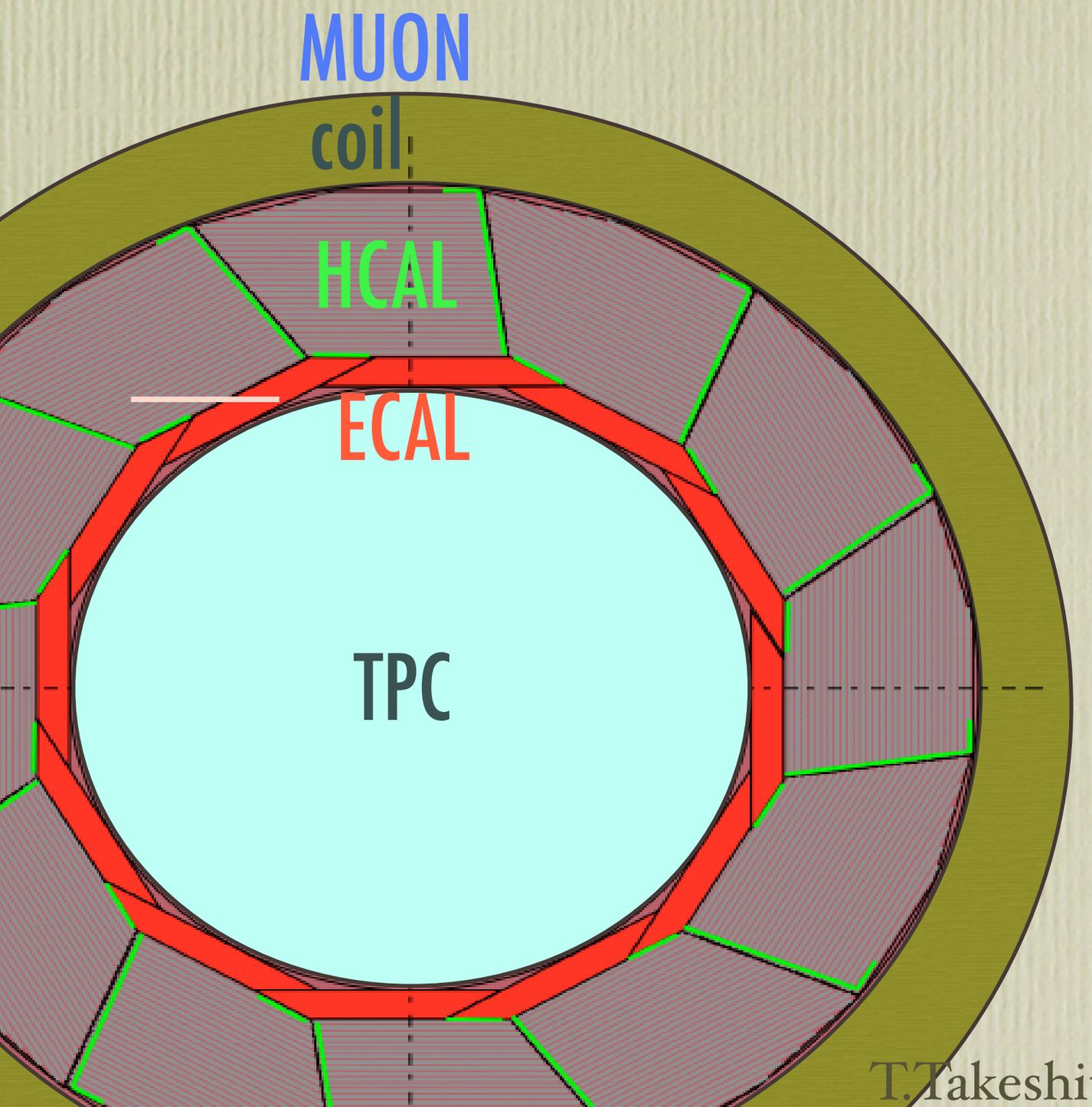
Progress of MPPC development

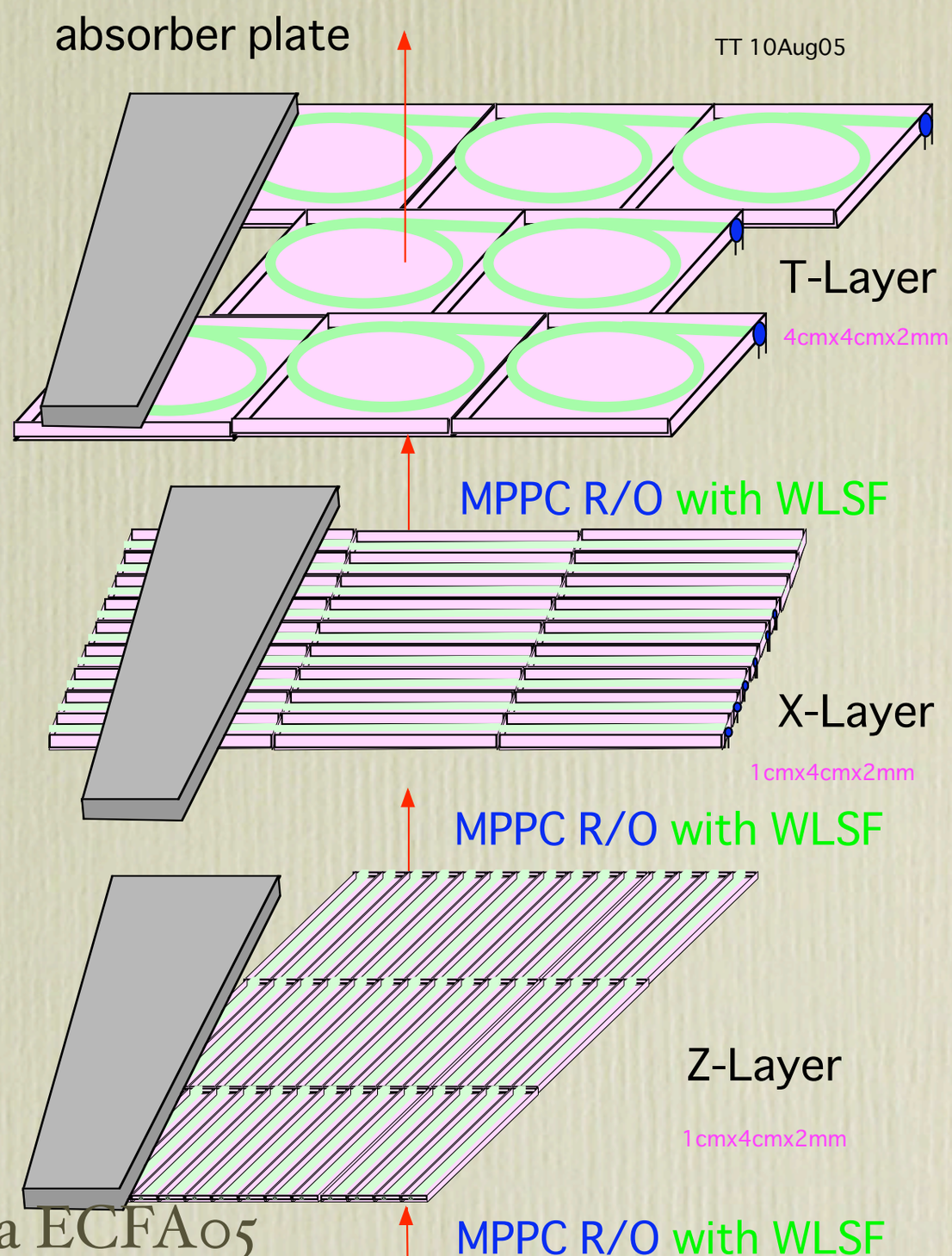
T. Takeshita for ILC-CAL group
at ECFA Vienna 2005

MPPC
current status
plan

GLD and MPPC

- GLD ECAL, HCAL and muon consist of scintillators with photon sensors



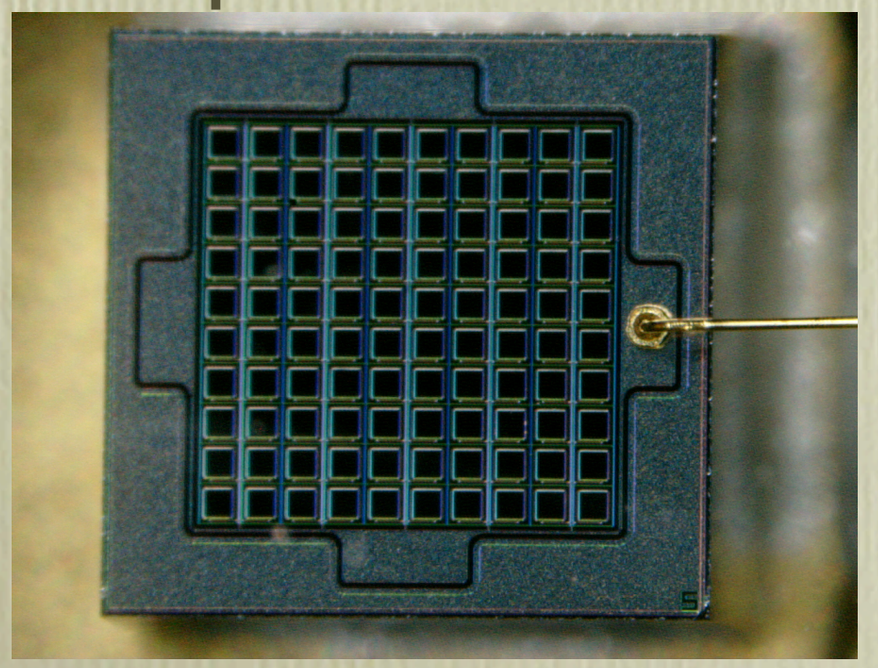


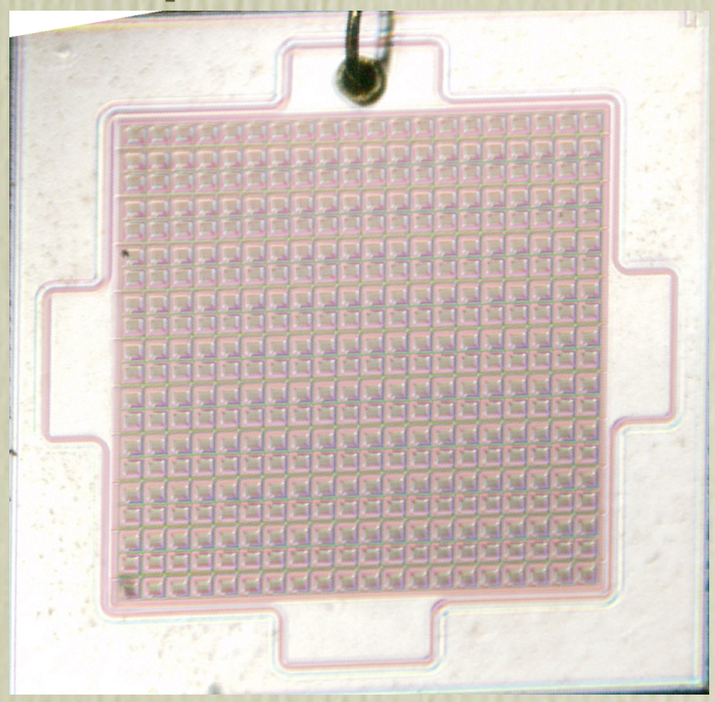
MPPC -1

- MultiPixel Photon Counter : photon sensor
- similar to SiPM but made in Japan at Hamamatsu photonics (HPK)

