

MPPC sensor – 2

Timing Resolution

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Motivation

- MPPC would be a great photon sensor for scintillation counter.
- We are studying MPPC performances at high light intensity for ILC Calorimeter.
- We measured Timing resolution of MPPC using blue LED of 15ns width at very big amount of photons where saturation phenomena is expected on the MPPCs.
- We measured light intensity dependences using pico-sec Laser at low light intensity

Timing Resolution

- ScECAL have good Timing Resolution and may be used as a TOF Counter.
- TOF resolution effect the limit of separation particle momentum.
- This is equation of momentum limit and TOF resolution.

$$P_{\max} = \frac{((m_K^2 - m_\pi^2)(d / c))}{6\sigma(TOF)}$$

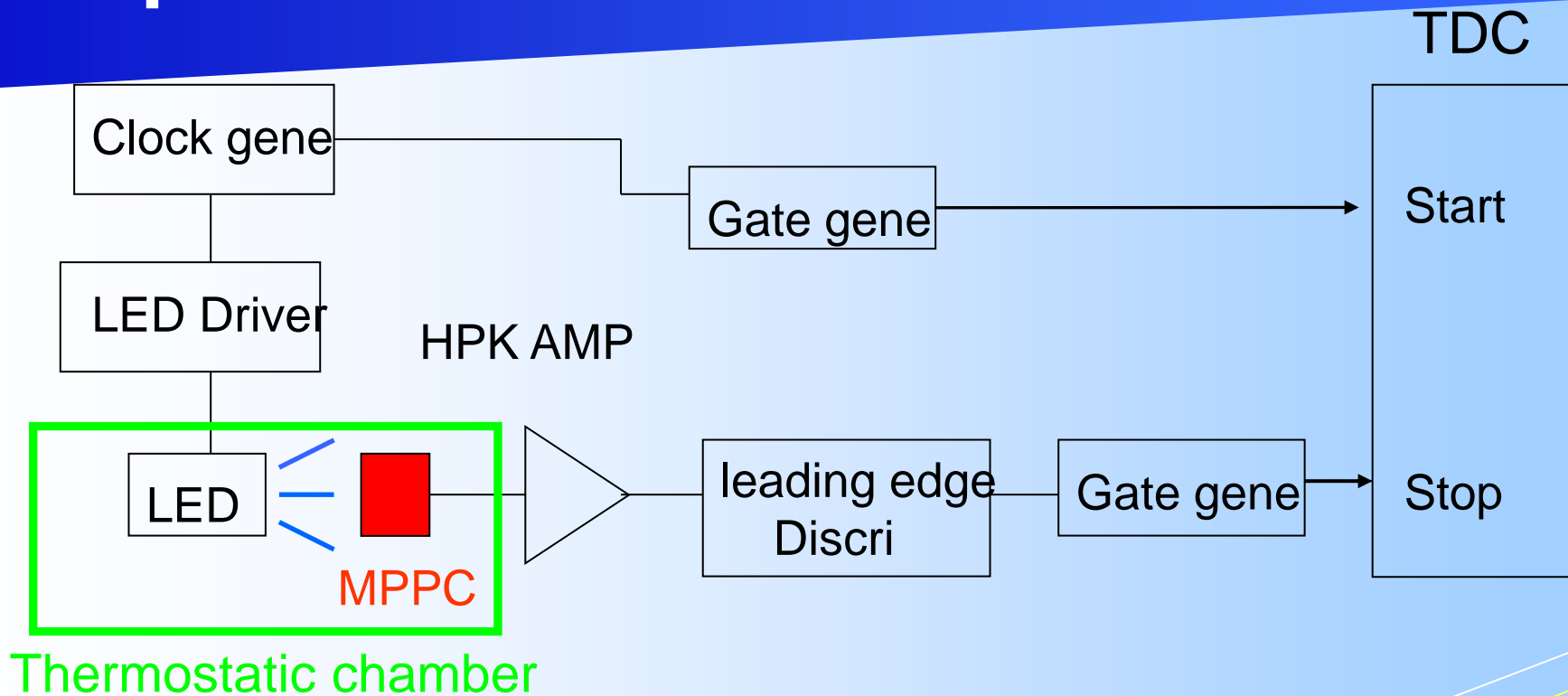
d : distance of flight
 $\sigma(TOF)$: timing resolution

- If ScECAL Timing Resolution is 100ps, we can separate π and K at 3σ and these momentum up to 1.5GeV.

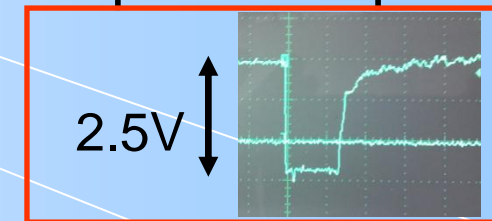
Measurement:1

Light intensity dependence using LED

Set up



- We can control drive pulse height for the LED by keeping the width of 15ns.
- We have tested four different pixel sizes of the MPPC.
- Signal shape into the discriminator is degraded by amplifier response at high intensity light.

