# Photon Counting

case of EasyPET

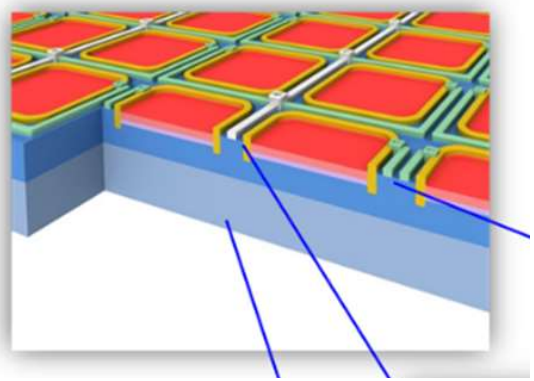
LYSO scintillating crystal causes 16,000 photon for 511keV gamma rays.

We see ~one direction out of 6 (L-R,U-D,F-B) direction.
So ~2,670 photon will come out.
LYSO is 2mm x 2mm but Sensor is 1mm x 1mm. It is 1/4
Consequently, only 670 photon will hits the sensor.

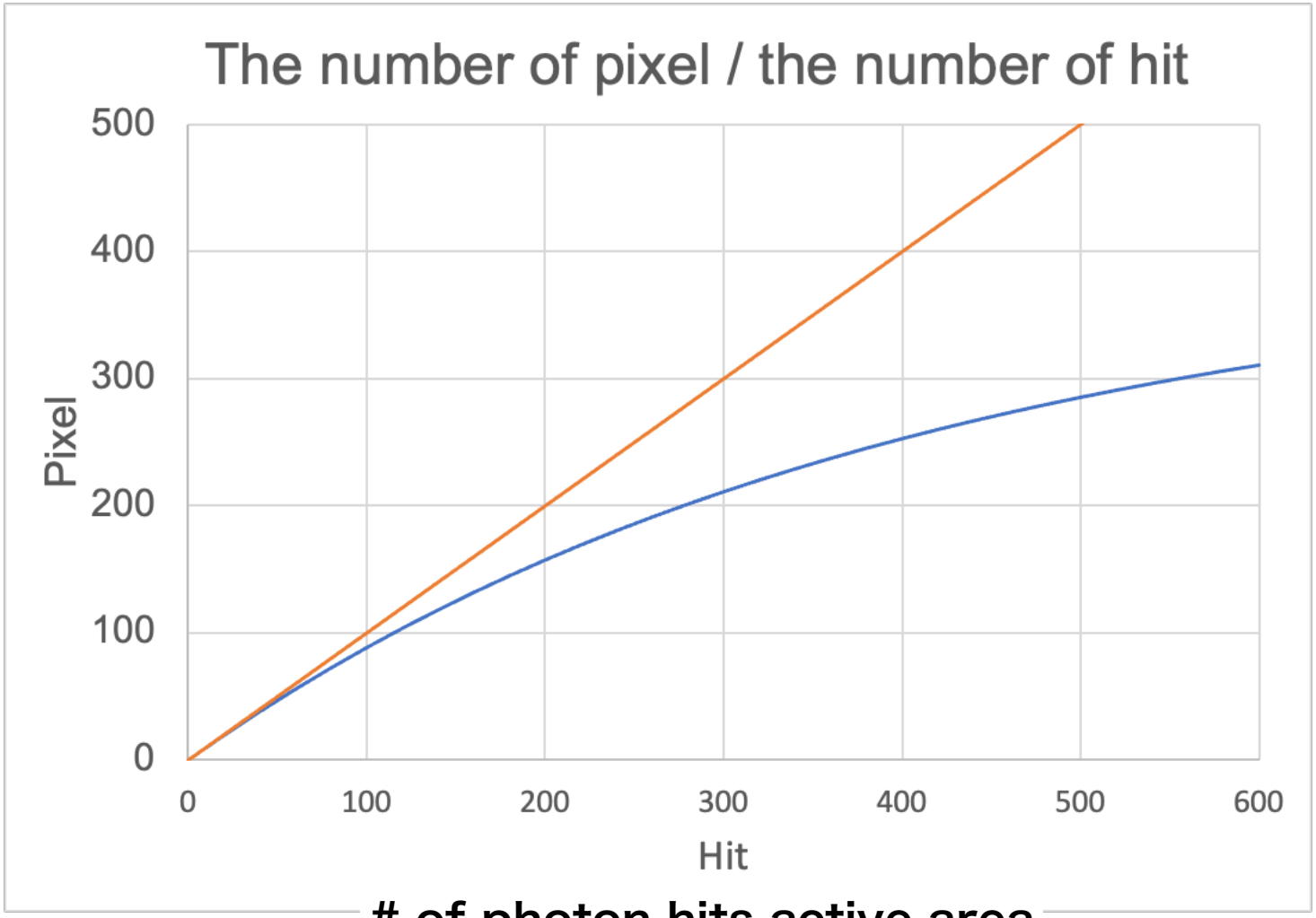
40% of area is active in SiPM
= about 270 photons will hits active area

