# Positronium intensity measurement preparation

SNU

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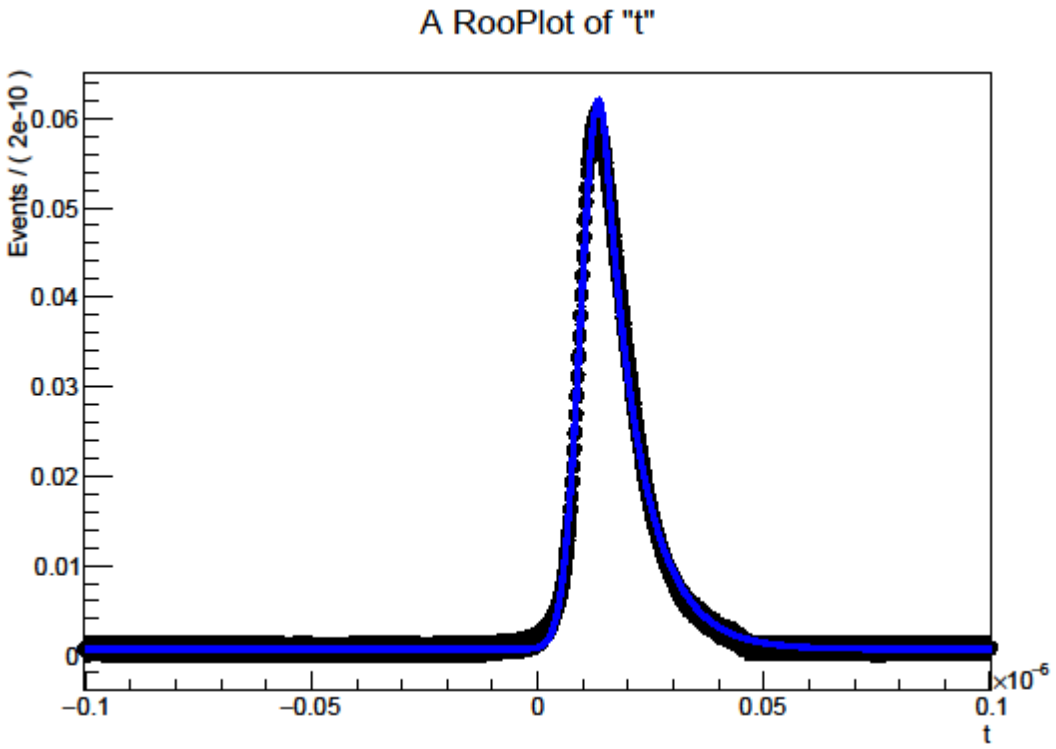
# Raw signal fitting




- PDF : Crystal ball PDF +poly(0)
- Chisq : 201. (not good..)
- Bin error: 0.001333($\Delta^2/12$)
- Can I use this PDF as signal?

