

Positronium intensity measurement preparation (GBAR)

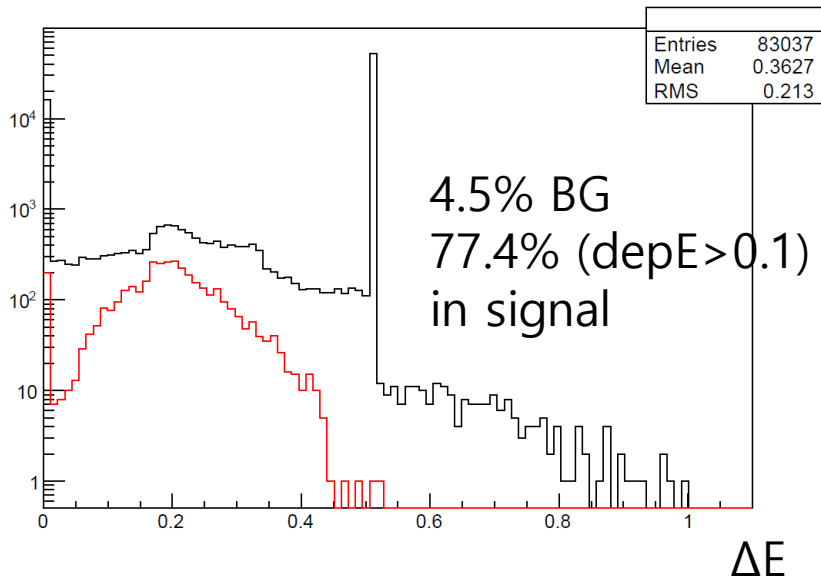
SNU

Bongho Kim

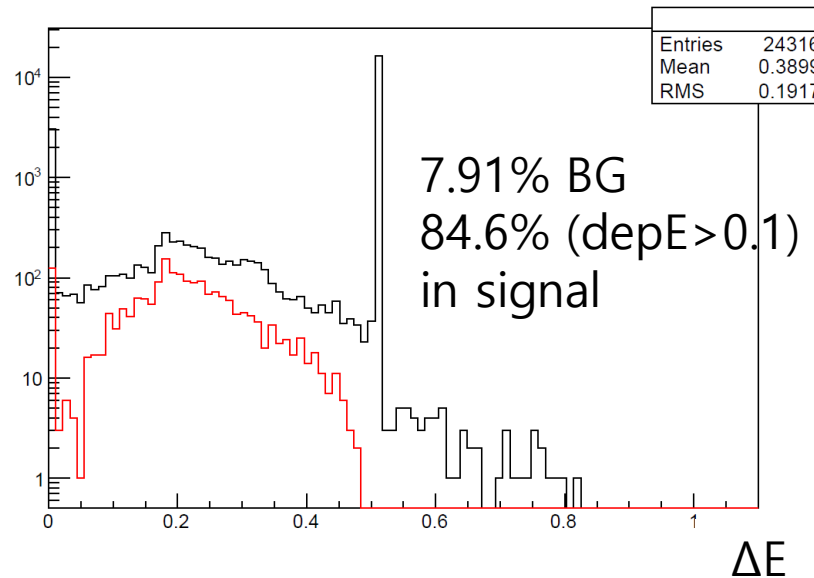
Simulation check

Last slide

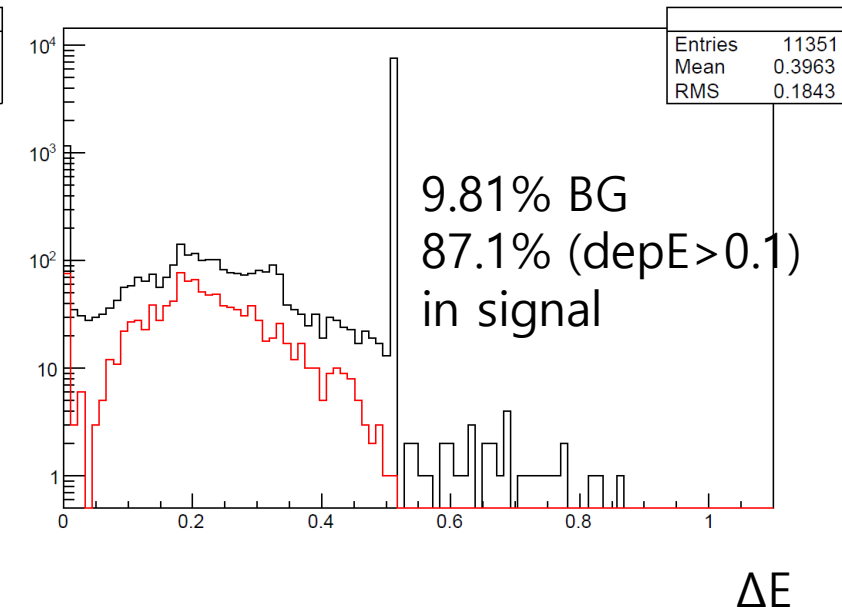
Total deposit E (5cm dist)



