Development of EM calorimeter for COMET

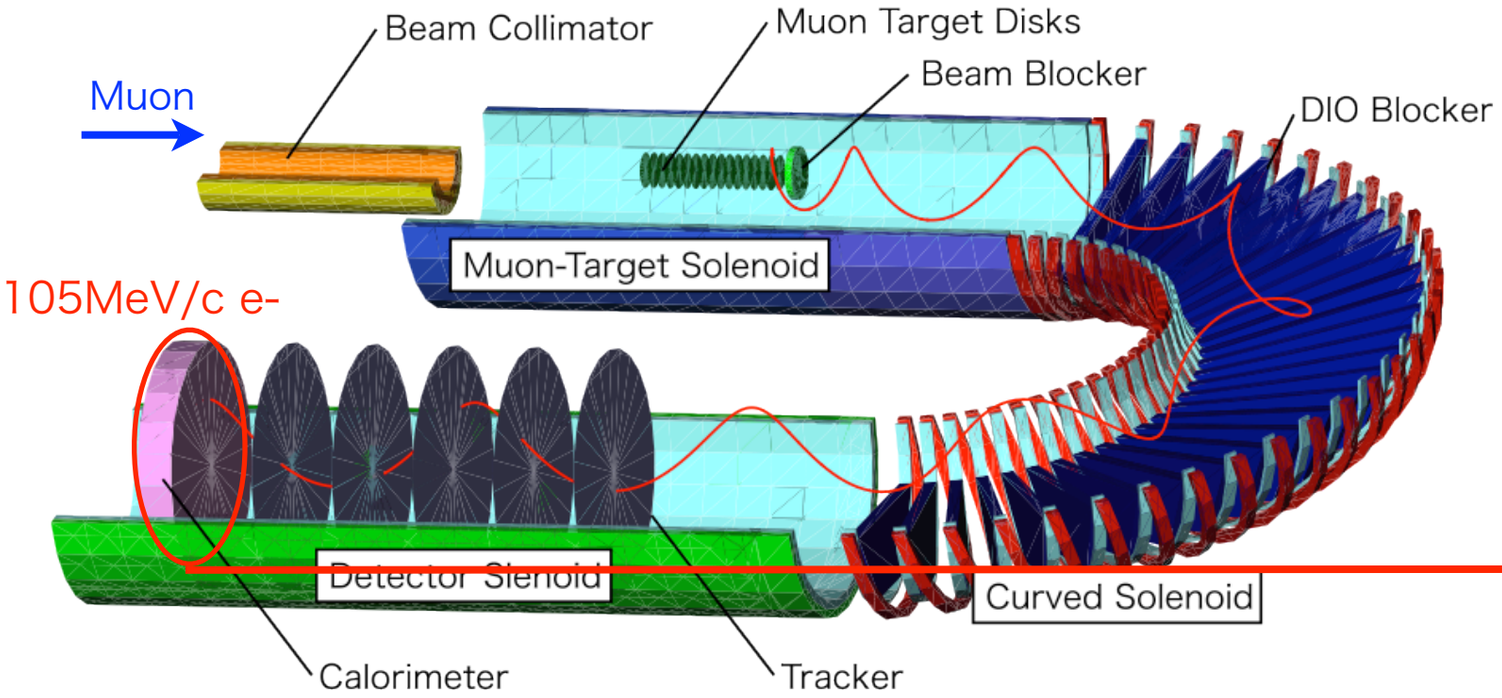
Dec 19/2011 久野研究室 M2 日浅貴啓

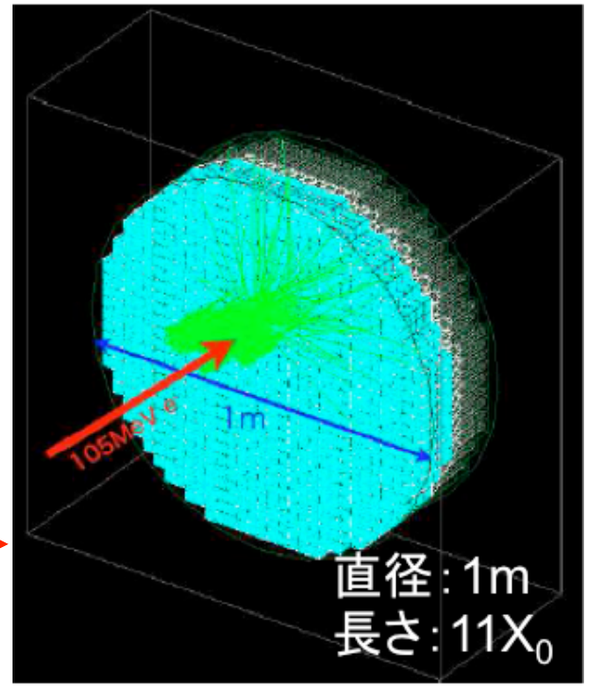
outline

- Introduction
- Experiment in Russia
- Energy resolution
- To do

EM calorimeter

for COMET





- A role of calorimeter
  - To measure the energy of electron and make an efficient event trigger
  - To recognize kinds of particle
  - To support some measurement at tracker

- The demands of COMET experiment
  - To be available in 1T magnetic field.
  - To withstand the 1MHz hit rate
  - Time resolution σ_t/t < 1ns @105MeV
  - Energy resolution σ_E/E < 5% @105MeV

Energy resolution

$$\sigma_E / E = a / \sqrt{E} \oplus b \oplus c / E$$

a: fluctuations from shower and photon statistics etc...
b: detector non-uniformity and calibration uncertainty
c: electronic noise

From experiment

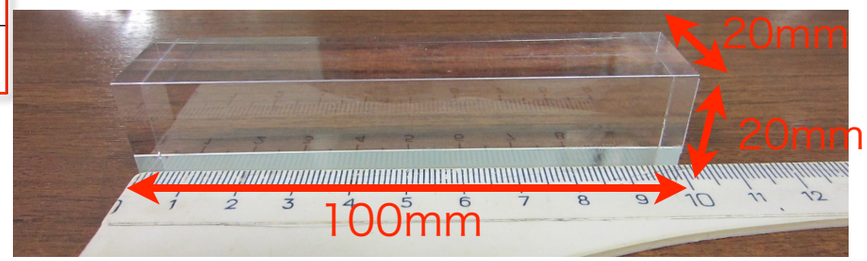
- σ_E/E and c is experimented at 2 energy levels, and I will calculate parameter a and b.
- This means that I can estimate the energy resolution at 105MeV.
- Line：From the result of the experiment with LYSO and ^{258}Pu-^{13}C(2.6MeV and 6.1MeV, γ-source) in Russia on this Nov, I will estimate it.