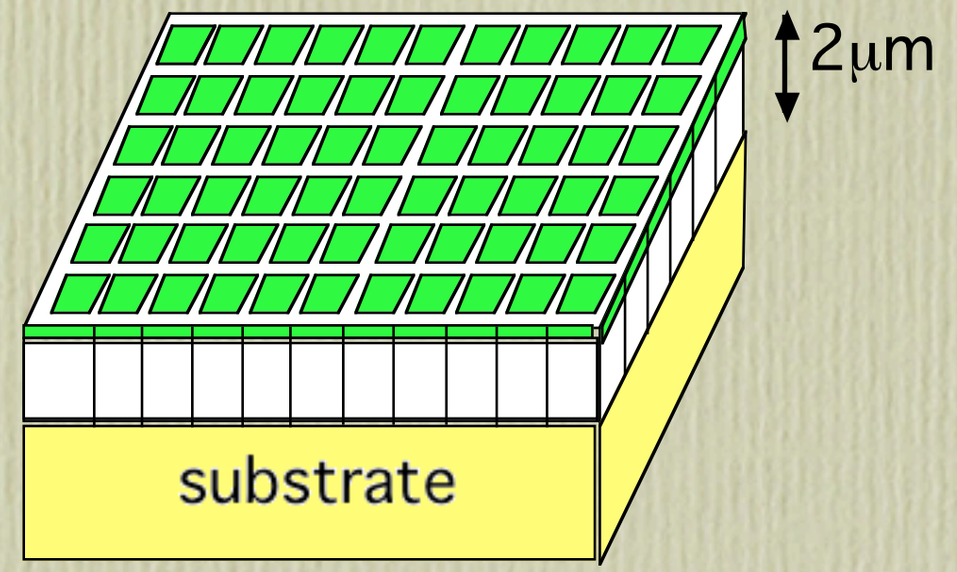
1mm x 1 mm

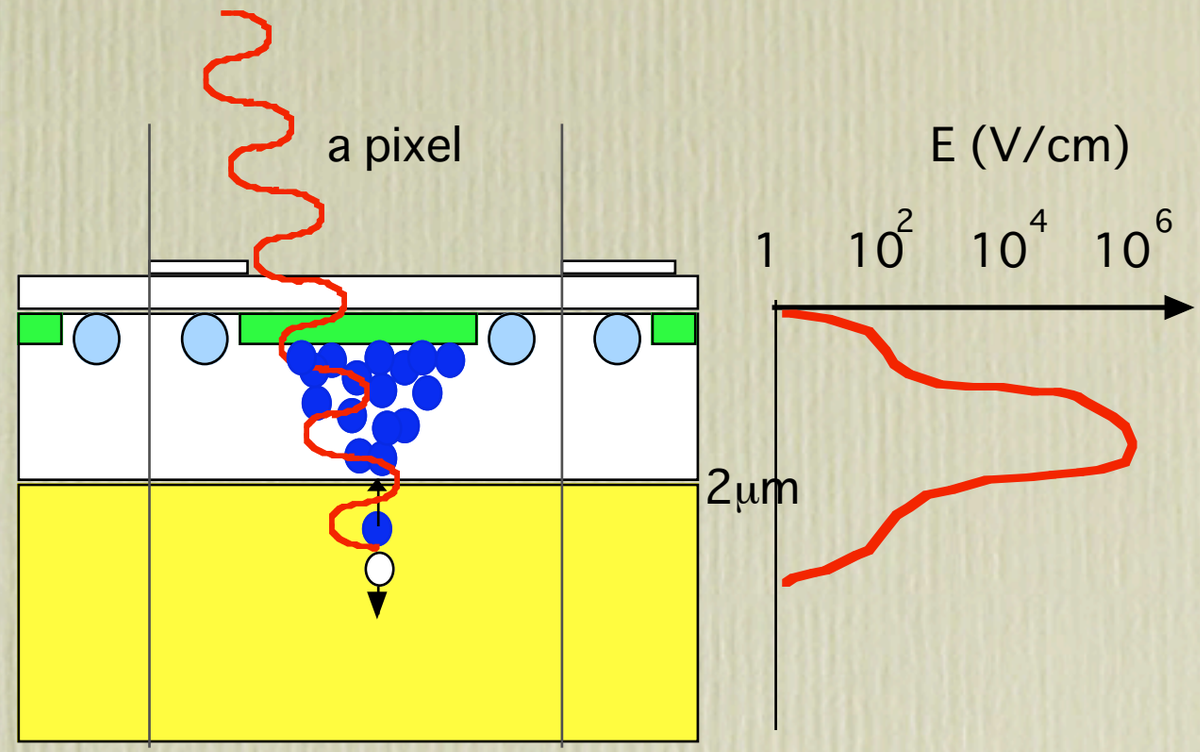
100pix=10 x 10 400pix = 20 x 20 1600pix



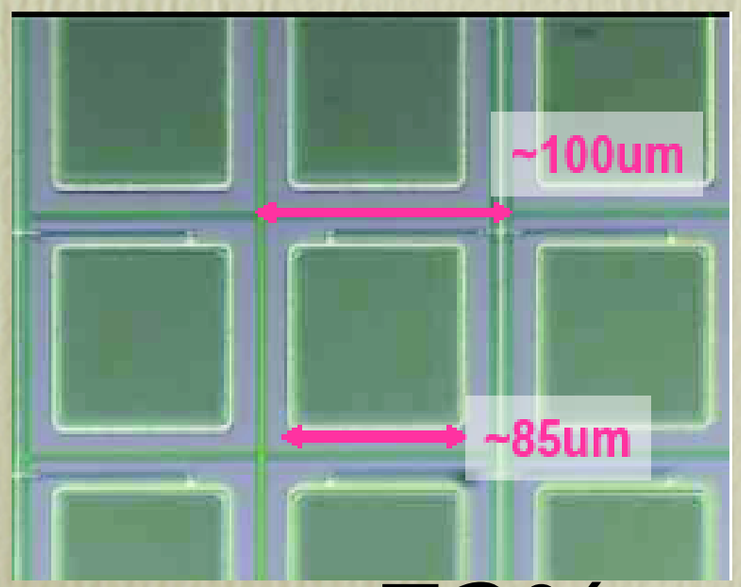


MPPC -2



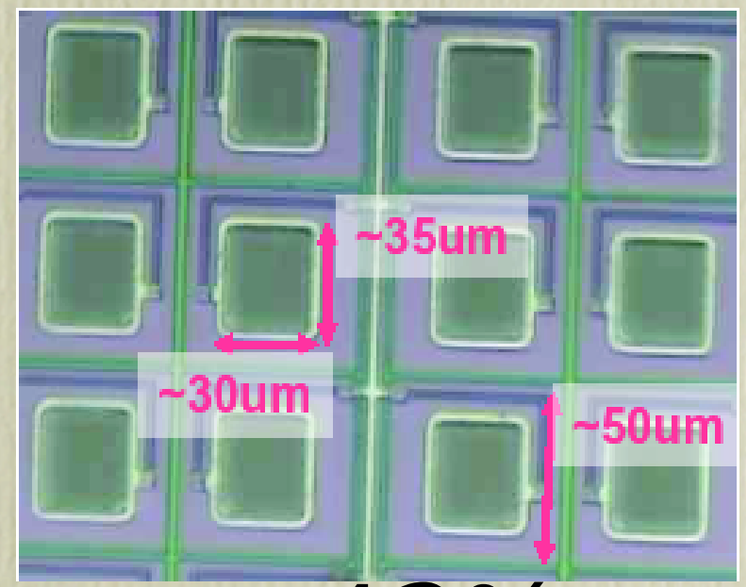


100pix=10 x 10



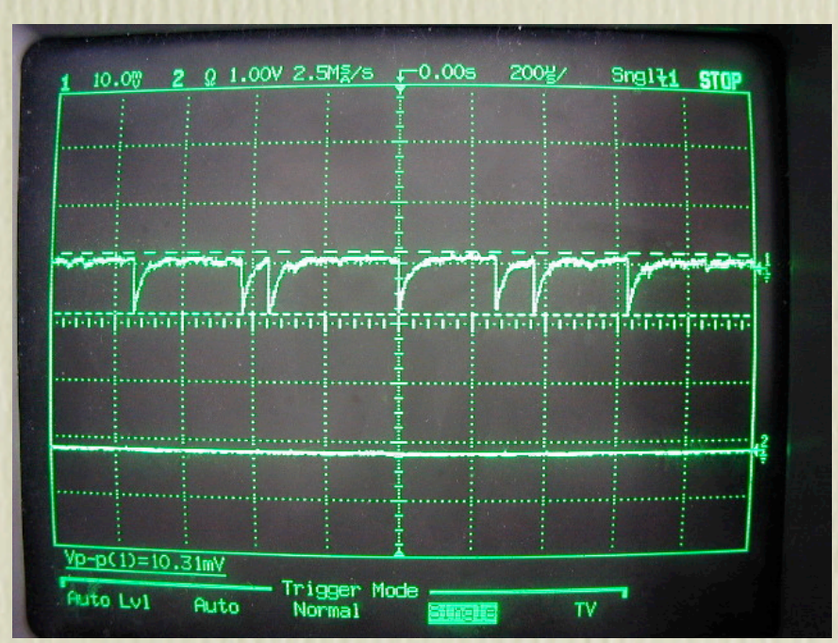
area : 72%

400pix = 20 x 20



42%

Geiger Mode op.



