

scintillator ECAL status report

Shinshu
University

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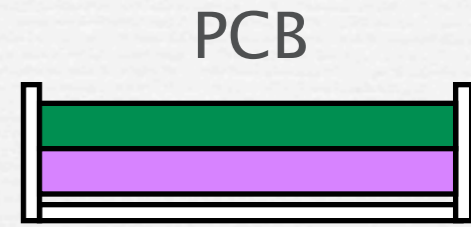
Shinshu
University

for CALICE meeting at Annecy 2013

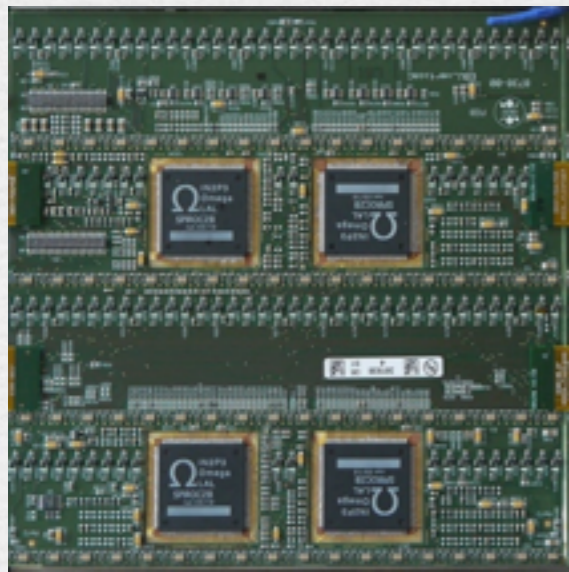
- (1) ScECAL beam test with SiECAL at DESY covered by Tomo.
- (2) MPPC progress
- (3) scintillator strip study

EBU + ECALA-Slab

- ☛ Slab made by LLR : U shape
- ☛ EBU contains scintillator sensors and read out electronics including SPIROC2b
- ☛ mechanical combination photo

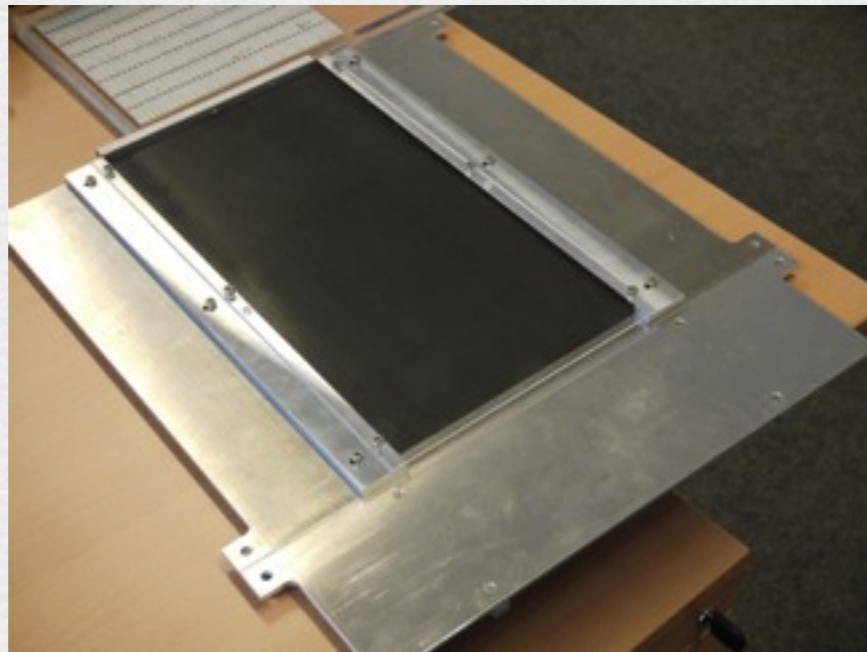


EBU

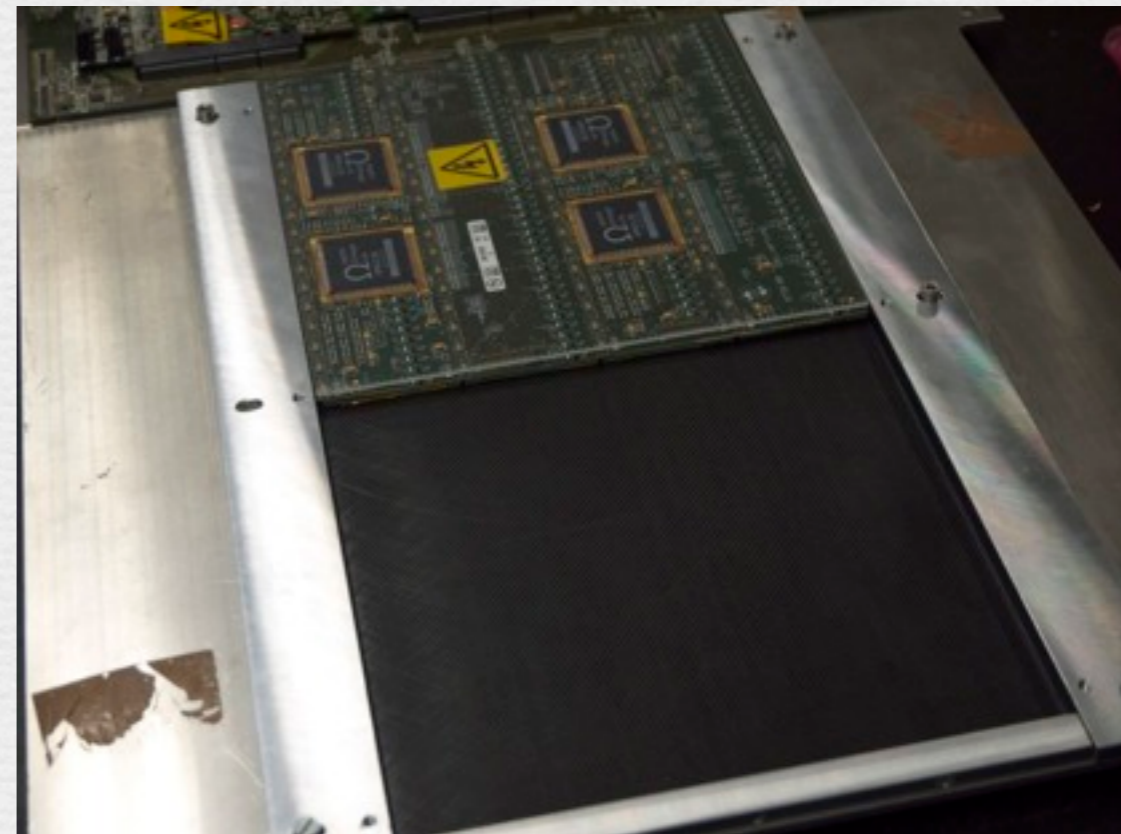


18x18cm²

U structure

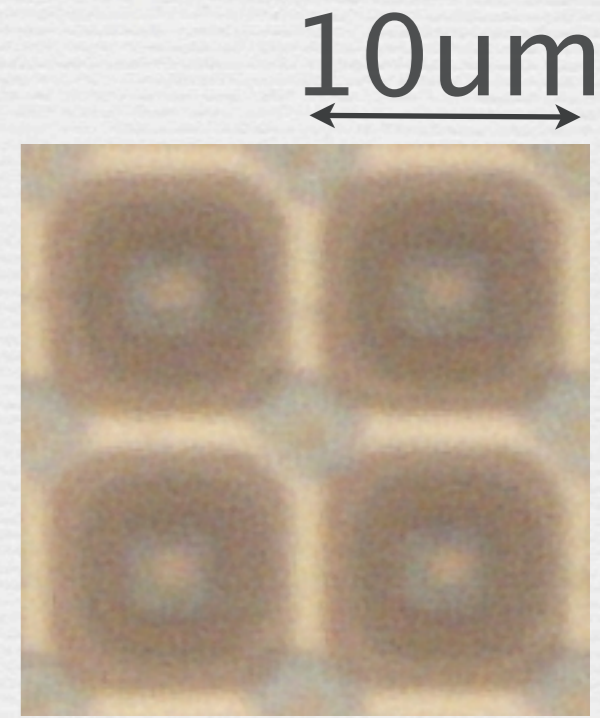


EBU in U



PPD: MPPPC

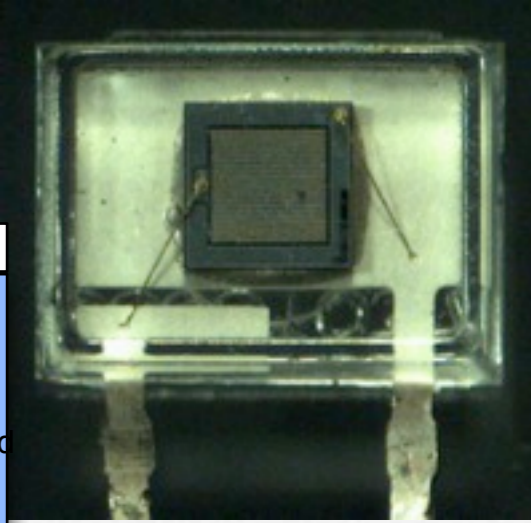
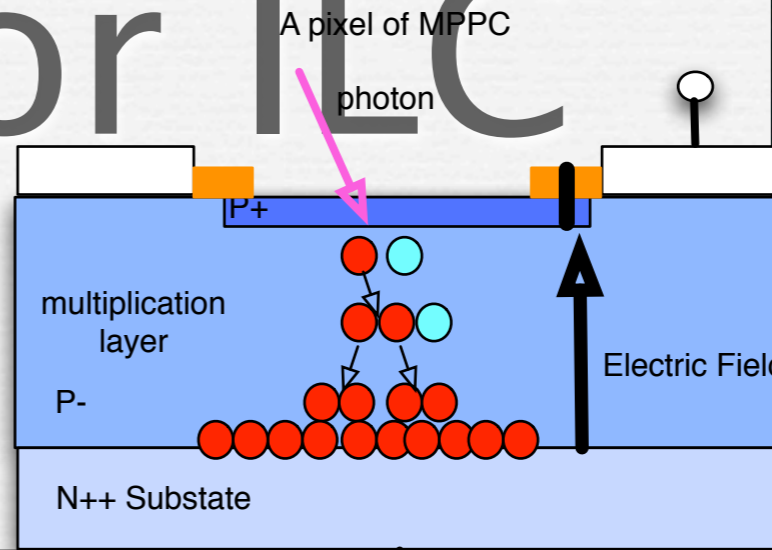
- new type of MPPPC will be available in a couple of week from HPK, where the quenching registor will be replaced by **metal(MR)** from poly-silicon (PSR)
- actively area can be expanded significantly
- now 10000 pixels (10um pitch) in 1mmx1mm is fabricated



MPPCs for ILC

in 1mm x 1mm active area

≥ 1600 pixels

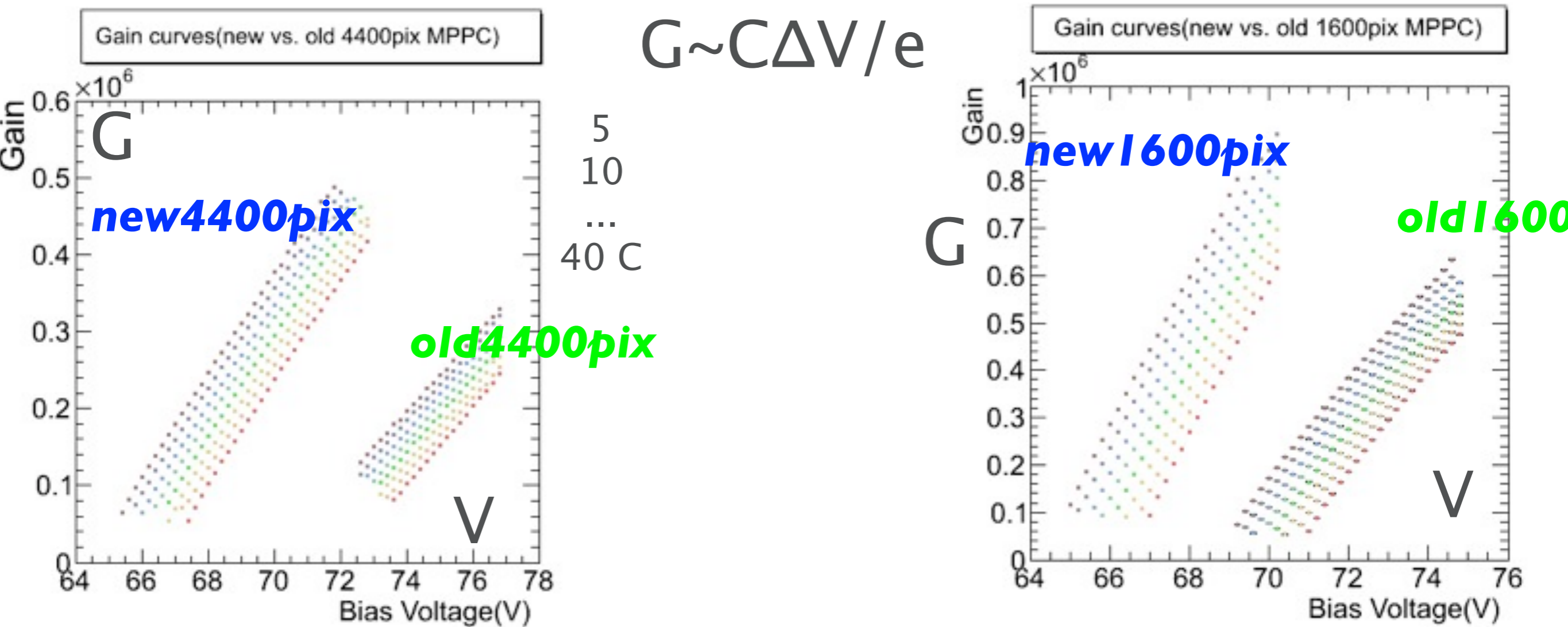


ILC-package

Npixels	pitch (um)	gain (10^5)	C(fF)	old PR	+Vbias	new MR
1600	25	2.7	17			
2500	20	2.0	12			X
4400	15	2	10			
10000	10	2	5	X		