Candidates of constructor

crystal

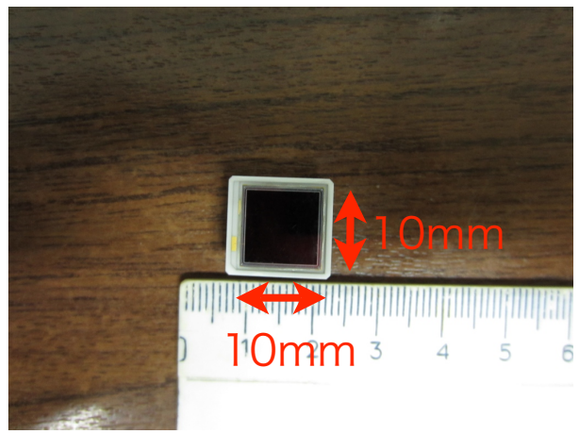
	ρ	MP	X0	RM	dE/dx	λ I	τ decay	λ max	Relative output	Hygro-scopic
Units	g/cm^(3)	℃	cm	cm	MeV/cm	cm	nsec	nm		
NaI(Tl)	3.67	651	2.59	4.13	4.8	42.9	230	410	100	yes
GSO(Ce)	6.71	1950	1.38	2.23	8.9	22.2	600^{S} 56^{f}	430	3^{s} 30^{f}	no
LYSO	7.1	2047	1.22	2.14	9.3	21.2	41	420	75	no

- LYSO: made by Dubna
  - size: 20×20×100mm^3
  - Rapping: teflon×3+Al mylar



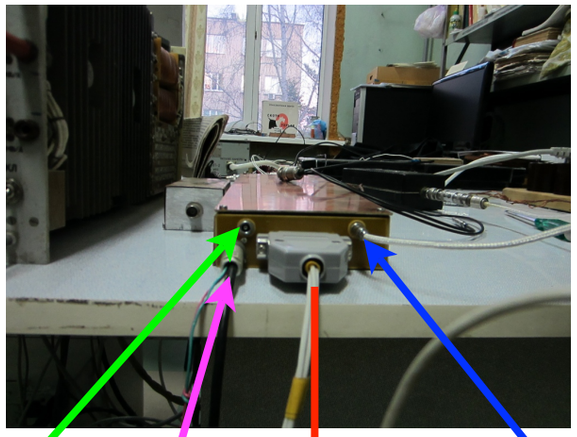
Photon sensor

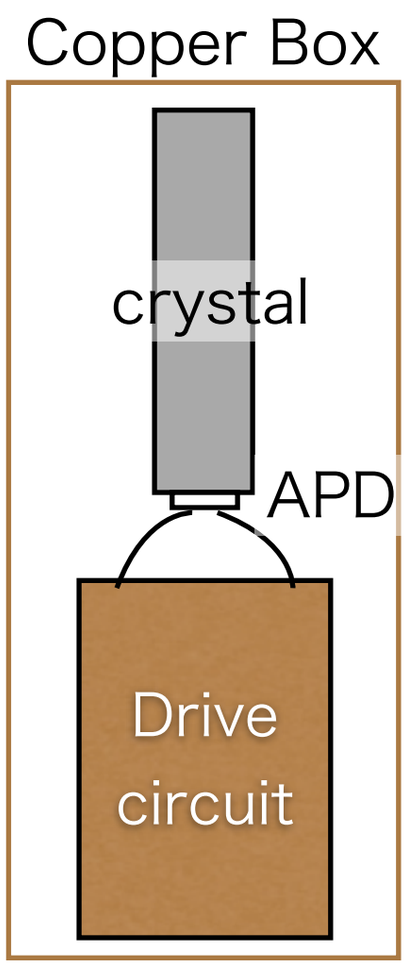
	Type No.	Effective area (mm^2)	PDE	Radiation resistance	operation voltage	Gain
APD	S8664-1010	10x10	~70%	high (CMS-2x1013 n/cm2)	~400V	~50
MPPC	S10362-33	3x3	~50%	poor (~10^{10} n/cm^2)	~70V	~10^6

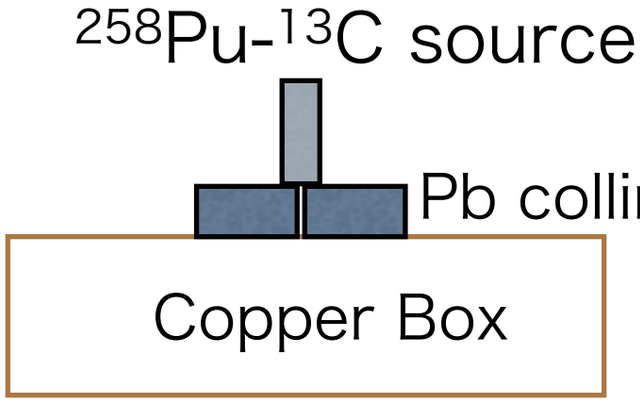


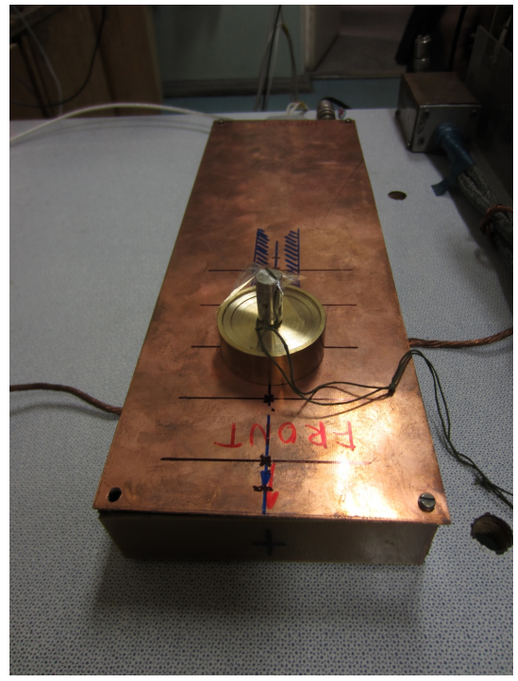
With LYSO single crystal and APD(S8664-1010) in Russia

