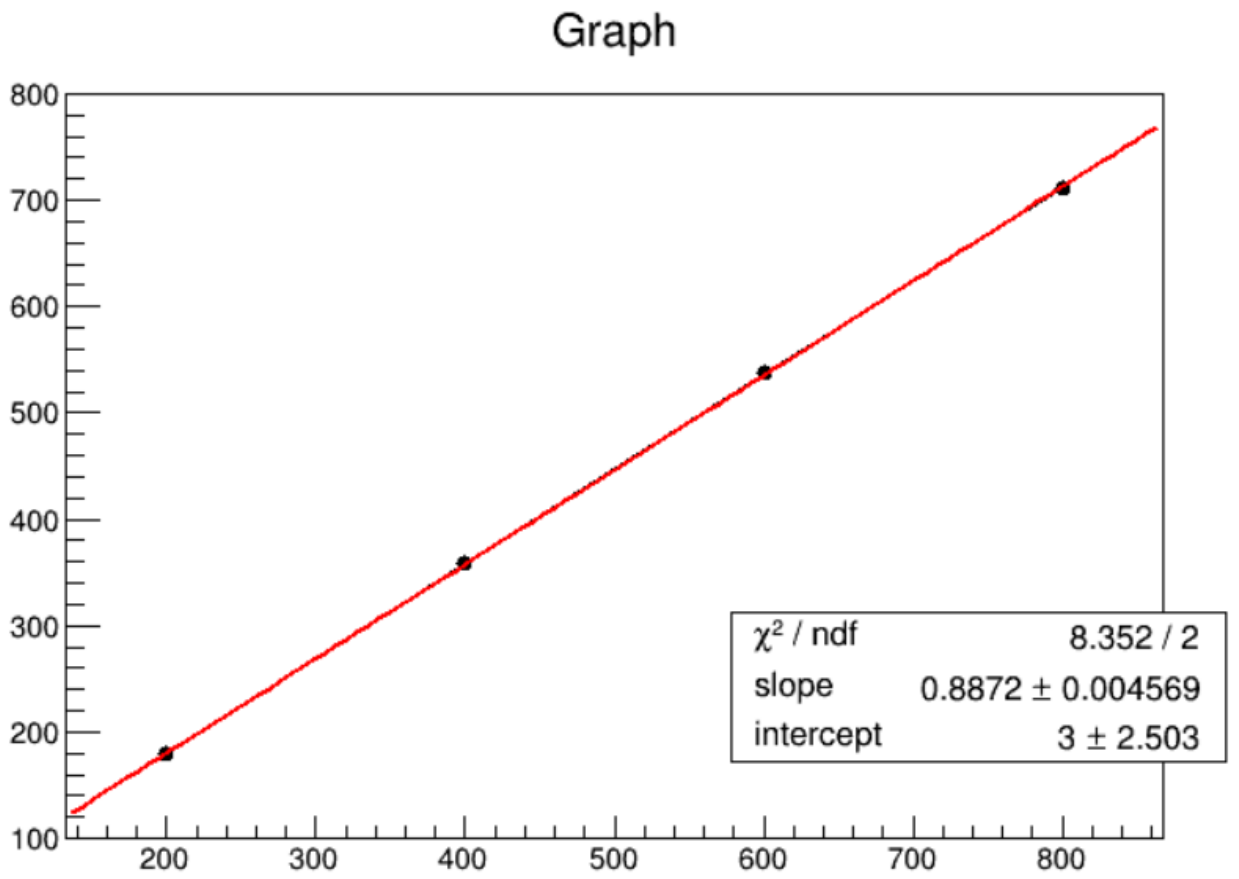


height



- 평균 channel 값은 179.6 이었다.
- FADC에서 1 ch는 0.8605 mV 였다.
- 따라서 154.54 mV 가 나타남을 알 수 있다.

Results



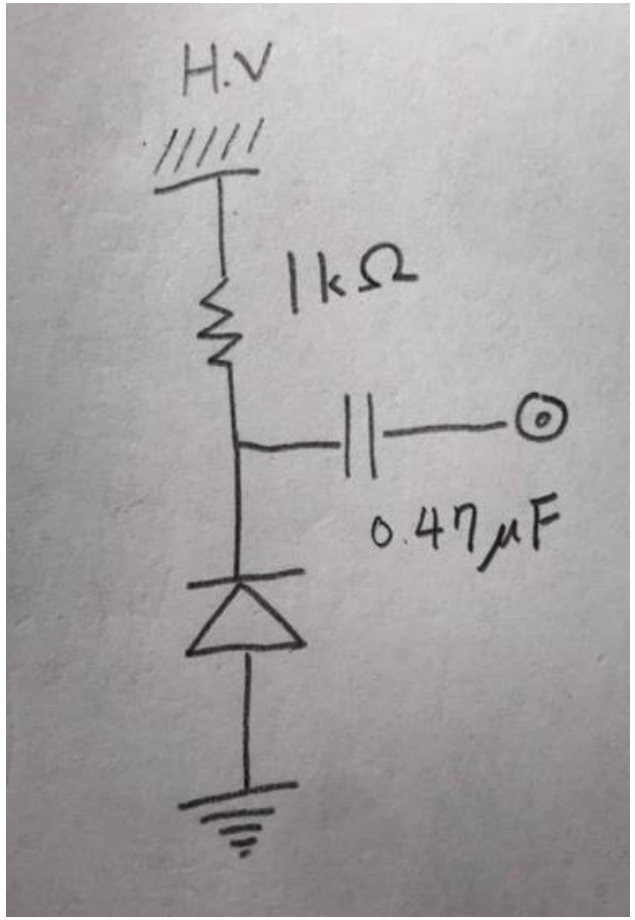
증폭된 전압 vs 채널 수

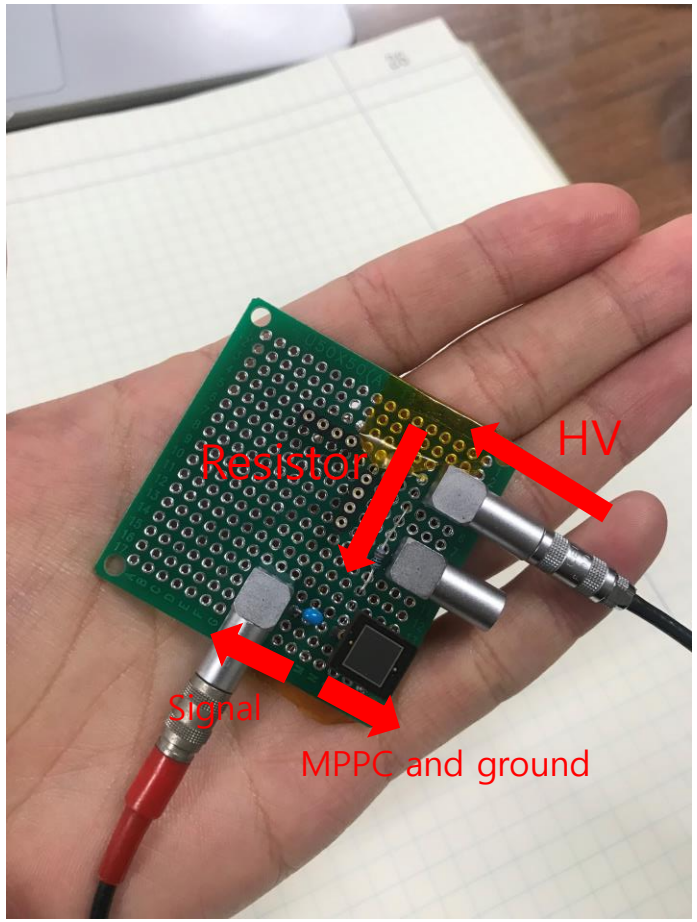
Single photon signal

Self trigger

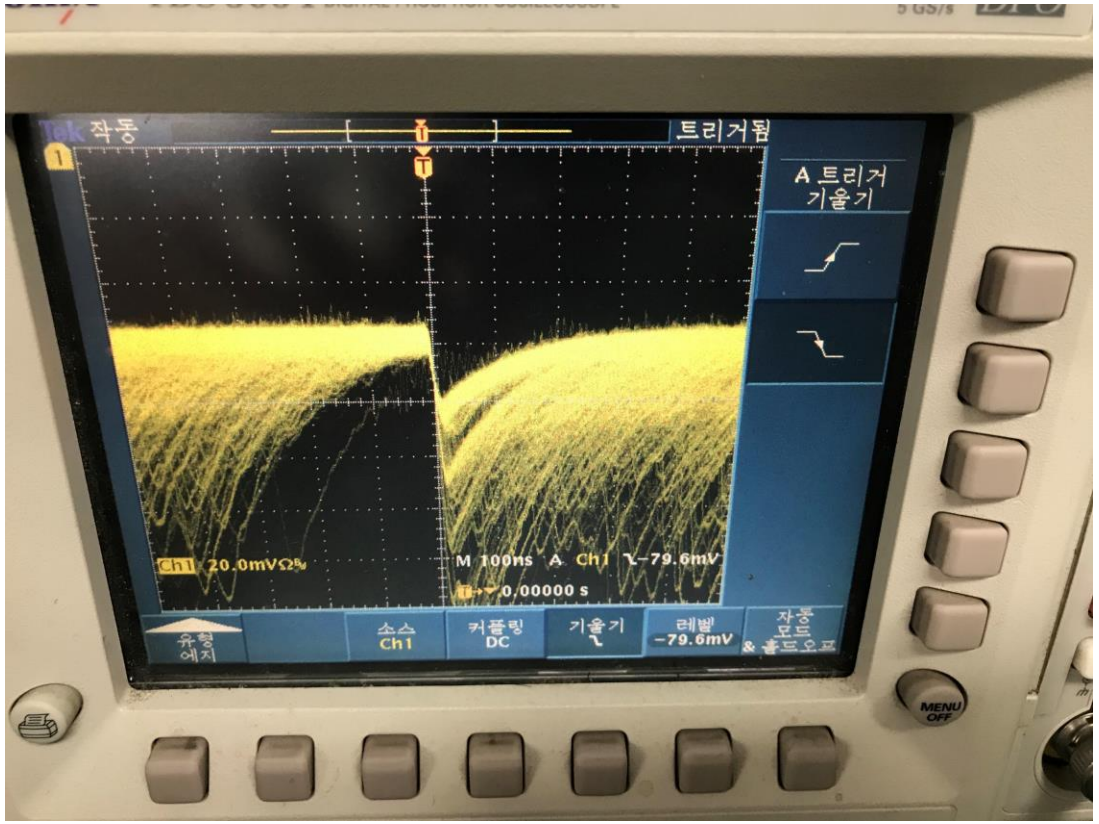
실험 사진

- 오른쪽의 사진은 실제로 사용한 회로도와 회로이다.
- 해당 회로를 LED 없이 black sheet로 덮은 뒤, dark current에 의한 신호를 통해 Single photon signal을 확인하였다.

