Efficiency Estimation for the FAC Test Experiment at SPring-8

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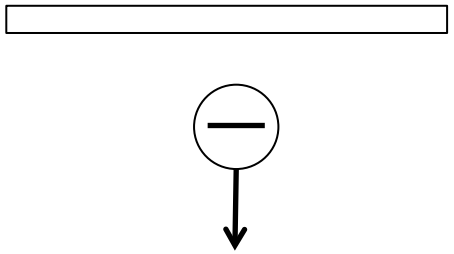
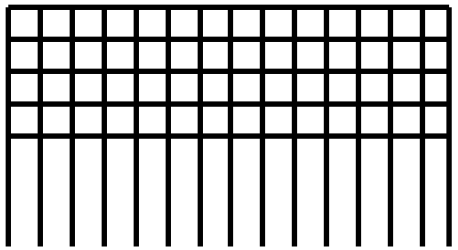
Npe Estimation from ADC Spectrum



Let's assume one pe makes Q with enough statistics.

Let's denote Q for ADC_{mean}-ped for 1 pe.



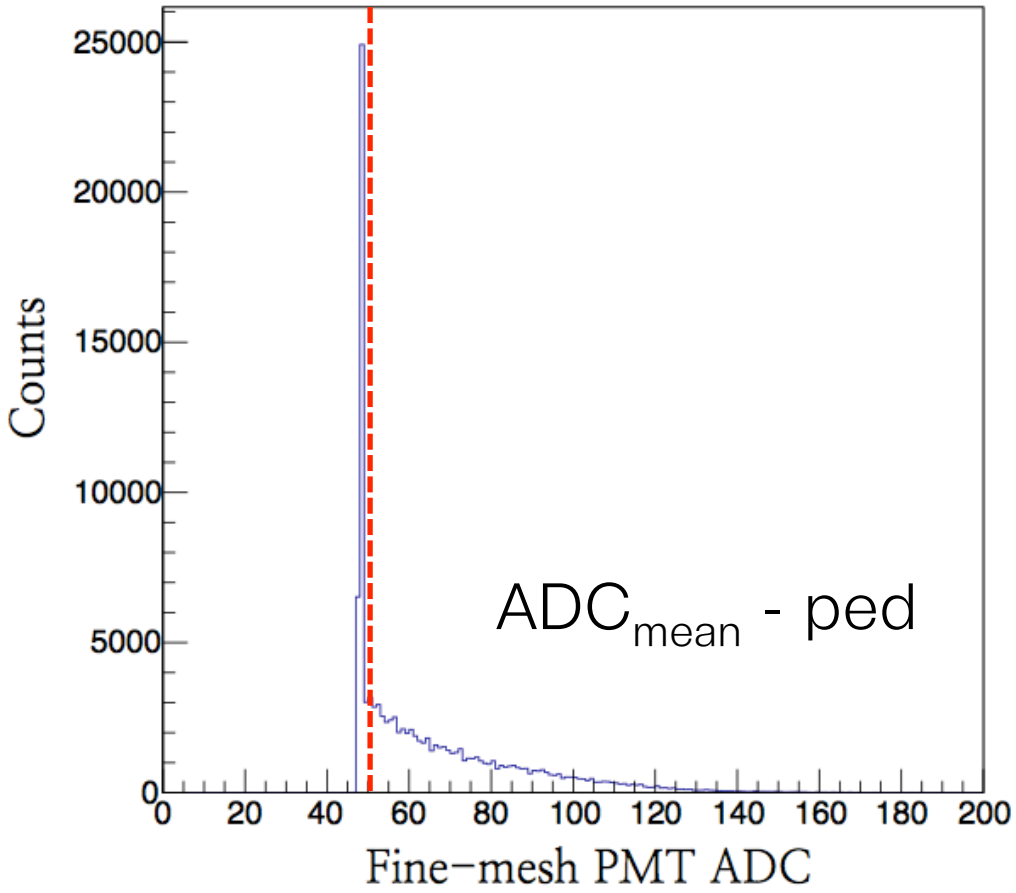
Then i photoelectrons make iQ.

