Test Beam analysis of SCECAL gain monitoring

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for CALICE

overview

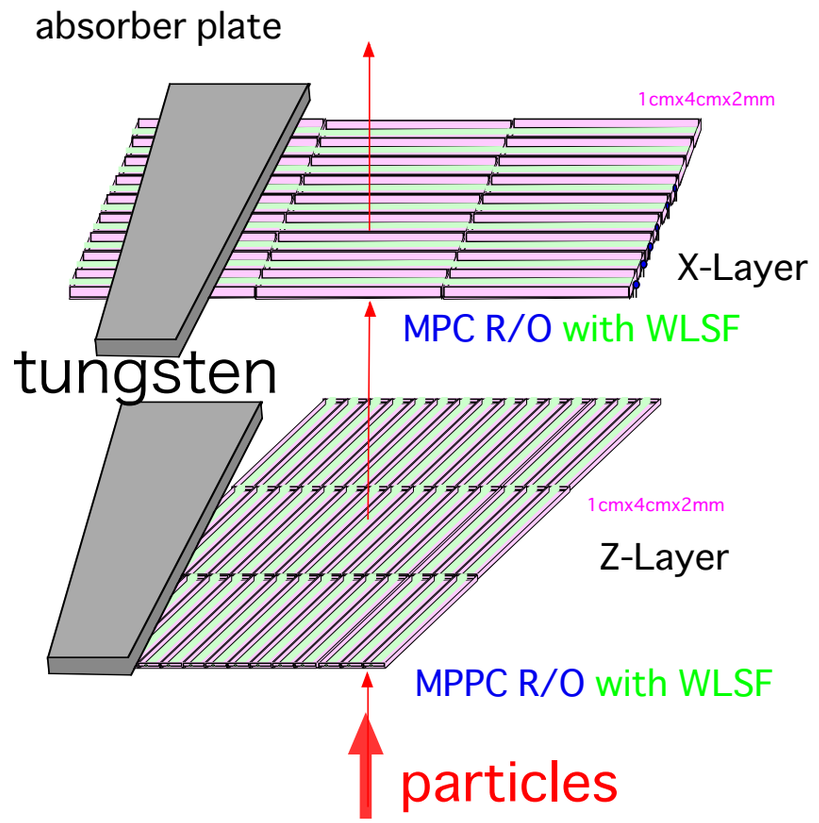
gain monitoring system

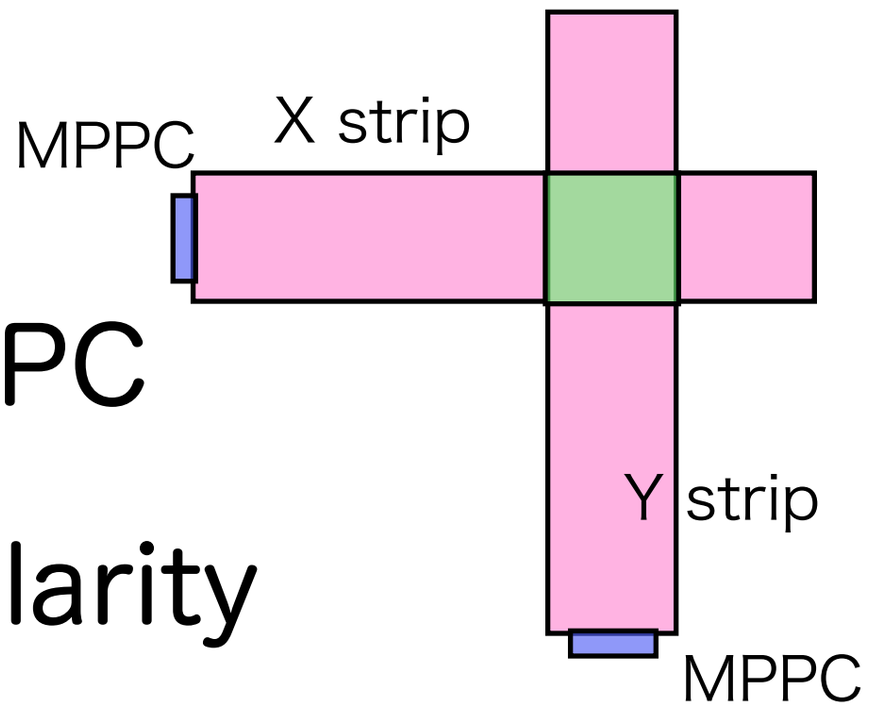
performance

beyond & summary

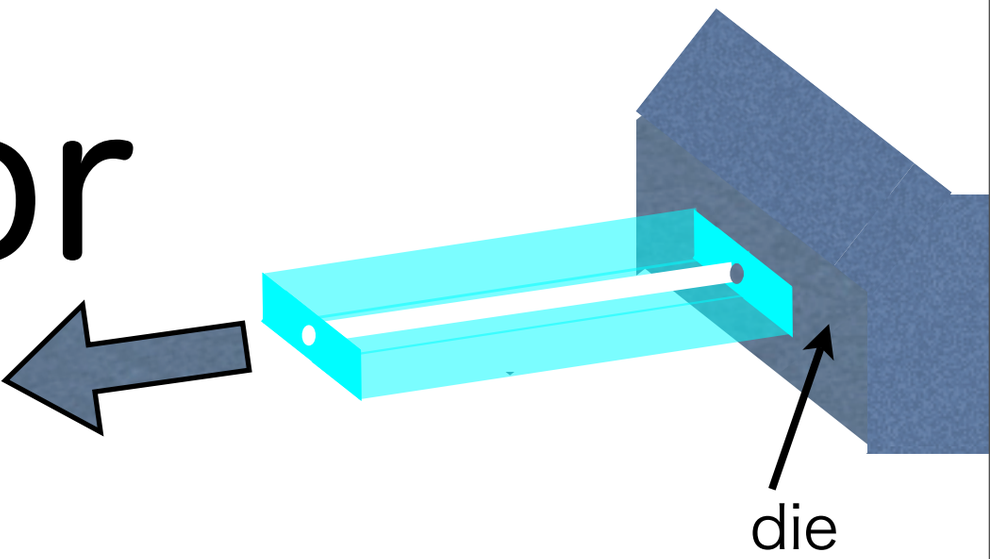
SCECAL

- SCintillator strip ECAL
- abs : tungsten
- active : scintillator strip
- 3 x 10 x 45 mm^3
  -> 2mm x 5mm
- compact photo-sensor : MPPC
- PFA requires < 10mm granularity
  10 -> 5mm
- cost effective way

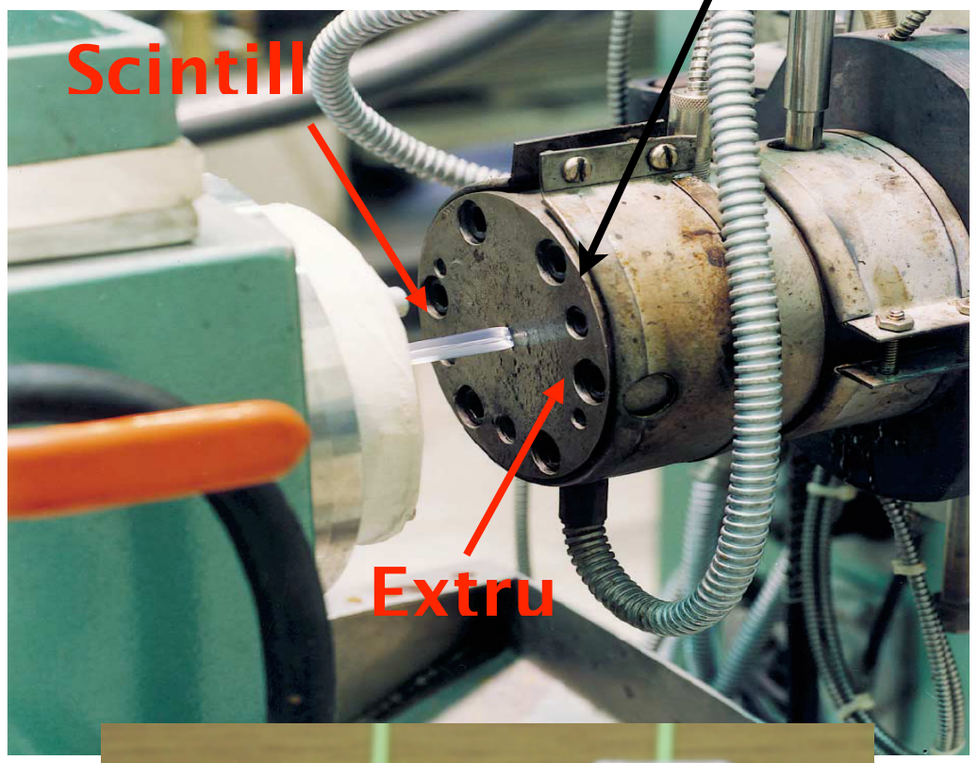




scintillator



- strip : long in one direction
  reduce cost
- extruded in Korea by KNU
- any length
- size is controlled by the die
- if needed a hole is easy
- even TiO2 covered
  we did not use