Total deposit E (10cm dist)

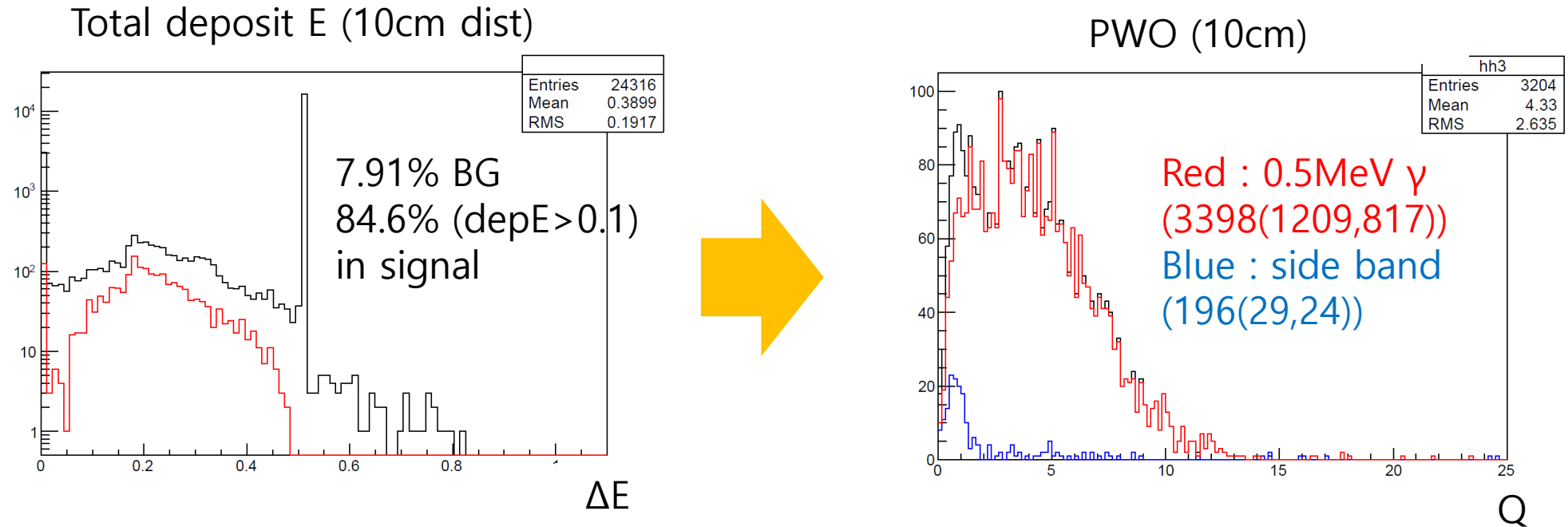


Total deposit E (15cm dist)



- Compton BG is stable (Al support frame also move)
 - As distance is increased, edge effect is decreased.
 - But more time is required for data taking
- (Plan to increase Plastic scintillator trigger threshold in Oscilloscope)

Task : simulation with detector resolution



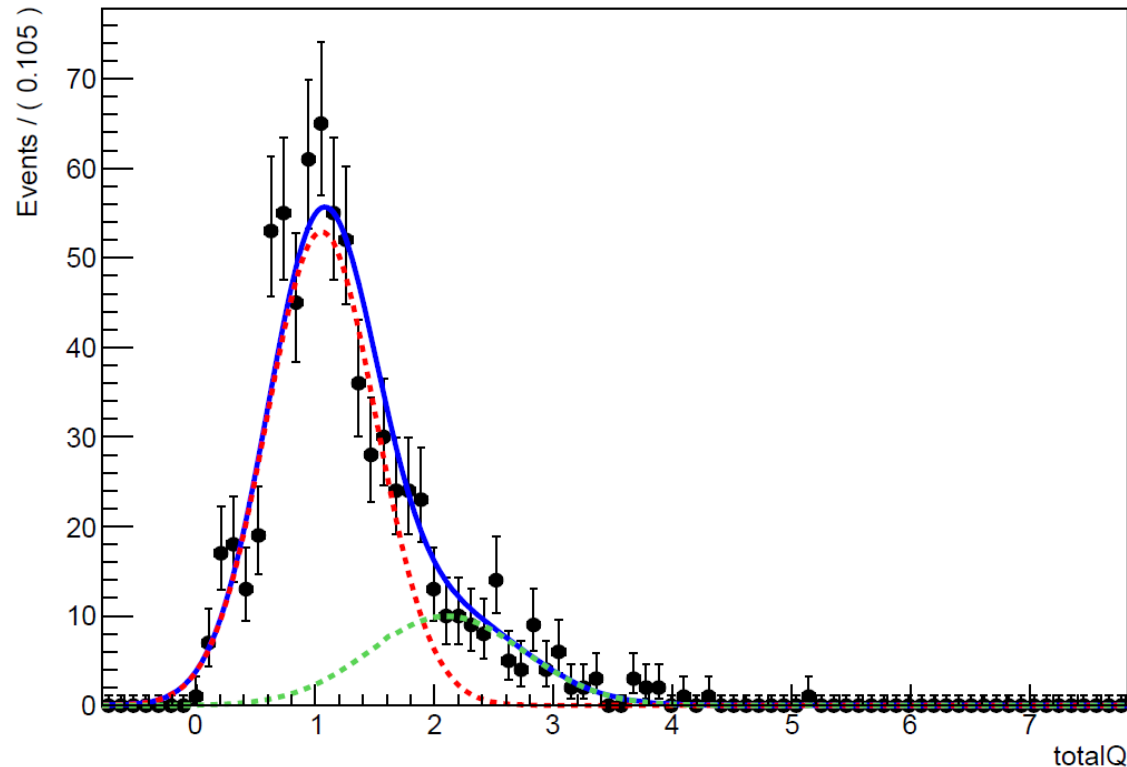
- Estimate total charge distribution from ΔE simulation(for 0.5MeV γ)
- Low photoelectron for 0.5MeV gamma : Poisson distribution
- Single photoelectron has been shown from before