Max hits is 400. We don't see bigger than that.

Non linear!



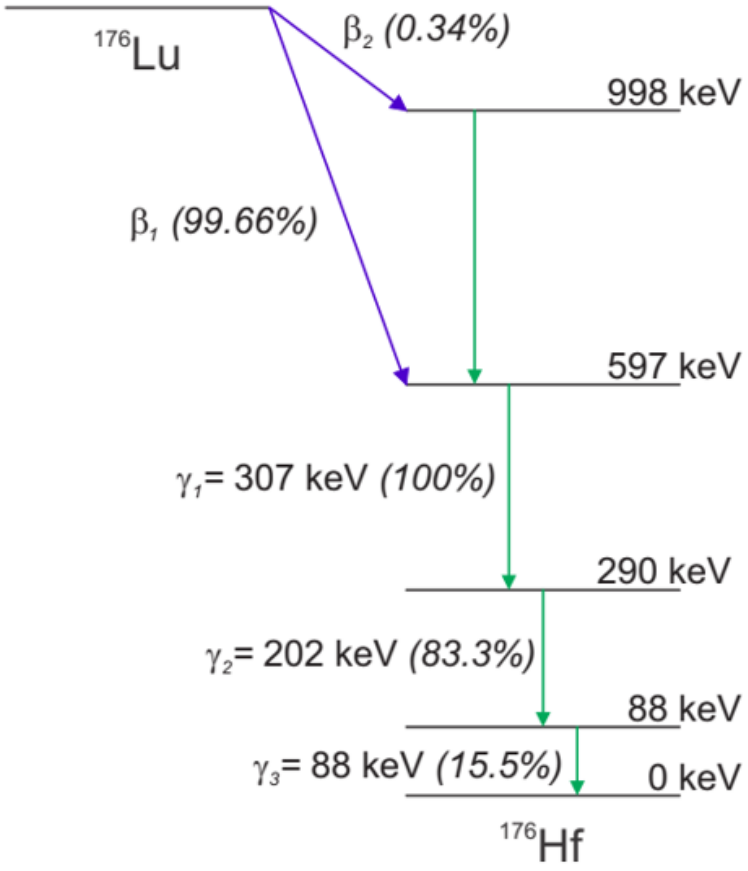
SiPM in eazyPET has 400 pixel.