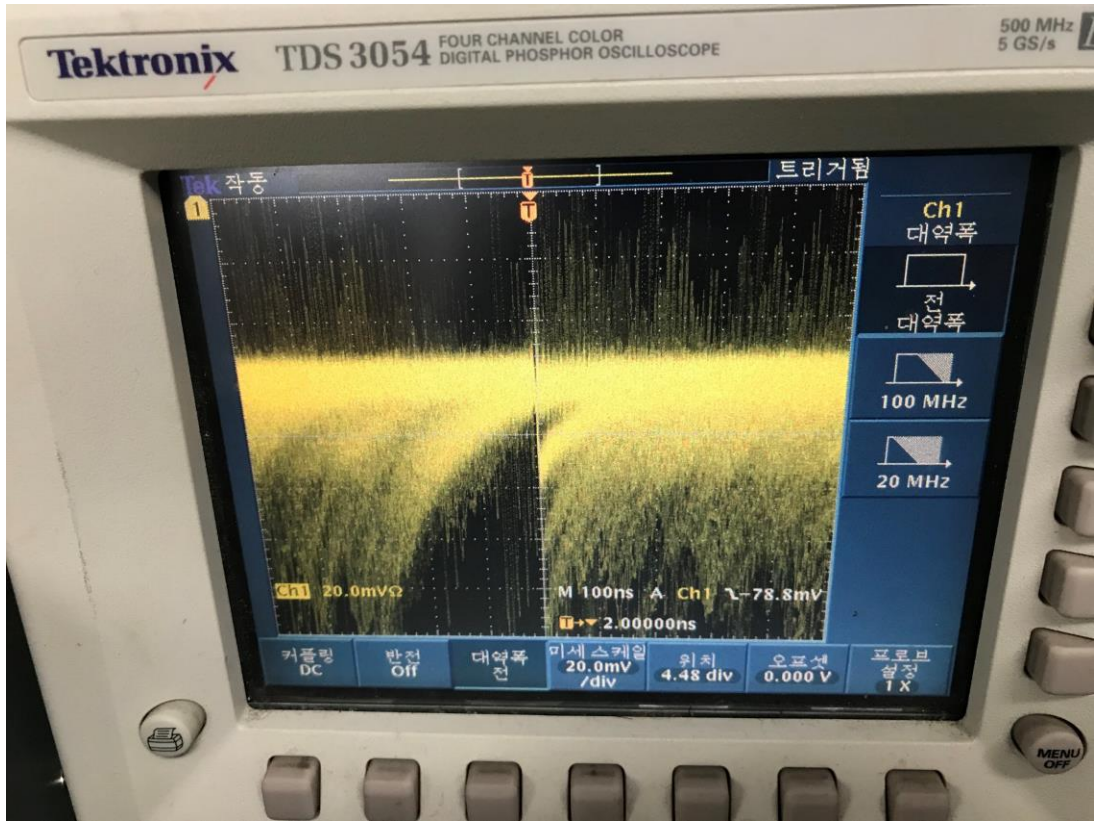




Oscilloscope

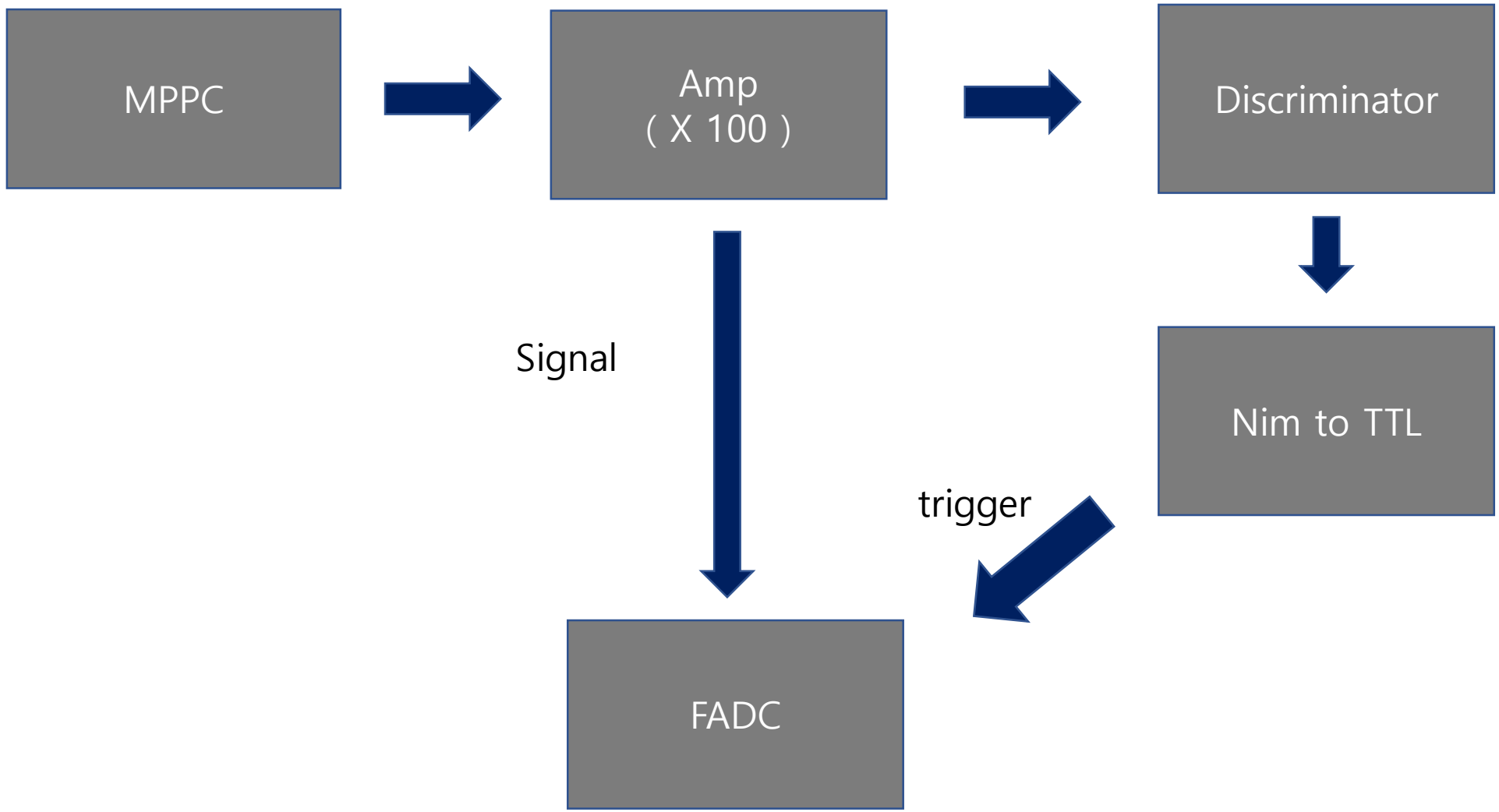


High voltage = 58 V
(Bandwidth = 12 MHz)

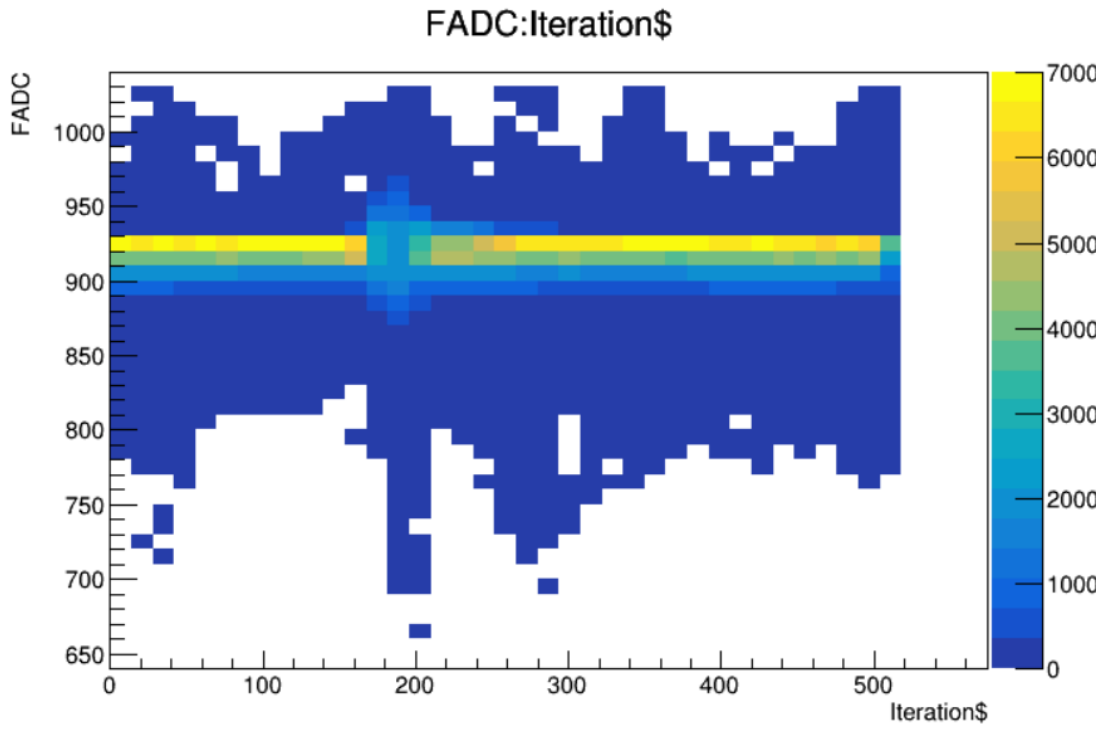


High voltage = 58 V
(No Bandwidth)

DAQ

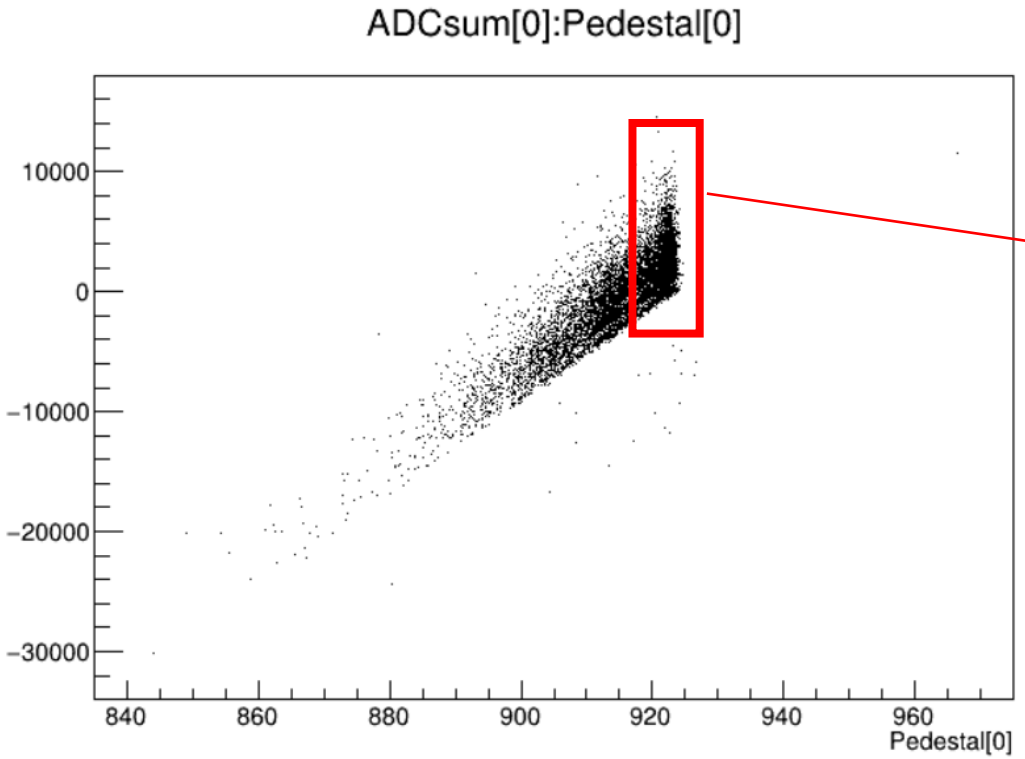


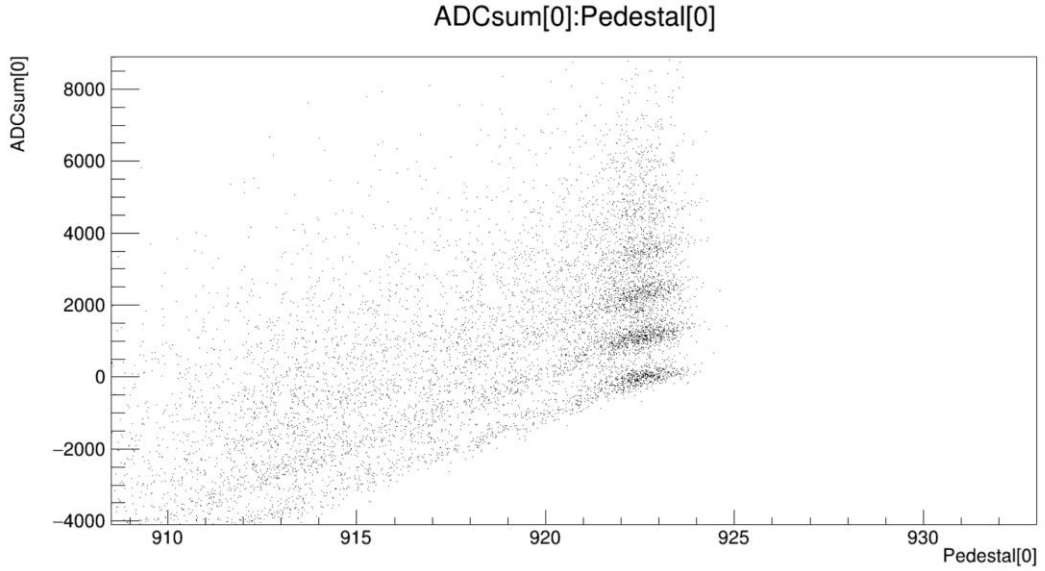
Waveform



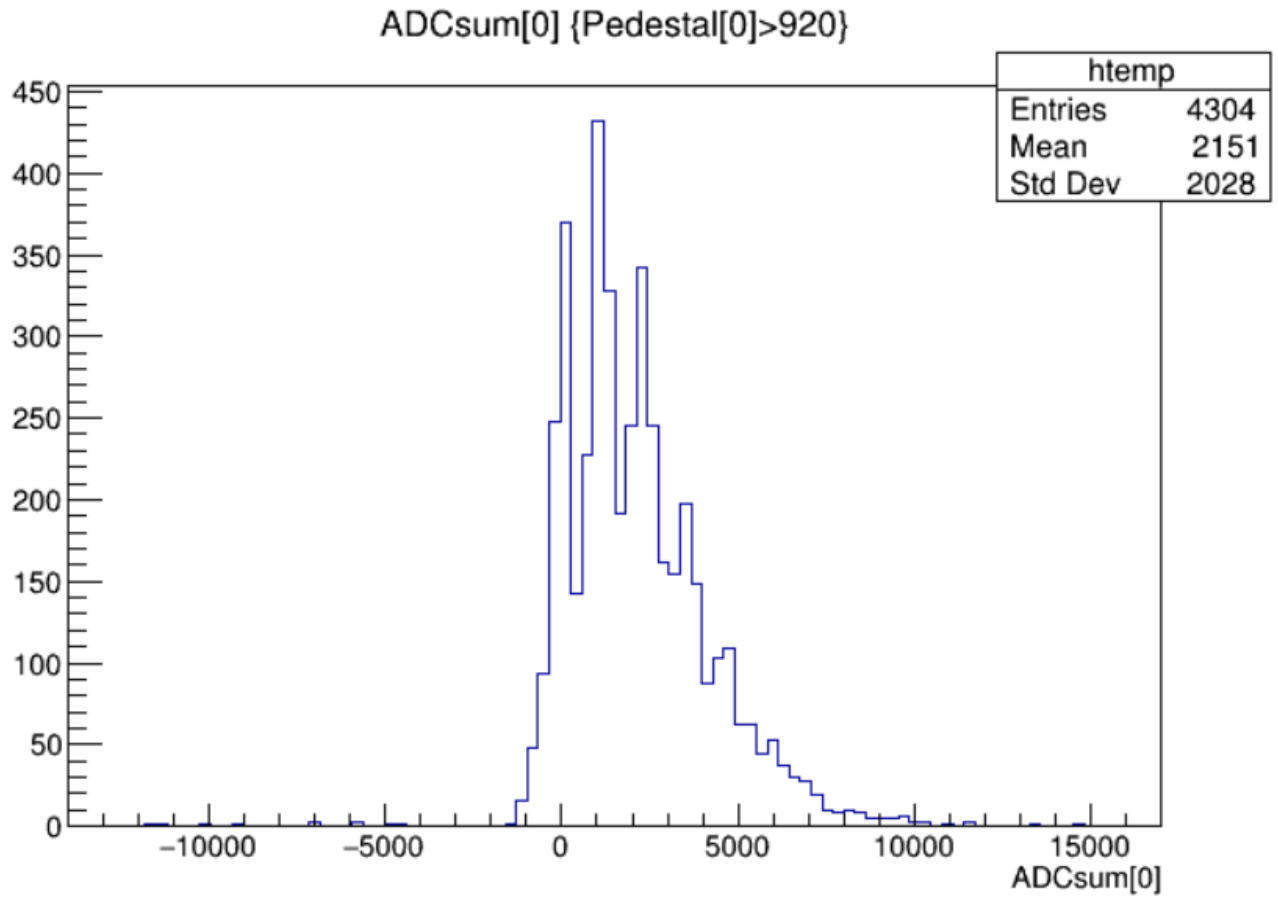
- 왼쪽의 그림은 high voltage로 58 V를 MPPC에 가해줬을 때, self trigger로 FADC를 이용하여 데이터를 받아서 모든 파형을 겹쳐서 그렸을 때의 그림이다.
- Oscilloscope 상으로 확인한 Single photon singla의 높이는 약 20~30 mV였는데, Discriminator의 threshol가 23 mV까지 밖에 내려가지 않아서 사실상 정확한 Single photon signal을 받을 수 없음을 확인할 수 있다.

Pedestal – ADC sum



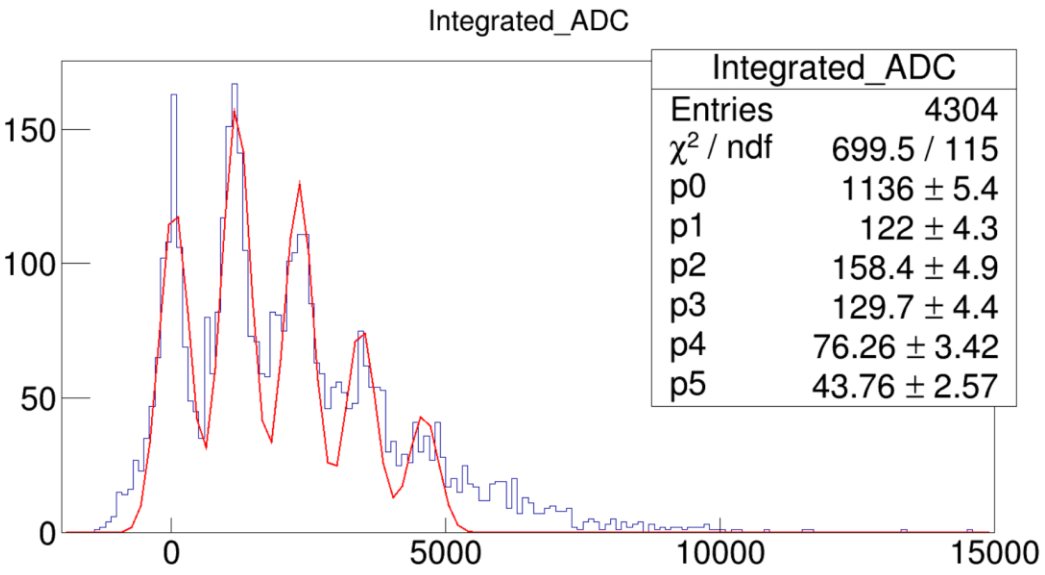


ADC sum with pedestal cut



Pedestal cut 조건을 줌으로써, Single photon signal에서 볼 수 있는 손가락 모양의 그래프를 확인할 수 있었다.