Therefore, if there is mean Npe μ,

ADC - ped

$$ADC_{mean} - ped = \sum_{i=0}^{\infty} iQ\left(\frac{\mu^i e^{-\mu}}{i!}\right)\left(\frac{1}{1-e^{-\mu}}\right) = \frac{\mu Q}{1-e^{-\mu}}$$

Npe Estimation from ADC Spectrum

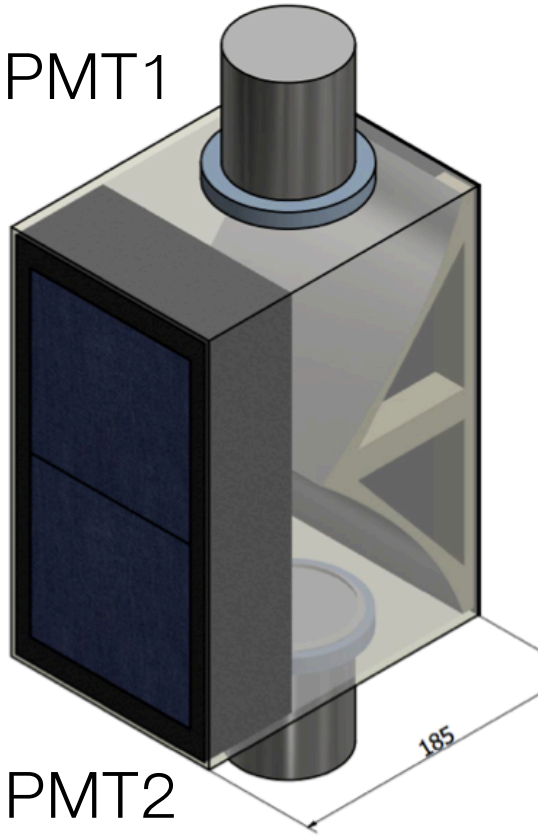


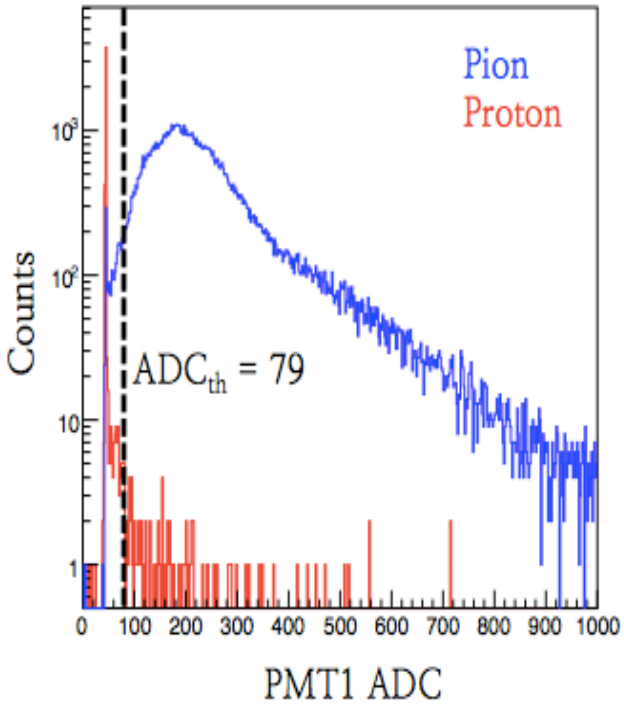
$$\mathrm{ADC}_{\mathrm{mean}} - \mathrm{ped} = \frac{\mu Q}{1 - e^{-\mu}}$$