old vs new MPPC

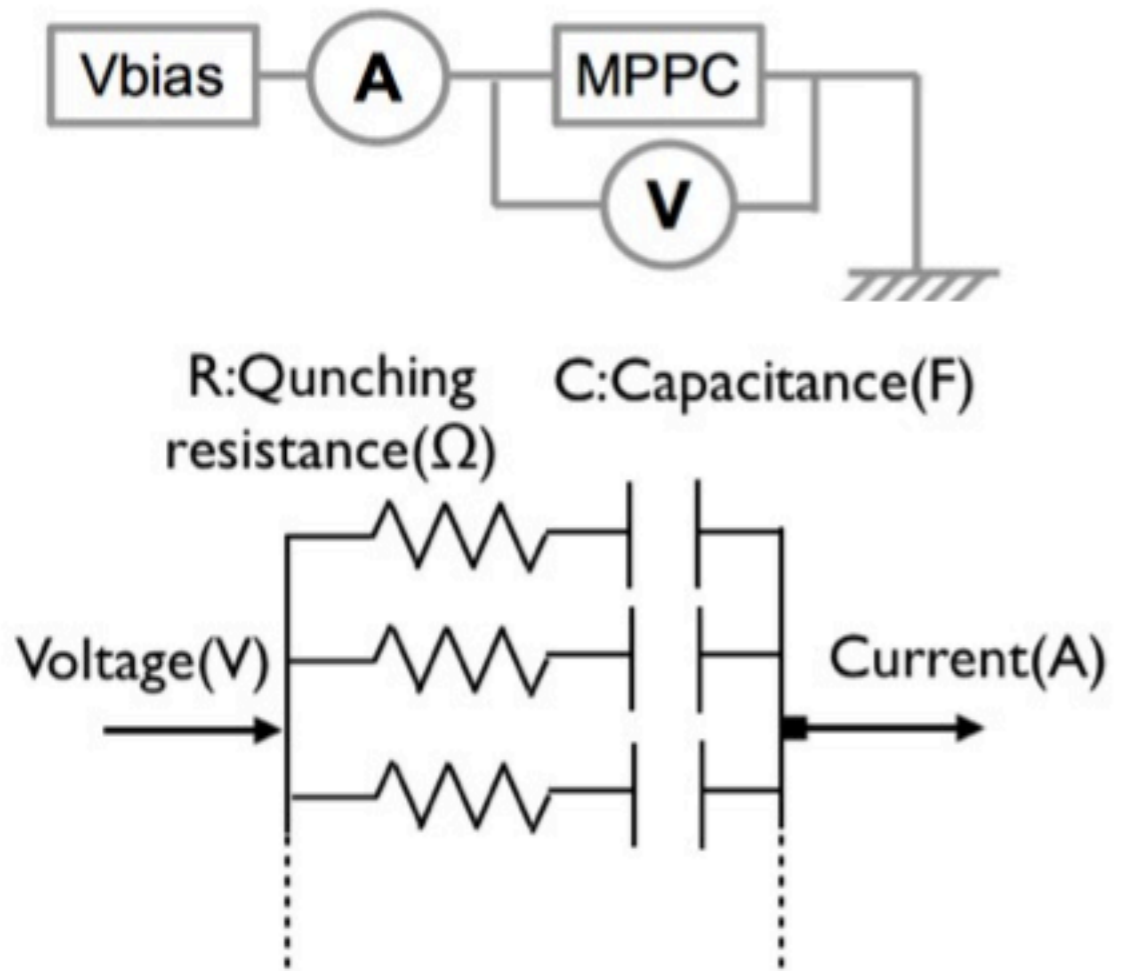
- R. Hamasaki : gain measurement vs Vbias
temperature: 5~40C



New MPPCs have bigger C ~Area
similar temp.dep.

new vs old MPPPC cont.

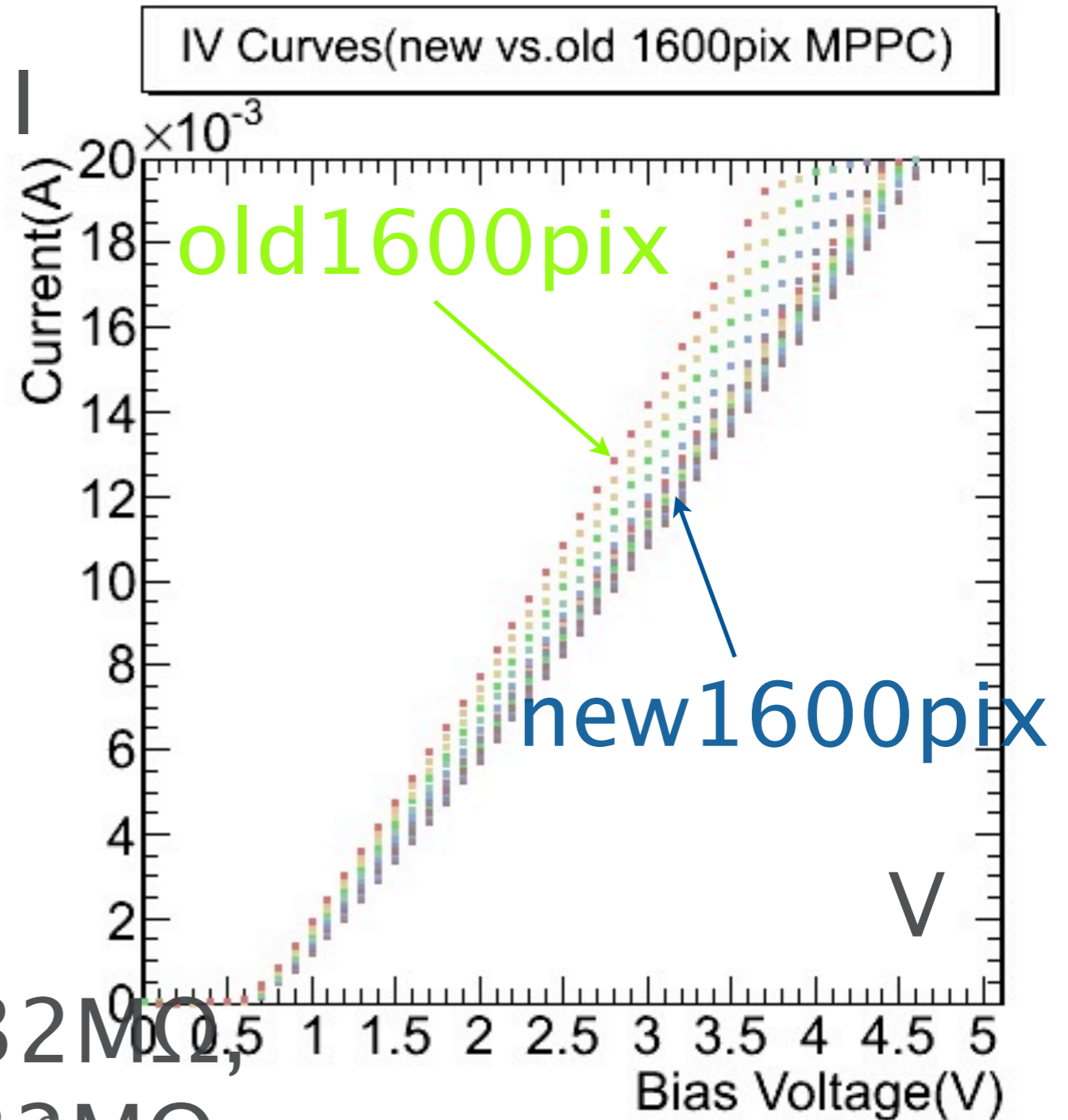
- IV curve : smaller temperature dependence for new
- similar quenching resistor a bit smaller temp.dep.



$$V = R_{total} I = \frac{1}{\sum_i^n \frac{1}{R_i}} I_i$$

$R_{new} \sim 0.32 M\Omega$,

$R_{old} \sim 0.32 M\Omega$



new vs old MPPCs cont.

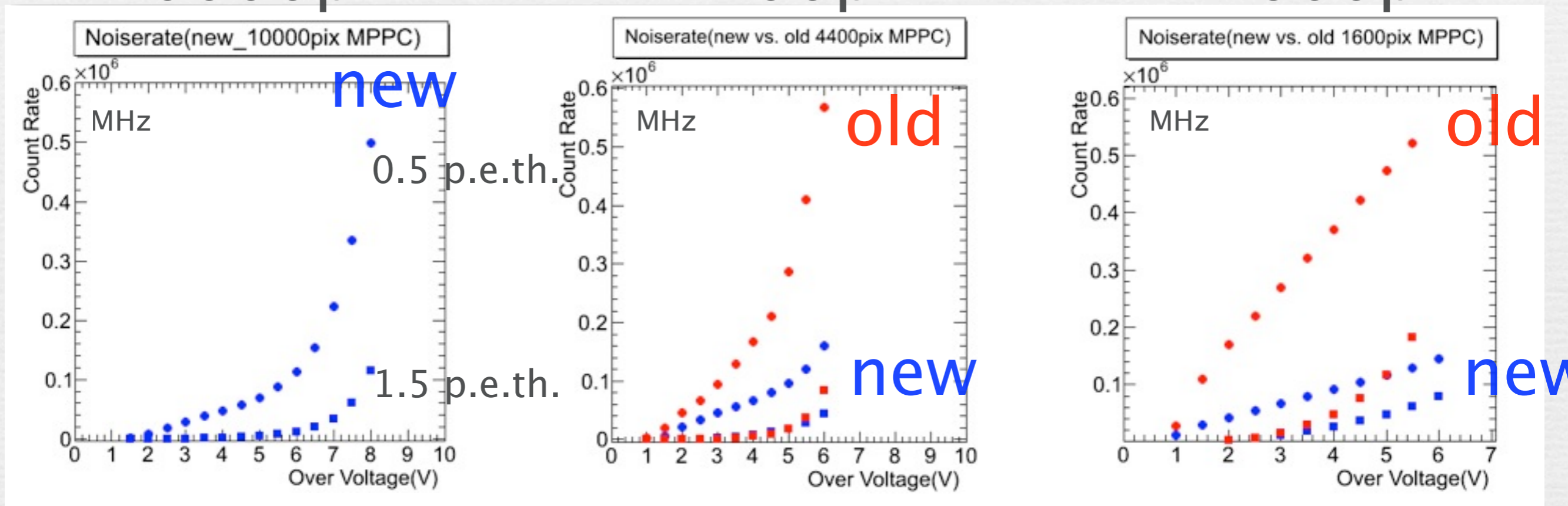
dark noise rate

threshold at 0.5 p.e. and 1.5 p.e.

10000pix.

4400pix.

1600pix.



very good improvement
less than 1/2~1/3

ΔV

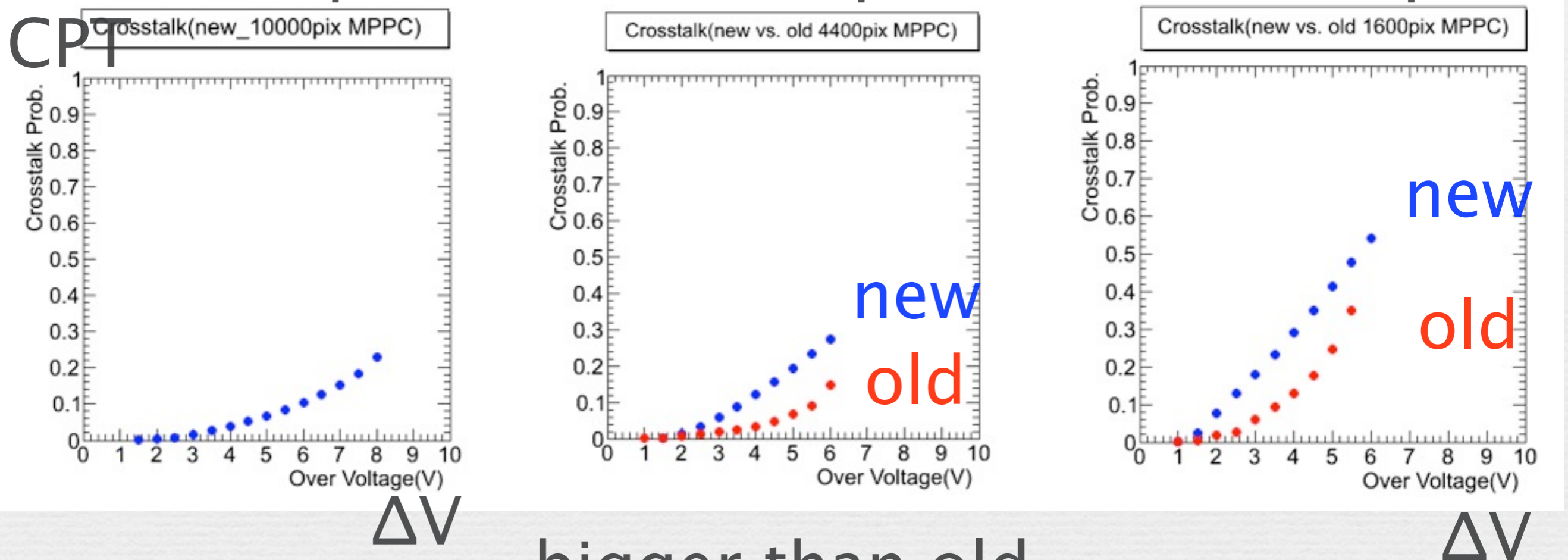
new vs old MPPCs cont.

