Status report

Tokyo University of Science

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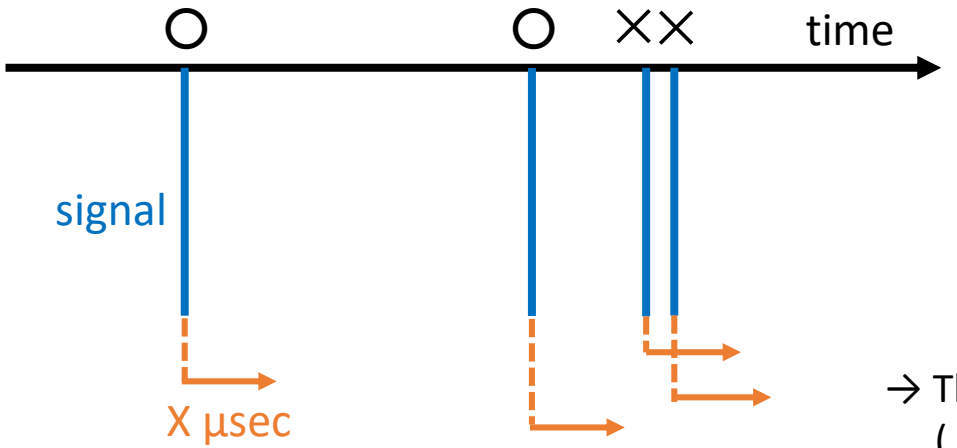
31th January, 2020

mPMT meeting

< Dark rate time structure >

- Changing the value of time frame, I reduced the signal count within that frame and check the dark rate.

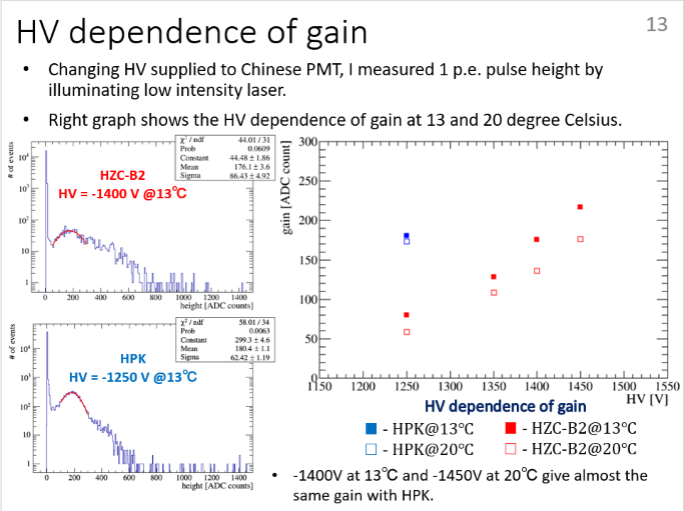


→ The rates of HPK decrease
(reported at last meeting)

Until this week…

- I applied same way to HZC new PMT.

(slide reported at 20th December)



- I found that -1400V at 13℃ for HZC-B2 gives almost same gain with HPK-1.