Mean : 1.3E-8 +-4.2E-11

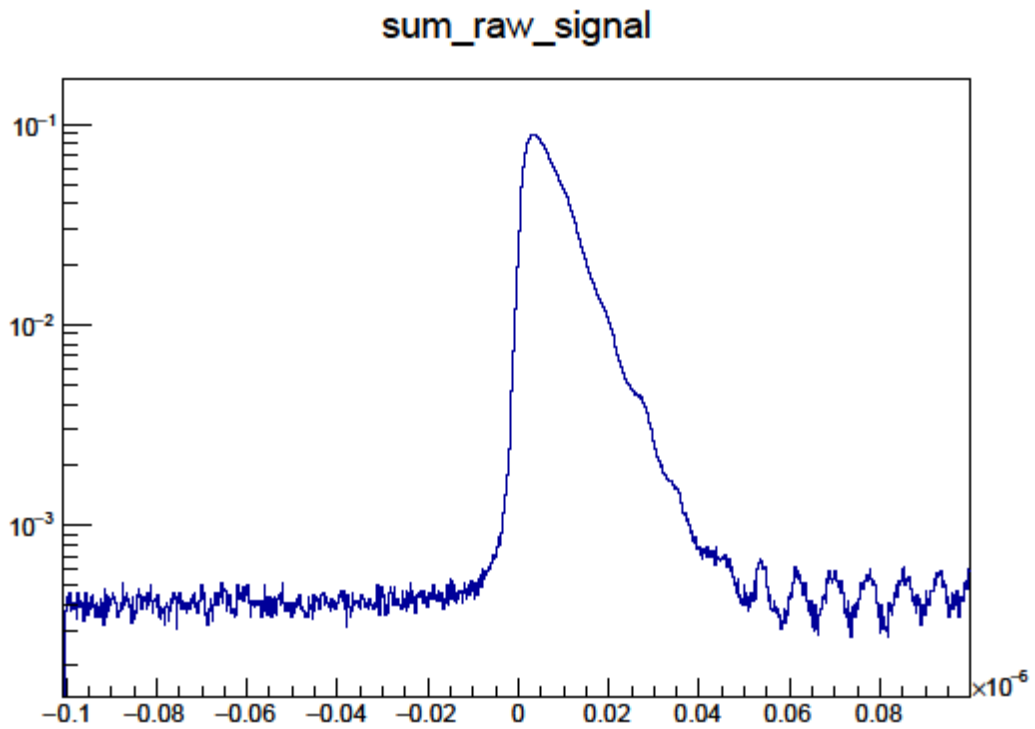
Sigma : 3.9E-9 +-4.3E-11

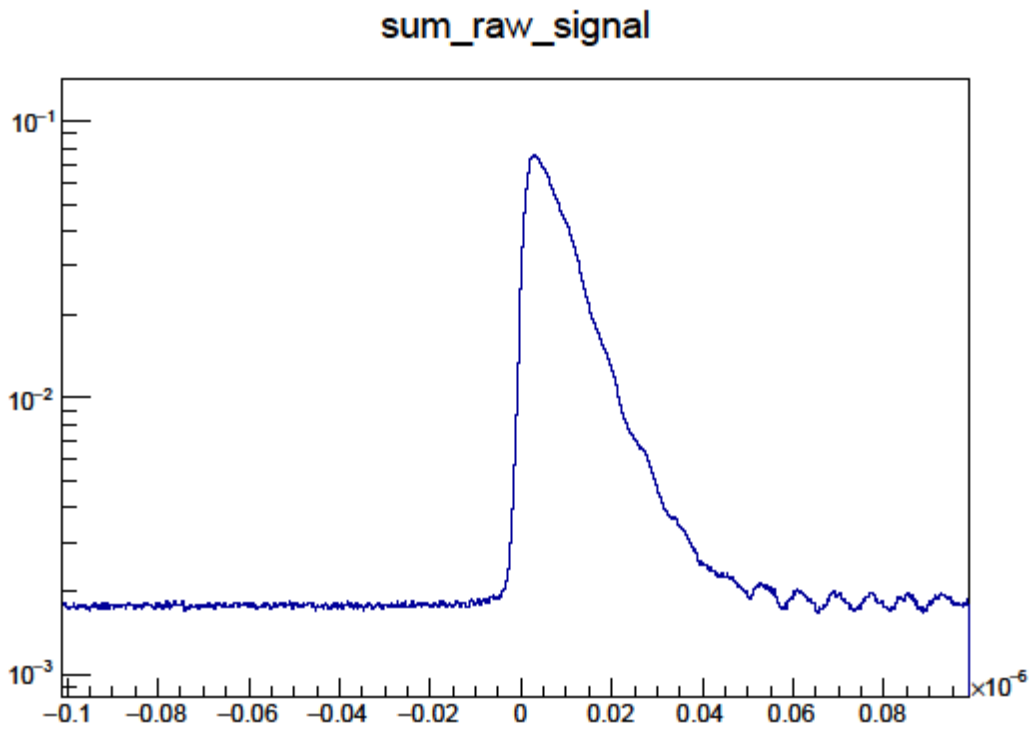
Alpha : -5.0E-1 +- 8.9E-3

N : 126+-1.7

FWHM : 11.8ns

# PWO signal



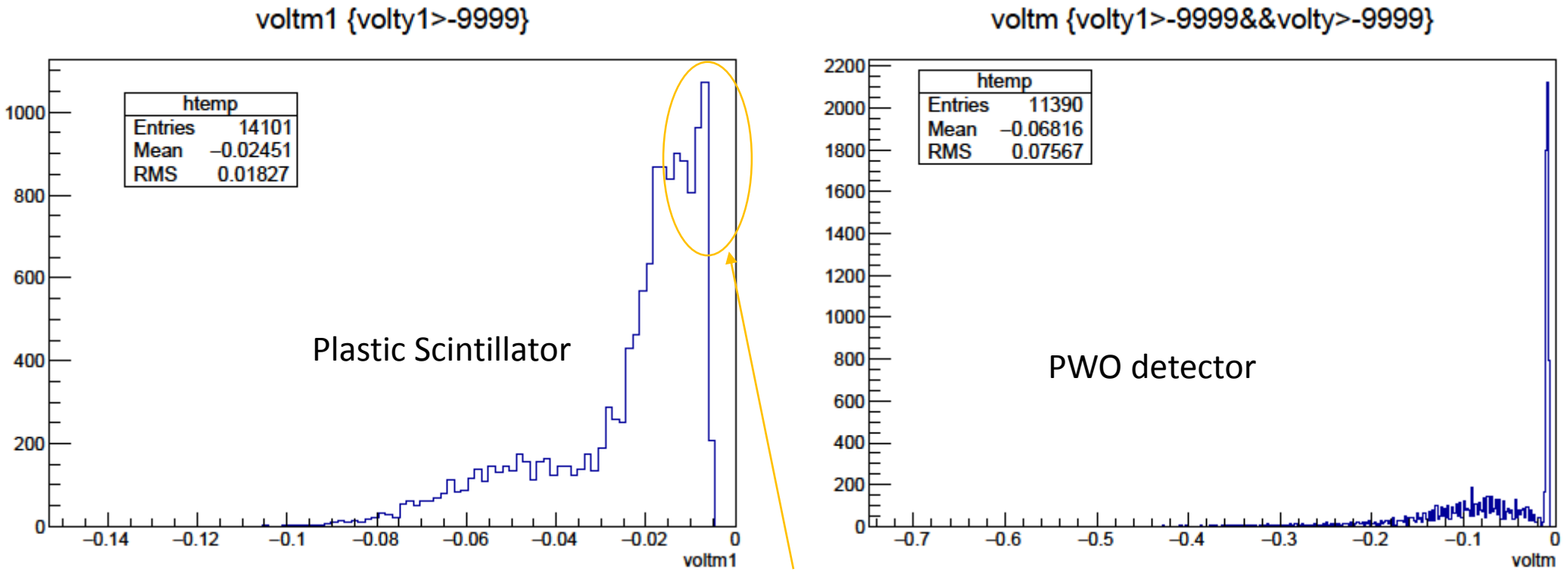

- Ringing shown with 10ns period. ← same pattern shown at P.S detector (hard to explain by signal reflection becuase wire length is just ~10cm..)

Delay ~5ns/m

# Coincidence data

- Basic setting
- Plastic scintillator : -1500V
- PWO detector : -2000V
- Trigger : - 4.2mV for PS ( -30mV for counting (discriminator limit))