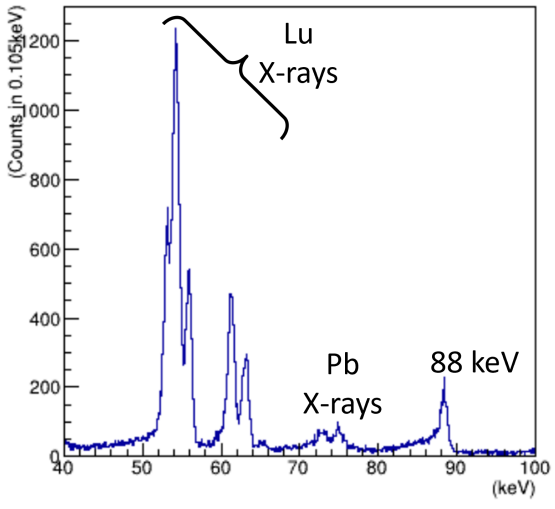


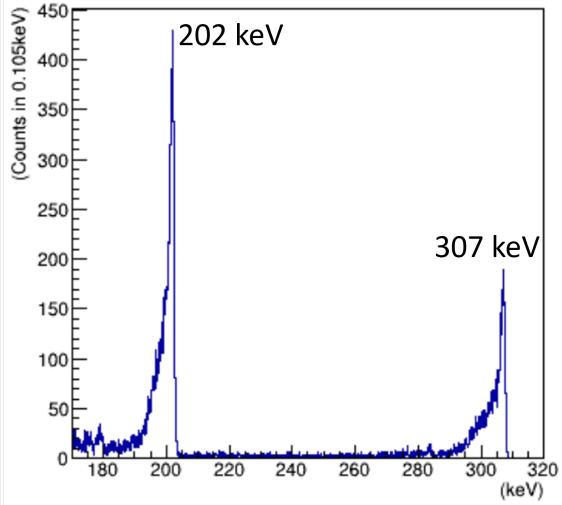

# of photon hits active area

# Intrinsic radio activity

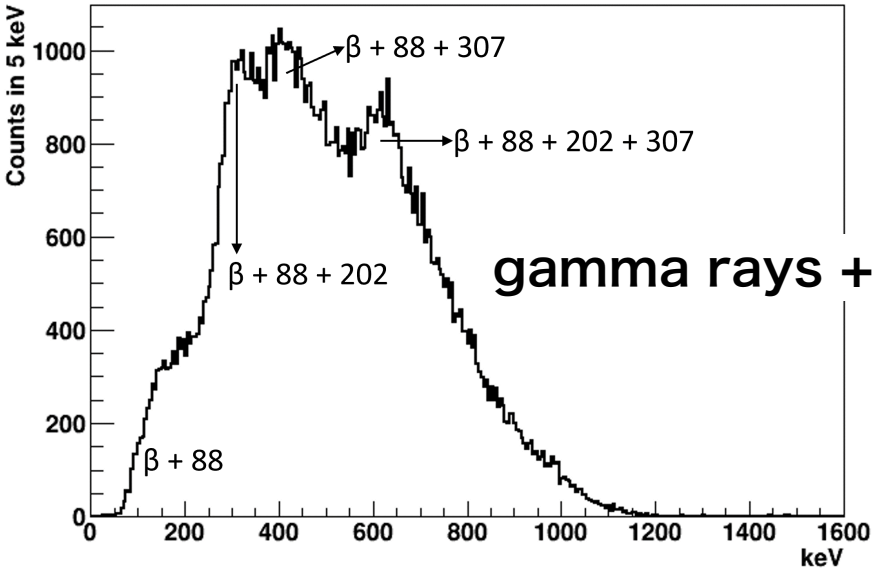
**LYSO crystal has intrinsic radioactivity.**




**gamma rays**




**gamma rays + beta rays**

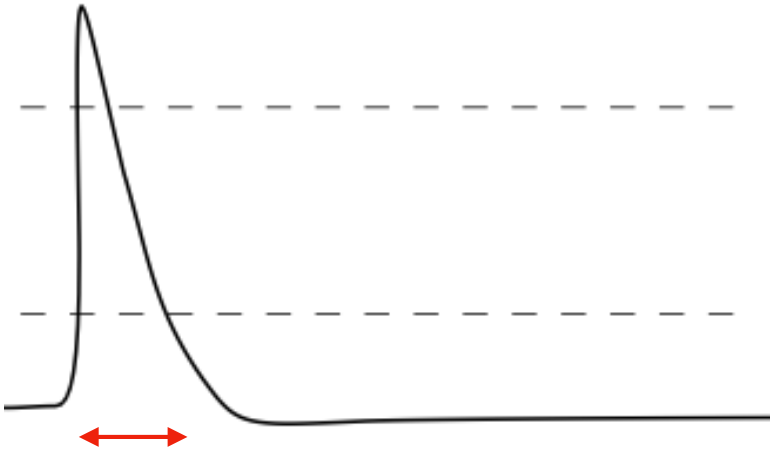
# Dark signal

**Signal in Dark**

**Thermal excitations causes avalanche.**

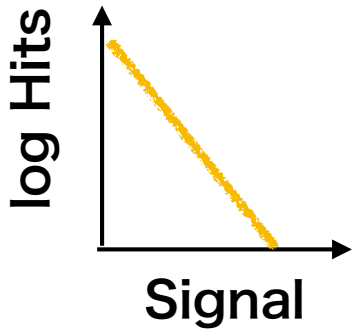
**Event rate for SiPM in EasyPET is 110 kHz**