Fitting Function and result

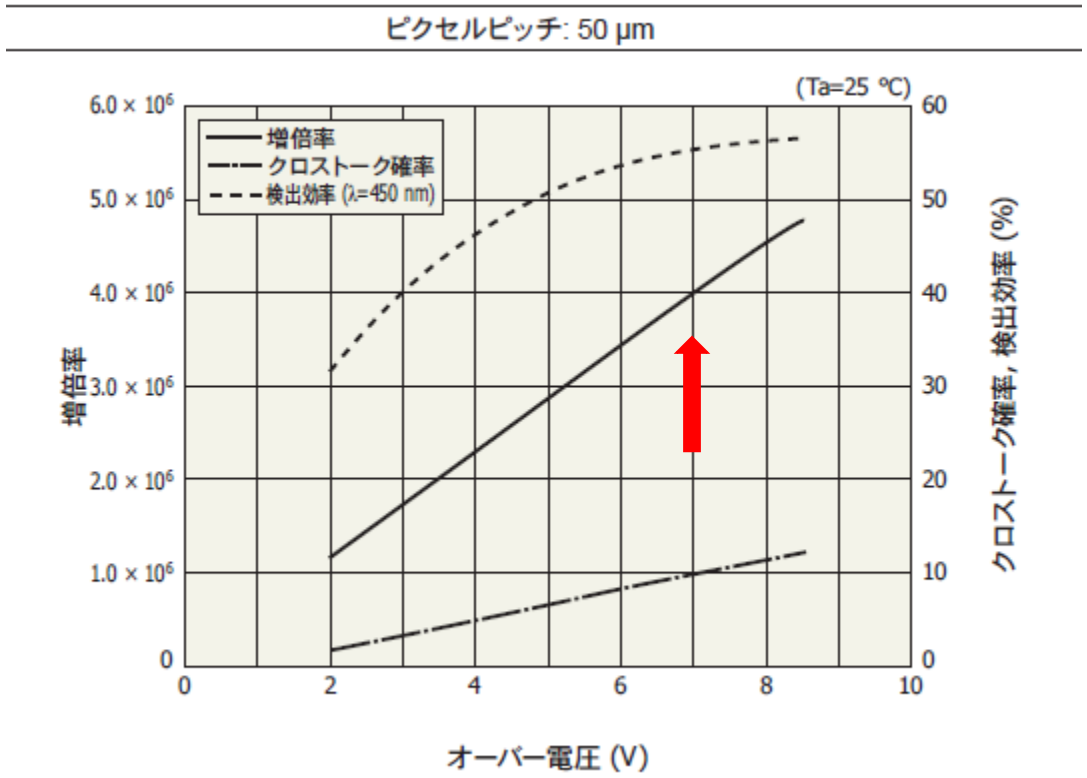



```
double finger_ft(double *x, double *par)
{
//  double ped = 167.5;
  double ped = 50.5;
//  double sigma = 410.5;
  double sigma = 270.5;

  double xx=x[0];
  double y=0;
  double y0=exp(-(xx-ped)*(xx-ped)/(2*sigma*sigma));
  double y1=exp(-(xx-par[0]-ped)*(xx-par[0]-ped)/(2*sigma*sigma));
  double y2=exp(-(xx-2*par[0]-ped)*(xx-2*par[0]-ped)/(2*sigma*sigma));
  double y3=exp(-(xx-3*par[0]-ped)*(xx-3*par[0]-ped)/(2*sigma*sigma));
  double y4=exp(-(xx-4*par[0]-ped)*(xx-4*par[0]-ped)/(2*sigma*sigma));
  double y5=exp(-(xx-5*par[0]-ped)*(xx-5*par[0]-ped)/(2*sigma*sigma));
  double y6=exp(-(xx-6*par[0]-ped)*(xx-6*par[0]-ped)/(2*sigma*sigma));
  double fitval = (par[1]*y0+par[2]*y1+par[3]*y2+par[4]*y3+par[5]*y4);

  return fitval;
}
```

Multiplication value



- 앞 슬라이드에서 Gaussian 평균 값 사이의 차이는 1136 ch 였다.
- FADC의 한 ch은 0.8872 mV이고 400 MHz이므로 점 사이의 간격을 2.5 ns라고 할 때, Signal 사이의 간격은 50.39 pC이다.
- 이를 바탕으로 증폭률을 다시 계산하면 3.149 X 10^6이다.

Multiplication value

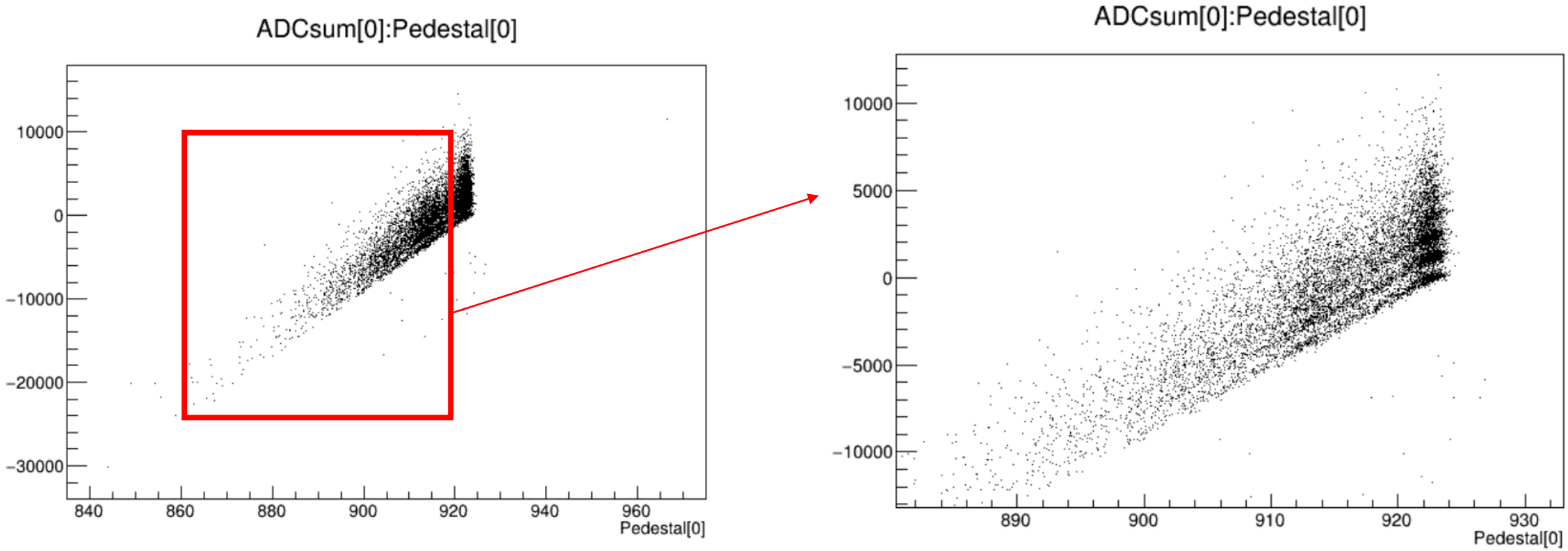
- 위의 ADC sum histogram에서의 실험조건은 58 V로 breaking down voltage(53 V)에서 5V 더 가해준 전압이었다.
- 해당 조건에서 data sheet를 확인해 보면 4.0 X 10^6 근처의 값이므로 측정한 값 근처임을 확인할 수 있다.

電気的および光学的特性 (指定のない場合はTyp. Ta=25 °C)

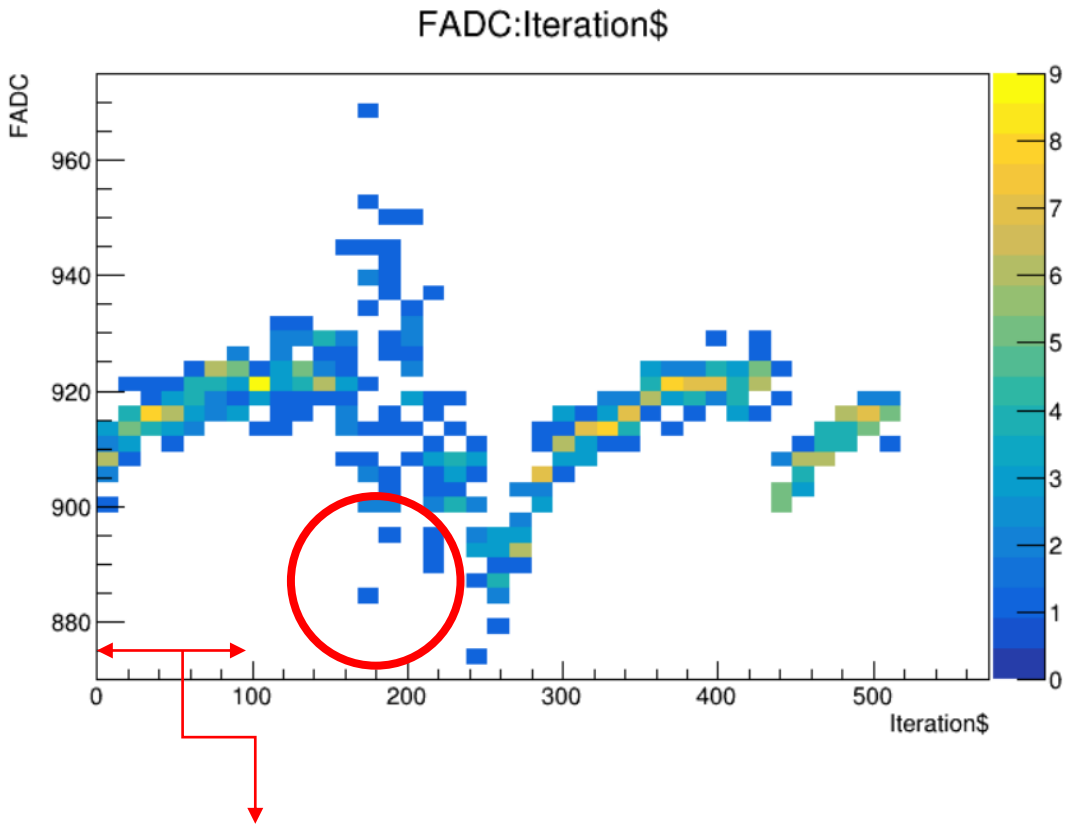
型名	測定条件	感度波長範囲 λ (nm)	最大感度波長 λp (nm)	検出効率 PDE*4 λ=λp (%)	ダークカウント*5 Typ. (kcps)	ダークカウント*5 Max. (kcps)	端子間容量 Ct (pF)	増倍率 M	降伏電圧 VBR (V)	クロストーク確率 (%)	推奨動作電圧 Vop (V)	推奨動作電圧の温度係数 ΔTVop (mV/°C)
S13360-1325CS	Vover =5 V	270 ～ 900	450	25	70	210	60	7.0 × 10^5	53 ± 5	1	VBR + 5	54
S13360-1325PE		320 ～ 900										
S13360-3025CS		270 ～ 900			400	1200	320					
S13360-3025PE		320 ～ 900										
S13360-6025CS		270 ～ 900			1600	5000	1280					
S13360-6025PE		320 ～ 900										
S13360-1350CS	Vover =3 V	270 ～ 900		40	90	270	60	1.7 × 10^6		3	VBR + 3	
S13360-1350PE		320 ～ 900										
S13360-3050CS		270 ～ 900			500	1500	320					
S13360-3050PE		320 ～ 900										
S13360-6050CS		270 ～ 900			2000	6000	1280					
S13360-6050PE		320 ～ 900										
S13360-1375CS	Vover =3 V	270 ～ 900		50	90	270	60	4.0 × 10^6		7	VBR + 3	
S13360-1375PE		320 ～ 900										
S13360-3075CS		270 ～ 900			500	1500	320					
S13360-3075PE		320 ～ 900										
S13360-6075CS		270 ～ 900			2000	6000	1280					
S13360-6075PE		320 ～ 900										

*4: 検出効率は、クロストークとアフターパルスを含んでいません。
*5: 閾値=0.5 p.e.
注) 上記の特性値は、表中の増倍率が得られる動作電圧における値です (製品に添付されるデータを参照してください)。

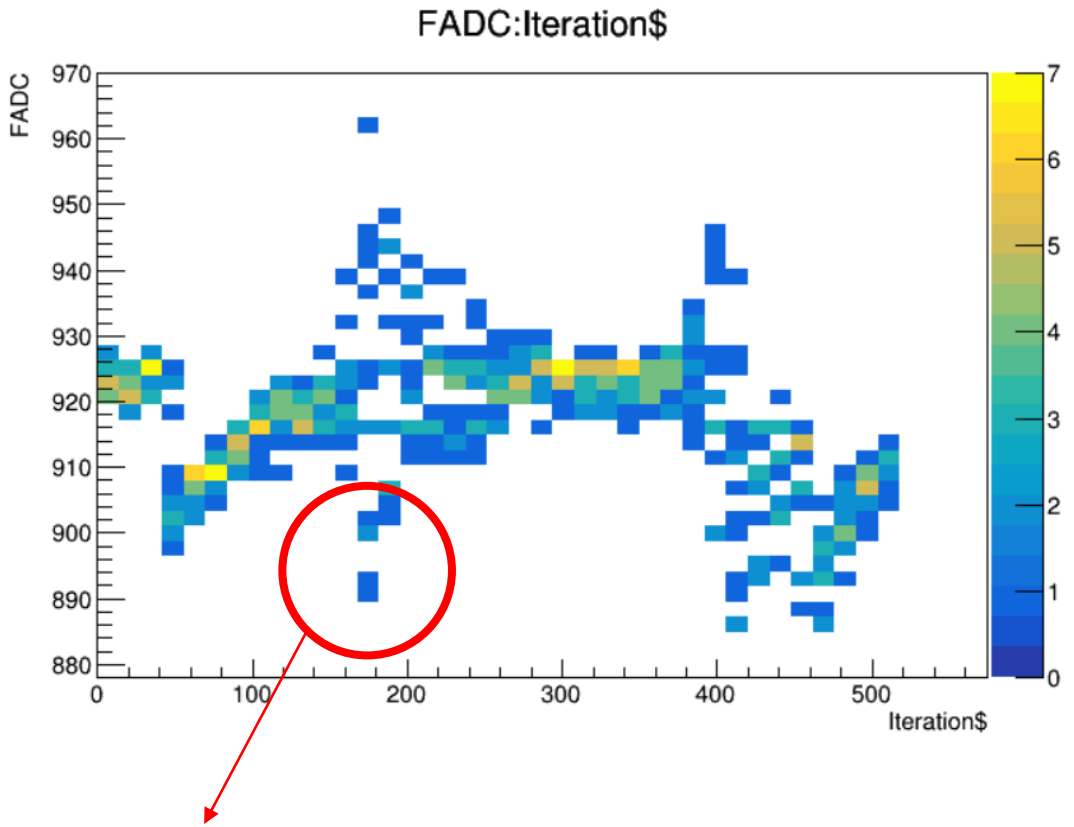
Pedestal


ADCsum[0]:Pedestal[0]
10000
0
−10000
−20000
−30000
840
860
880
900
920
940
960
Pedestal[0]
ADCsum[0]:Pedestal[0]
10000
5000
0
−5000
−10000
890
900
910
920
930
Pedestal[0]

