

MEG実験用LXe scintillation detectorの

$\pi^-p \rightarrow \pi^0n$ を用いたビームテスト II

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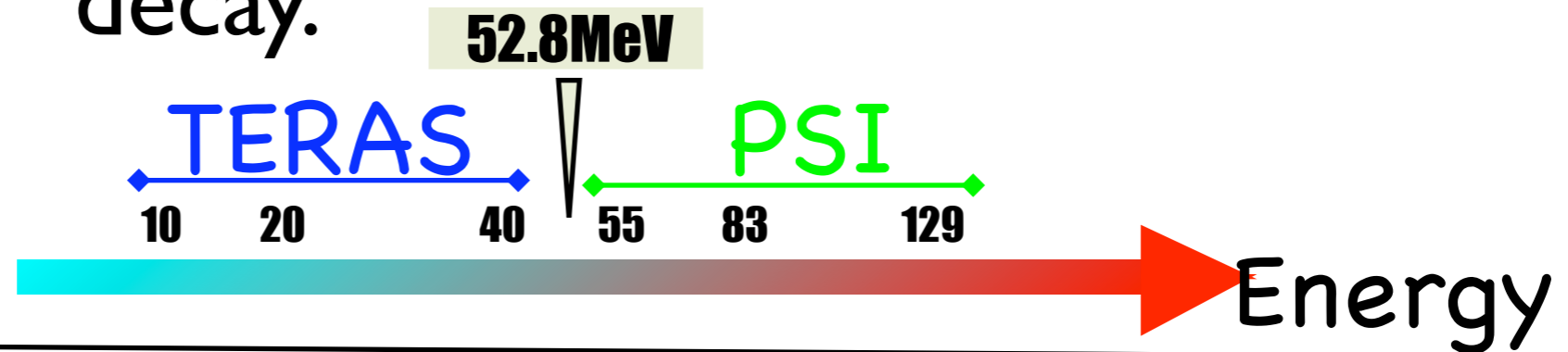
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G.Signorelli

PSI

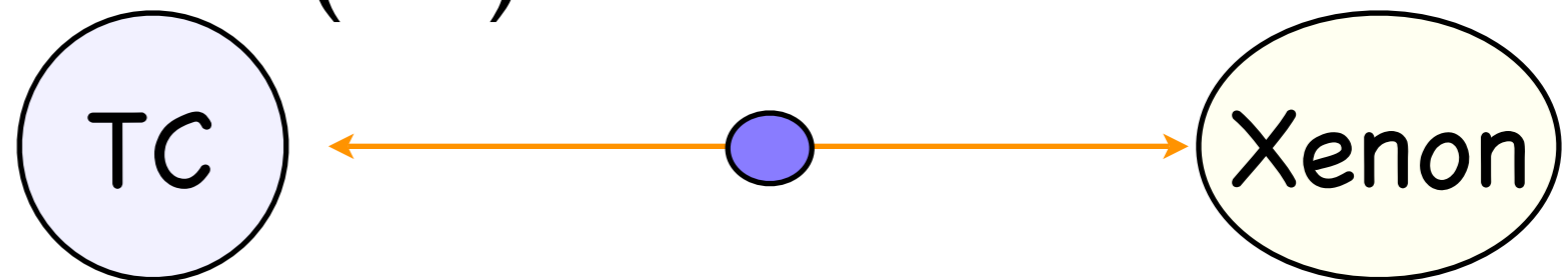
P.-R.Kettle, S.Ritt

Resolution

- Energy : using Monochromatic gamma from π decay.

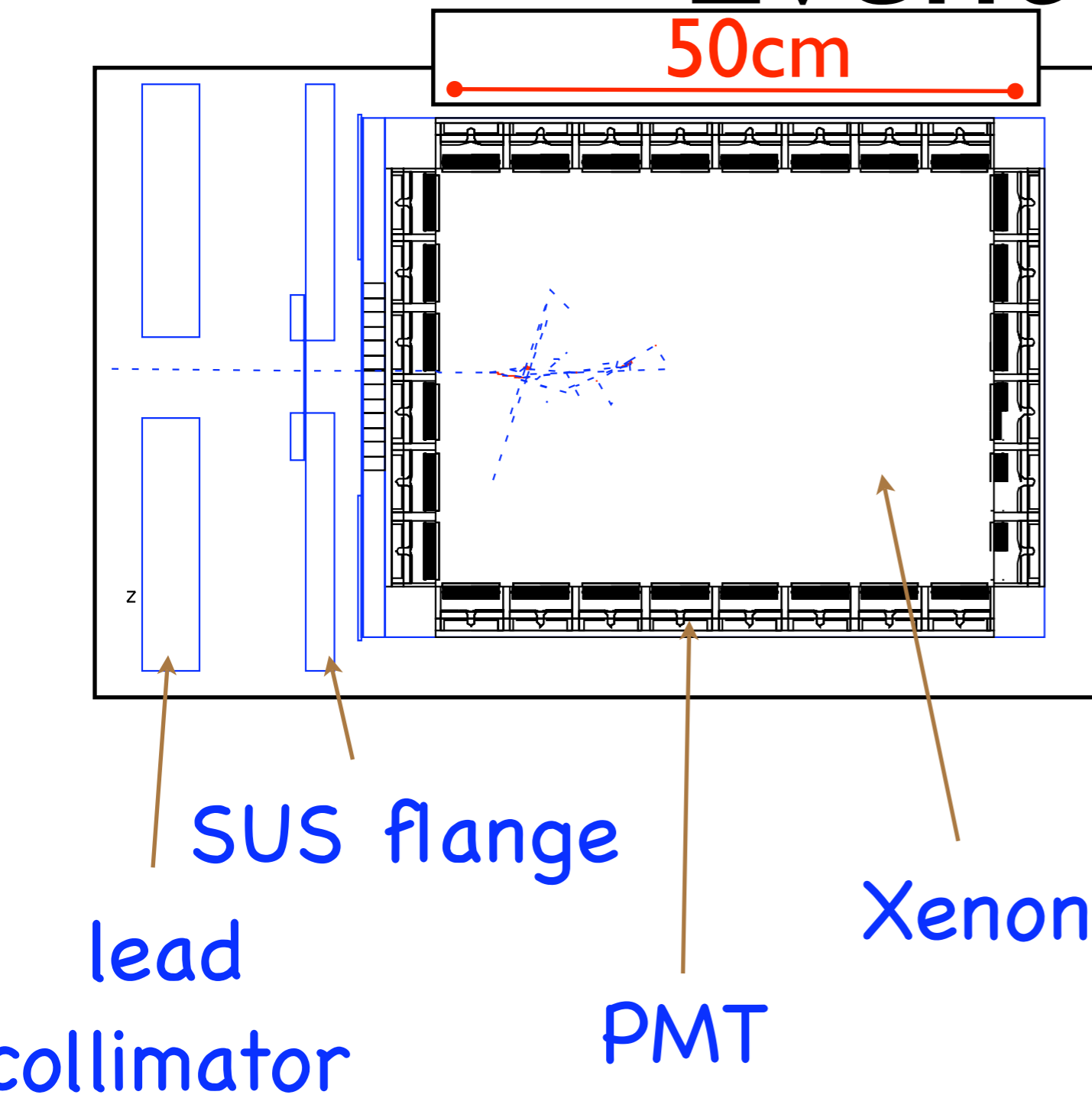


- Timing : detect pair gamma with Timing Counter(TC)