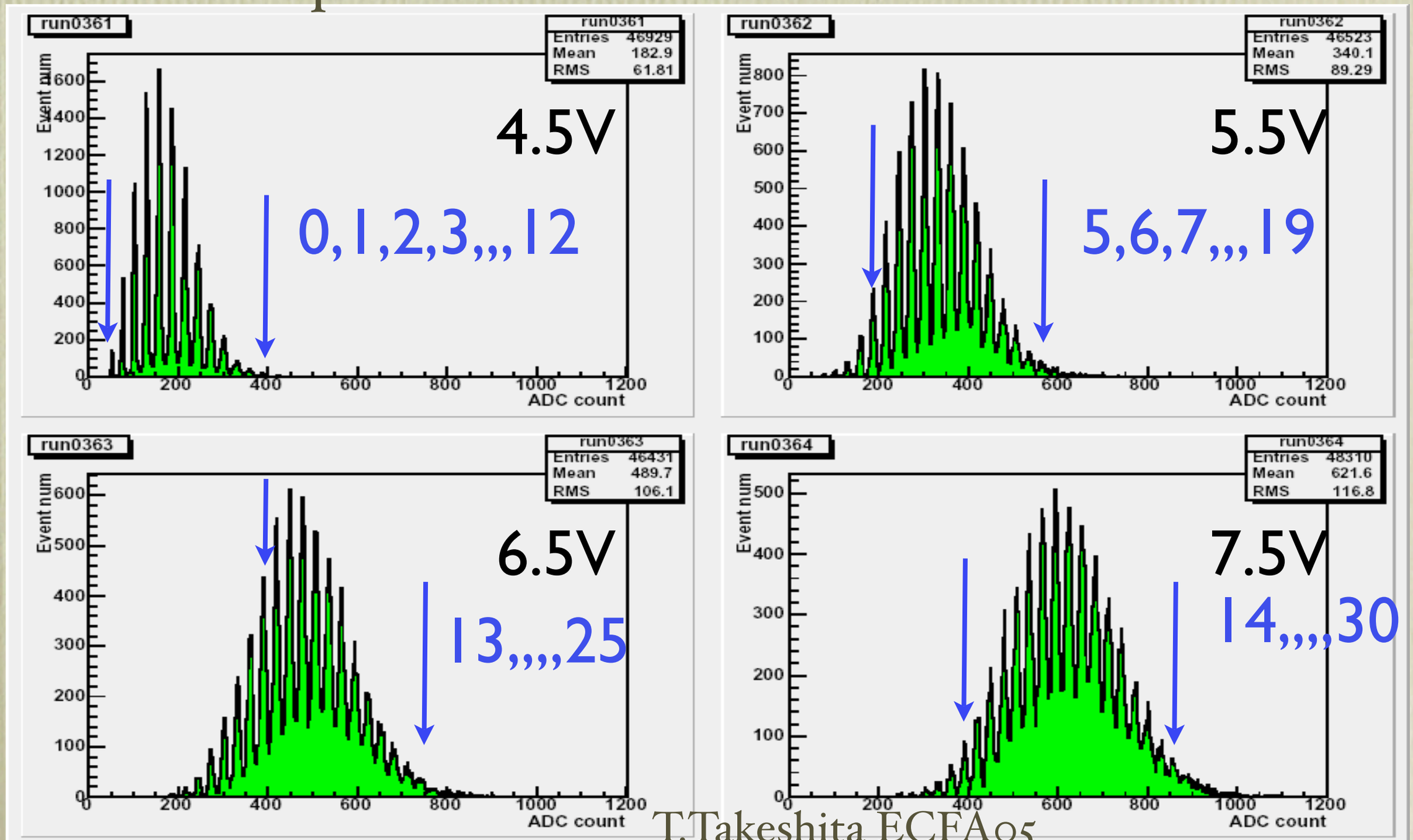
T.Takeshita ECFA05

MPPC : Photon Counter

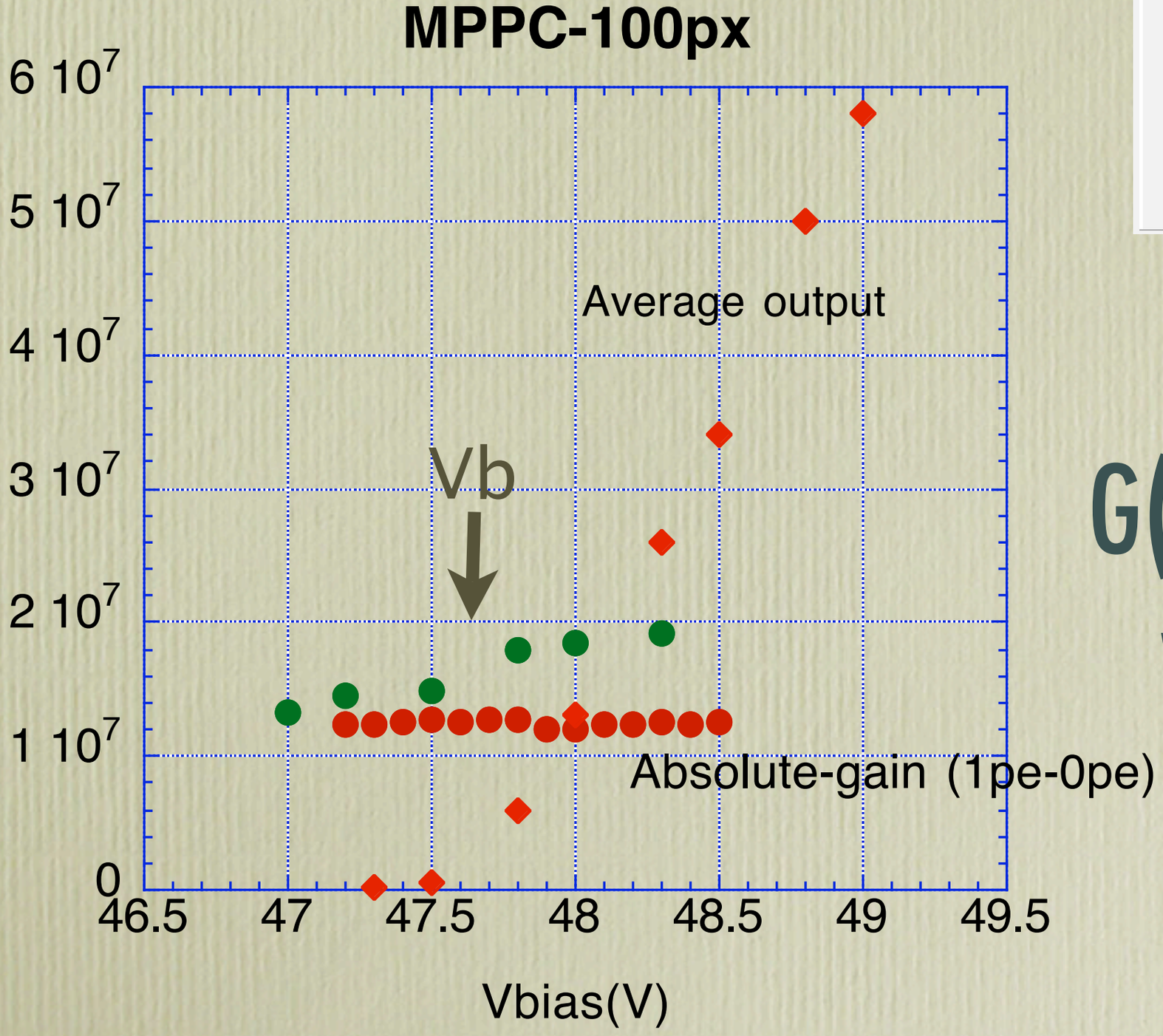
by changing LED pulse height with 10ns width

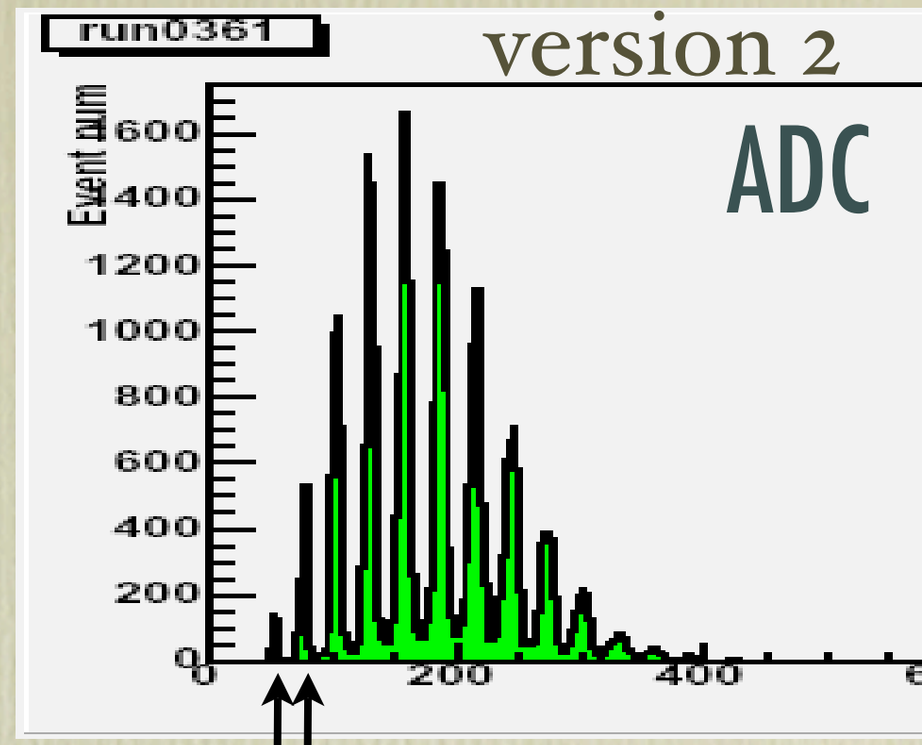
ADC dist.

100pix version 2



MPPC : Gain
Break down Voltage





0,1pe

G(1pe-0pe) ~ 10^7

Vb ~ 47.7V

A ~(V-Vb)

MPPC : X-talk

Cross talk in adjacent pixels : due to light or electrical coupling

No LED, at 1V higher than Vb

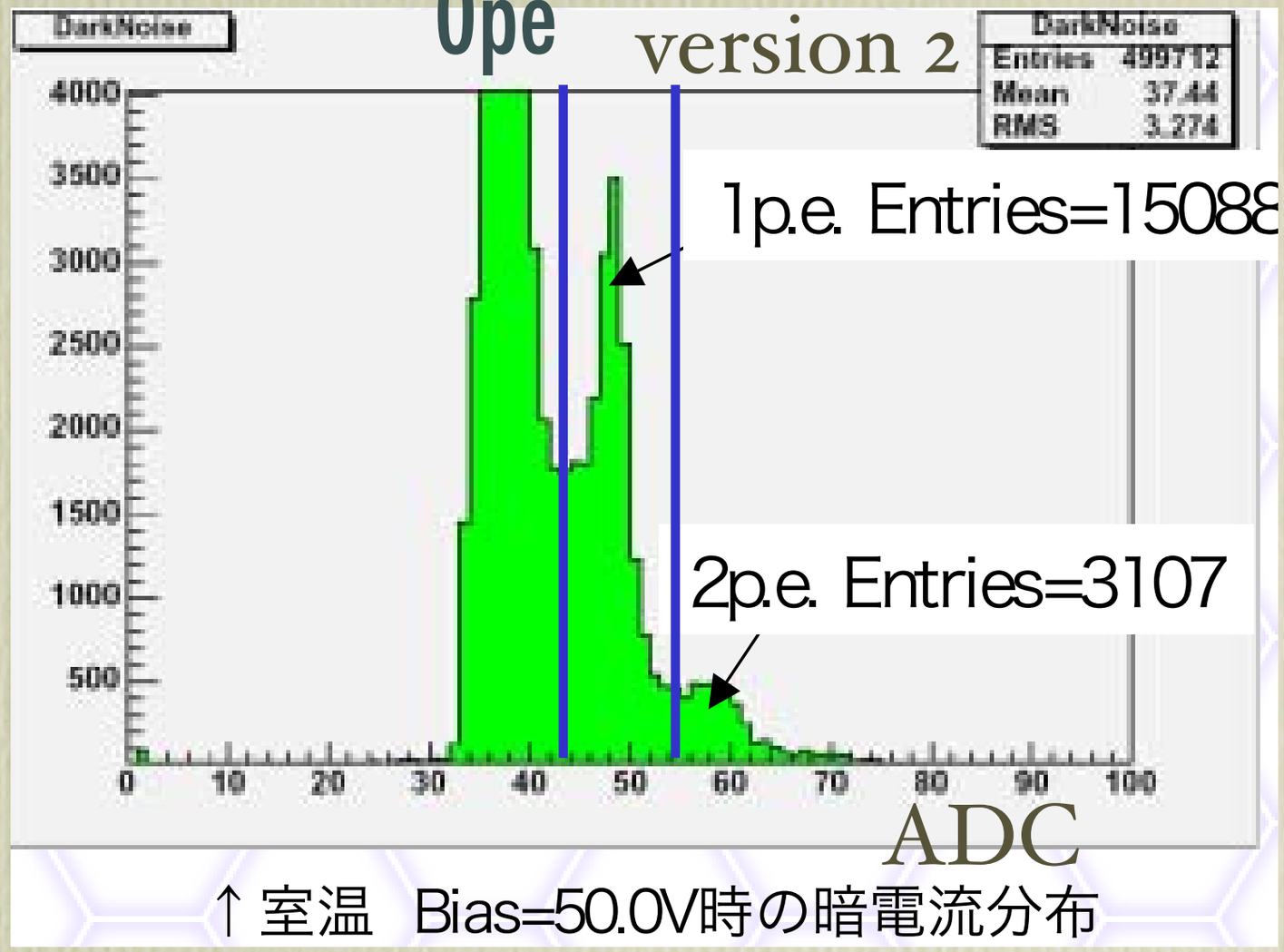
Assuming Poisson statistics

Average taken by 0pe + 1pe

↓

deviation from Poisson dist.