Task : simulation with detector resolution

1. Fitting single photoelectron by Gaussian PDF and decide mean and sigma of total charge.
2. Then $\rightarrow \text{gaus}_1(q, m, s), \text{gaus}_2(q, 2m, \sqrt{2}\sigma), \text{gaus}_3(q, 3m, \sqrt{3}\sigma)$
3. Giving weight to each gaussian by poisson distribution ($= a^n e^{-a} / n!$)
4. With assumption of linearity, making function for several ΔE (divided bin)
5. Fraction of each ΔE is decided by simulation
6. Fitting with real data by signal function + bg function.
7. Measur efficiency with real signal fraction and Compton BG estimation.

1. Single photoelectron fitting

A RooPlot of "totalQ"



Funtion : $\text{gaus}_1(m,s) \times \text{fr}(\text{gaus}_1) + \text{gaus}_2(2m,\sqrt{2}\sigma) \times \text{fr}(\text{gaus}_2) + \text{poly}(0)$

NO.	NAME	VALUE	ERROR	STEP SIZE	VALUE
1	fr(gaus ₁)	7.87453e-01	3.40992e-02	4.28643e-06	6.12489e-01
2	fr(gaus ₂)	2.10154e-01	3.38594e-02	4.31271e-06	-6.18352e-01
3	m	1.05161e+00	2.83239e-02	4.88906e-05	-3.03565e-01
4	s	4.58174e-01	1.78638e-02	5.47739e-05	-7.67796e-01