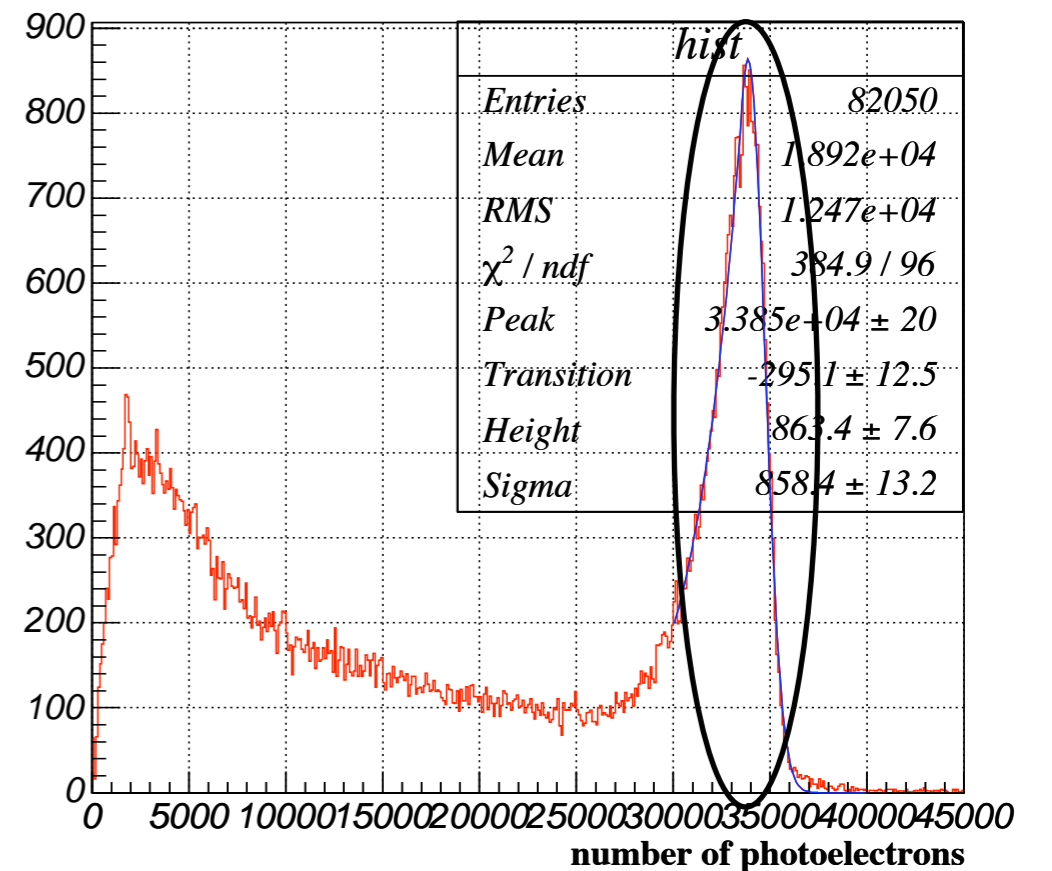


- (Position : measured at TERAS beam test

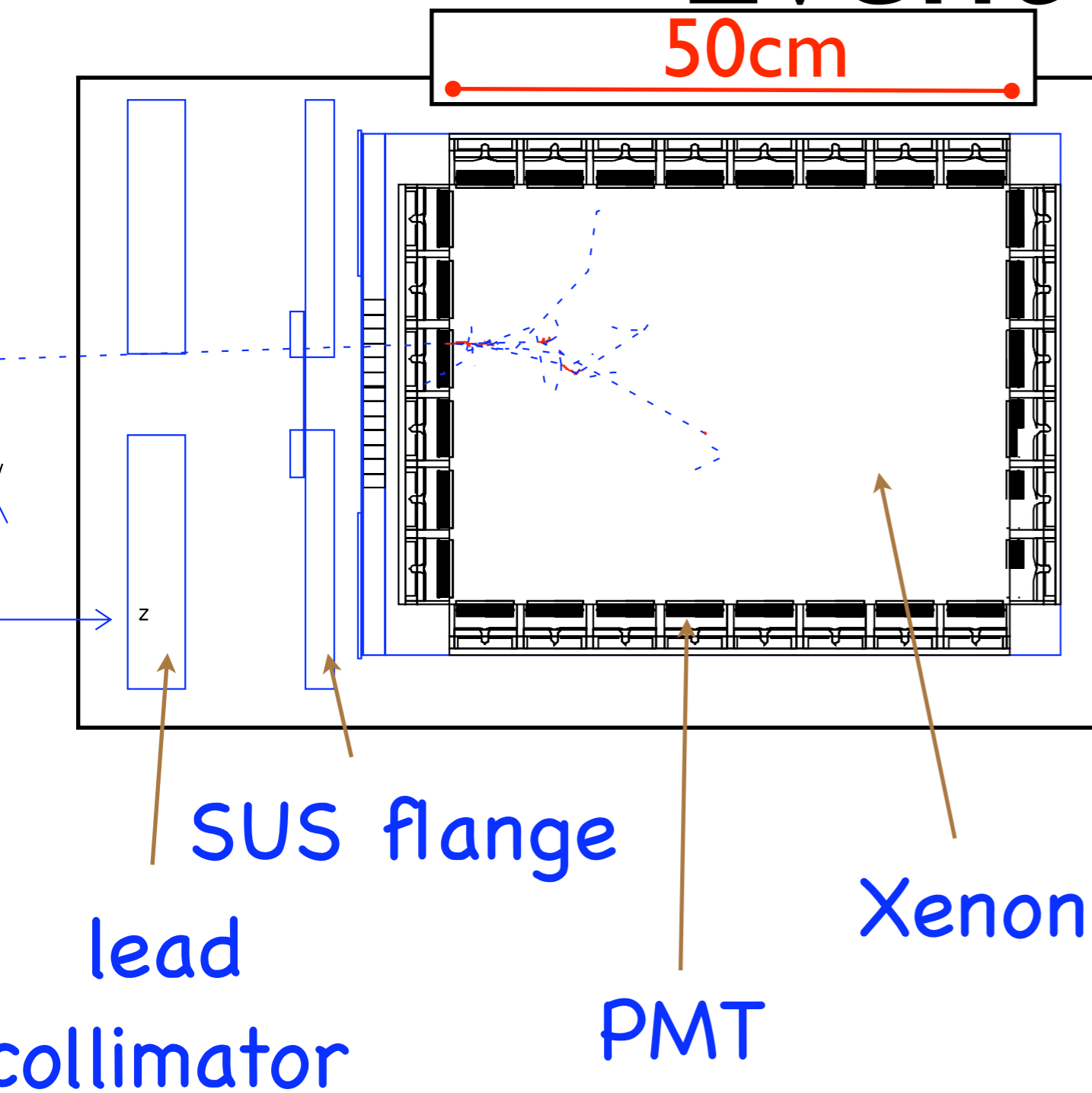
Event type



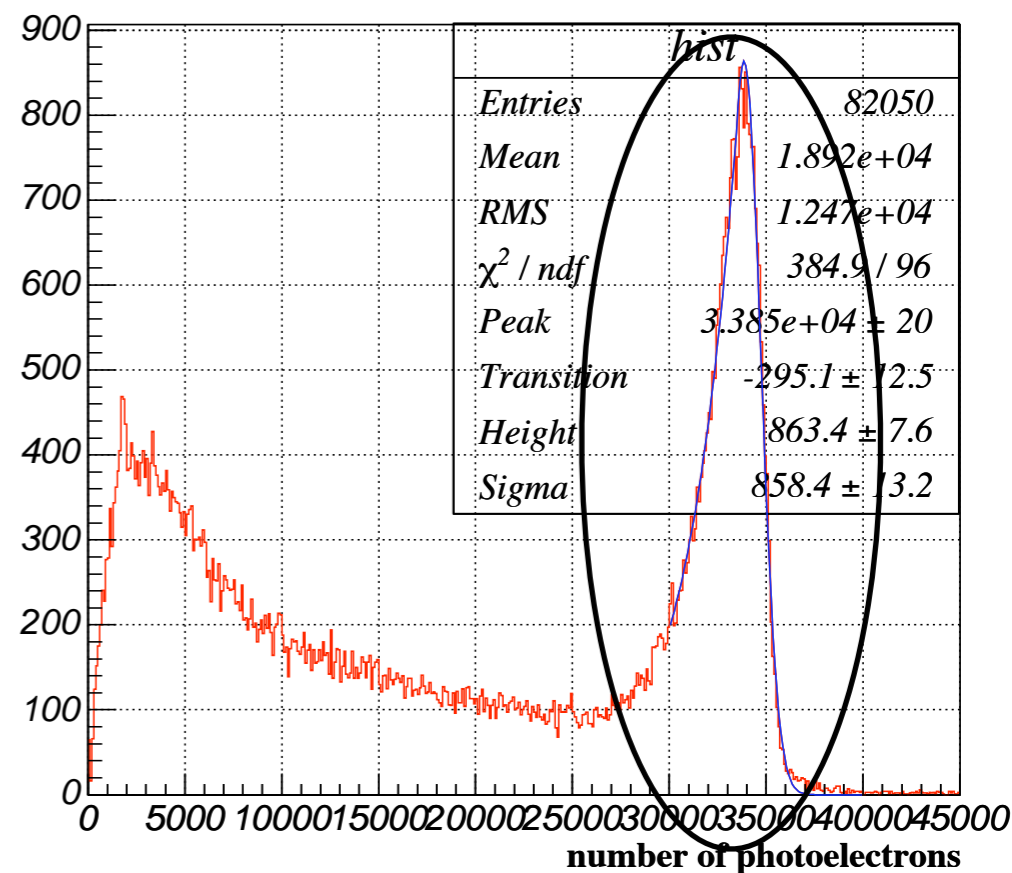
Good Events make peak.



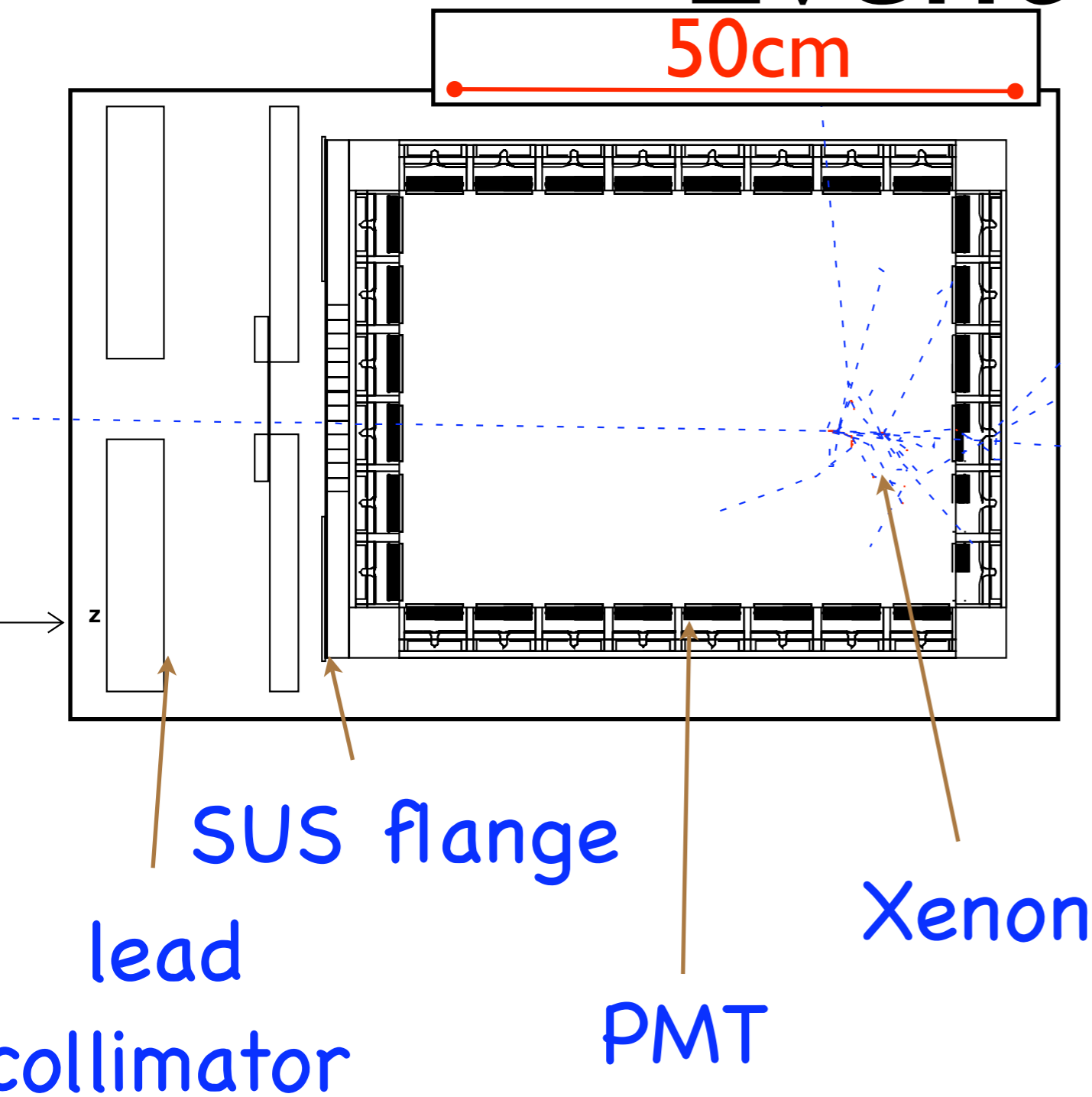
Event type



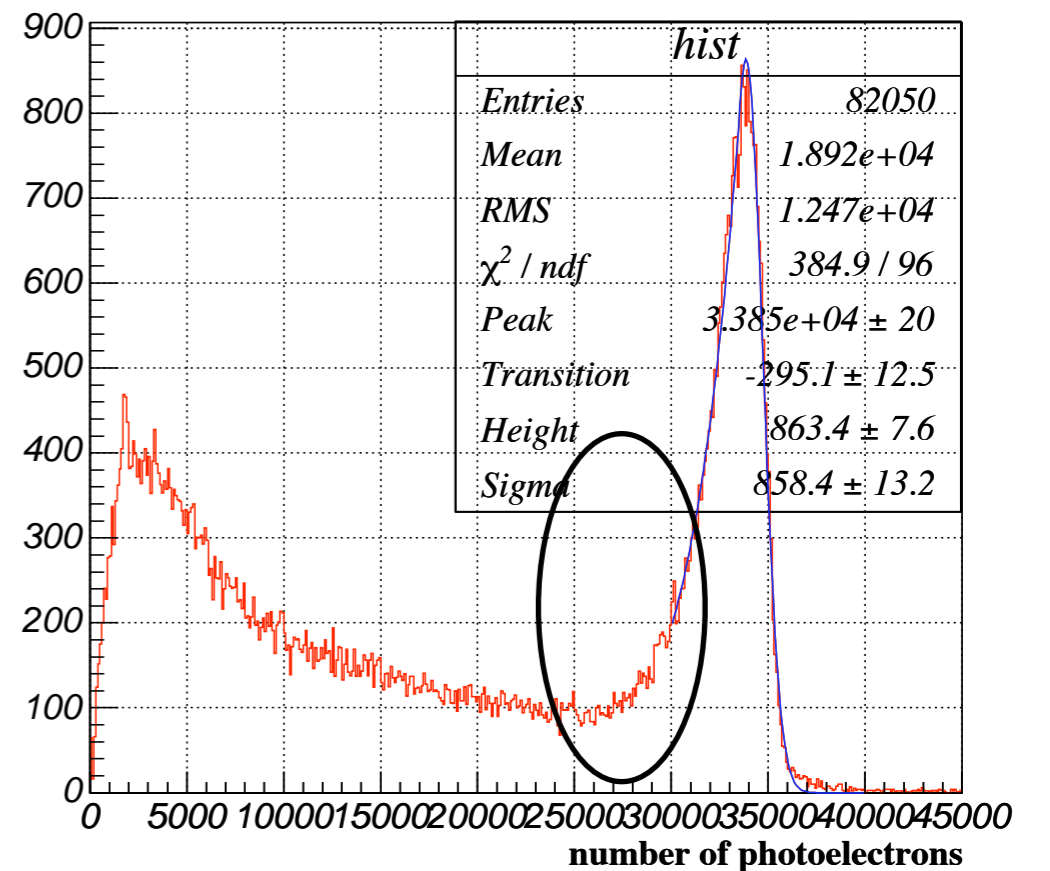
Very shallow events can be used.
(with poor resolution)



