Performance of the prototype detector of AXEL

Kyoto University, Univ. of Tokyo[A], Tohoku University[B], Kobe University[C]

Sei Ban,

A.K.Ichikawa, T.Nakaya, A.Minamino, K.D.Nakamura, Y.Ishiyama, S.Tanaka, K.Nakamura, M.Yoshida, M.Hirose, H.Sekiya[A], Y.Nakajima[A], K.Ueshima[B], K.Miuchi[C]

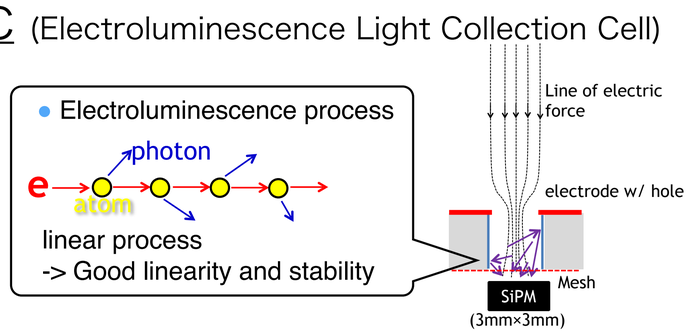
What's AXEL?

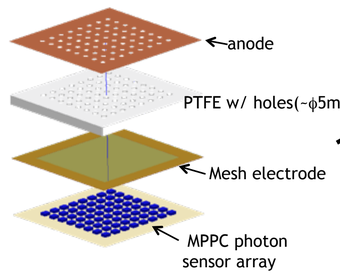
We are developing a high pressure Xe gas TPC to search for 0νββ from ^{136}Xe (Q=2458keV).

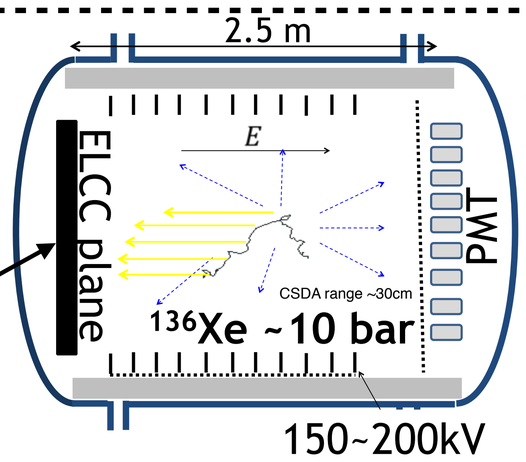
Feature

- Good energy resolution : 0.5% (FWHM@2.4MeV)
  -> Using proportional scintillation mode
- Large mass (high pressure gas)
- Background rejection with tracking

ELCC (Electroluminescence Light Collection Cell)