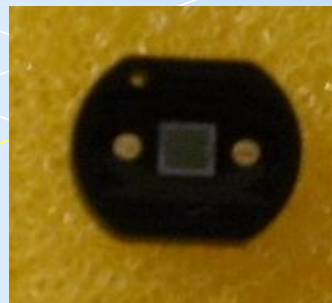


MPPC parameters

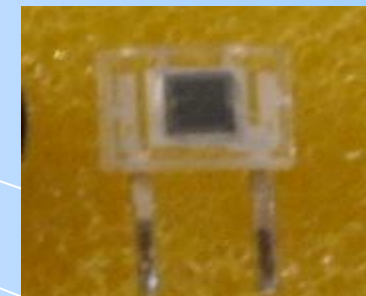
MPPC types 1mm × 1mm.

Pixel size[um]	100	50	25	20
Npix	100	400	1600	2500
over voltage[dV]	1.0	1.0	1.0	1.0
Gain[10 ⁵]	22	6.1	1.2	0.8
Threshold[mV]	300	100	100	100

To compensate gain deference

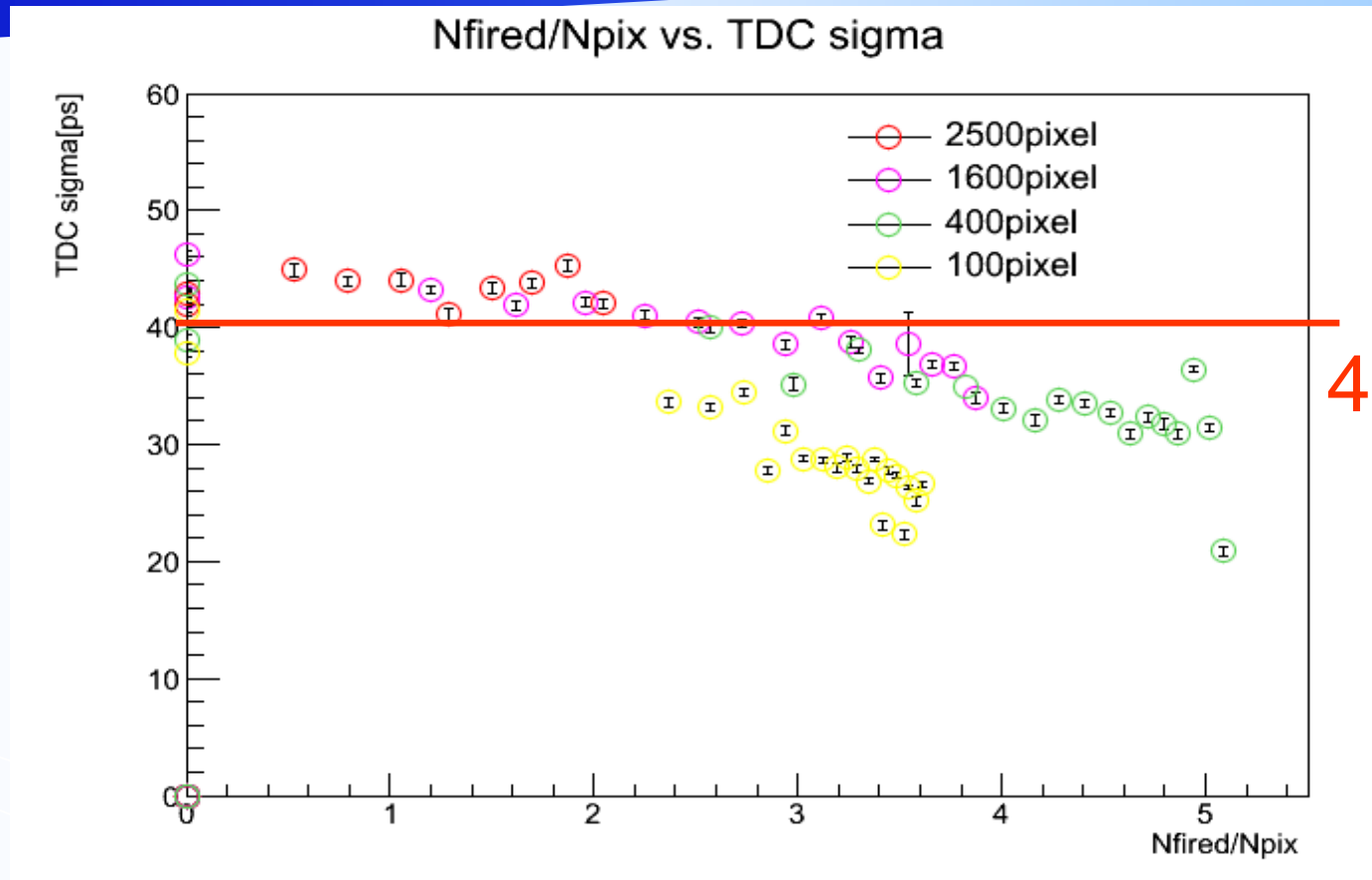


100um , 50um



25um , 20um

Timing resolution using LED



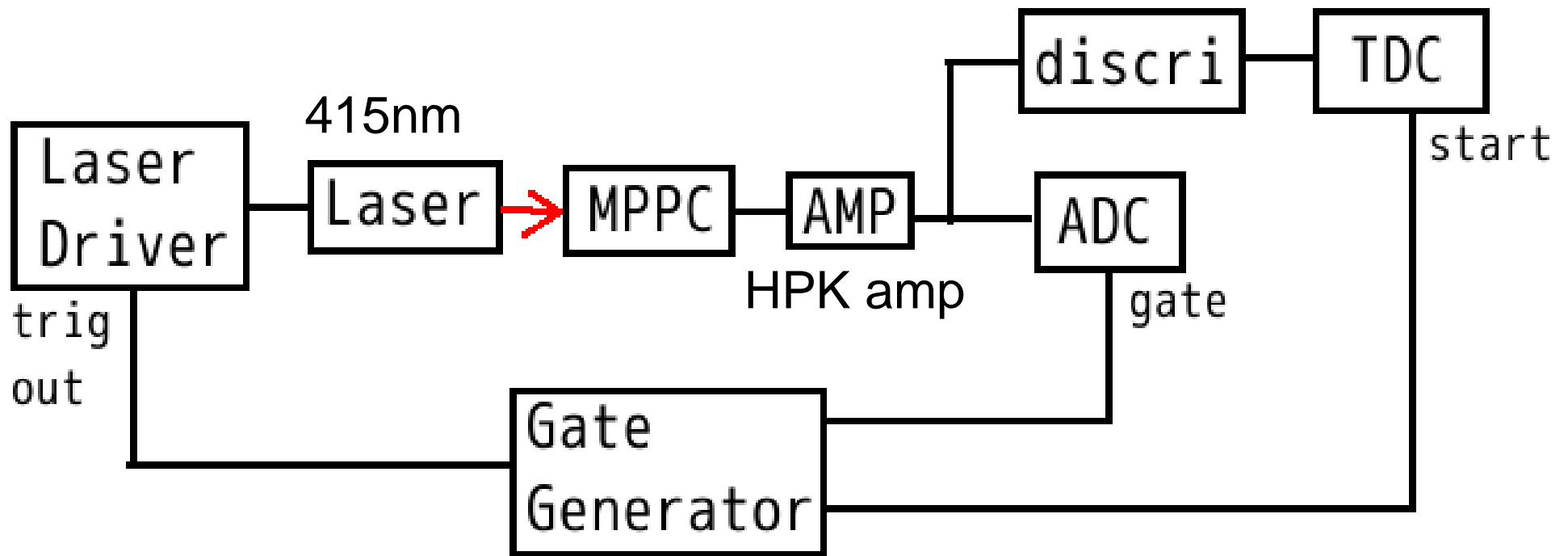
40ps

- Timing resolutions are around 40 ps.
- Resolution becomes slightly better with increasing amount of light.
- Data points of 400pixel , 1600pixel , 2500pixel aligned.