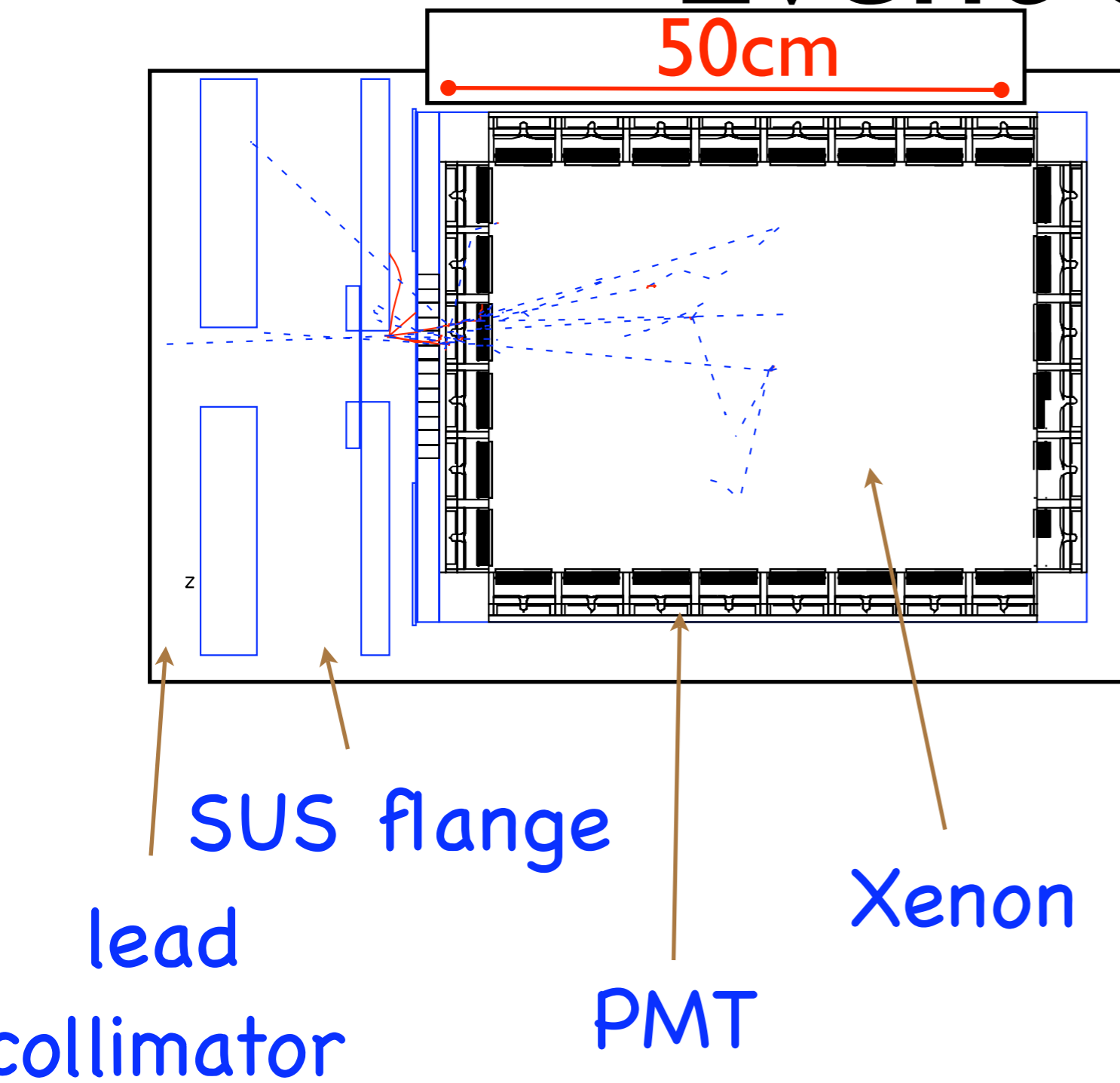
Event type



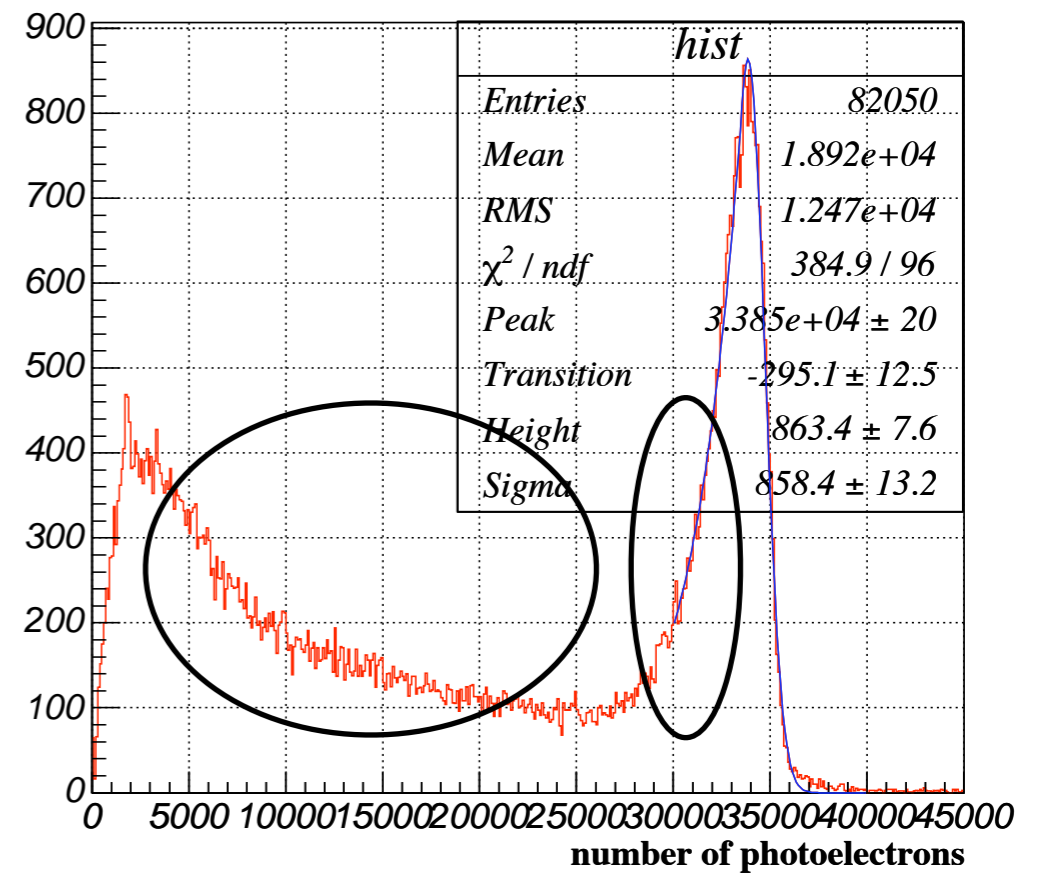
Very deep events make lower tail due to missing PMTs



Event type



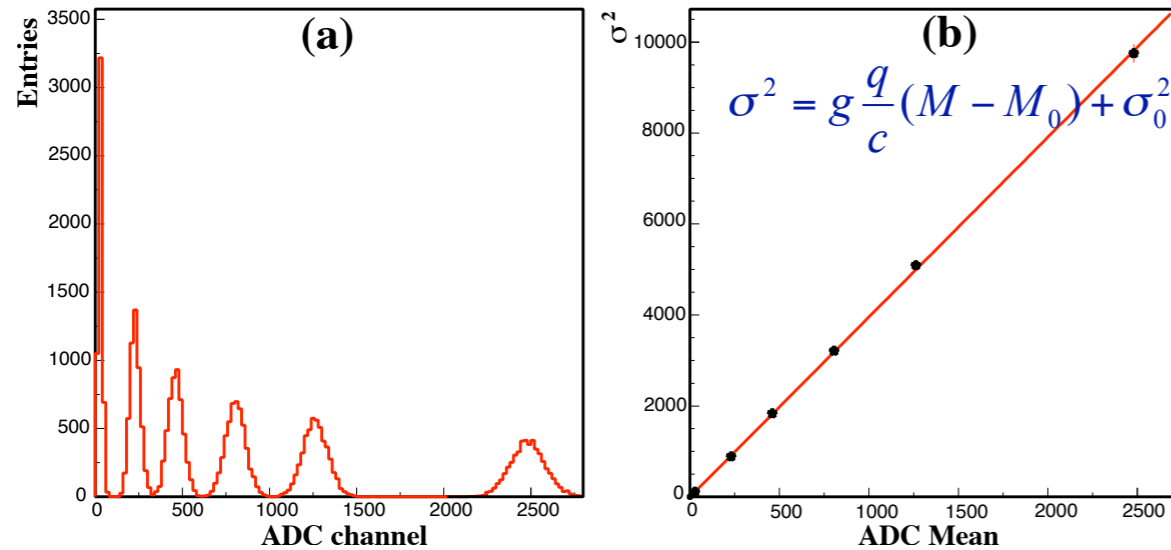
Interaction occurred
in material



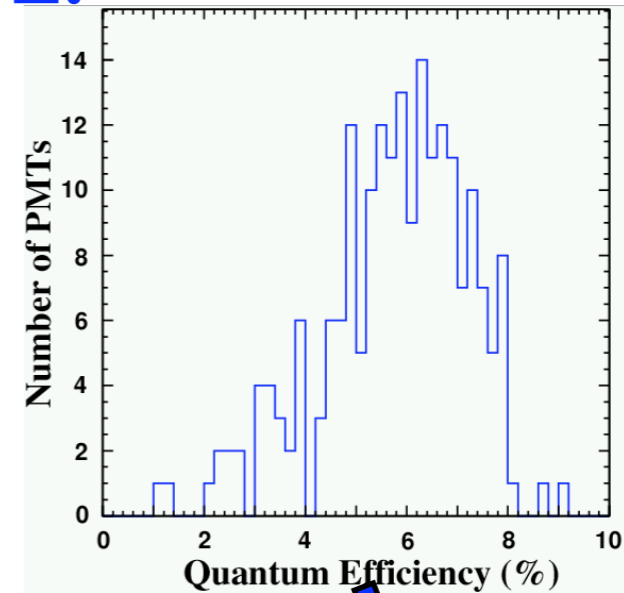
Energy Resolution

Calibration & Reconstruction

PMT Gain



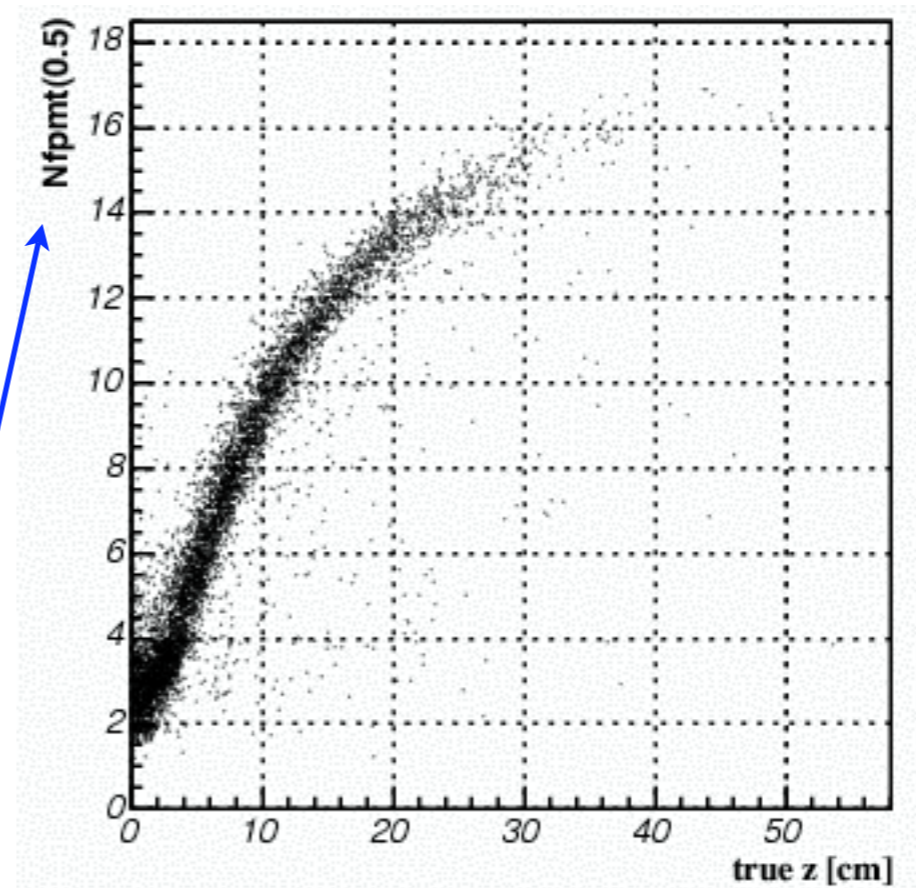
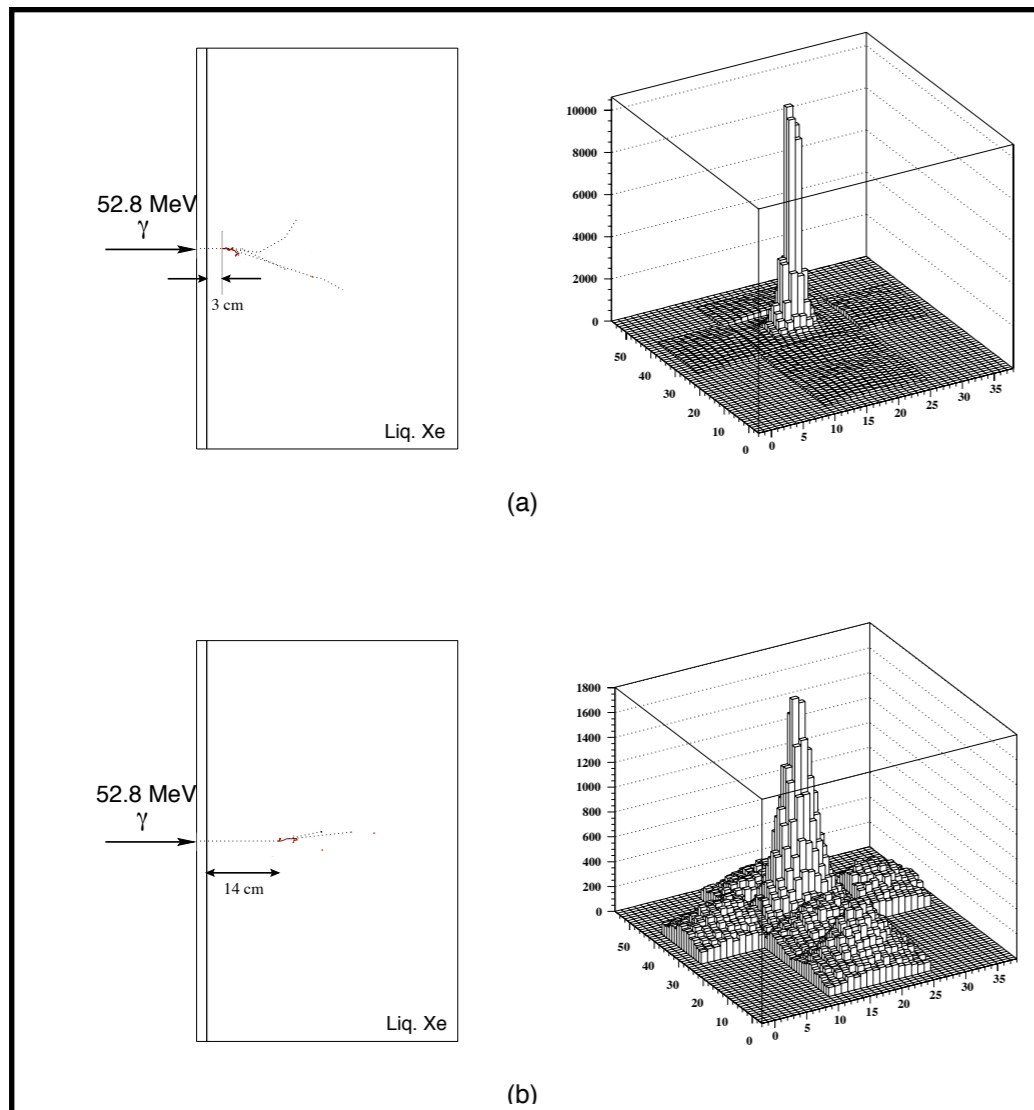
PMT Q.E.



$$Q_{sum} = \sum_i C \times (\text{ADC}_i - \text{pedestal}_i) / \text{gain} \times \frac{\overline{QE}}{QE_i}$$