**110 k in sec ~ 1 in 9 $\mu$sec**



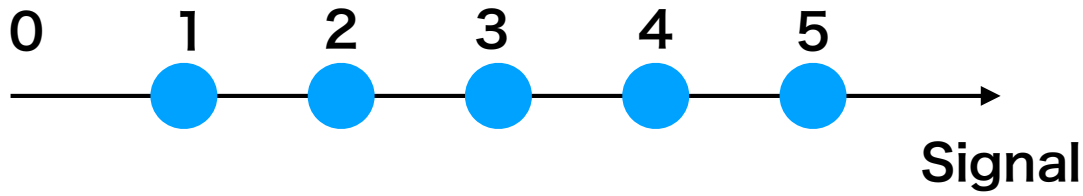
**Probability of overlap on 1 us signal is 1 x 1/9 = 11 %.**

**1 hit = 110 kHz**
**2 hit = 110 x 0.11 = 12.1 kHz**
**3 hit = 1.3 kHz**
**4 hit = 140 Hz**

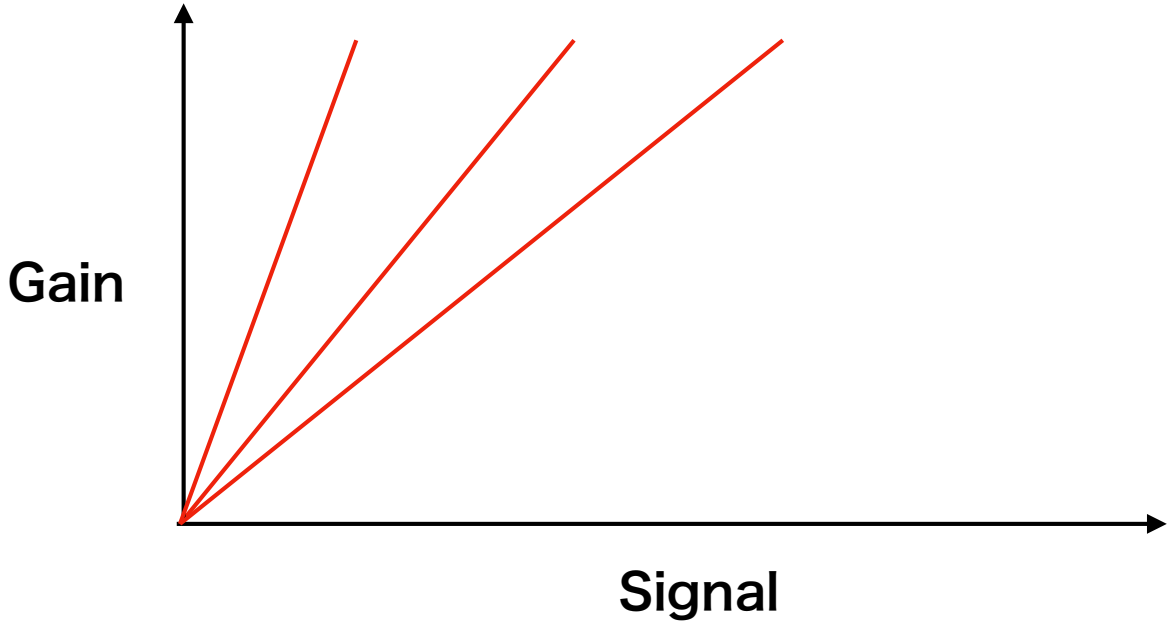


# Hits and Signal

Signal is proportional to the number of hits.



