

R&D of Calorimeter using Strip/Block Scintillators with SiPM

H. Miyata, E.P. Jacosalem, S. Iba, N. Nakajima,
H. Ono, & A.L. Sanchez
Niigata University
For GLD-CAL group

Contents

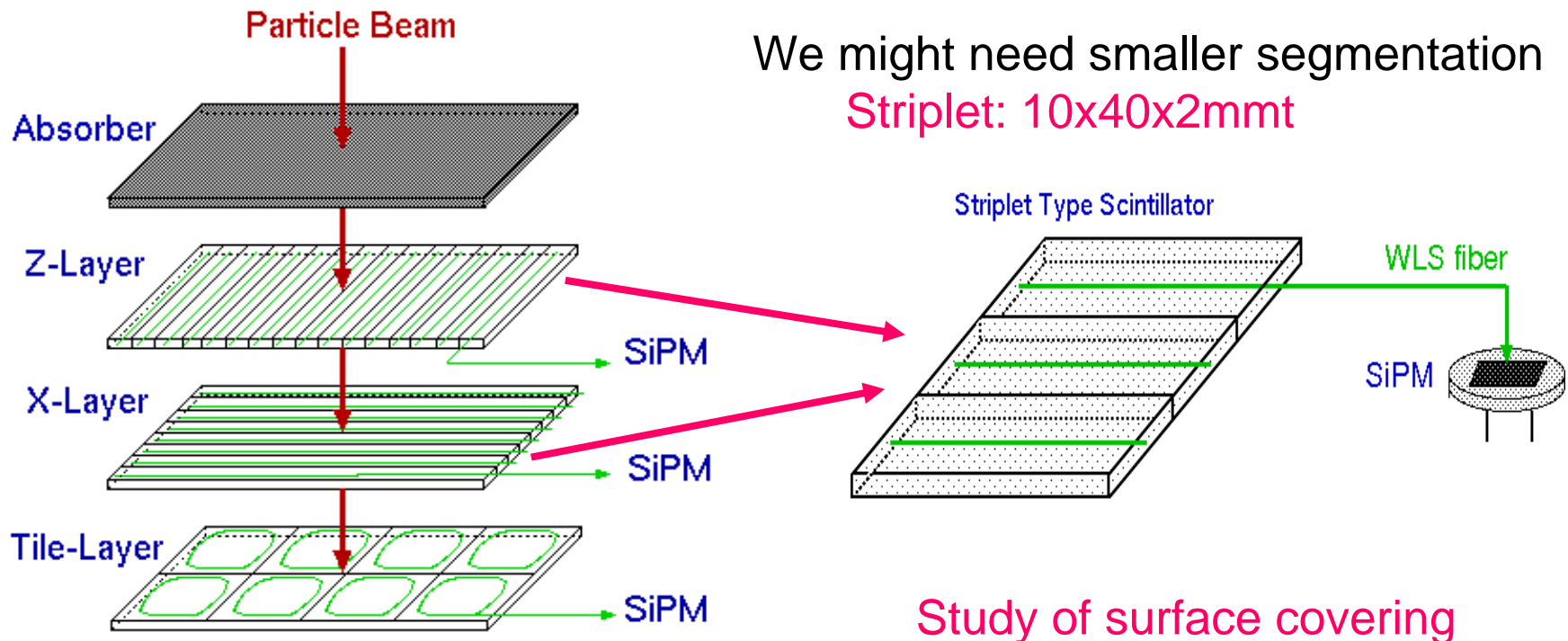
1. Motivation
2. Study on scintillator strips
3. Laser test of SiPM
4. Source test of scinti. strip
with SiPM
5. Summary

Calorimetry and Muons session
LCWS05 at Stanford
March 19, 2005

1. Motivation

Present design of GLD Calorimeter

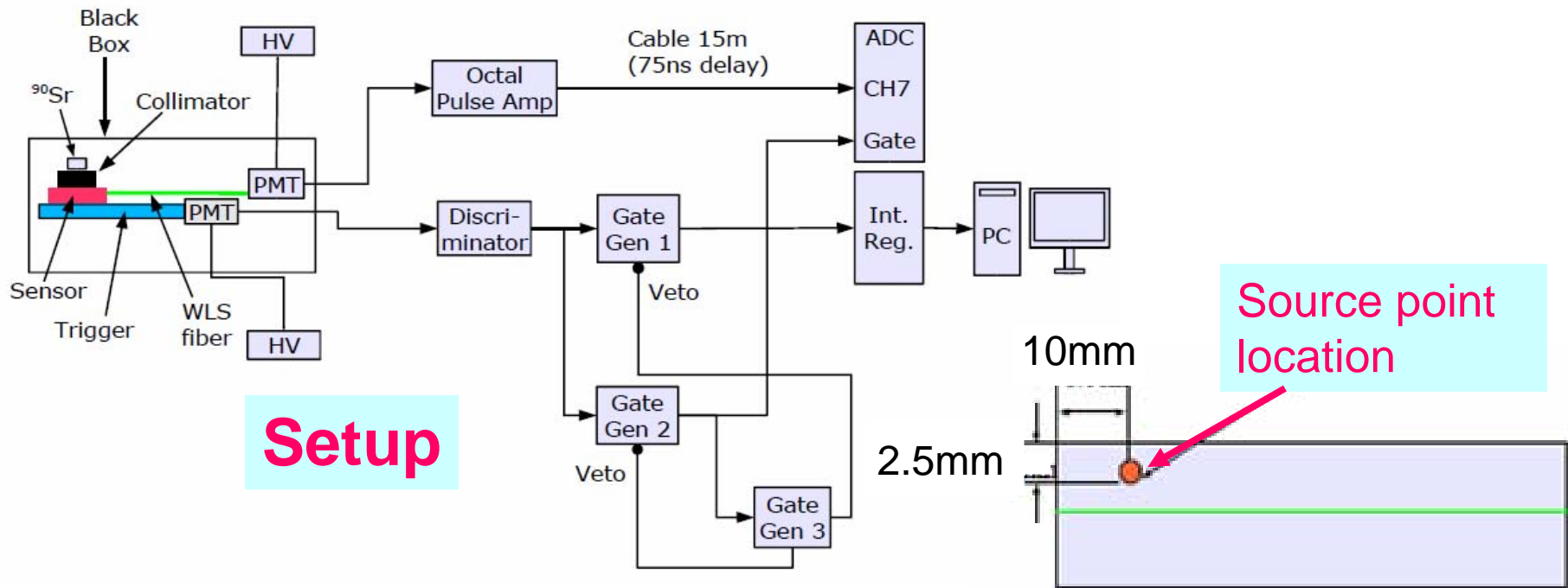
Fine segmentation scintillator
read out by SiPM