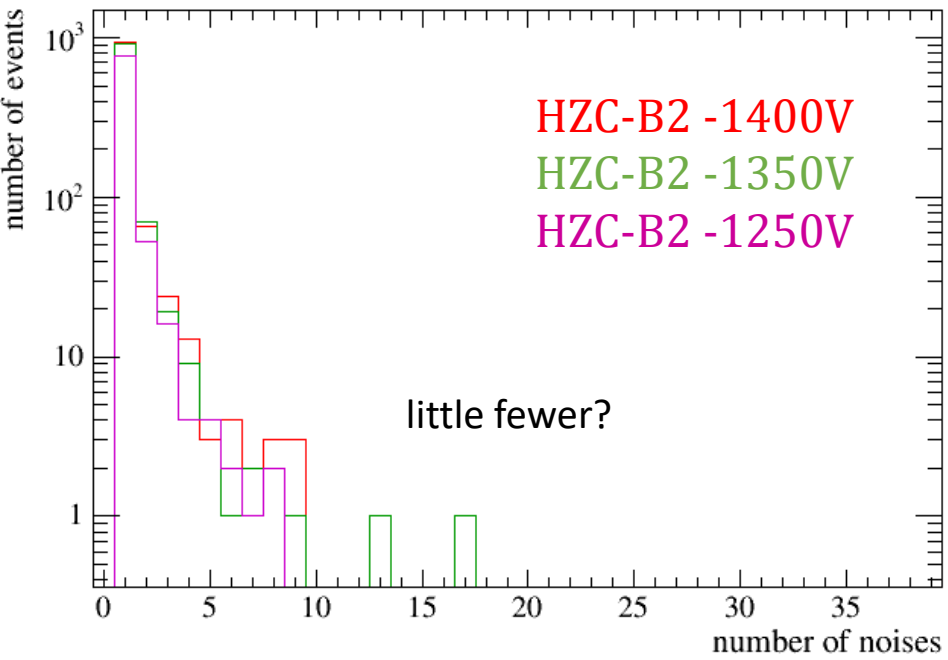
The list of PMTs

	ID	Type	HV
Hamamatsu	HPK-1	H14374	-1250V
	HPK-2	H14374	-1400V(gain tuned)
			-1350V
			-1250V
New HZC type	HZC-B2	XP72B2F	-1400V(gain tuned)
			-1350V
			-1250V

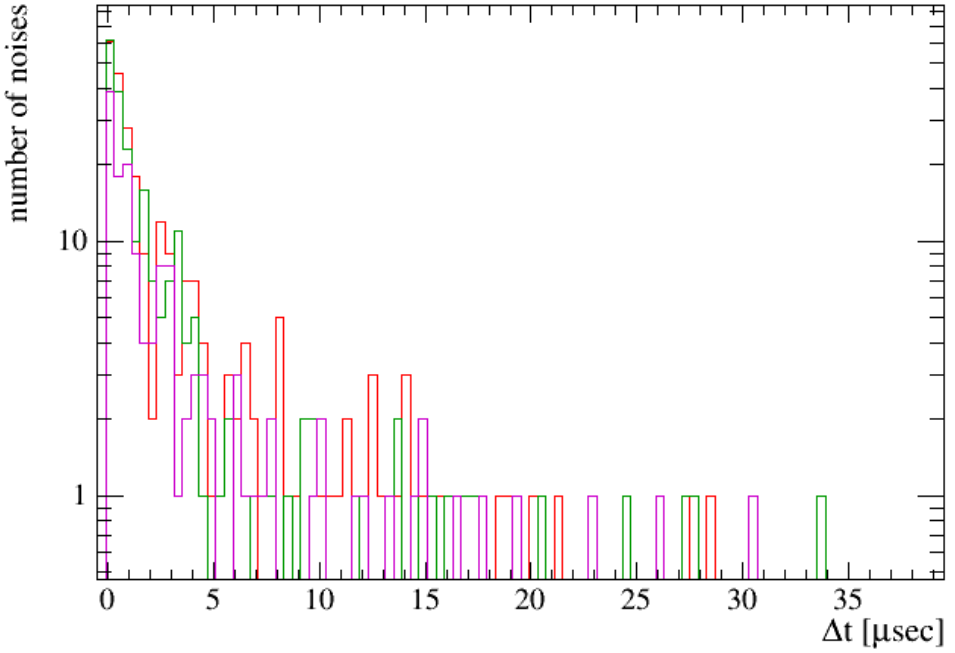
Previous measurement

- 13℃
- Threshold = 0.4 p.e.

Dark rate time structure of HZC PMT

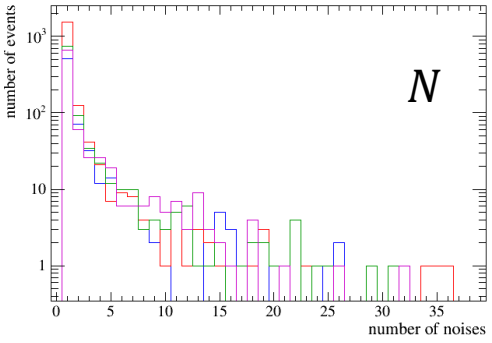


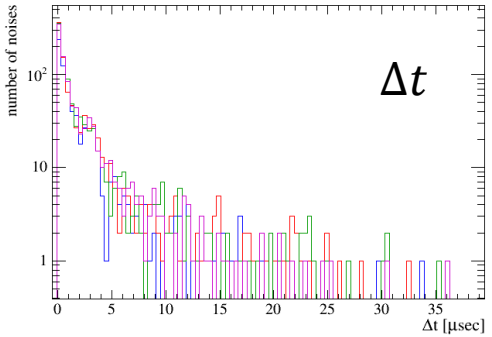
the number of dark noises N in each event