- Event selection with position, depth
- Qsum correction with depth

Depth Reconstruction

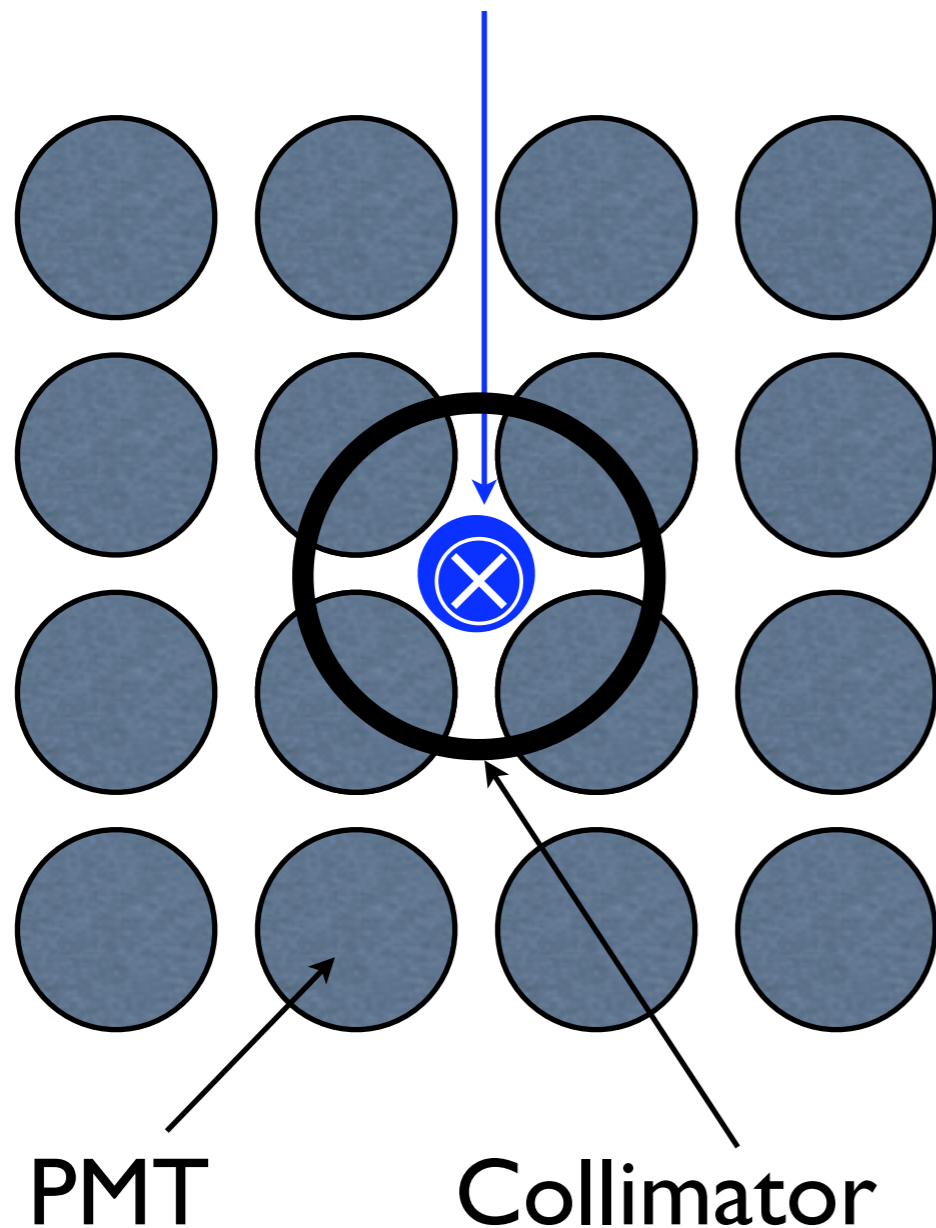


$$\frac{\sum_{i=1}^D Q_i}{Q_{\text{front}}} = 0.5$$

Position selections and corrections

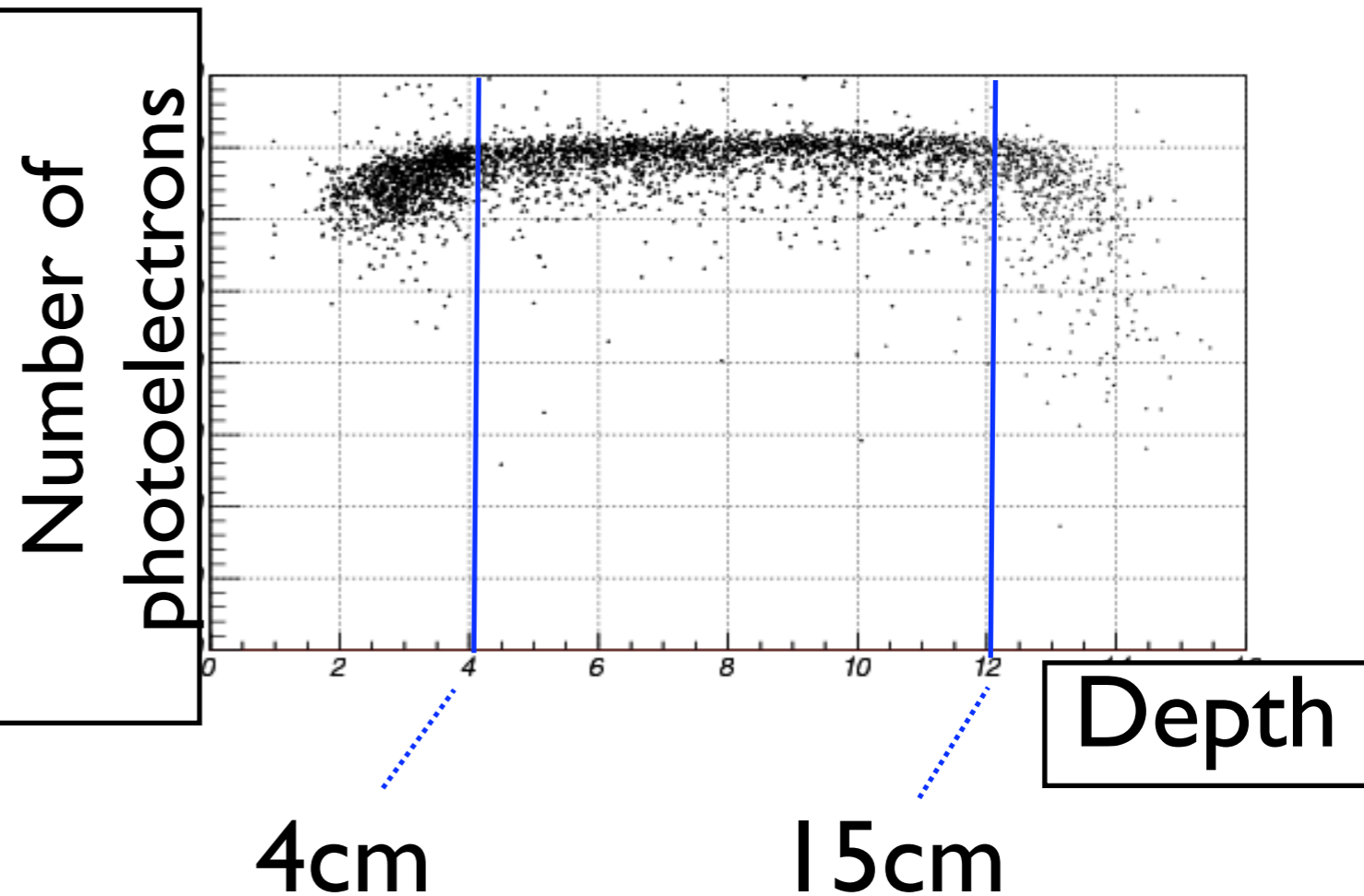
X-Y Selection

● $r < 1.5$ cm

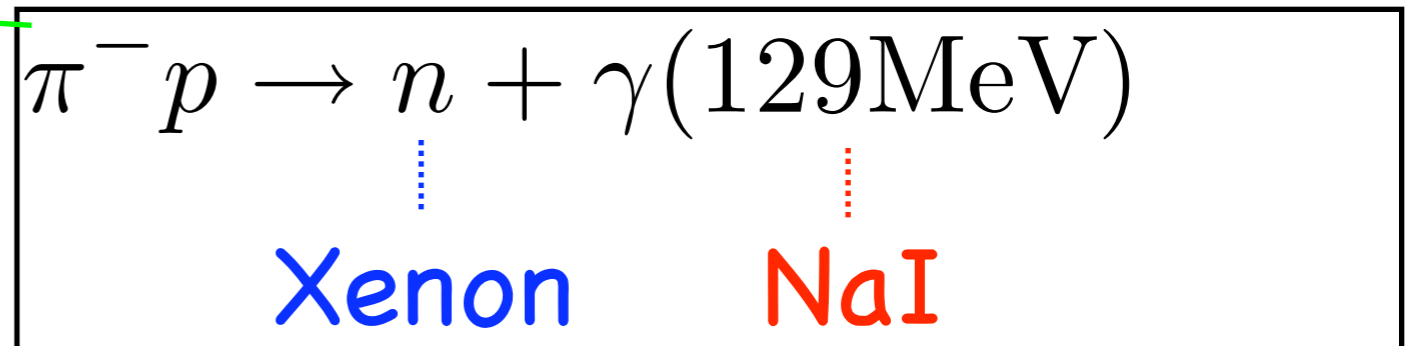
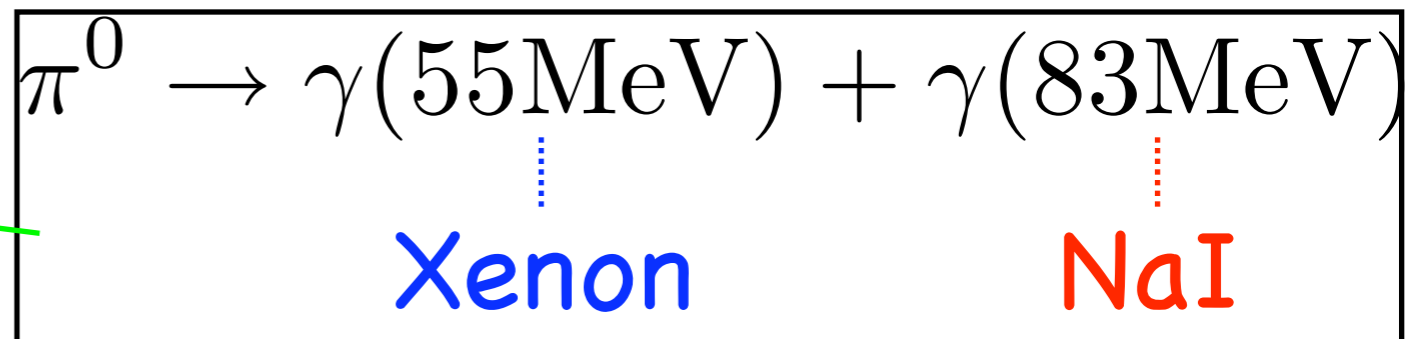
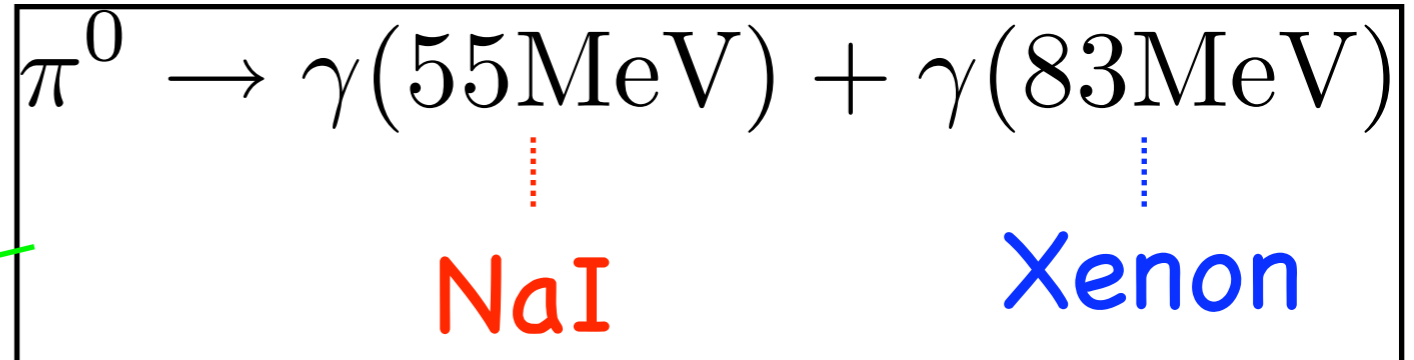
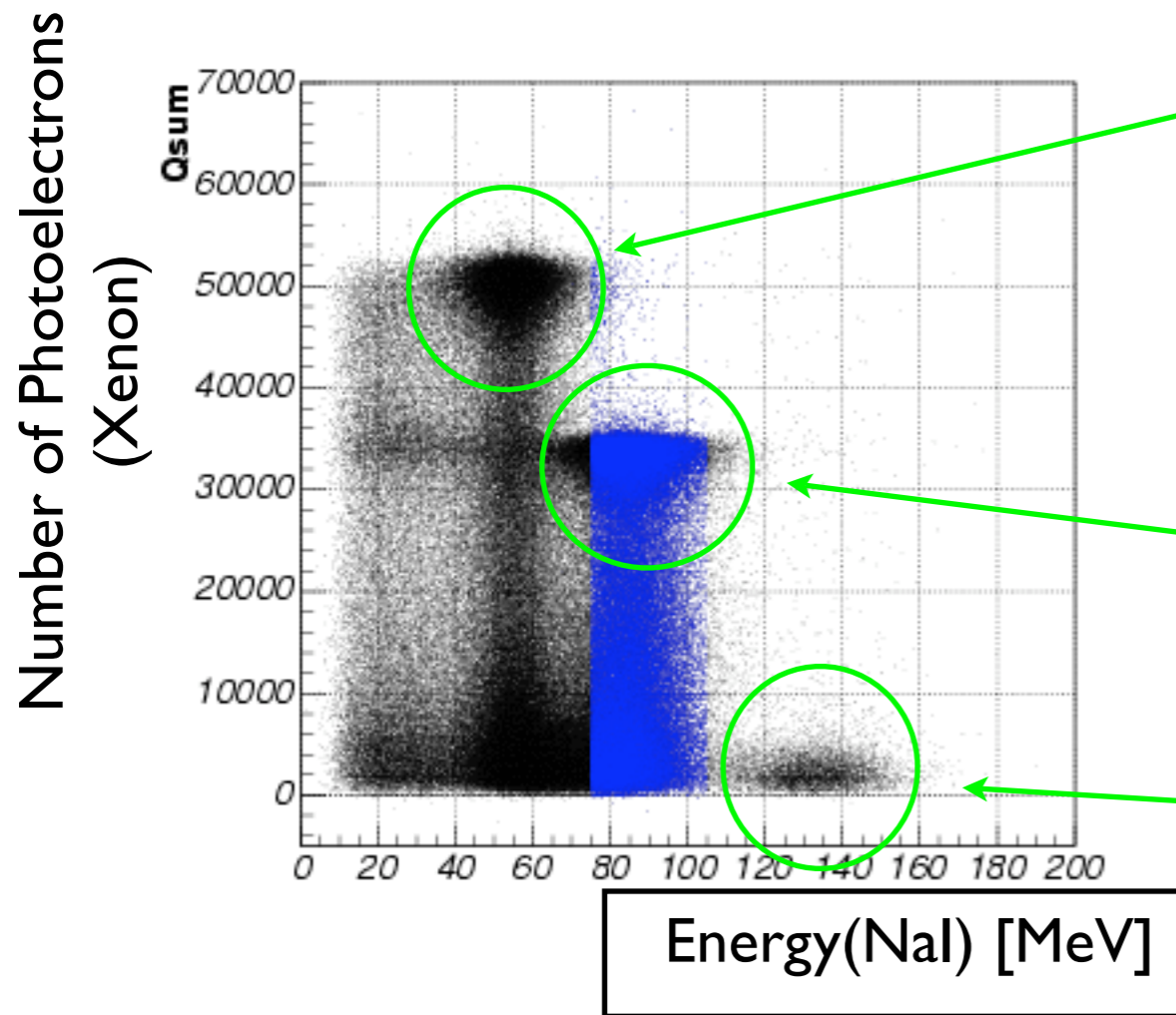