- ☛ cross talk probability (CPT)
- ☛ $= N(> 1.5 \text{ p.e.}) / N(> 0.5 \text{ p.e.})$

10000pix.

4400pix.

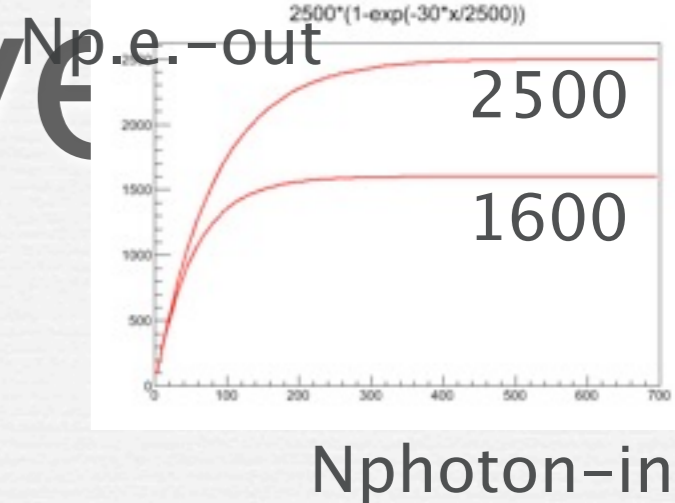
CPT 1600pix.



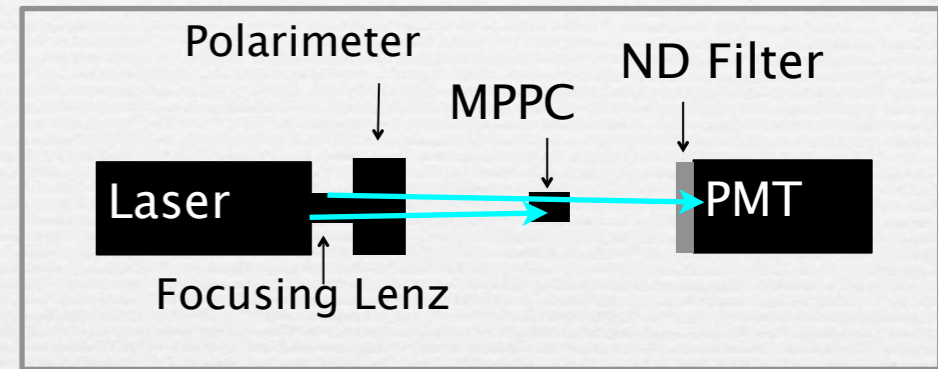
bigger than old

Thus HPK produced with trench version

response curve for old MPPCs



PPD has non-linearity due to limited numbers of pixels in the sensitive area \leftrightarrow non-linearity

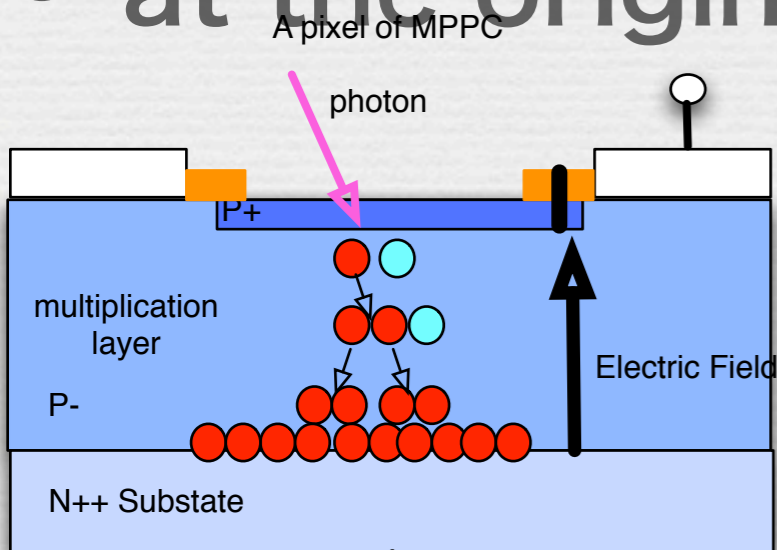


direct measurement with blue picosec-laser $< 10ps$

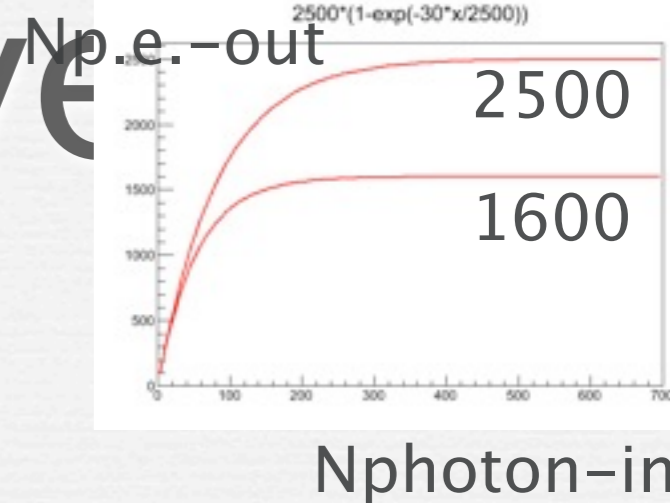
N_{out} old MPPCs
2500
1600

at the origin, $N_{out}/N_{in}=1$

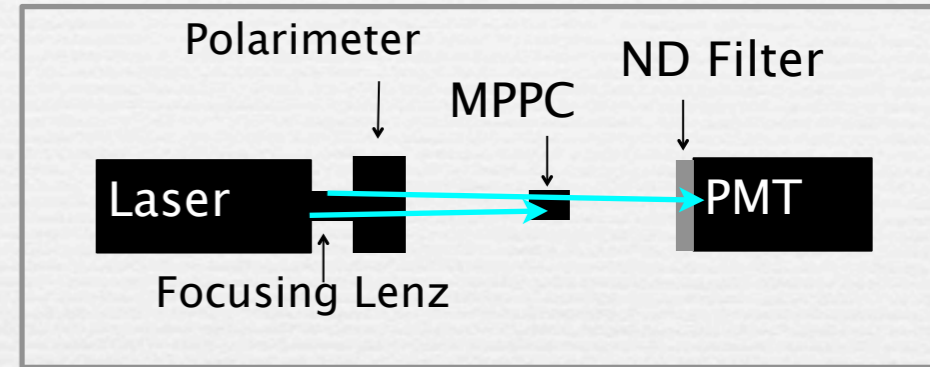
N_{in}



response curve for old MPPCs

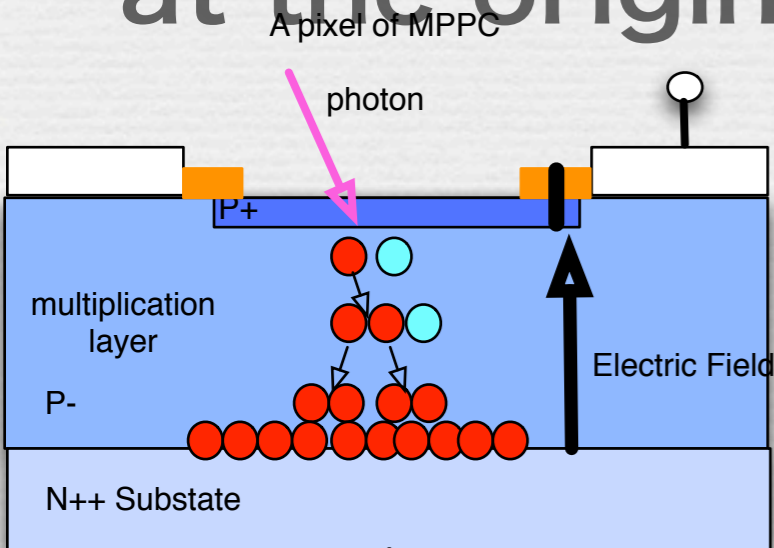
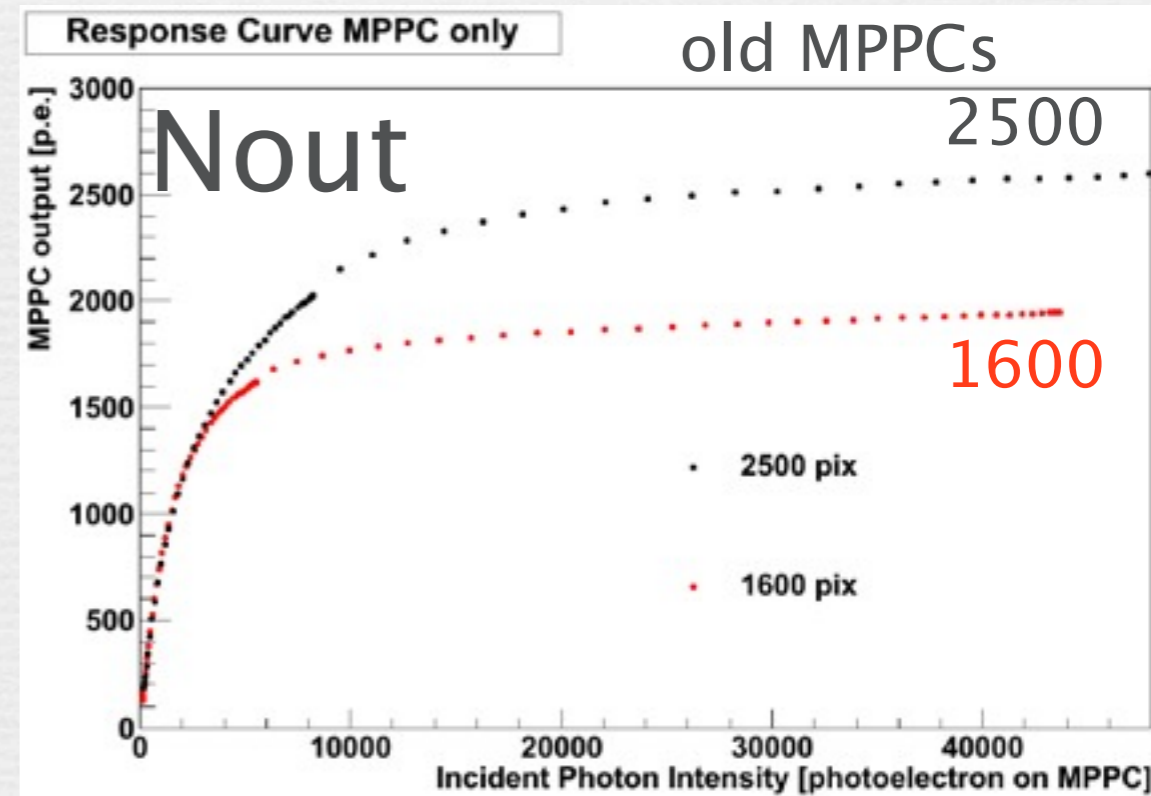


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direct measurement with blue picosec-laser $< 10\text{ps}$