at 2pe ~ 15%

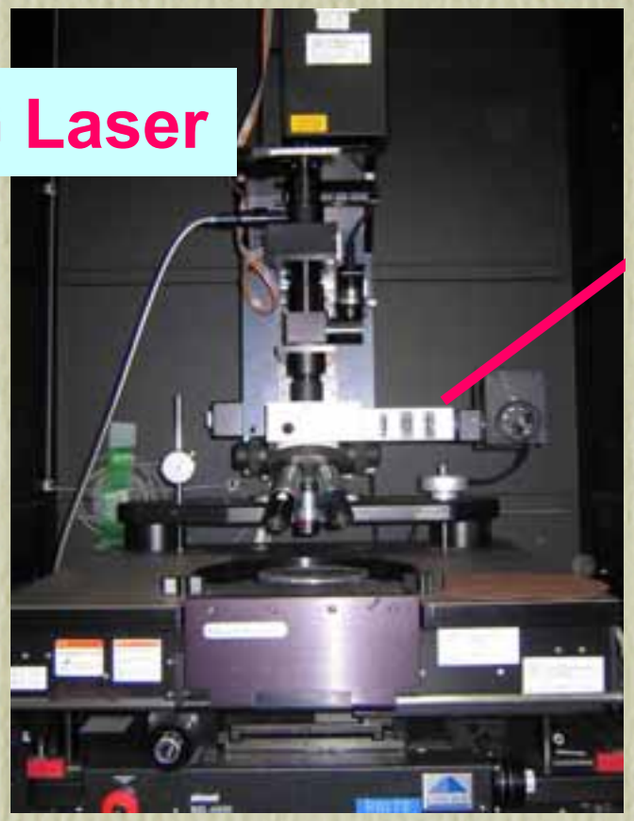


↑室温　Bias=50.0V時の暗電流分布

at lower bias voltage, deviation from Poisson is small

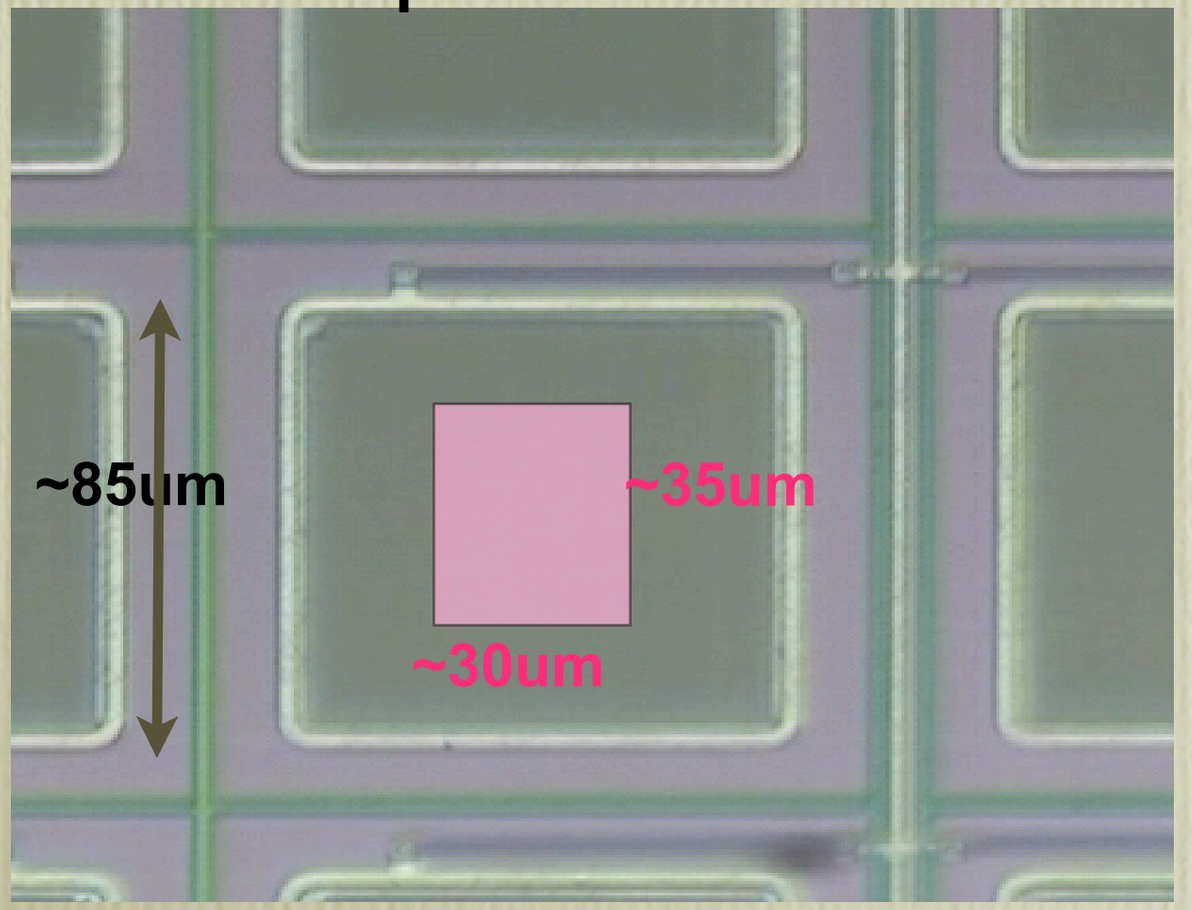
T.Takeshita ECFA05

Pixel test - 1

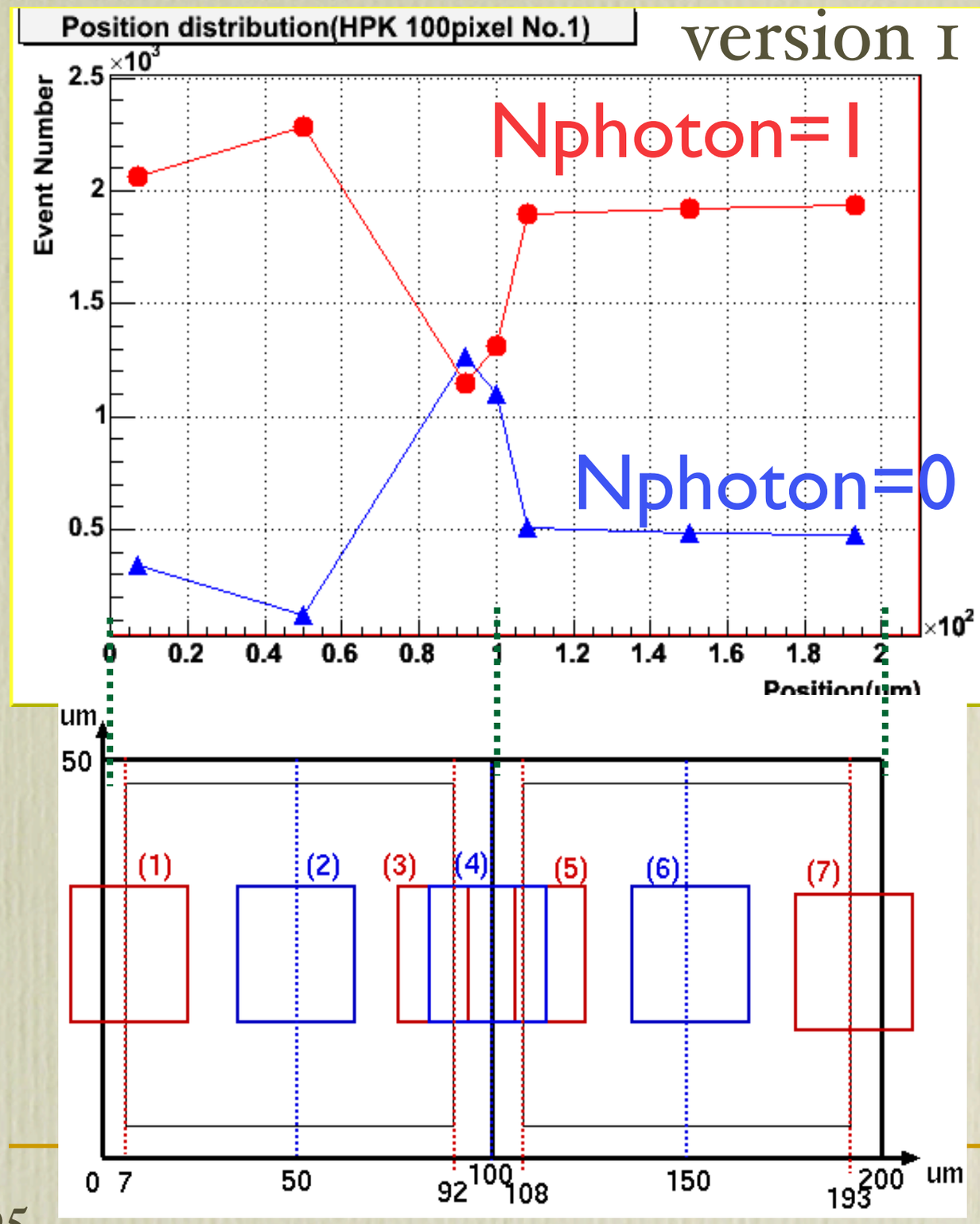


532nm

Nphoton~1

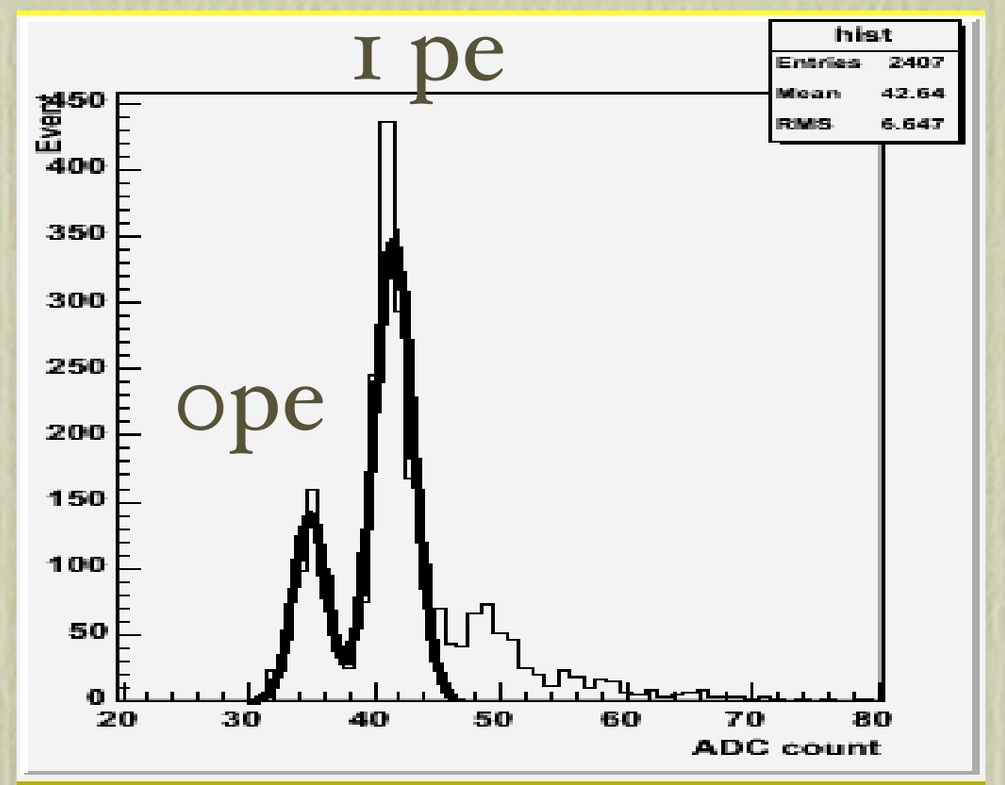