X,Z-layer strip scinti.: 10x200x2mmt

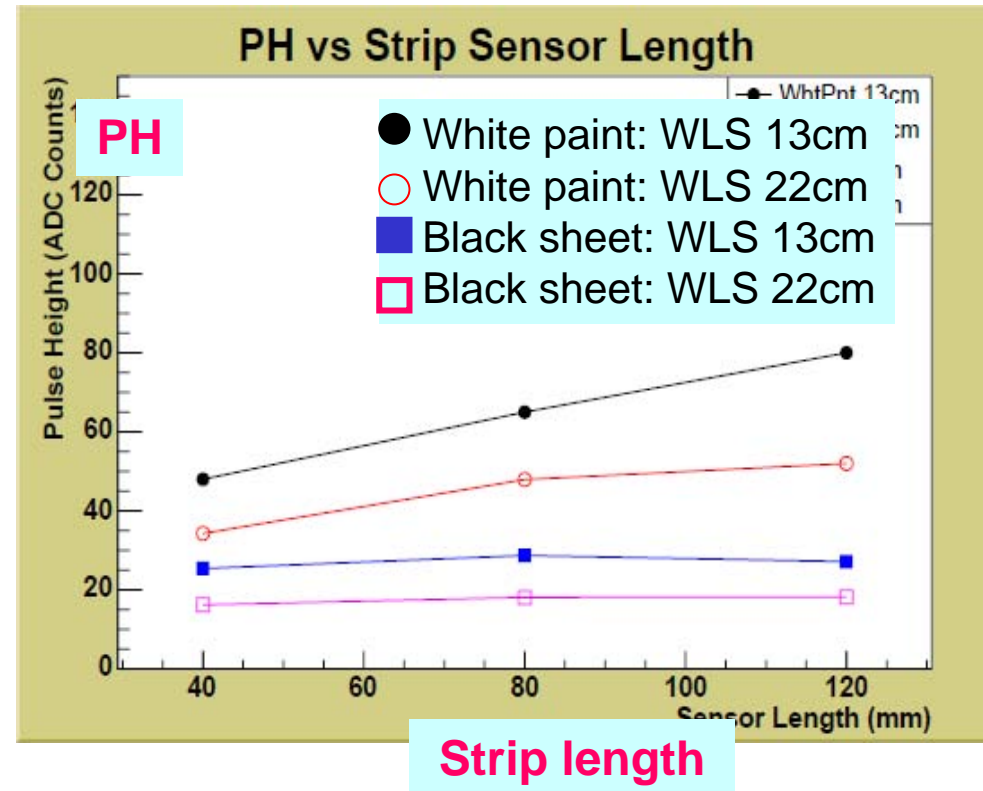
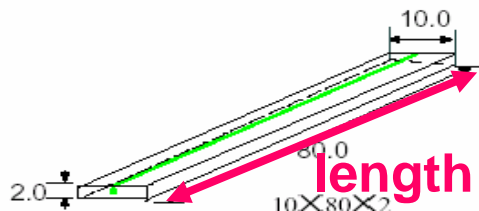
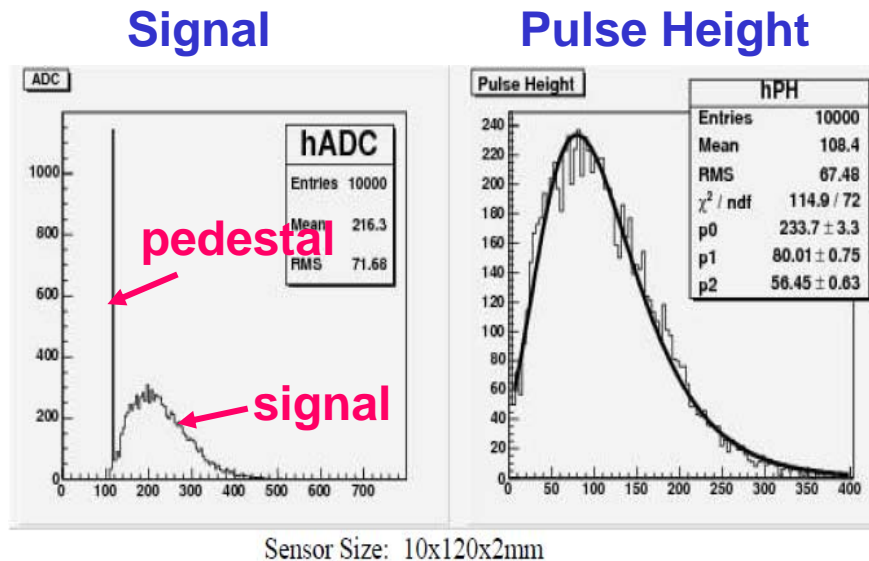
Tile-layer: 40x40x2mmt

2. Scintillator study



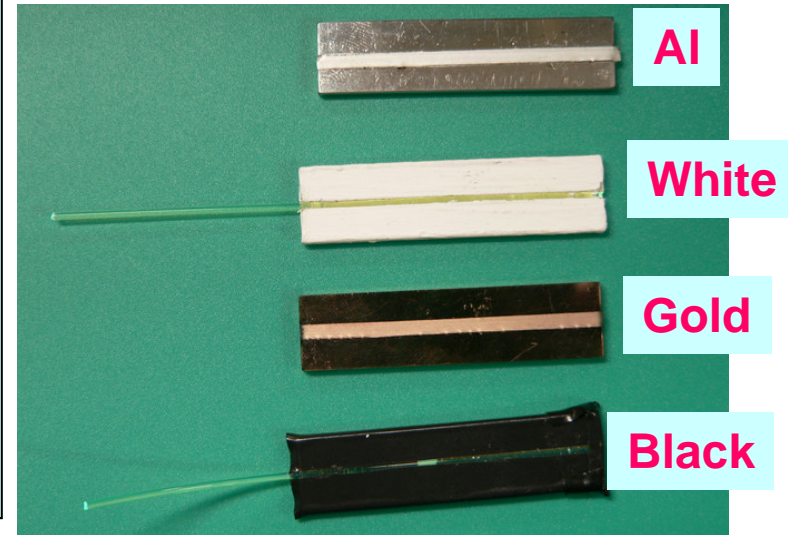
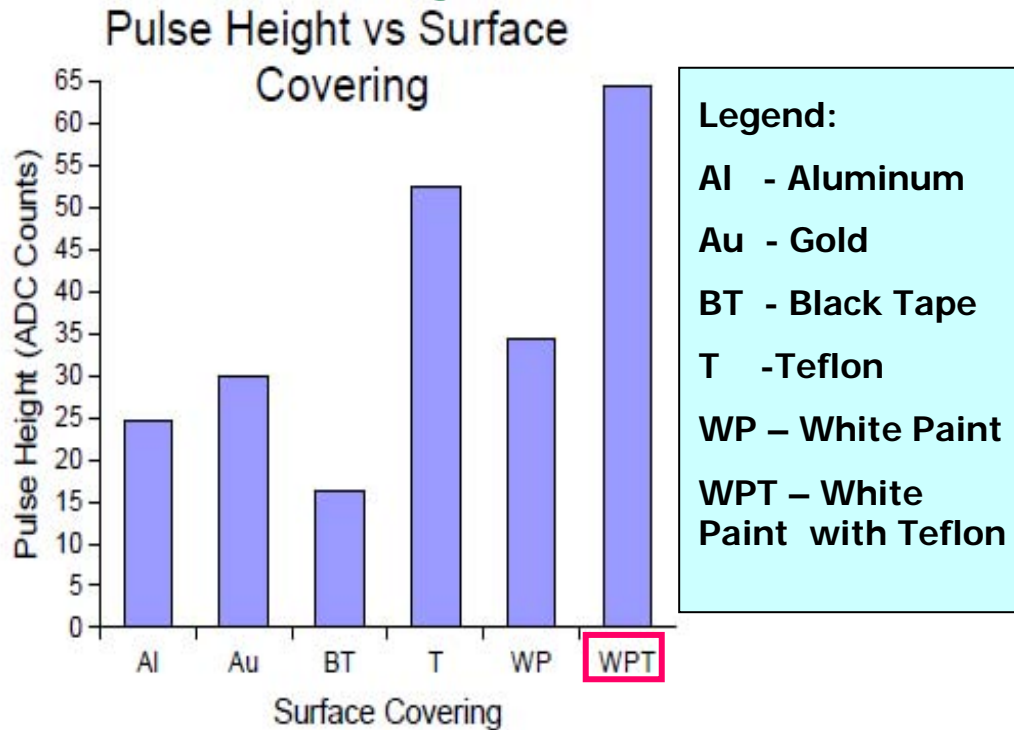
- Sensor : Strip type scintillator (10mmx2mm with length: 4,8,12cm)
- Surface covering: Black tape, White paint, Teflon wrapped, White+Teflon, Al and Gold evaporation
- WLS fiber diameter: 1.0mm (length 13cm, 22cm)
- Source : Sr-90 (beta-ray)
- PMT (sensor) : 16 Ch MAPMT H6568-10, HV : -950V