Depth Selection/Correction

● $4\text{cm} < \text{depth} < 15\text{cm}$
● with linear correction

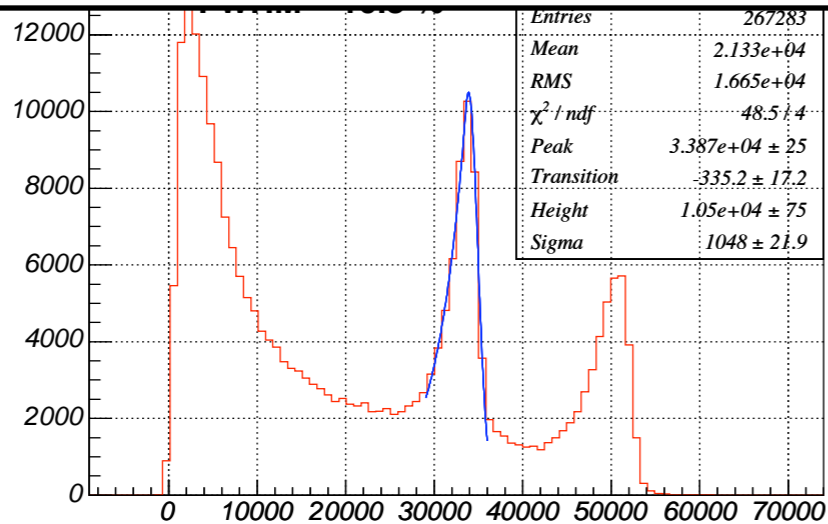


Event Selection with NaI Energy

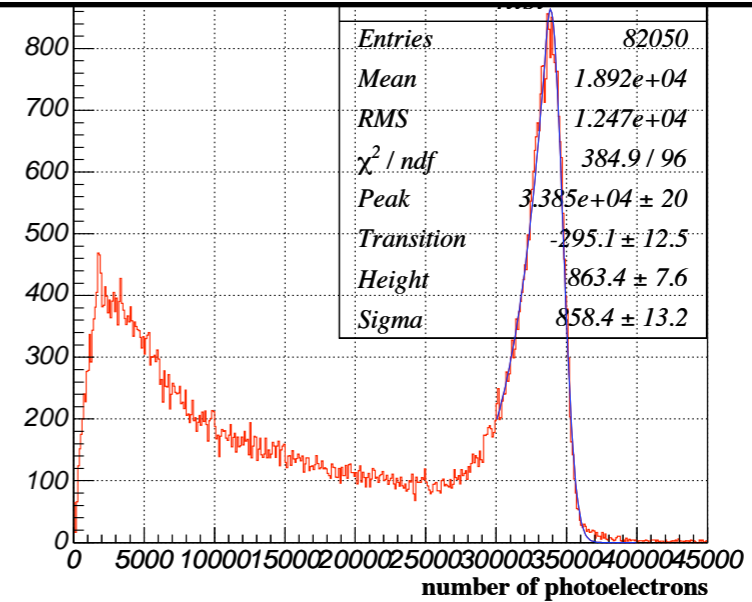


Resolution after cut/correction

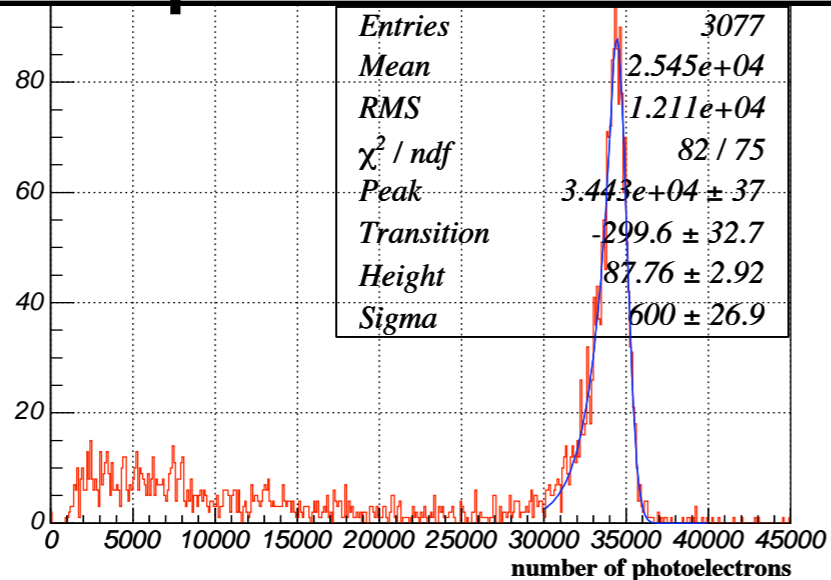
w/o cut/correction



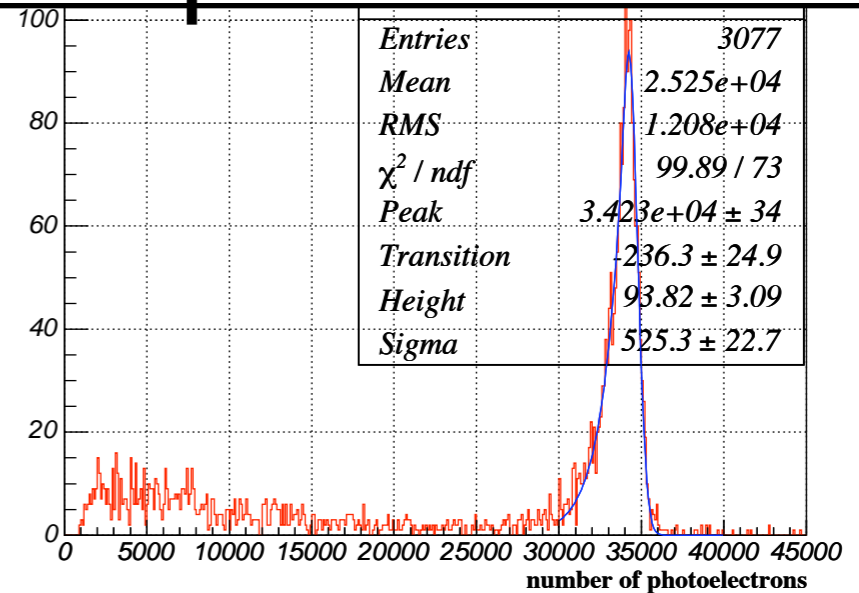
+ NaI Selection



+ position cut



+ depth correction



FWHM = 4.5 ± 0.3%
 $\sigma(\text{right}) = 1.6 ± 0.1%$