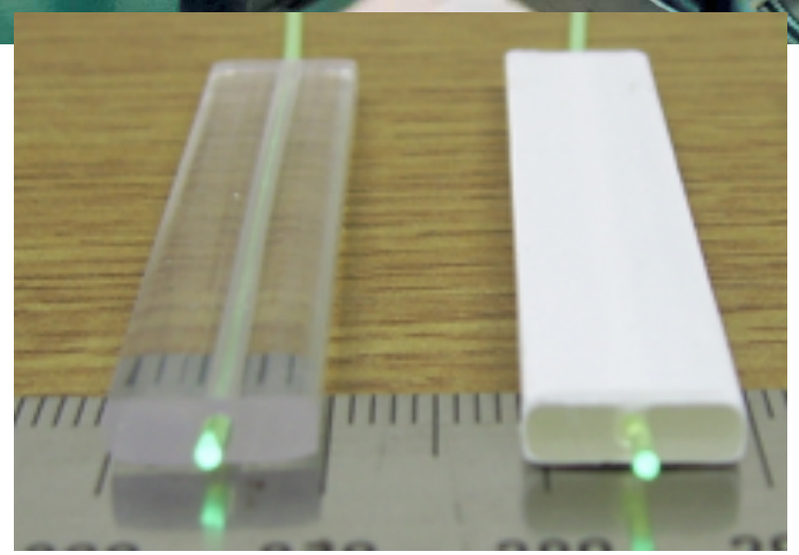
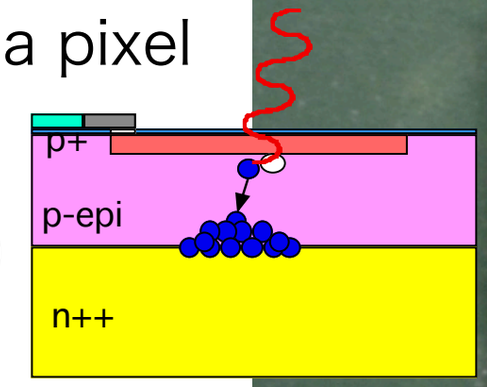
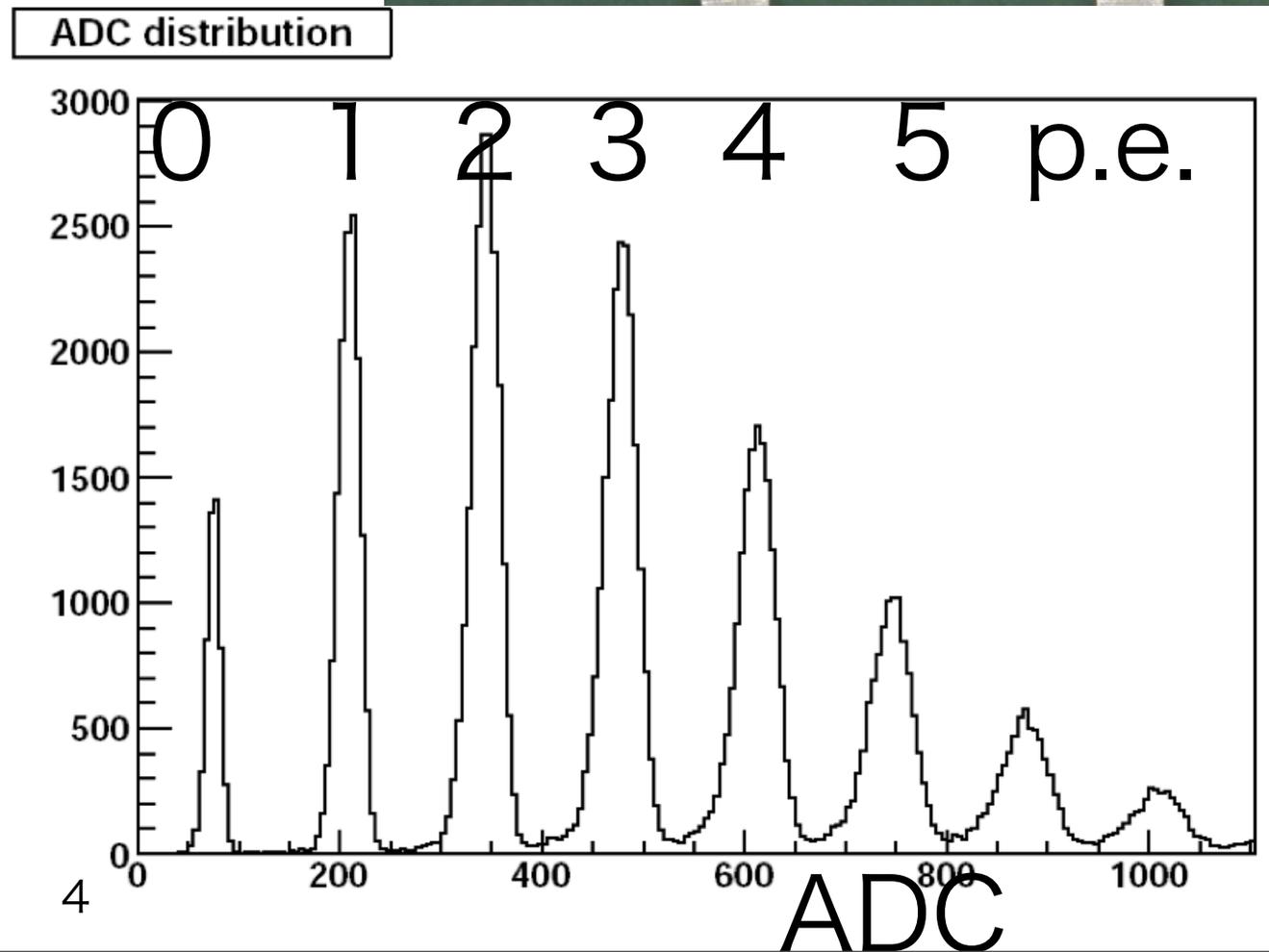


photo sensor MPPC

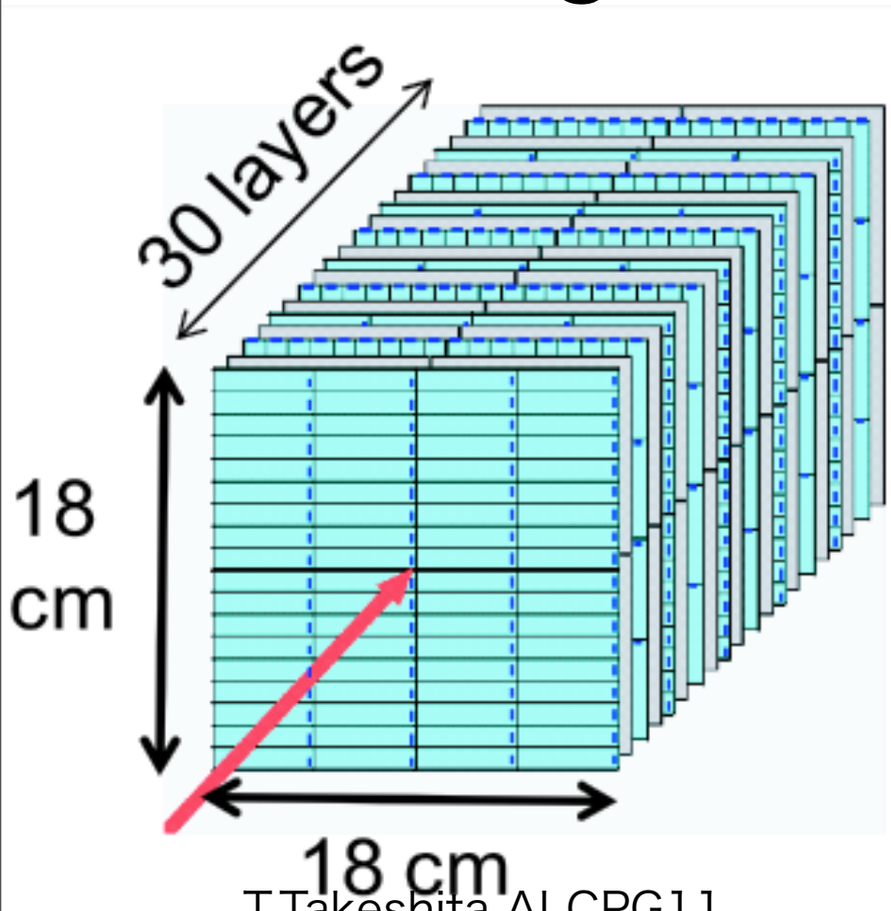
- compact 1 x 1 mm^2
- pixelated G-Mode APD
  1600 pixels
- MPPC has photon counting capability
- auto calibration
  - gain monitored
  - temperature dep.

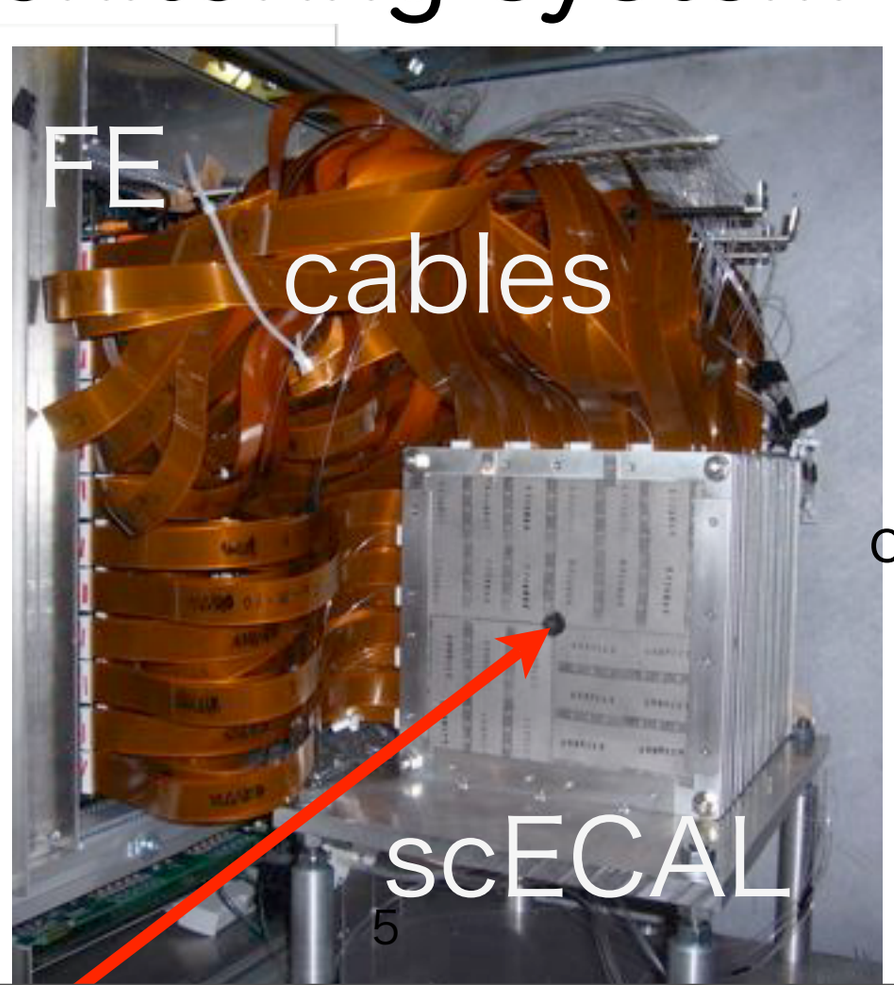




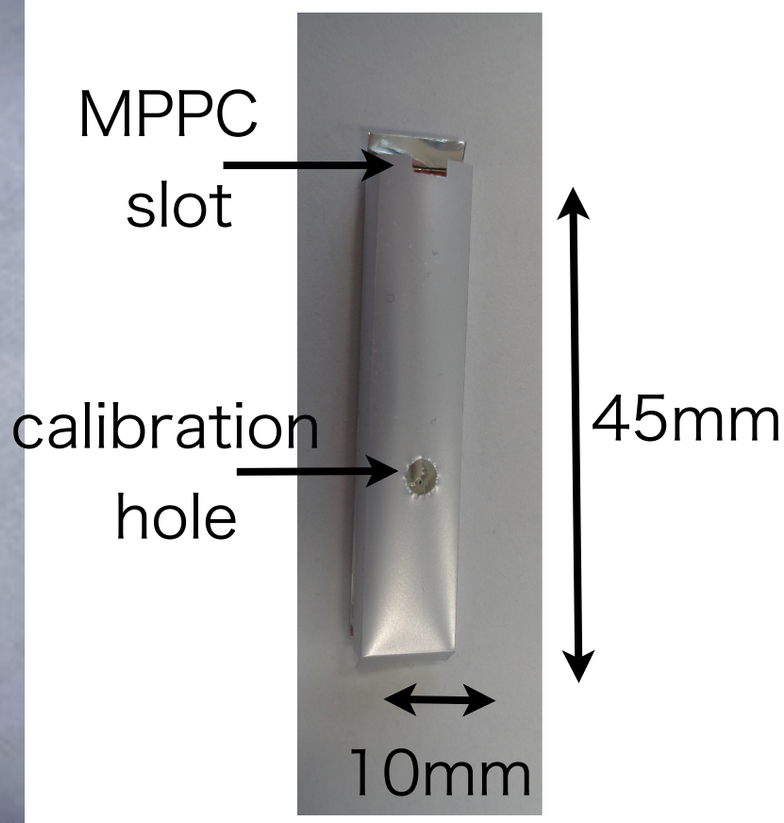
Beam Test at FNAL

- Sep.2008 & May2009 in CALICE
- 3x10x45mm^3 strips with WLSFibre
- 4x18 x 30 layer = 2160ch
- with gain monitoring system