PH vs strip length for different WLS fiber length



PH increases as scintillator strip becomes long for White paint covering due to the larger acceptance of reflection lights.

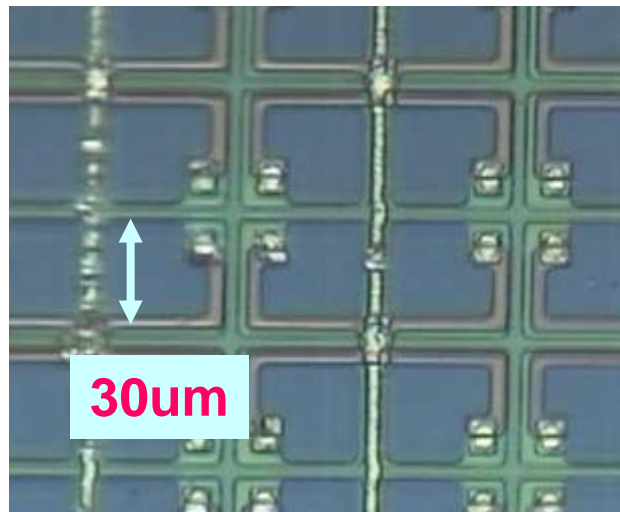
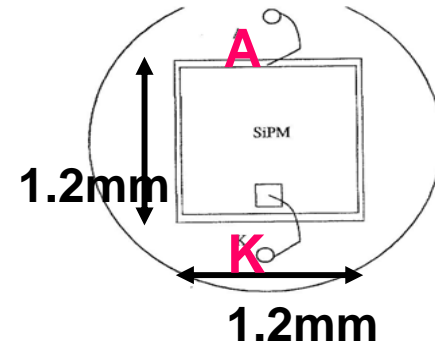
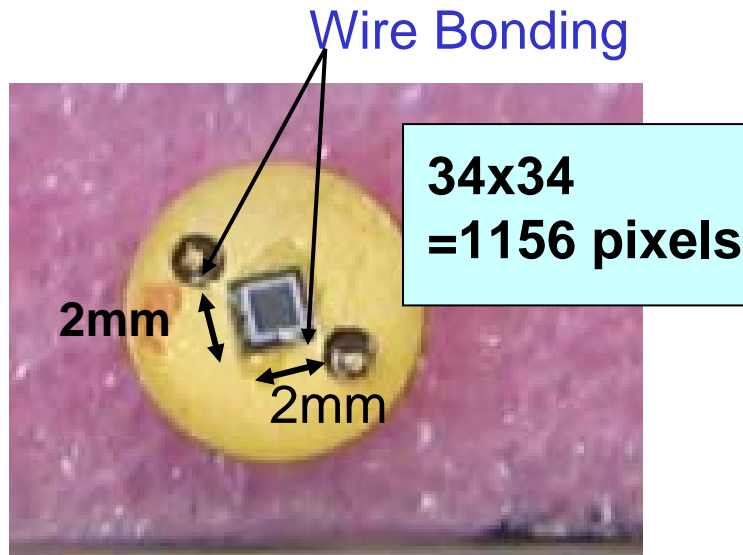
Pulse height vs surface covering



- Used Strip type scintillator: 10x40x2mm, WLS fiber length : 22cm
- Compared surface covering effect on the scintillator
Black tape, White paint, Teflon wrapped, White+Teflon, Al and Au evaporation