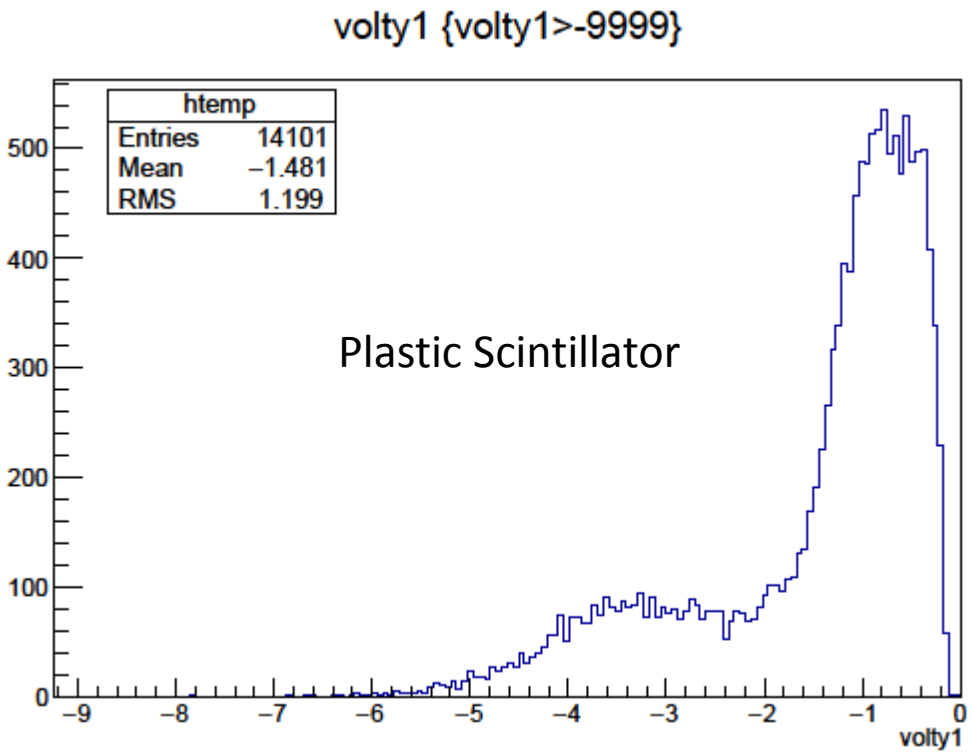
# Pulse height distribution

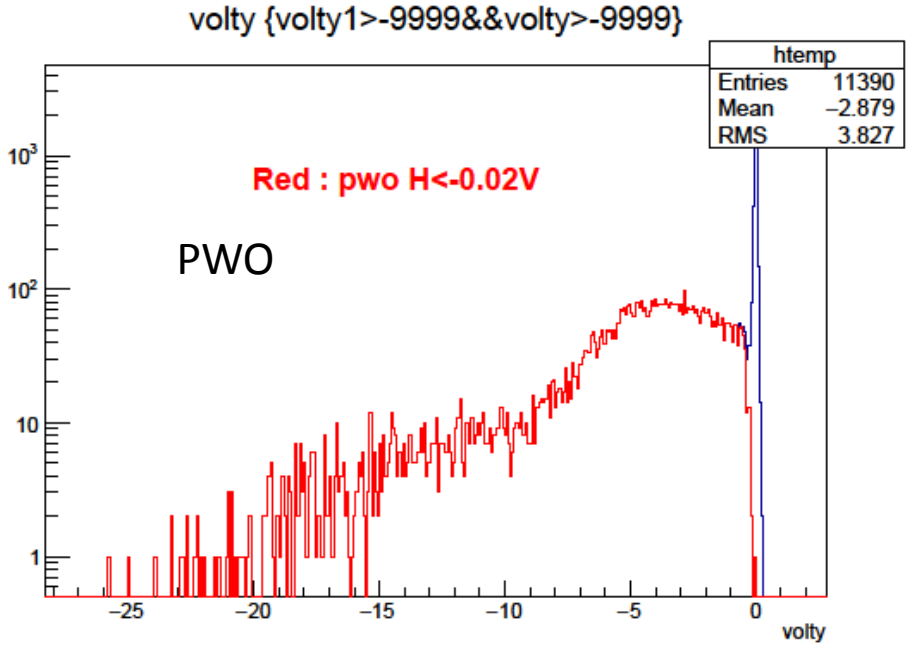


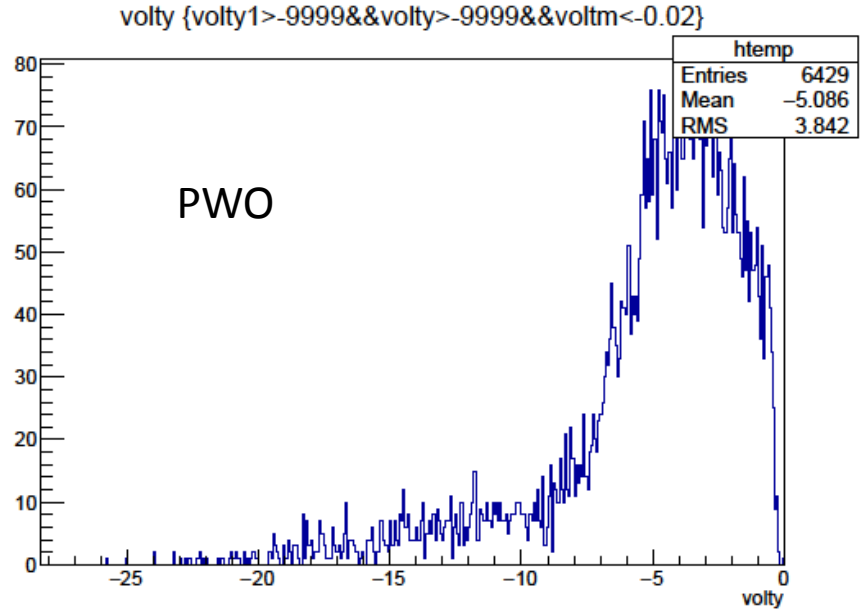

- In PS(Plastic Scintillator) case, no noise is expected because counting rate for $^{22}Na$ 421748#/(40s) is large enough to compare with normal counting rate 396#/(40s).

→But there's some peak and discriminator threshold is higher than oscilloscope trigger