the time intervals of multi signals

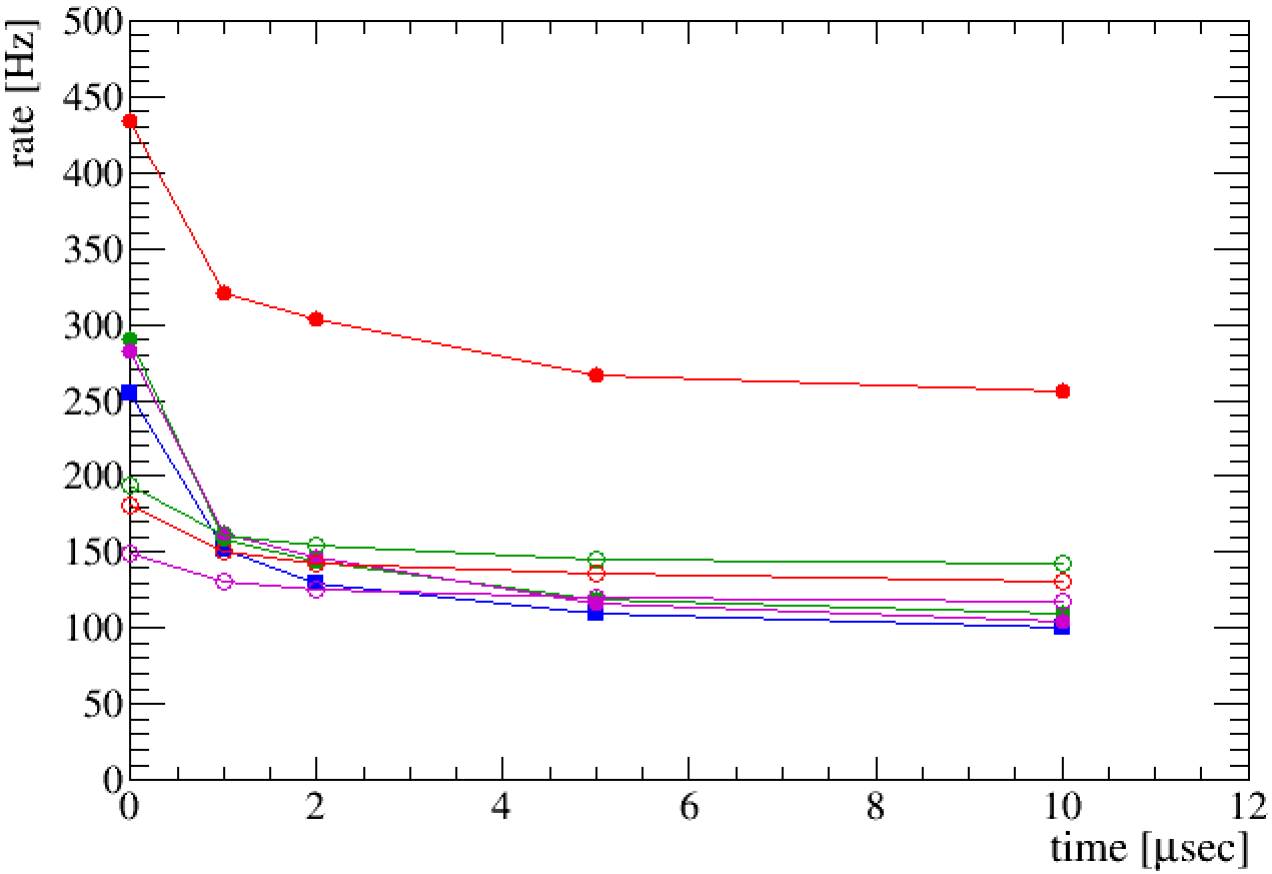
- The distribution similar to HPK was seen.
  → set the cutting time frame for 1, 2, 5 and 10 μsec.