Waveform

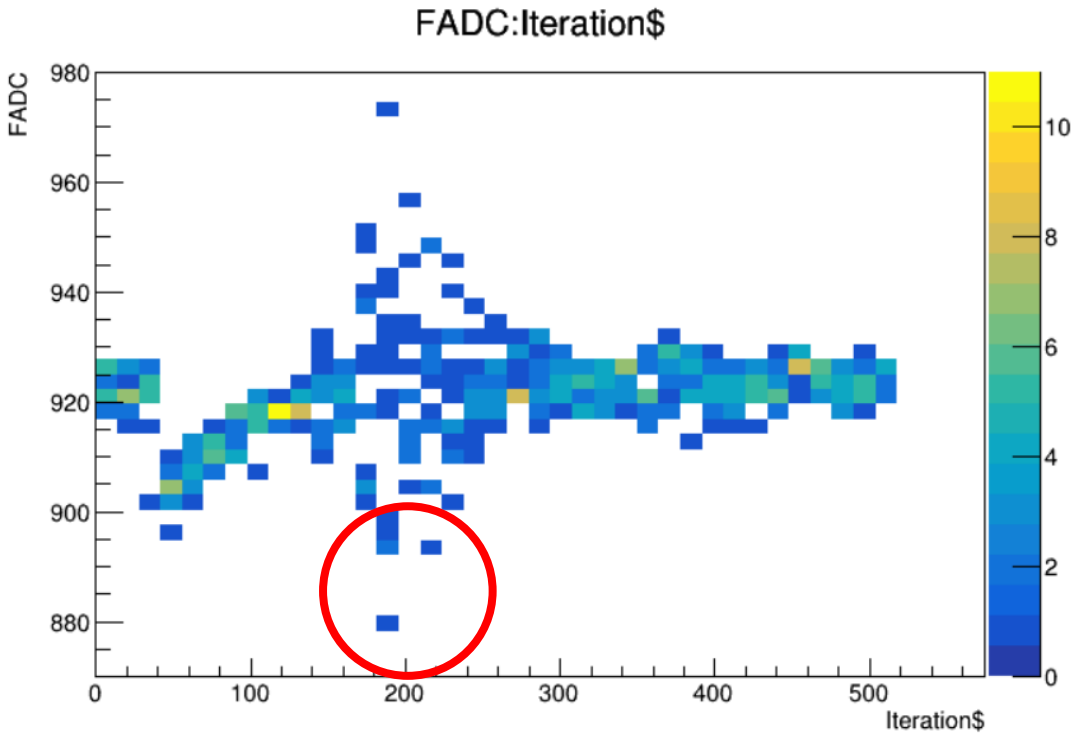


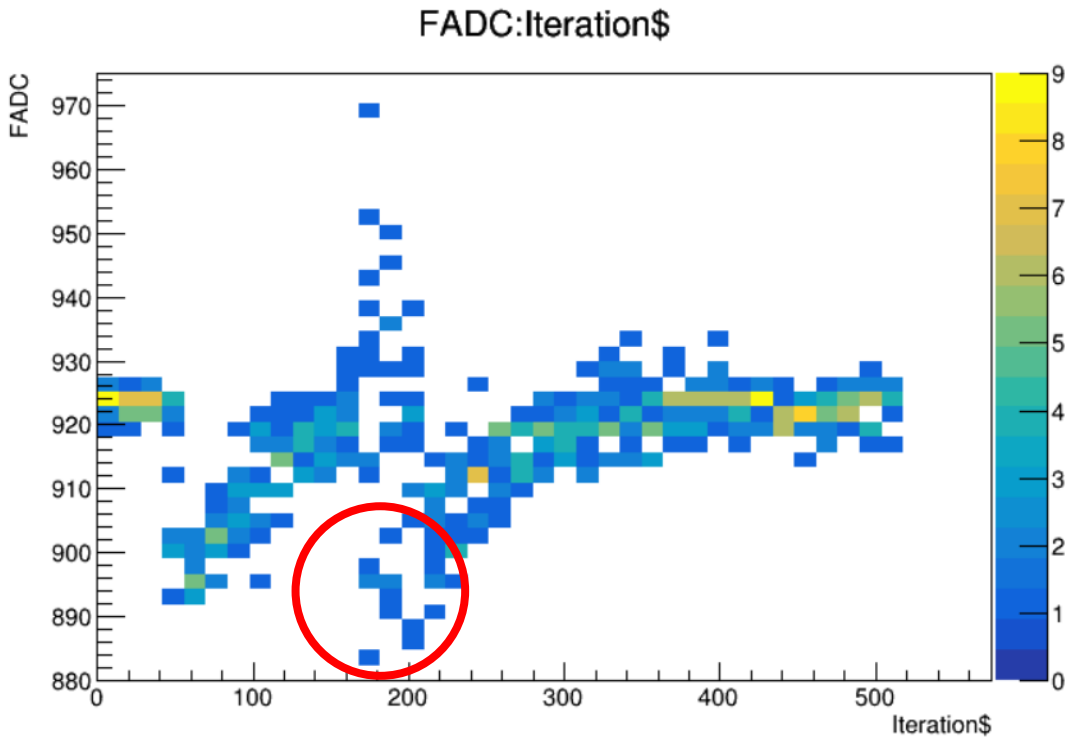
Pedestal을 계산할 때 사용된 범위



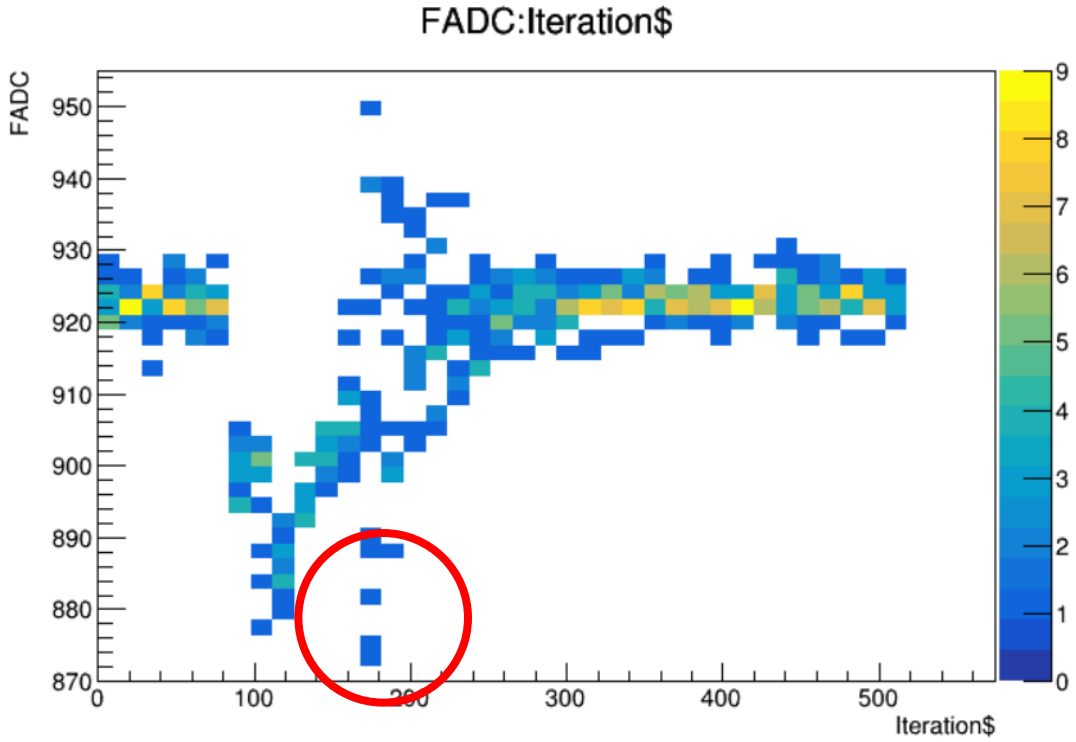
Trigger

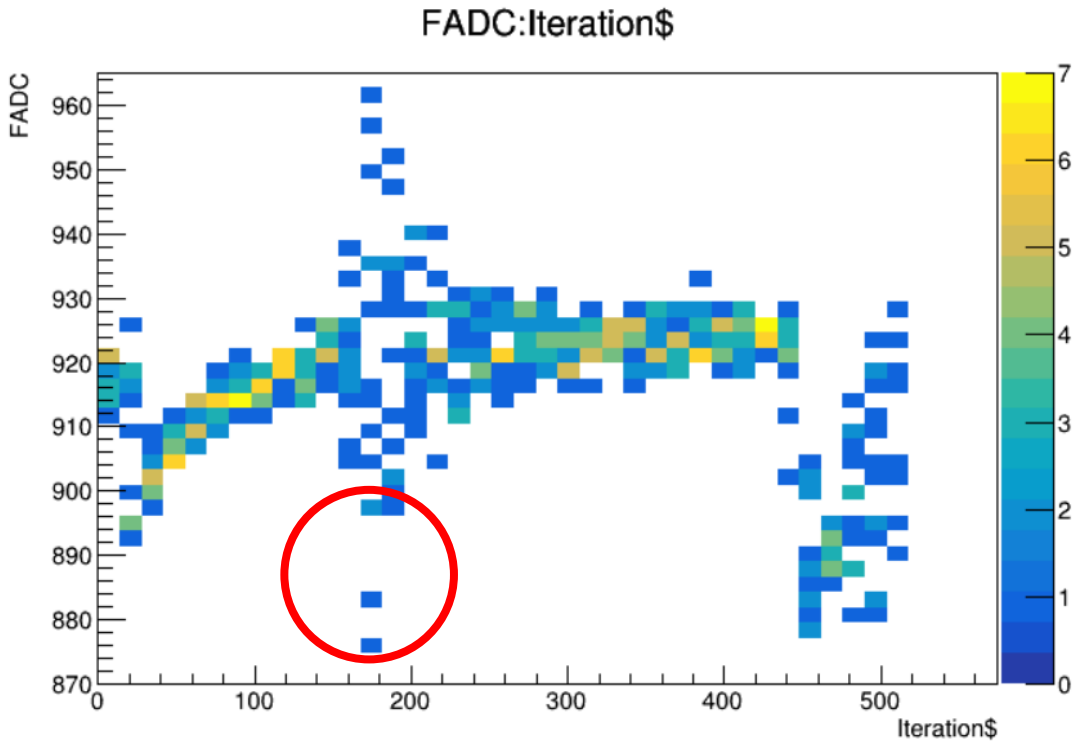
Waveform


FADC:Iteration$
FADC
980
960
940
920
900
880
0
100
200
300
400
500
Iteration$
10
8
6
4
2
0

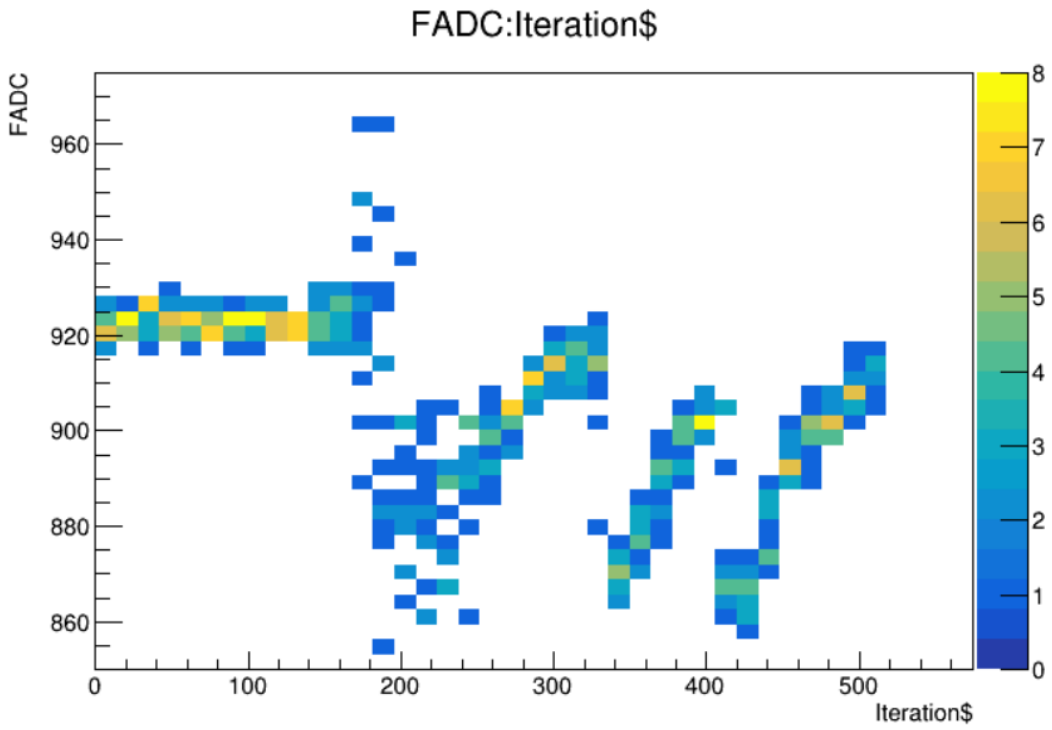

FADC:Iteration$
FADC
970
960
950
940
930
920
910
900
890
880
0
100
200
300
400
500
Iteration$
9
8
7
6
5
4
3
2
1
0

Waveform


FADC:Iteration$
FADC
950
940
930
920
910
900
890
880
870
0
100
200
300
400
500
Iteration$
9
8
7
6
5
4
3
2
1
0