a strip covered by reflector sheet



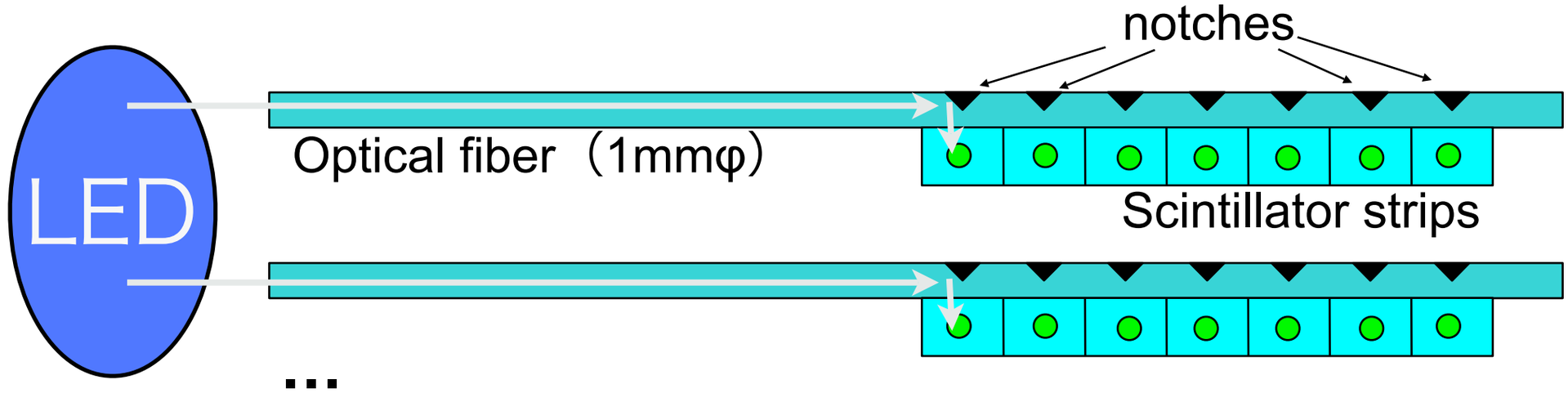
gain monitoring sys.