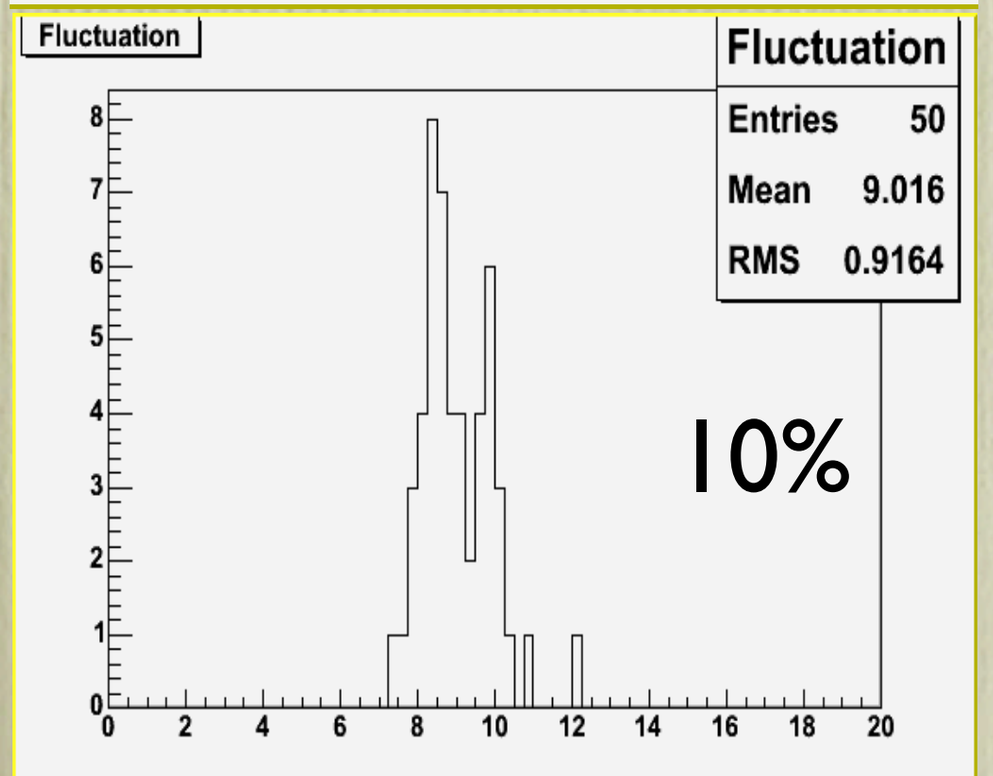
version 1



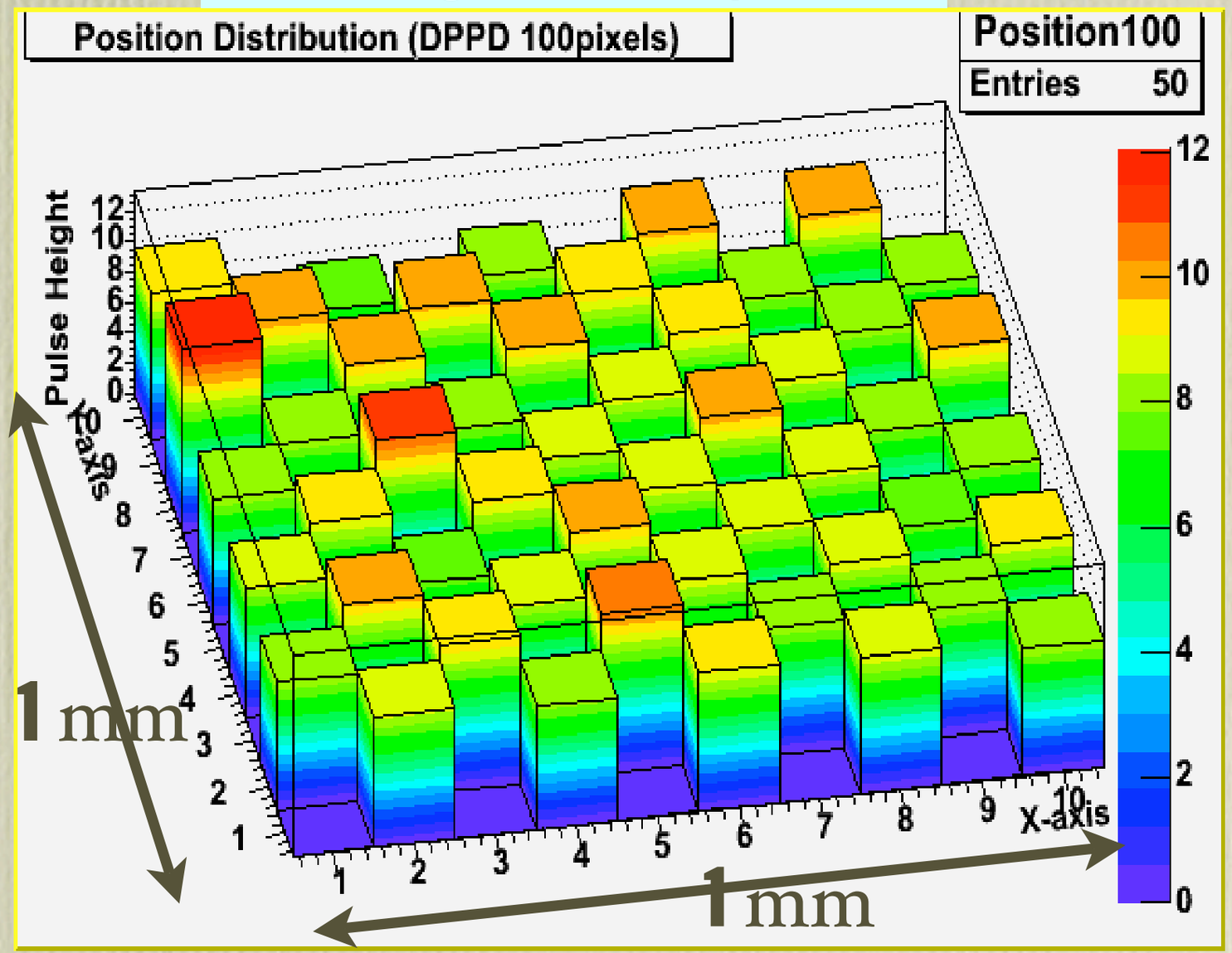
Pixel test -2 : Uniformity

version 1





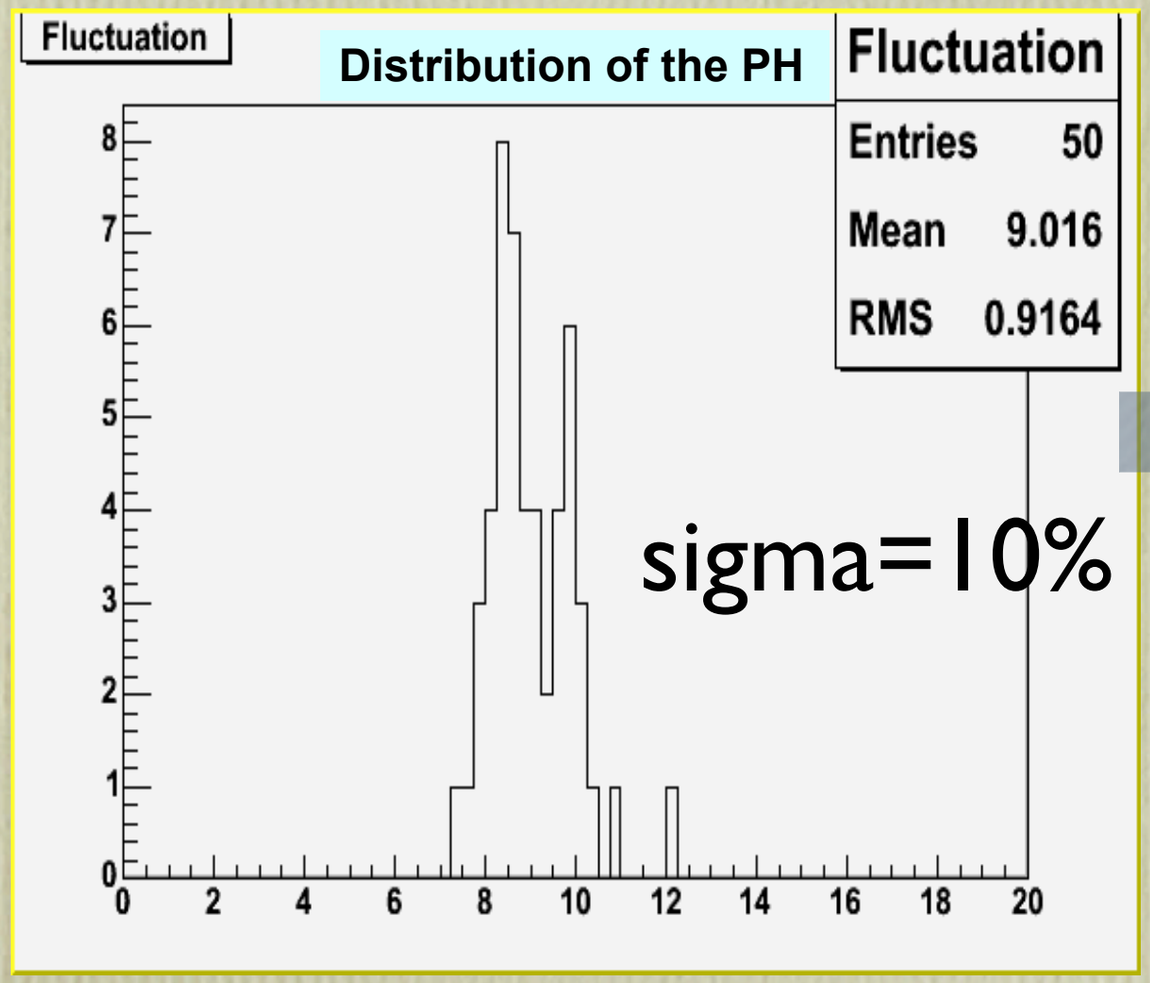
Pulse height vs Pixel position



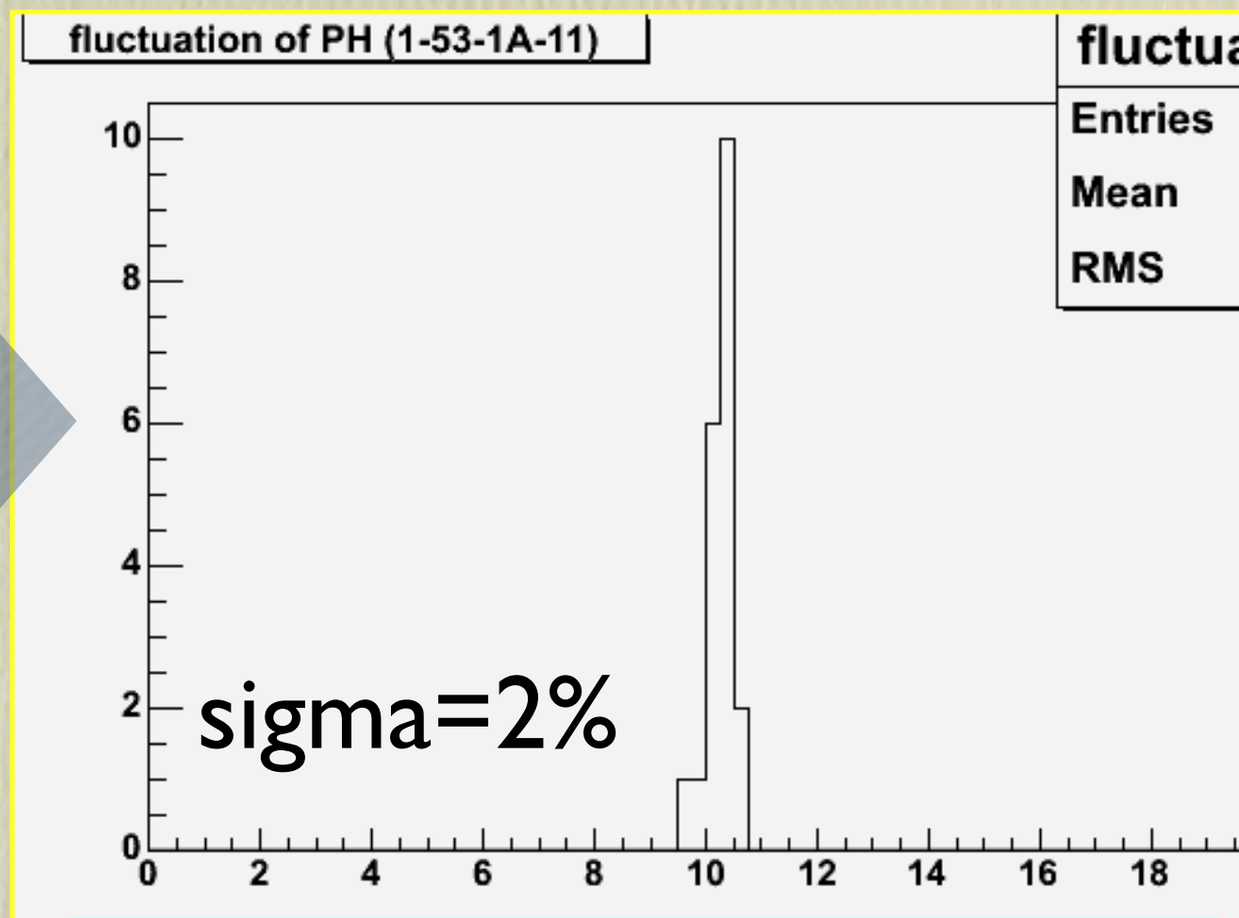
T.Takeshita ECFA05