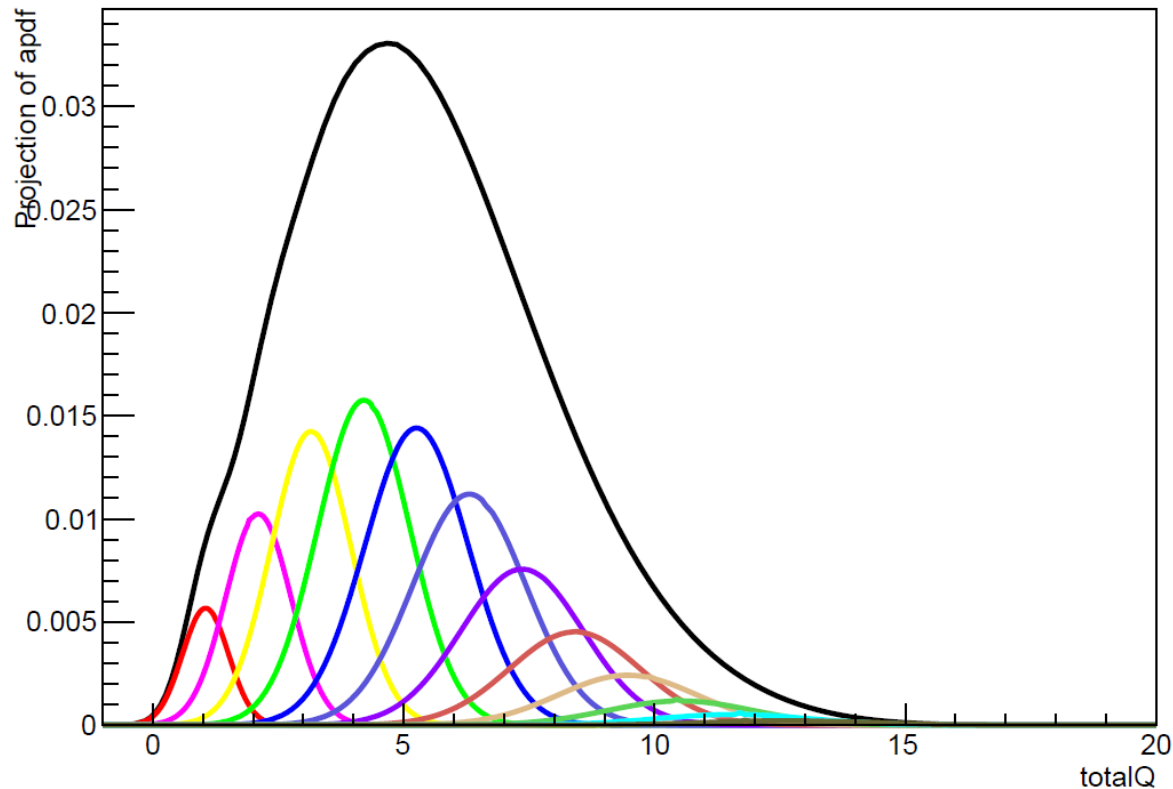
ERR DEF= 0.5

Chisquare/ndf = 1.25

- Single p.e is selected by signal width (double p.e looks shown)
- Data from Back to back sample

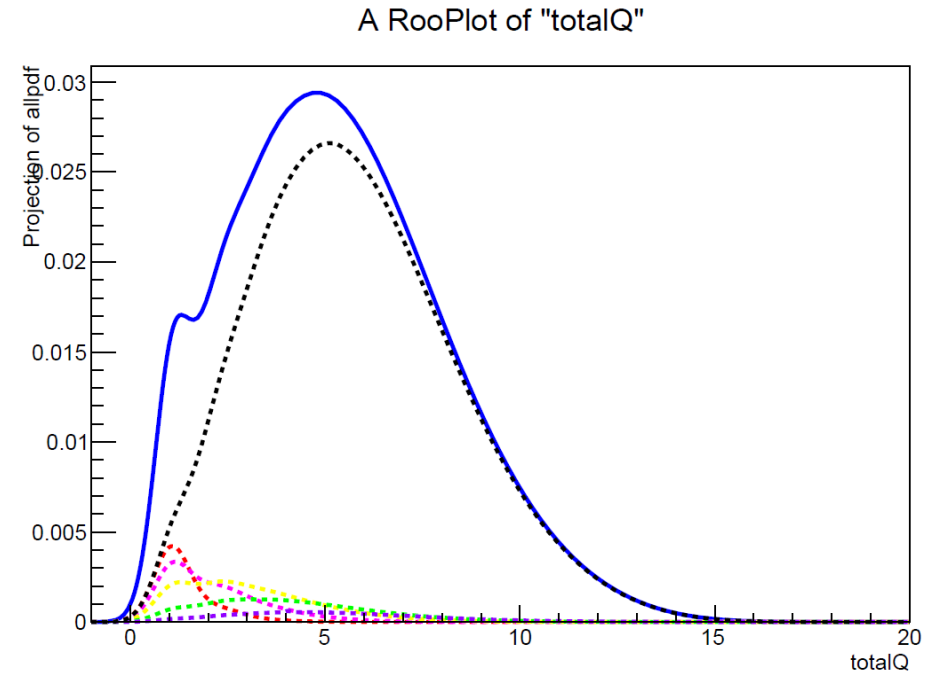
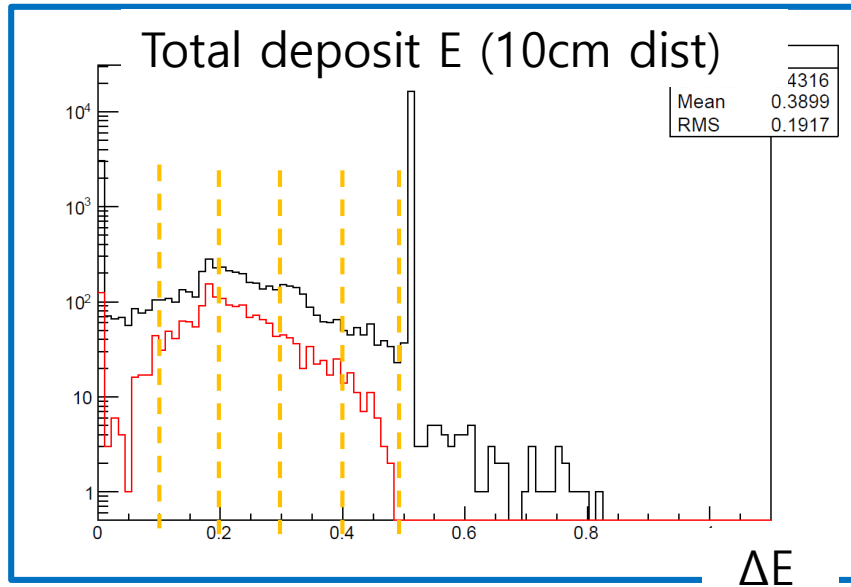
2&3 Gaussian with poisson weight

A RooPlot of "totalQ"



- $Poisson\ PDF = \frac{a^n e^{-a}}{n!}$ $\leftarrow$ a : mean photoelectron number
- Left plot shows example at $a = 5.11$, from red line, each pdf shows single, double,...,12th photoelectron gaussian
- Weight by poisson PDF is given.