- test each channel
- dead/alive, gain, response

photon counting

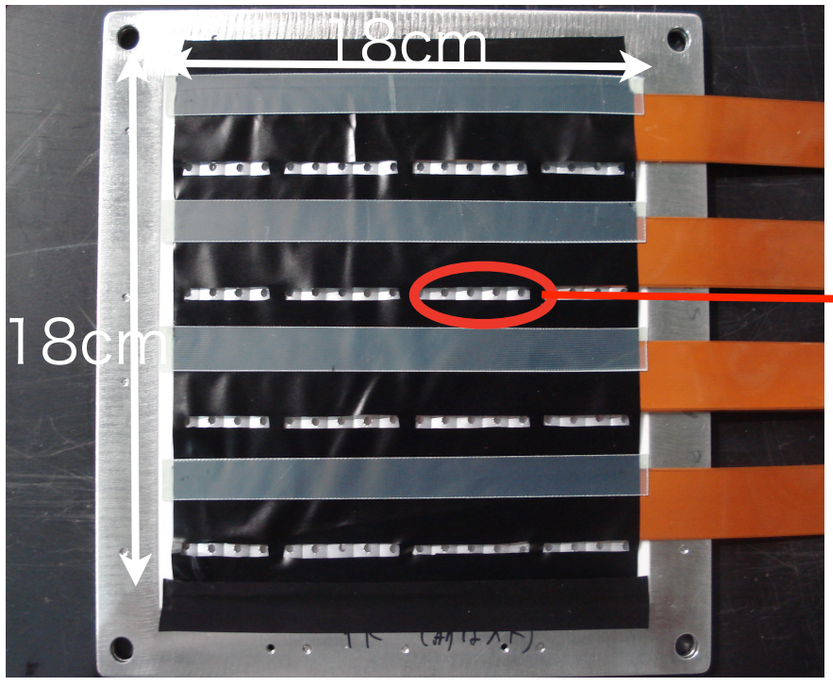
- light fed though from LED

- distributed optical fiber with notches
- 16 fibers x 18 notches / blue LED

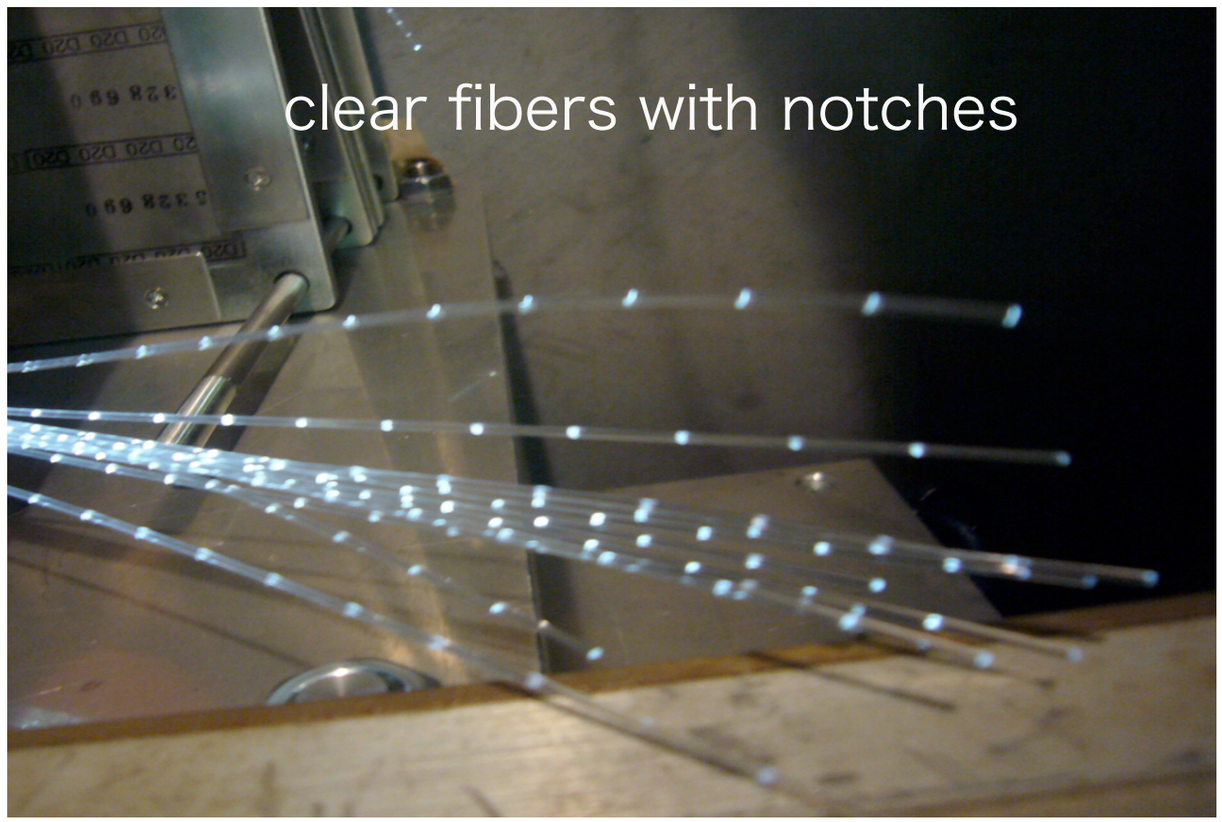


light distribution

a layer 72 strips

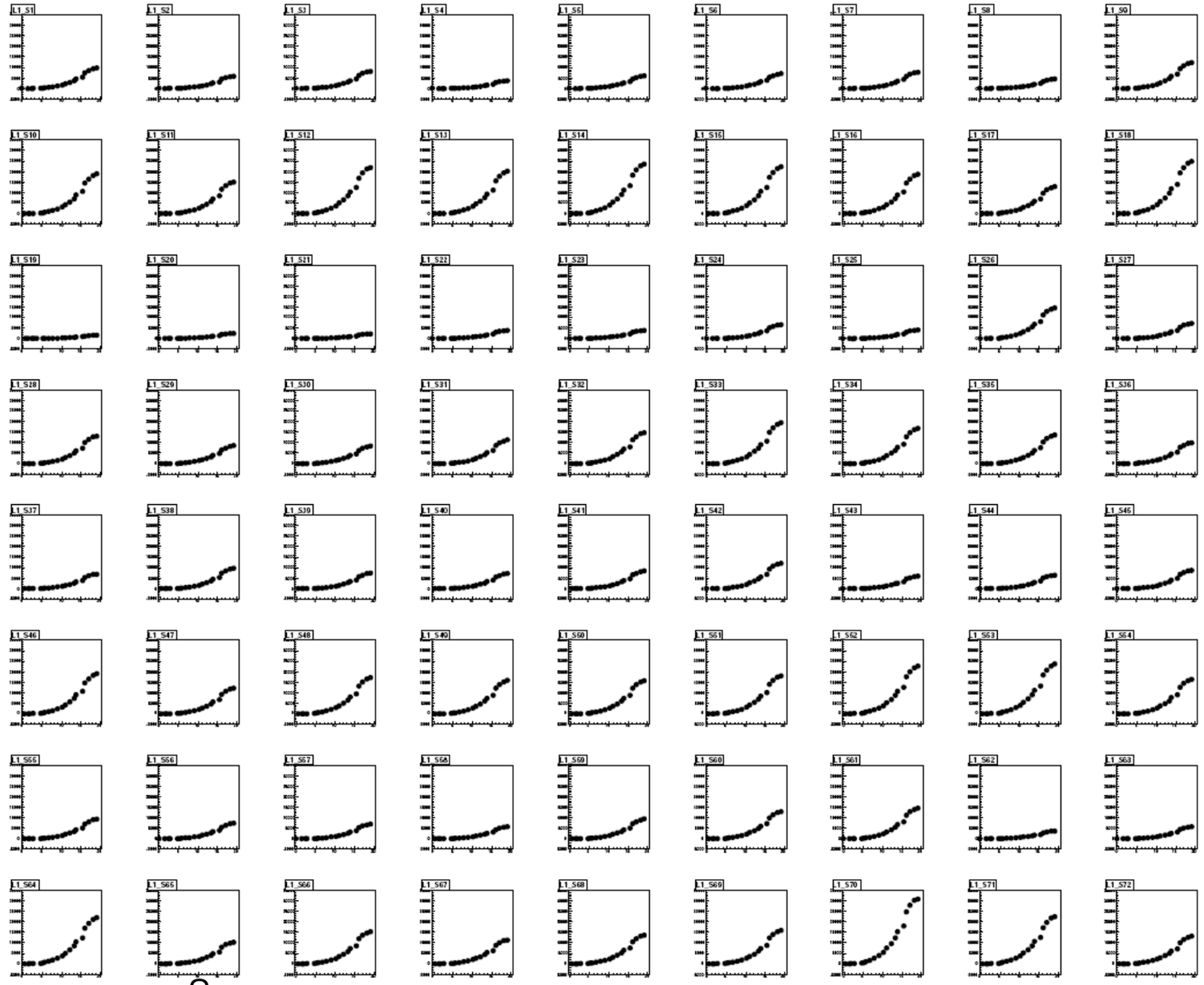


expanded view

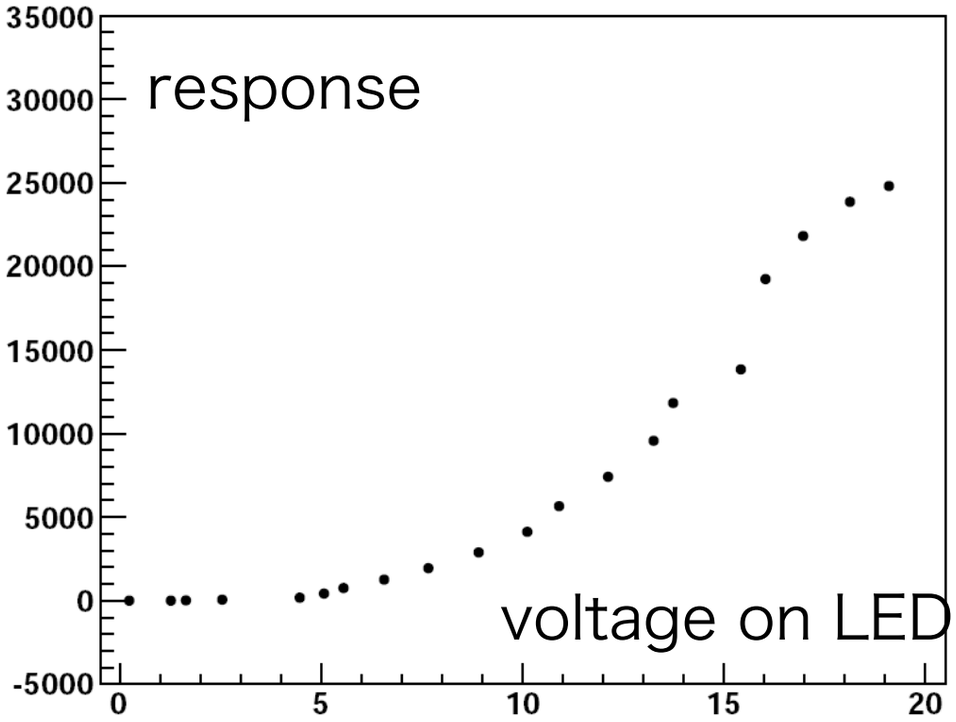


LED light control

- by changing voltage on LED pulses
- response measured　　a layer (1st)
- success 100%



one strip



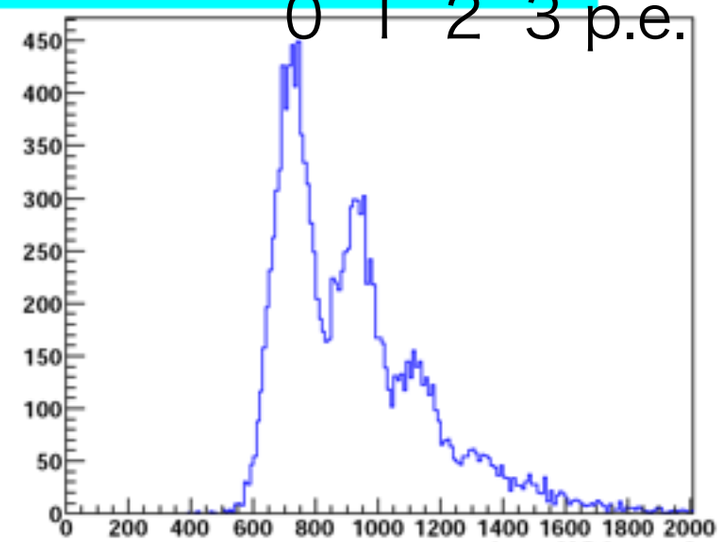
gain monitoring

two amp.s

- high gain amp.
  - single photo-elec. signal
    p.e.
  - inter-calibration
    gain ratios
- low gain amp.
- gain monitoring
- temperature dep.

High gain mode

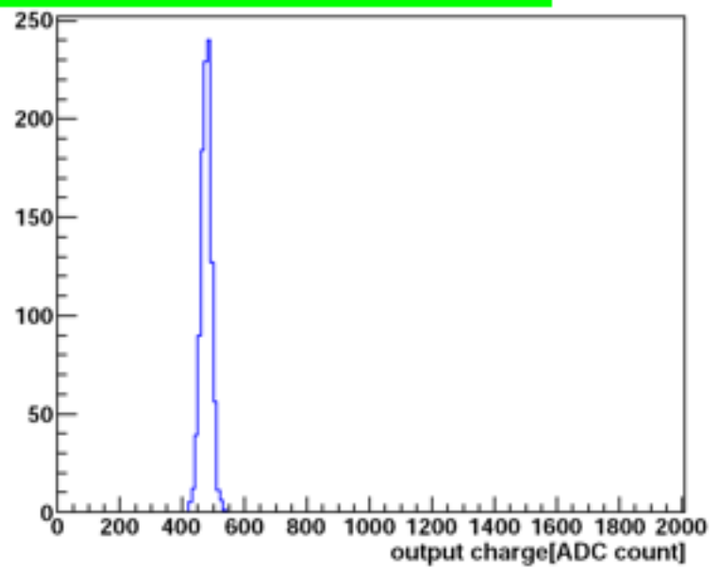
0 1 2 3 p.e.



same LED lights

ADC

Low gain mode



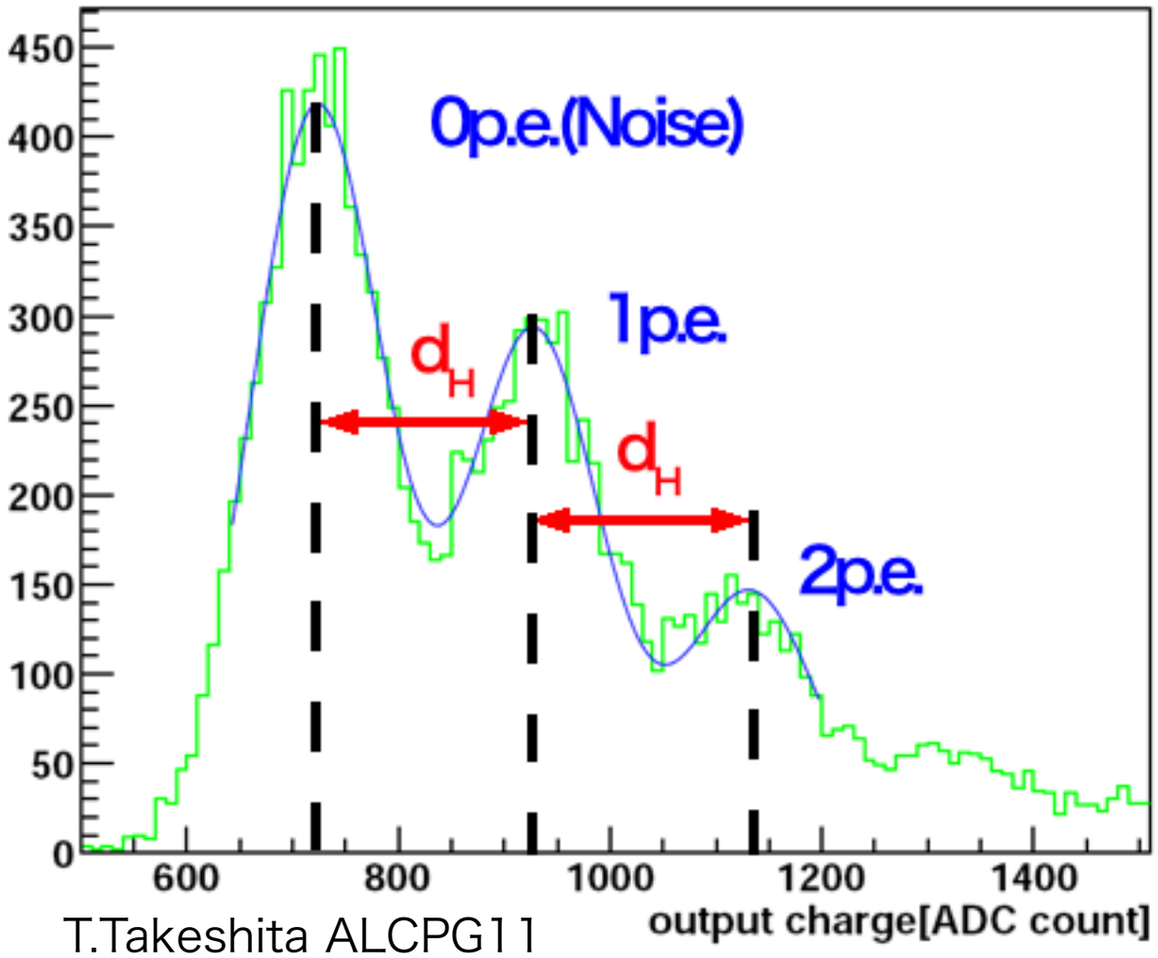
ADC

high gain mode

- measure 1 p.e. response by LED light
- success 1755/2160 ch. (81%)
- fail due to noise