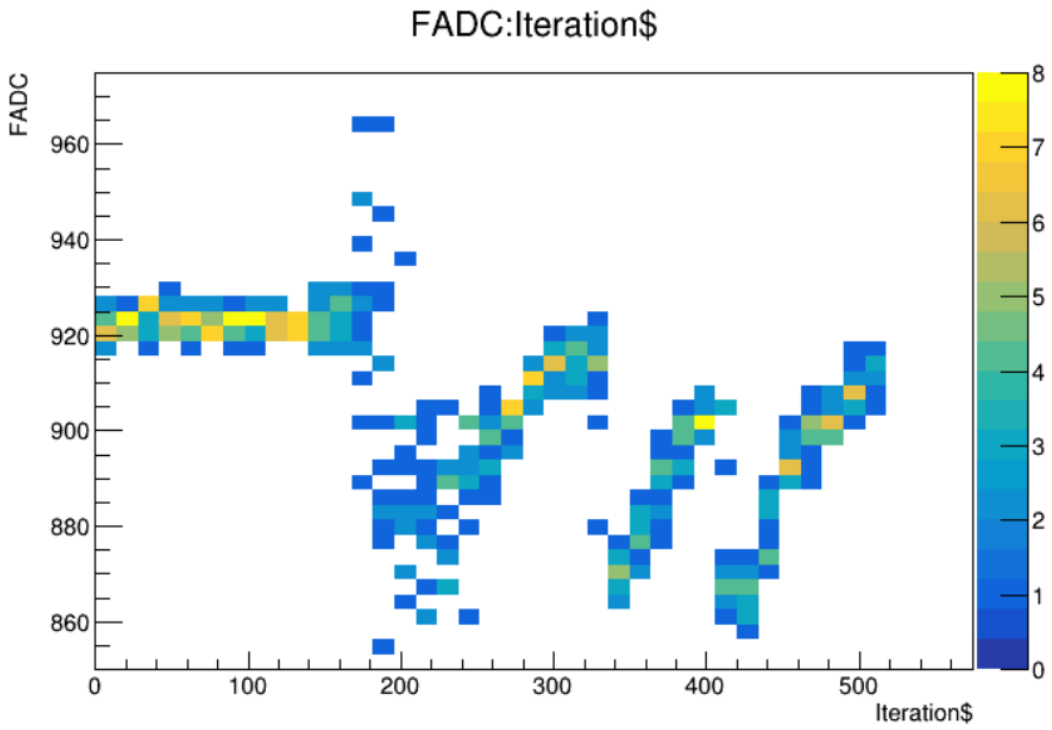

FADC:Iteration$
FADC
960
950
940
930
920
910
900
890
880
870
0
100
200
300
400
500
Iteration$
7
6
5
4
3
2
1
0

Waveform



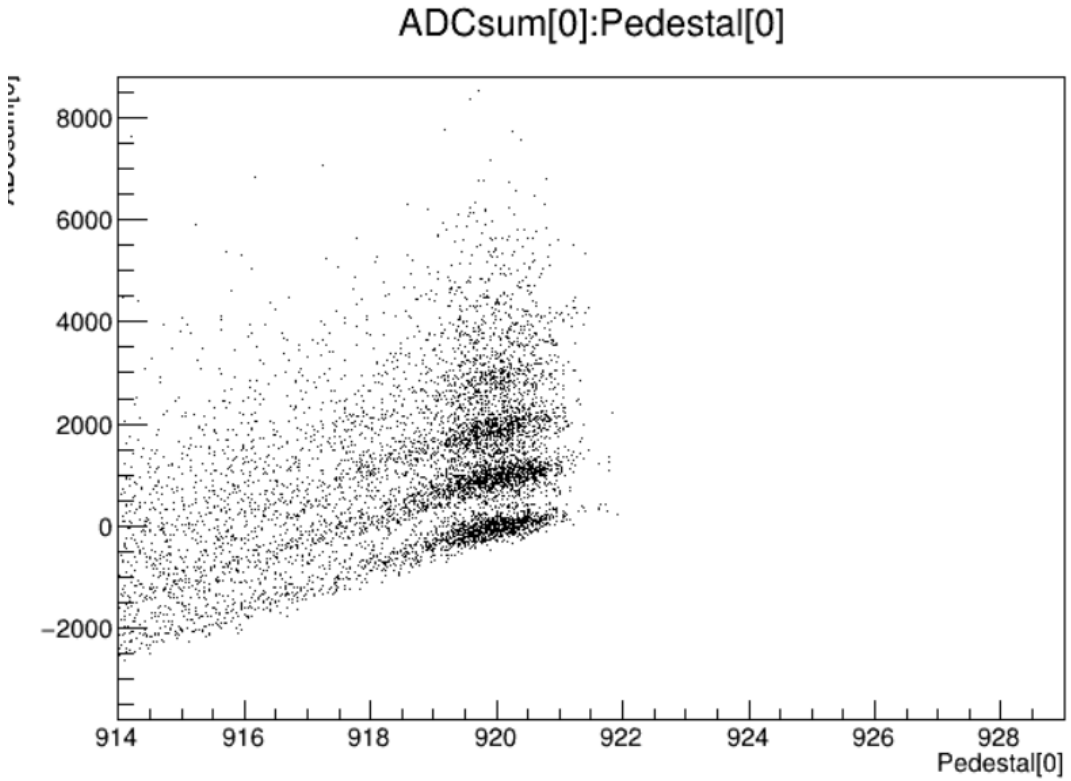
- 실제로 100배를 해 주더라도 Single photon signal의 높이는 20 mV ~ 25 mV 사이의 값을 가졌다.
- Self trigger에서 discriminator를 이용해서 threshold 값을 넘을 때 trigger를 만들어 줬는데, discriminator threshold의 최소값이 23 mV였다.
- 따라서 실제로 Single photon signa이 아니라 noise가 trigger를 해줬고, noise 뒤나 noise와 같이 signal이 생긴 경우 제대로 된 신호가 나타났지만, noise 앞에 single photon signal이 있는 경우, pedestal 값을 낮추었음을 확인할 수 있다.

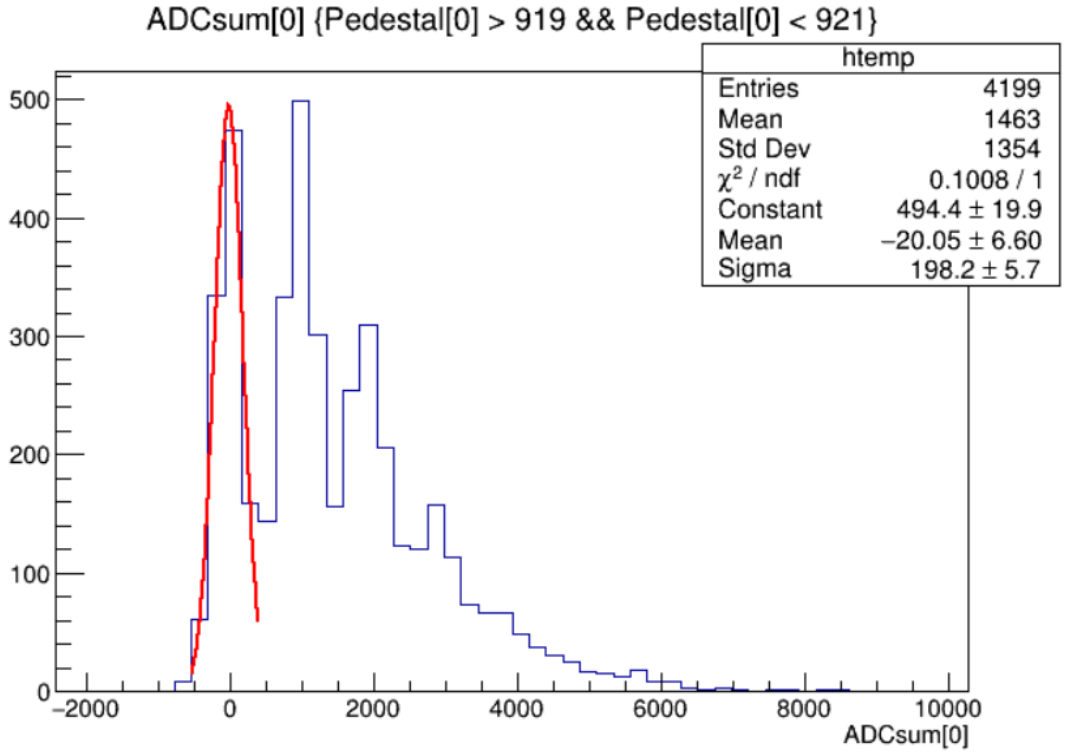
Waveform



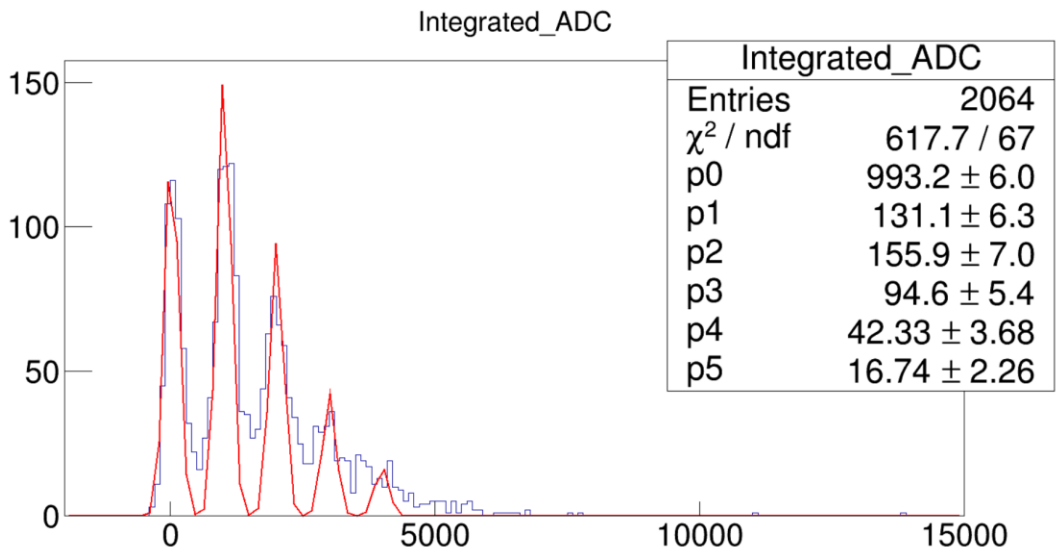
- 실제로 100배를 해 주더라도 Single photon signal의 높이는 20 mV ~ 25 mV 사이의 값을 가졌다.
- Self trigger에서 discriminator를 이용해서 threshold 값을 넘을 때 trigger를 만들어 줬는데, discriminator threshold의 최소값이 23 mV였다.
- 따라서 실제로 Single photon signa이 아니라 noise가 trigger를 해줬고, noise 뒤나 noise와 같이 signal이 생긴 경우 제대로 된 신호가 나타났지만, noise 앞에 single photon signal이 있는 경우, pedestal 값을 낮추었음을 확인할 수 있다.

Input voltage = 57 V



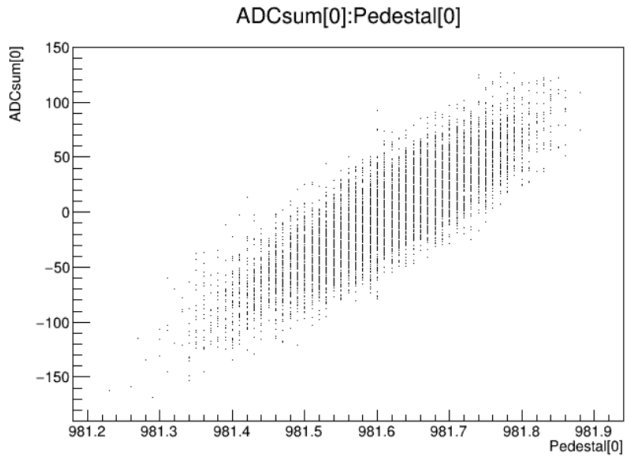


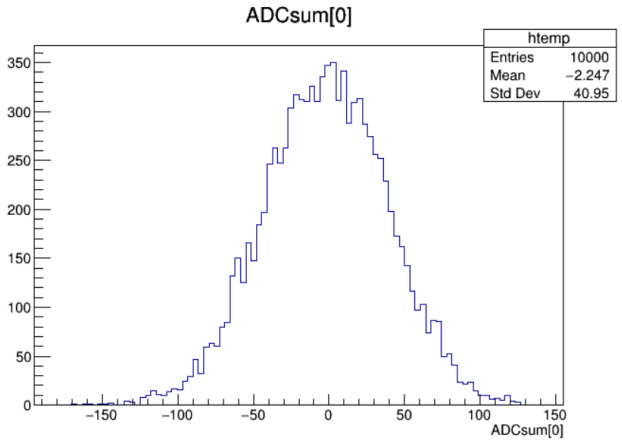
Fitting

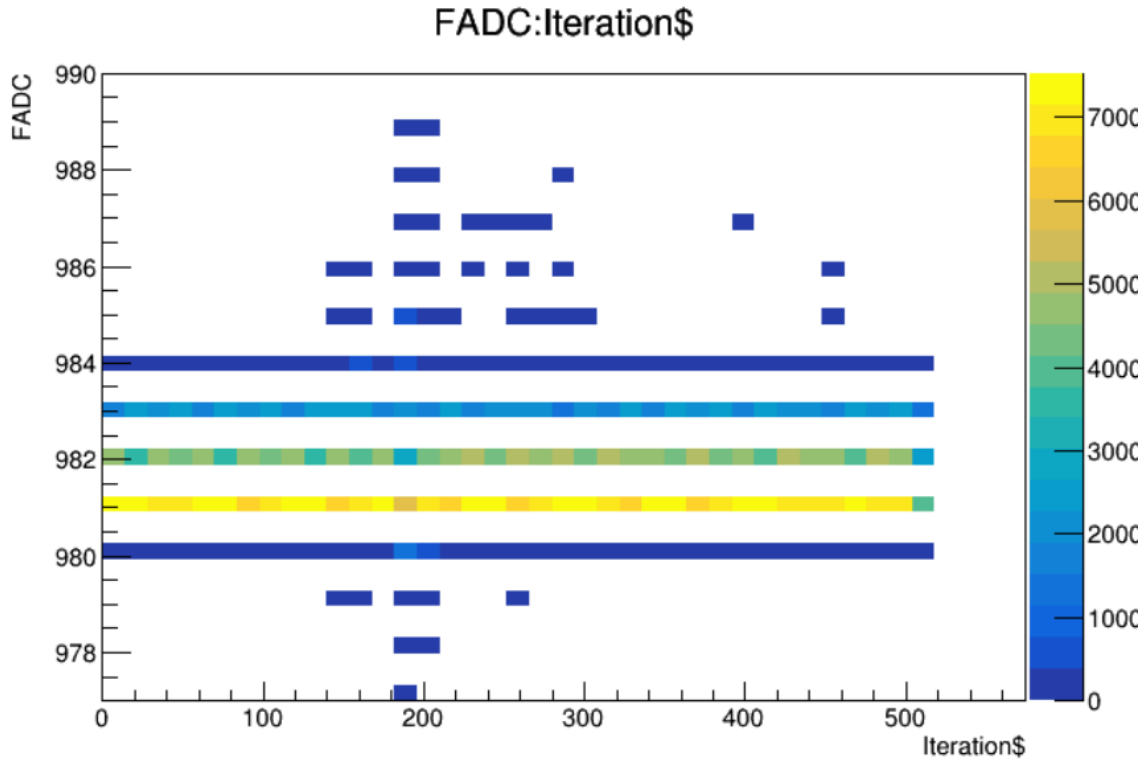


- Peak 사이의 간격은 993.2 ch 였다. 이를 전하량으로 바꿔주면 약 44 pC임을 알 수 있다.
- 마지막으로 Multiplication값을 구해주면 2.75 X 10^6이다.