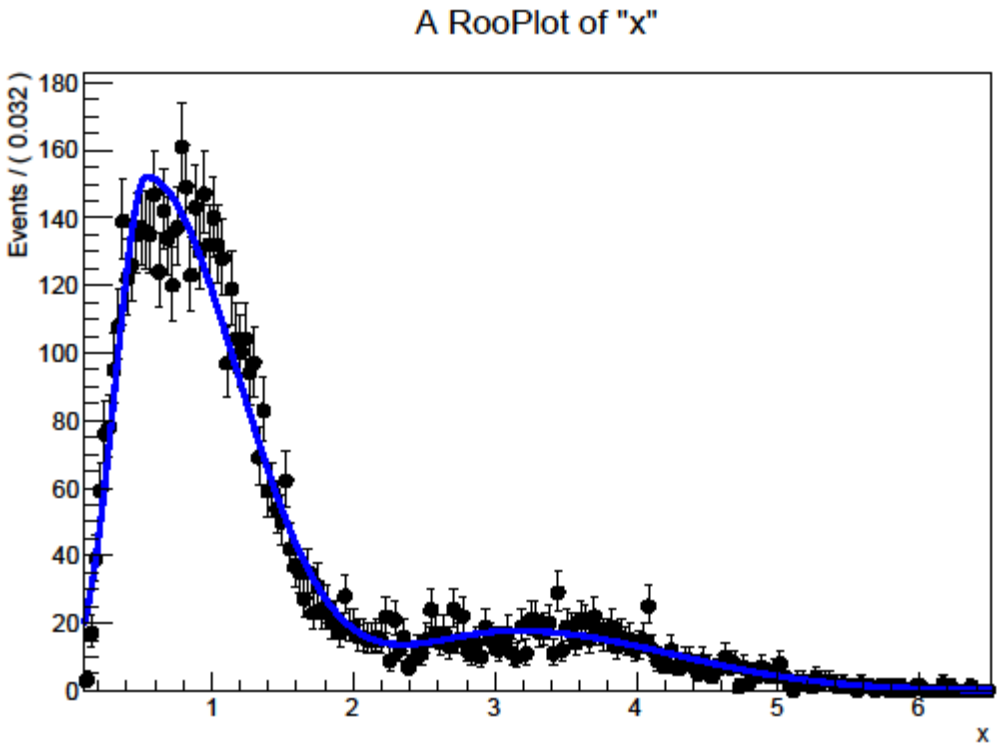
# Pulse yield distribution



# Fitting for Plastic Scintillator




- Two bifur-gaussian PDF

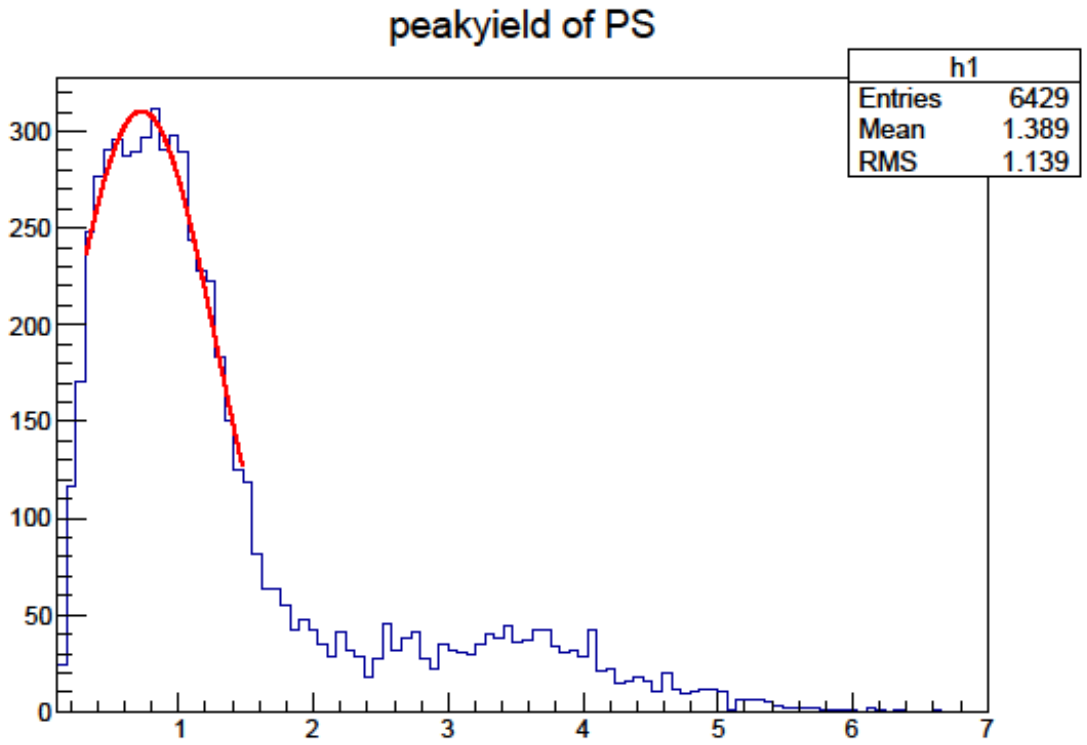
Ratio : 0.796+-0.013 (total 6429#)

1311.5# is 1.27MeV

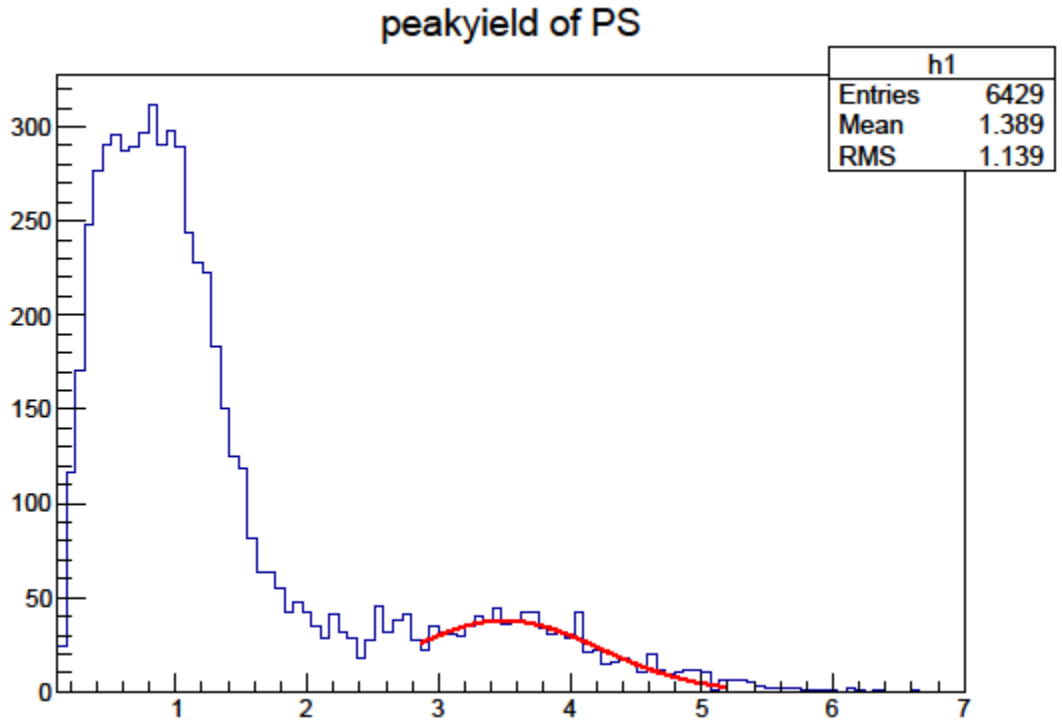
→Fitting is not good…
Crystall ball fitting is also not good…

➔ Do I need to use gaussian (x) poisson convolution function?