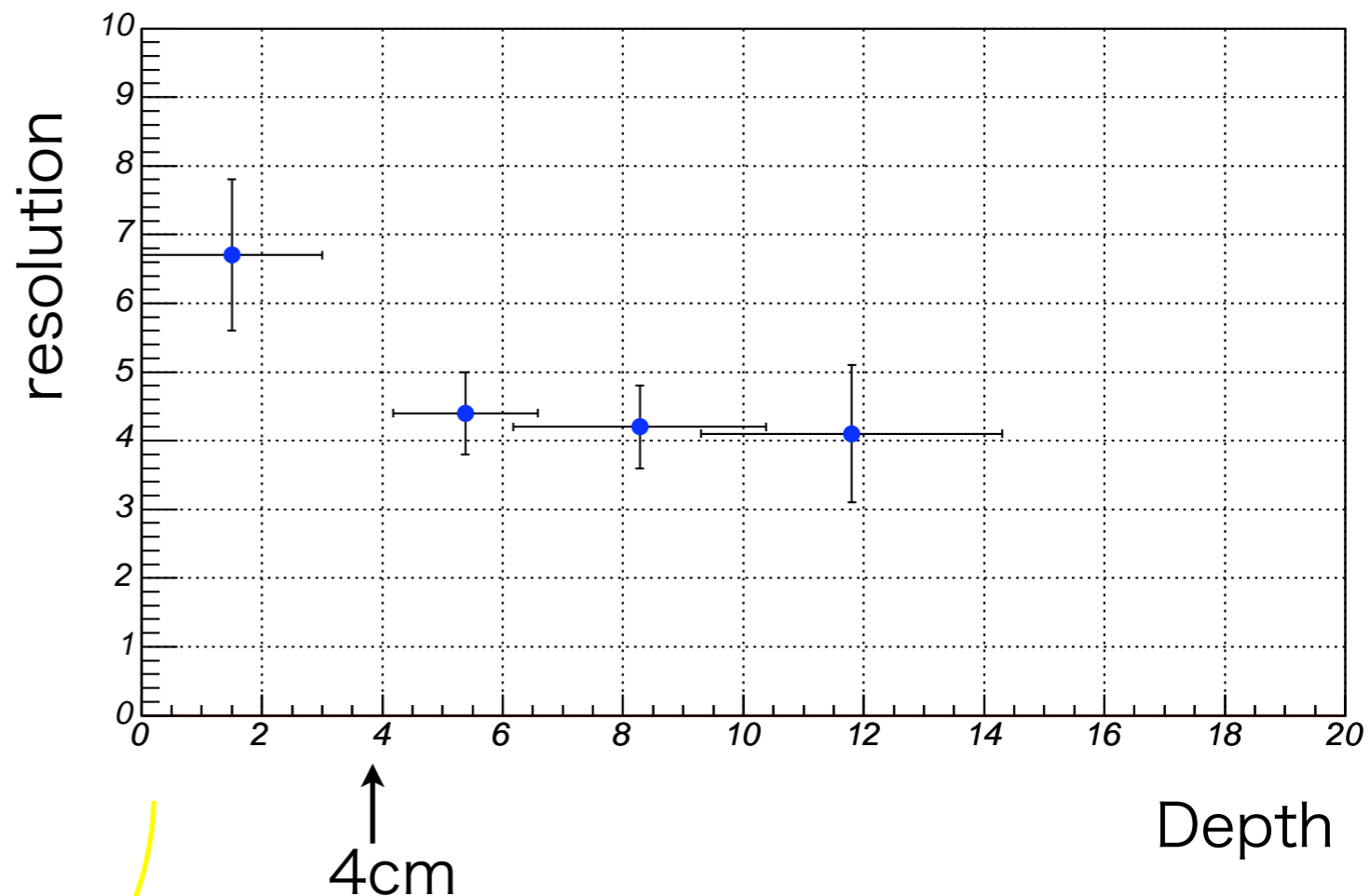
Position dependence of resolution

X-Y dependence

Depth dependence

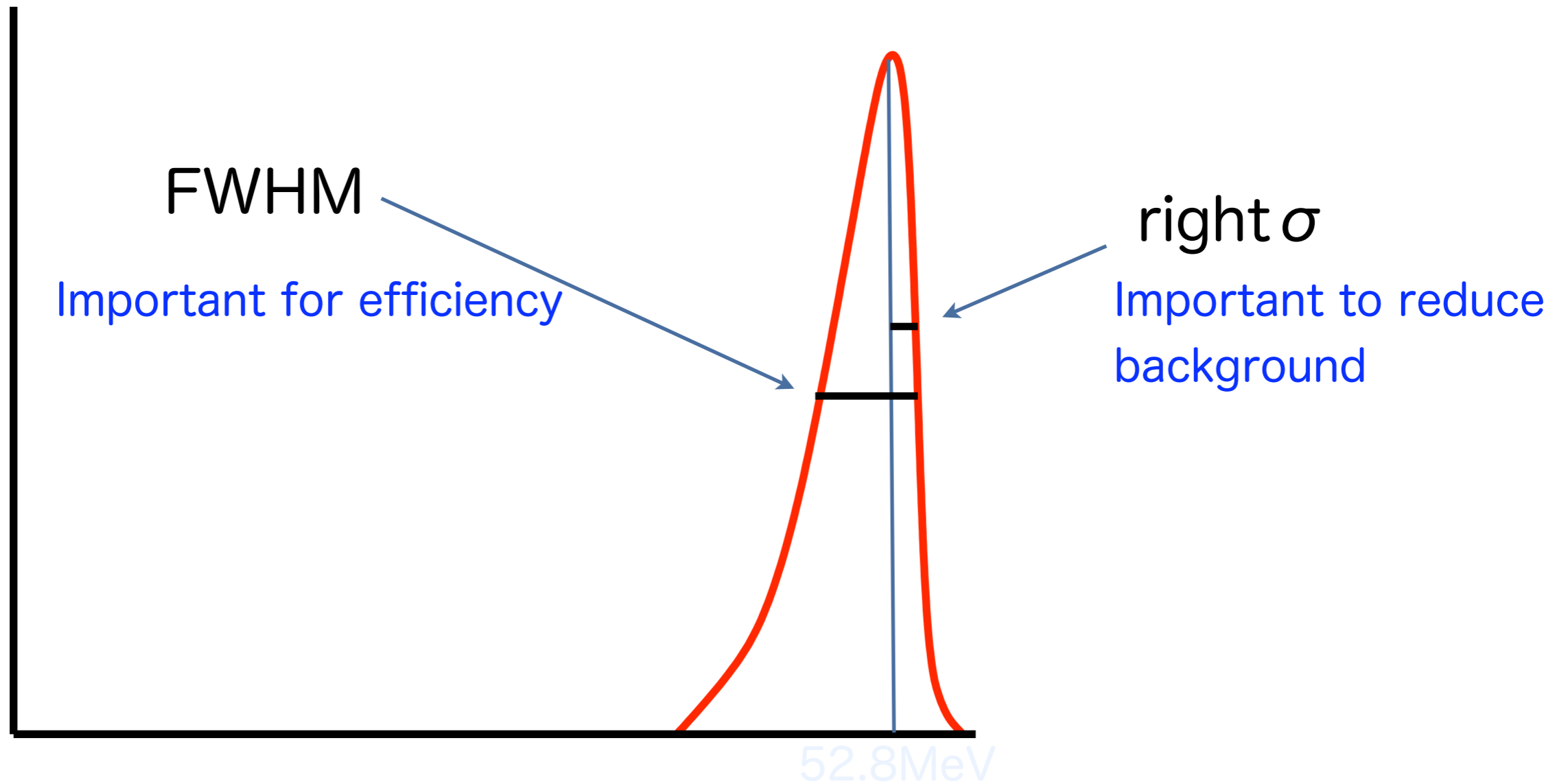
PMT →

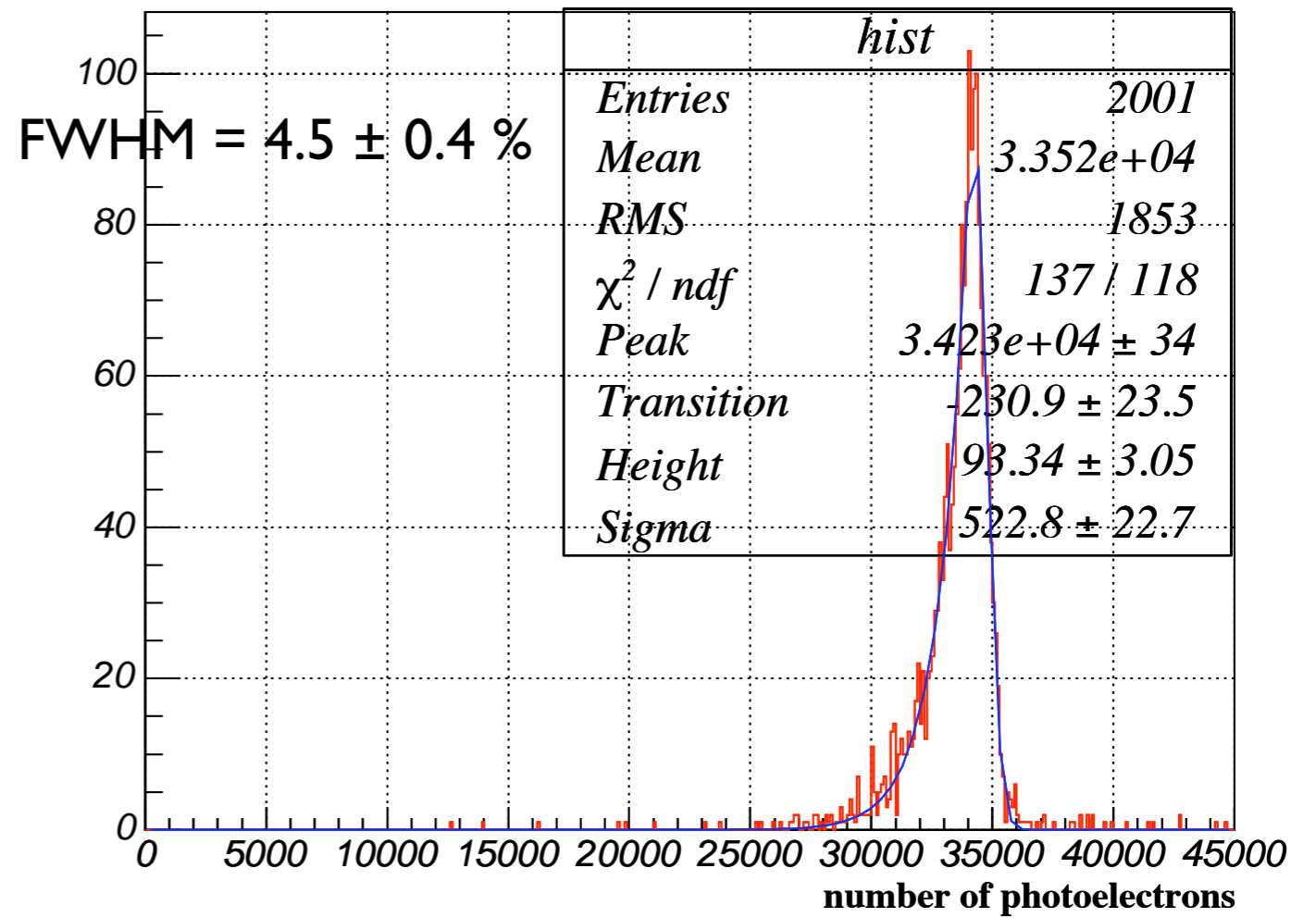
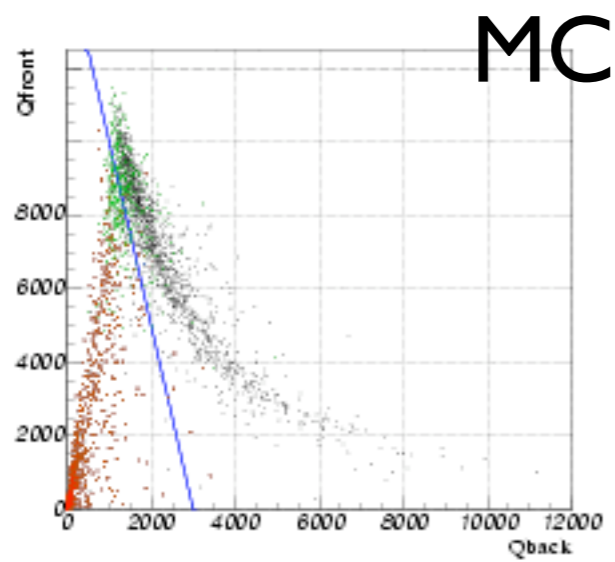
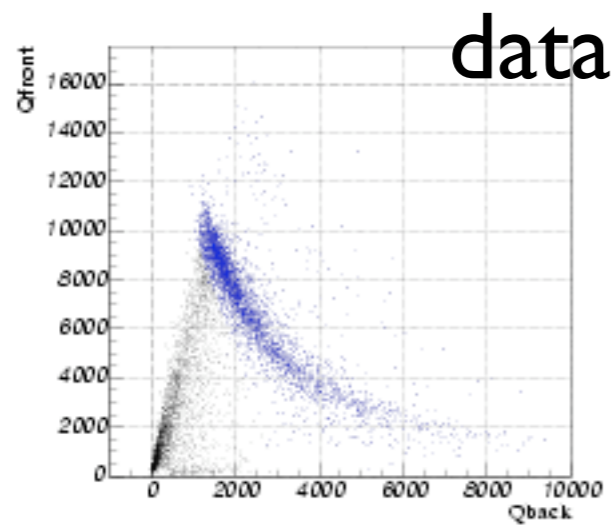
4.3 ± 1.0	4.8 ± 0.4	4.6 ± 0.7
4.5 ± 0.6	4.5 ± 0.3	4.5 ± 0.6
4.1 ± 0.9	5.0 ± 0.5	5.0 ± 1.6



FWHM [%]

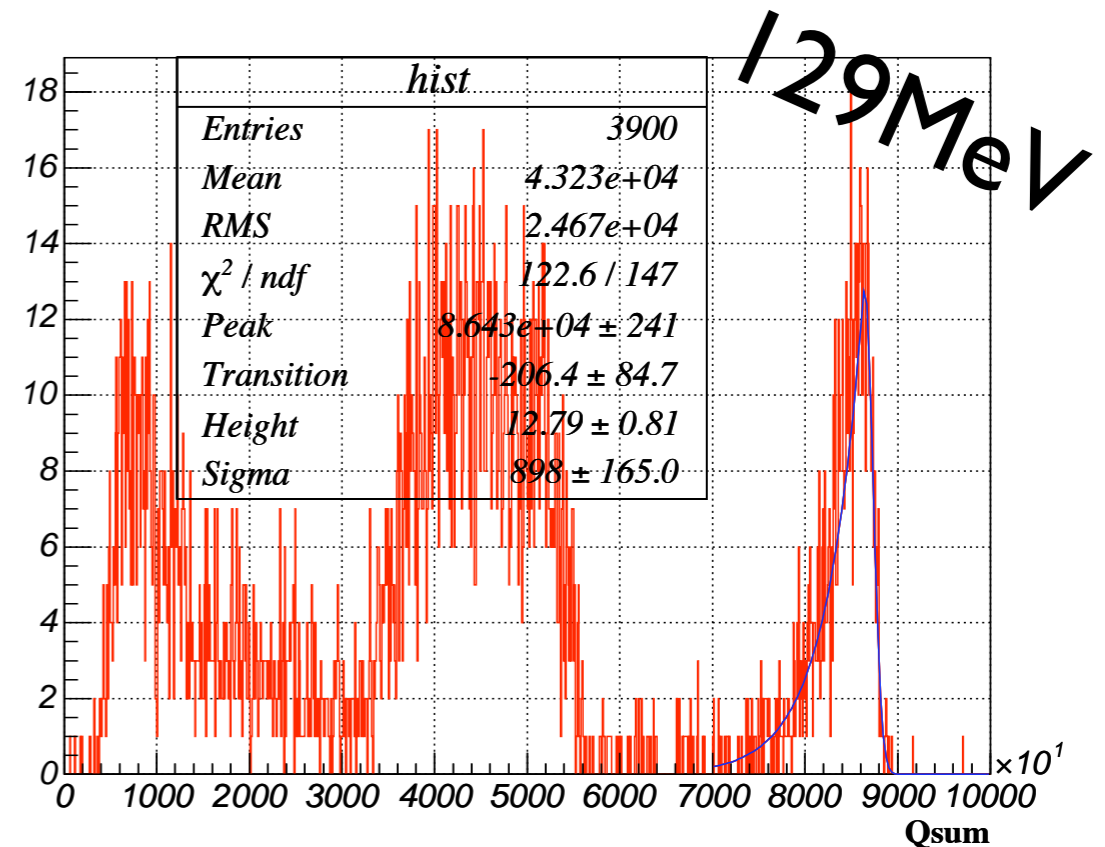
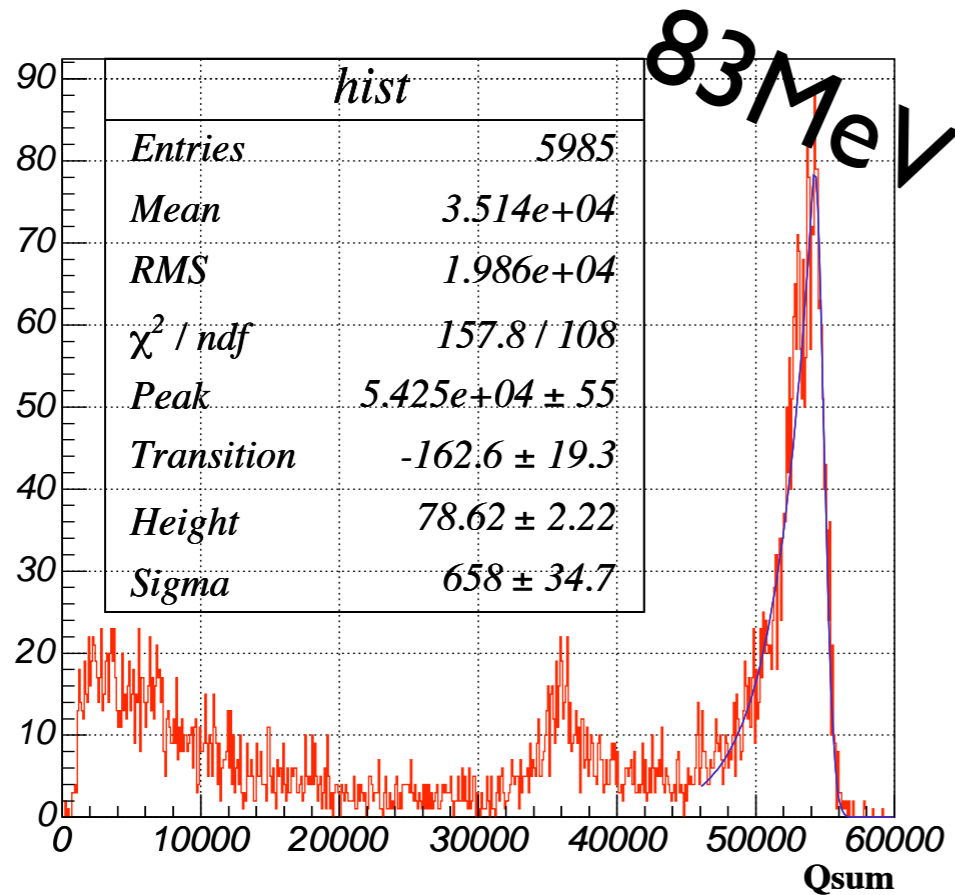
Resolution