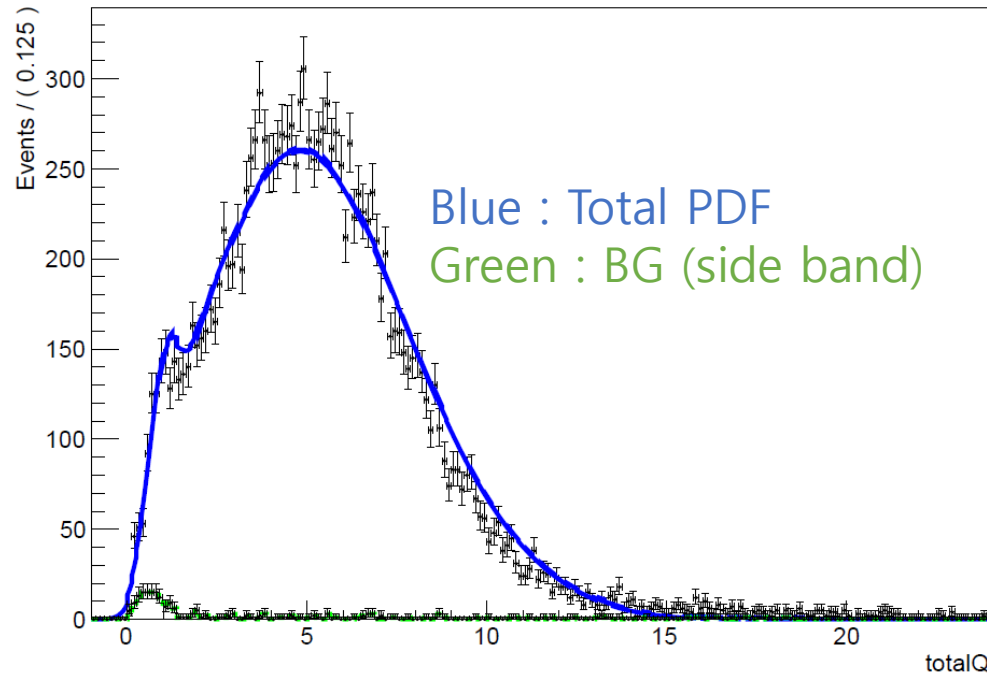
4&5. ΔE correction by simulation



- Back to back(no Compton), 10cm distance measurement(with Compton)
 - At right plot (back to back case), each line shows each ΔE bin
- : Red ($0 < \Delta E < 0.1$), pink ($0.1 < \Delta E < 0.2$), yellow ($0.2 < \Delta E < 0.3$), green ($0.3 < \Delta E < 0.4$), violet ($0.4 < \Delta E < 0.5$), and black (> 0.5 (signal))

6. Fitting with real data

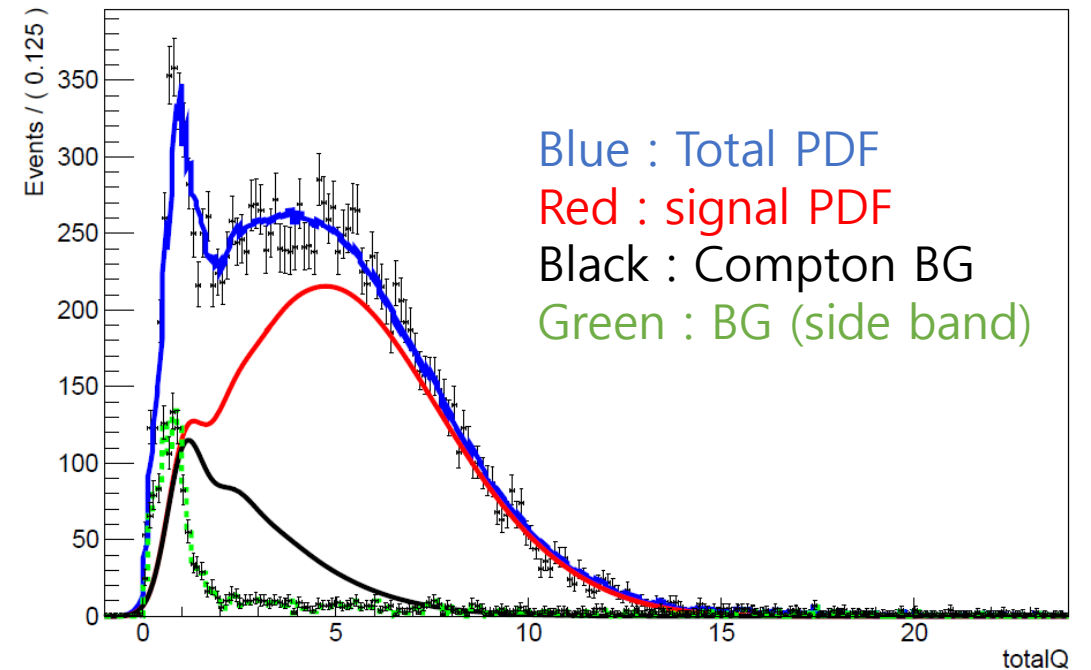
PWO Back to back (with PS)