# Simple fitting with single gaussian of PS

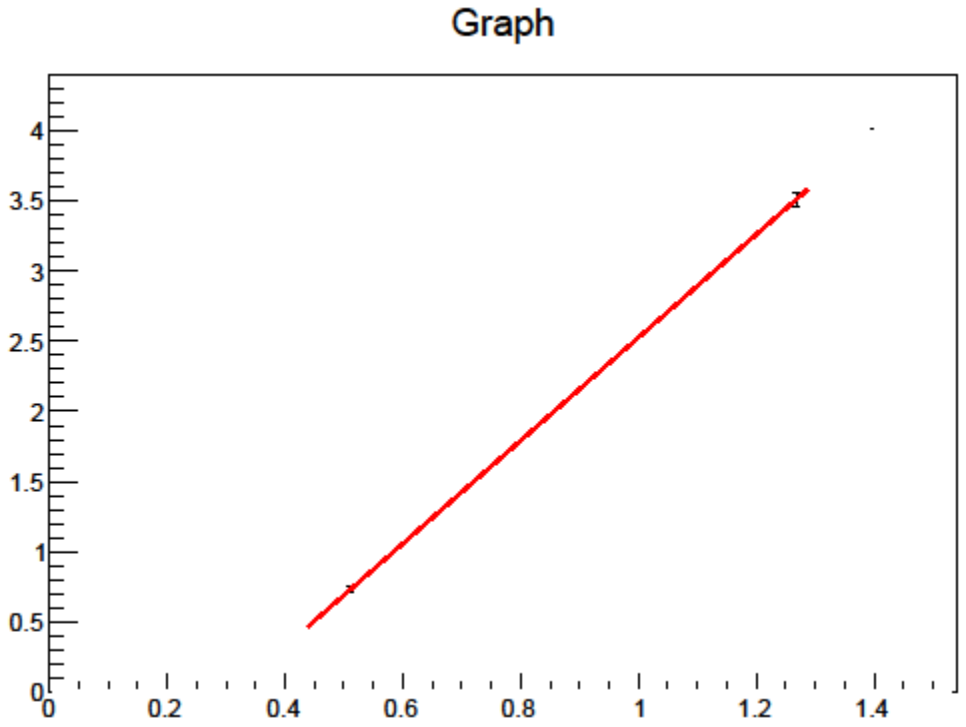



- Mean : 0.726 +-0.021
- Sigma : 0.559 +-0.028




- Mean : 3.50 +-0.052
- Sigma : 0.728 +-0.042

# Linearity for Plastic Scintillator

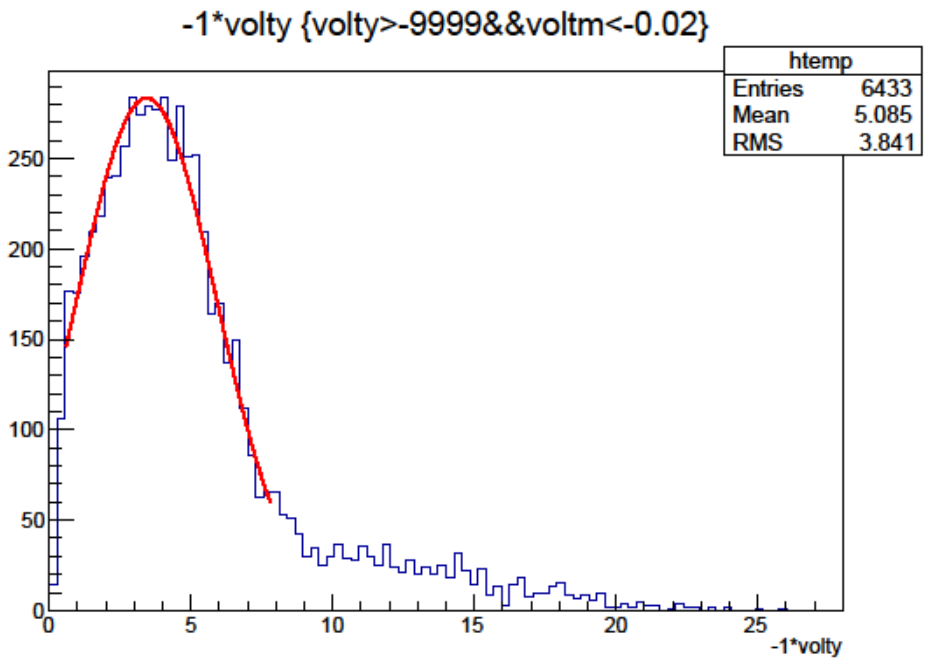



- Not from 0,0

Y= 3.67(+-0.07)*X – 1.15(+-0.05)

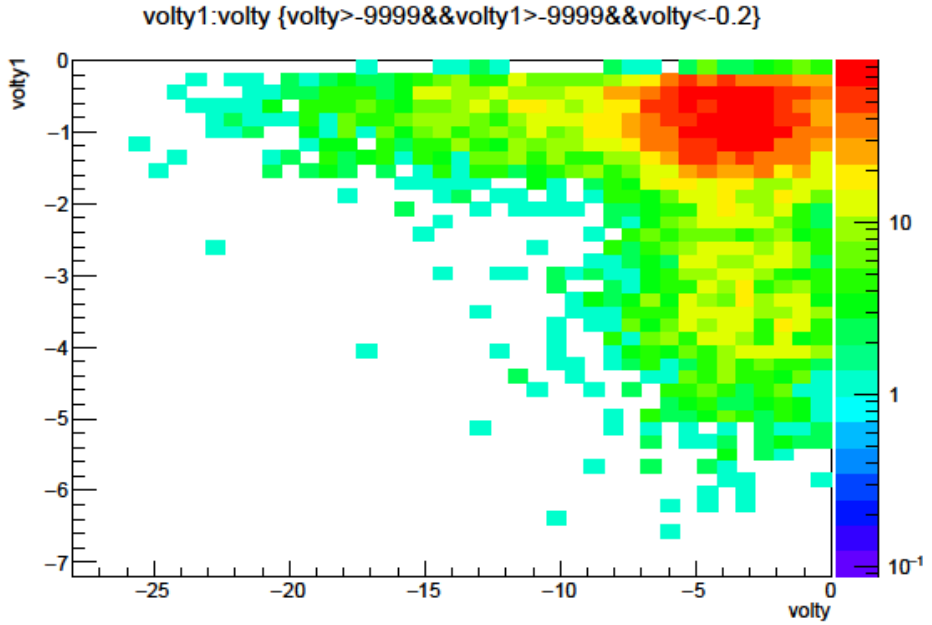
→Does it make sense?

# Simple fitting with single gaussian of PWO




- Mean : 3.441 +-0.056
- Sigma : 2.472 +- 0.062

→To fitting second peak, better modelling required.