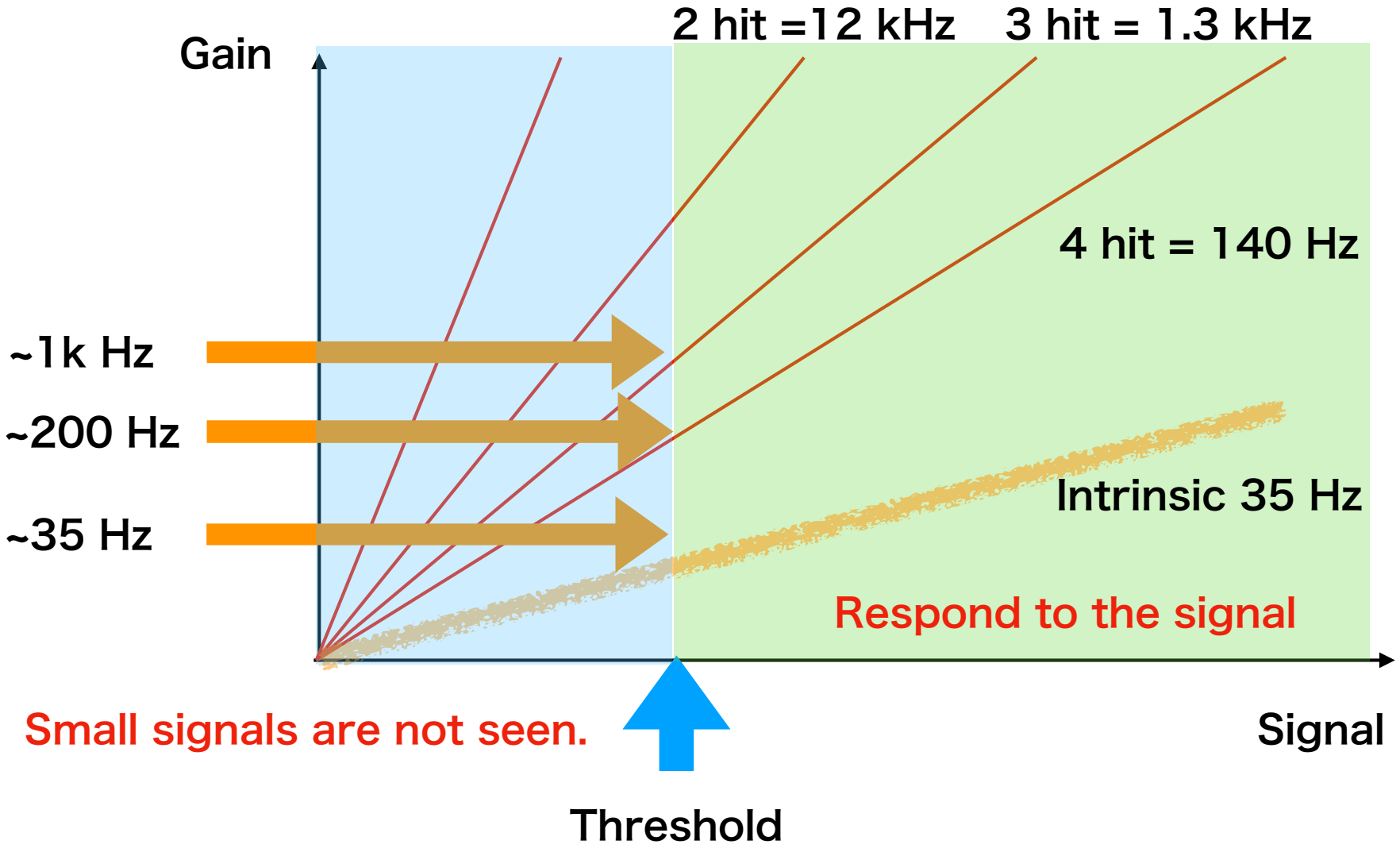

Signal is proportional to the Gain.