Measurement:2

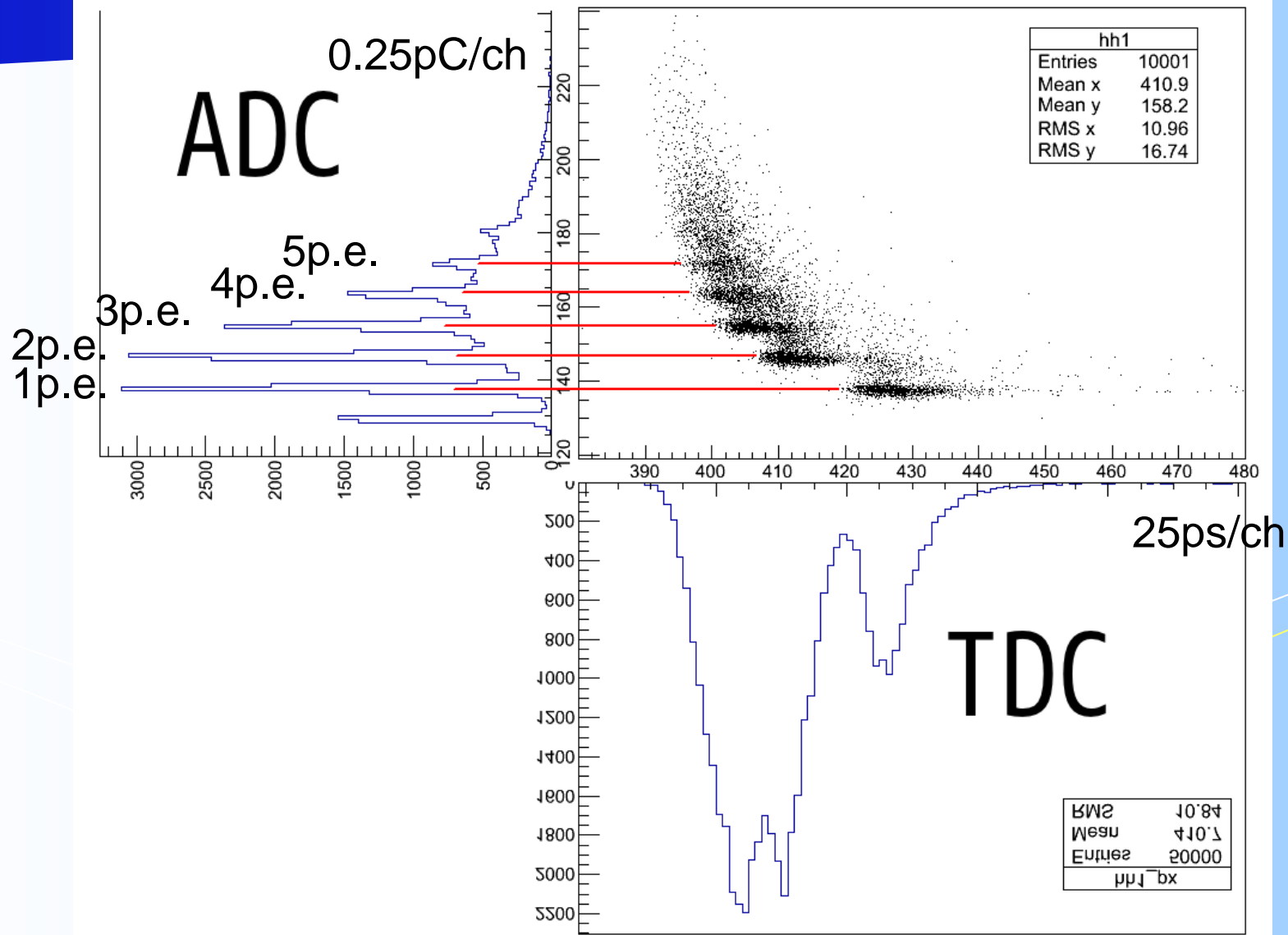
Light intensity dependence using Laser for 1600pixel only

Setup