High gain mode

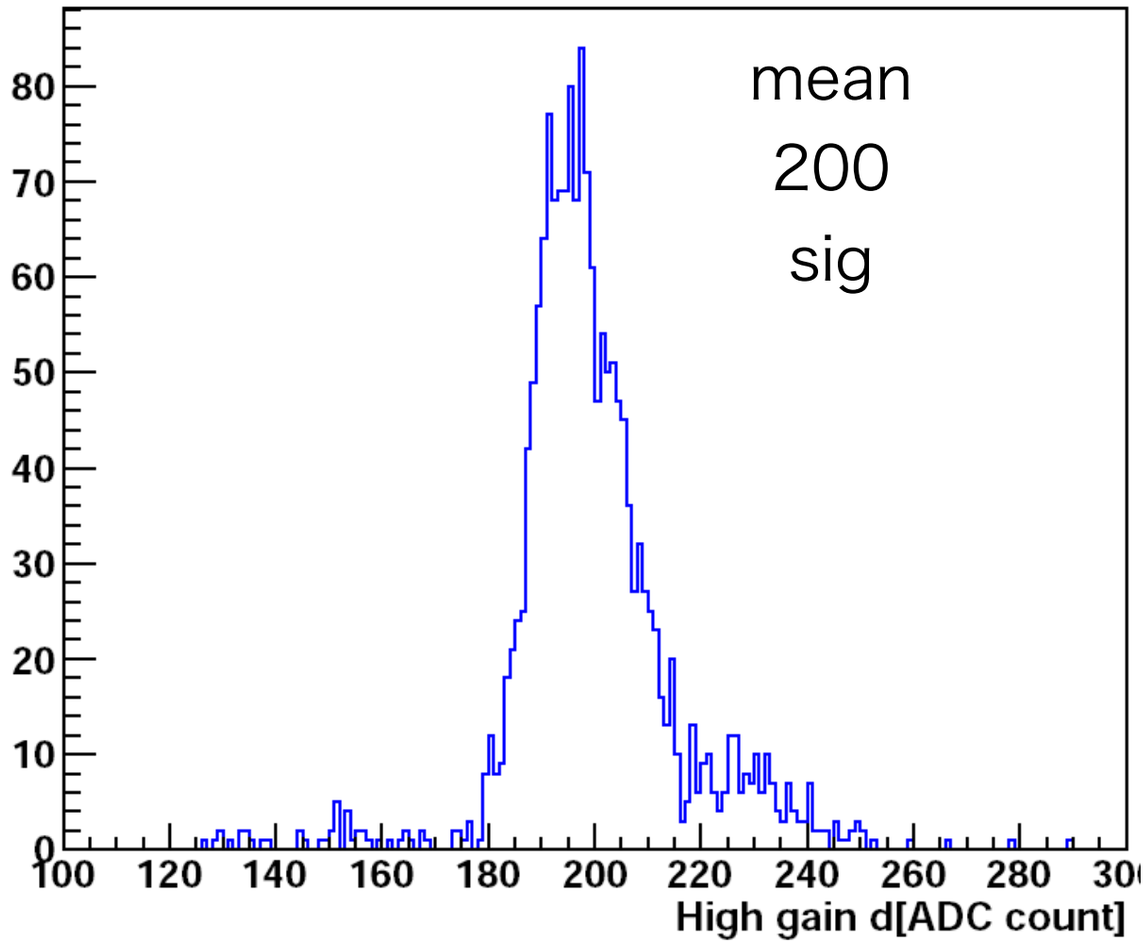
an example



High gain d

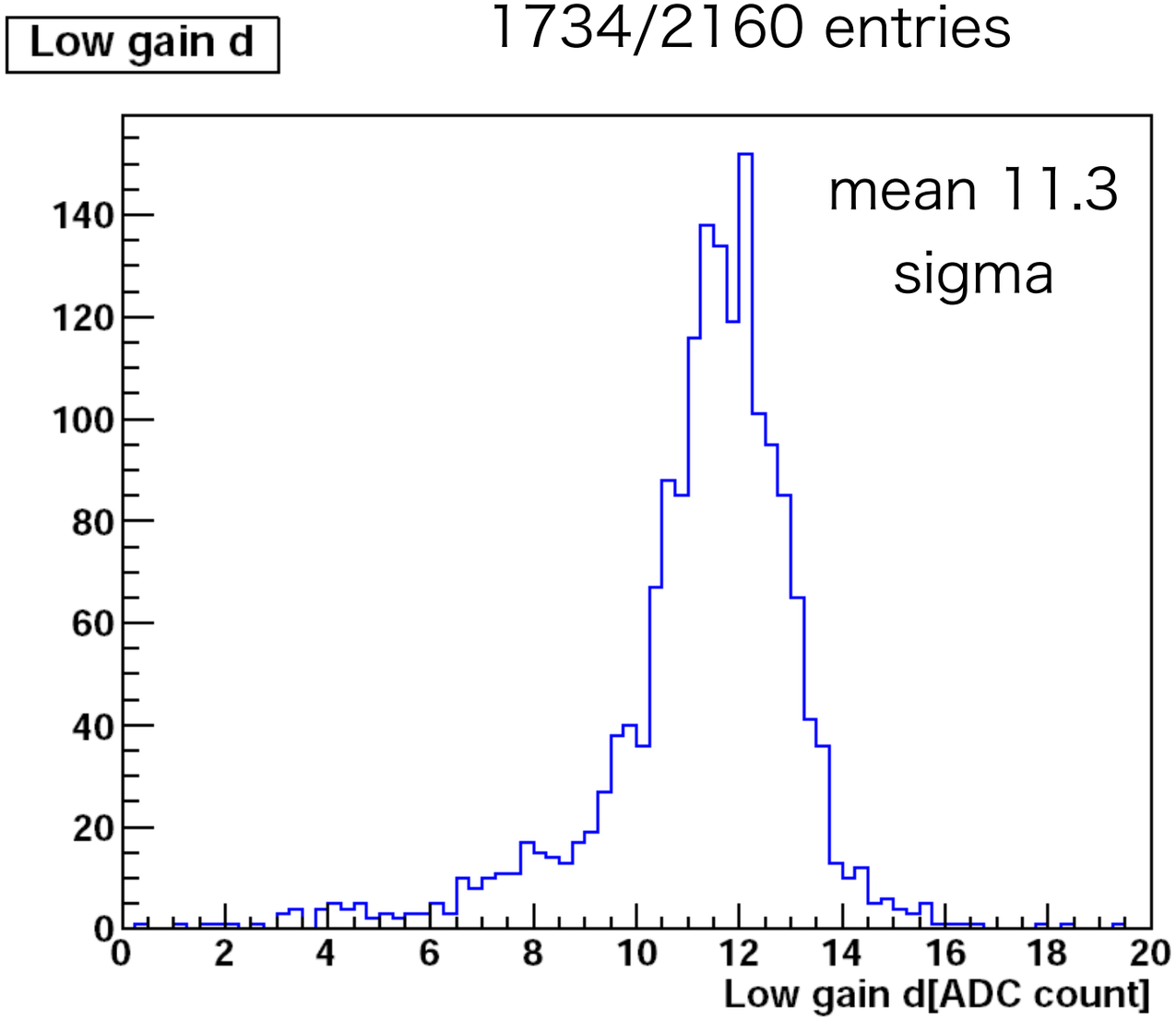
dist. of 1 p.e. response

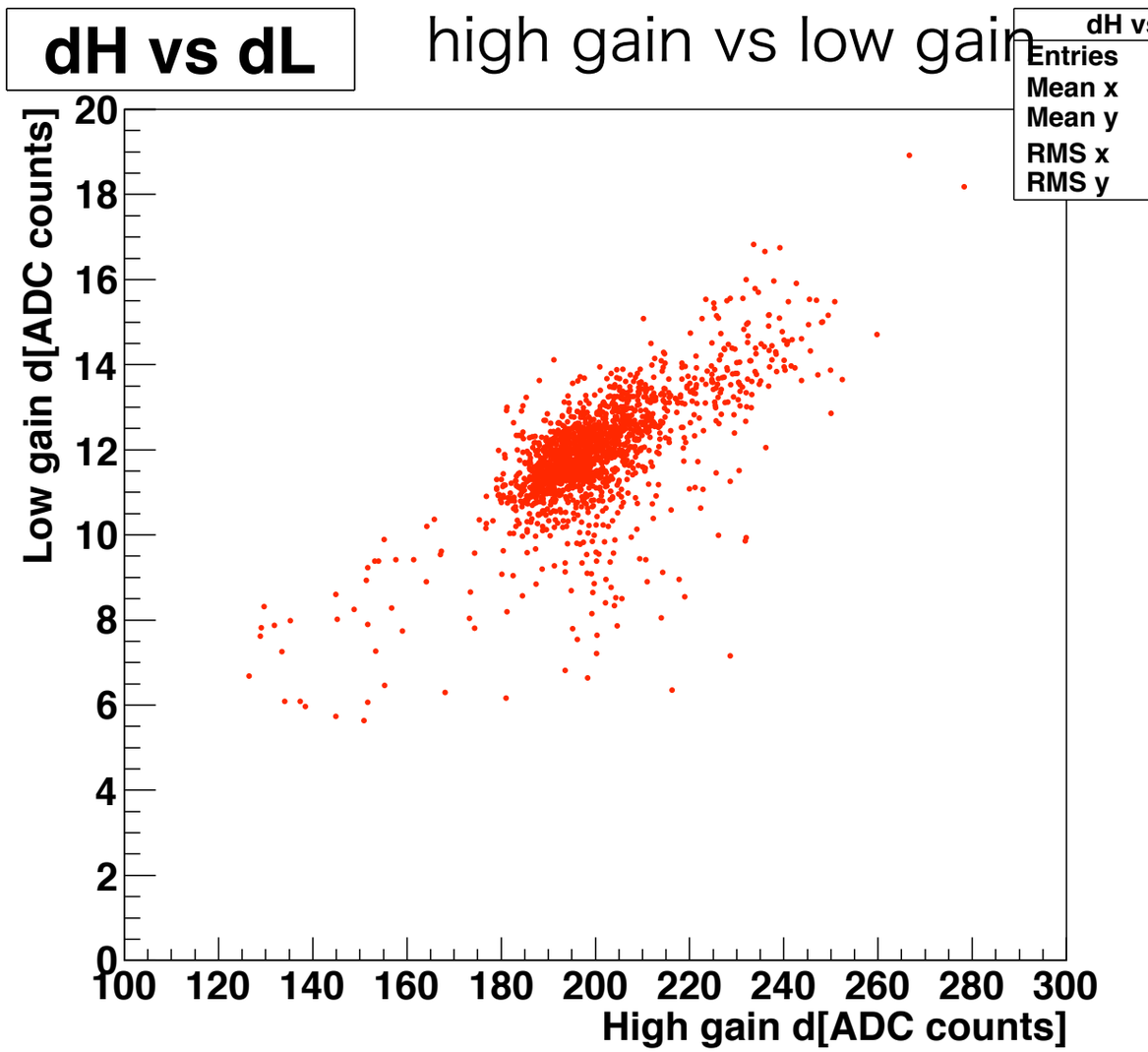
small



low gain mode

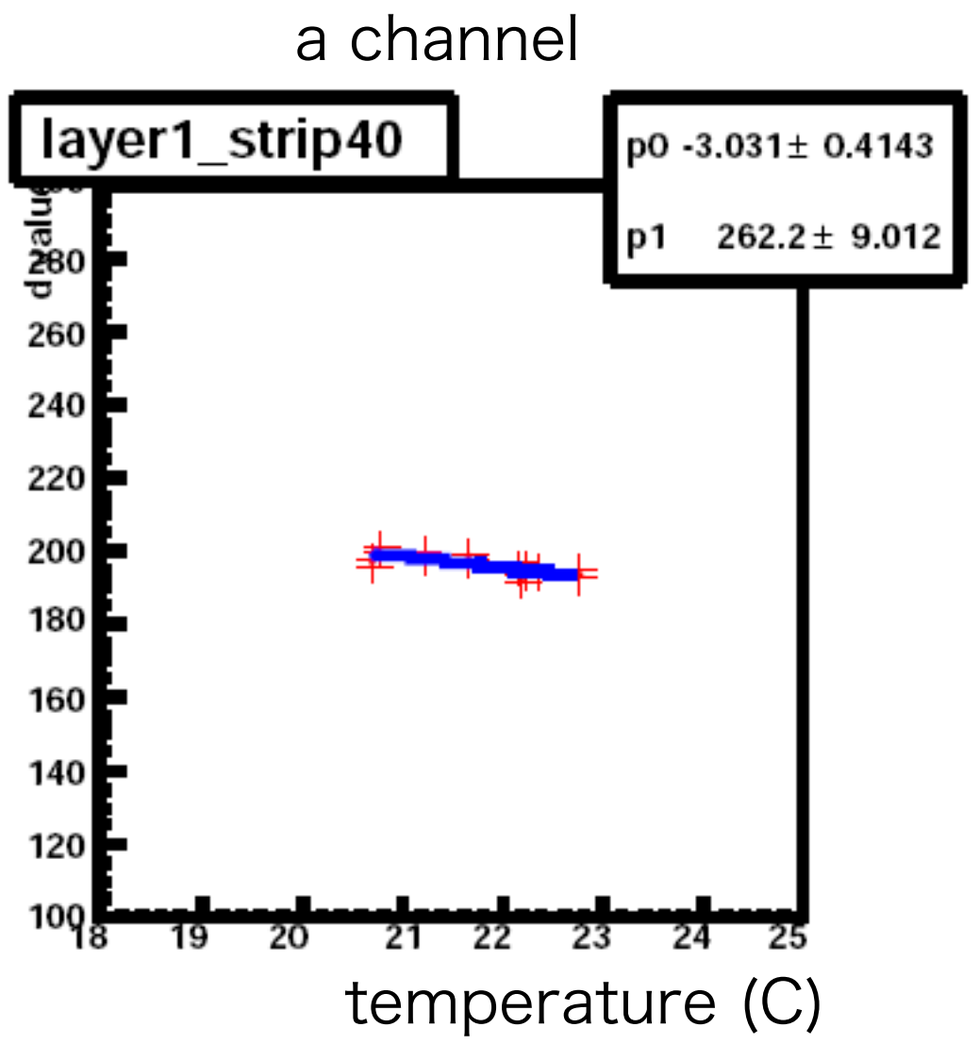