Setup in Russia using LYSO and APD





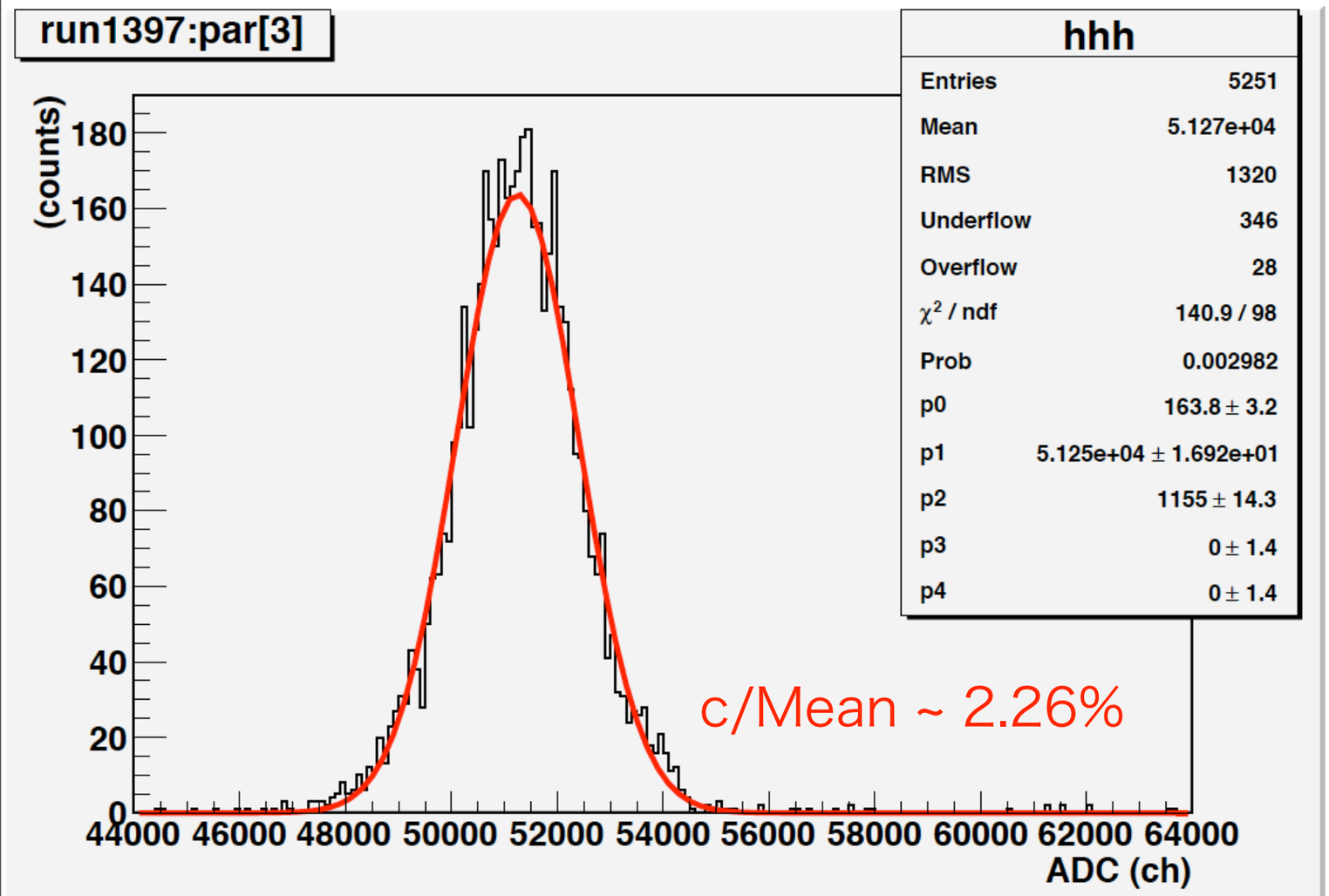




○noise measurement with test pulse

○ σ_E/E measurement with ^{258}Pu-^{13}C

Electric noise



Mean: $(5.13\pm0.02)\times10^4$

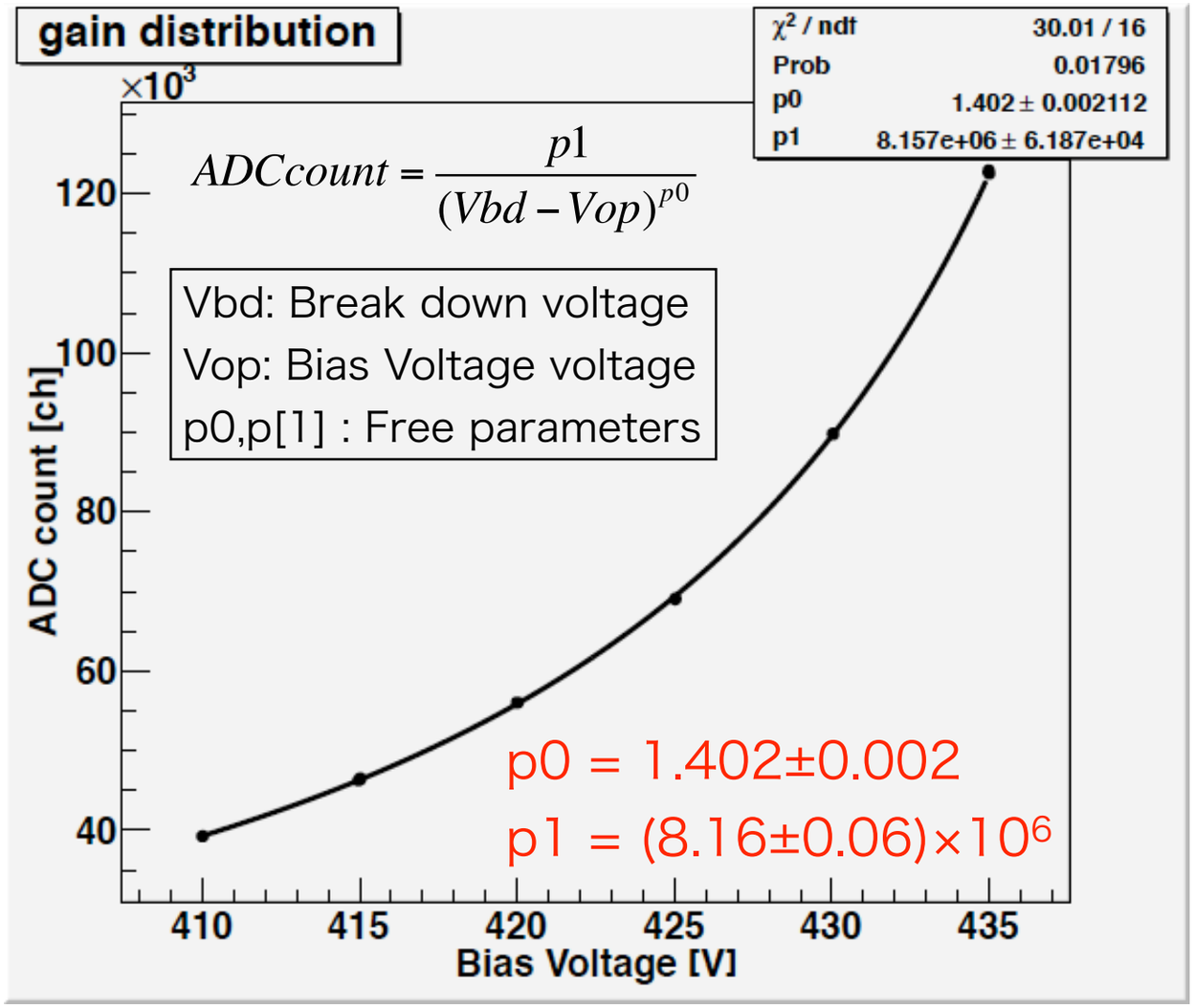
Sigma: $(1.16\pm0.01)\times10^3$

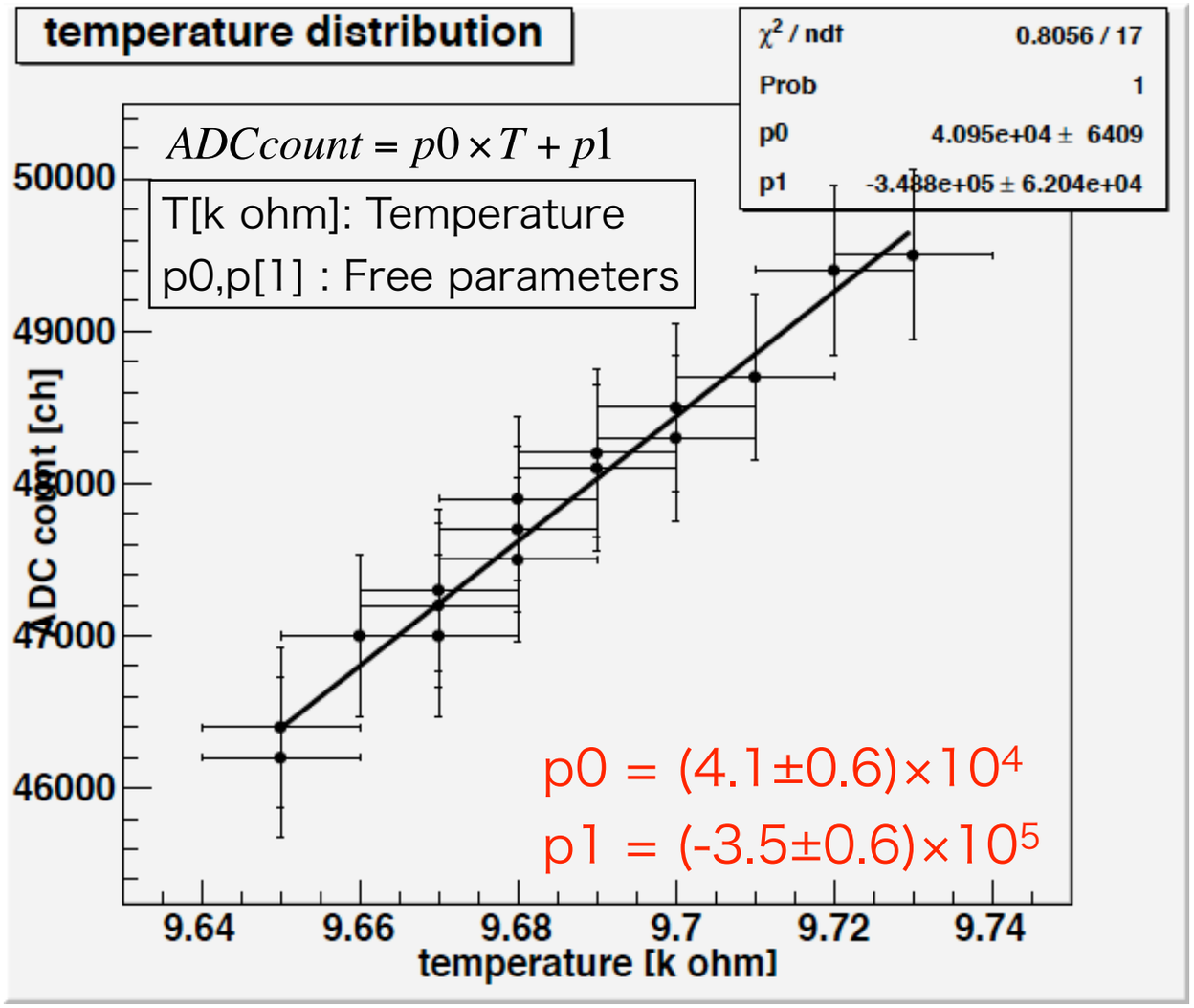
c = sigma = $(1.16\pm0.01)\times10^3$

I assume adc count of
the test pulse is delta function.