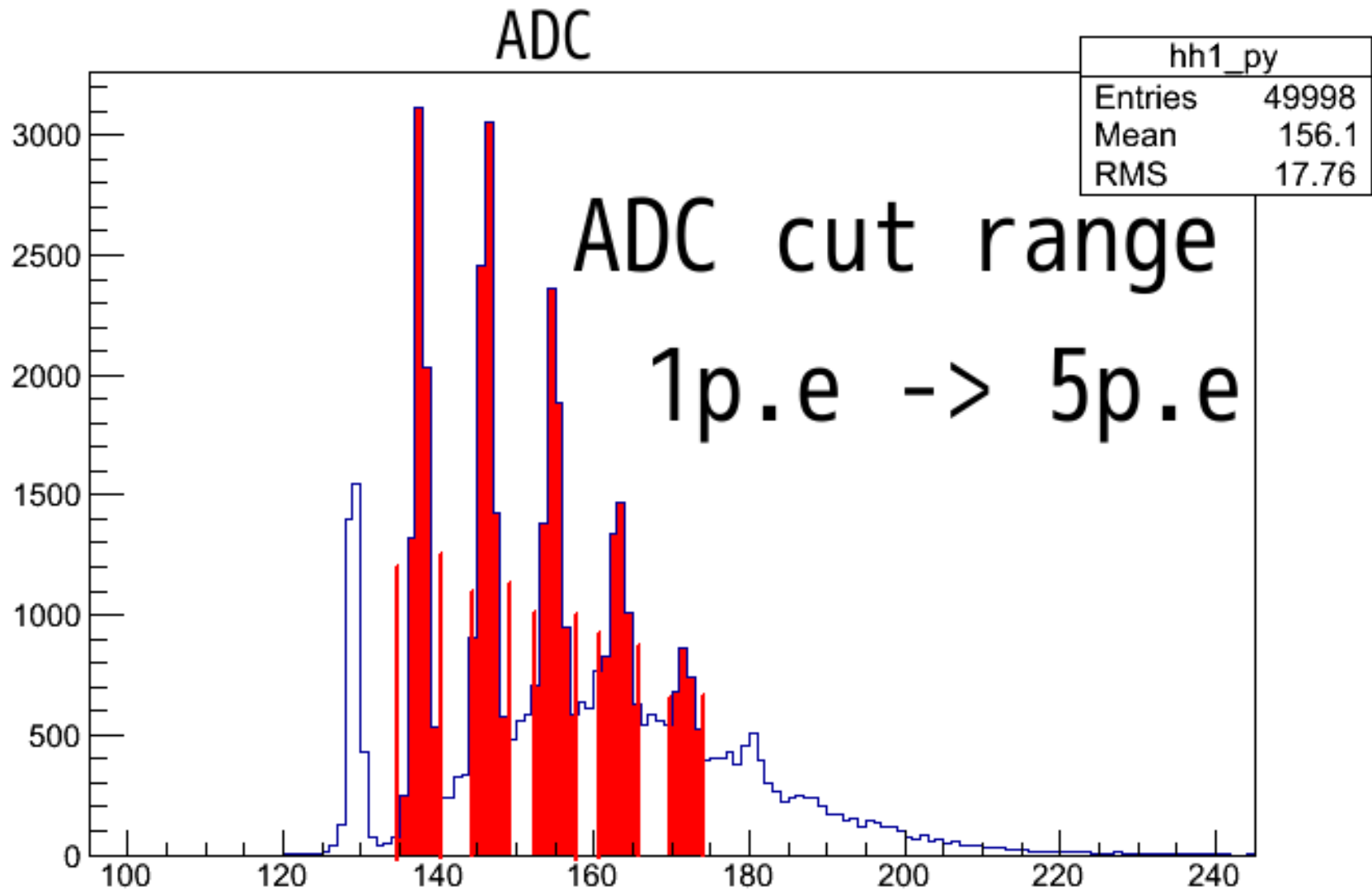
- Tested 1600 pixel and 25um pitch MPPC.
- Measured at low light intensity (1~5p.e.)