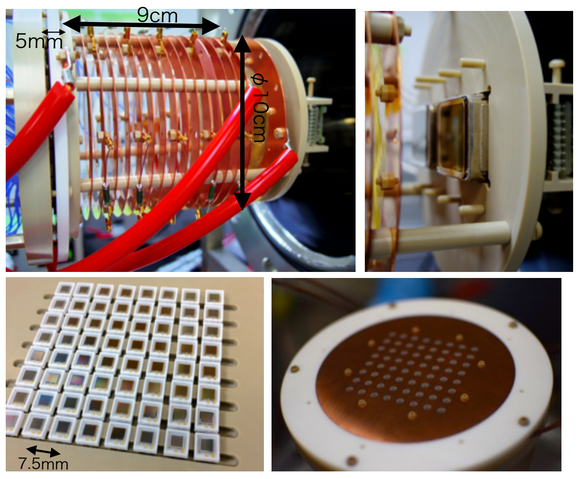


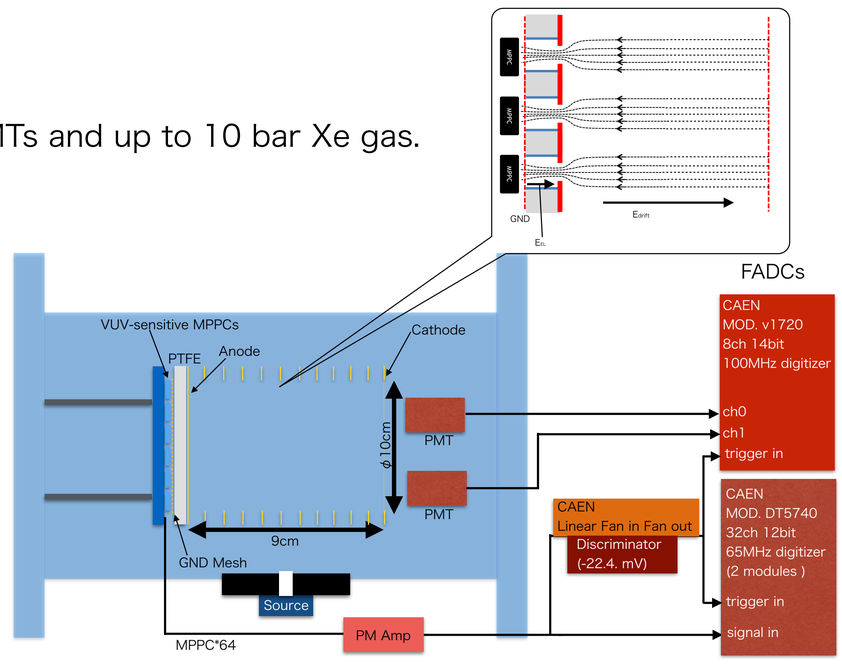


R&D Status

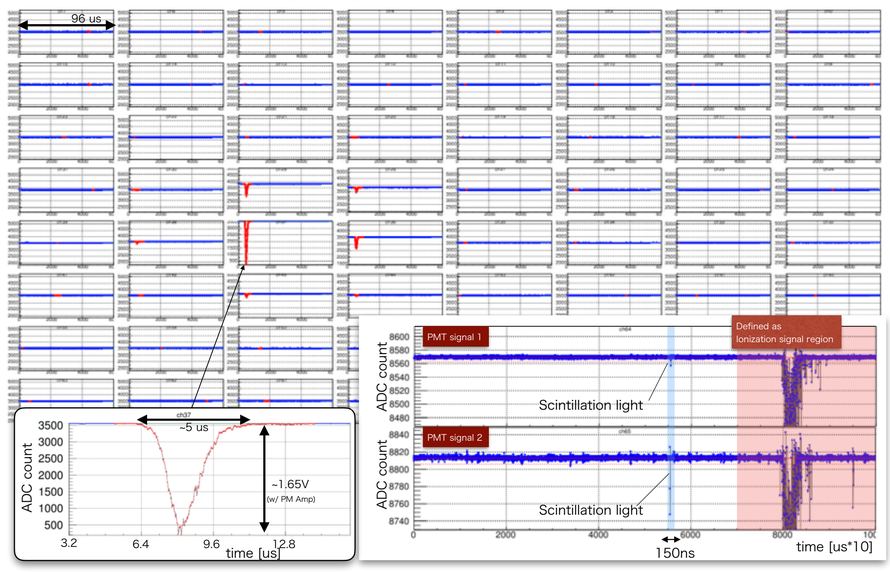
Prototype Chamber

Prototype chamber with 64ch MPPCs, two PMTs and up to 10 bar Xe gas.

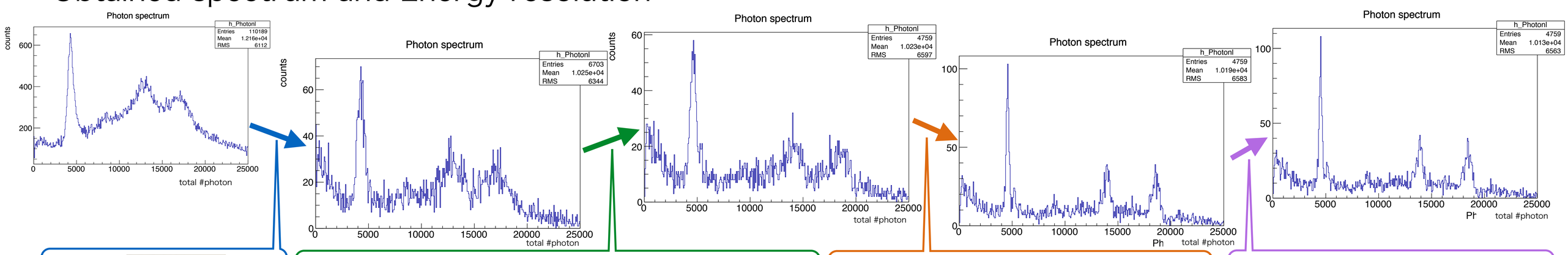




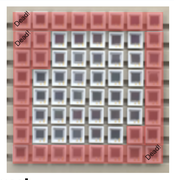
Wave form sample (122keV event)