Since APD is bias voltage-sensitive and temperature-sensitive,
I should calibrate the results with them about the energy resolution
for ^{258}Pu-^{13}C(2.6MeV, 6.1MeV).

Calibrations of bias voltage and temperature

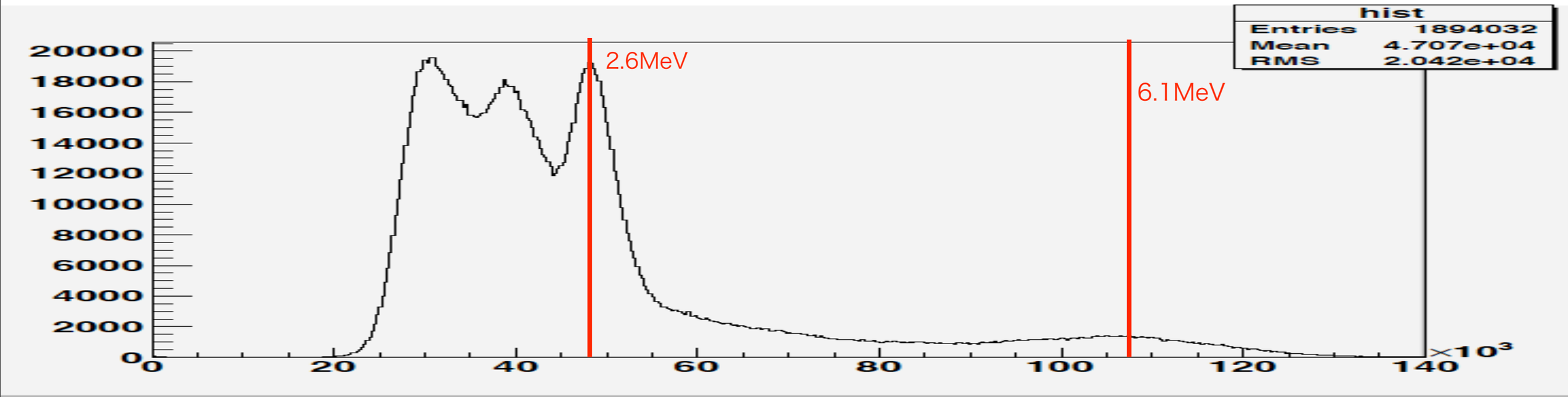




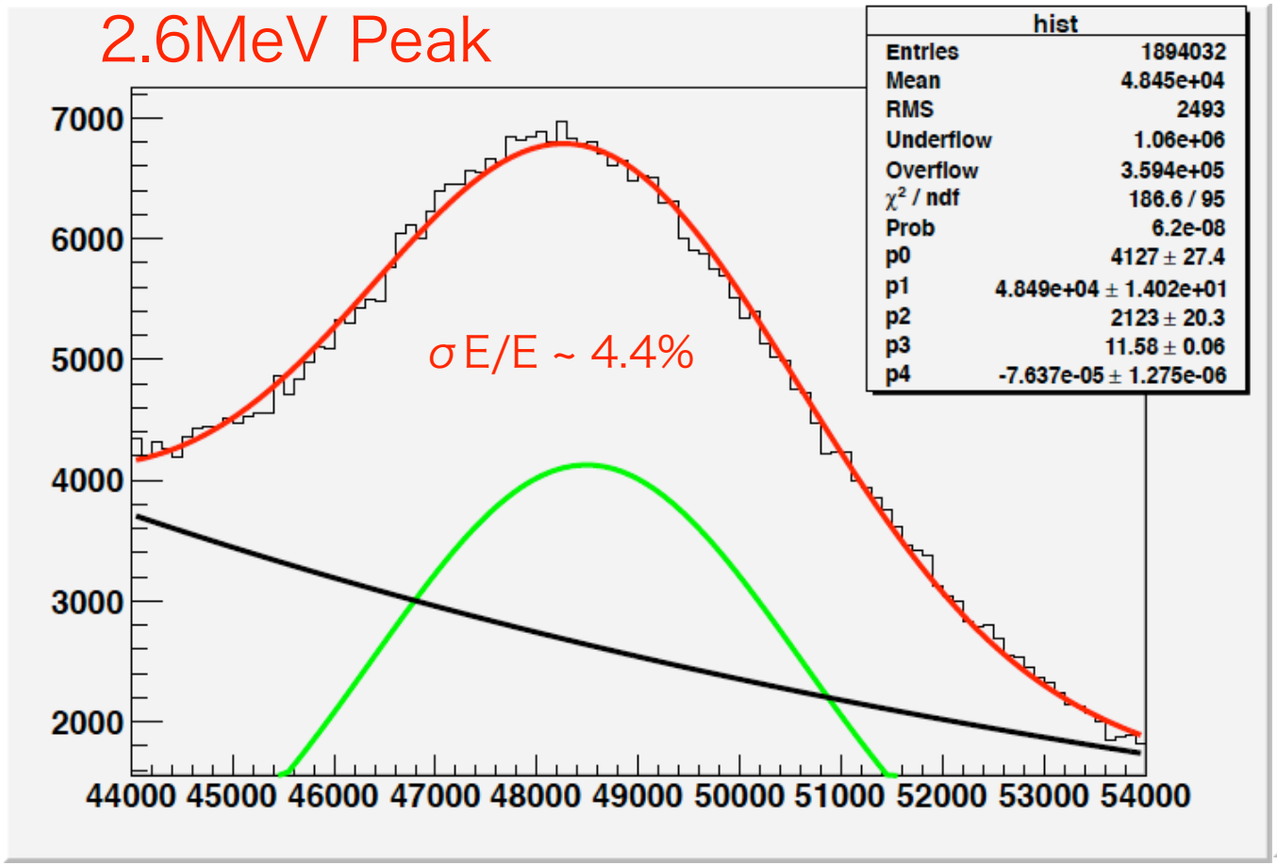
Reference of fitting function
Proc. SPIE Vol. 7212, 721210(Feb.6 2009)
Laforce, Frederic