- measure 1 p.e. corresponding ADC counts
- after inter-calibration (ratio high/low gain)

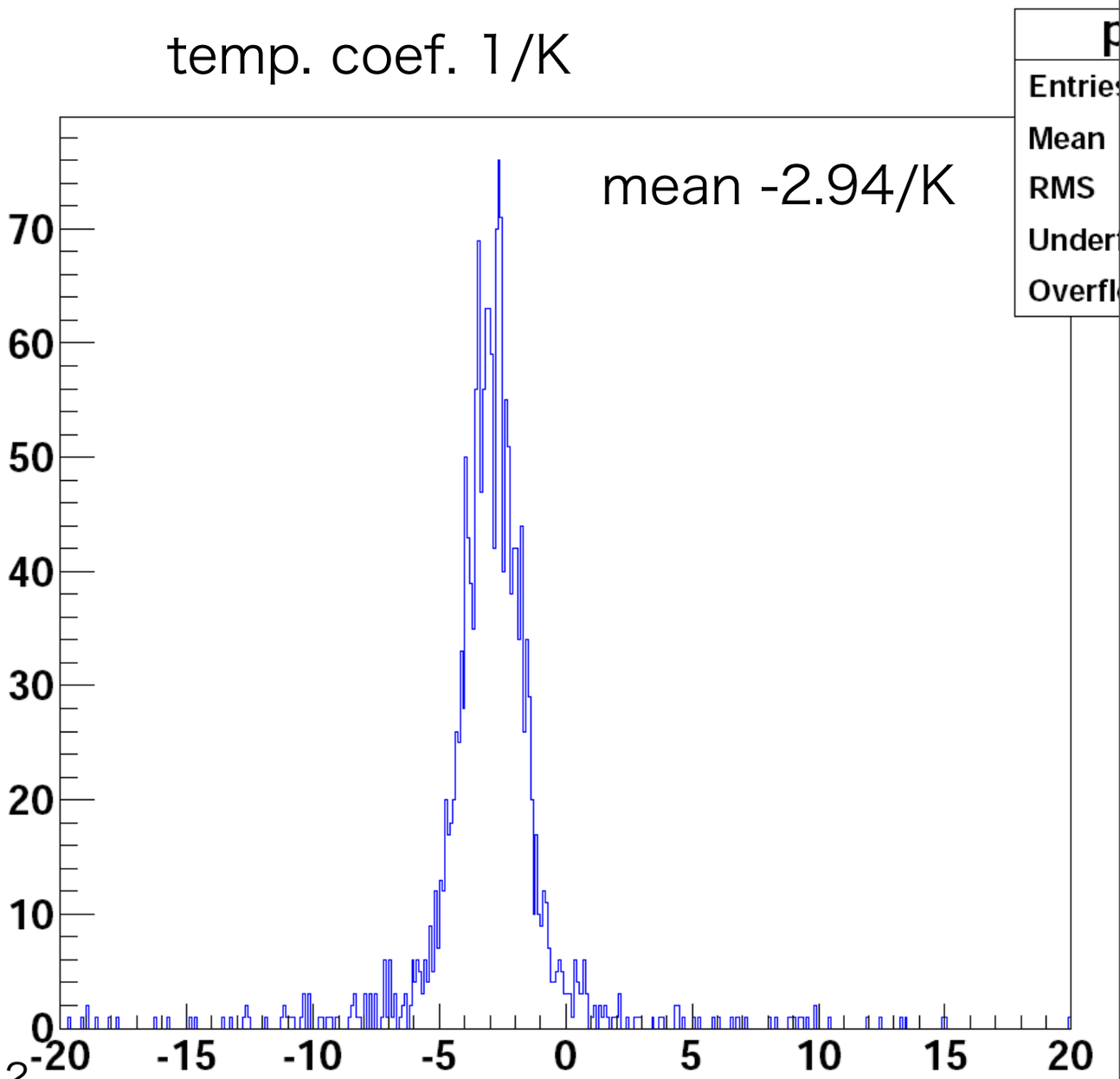




performance

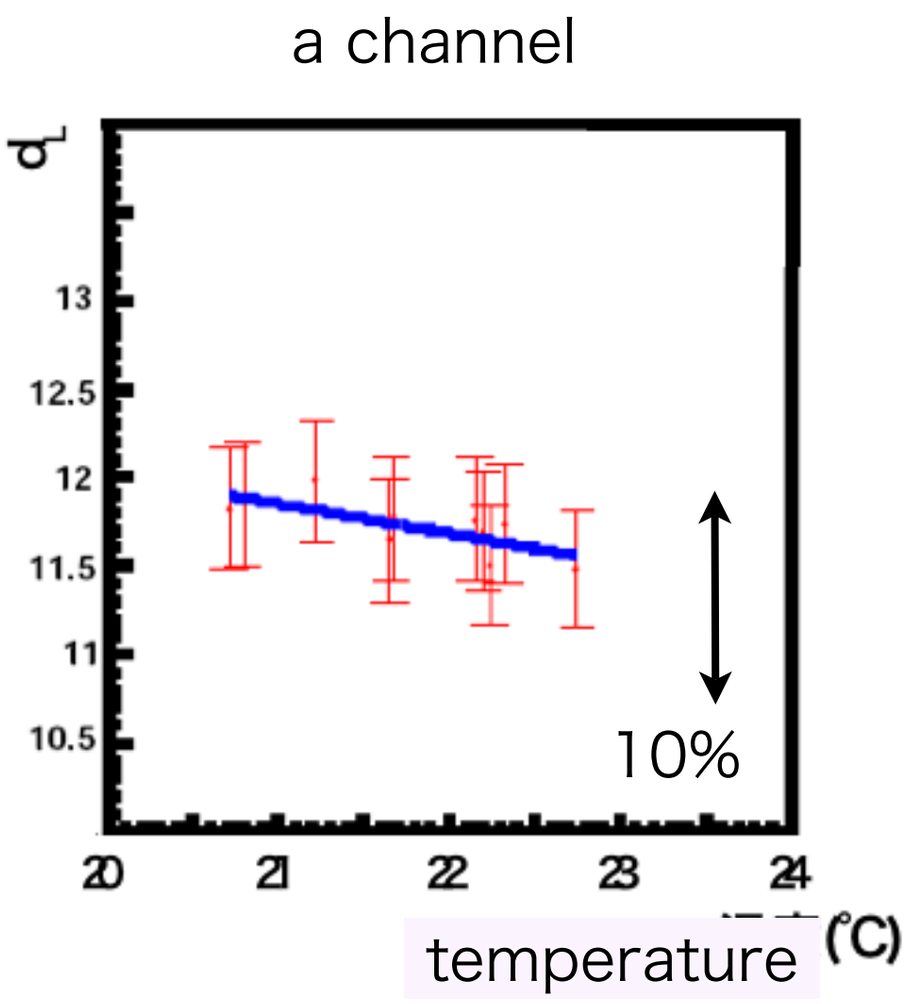
- temperature coef. (high gain)
- ~ -1.5%/K @ 20 C