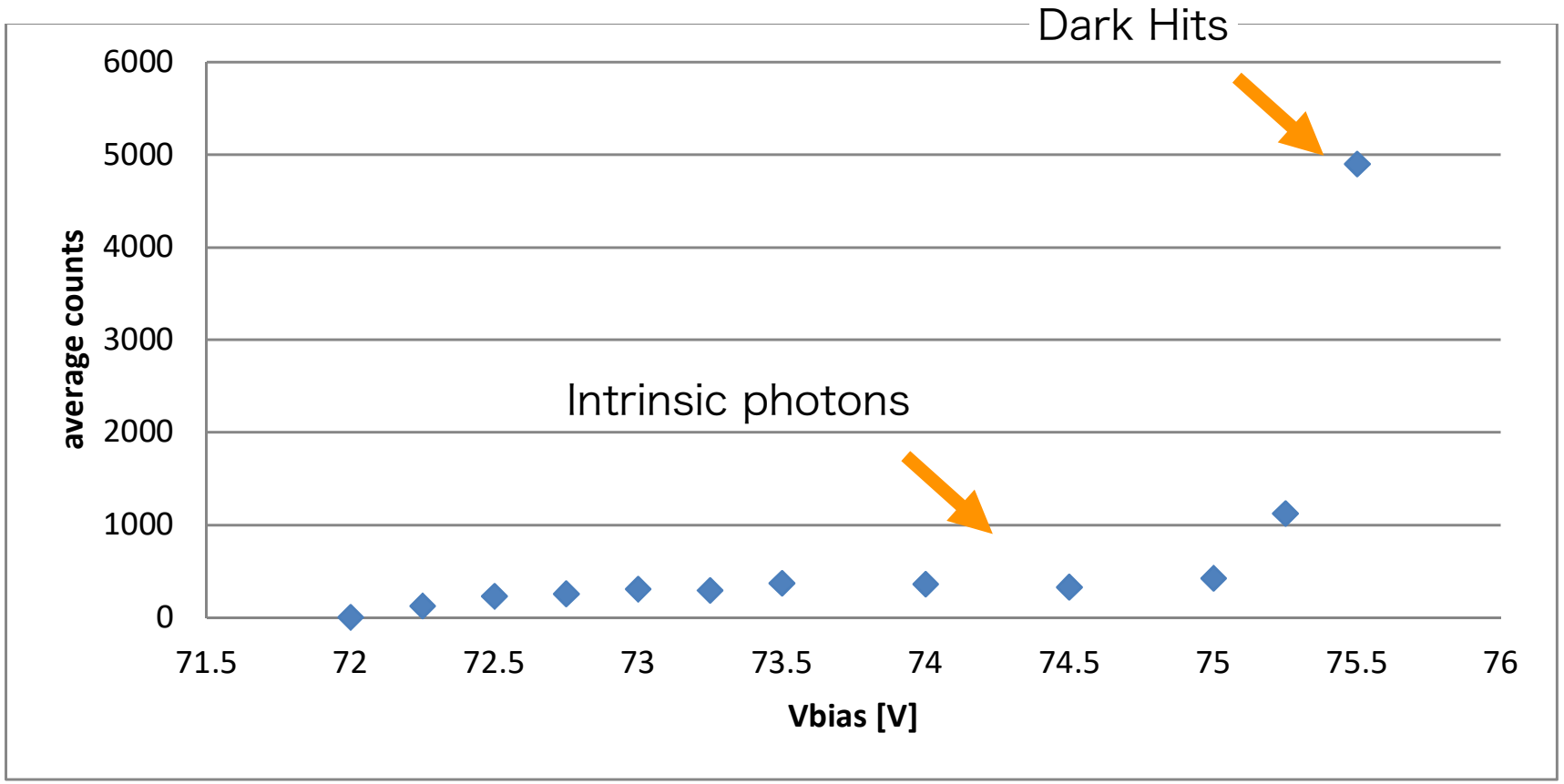



Gain changes the size of signal but does not change the number of hits.

# Threshold

Signal is proportional to the Gain.