TDC vs. ADC

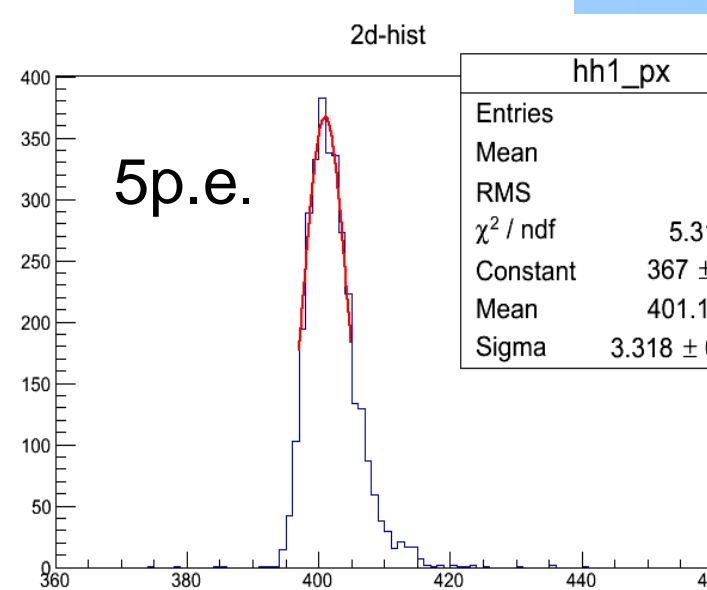
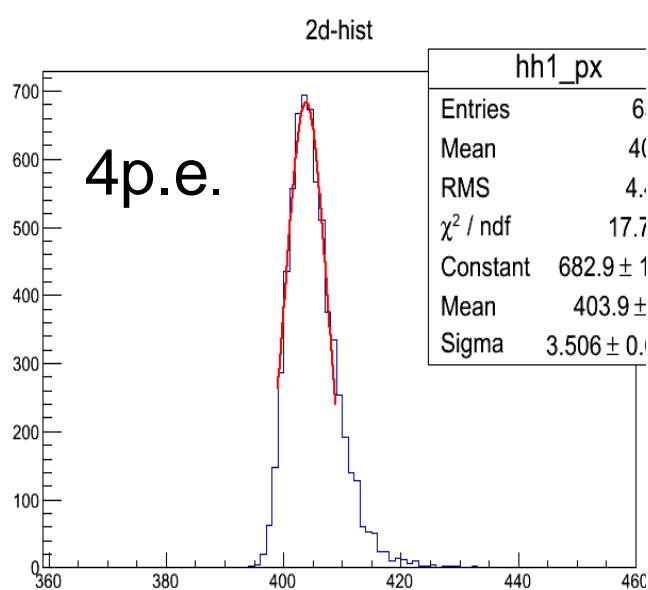
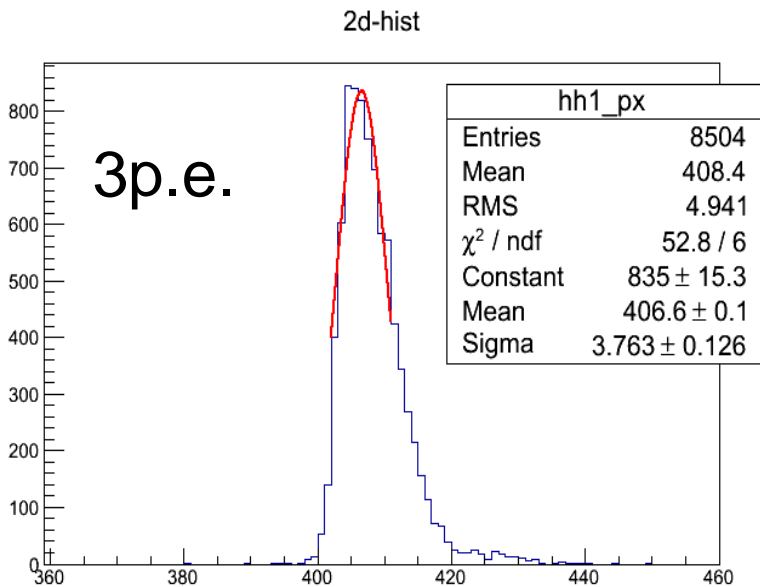