Obtained spectrum and Energy resolution

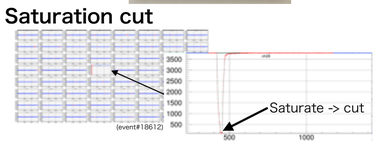


Fiducial cut



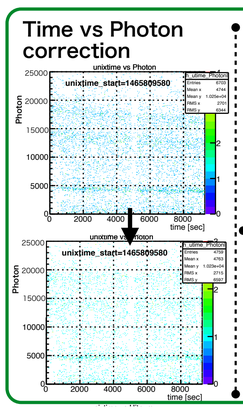
Red : veto

Saturation cut

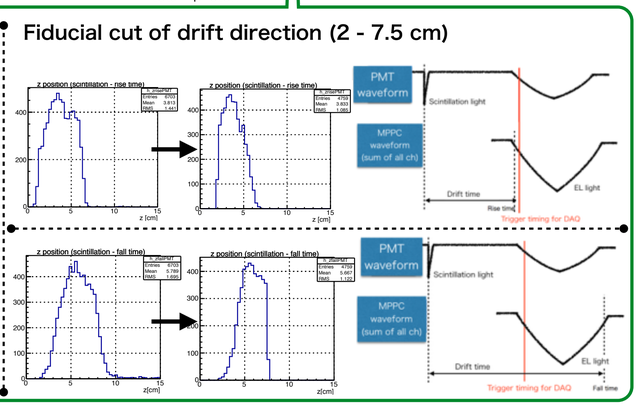


Event which has no coincidence of two PMTs
-> cut

Time vs Photon correction

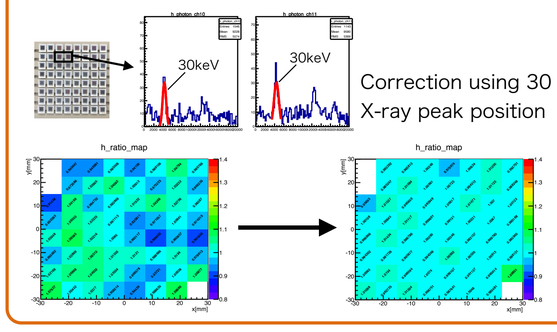


Fiducial cut of drift direction (2 - 7.5 cm)



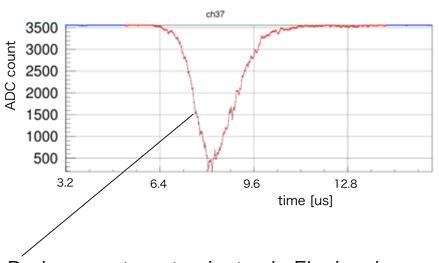
EL gain correction

Total number of photon of 30 keV gamma ray for "each cell"

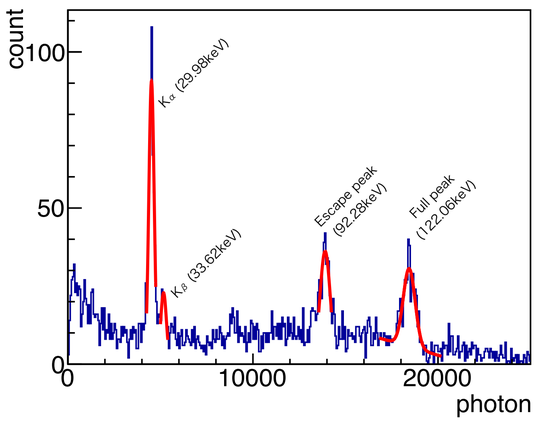


Correction using 30 keV X-ray peak position

Dark current correction



Dark current contaminates in EL signal
-> Subtract the contribution channel by channel.

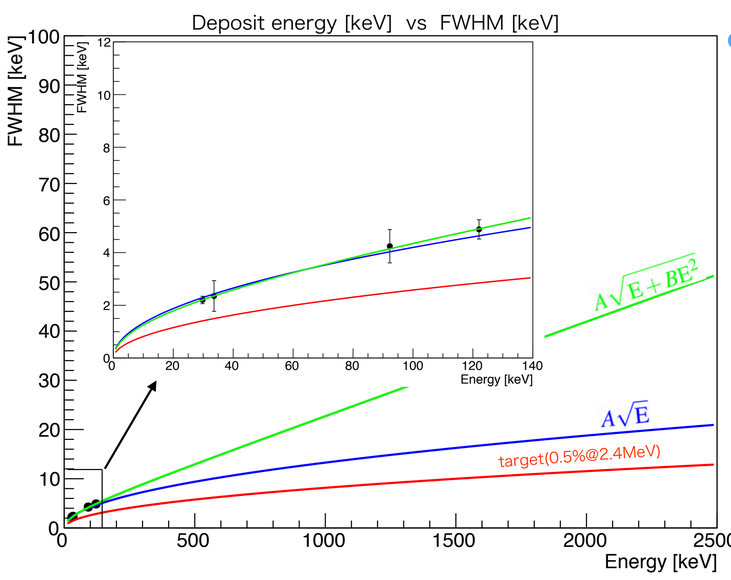


Measurement conditions

Gas Pressure	4.0 bar
E (EL regeion)	2.7 kV/cm/atm
E (drift region)	100 V/cm/atm
Source	^{57}Co (122 keV γ-ray)