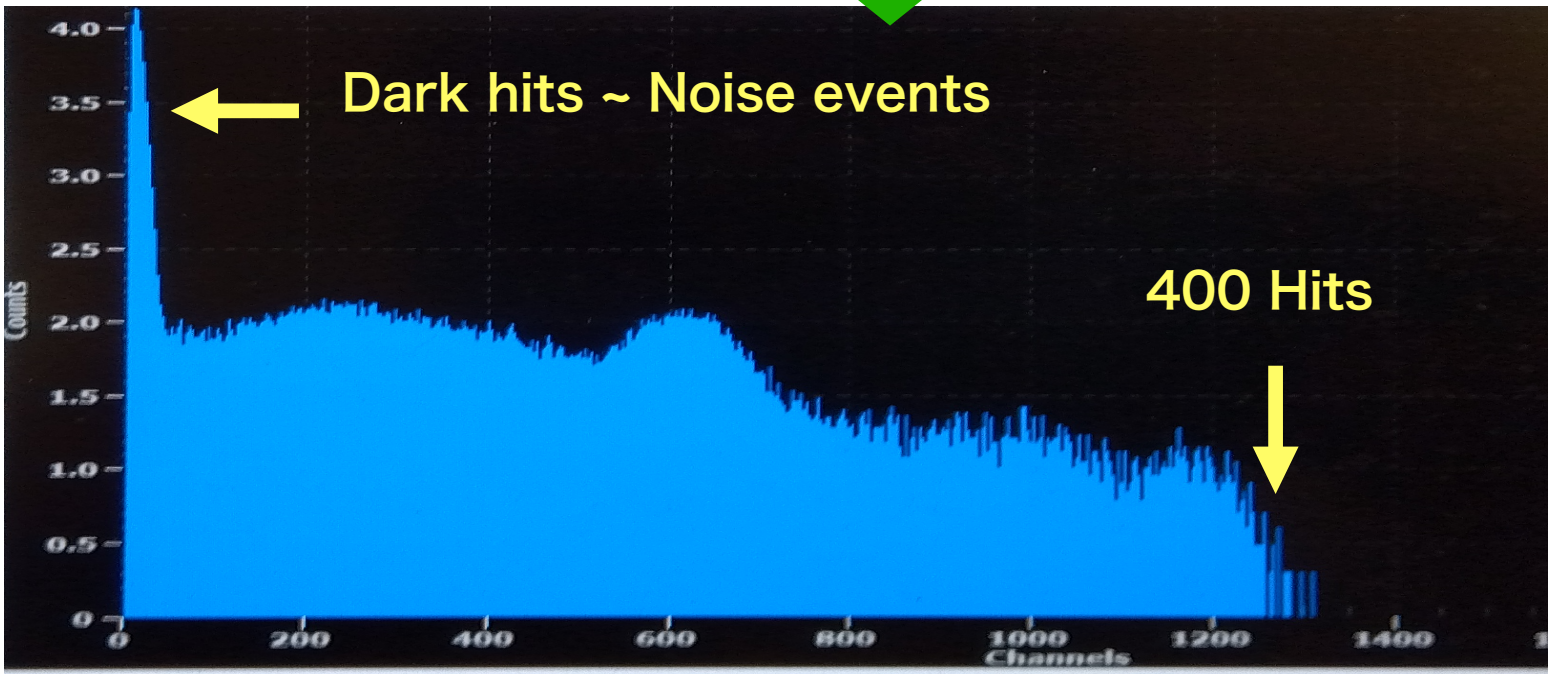

higher over voltage = higher gain

Getting more than 100 Hz ~~ Getting dark hits (Noise events)

Vias voltage depends on temperature, device etc.


Dark hits ~ Noise events
400 Hits
Counts
Channels
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
0
200
400
600
800
1000
1200
1400