White paint +Teflon is the best surface covering

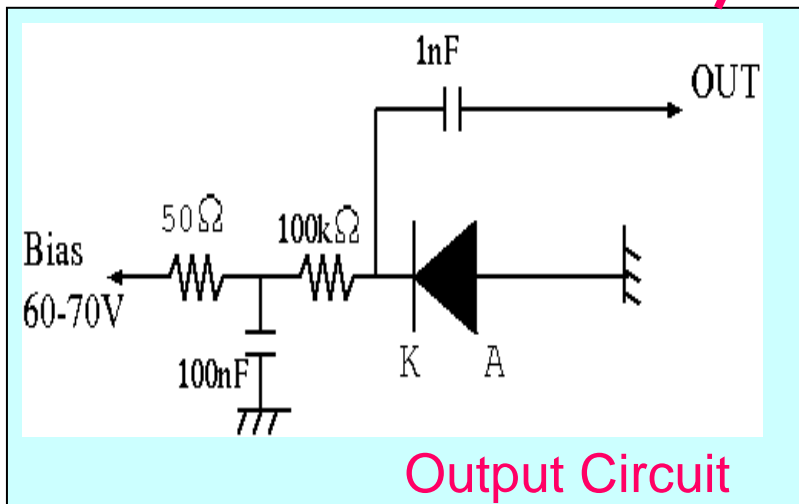
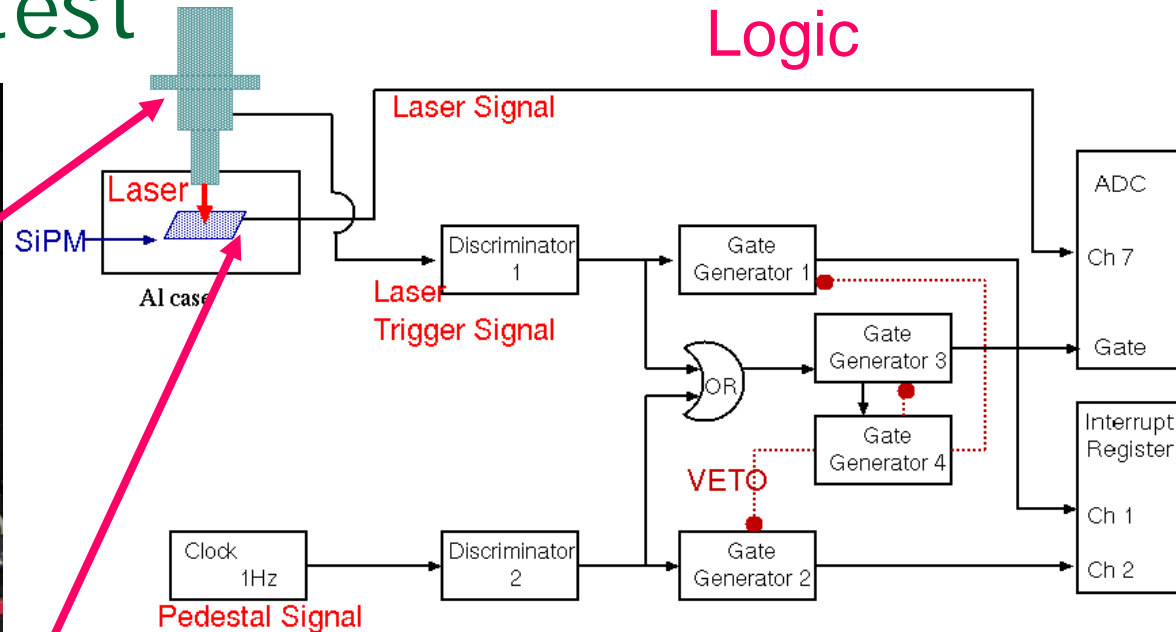
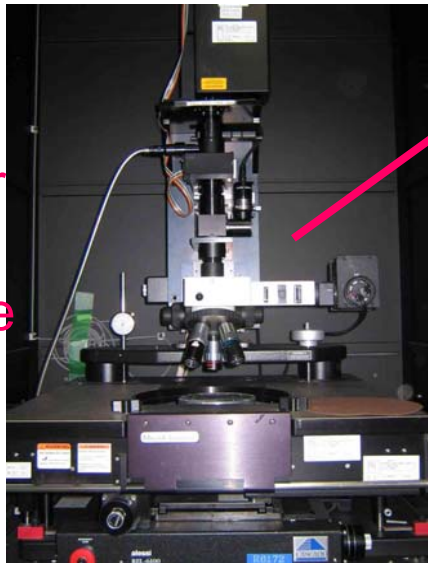
3. SiPM study



- Micro Avalanche Photo Diode (APD) with each pixel in Geiger mode
- 34x34=1156 pixels in small area (1.2x1.2mm)
- Pixel Size : 30x30um
- High Gain : $\sim 10^6$
- Operational at low voltage (60~70V)

Setup of laser test

YAG Laser
&
Scan Table
System



Output Circuit

YAG Laser & Scan Table System

Wave length & Power:

532 nm (10mJ), 1064 nm (20mJ)

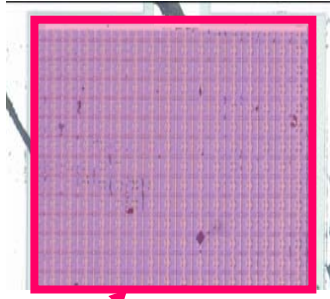
Pulse width : < 10nsec

Filter: down to 10^{-8}

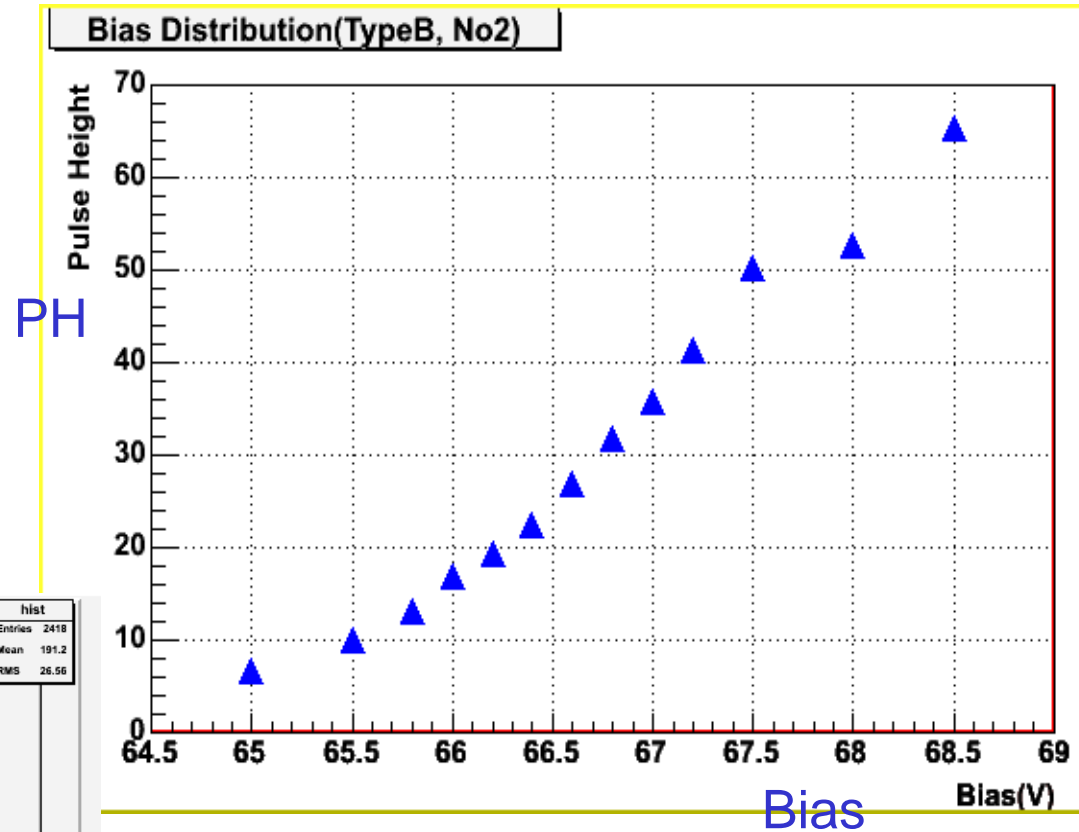
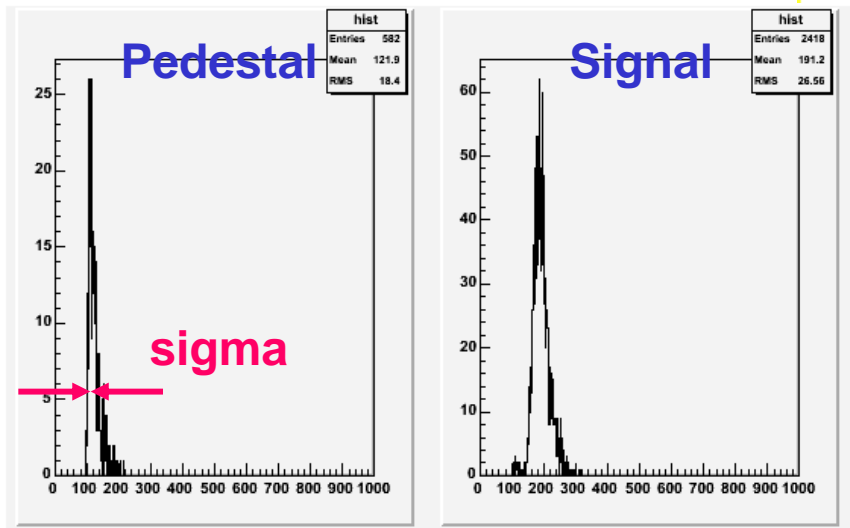
Precision of laser position: $\pm 2\mu\text{m}$