red points:
 z of conversion point $<$ Front face

Resolution of 83, 129 MeV gamma



FWHM: 5.0 \pm 0.6 %

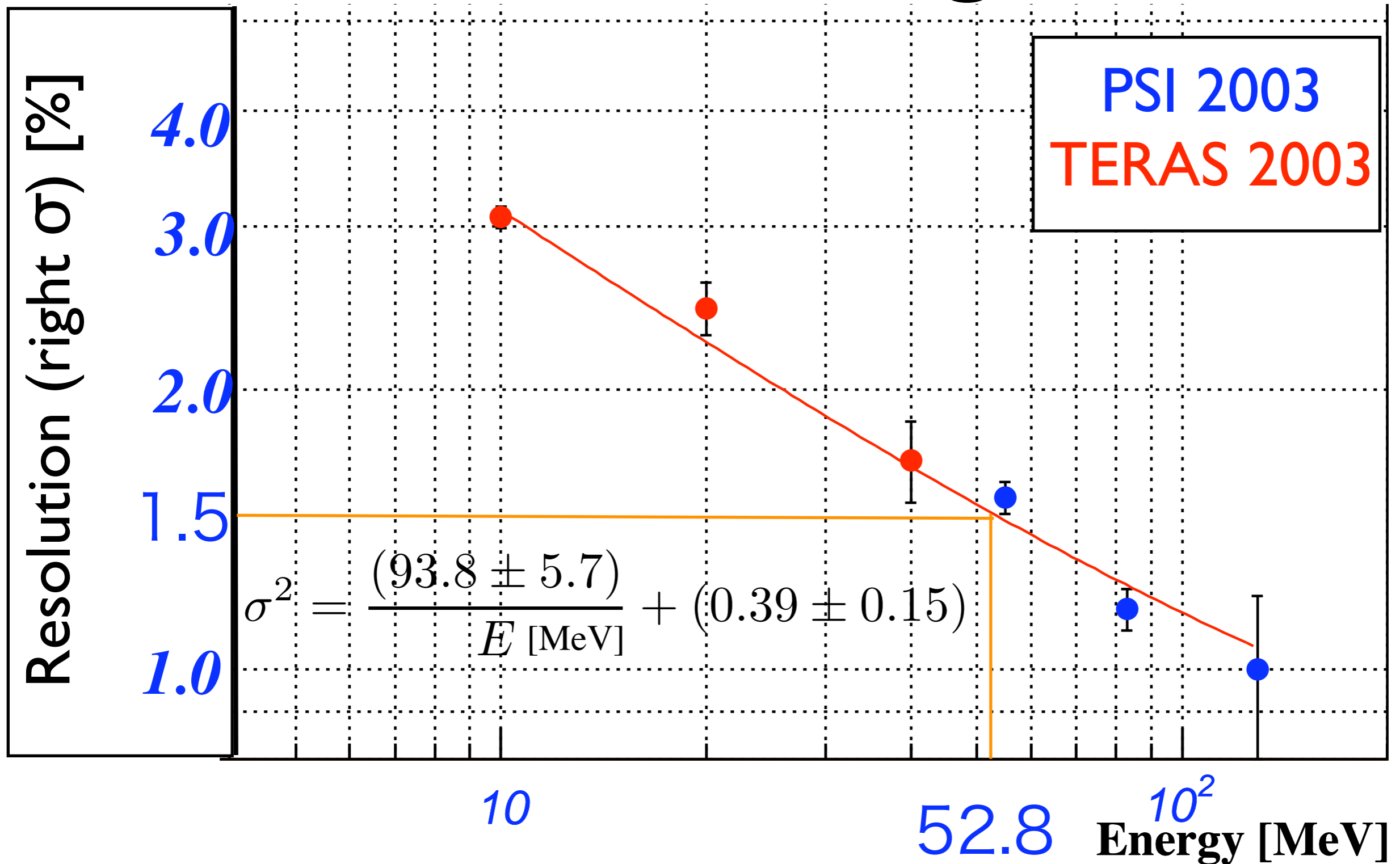
$\sigma(\text{right})$: 1.16 \pm 0.06 %

FWHM: 4.5 \pm 1.8 %

$\sigma(\text{right})$: 1.0 \pm 0.2 %

Now we see 55, 83, 129 MeV together, (also TERAS)

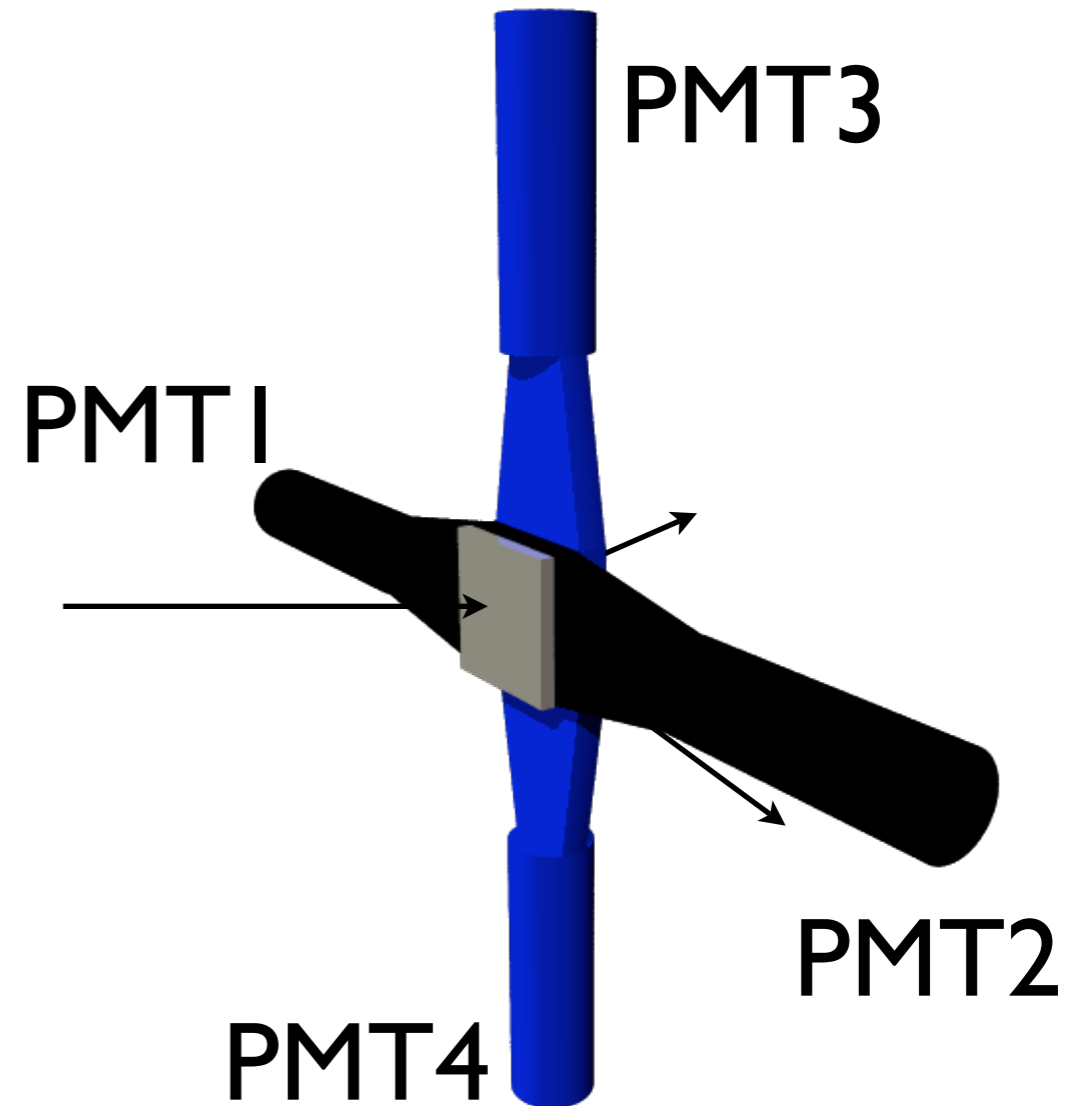
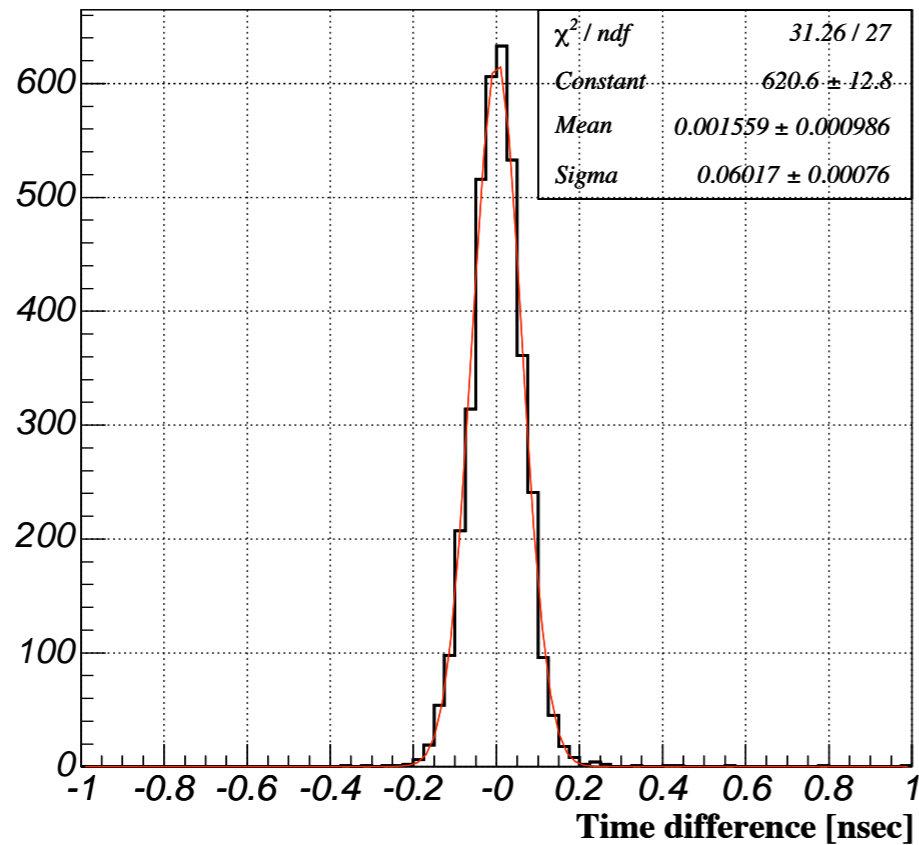
PSI, TERAS together