Pixel test -2 : Uniformity

version 1



version 2 from HPK



Histogram of deviation for PH

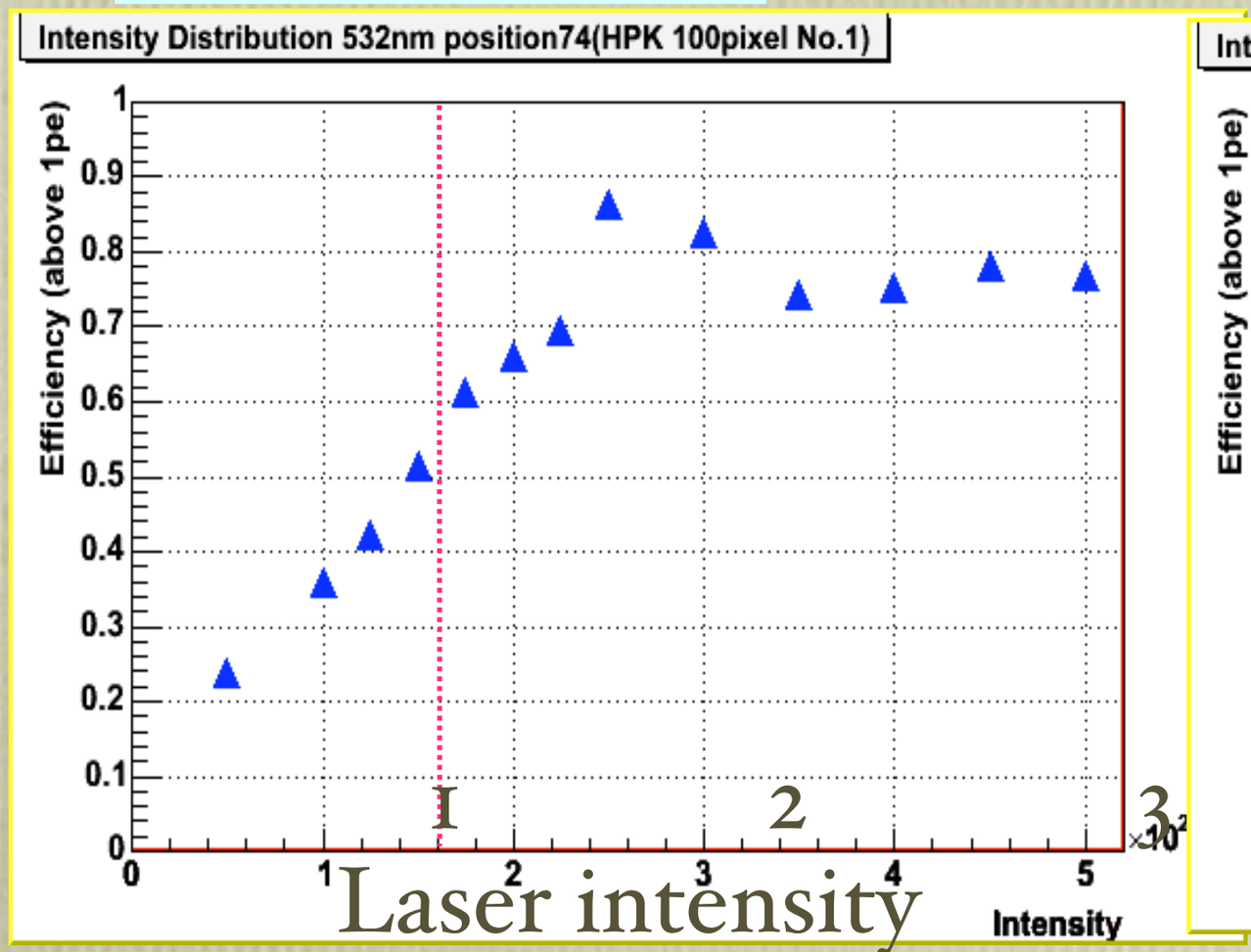
version 2 is much more uniform in pixels

Pixel test -3 : Geiger Mode

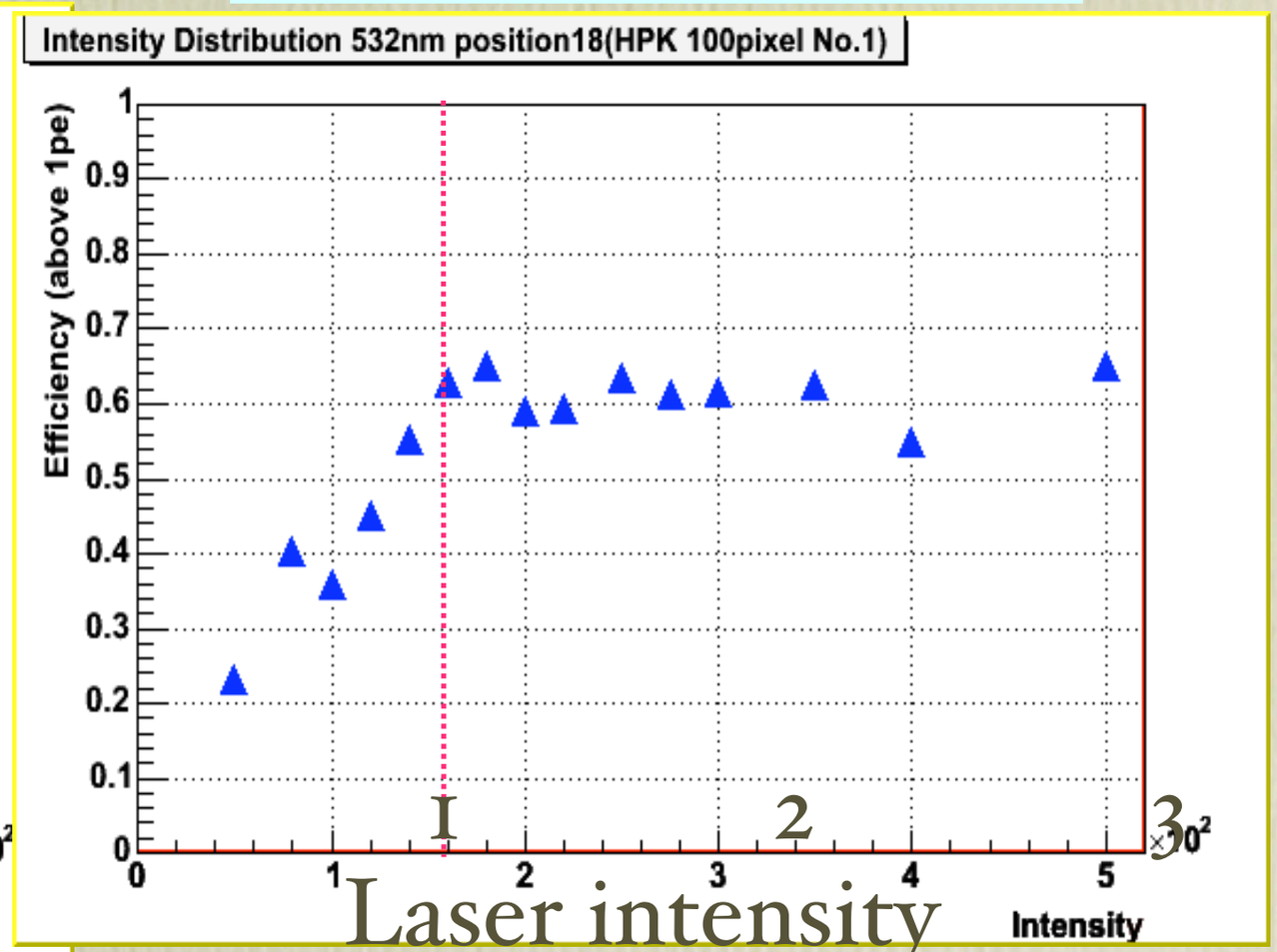
Efficiency of Np>= 1photon event vs. Laser intensity