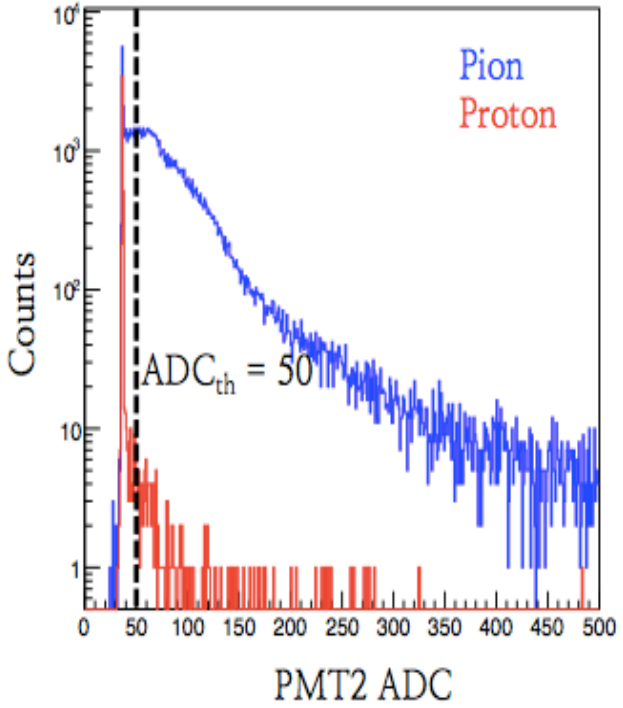
We study $\mathrm{ADC}_{\mathrm{mean}}$-ped and μ from LED test → Find Q.

We study $\mathrm{ADC}_{\mathrm{mean}}$-ped and Q in offline analysis → Find μ.

Pion Efficiency of Test Module





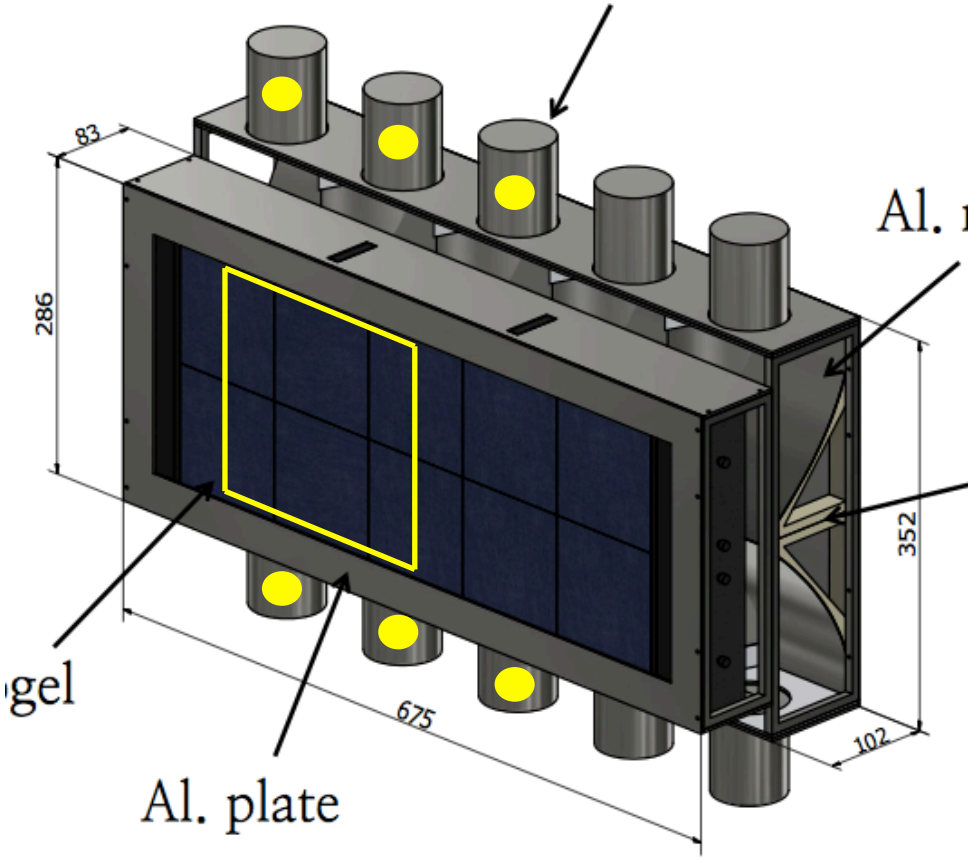


$$\text{Pion efficiency} = \frac{\text{PMT1 signal or PMT2 signal}}{\text{total pion events}}$$

with ped+2Q ADC threshold for both PMTs.