Input voltage = 56 V



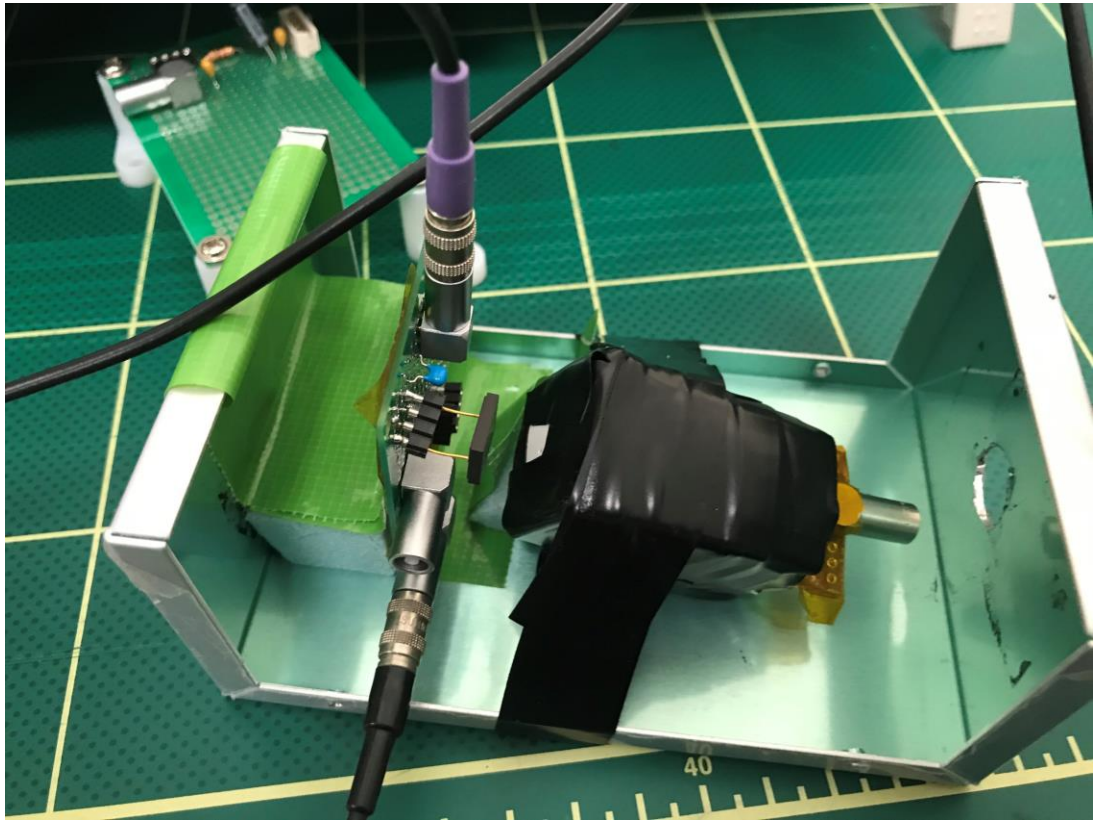




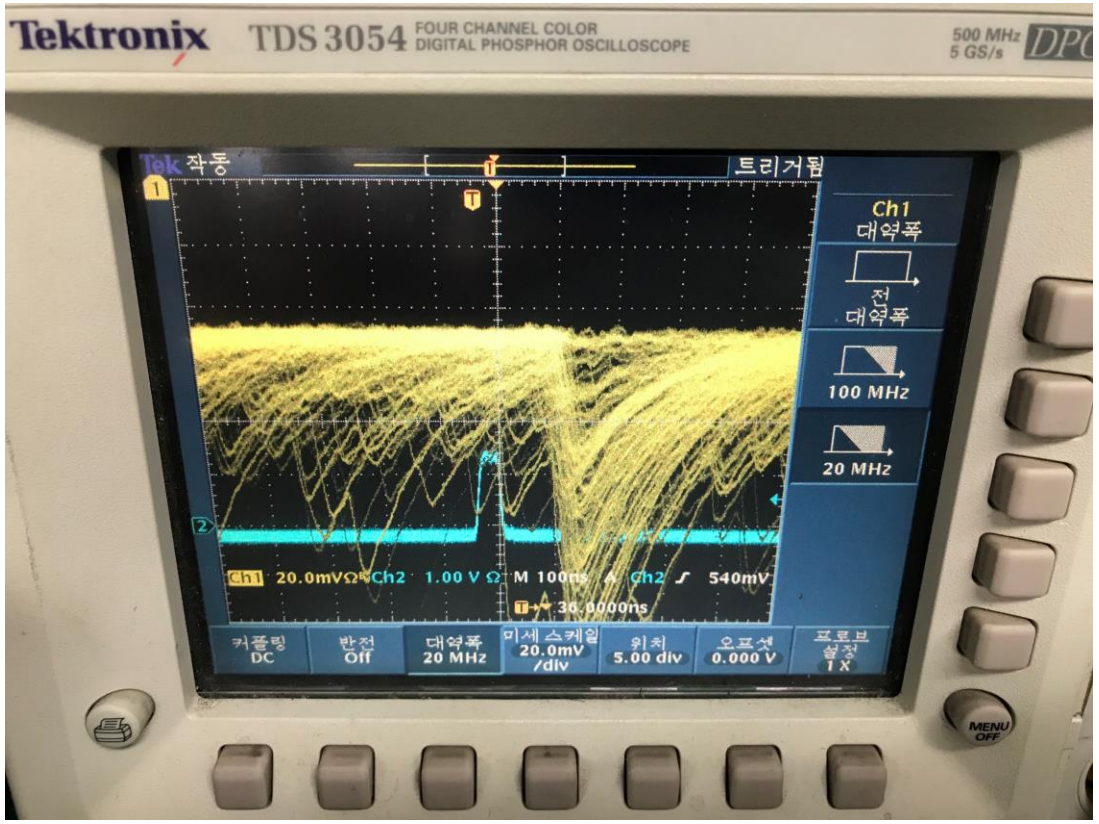
- 그 이하의 전압에서는 FADC로 받은 데이터에서 Single photon signal의 손모양을 관측할 수 없었다.
  (Oscilloscope 상으로는 관측 됨)
- 그 이유는, Single photon signal의 높이가 그렇게 크지 않아 관측되지 않은 것으로 짐작된다.