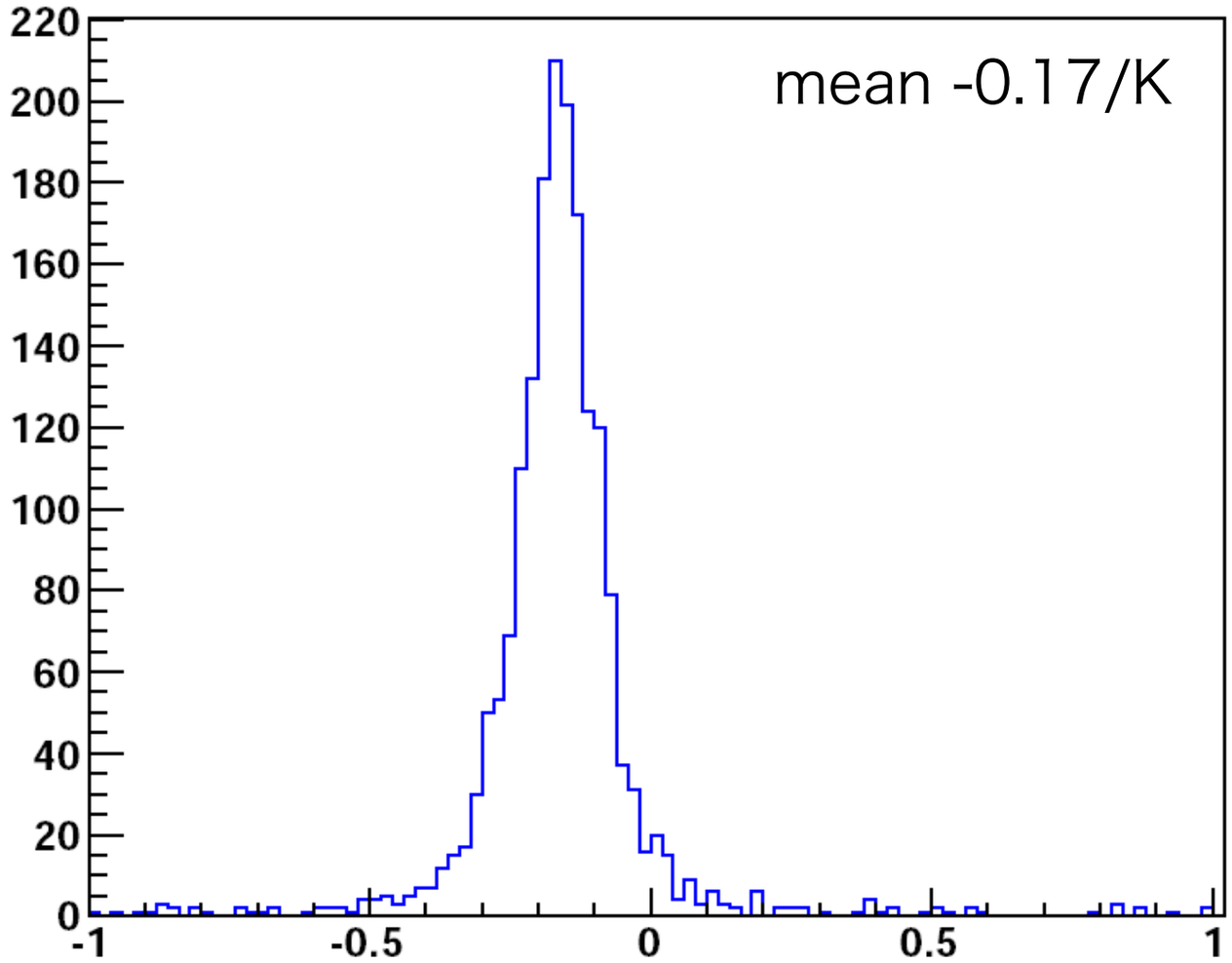




performance cont.

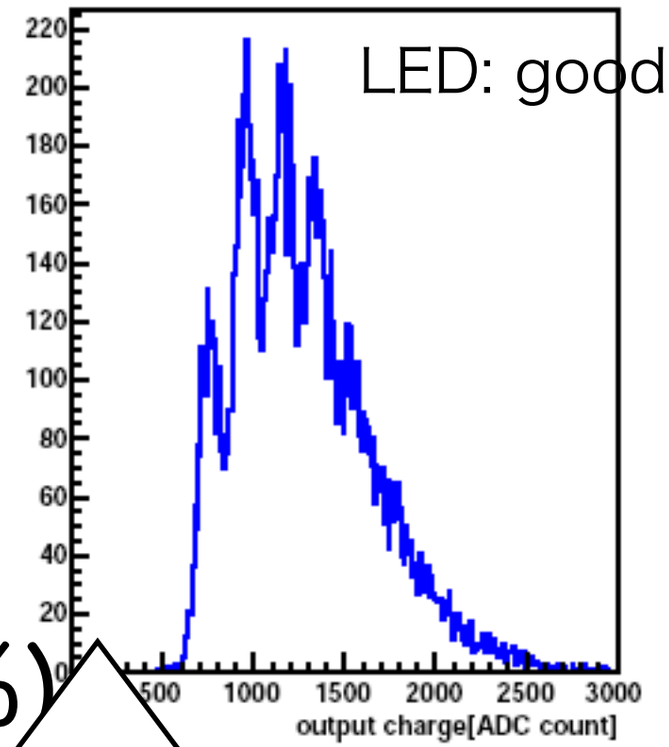
- temperature coef. (low gain)
- success 1881 /2160 ch (87%)



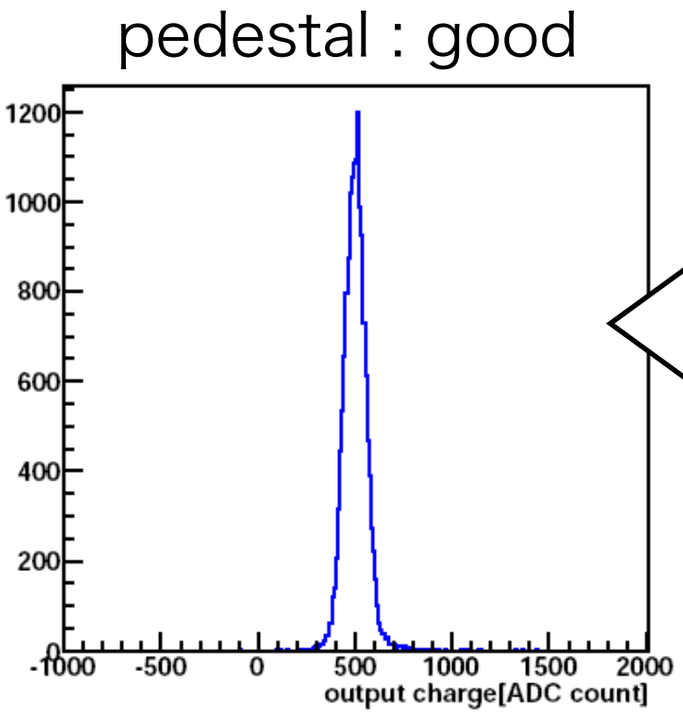


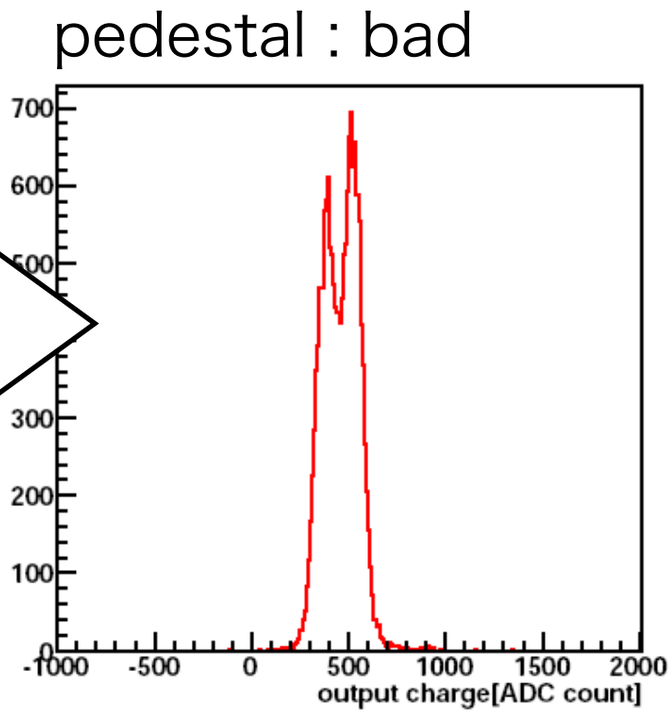
improvement req.

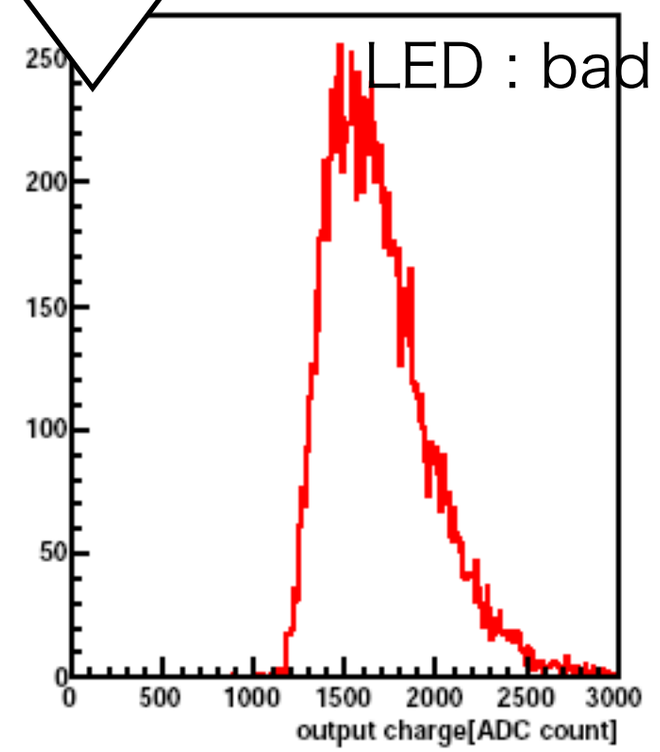
- need to be improved
- electronics noise
- signal (fail 16%)