Timing Resolution

Timing Counter

$\sigma=60\text{psec}$



$$(T_1 + T_2) / 2 - (T_3 + T_4) / 2 * 0.5$$

$$T_{TC} = (T_1 + T_2 + T_3 + T_4) / 4$$

Timing Reconstruction

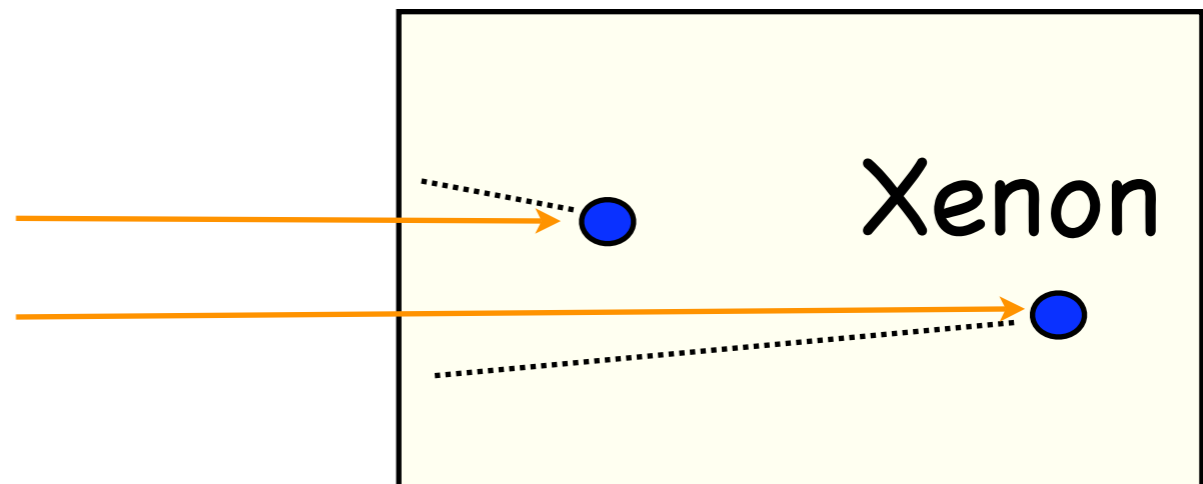
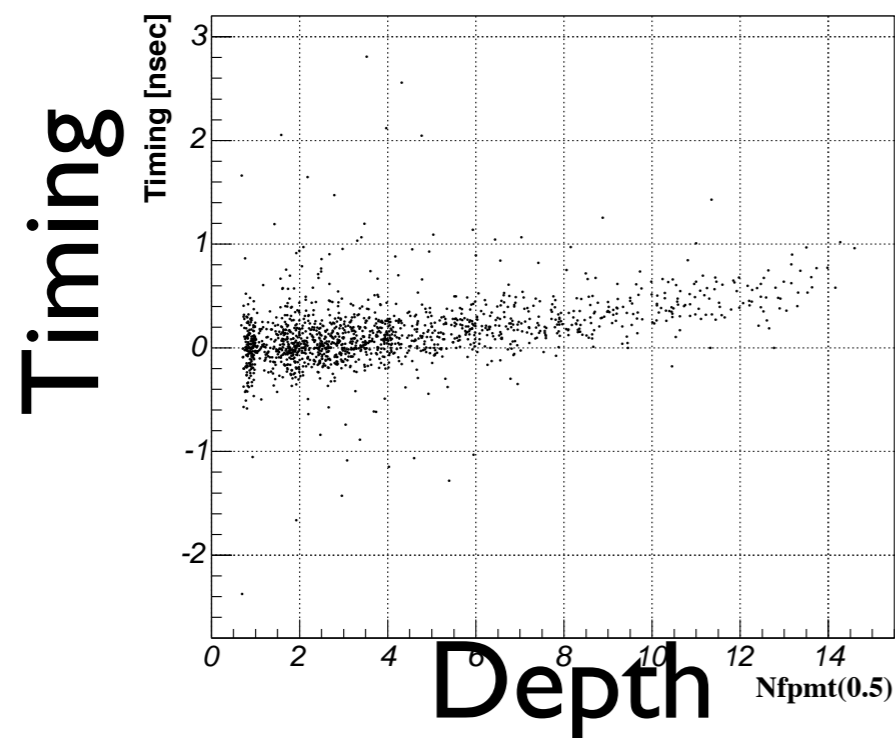
- Time walk correction

$$T'_i = T_i - \frac{C_i}{\sqrt{ADC_i}}$$

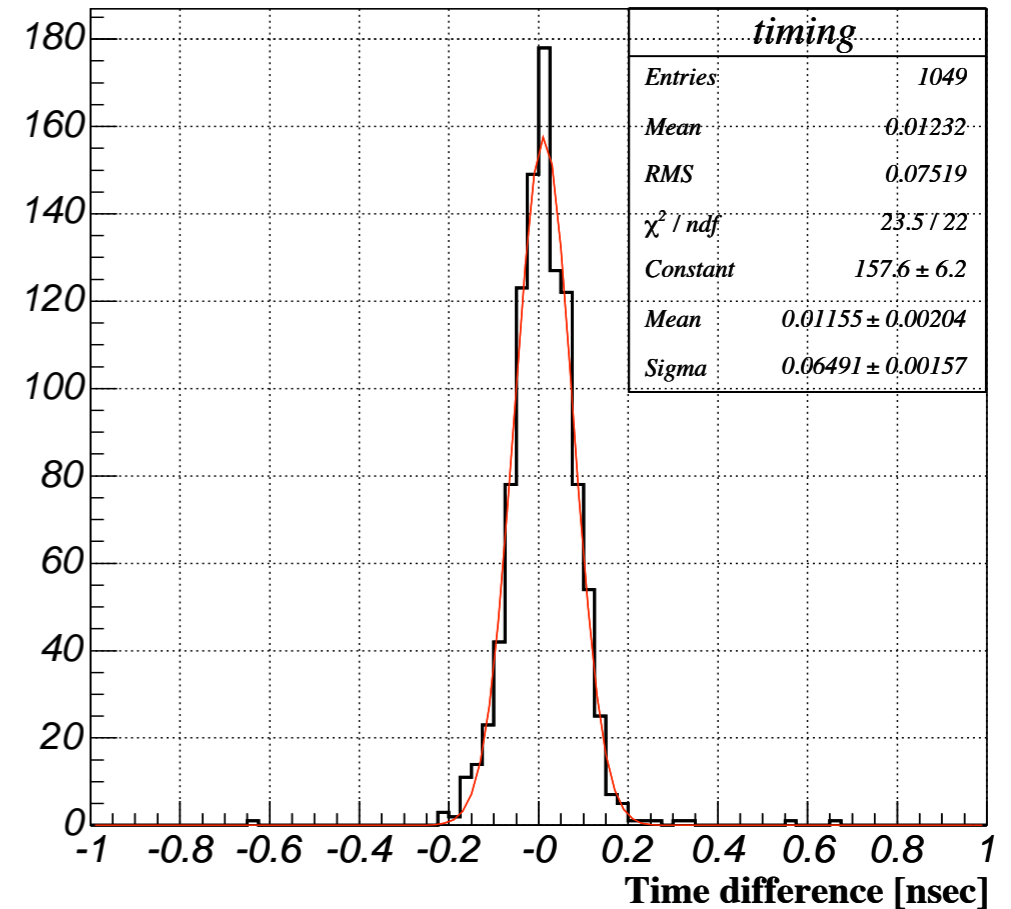
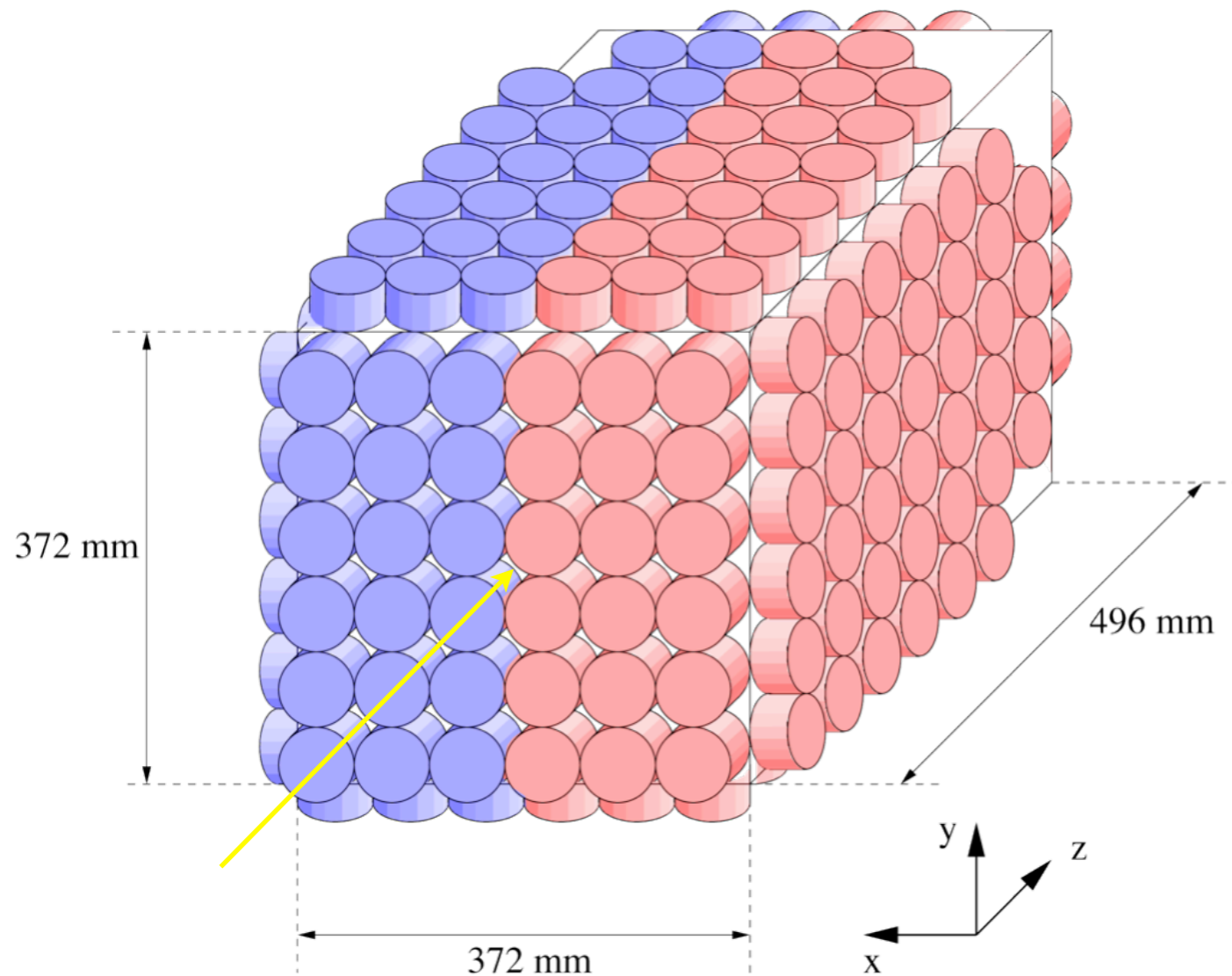
- Weighted mean

$$T_{Xe} = \frac{\sum_i T_i \cdot w_i}{\sum_i w_i} \quad (w_i = \sqrt{ADC_i})$$

- Correction with position



Intrinsic time resolution



evaluate $(T_L - T_R)/2$



65 psec (55MeV)

depth dependence is canceled.

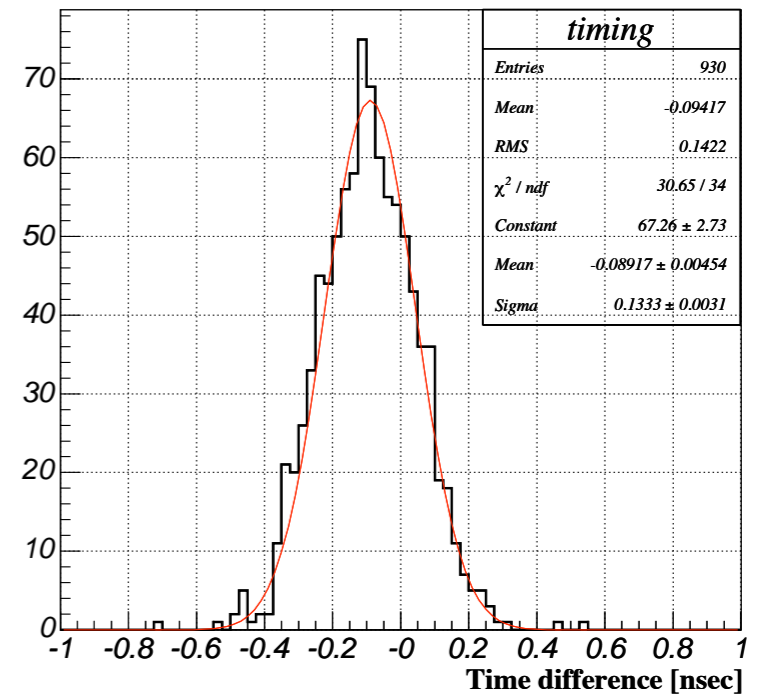
Timing resolution (Xe - TC)

133 psec

$$(\delta T_{Xe})^2 = (\delta(T_{Xe} - T_{TC}))^2 - (\delta T_{TC})^2 - (\delta r_{beam})^2$$

60 psec

60 psec

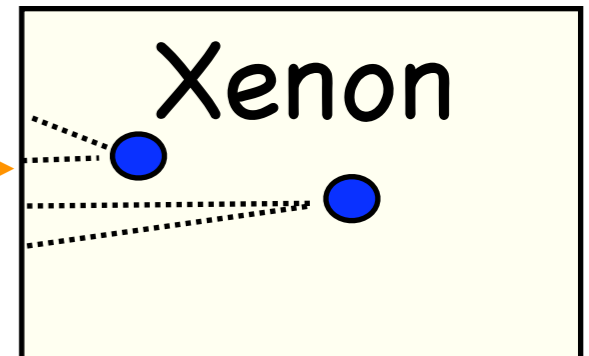


$T_{Xe} = 102 \text{ psec}$

TC

target

Xenon



Summary

- A beam test of calorimeter prototype was carried out at PSI using 55, 83, 129 MeV monochromatic gamma rays.
- Energy resolution was estimated for each energy. FWHM and right σ for 55 MeV gamma are $4.5 \pm 0.3\%$ and $1.6 \pm 0.1\%$ respectively.
- Estimated timing resolution is 102psec (including z resolution) for 55MeV gamma. Better z reconstruction can improve it.

Background rate at MEG experiment

$$B_{\text{acc}} \propto \delta E_e \cdot \delta t_{e\gamma} \cdot (\delta E_\gamma)^2 \cdot (\delta \theta_{e\gamma})^2$$

Energy resolution	4.5-5.0 [%]
Timing resolution	< 0.23 [nsec]
Position resolution	4.5-9.0 [mm]
Muon rate	$0.2-0.3 \times 10^8$ [muon/sec]
Background rate	$2.3-3.5 \times 10^{-14}$ [event/sec]