version 1

position X=4,Y=3 eff: good



position X=8,Y=9 eff: poor



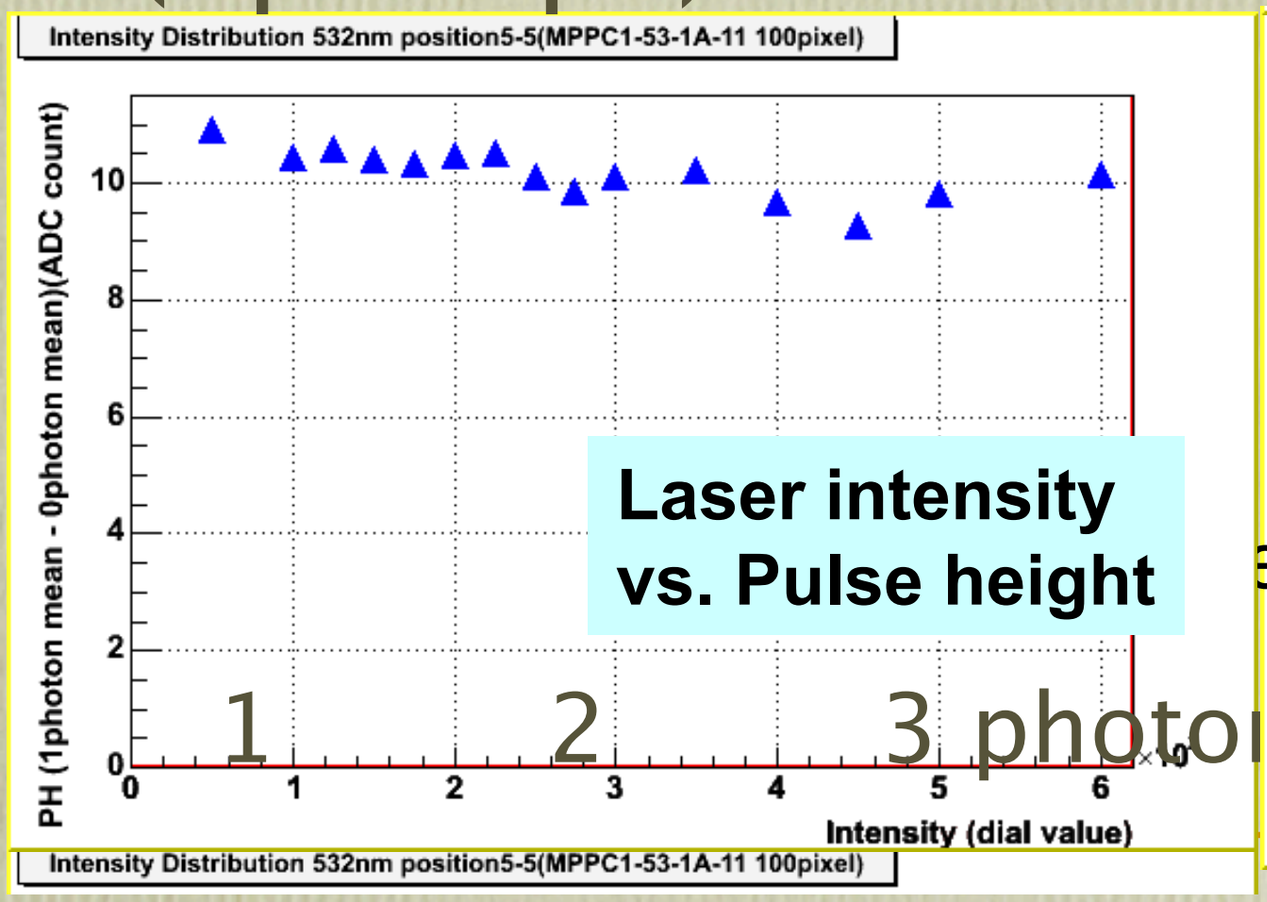
const. response at Nphoton >= 1

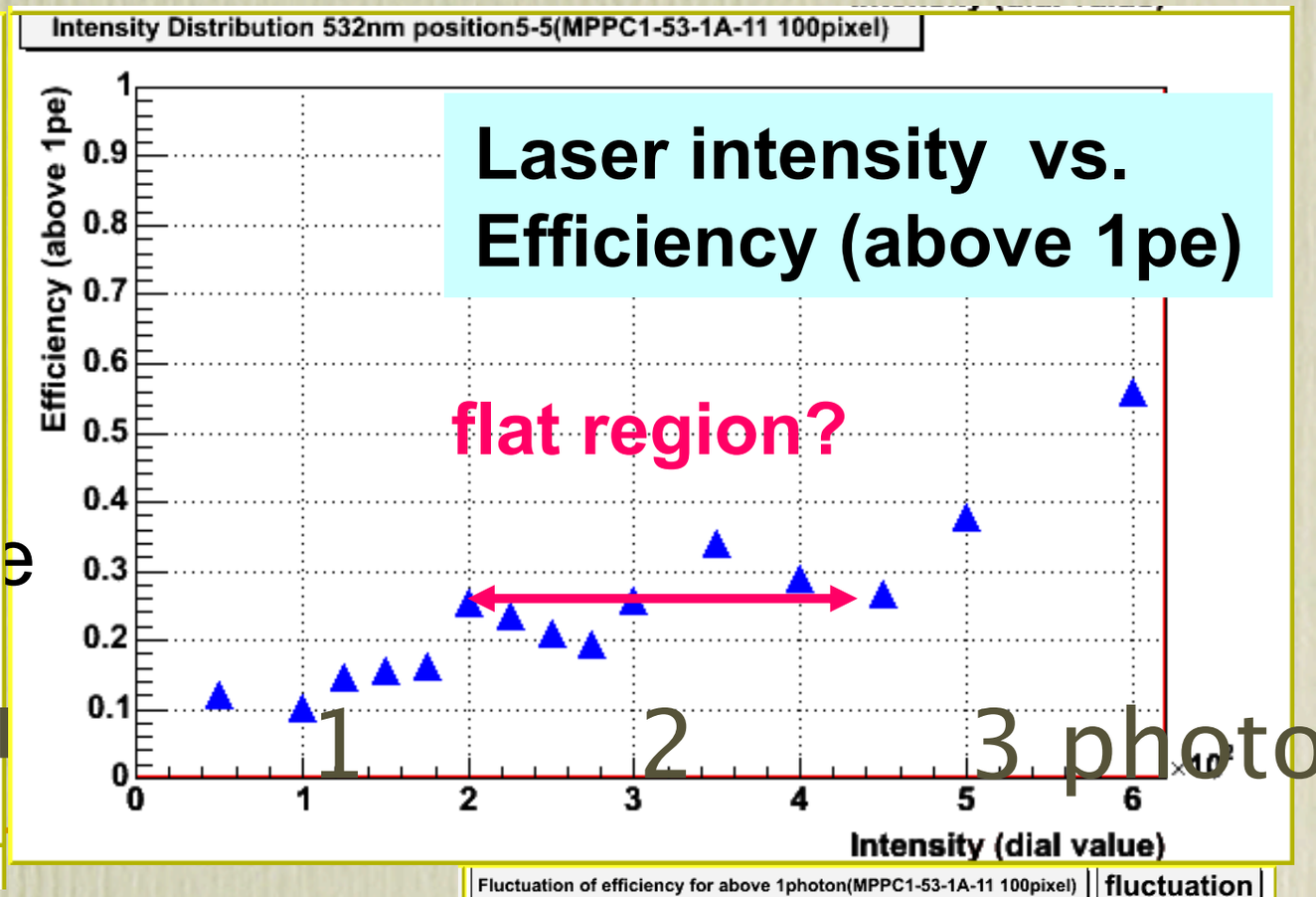
T.Takeshita ECFA05

Pixel test -3 : gain and efficiency

G(1pe–0pe) at (5,5) position pixel

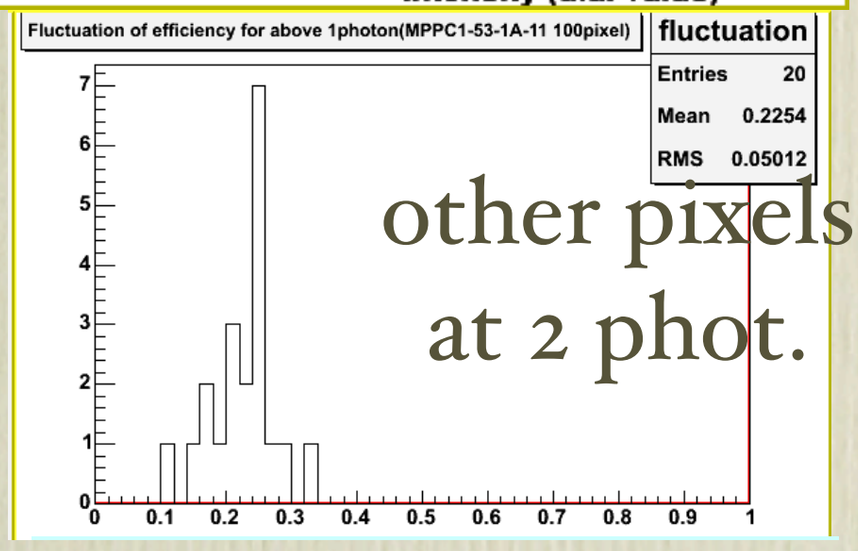
version 2





Absolute gains look fairly const.

Small efficiency



other pixels at 2 phot.

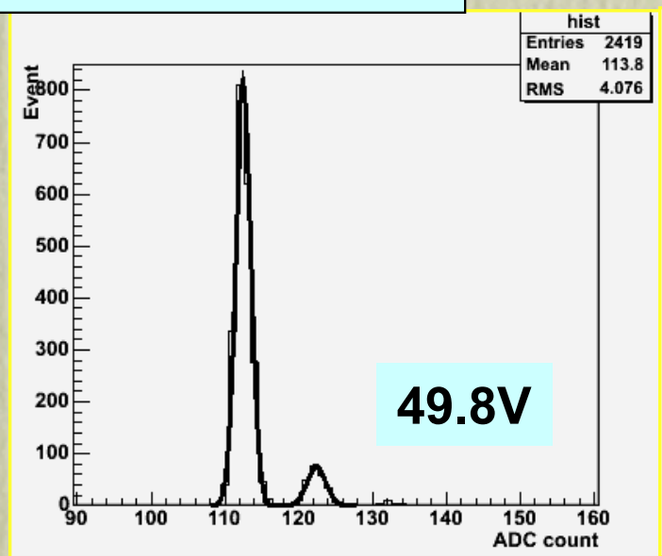
T.Takeshita ECFA05

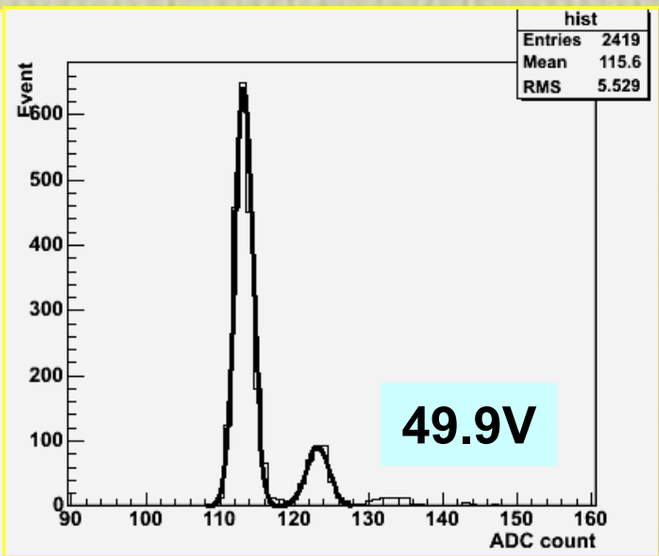
Pixel test -3 : break down Voltage

ADC dist.