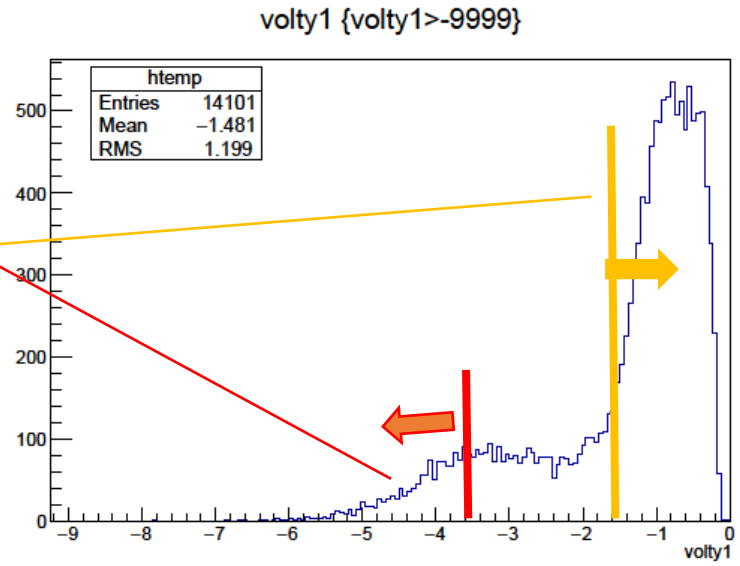


# Check efficiency

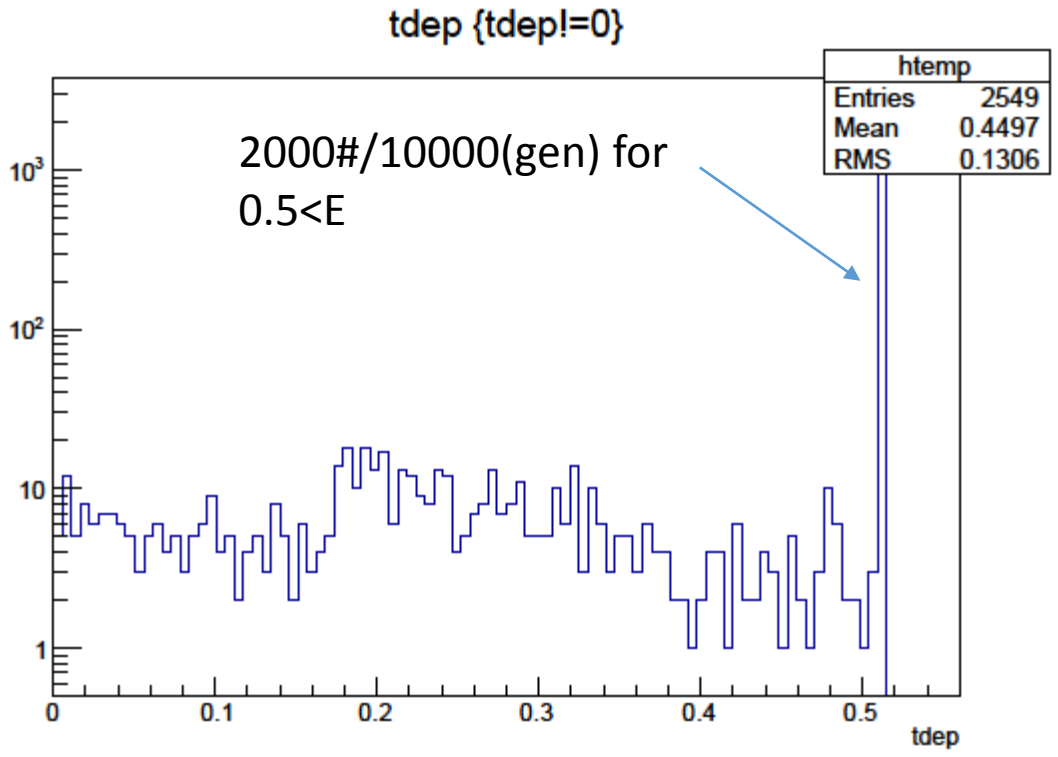
- By 6429# coincidence signal(trigger for -20mV(PWO), -4.2mV(PS) and highest peak near trigger time in data window)
- Give peak yield cut for PS

Efficiency(0.5MeV) = 0.517(+-0.022)/acceptance

Efficiency(0.5&1.2MeV) = 0.592(+-0.009)/acceptance1



# Simulation

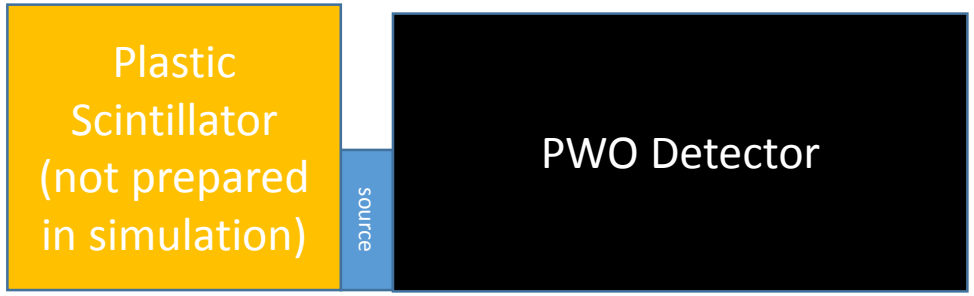


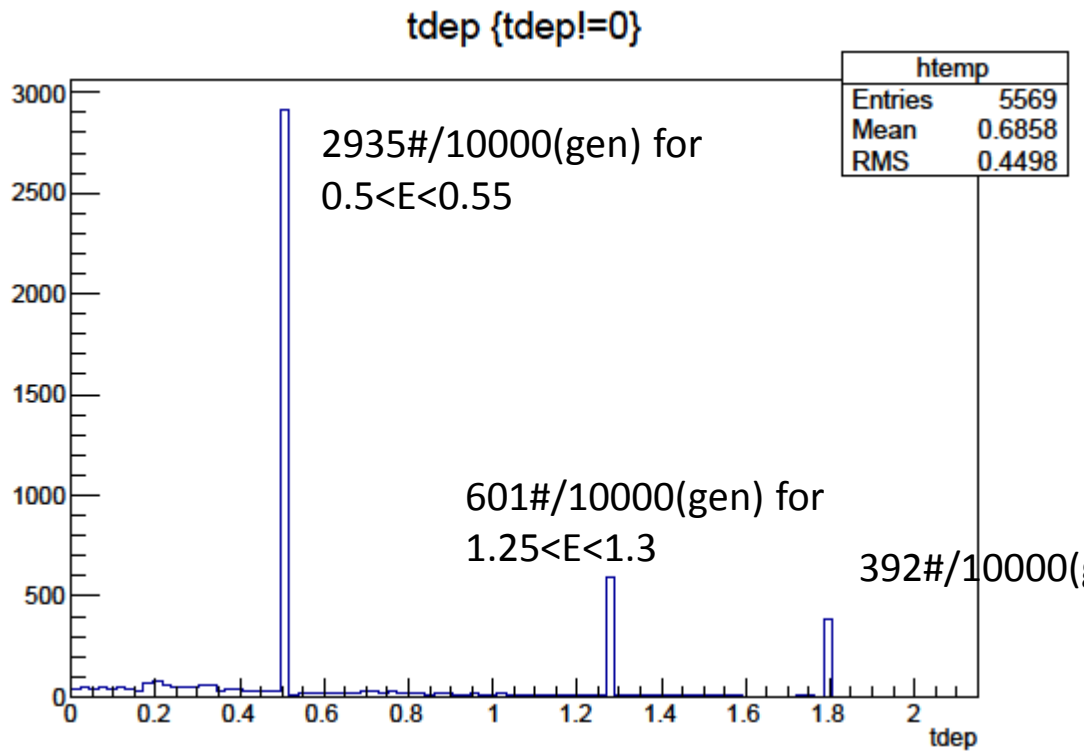

- 2000#gamma detected for 10,000# generated in source position.
- In back to back case, acceptance will be twice.