Trigger : from laser system

Bias voltage dependence (532nm)



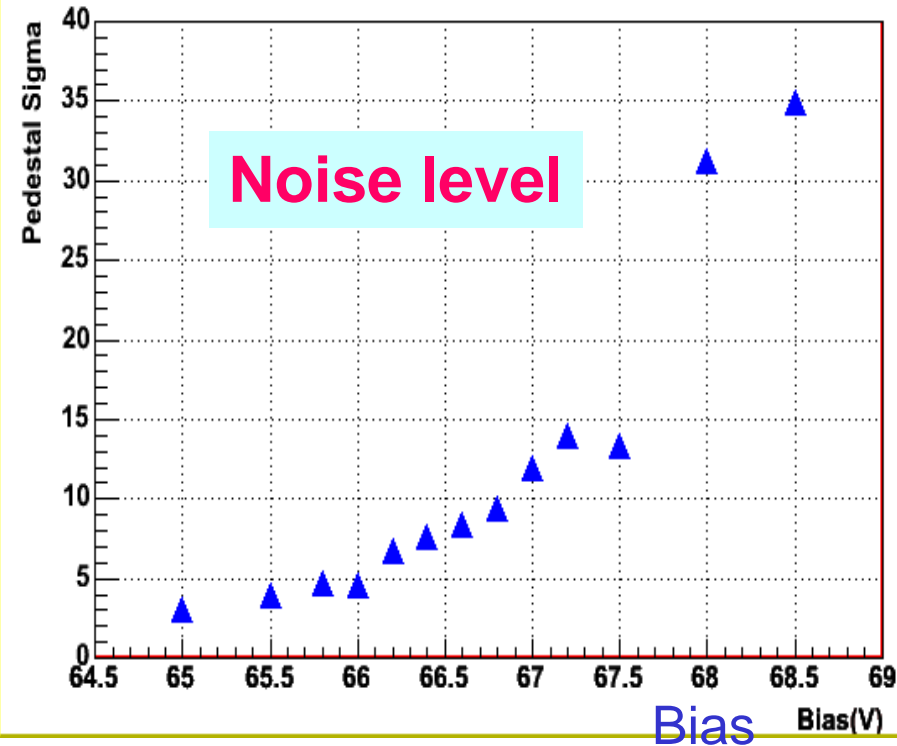
Whole sensitive area is covered by Laser



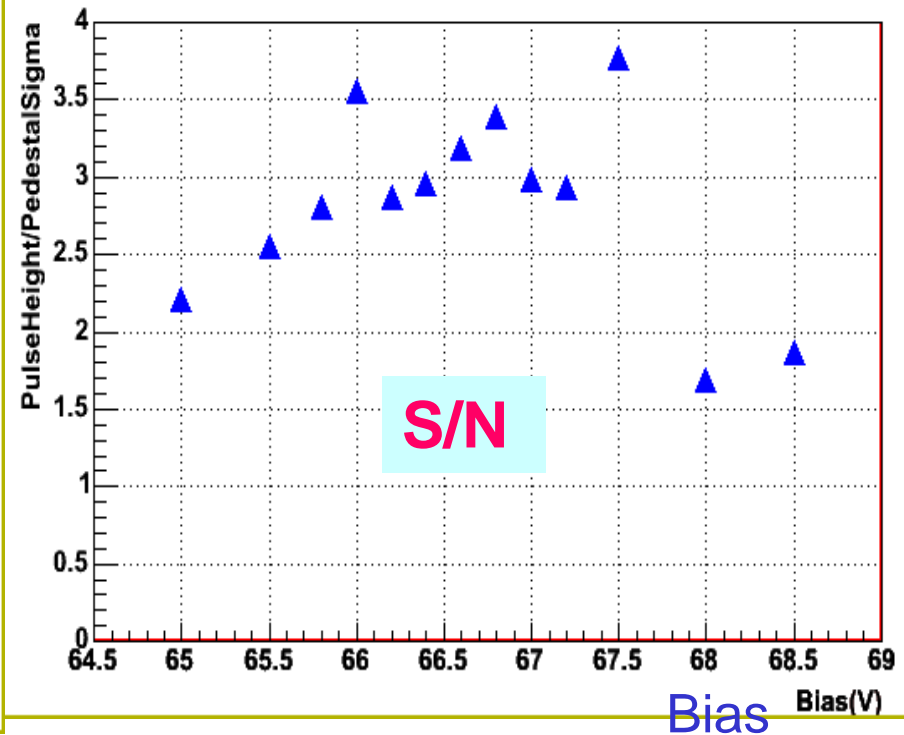
Very low gain for $< 65V$
No saturation up to 68.5V

Noise level & S/N (532nm)

Noise Distribution(TypeB, No2)

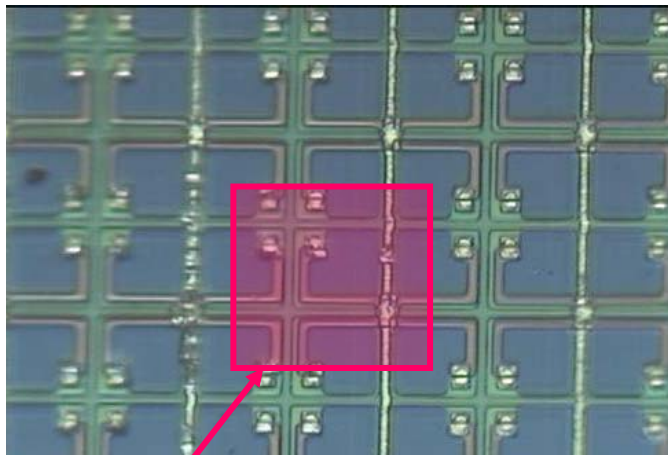
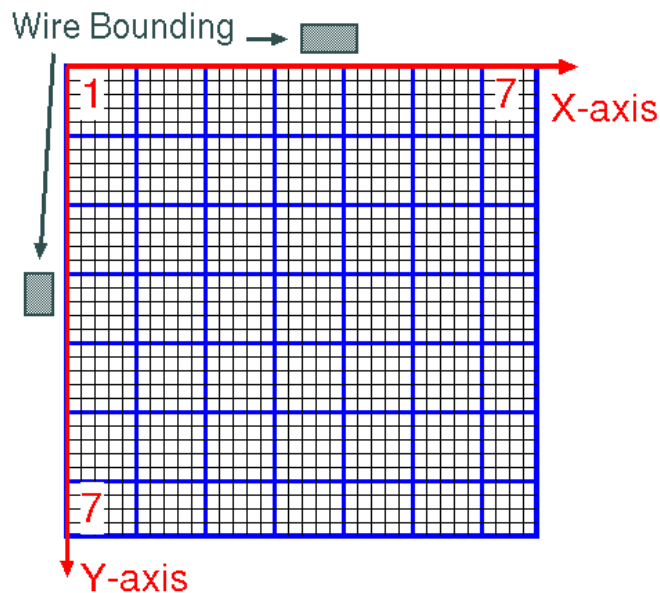