The energy resolution was evaluated by fitting these peaks with Gaussian.
Using "Gaussian + pol1" for 122 keV peak considering continuous component.

Energy [keV]	29.78	33.62	92.28	122.06
# of photon	4517.3	5169.5	13900.2	18445.0
FWHM	7.3%	7.0%	4.6%	4.0%



- Extrapolated energy resolution at Q-value

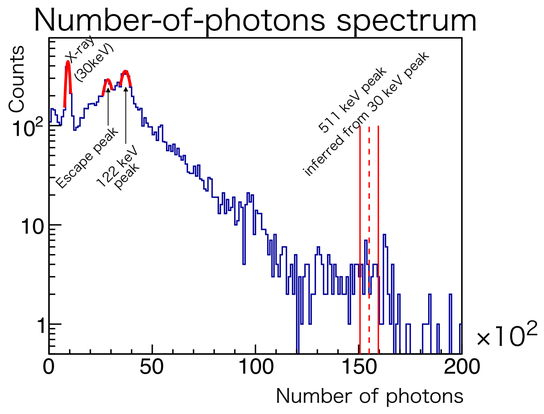
$A\sqrt{E+BE^2}$

A = 0.3907 +/- 0.0365
B = 0.0023 +/- 0.0028
-> Extrapolate to Q-value
FWHM 2.03% (@2458keV)

$A\sqrt{E}$ 0.4197 +/- 0.0191
-> Extrapolate to Q-value
FWHM 0.85% (@2458keV)

On-going project and Problems

Number-of-photons spectrum

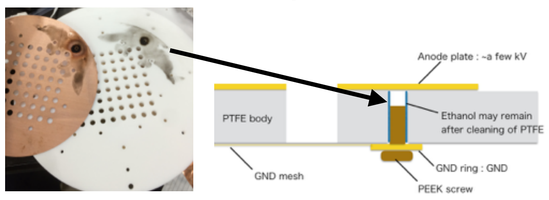


Measurement conditions

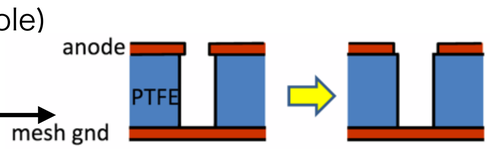
Gas Pressure	8.0 bar
E (EL regeion)	2.125 kV/cm/atm
E (drift region)	57.8 V/cm/atm
Source	^{57}Co & 22Na

Evaluating the energy resolution using higher energy gamma ray (511 keV)
But cannot seen the peak of 511 keV
-> Due to too weak electric field.

Problem : spark!!



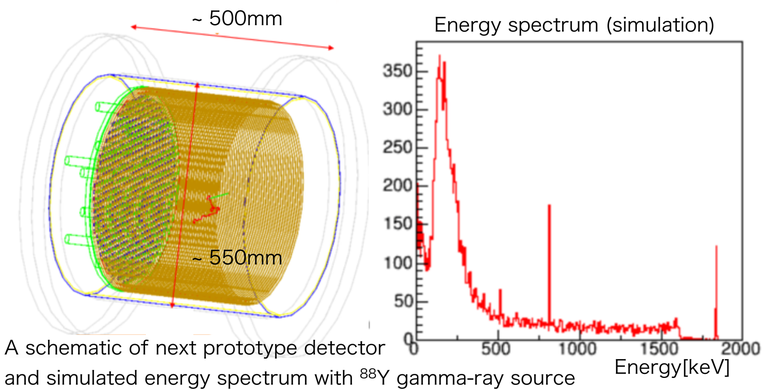
Sparks is the biggest problem now.
-> prevention of discharge
- Fixed the weak point to spark (screw hole)
- more controlled hole size of the anode and the PTFE body.



Enlargement

Next prototype detector

- Demonstration of the energy resolution using higher energy gamma-ray source (around Q-value)
- Started simulation now.
- Design of detection region and readout electronics are also started to consider



A schematic of next prototype detector and simulated energy spectrum with ^{88}Y gamma-ray source