LED trigger

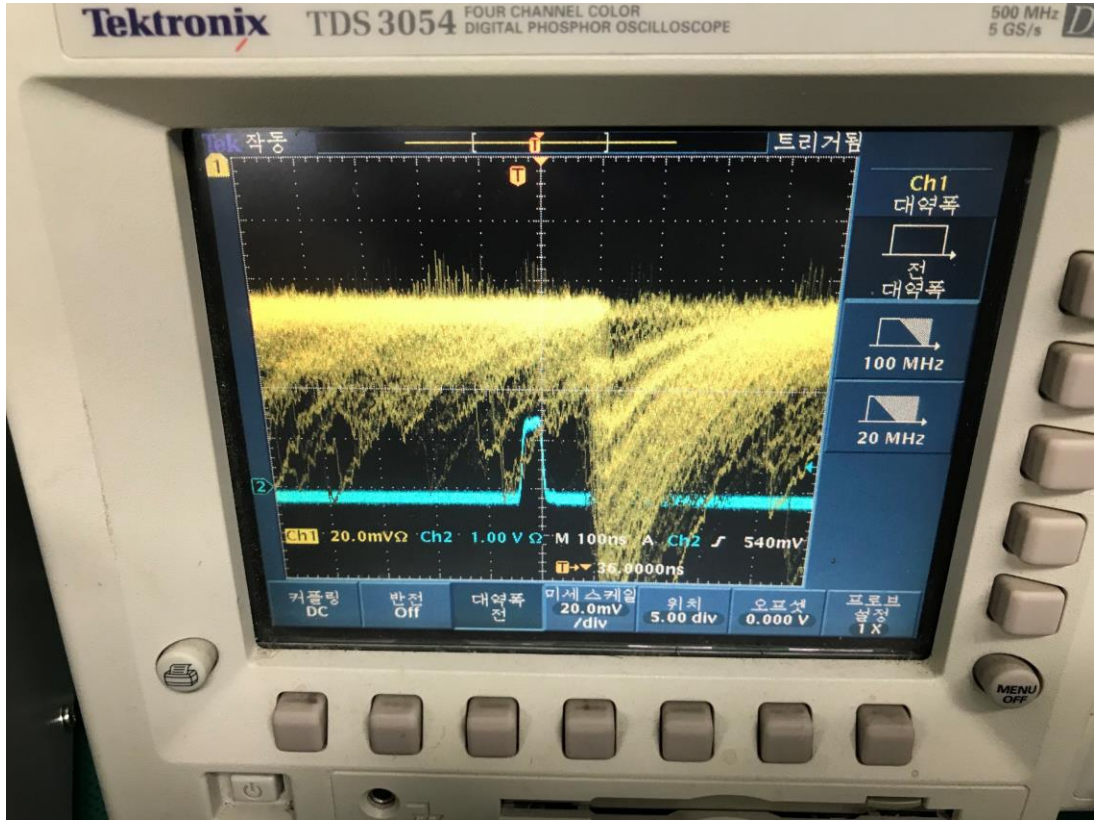
실험조건



Oscilloscope

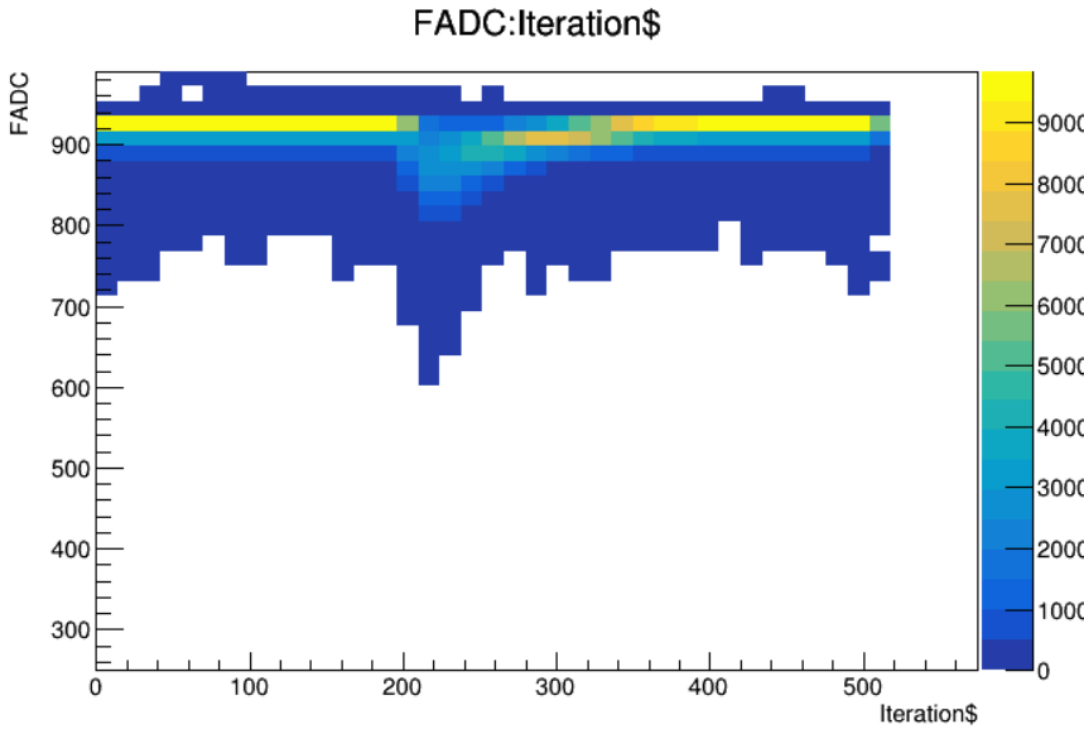


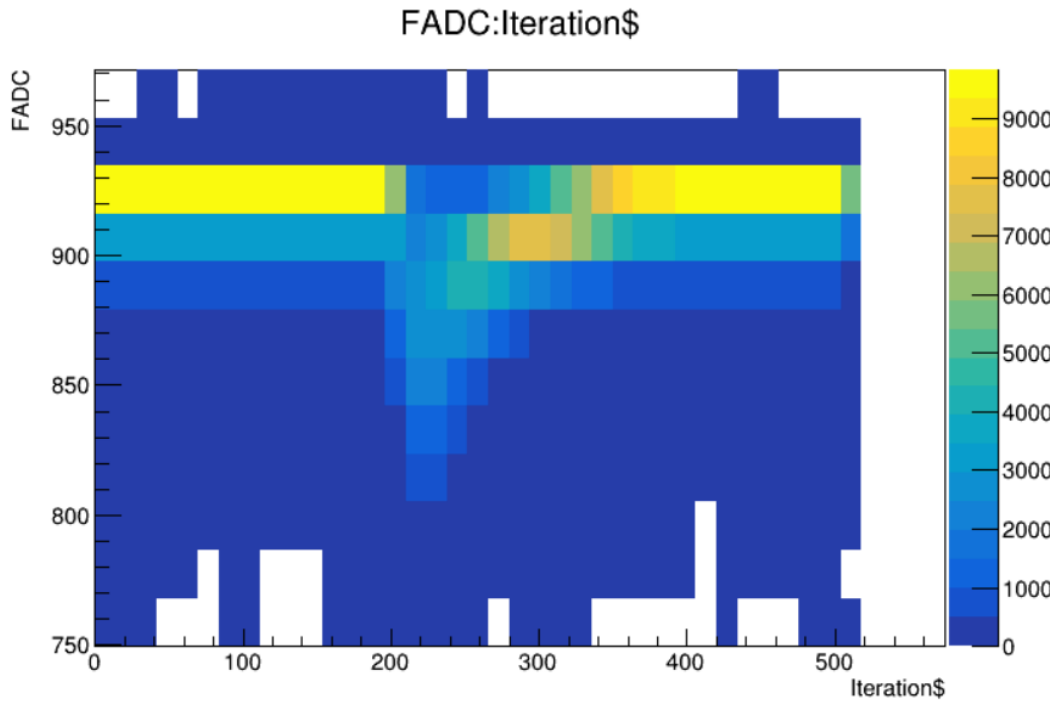
Input Voltage = 58 V
Bandwidth = 12 MHz



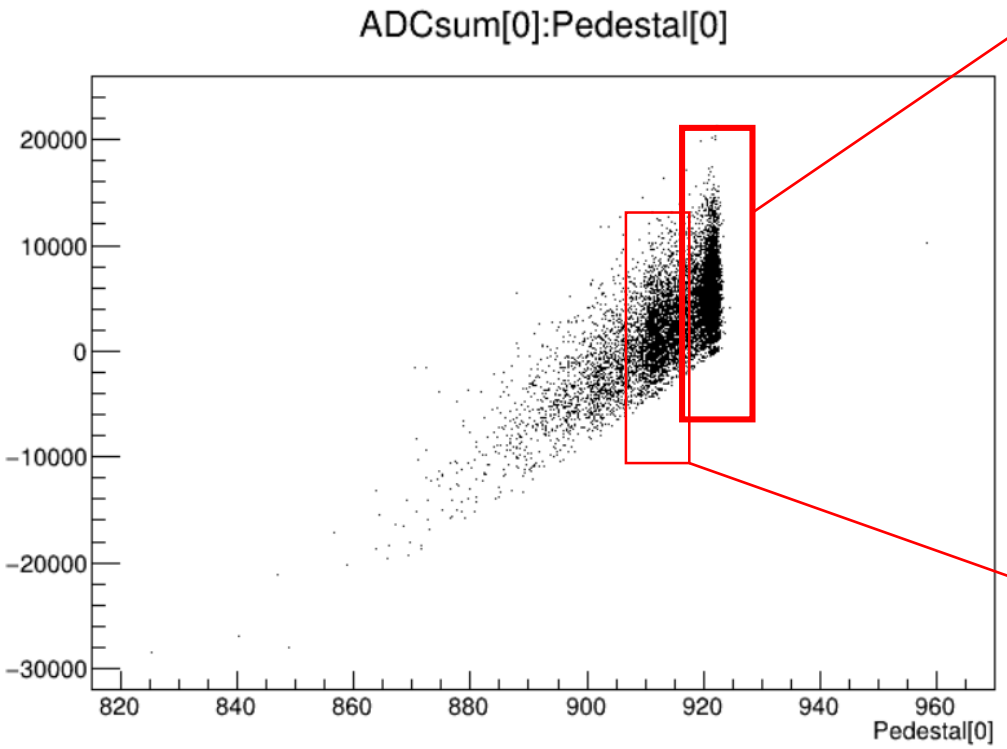
Input Voltage = 58 V
No Bandwidth

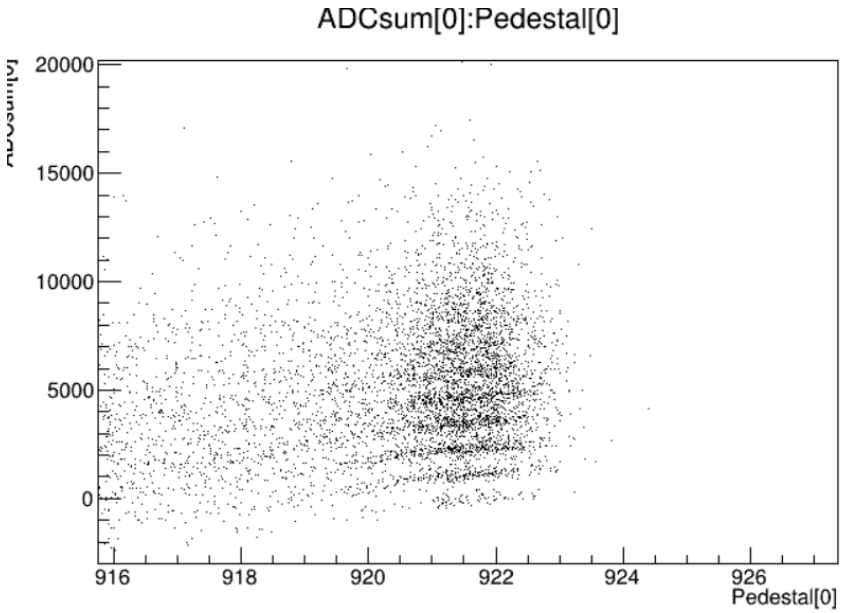
Waveform

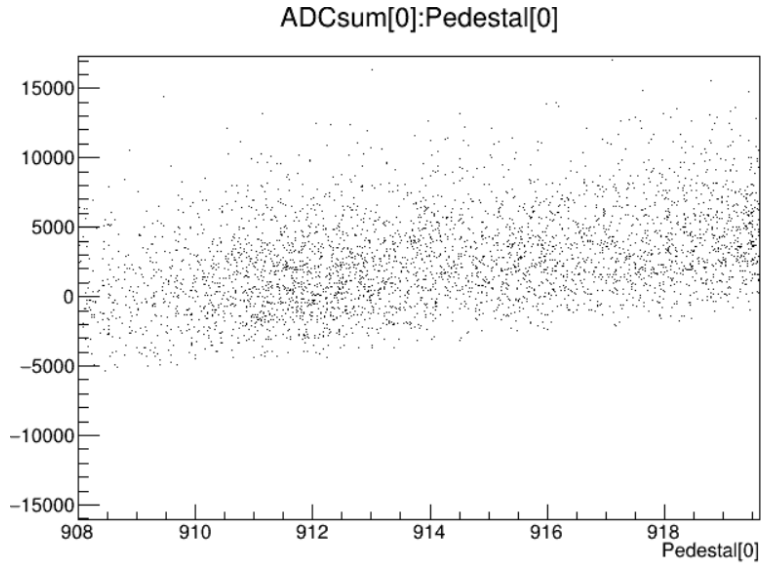

FADC:Iteration$
FADC
900
800
700
600
500
400
300
0
100
200
300
400
500
Iteration$
9000
8000
7000
6000
5000
4000
3000
2000
1000
0


FADC:Iteration$
FADC
950
900
850
800
750
0
100
200
300
400
500
Iteration$
9000
8000
7000
6000
5000
4000
3000
2000
1000
0

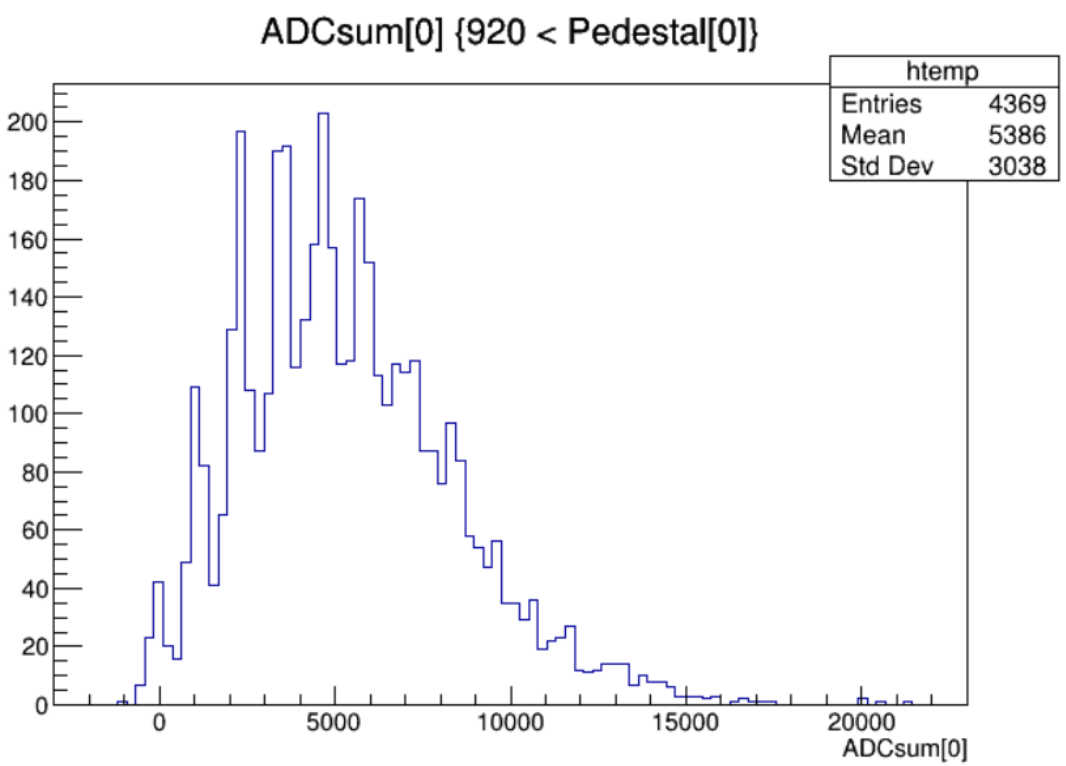
FADC

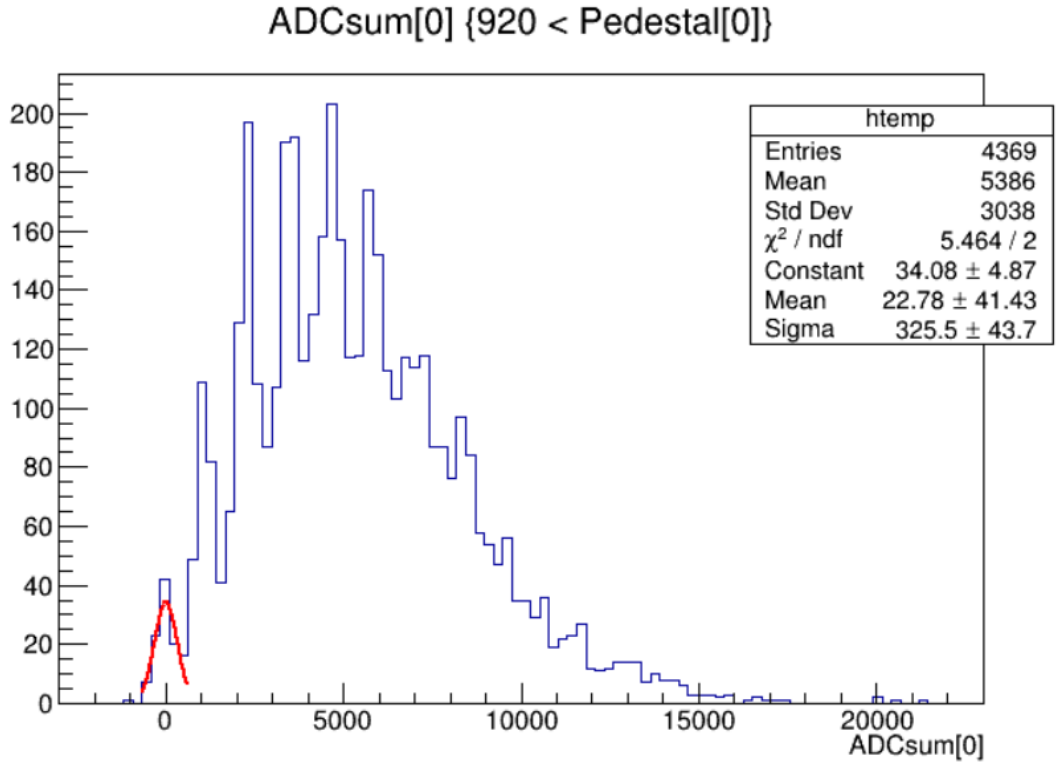

ADCsum[0]:Pedestal[0]
20000
10000
0
−10000
−20000
−30000
820
840
860
880
900
920
940
960
Pedestal[0]


ADCsum[0]:Pedestal[0]
20000
15000
10000
5000
0
916
918
920
922
924
926
Pedestal[0]

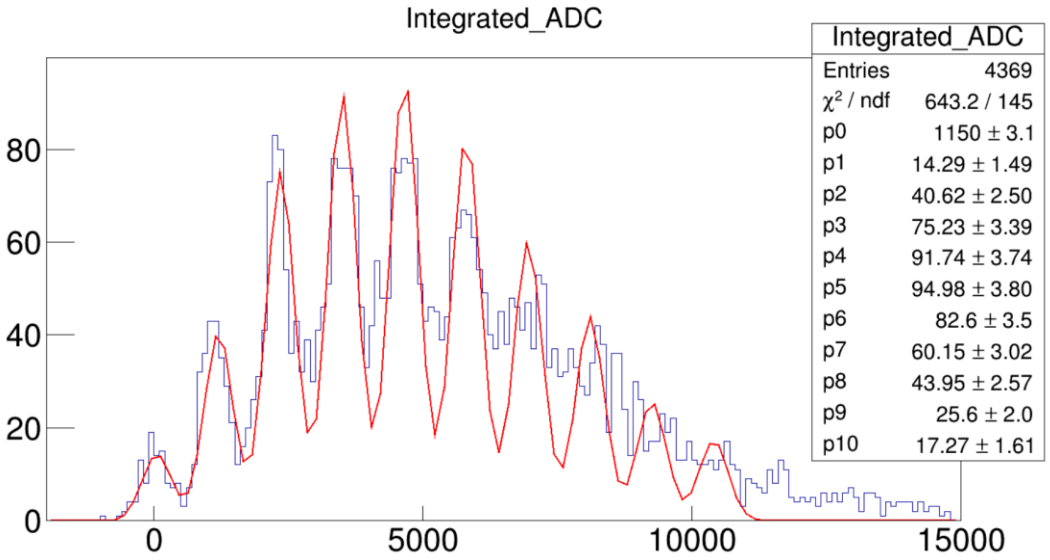

ADCsum[0]:Pedestal[0]
15000
10000
5000
0
−5000
−10000
−15000
908
910
912
914
916
918
Pedestal[0]

FADC


ADCsum[0] {920 < Pedestal[0]}
htemp
Entries 4369
Mean 5386
Std Dev 3038
0
20
40
60
80
100
120
140
160
180
200
0
5000
10000
15000
20000
ADCsum[0]

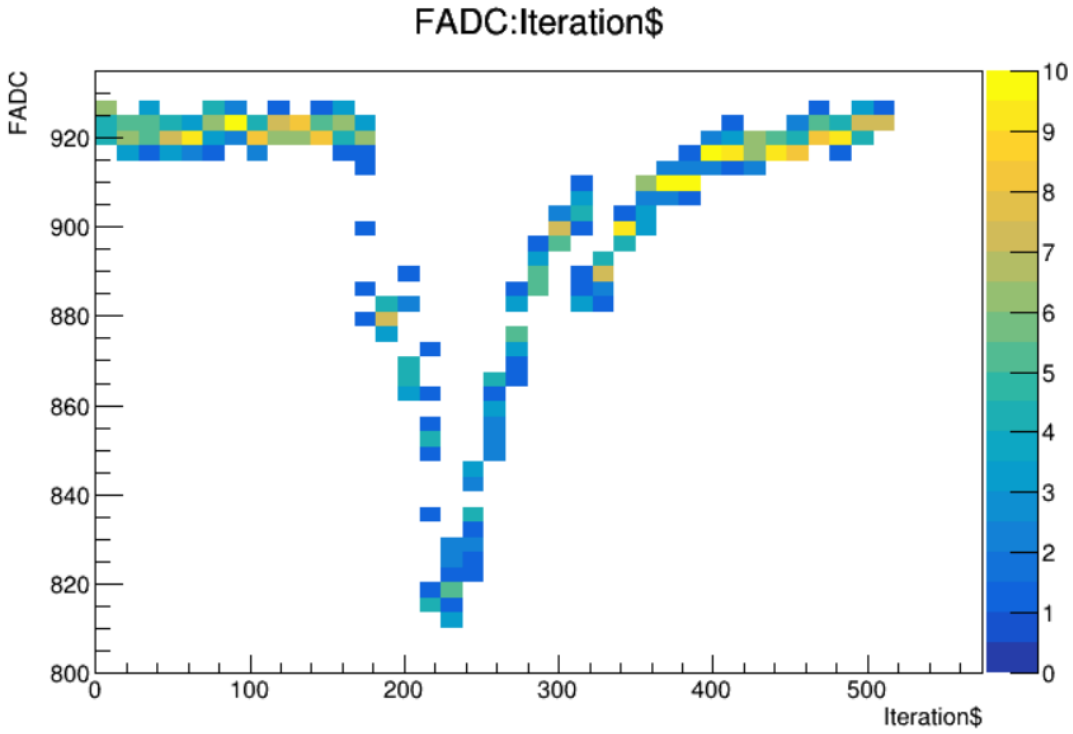

ADCsum[0] {920 < Pedestal[0]}
htemp
Entries 4369
Mean 5386
Std Dev 3038
χ² / ndf 5.464 / 2
Constant 34.08 ± 4.87
Mean 22.78 ± 41.43
Sigma 325.5 ± 43.7
0
20
40
60
80
100
120
140
160
180
200
0
5000
10000
15000
20000
ADCsum[0]