Signal/Noise (TypeB, No2)

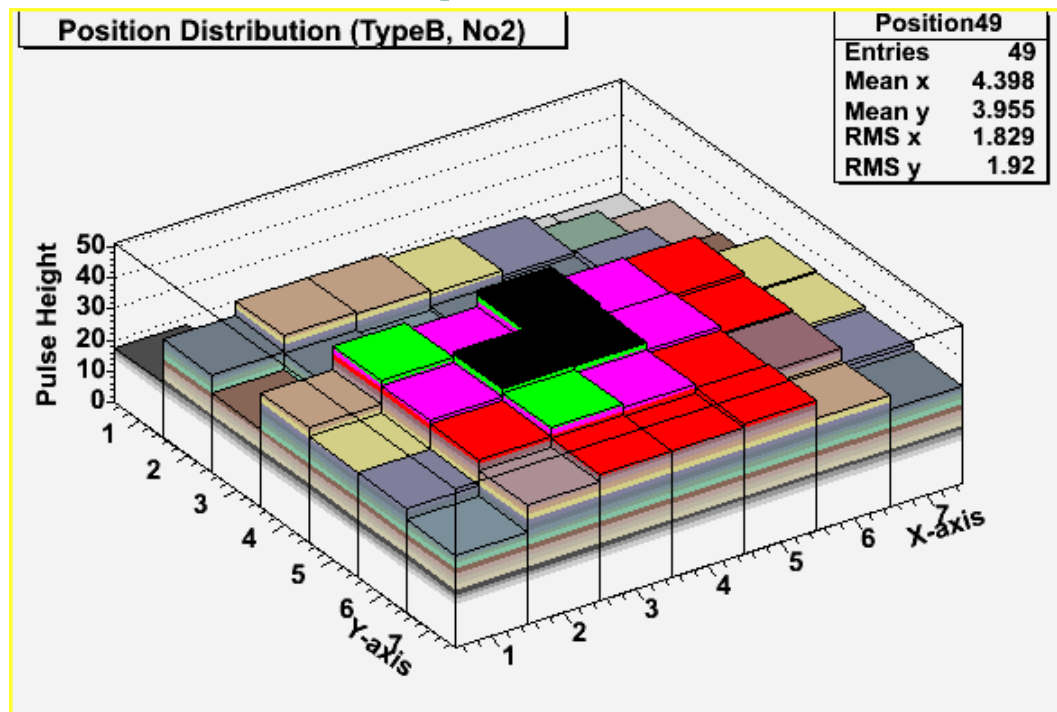


- Noise level (Pedestal sigma) increases for higher voltages
- Best S/N (Pedestal sigma /PH) seems to be achieved around 66.0V ~67.5V

Position dependence of pixel PH



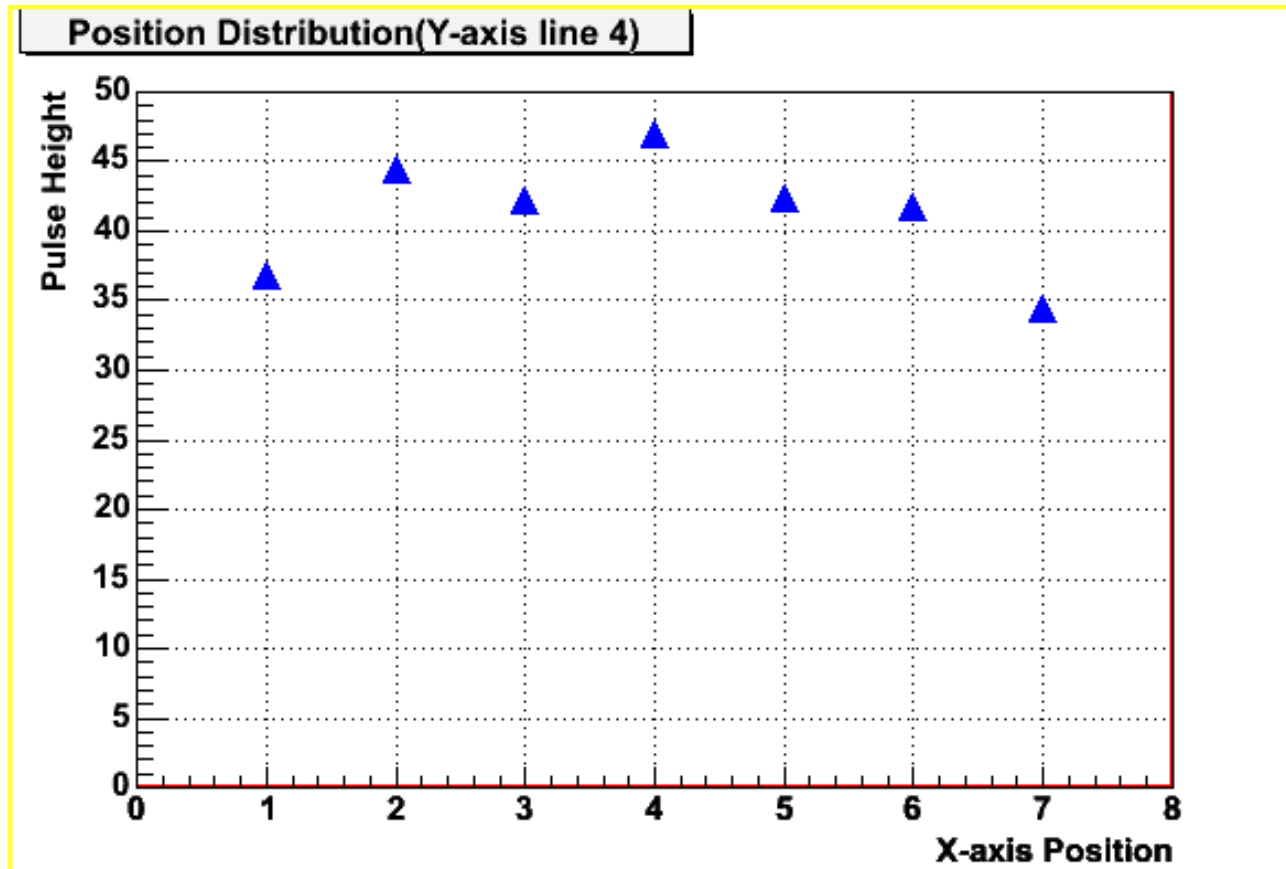
Laser hitting area
(9 pixels)