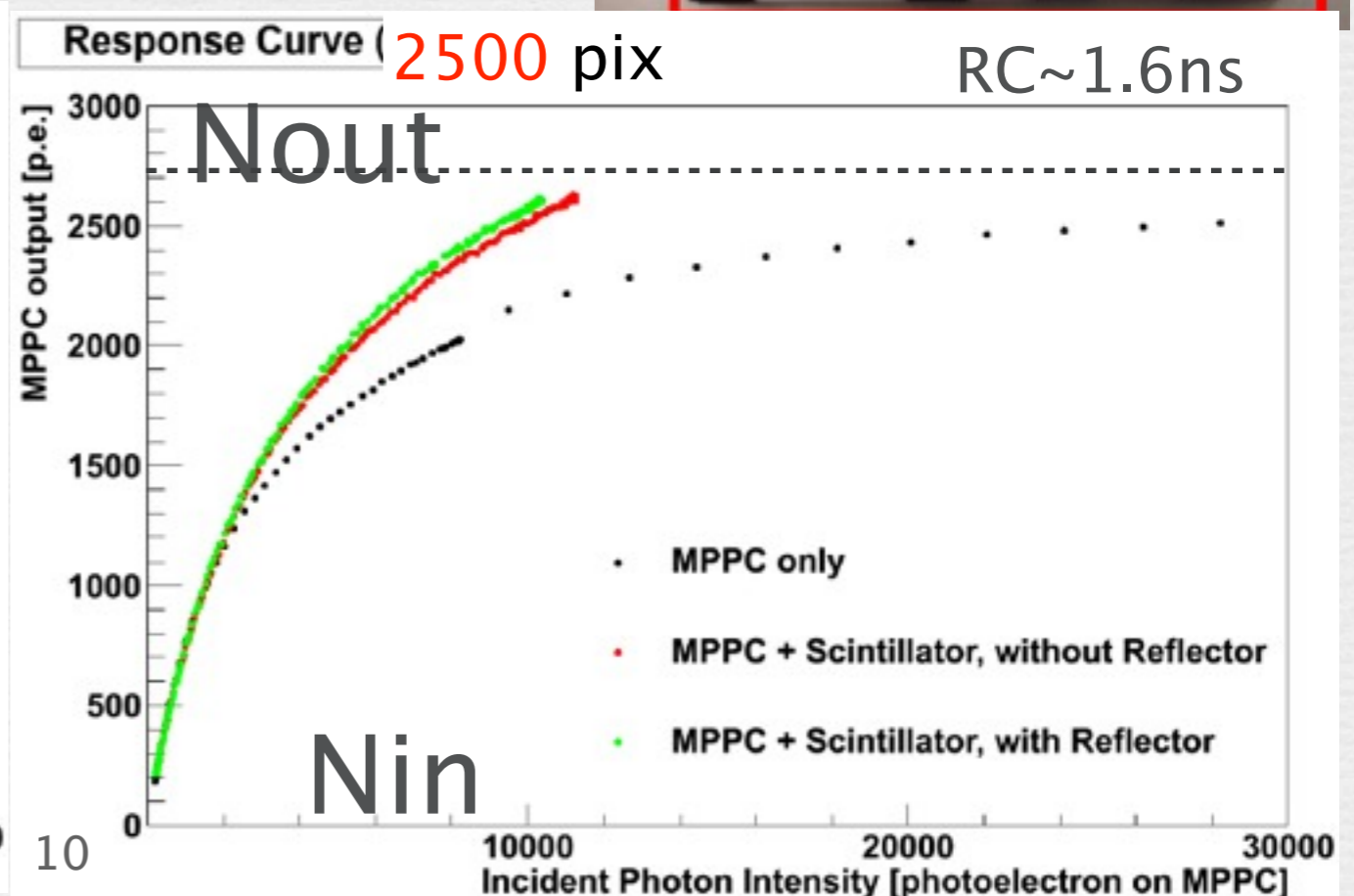
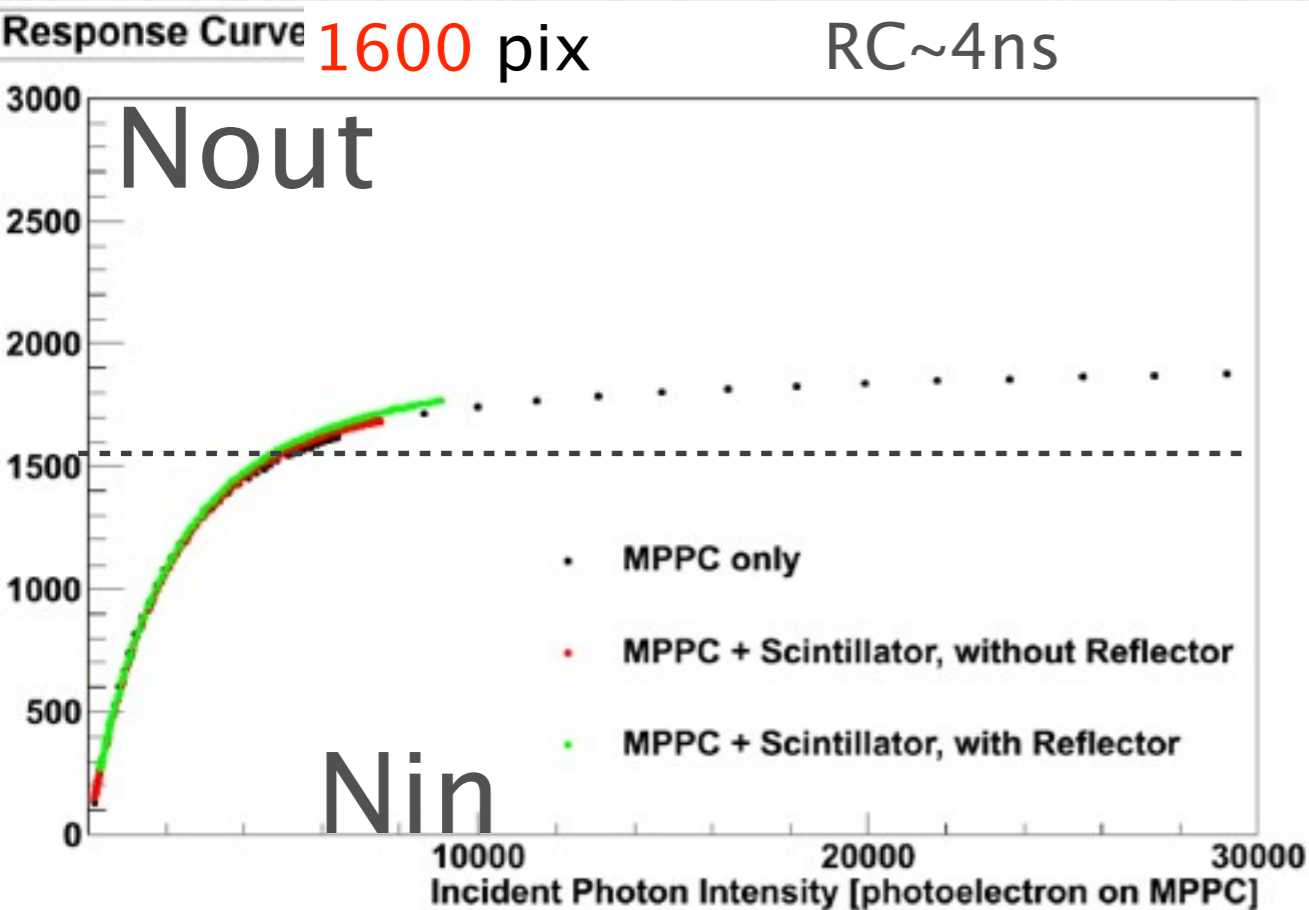
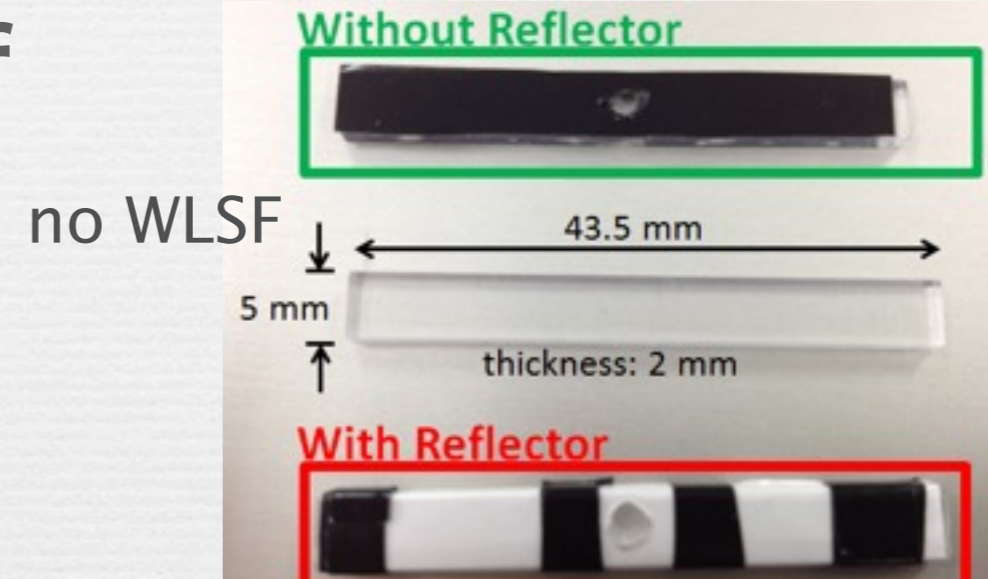
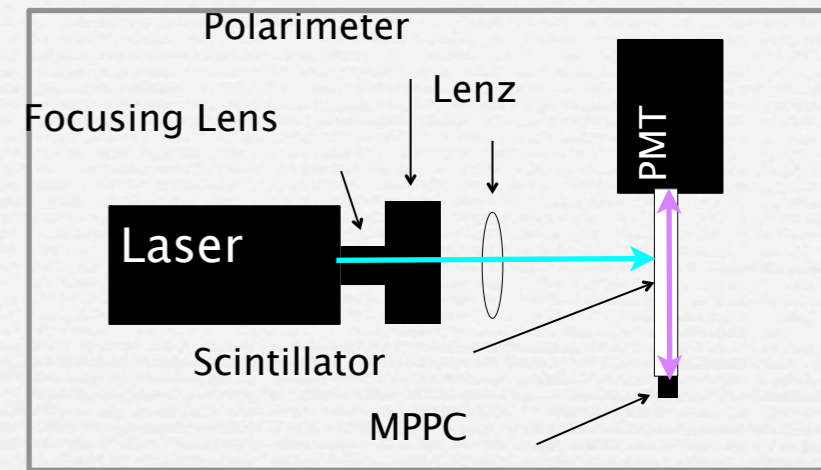
at the origin, $N_{out}/N_{in}=1$



strip response

- scintillator emits sc-lights with some time variation
- thanks to rapid recovery of pixel response
- response curve improved with **old** MPPCs

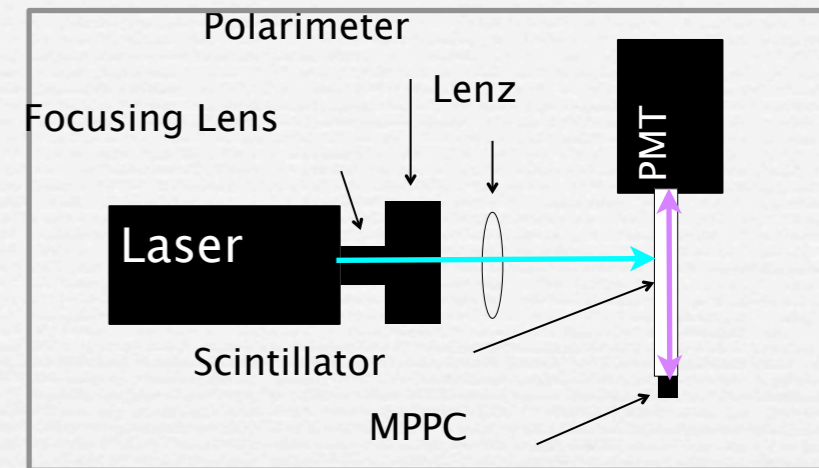
Thermostatic chamber(15 °C)



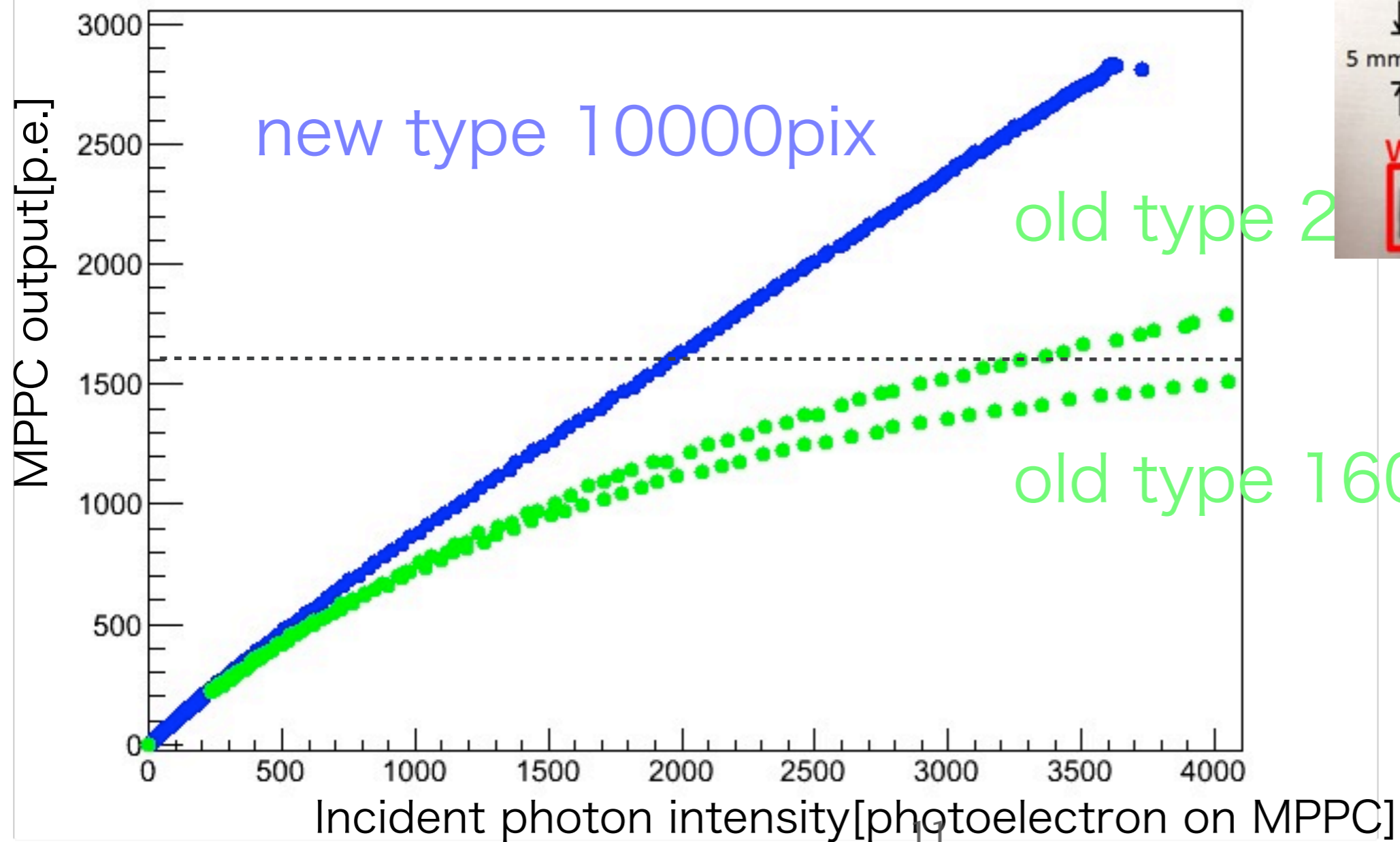
strip response

- new MPPC 10000 pixel
- compare relative outputs

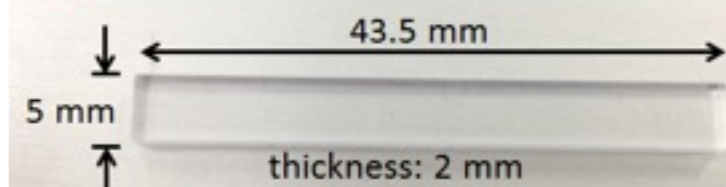
Thermostatic chamber(15 °C)