σ /ADC count~1%

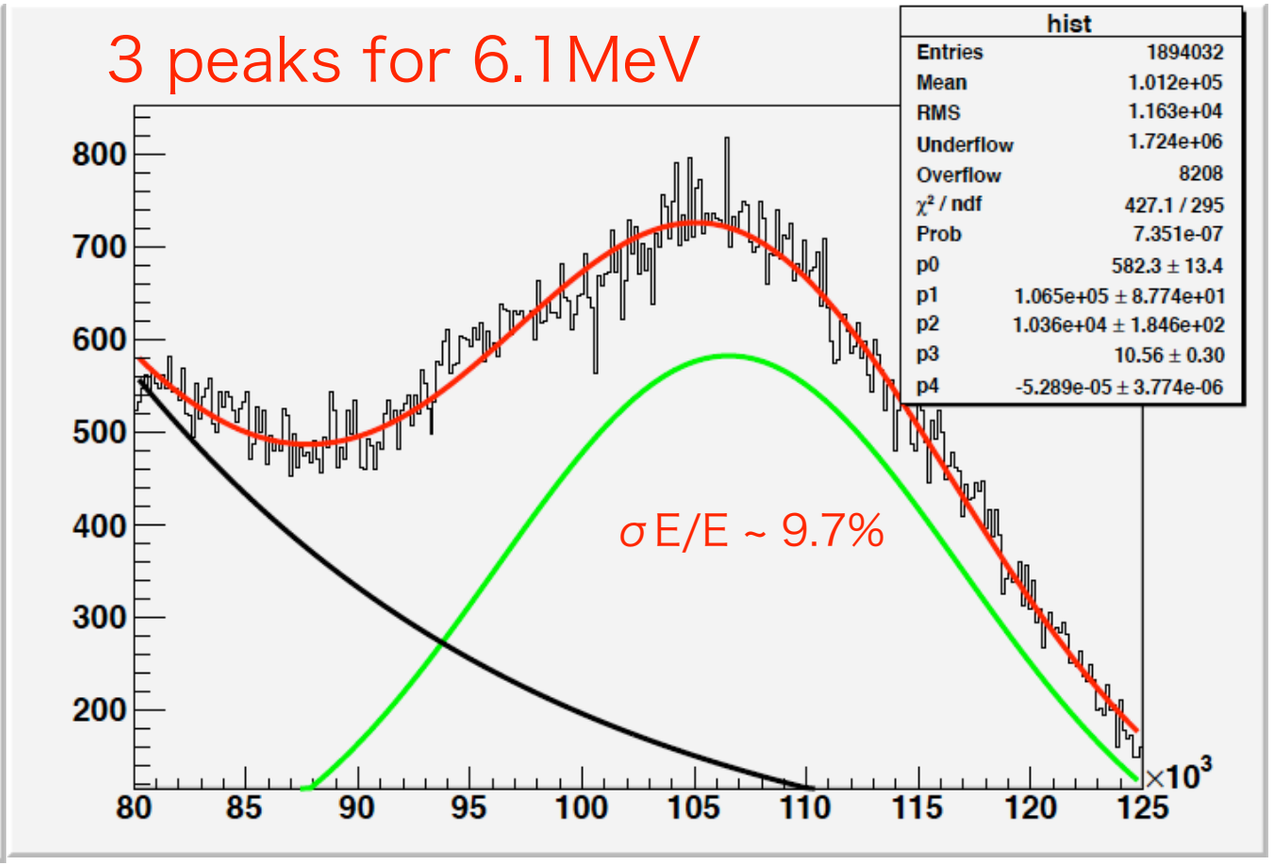
result after calibration



2.6MeV Peak



3 peaks for 6.1MeV



To do and summary

- To do
  - I will calculate the energy resolution of the peak for 6.1MeV.
  - I will calculate a and b parameter and energy resolution at 105MeV.
  - I will implement the simulation for real calorimeter with this result and discuss the best clustering method.
- Summary
  - Energy resolution are 4.4%@2.6MeV and 9.7%@sum of 3peaks for 6.1MeV.