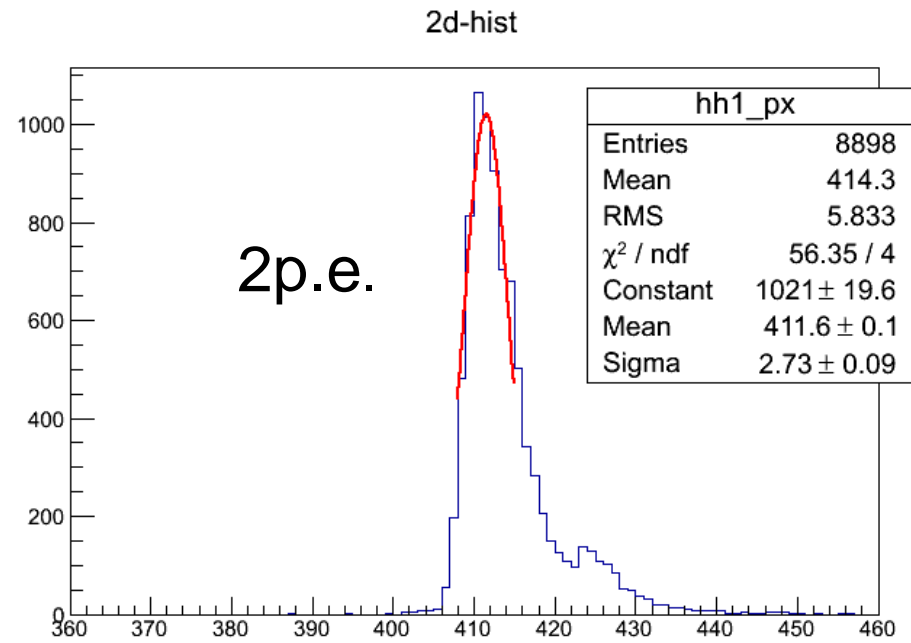
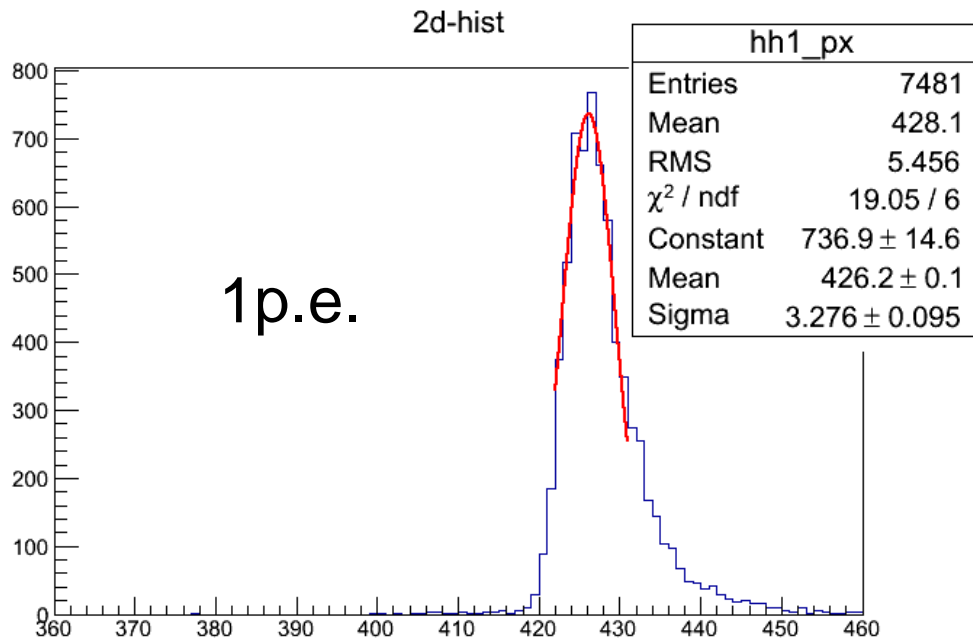


- There are some TDC peaks and these are corresponding to each p.e. peaks.