- Laser wave length : 1064nm
- Sensor bias : 66.5V
- 49points (7x7points) were measured
- Laser output fluctuation: ~10% or less

Central part showed higher PH

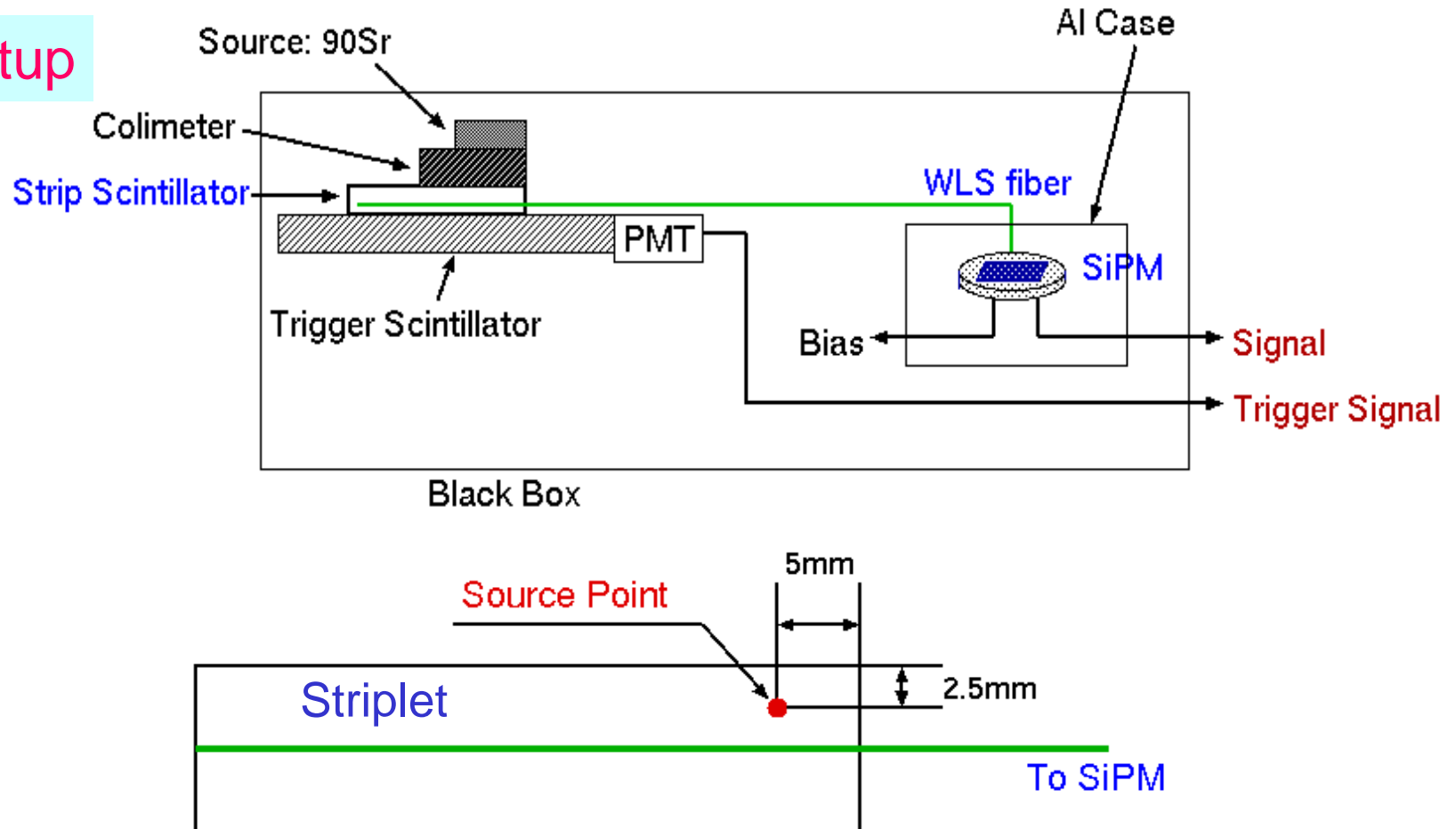
Cross sectional view



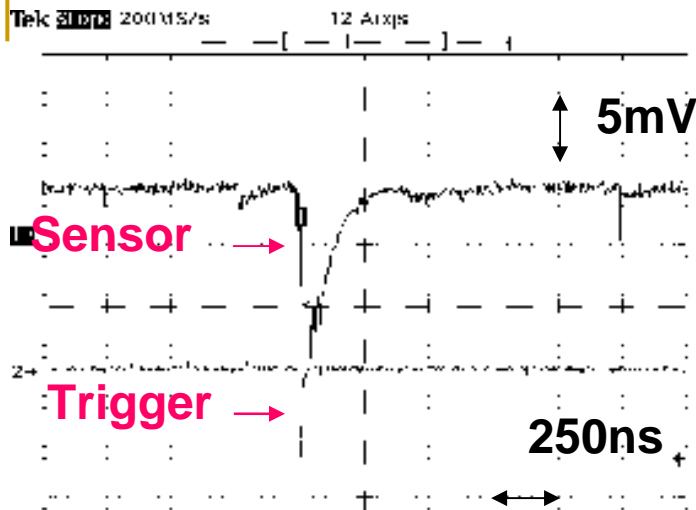
1 pixel = 5 ADC counts

4. Source test of scinti. strip with SiPM

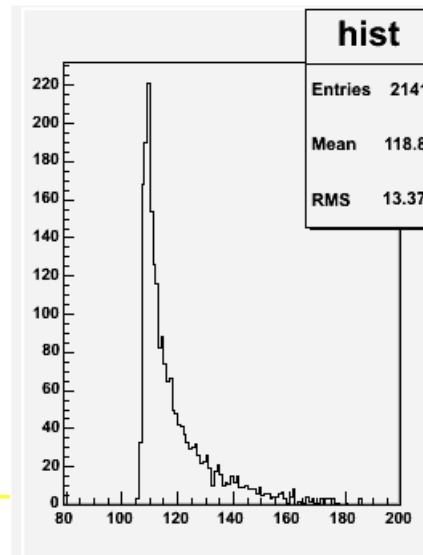
Setup



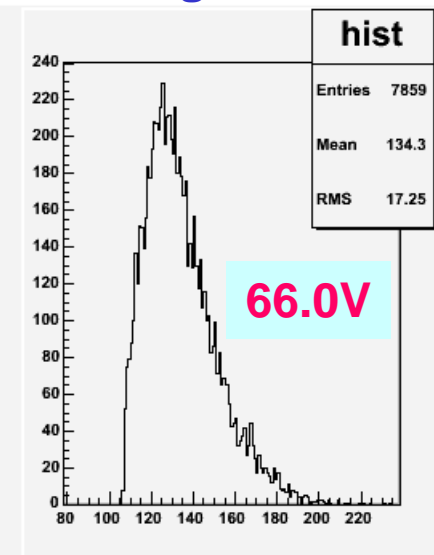
- Sensor scinti. type: 10x40x2mmt striplet
- Surface covering: White paint & Teflon wrapped