COVARIANCE MATRIX CALCULATED SUCCESSFULLY
 FCN=38286.4 FROM HESSE STATUS=OK 5 CALLS 24 TOTAL
 EDM=3.81779e-07 STRATEGY= 1 ERROR MATRIX ACCURATE
 EXT PARAMETER INTERNAL INTERNAL
 NO. NAME VALUE ERROR STEP SIZE VALUE
 1 a 5.52587e+00 2.52729e-02 2.73804e-05 1.05369e-01
 ERR DEF= 0.5
 frame1->chiSquare() = 2.483534e+00

2017-06-01

PWO 10cm distance



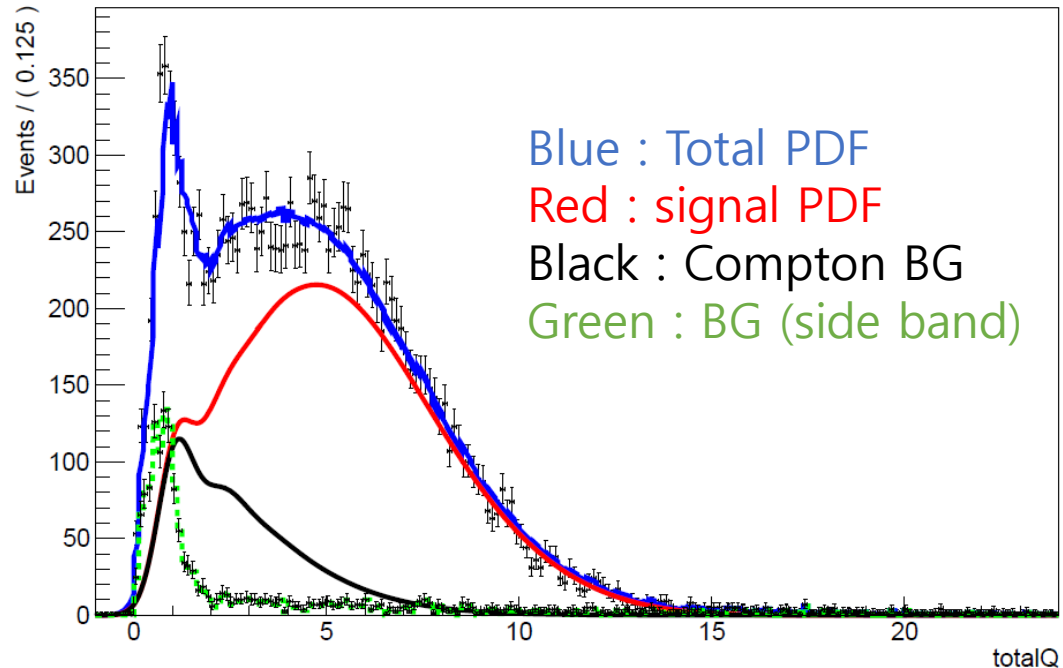
COVARIANCE MATRIX CALCULATED SUCCESSFULLY
 FCN=40718.7 FROM HESSE STATUS=OK 10 CALLS 66 TOTAL
 EDM=1.04523e-07 STRATEGY= 1 ERROR MATRIX ACCURATE
 EXT PARAMETER INTERNAL INTERNAL
 NO. NAME VALUE ERROR STEP SIZE VALUE
 1 a 5.45141e+00 4.89625e-02 3.25220e-05 9.04061e-02
 2 ssf 7.29007e-01 1.36845e-02 1.25562e-04 6.51594e-01
 ERR DEF= 0.5
 frame1->chiSquare() = 1.253412e+00

Weekly meeting

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7. Compton BG fraction check