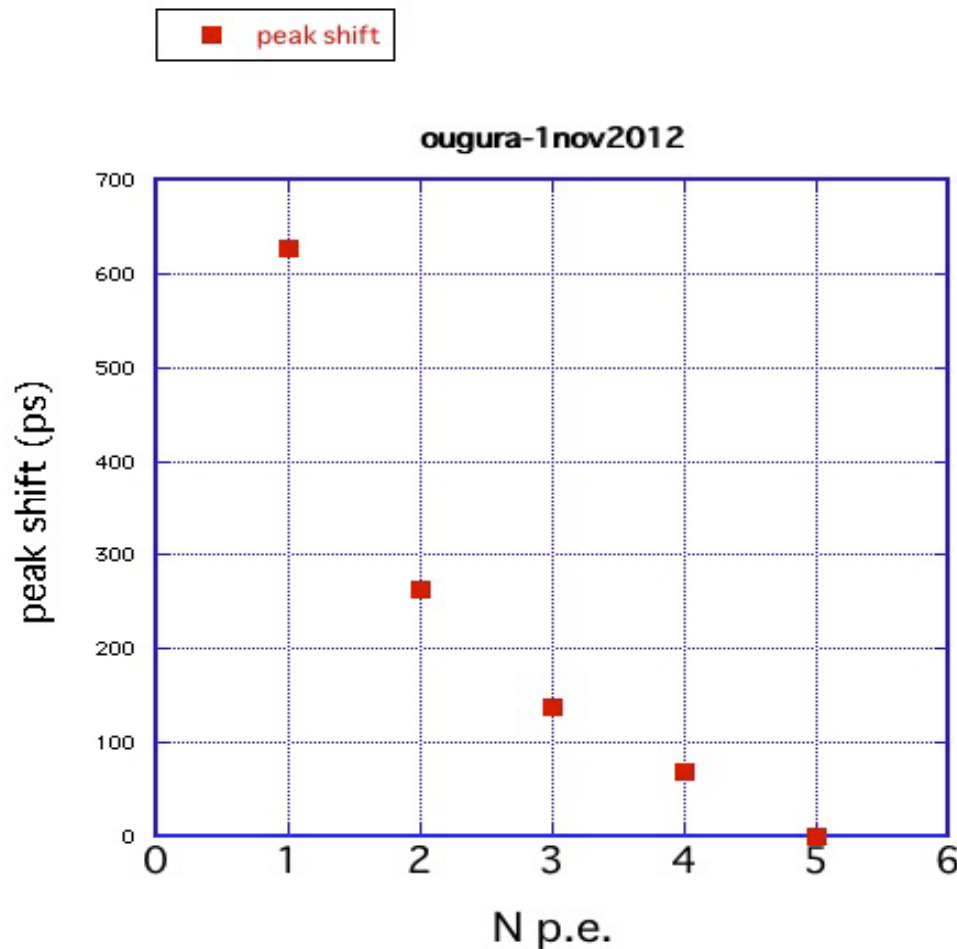
ADC cut



TDC dist for each p.e. peak



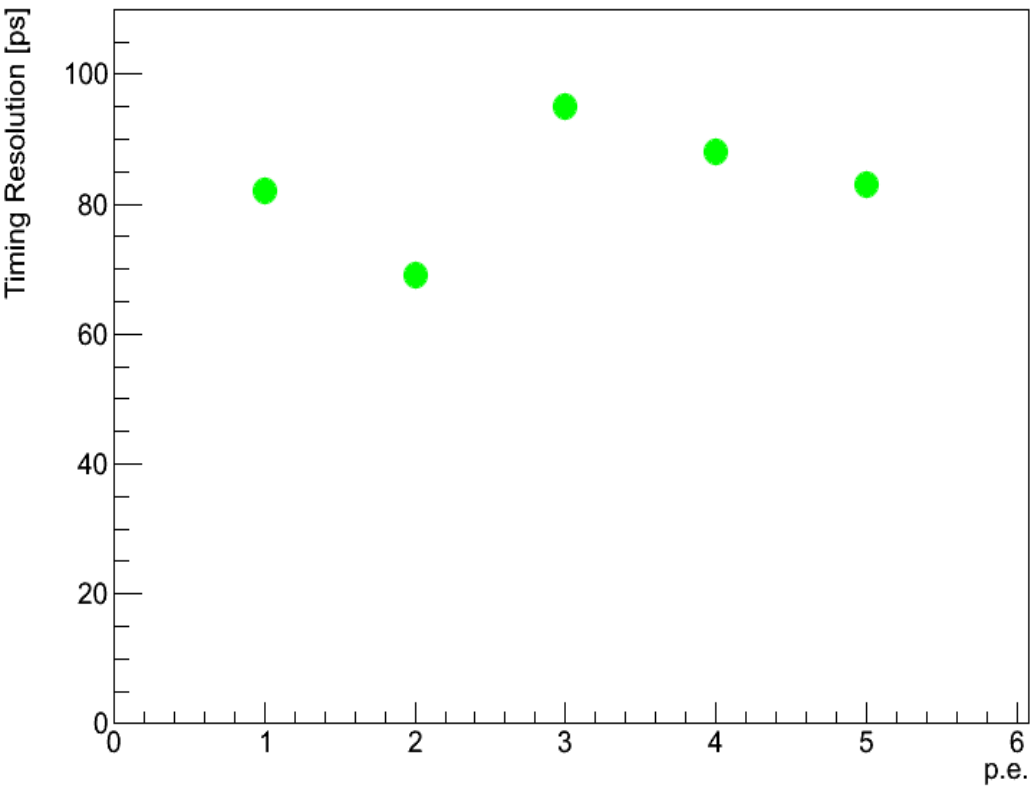
TDC peak shift



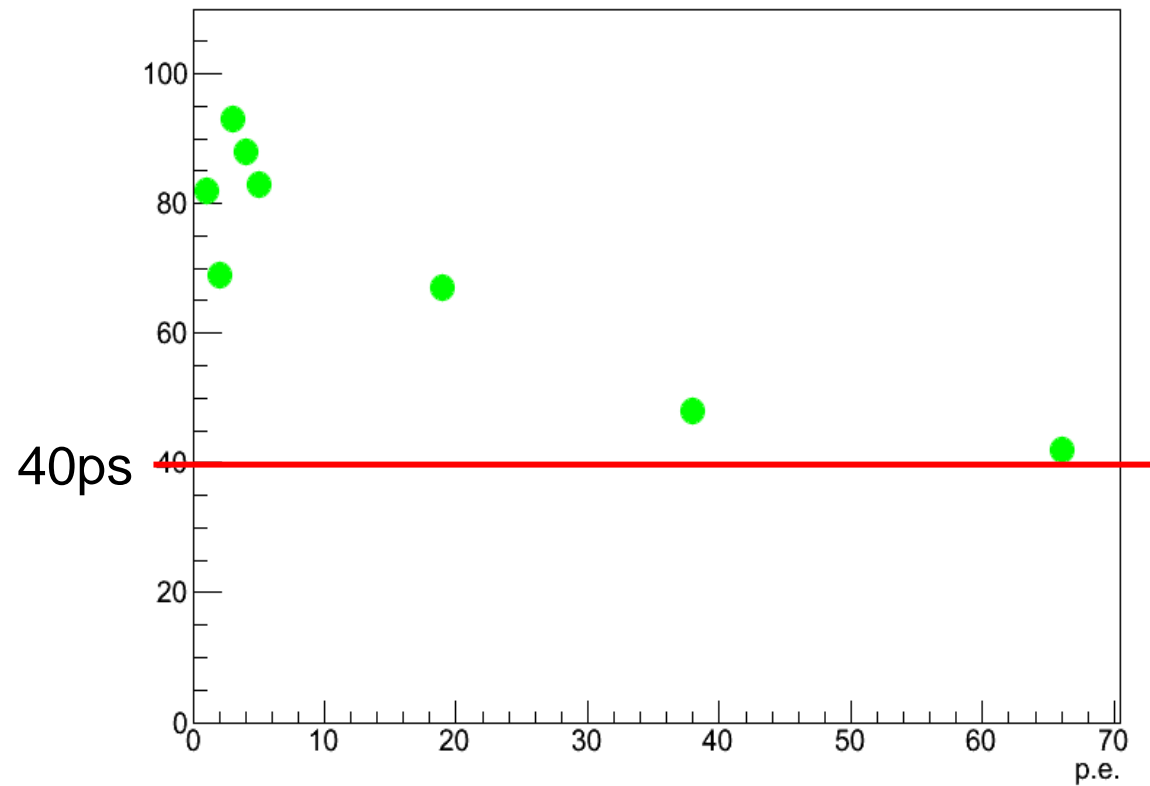
- TDC peak becomes faster with increasing amount of light.
- The Big signal can reach to threshold voltage faster than small one.

Timing resolution

Light intensity dependence



Light intensity dependence



- Resolution is around 80ps at low light intensity.
- Resolution became better with increasing amount of light.
- Resolution may reach to 40ps.

Summary

- Measured MPPC timing resolution using LED and Laser.
 - > Using LED
 - Resolution was around 40ps.
 - Similar relationship could be seen in data of 3 kinds of MPPC.
 - Resolution was slightly better in lower threshold voltage.
 - > Using Laser.
 - Resolution is around 80ps at low light intensity.
 - Resolution became better with increasing amount of light and expected to reach to 40ps at high light intensity.
- From these results, TOF resolution is expected under 100ps. Then ScECAL can separate π and K at 3σ , $P_{\max} > 1.5\text{GeV}$.

prospects

- Measure timing resolution using Laser at high light intensity($N_{p.e.} \sim 1000$).
- Measure timing resolution of the other MPPC using Laser.