back up

^{258}Pu-^{13}C source

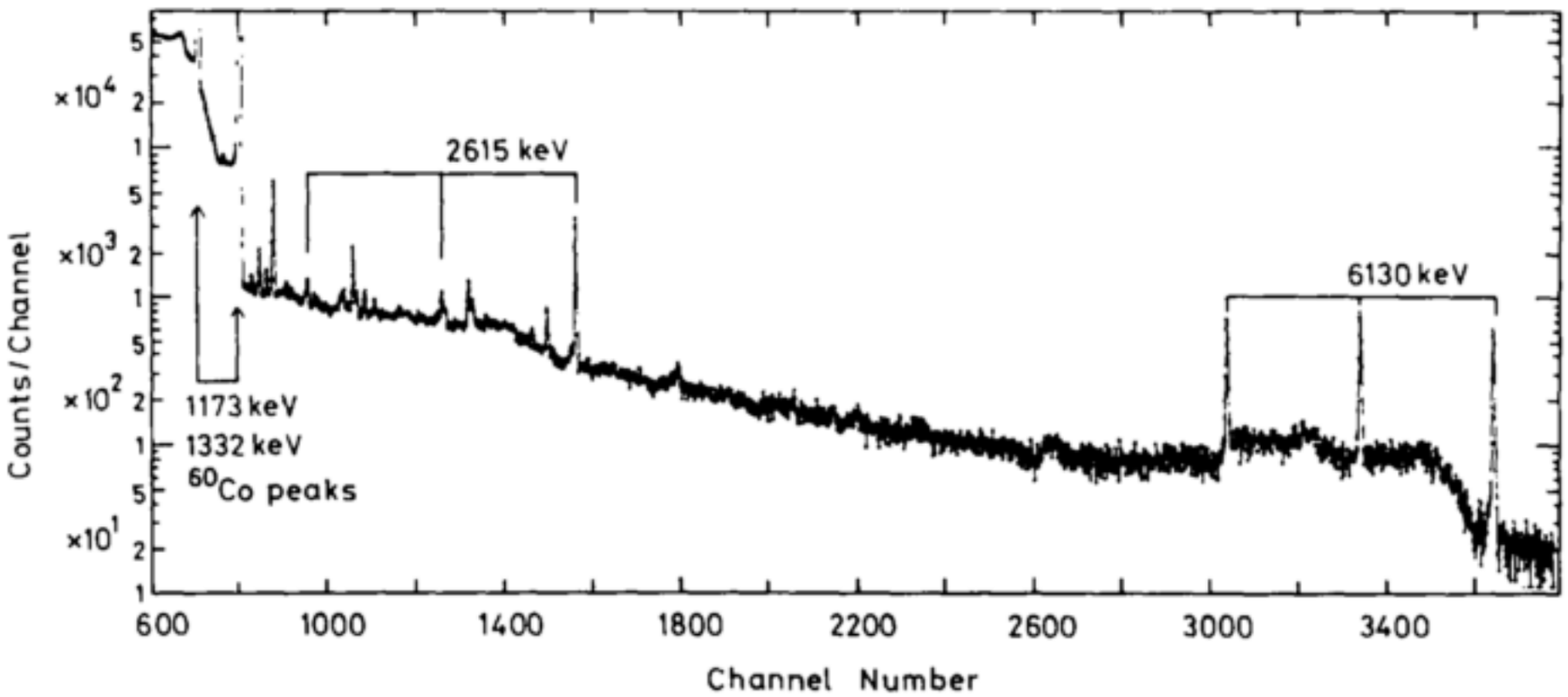
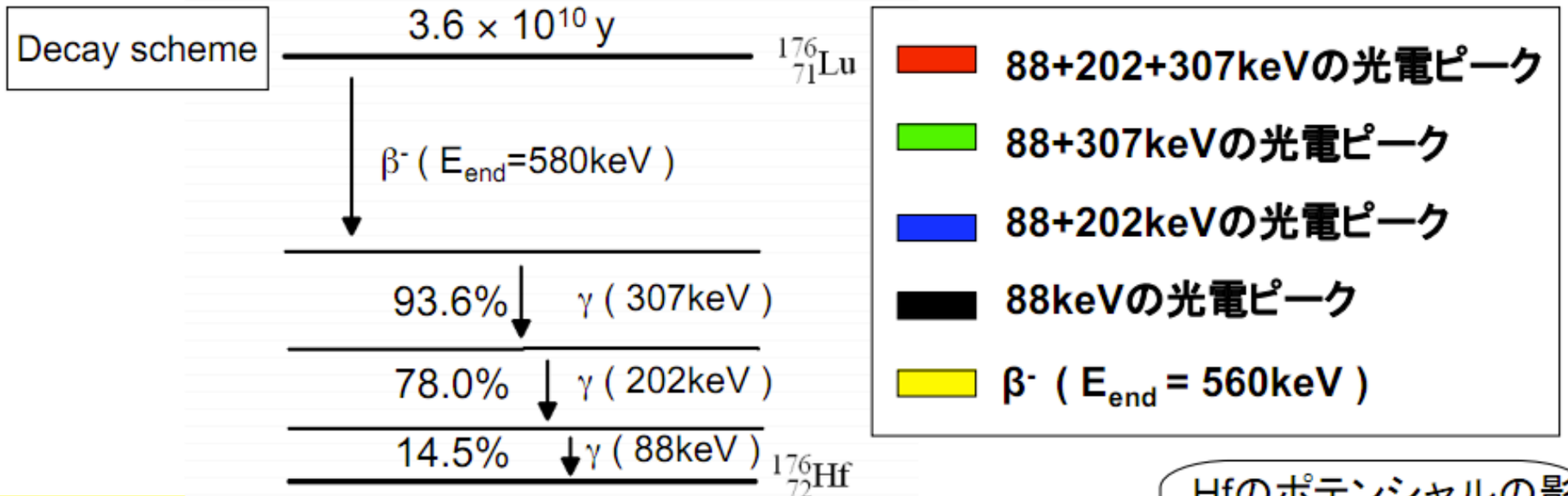
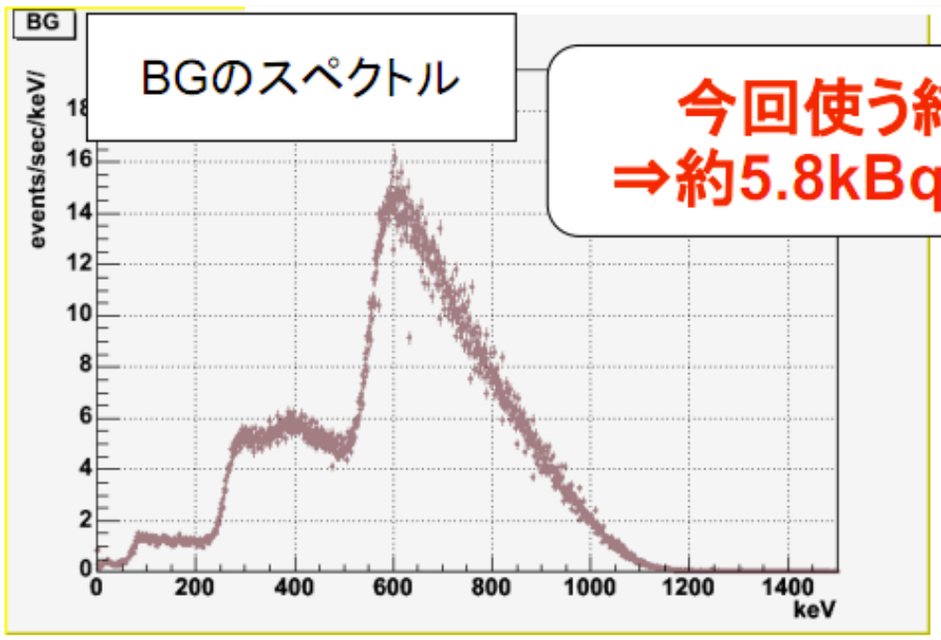


Fig. 1. The gamma-ray spectrum obtained after ~10 h with the ^{238}Pu/^{13}C source placed 25 cm from the front face of a 110-cm^3 n-type Ge detector. All events detected with energies >1 MeV are shown; no background has been subtracted. The peaks at 1173 and 1332 keV which go off-scale are due to the presence of the ^{60}Co calibration source.