Graph For Break down voltage



Without Reflector

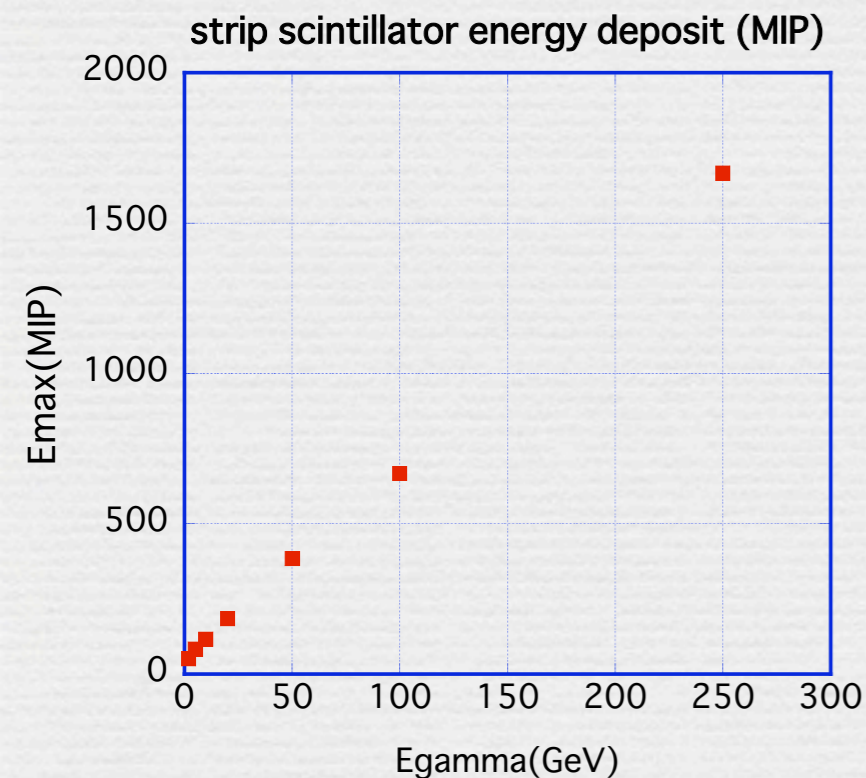
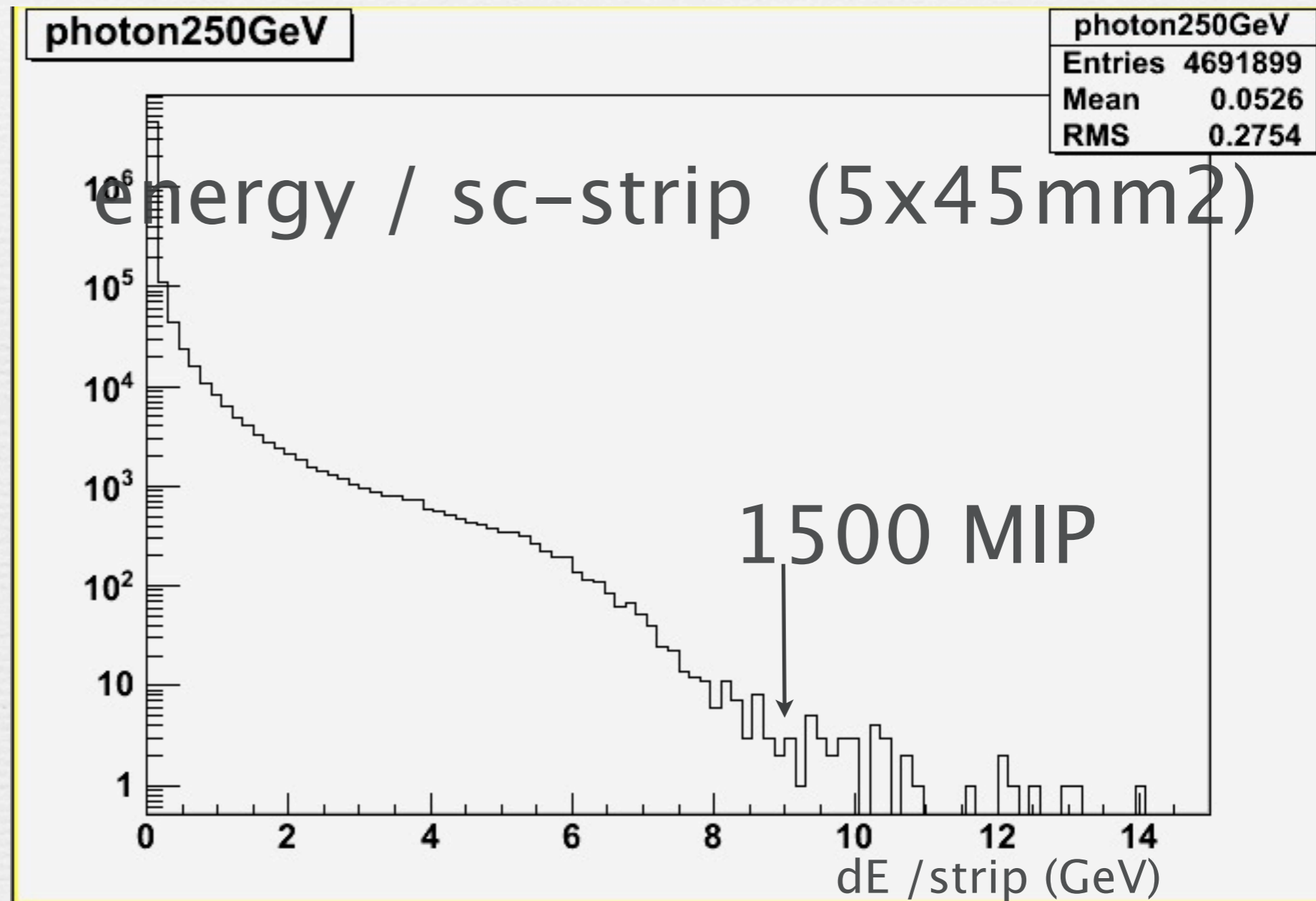


With Reflector



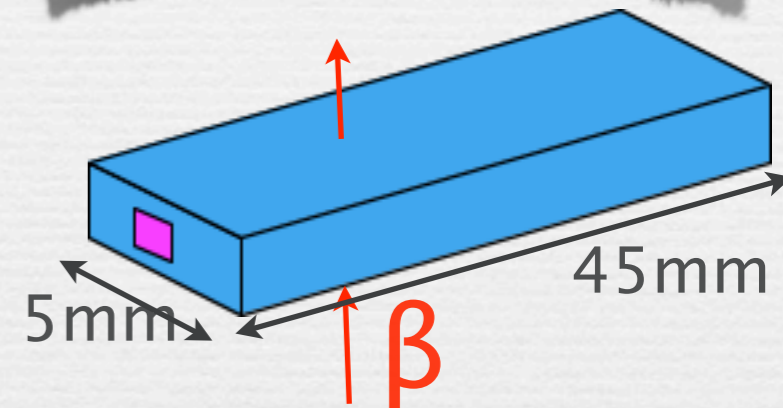
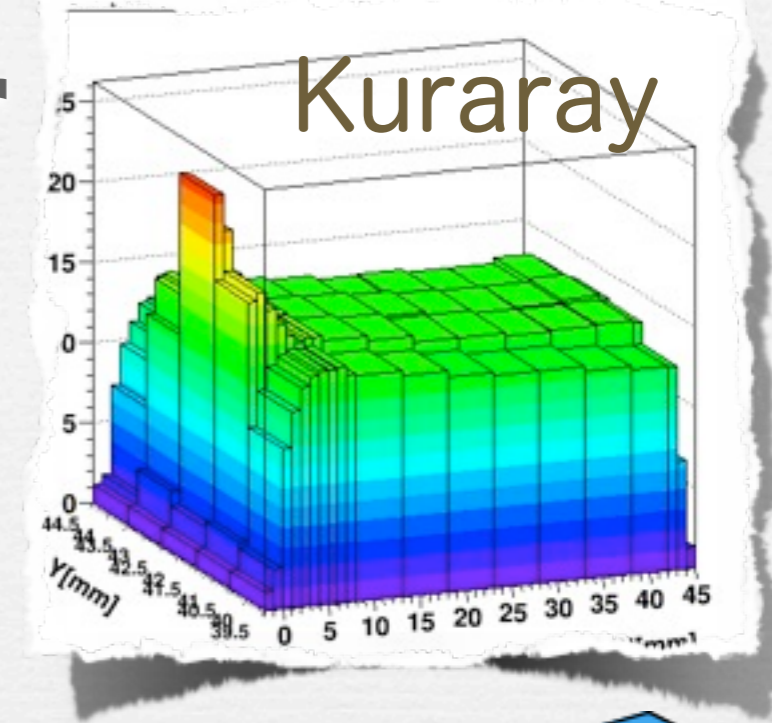
Max energy observed

- by a scintillator strip
- for Bhabha events of 250GeV
- 1500 MIPs
- ~ 10500 p.e.
- if 7p.e./MIP

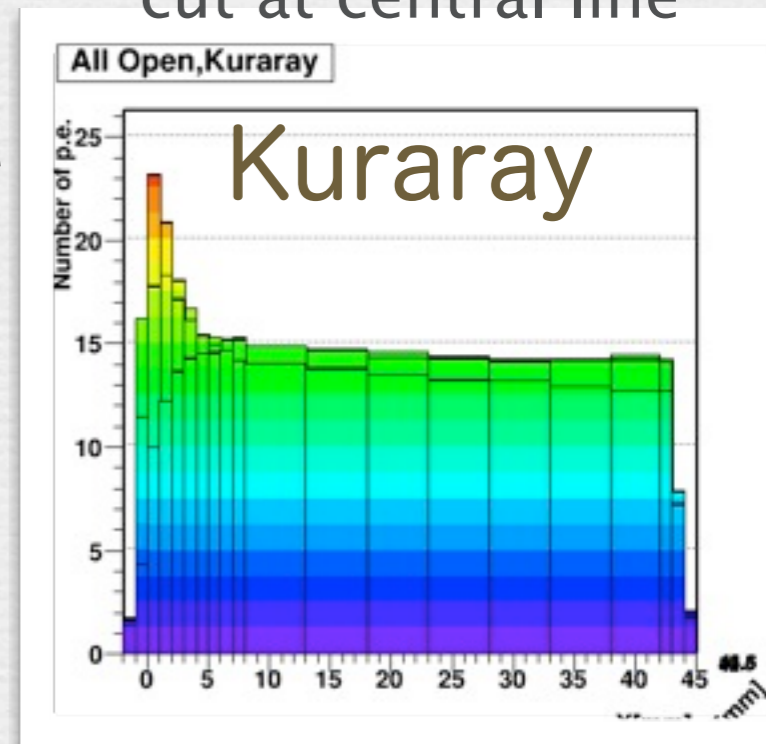


strip scintillator

- Np.e. by MIPs depending on the location
- base line : Kuraray 2mm thick, 5x45mm²
- fairly uniform : wrapped by reflector film
- 13 p.e. except in front of the MPPC
- direct solid angle gives the effect
- MPPC is standing on the FPC : difficult to install