PWO 10cm distance



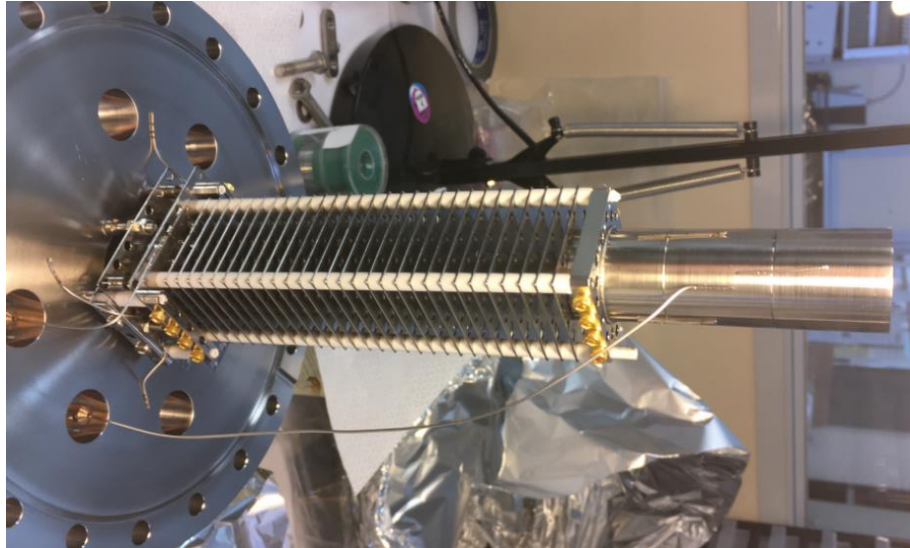
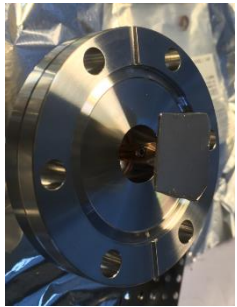
$$\bullet \text{ } Eff(10cm) = \frac{(16861-1558) \times 0.729}{619925 \times 0.02403 \times 0.967 \times 0.906}$$

$$= 85.47 \pm 0.69\%(stat) \pm 1.6(geometry) \pm 1.6(fitting)$$

Need to study more to sure about this result

→ Fitting with 5cm distance, 15cm distance

CEA Saclay & CERN status



CERN

- Possible to use anti-P beam in July (positive)
← But without focusing
- Positron beam will be available from mid of July.
- Some discussion about rail for anti-P trap (for movable option)
- Antion, BG trap moving preparation will be started from July

2017-06-01

Weekly meeting

CEA Saclay

- Buncher + target is installed and test has gone from last week.
- Acceleration by the buncher after BG trap was tested and operation looks Okay. (beam width decreased $\sim 100\text{ns}$ $\rightarrow 50\text{ns}$ with $\sim 100\text{kV}$ order $\rightarrow 4\text{kV}$)
(Need to modify switch circuit because of inductance problem (slow signal))
- BG trap tuning is required.
- Proton beam line need more time for preparation...
- Tomorrow, Antion chamber will be connected with buncher.

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To do list

- Fitting back to back data with 1.2MeV PDF.
- Fitting with 5cm, 10cm and 15cm to check.
- Because efficiency calibration is almost done, I will focus on Antineutrino preparation and simulation.
- ← Help a little proton beam preparation or BG trap also..