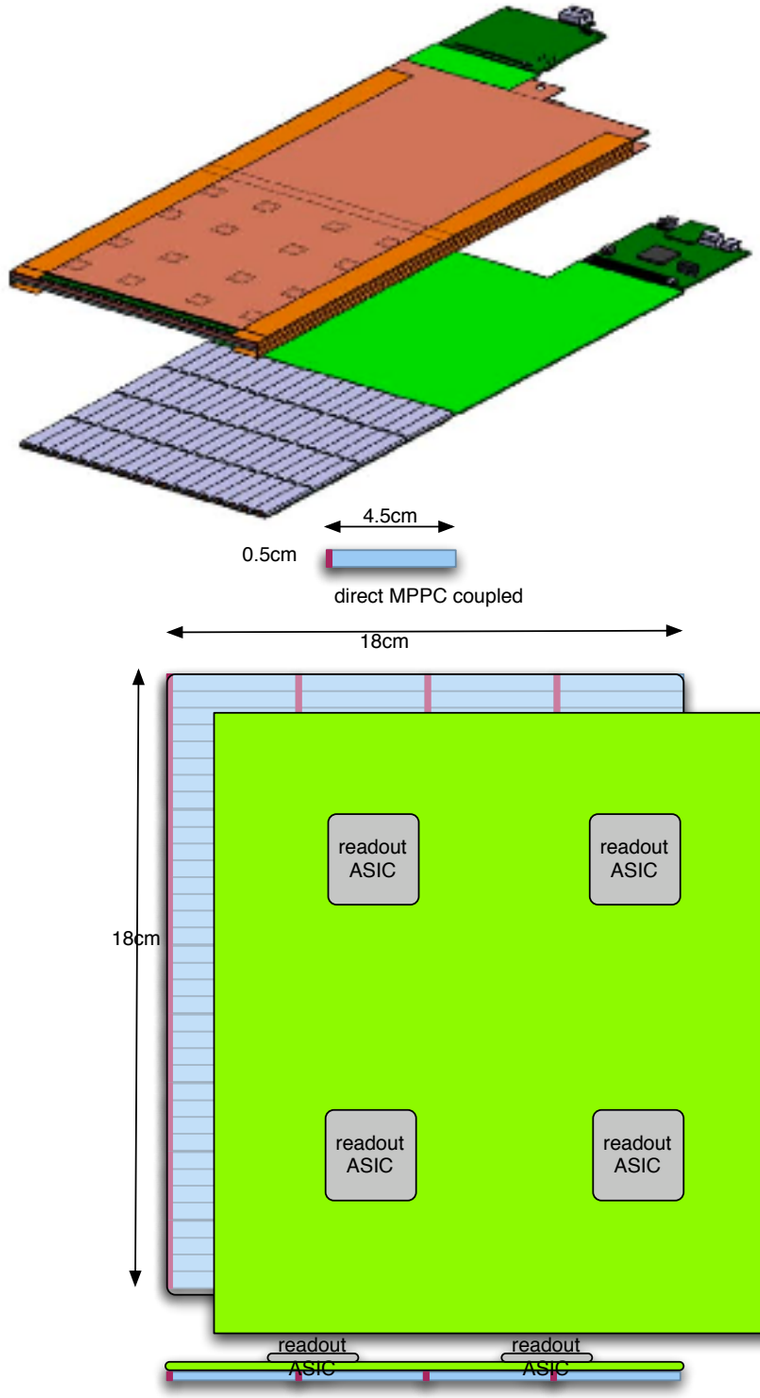
- LED driver makes noise (fail 3%)



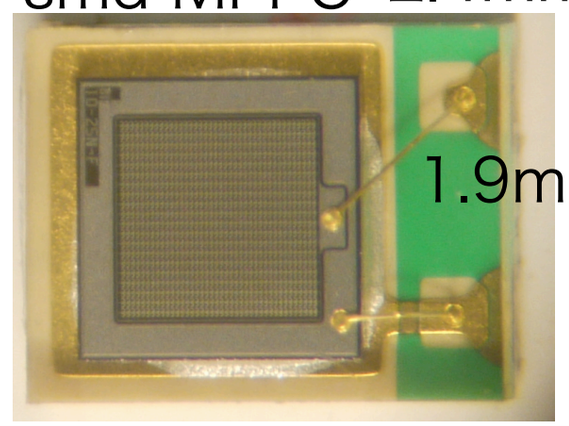




technological prototype

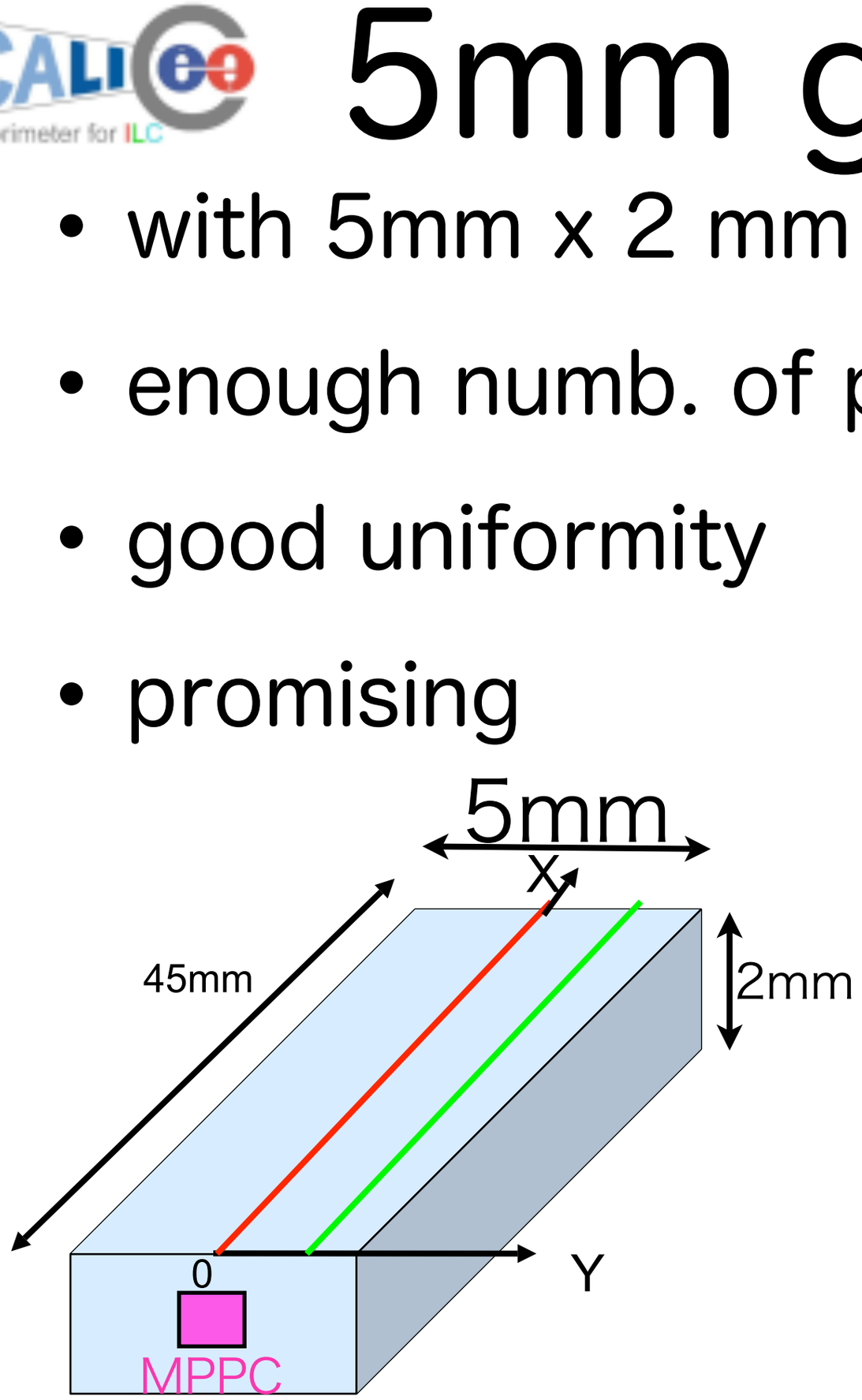


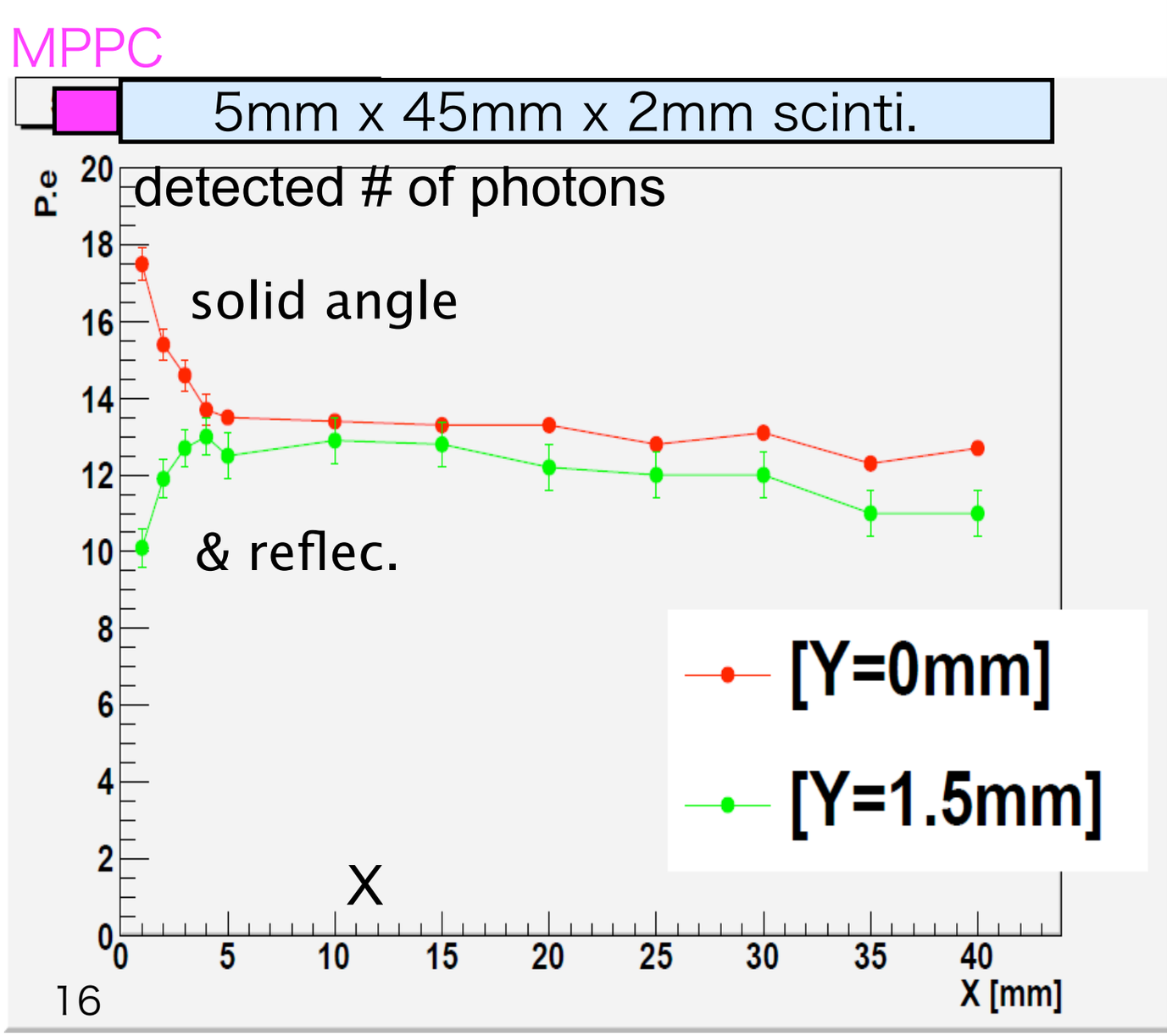
- integration in a layer
  - scintillator & electronics
    - less noise problem
    - 5mm wide scintillator strips
    - direct attachment of a smd MPPC
      - without WLSF



5mm granularity

- with 5mm x 2 mm 45 mm strip
- enough numb. of photons~13 p.e.
- good uniformity
- promising





summary & outlook

- CALICE scintillator ECAL
- gain monitoring system & performance
  - establish procedure for LED calibration
  - technological prototype is under construction
  - with finer granularity 5mm
- will be test at the beam till DBD