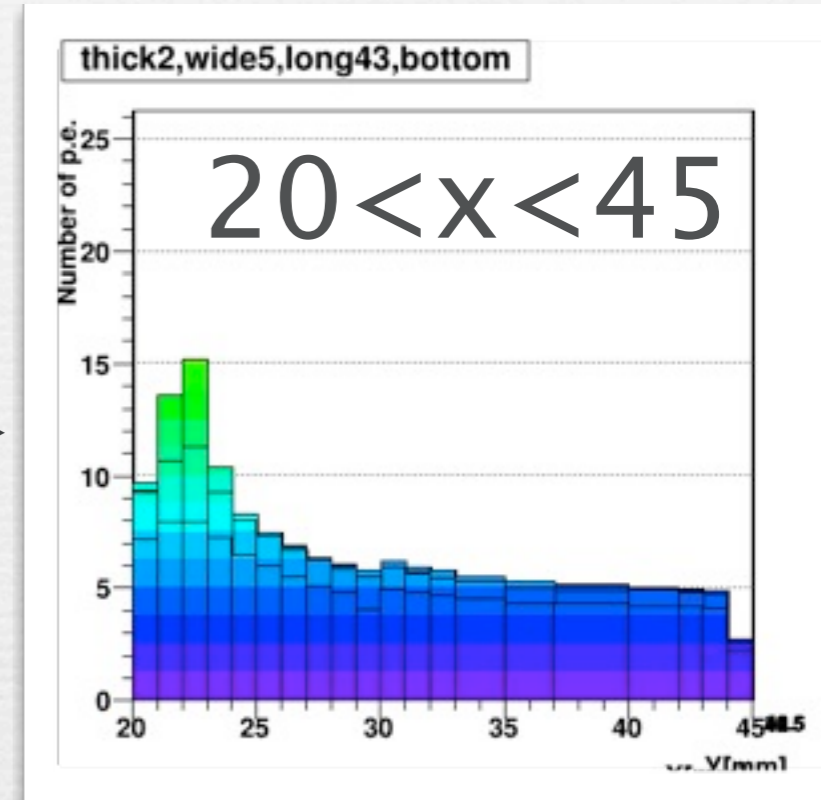
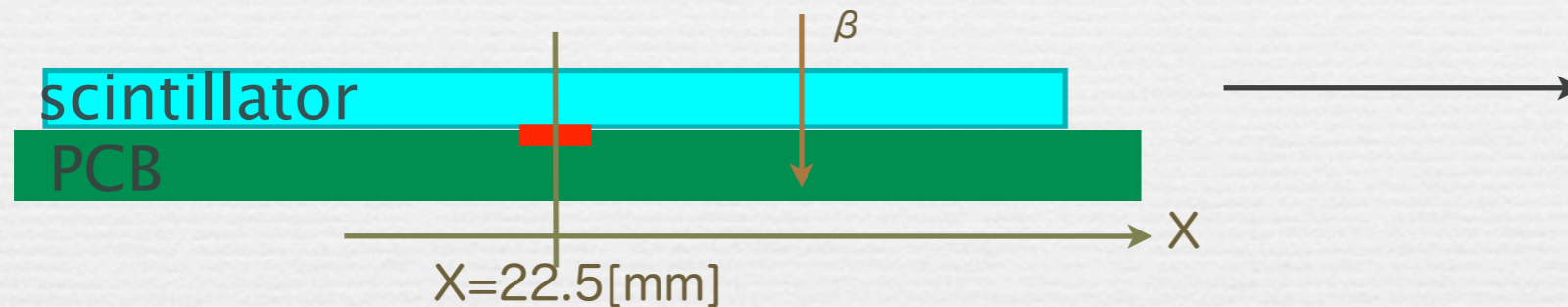


cut at central line



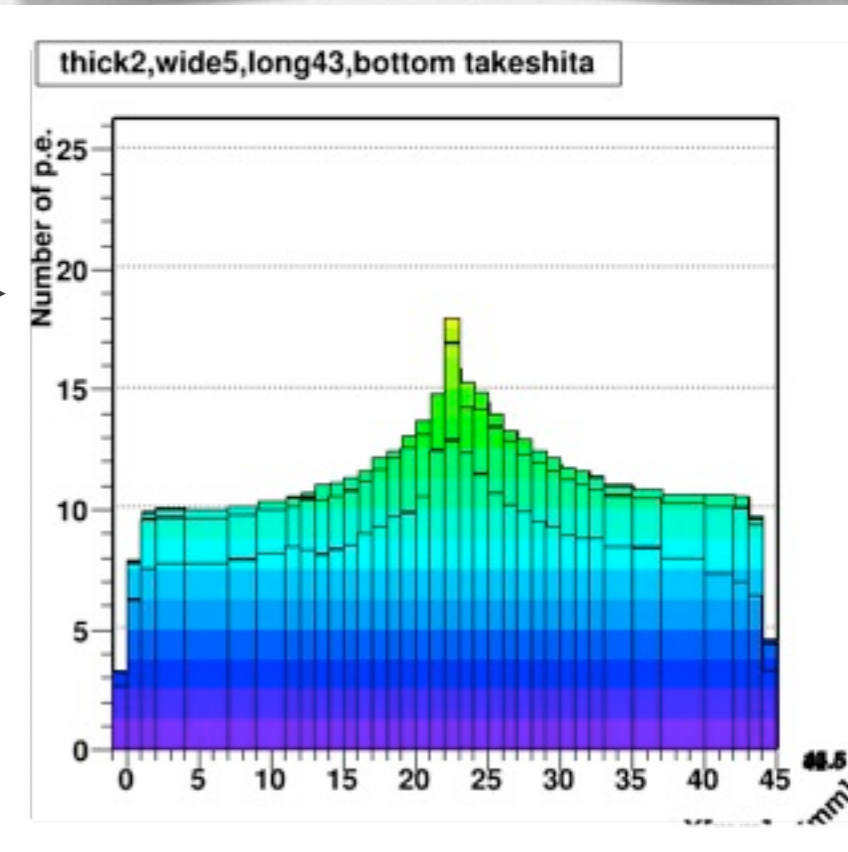
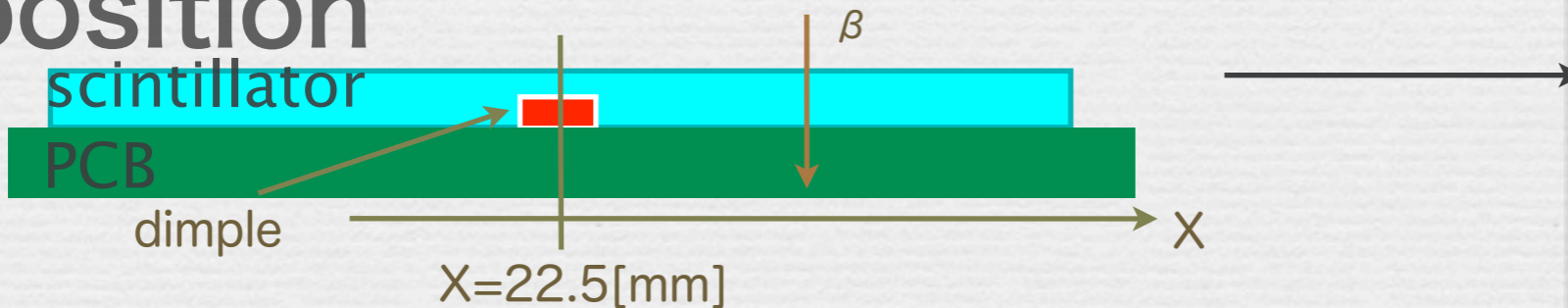
strip read out vs uniformity