→40%(~51%) acceptance expected.

→efficiency(0.5MeV)~100%

# Simulation for $^{22}$Na




- For 9047# total positrons from $^{22}$Na, 2300# positrons are passing through source cover(PE)..

Does it make sense??

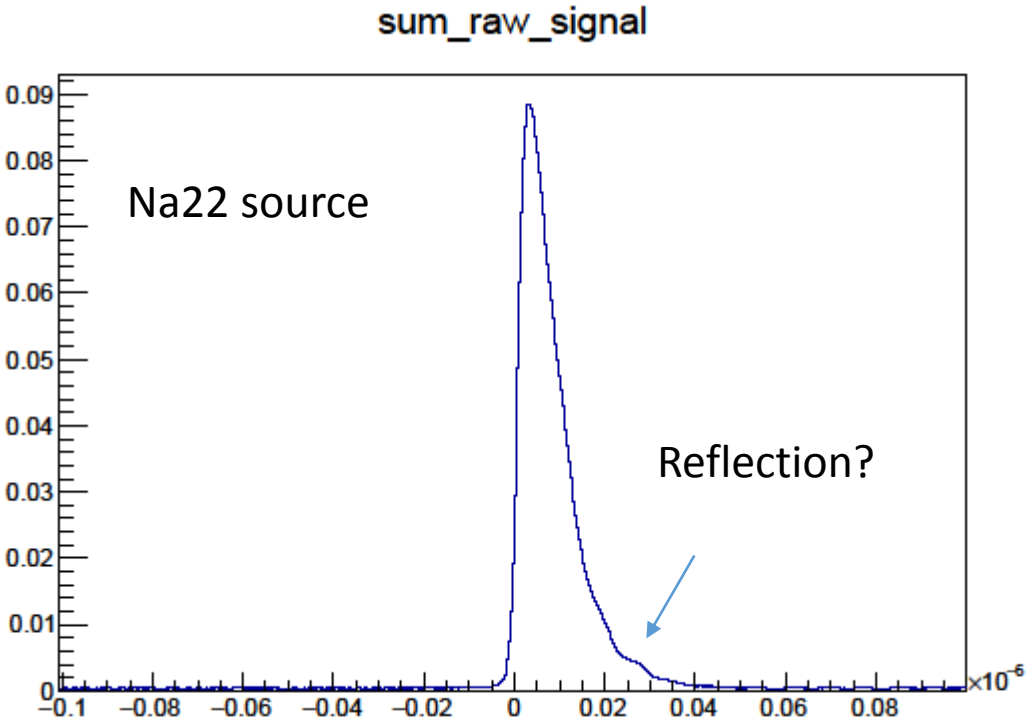
# To do list

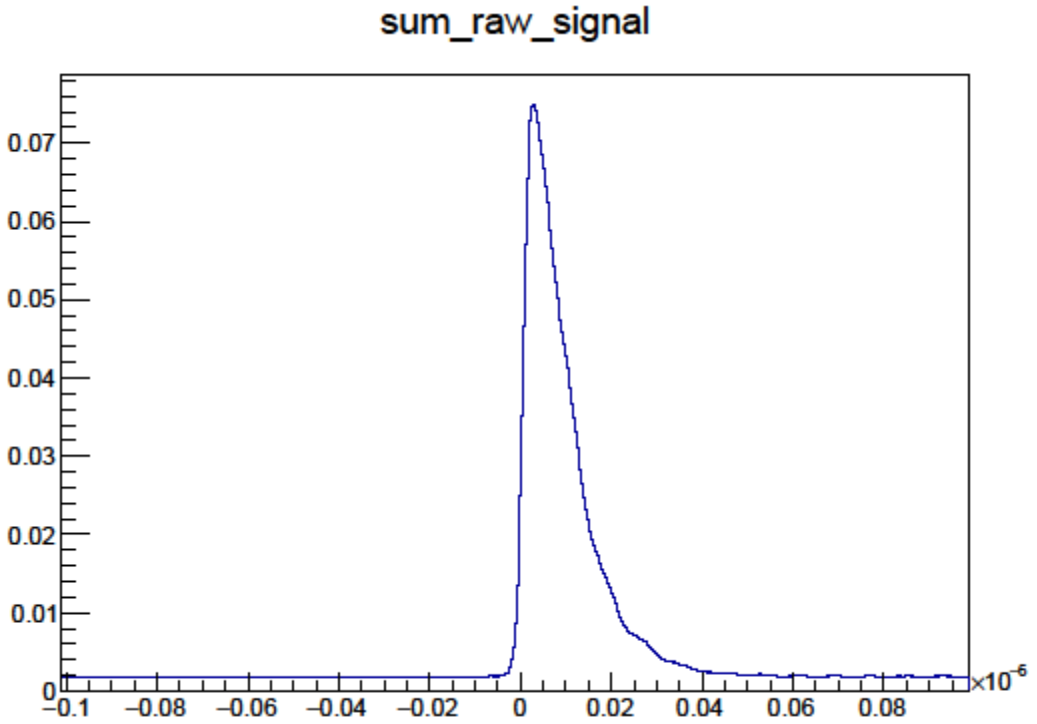
- Toy MC for positronium signal estimation : raw signal modelling is on going
- Linearity check : better modelling required?
- Efficiency check : ongoing but I can’t sure how much we can believe the simulation.

→we can measure positron annihilation gamma in beam line with plastic scintillator with coincidence.