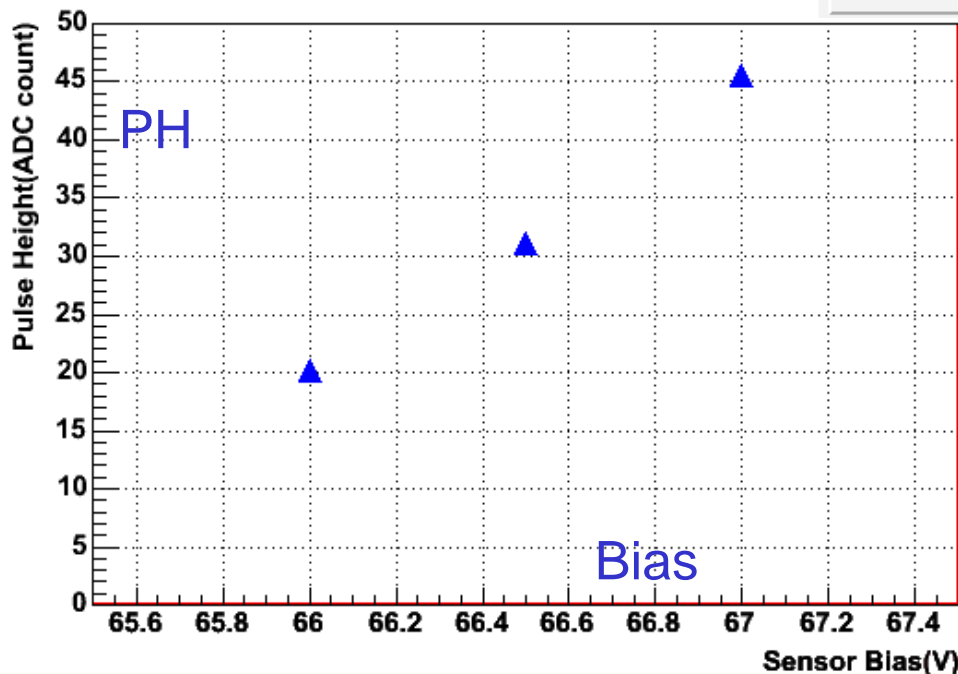
Pedestal



Signal



Bias Distribution(scinti:20x40x2mm)



Comparing ADC counts of laser injection and beta ray signals at same bias voltage (66.5V), the number of photons we observed for beta ray is ~5.

5. Summary

■ Scintillator study

- ❑ White Paint +Teflon is the best surface covering
- ❑ Longer strip-type with shorter WLS fiber has largest PH

■ SiPM study

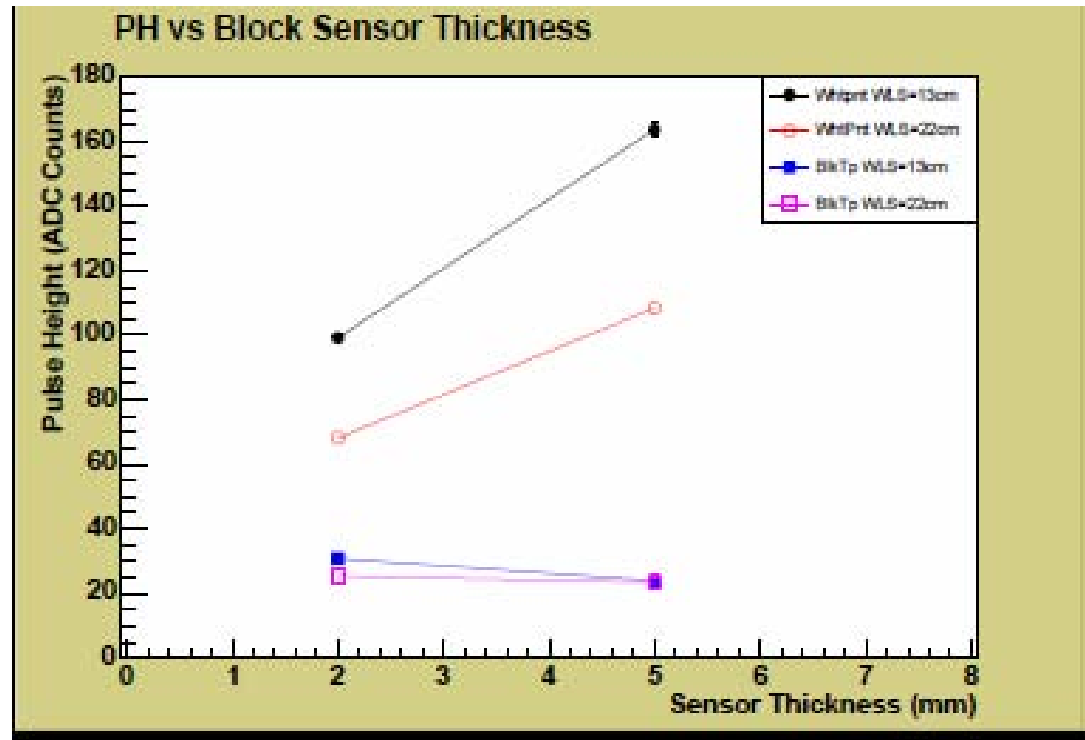
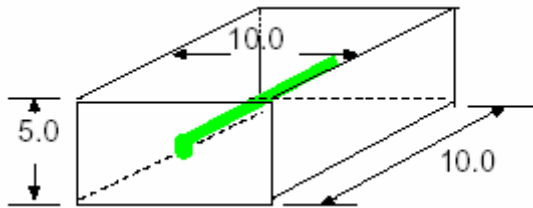
- ❑ Bias voltage dependence of PH, Noise, S/N were measured. For whole area exposure of 1000 pixels SiPM with 532nm laser light, good operation voltage span was $\sim 1.5V$.
- ❑ Central region of SiPM showed higher PH. Need to check more SiPMs.

■ Beta ray signal from scintillator strip with SiPM

- ❑ Signal was observed for 10x40x2mmt striplet
- ❑ Number of photons: ~ 5

予備

PH vs Block Type Scintillator Thickness



- Compare the PH vs thickness
- 5mm thick scintillator had greater PH

Photon number of scintillator and SiPM measurements

- Position distribution(1064nm)
 - Laser insert into 9 pixels
 - Saturation occurred -> 9 photons yielded
 - 66.5V : PH=47 (ADC count)
 - **5.2 (ADC count) / 1 photon**
- Connection scintillator and SiPM
 - 66.5V : PH=31 (ADC count)
 - **~6 photon yielded**