- MPPC on the PCB board
- simplest : Np.e. ~ 5 : too small
- PCB is in a hole

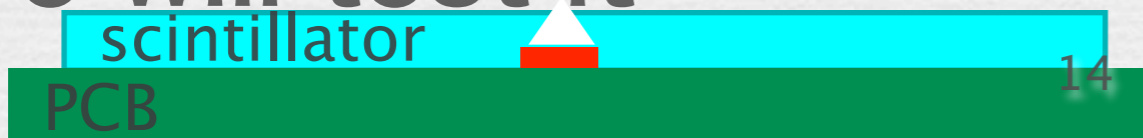


with a dimple, MPPC is soldered easily

- Np.e. ~ 10 , except MPPC position



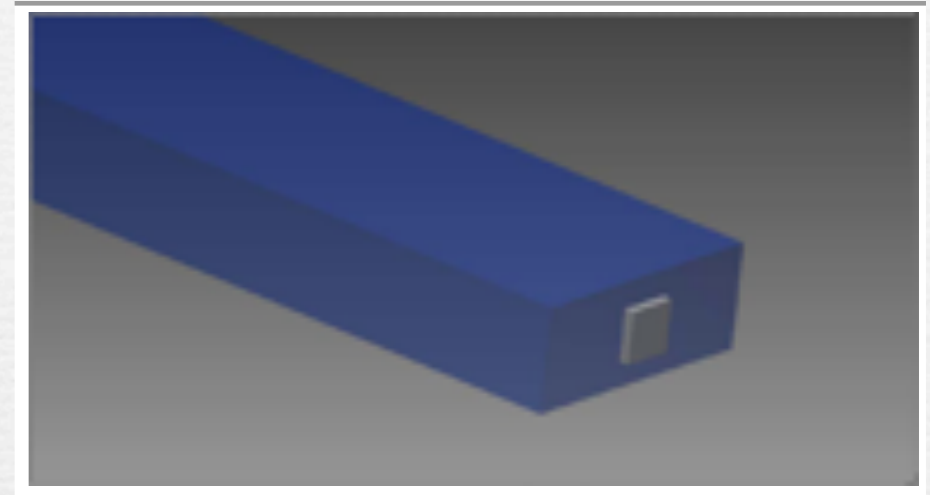
- we will test it



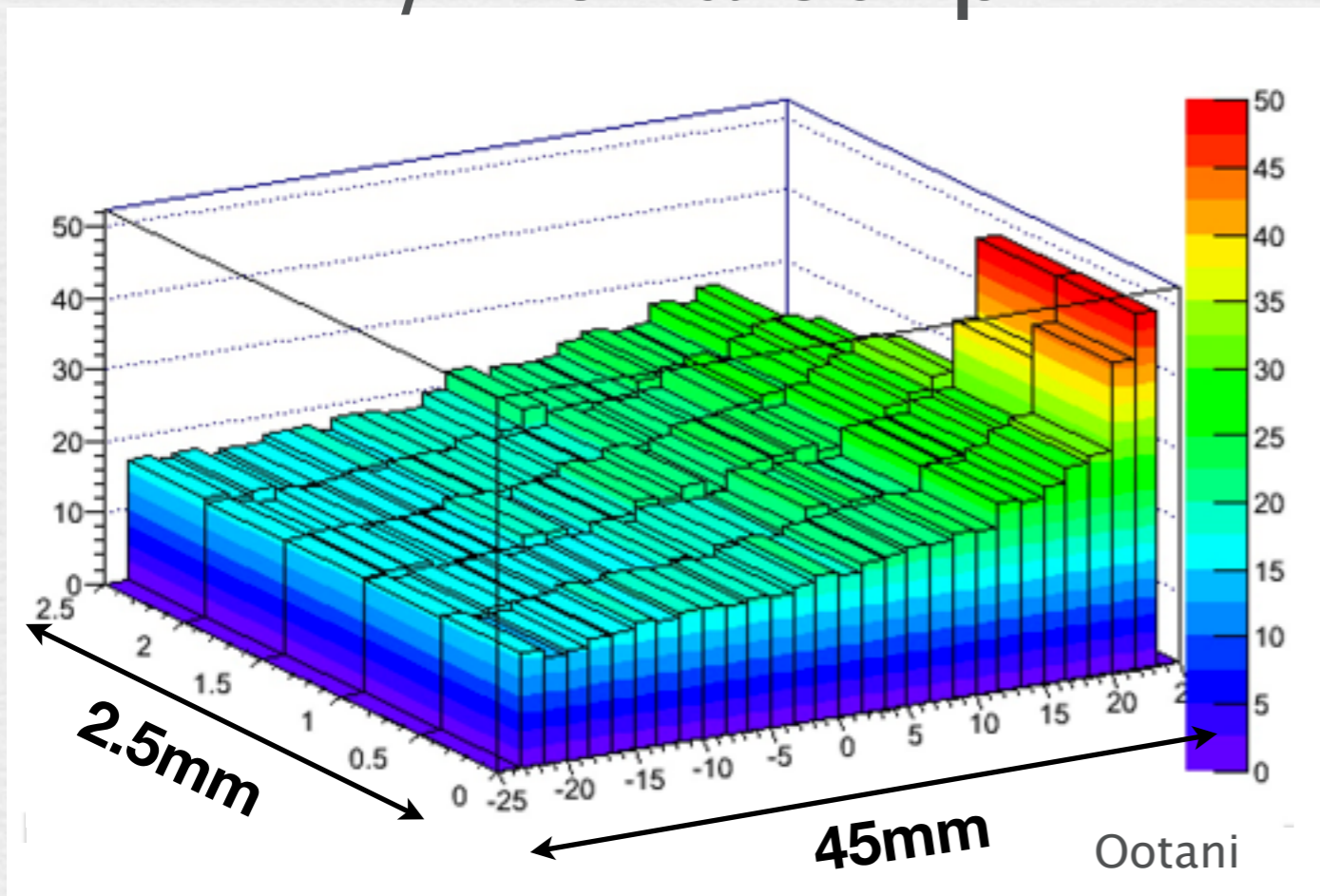
scintillation light simulation

- to study uniformity & amount of photons

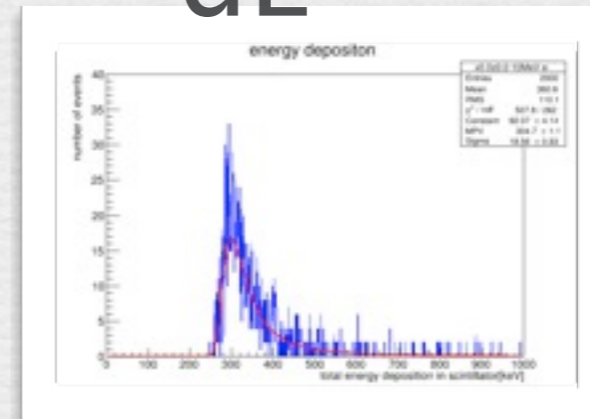
1/4 of a strip



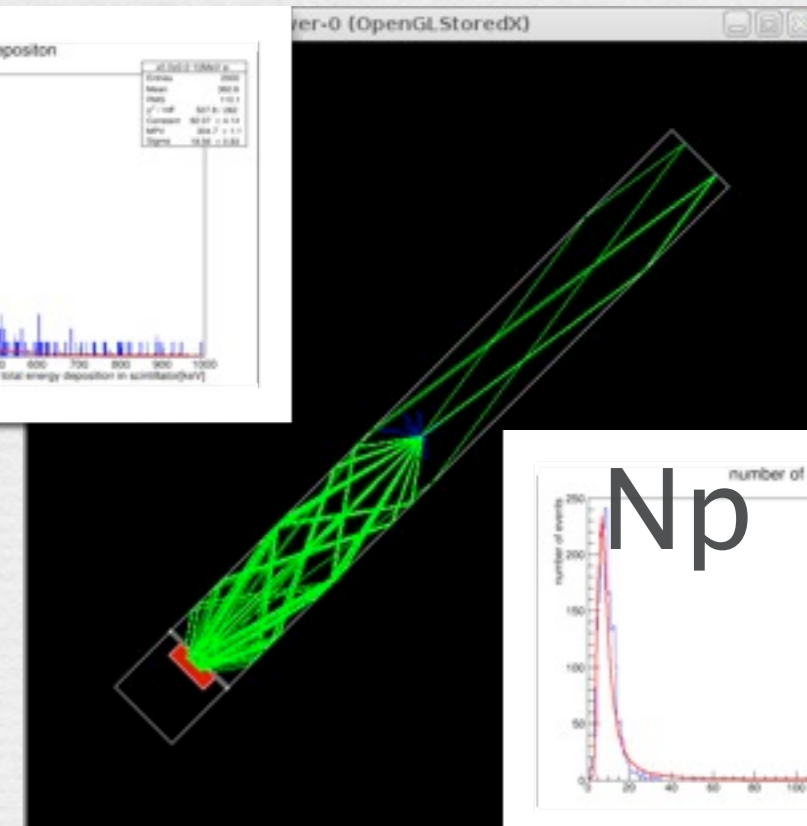
Ootani



dE



Tsuzuki

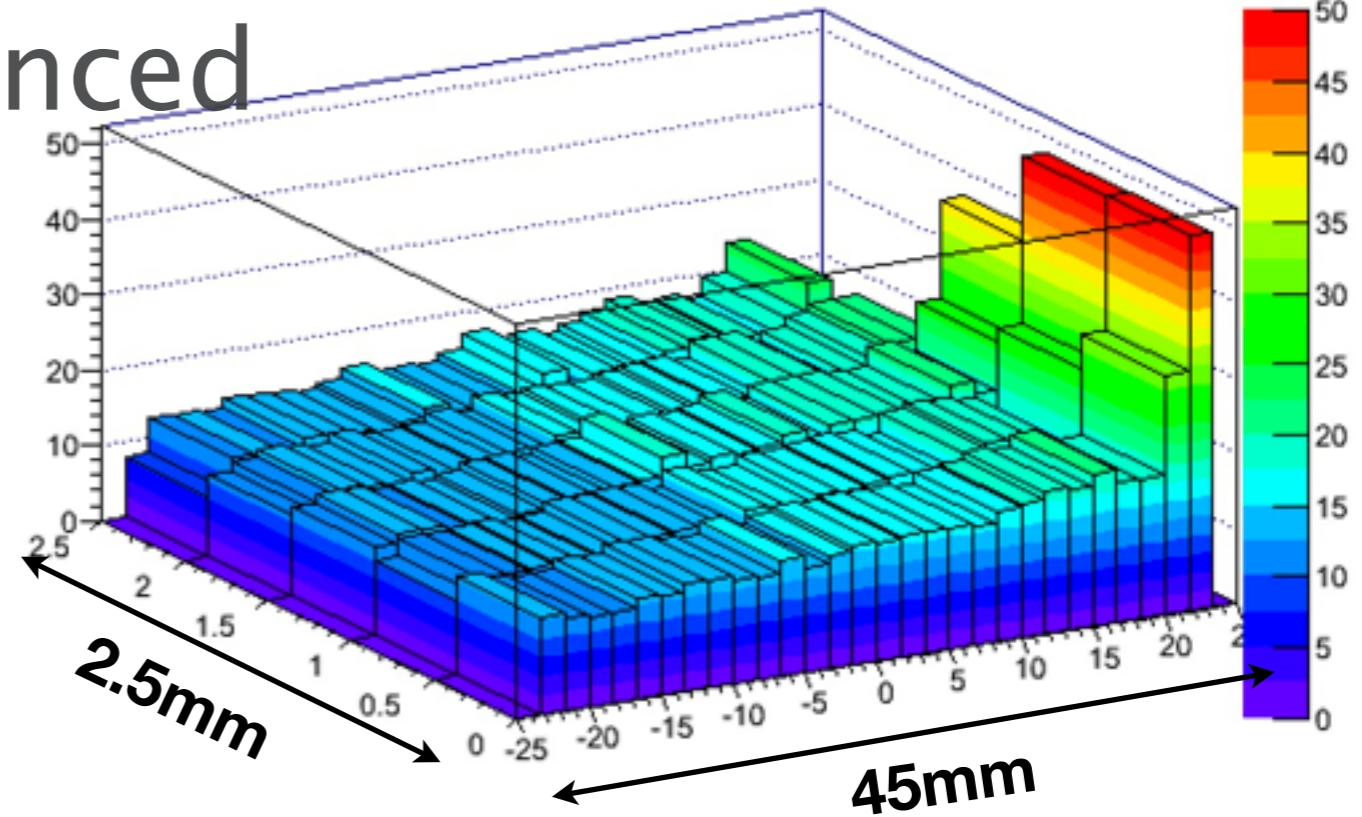
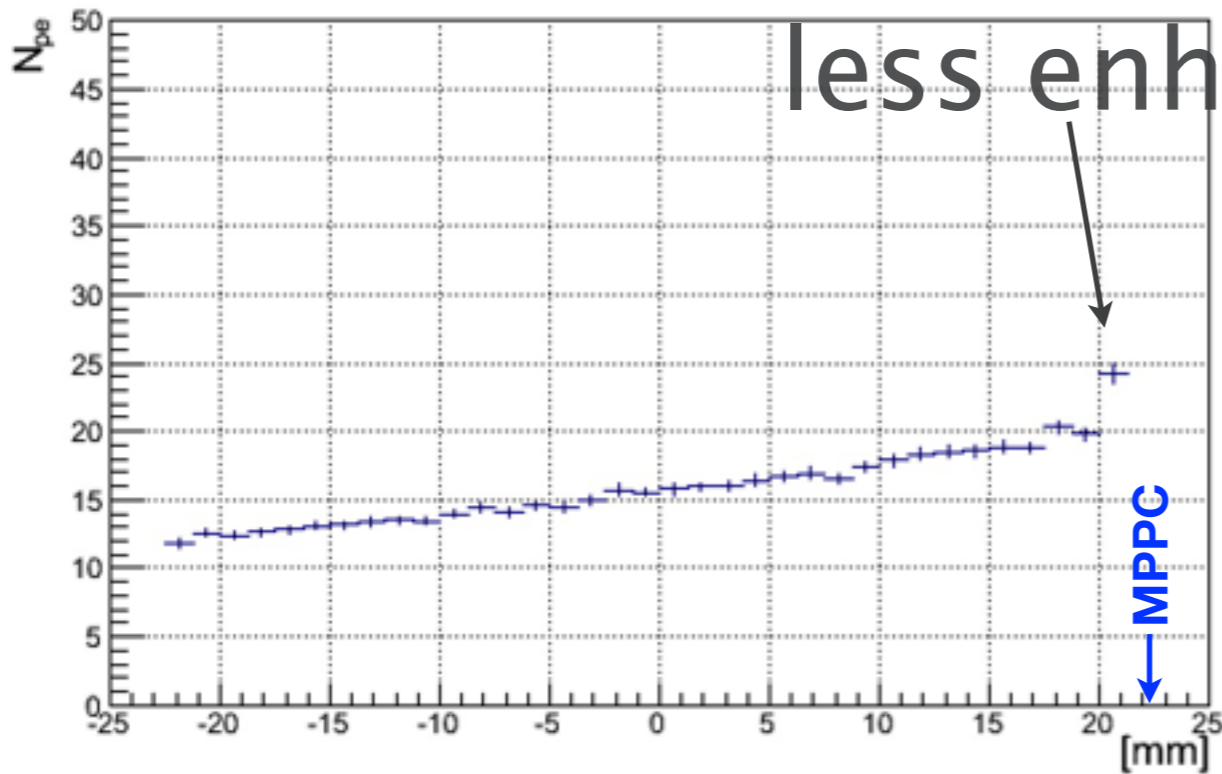
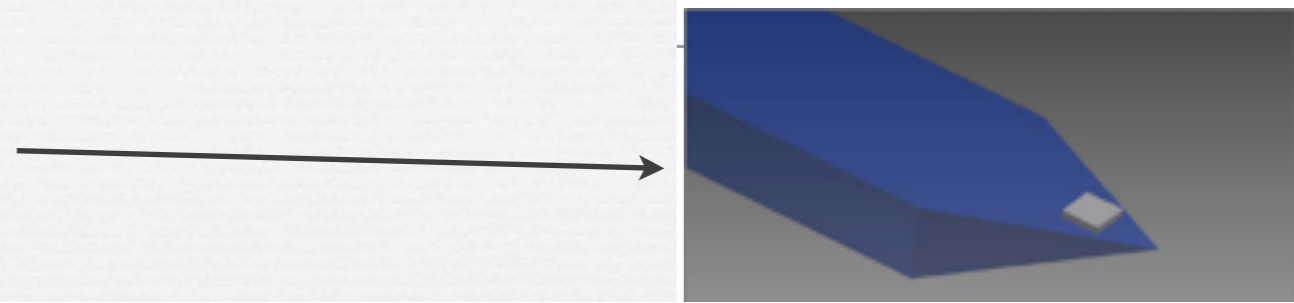


Np

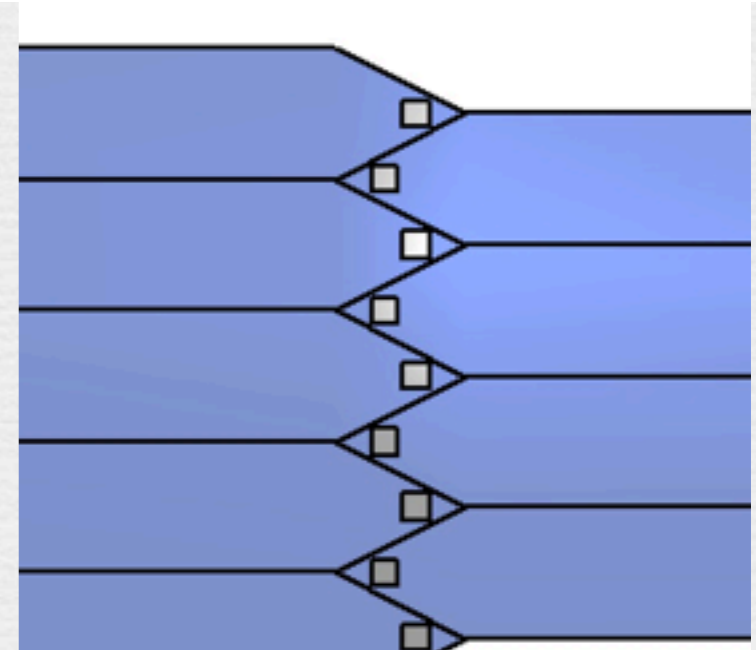
a bit steeper than measurement

scintillation light sim. cont.