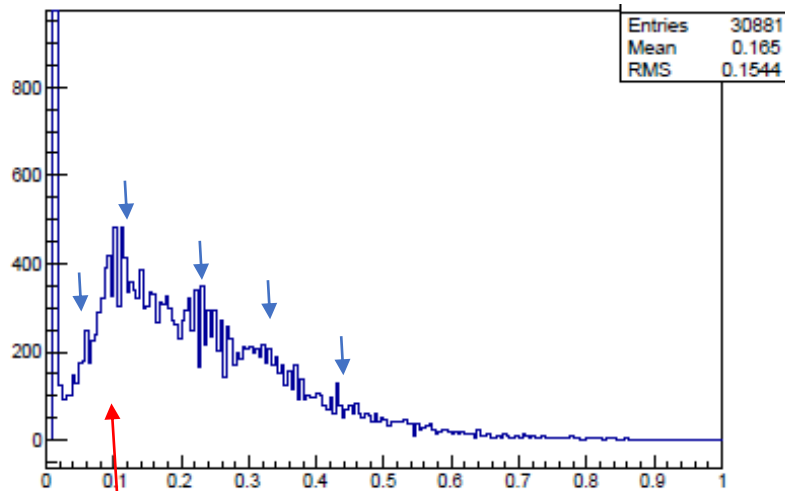
BACK UP

Test with high gain

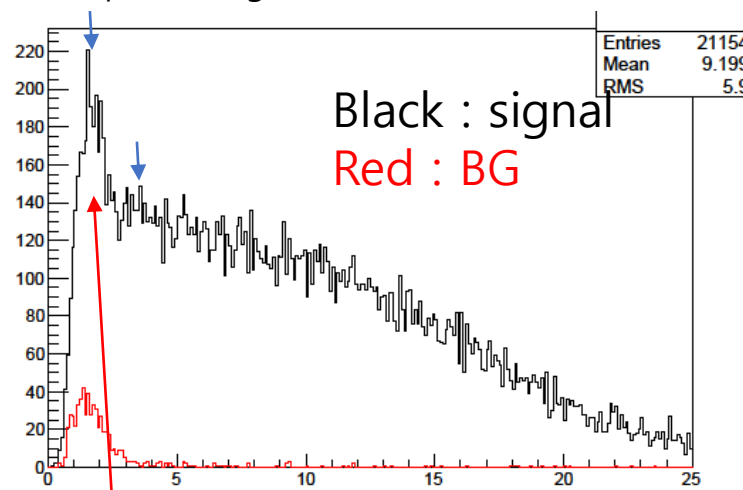
- HV changed from -2kV to -2.3kV

→ Gain increase 2.5 times from $8e^6$ to $2e^7$

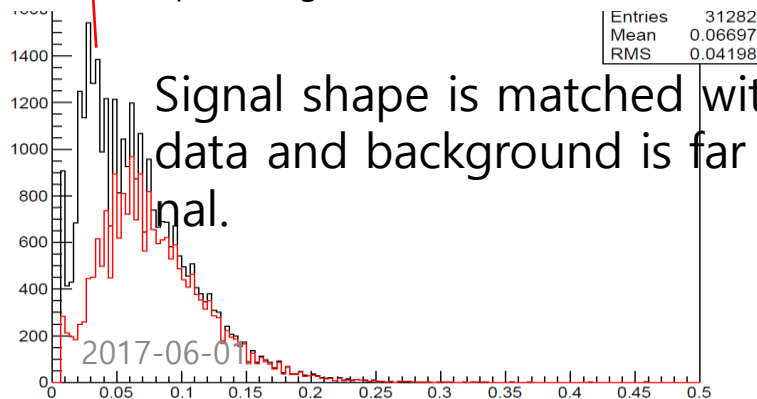
peak height distribution(-2.3kV)



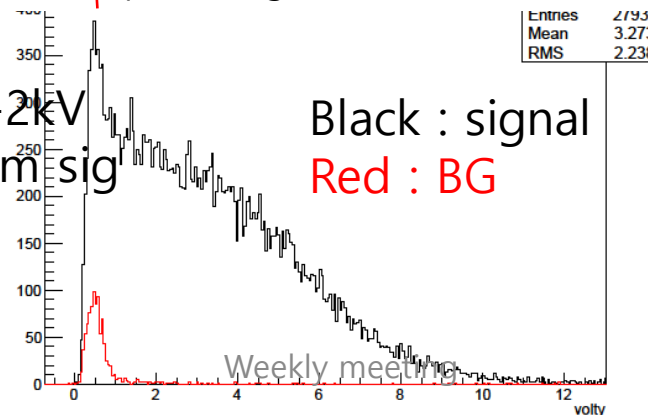
peak charge distribution (-2.3kV)



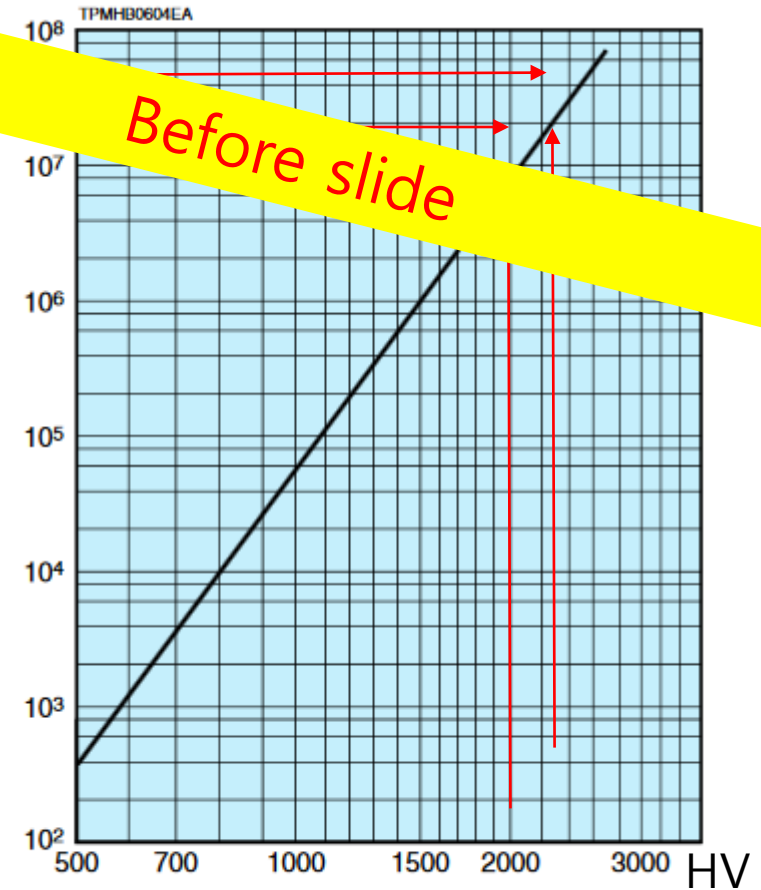
peak height distribution (-2kV)



peak charge distribution (-2.kV)



GAIN



peak width(99%) distribution (-2.3kV)