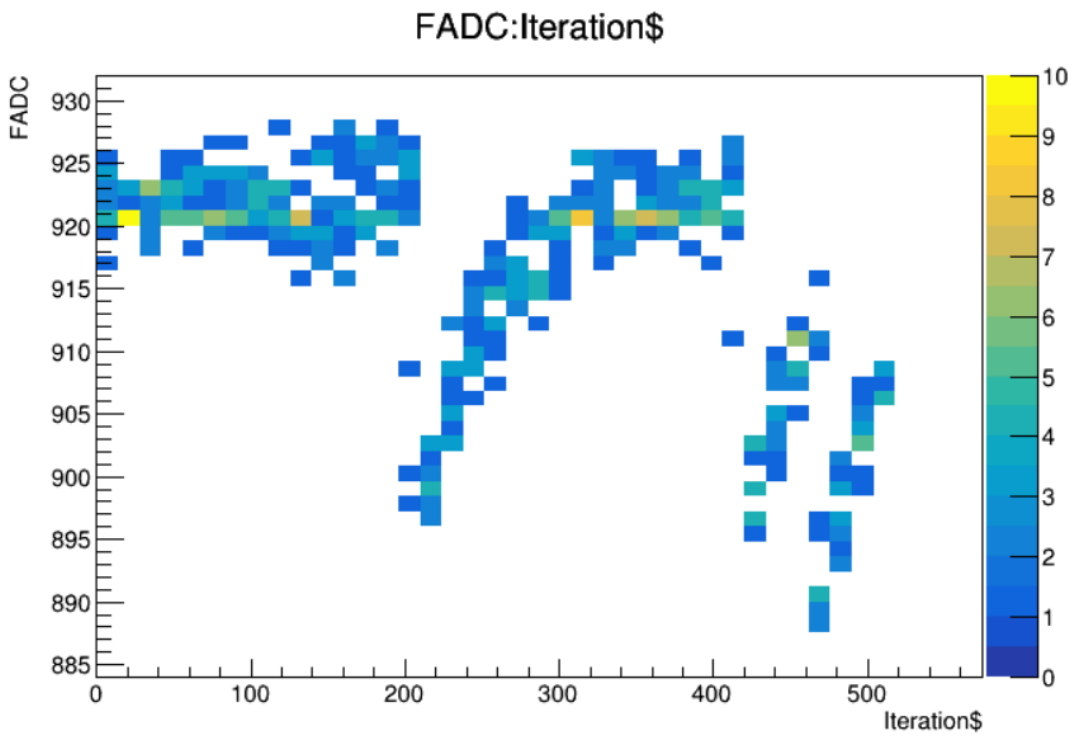
Fitting Function



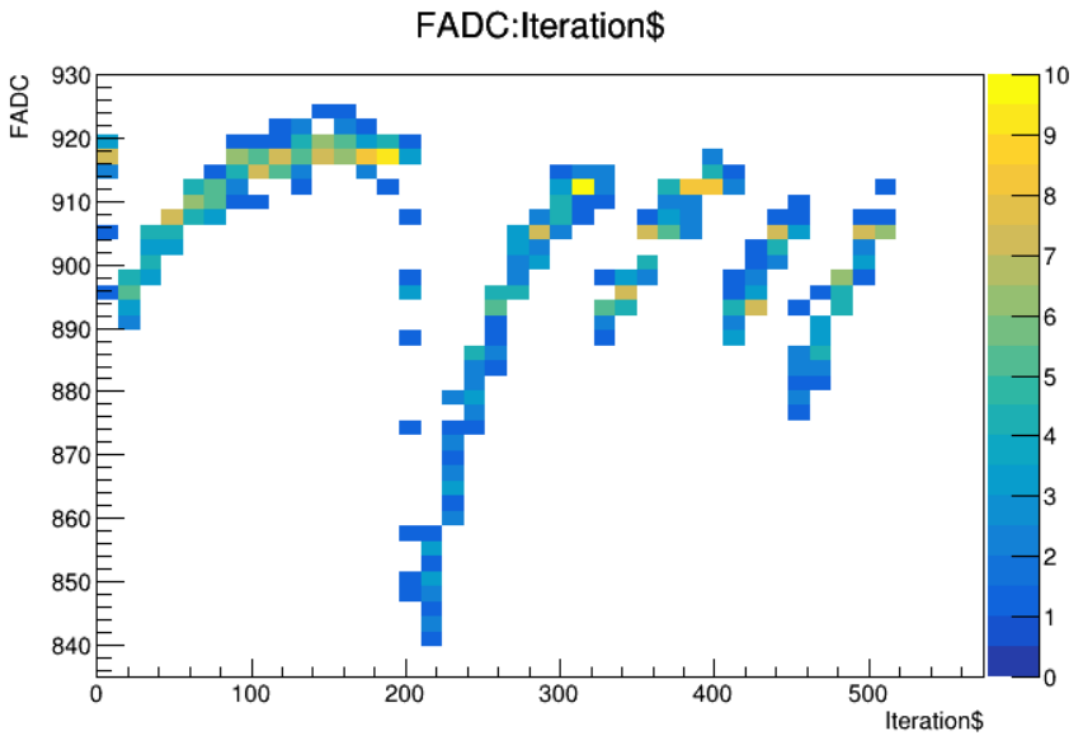
- 앞 슬라이드에서 Gaussian 평균 값 사이의 차이는 1150 ch 였다.
- FADC의 한 ch은 0.8872 mV이고 400 MHz이므로 점 사이의 간격을 2.5 ns라고 할 때, Signal 사이의 간격은 51.01 pC이다.
- 이를 바탕으로 증폭률을 다시 계산하면 3.188 X 10^6이다.
- Self trigger를 통해 받은 data의 값과 비슷함을 알 수 있다.(charge = 50.39 pC, Multiplication = 3.149 X 10^6)

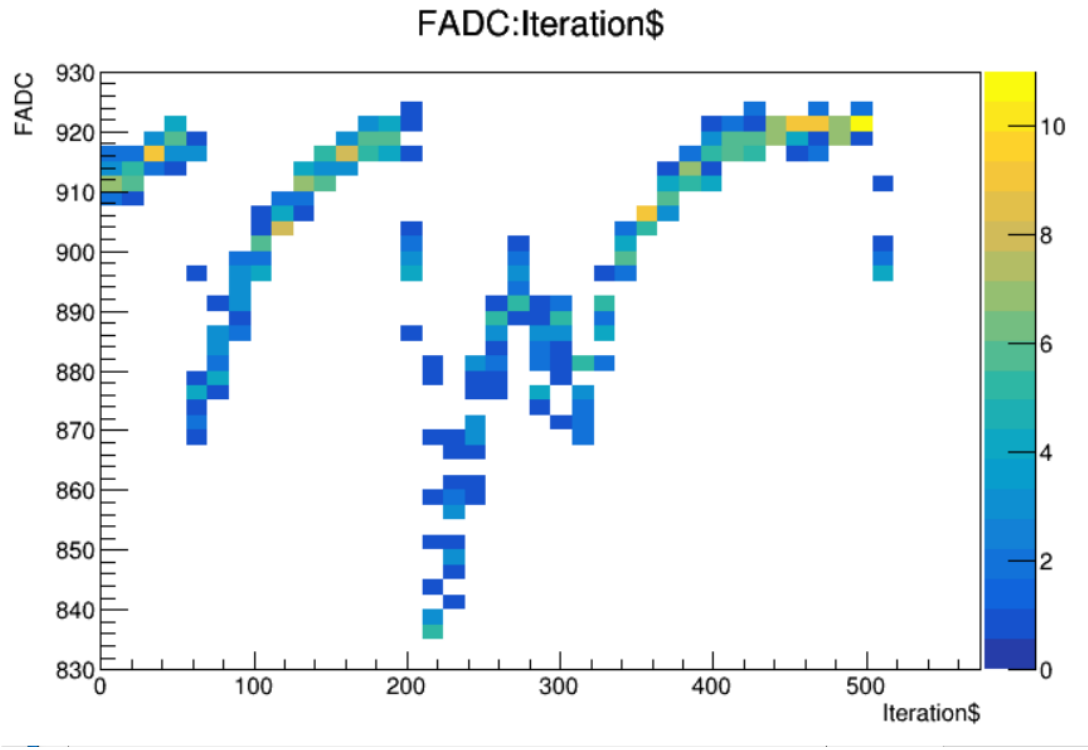
Waveform


FADC:Iteration$
FADC
920
900
880
860
840
820
800
0
100
200
300
400
500
Iteration$
10
9
8
7
6
5
4
3
2
1
0

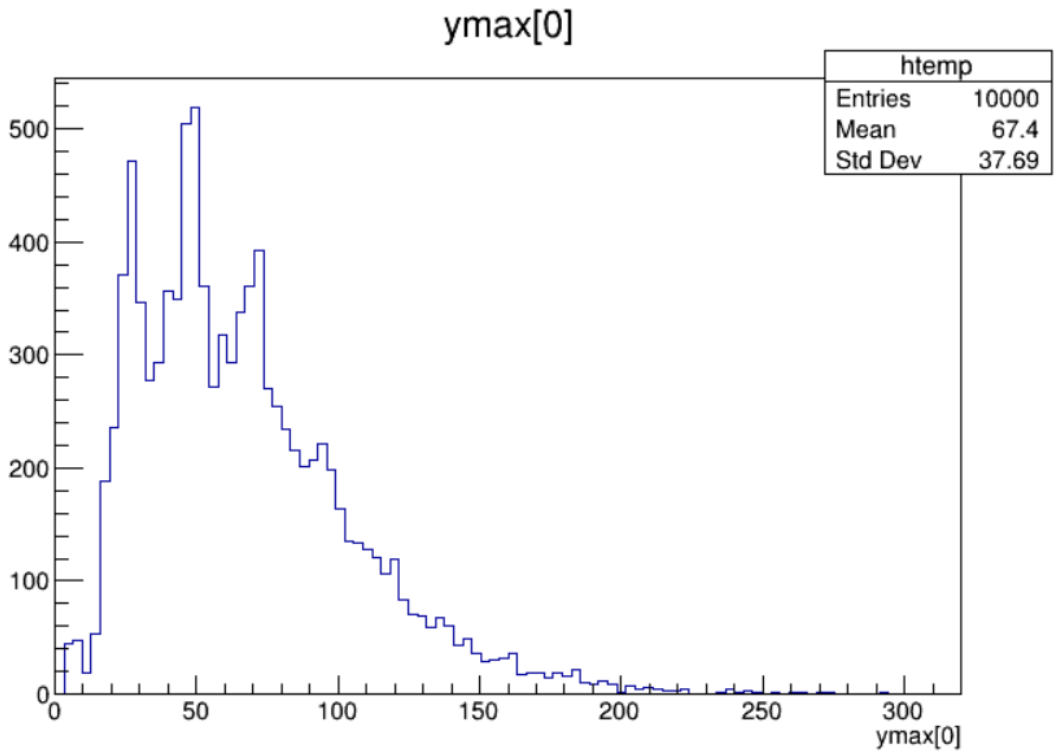

FADC:Iteration$
FADC
930
925
920
915
910
905
900
895
890
885
0
100
200
300
400
500
Iteration$
10
9
8
7
6
5
4
3
2
1
0

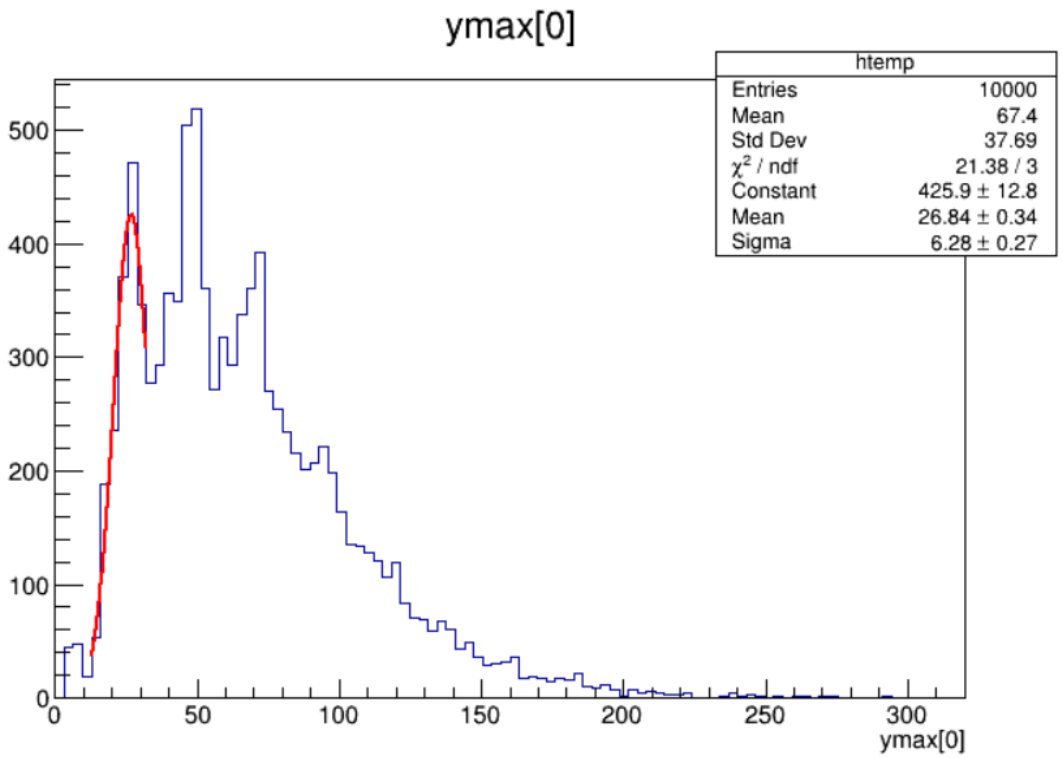
Waveform


FADC:Iteration$
FADC
930
920
910
900
890
880
870
860
850
840
0
100
200
300
400
500
Iteration$
10
9
8
7
6
5
4
3
2
1
0


FADC:Iteration$
FADC
930
920
910
900
890
880
870
860
850
840
830
0
100
200
300
400
500
Iteration$
10
8
6
4
2
0

FADC


ymax[0]
htemp
Entries 10000
Mean 67.4
Std Dev 37.69
0
100
200
300
400
500
0
50
100
150
200
250
300
ymax[0]


ymax[0]
htemp
Entries 10000
Mean 67.4
Std Dev 37.69
χ² / ndf 21.38 / 3
Constant 425.9 ± 12.8
Mean 26.84 ± 0.34
Sigma 6.28 ± 0.27
0
100
200
300
400
500
0
50
100
150
200
250
300
ymax[0]

Fitting Result