yet another strip idea

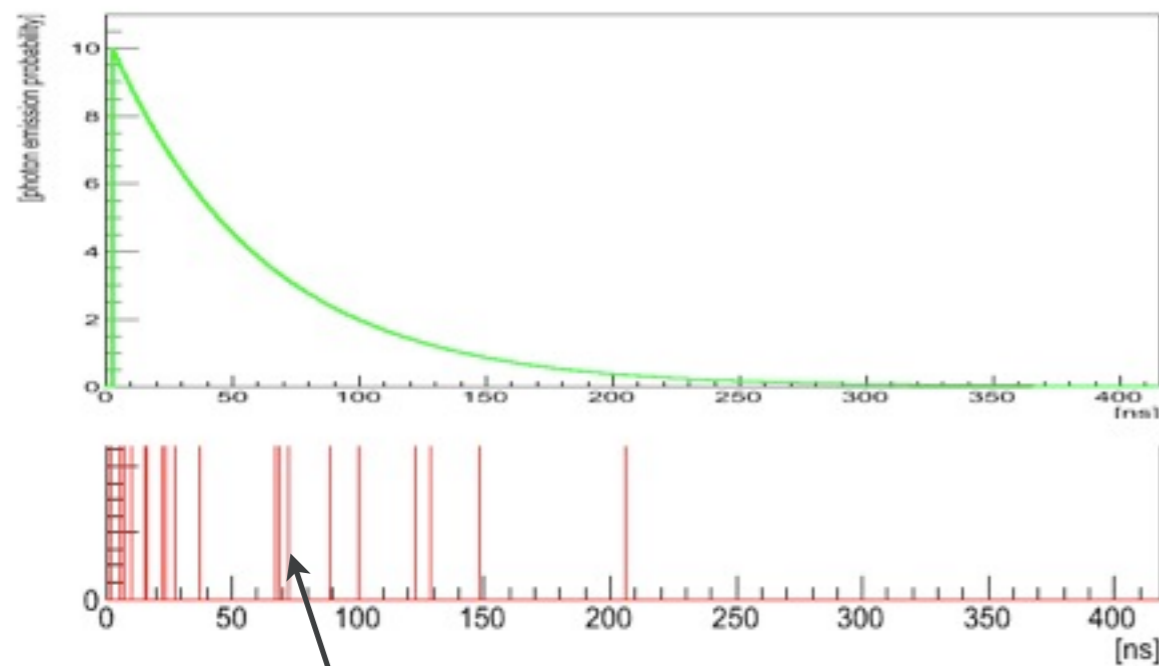


amount of scintillation light seems to be enough
homogeneity is good
installation looks promising



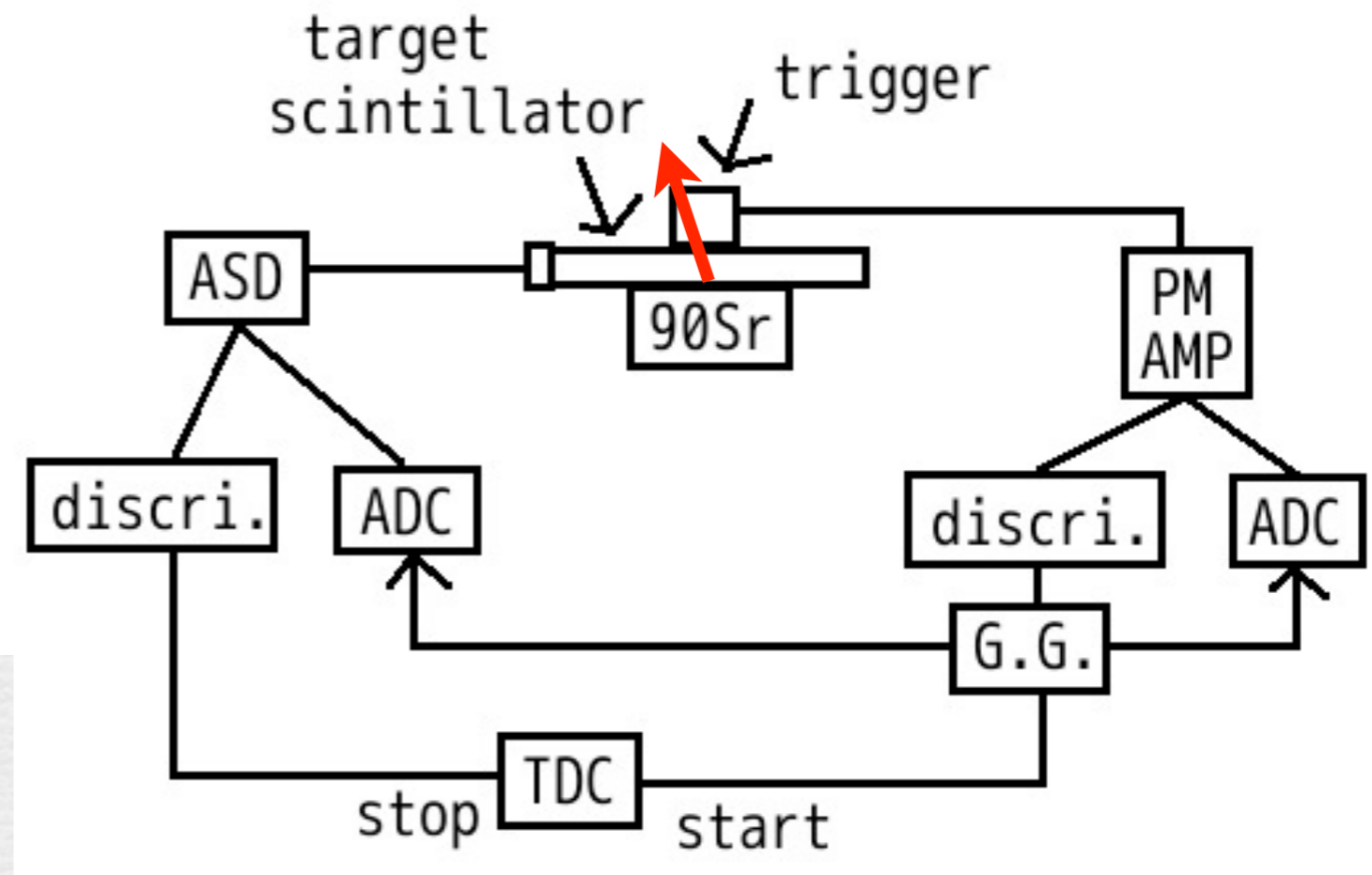
scintillation decay time

- T.Ogura by beta ray at the center
- measuring timing of emitted single photons



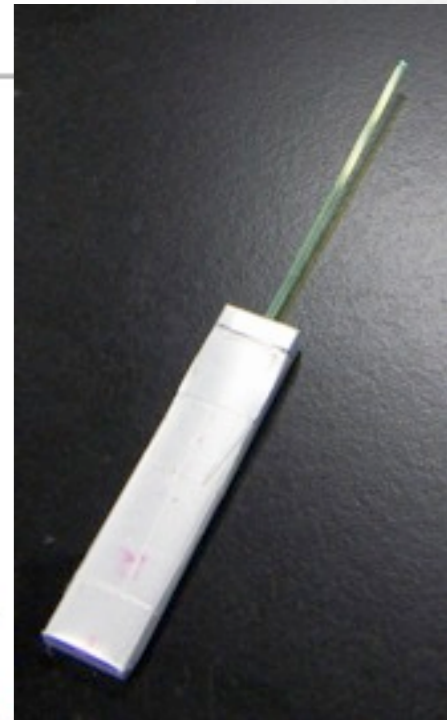
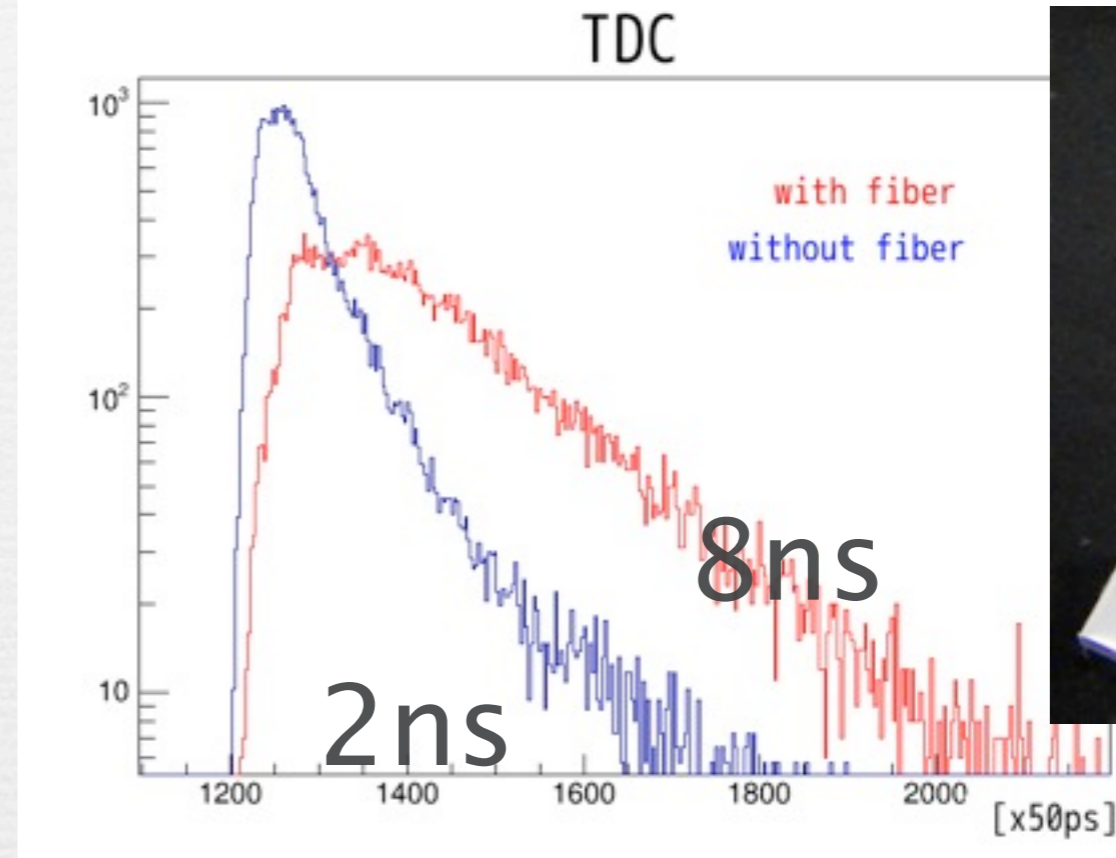
time

single photon

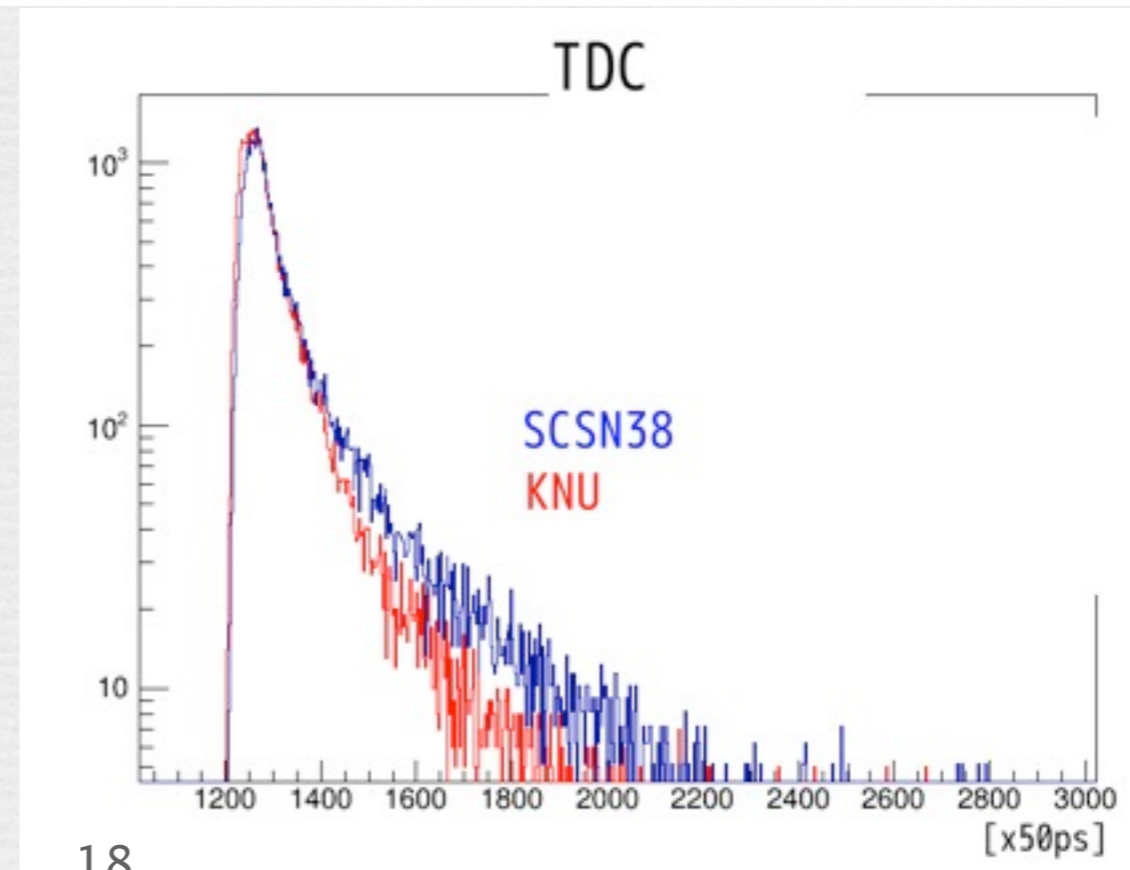


scintillation decay time

- ☞ decay curves
- ☞ WLSF decays slower
- ☞ kuraray is almost the same to KNU



KNU



scintillator ECAL

summary

- ❧ photosensor progress : 10000 pixels in 1mmx1mm
- ❧ need to detailed study
- ❧ better solution for scintillator layer is being searched for toward the real detector

I-V measurements

IV curve (new types & old types MPPC)