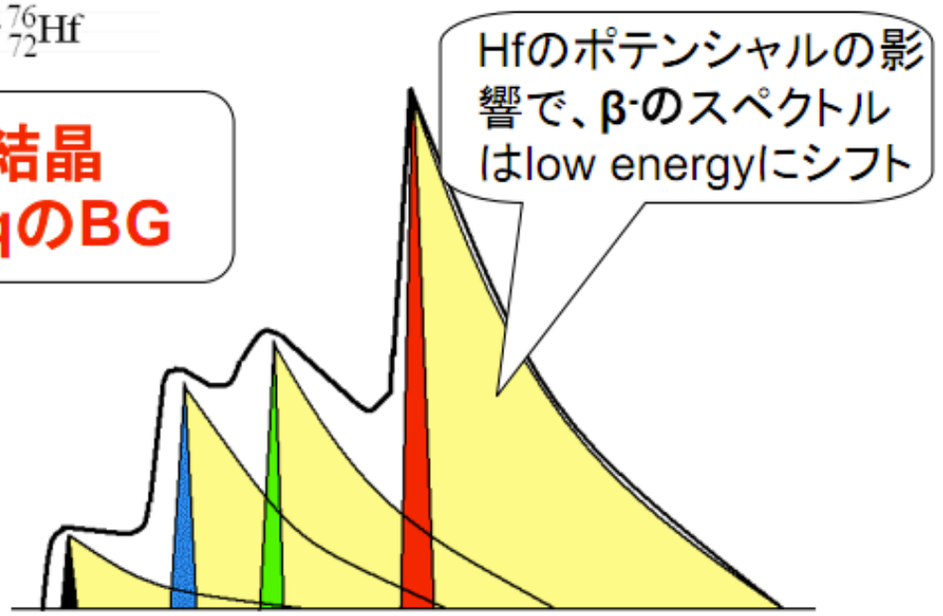
Natural back ground of ^{176}Lu

^{176}Luの崩壊によるbackground



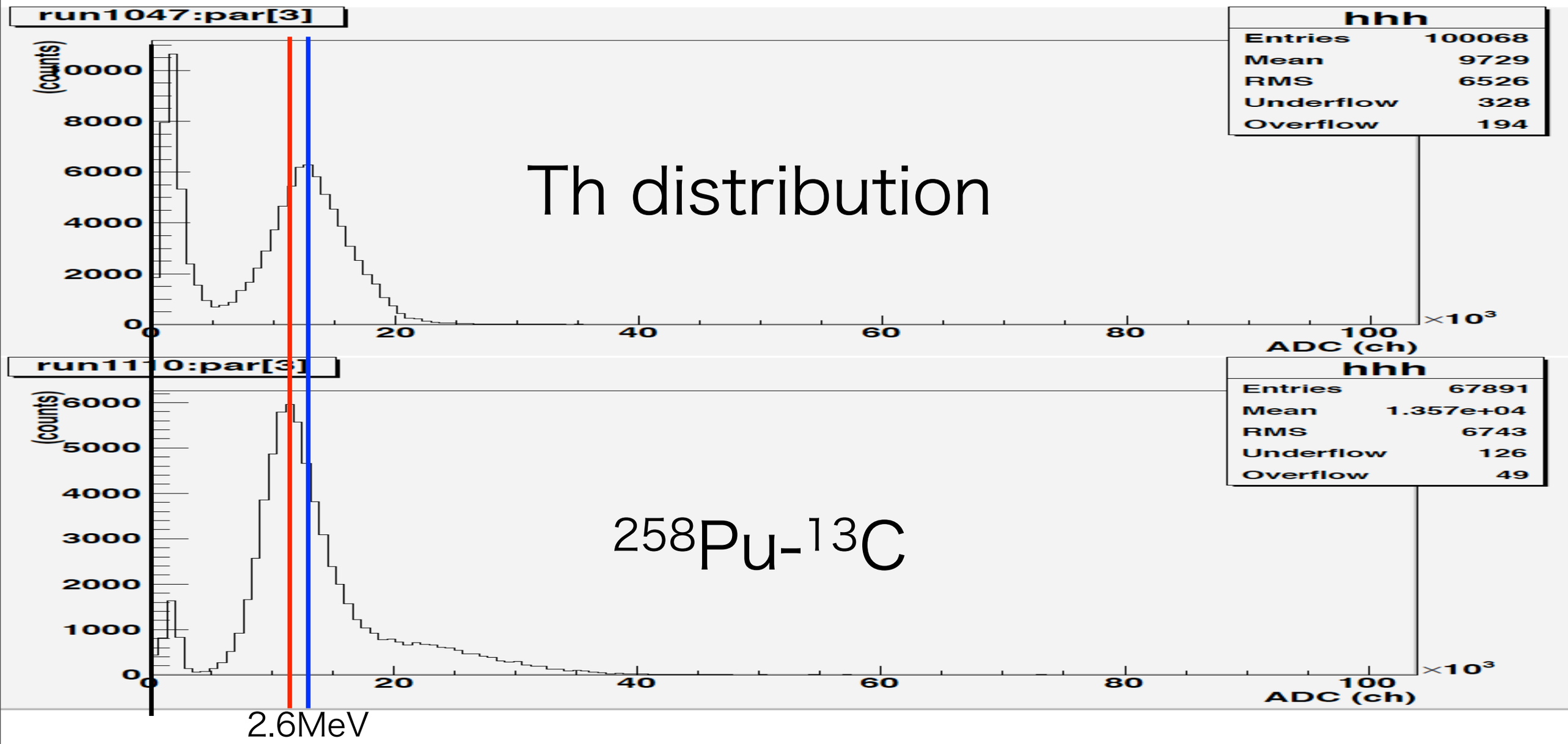


今回使う結晶
⇒約5.8kBqのBG



東京大学素粒子物理国際センター
「LYSOシンチレータの特性評価」冨島佑允

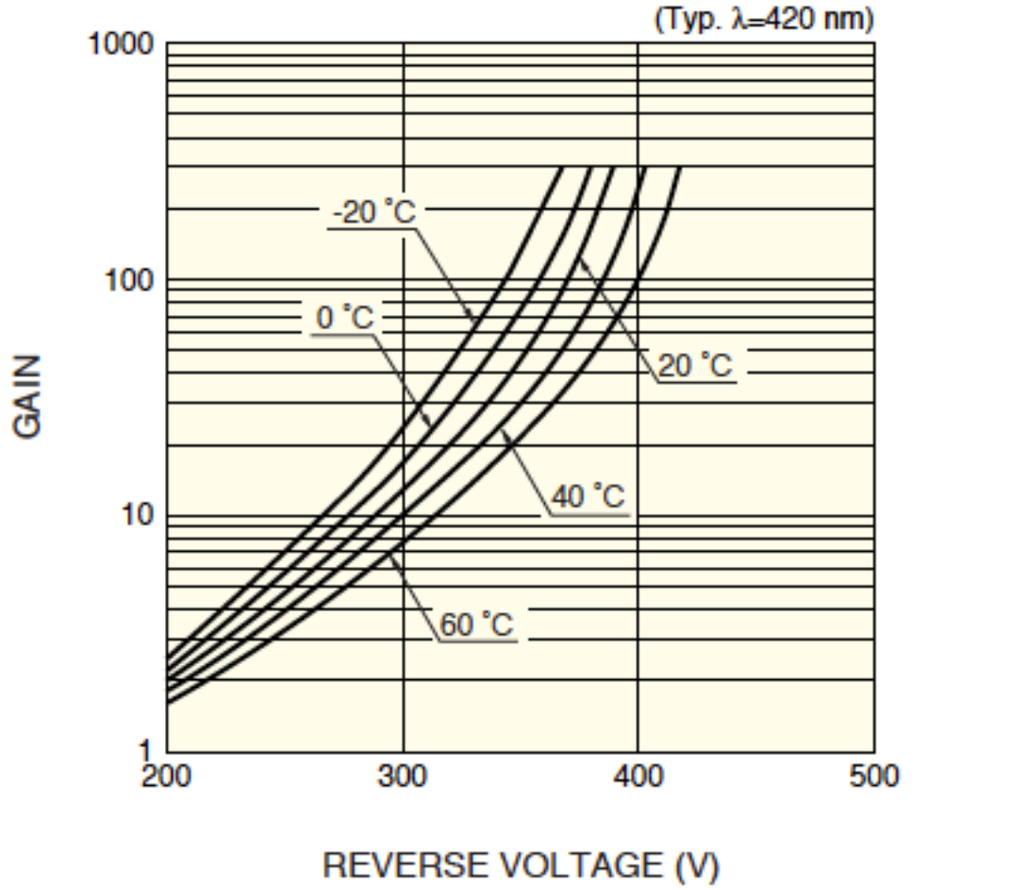
Response of GSO



This cause comes from two APD features.