Corresponding proton misidentification is less than 4 %.

Pion Efficiency of Mockup



Not all Q information of 6 PMTs were studied.

We can estimate 0 Npe threshold efficiency.

$$e_0 = 1 - e^{-\mu_{\text{estimated}}}$$

If there is 0.1 % wrong event selection,

estimated μ is always smaller than 7.

Pion Efficiency of Mockup

There are N selected events, actual average Npe μ

and wrong event selection ratio e_{mis}.

Pedestal events (0 Npe th): $Ne_{\mathbf{mis}} + N(1 - e_{\mathbf{mis}})e^{-\mu}$

Signal events (0 Npe th): $N(1 - e_{\mathbf{mis}})(1 - e^{-\mu})$

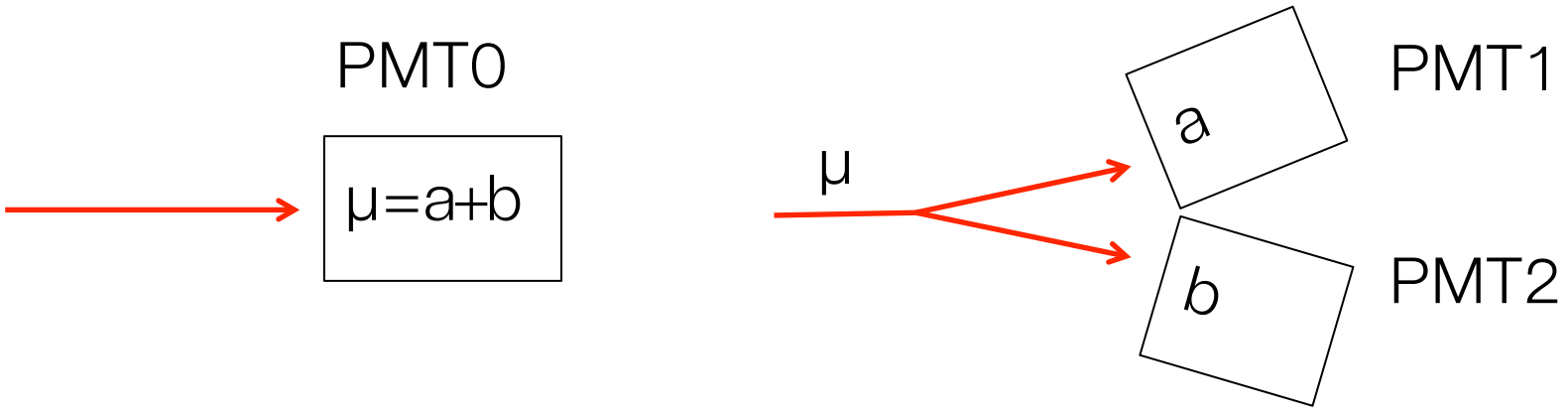
Then modified efficiency: $(1 - e_{\mathbf{mis}})(1 - e^{-\mu})$

$1 - e_{\mathbf{mis}}$ ≥ all estimated efficiencies

Maximum value is set with consideration for the maximum pion efficiency (1.2~1.3 GeV/c) and minimum as 0.

Back up

Efficiency Estimation with Several PMTs



Npe ≥ 1 = (a Npe ≥ 1) or (b Npe ≥ 1) = $1 - e^{-\mu}$

Npe ≥ 2 ≠ (a Npe ≥ 2) or (b Npe ≥ 2)

Npe ≥ 3 ≠ (a Npe ≥ 3) or (b Npe ≥ 3)

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