Higher Gain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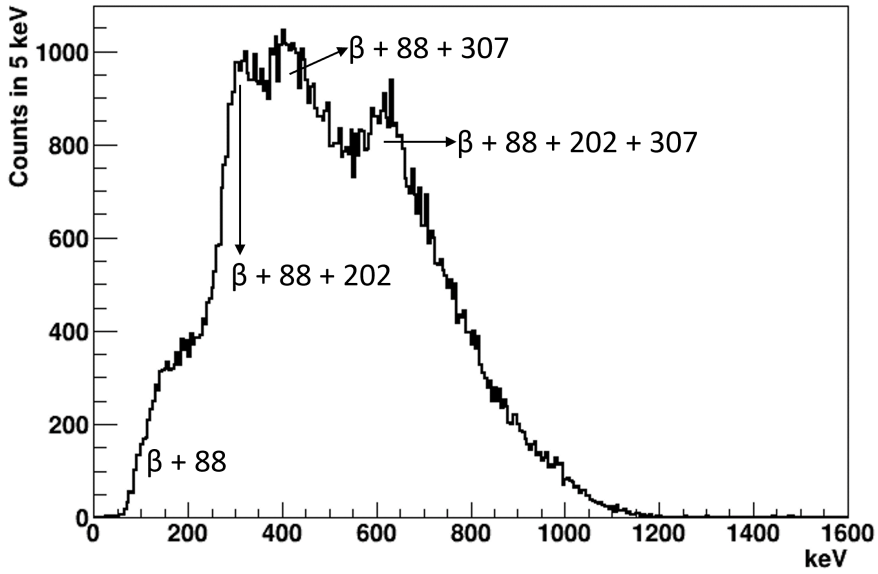
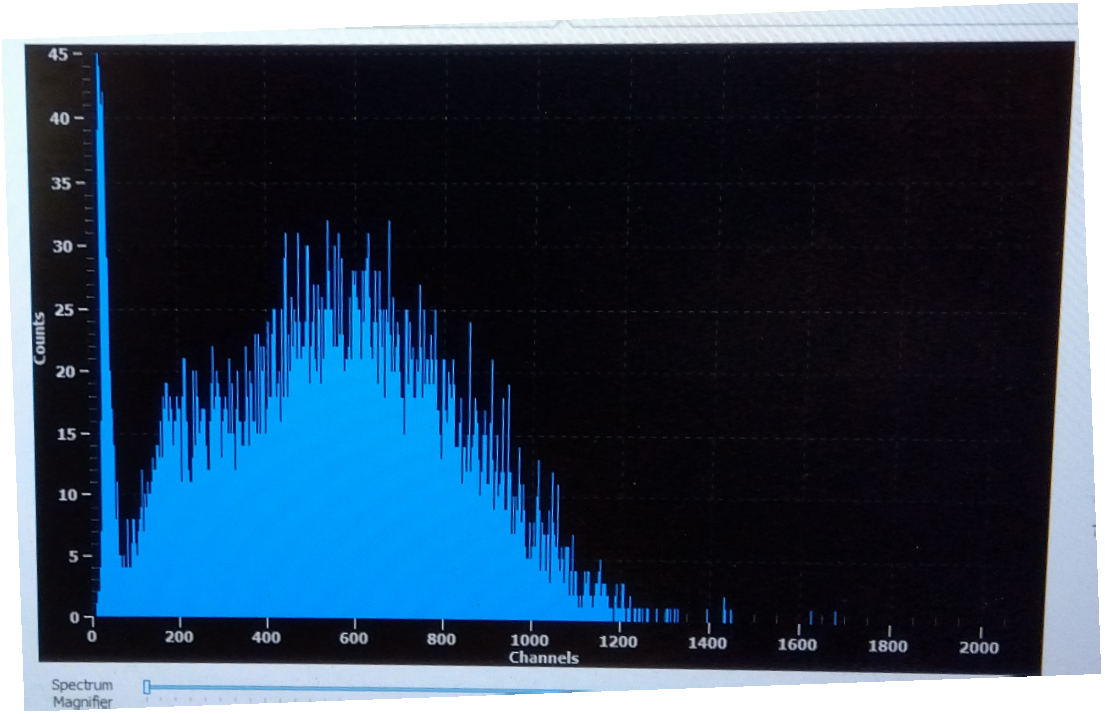
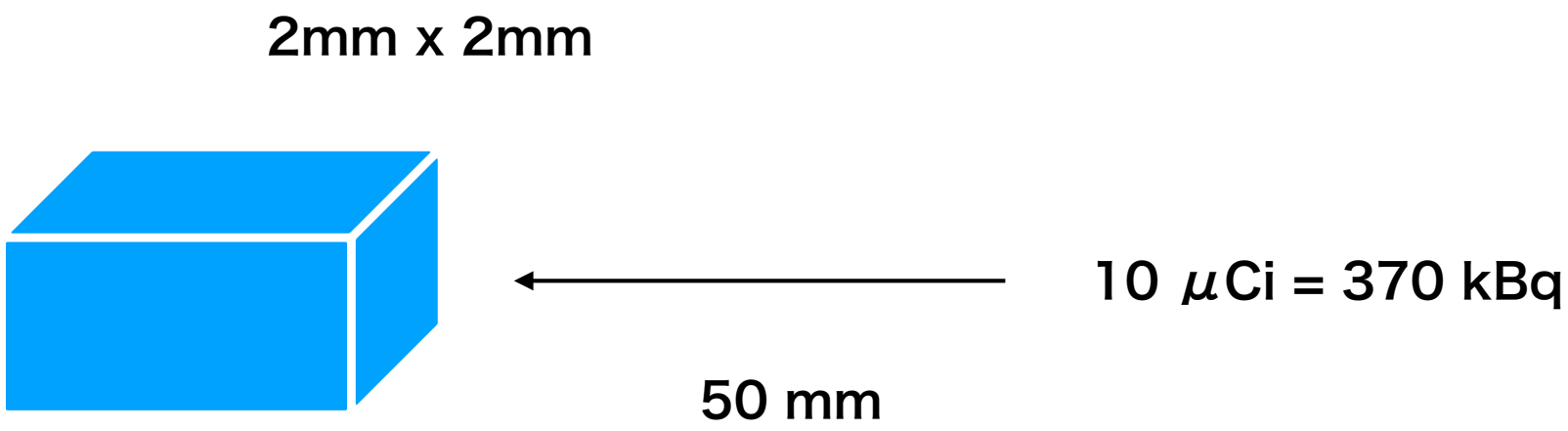



External = No beta

Internal = gamma + beta



# Coincidence rate




370 k x 2x2 / 4 π 50x50 = 370 k x 1.3/10000 = ~50

Coincidence rate should be an order of ~50.