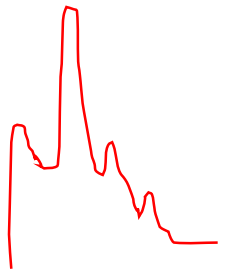
# backup

# Pwo signal



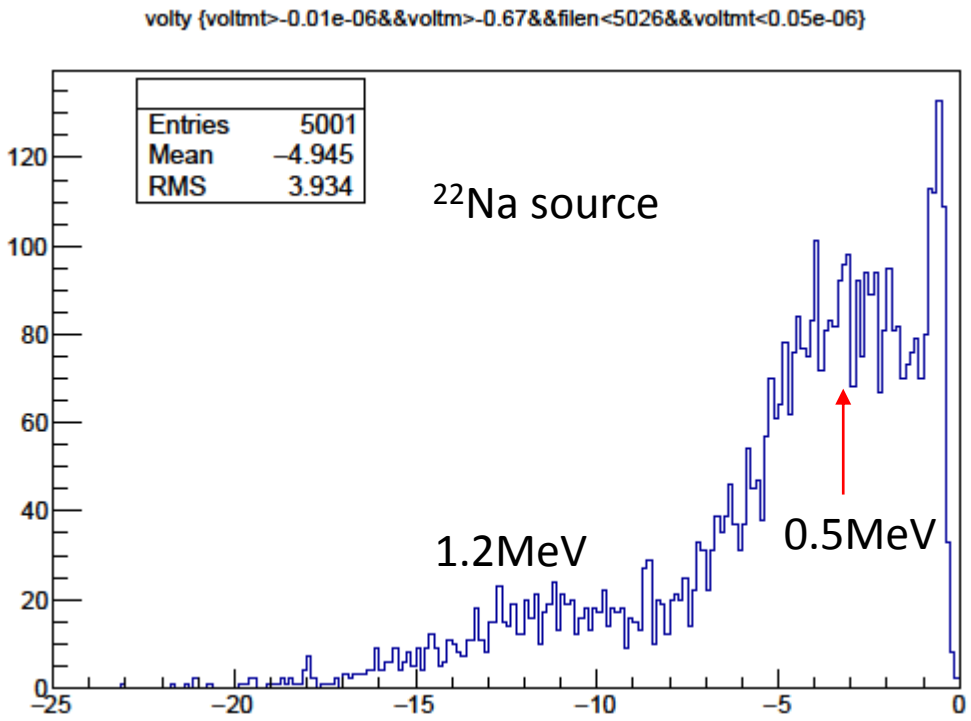

- Basic cut to reject bad noises and too big signals
- Each signals show several peaks normally

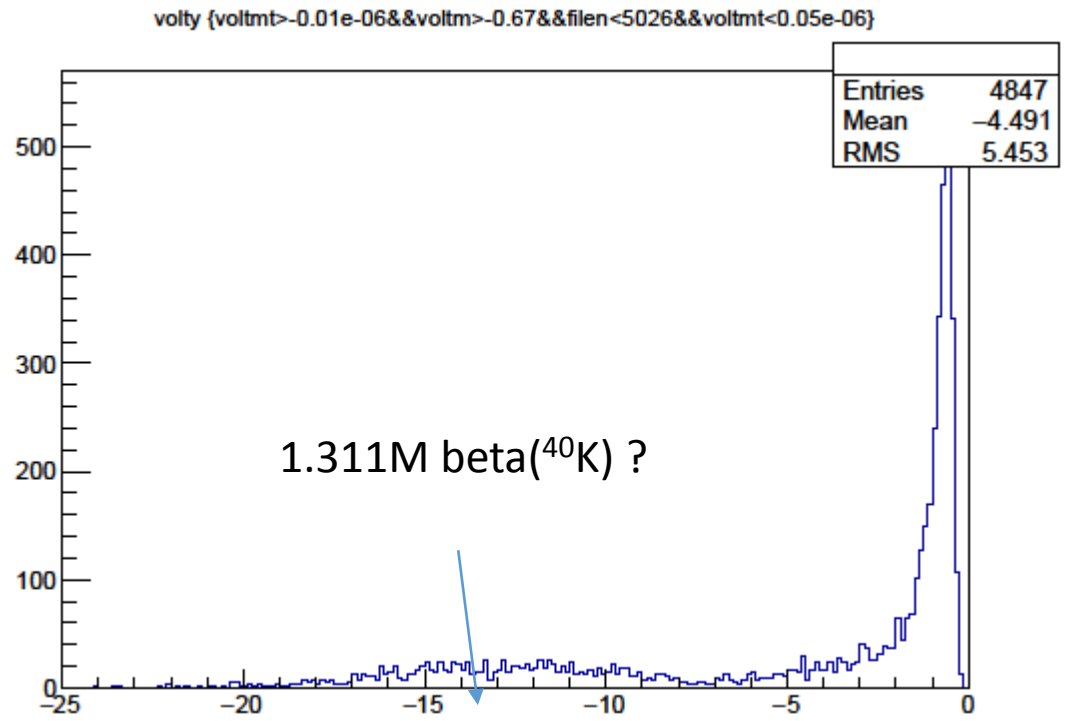


# How much we can achieve

- Will be depends on Oscilloscope spec.
- 8bit for adequate dynamic range
- 200ps/bin →time resolution is good enough
- Long time range means large data size.

# Peak yield distribution




- I want to subtract noise and cosmic ray to analysis but at last time data taking, there was no counter.
- I got new data today with counter and discriminator(-30mV threshold limit which is below oscilloscope threshold used)

→Will be updated next time

# Photo-electron number

- Vsum = ~4V (for 0.5MeV gamma)

$I = 4V/50\Omega = 0.08A = Q/\Delta t = Q/10ns$

$Q = 0.8C = 5x10^{9}\#(electron)$

$P.E = Q / (Gain \times efficiency) = 5x10^{9} /( 8x10^{6} \times 0.8) = 7.5 \times 10^{2}$ #

← Too big…. Did I calculate something wrong?

# The way to calibration

- Energy calibration
- Peak yield(v*s) for one 0.5MeV gamma to estimate yield.
- Peak yield of 1.2MeV gamma to check linearity? (y = a*x)

- Efficiency measurement
- Acceptance check of PWO crystal and plastic scintillator(or CsI) for back to back signal or « 1.2MeV and 0.5MeV » signal
- Today's data shows that plastic scintillator has too bad energy resolution
- At last time, I checked CsI detector but that has quite big noise compared with 0.5MeV gamma.

# Last day setup


# To do list

- PWO detector calibration
- Energy calibration & efficiency check
- Toy MC check

- Simulation preparation
- Positronium reflection inside cavity target(positronium target)
- Membrane geometry for positronium target (Si with holes inside)

- Helping to develop Antion detection →MCP & other detectors?