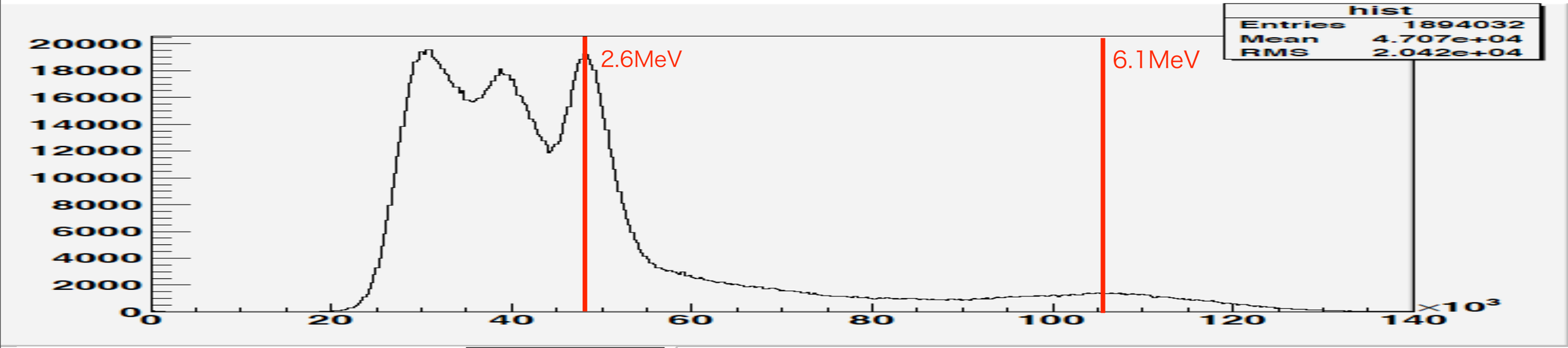
Feature of APD

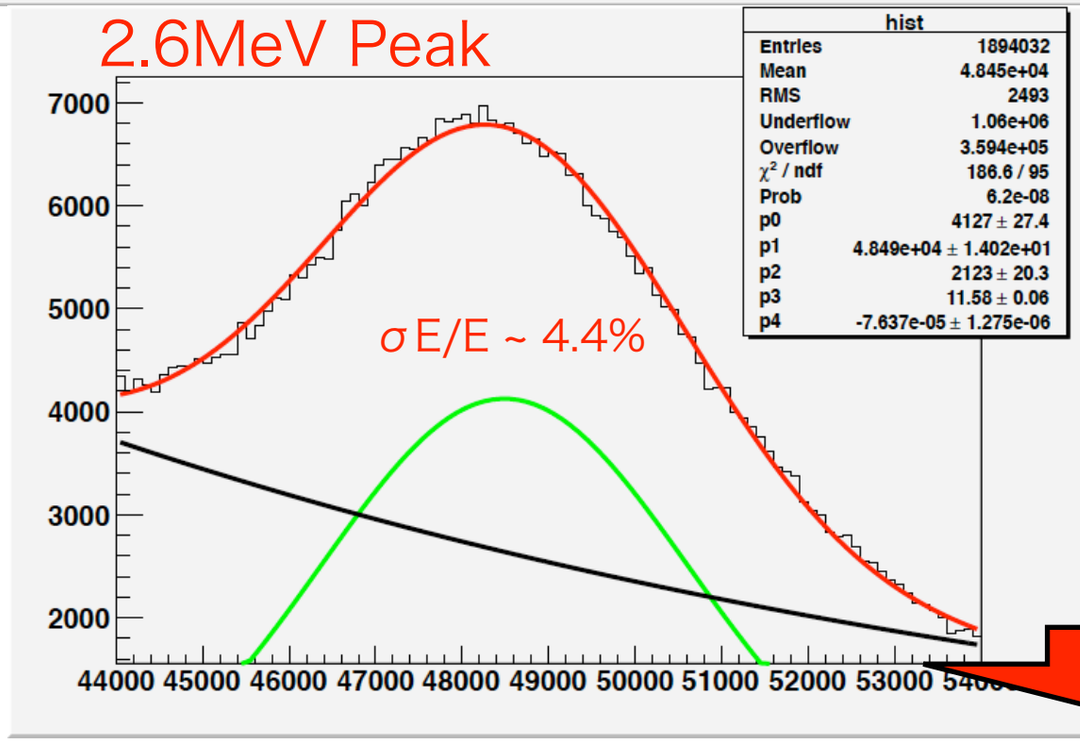
- gain dependence
- temperature dependence

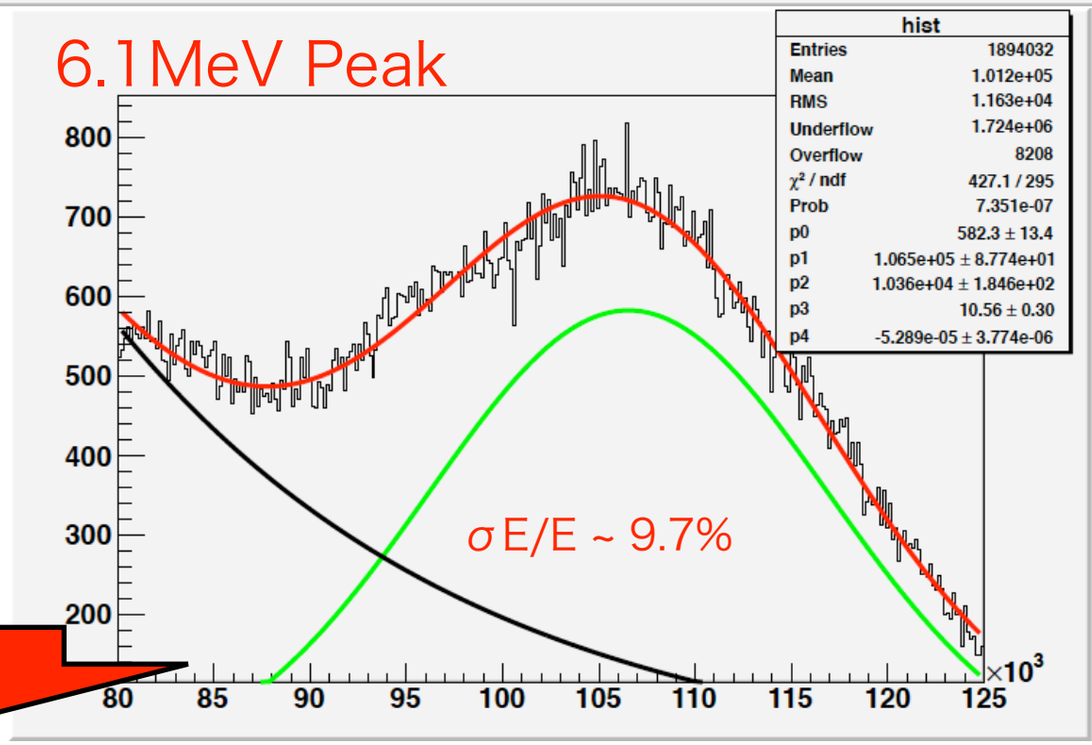


GSO measurements were failure,
since we didn't considered these features.

result after calibration







I will determine parameter a and b
from the results at 2 energy levels.

calculations for parameters of energy resolution

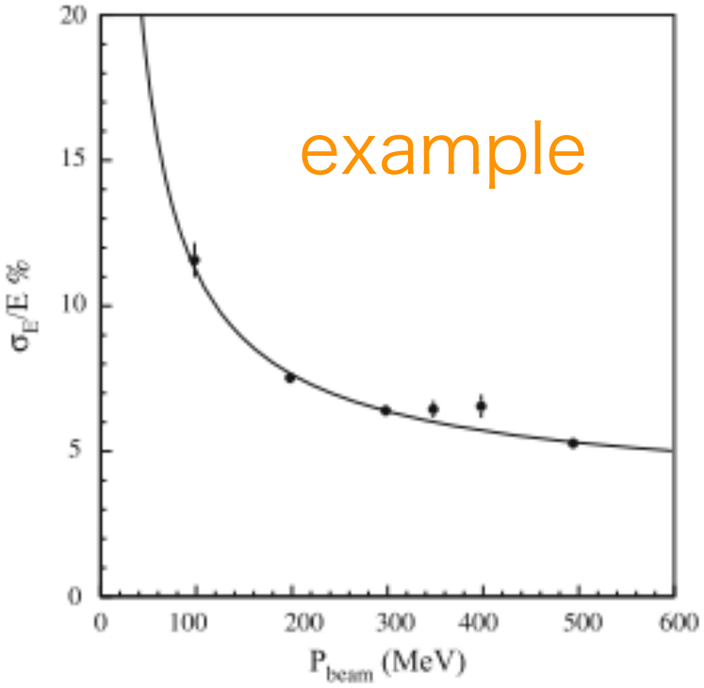


Fig. 5. Dependence of the energy resolution on beam momentum.

図に関して本実験の結果を出して
差し替えを行う。

parameter a,bの算出。
105MeVの時のエネルギー分解能を求める。