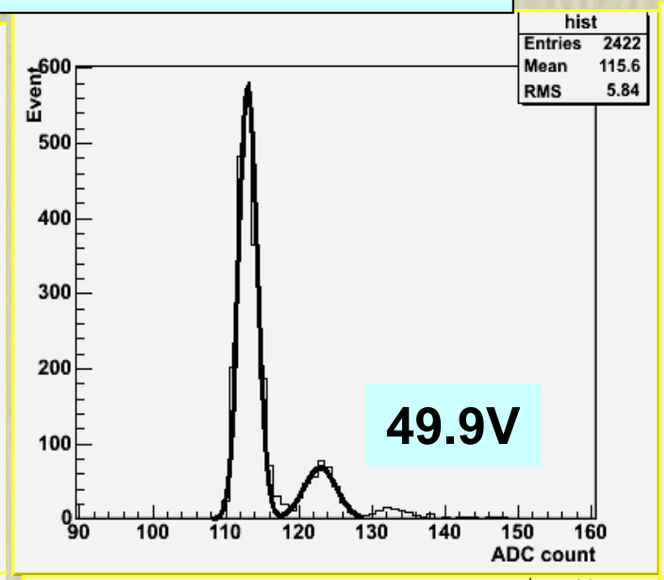
100 pix version I

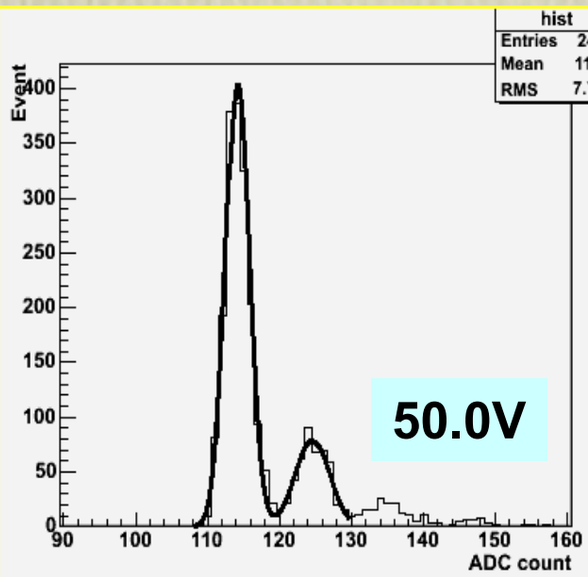
X=5, Y=5 Eff.: 24%

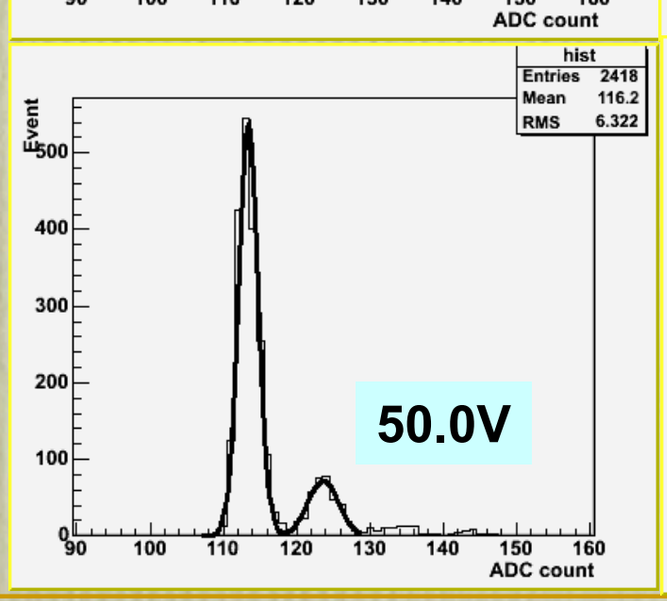


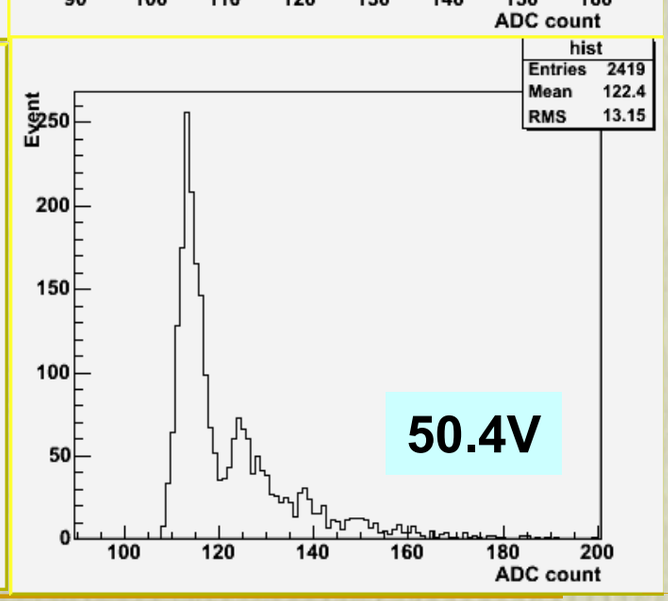


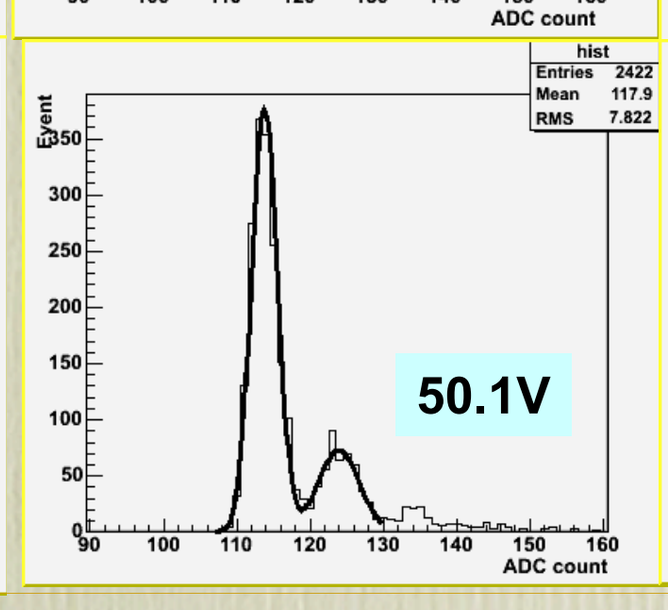
X=5, Y=2 Eff.: 33%

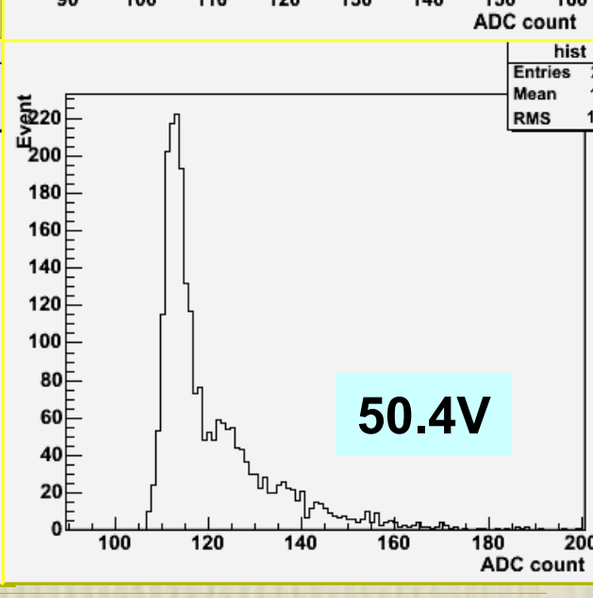












Vb=49.9V (5,5)

Vb=50.0V (5,2)

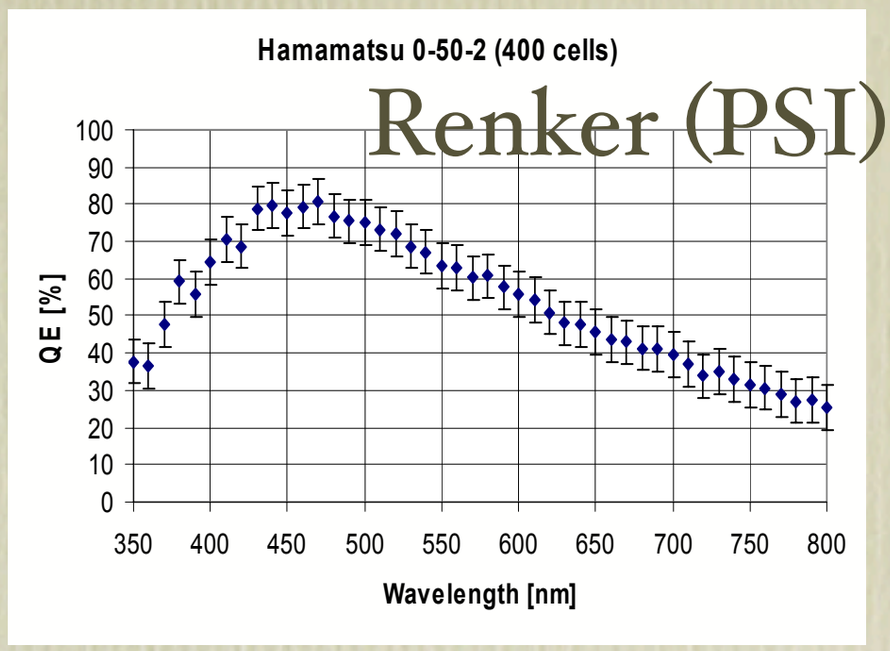
ΔVb~0.1V for 20 pixels

Progress of MPPC

December/04 → March/05

100pix	version 1	version 2
operation bias Voltage range	0.1 V	0.4 V
gain uniformity	10 %	2%
average efficiency	60 %	30%
break down Voltage range	0.2V	0.2V

to understand MPPC



- DE=QE x e(GM) x e(geom)
  - QE: Quantum eff. ~ 65%
  - e(GM) : e-hole pair goes to GMode
- e(geom) : geometrical eff. = dep. Npix
  - ~70% for 100 pix , 45% for 400 pix
- e(GM) strong Vbias dep.
- X-talk effect ?? as a function of bias V

Requirements for ILC det.

WLSF-RO, 10 pix for a MIP

GLD	dynamic range	strip cm^3
ECAL	**>2000** pix	1 x 5 x 0.2
HCAL	< 2000 pix (analog)	1 x 20 x 0.5
Muon	< 500 pix	5 x 500 x 2

T.Takeshita ECFA05

Summary and outlook

- progress of MPPC development
  - version 1 to 2 from HPK
  - version 3 will come up this week
- ECAL production with the MPPC
  - for Beam Test 2007
  - with 1.5mm and 3000 pieces