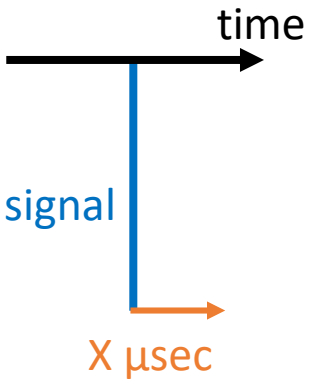




HPK-1 -1250V
HPK-2 -1400V
HPK-2 -1350V
HPK-2 -1250V

Cutting time frame dependence





■ HPK-1 -1250V
● HPK-2 -1400V
● HPK-2 -1350V
● HPK-2 -1250V

○ HZC-B2 -1400V
○ HZC-B2 -1350V
○ HZC-B2 -1250V

- The graph shows the dark rates at each value of cutting time frame. The plot at X=0 corresponds to no cutting.
  - The rate reduction of HZC was not so much than that of HPK.

Ratio of rate reduction

	HPK-1 -1250V	HPK-2 -1400V	-1350V	-1250V	HZC-B2 -1400V	-1350V	-1250V
X=0 µsec	0% (254.4Hz)	0% (433.9Hz)	0% (289.7Hz)	0% (281.8Hz)	0% (180.1Hz)	0% (194.0Hz)	0% (149.2Hz)
X=1 µsec	40.5% (151.3Hz)	26.2% (320.2Hz)	45.1% (159.0Hz)	42.3% (162.7Hz)	16.4% (150.5Hz)	17.0% (161.1Hz)	12.5% (130.6Hz)
X=2 µsec	49.3% (129.0Hz)	30.2% (302.9Hz)	50.2% (144.2Hz)	48.1% (146.3Hz)	20.7% (142.8Hz)	20.1% (155.0Hz)	15.5% (126.0Hz)
X=5 µsec	57.0% (109.3Hz)	38.4% (267.0Hz)	58.8% (119.3Hz)	58.3% (116.0Hz)	24.7% (135.6Hz)	24.9% (145.7Hz)	19.6% (120.0Hz)
X=10 µsec	60.3% (101.0Hz)	41.0% (256.3Hz)	62.0% (110.0Hz)	62.8% (104.9Hz)	27.7% (130.2Hz)	26.5% (142.6Hz)	20.8% (118.1Hz)

- The rates at 5µsec were cut down for almost 40-60% for HPK, while less than 30% for HZC.

Future plan

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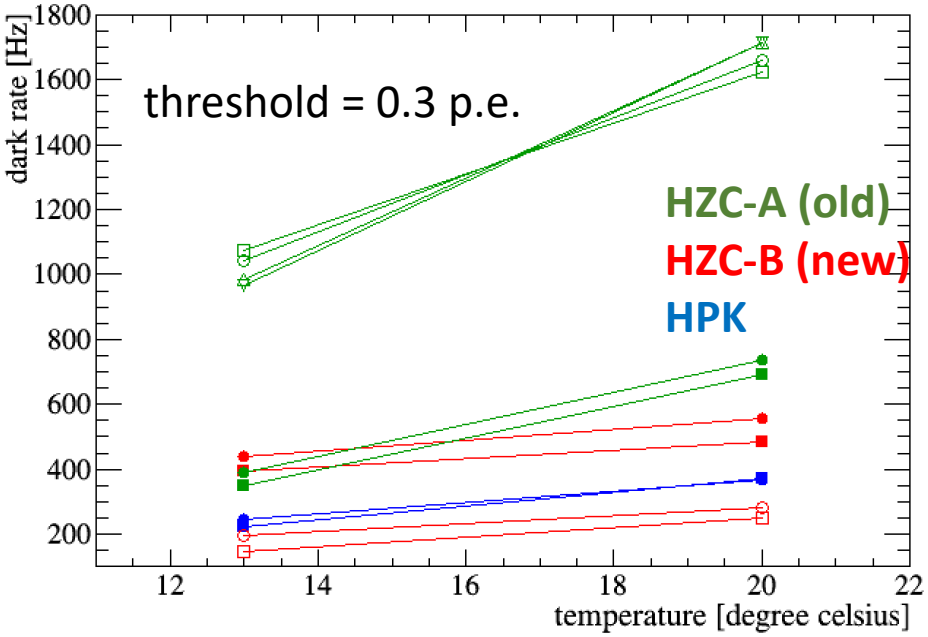
List of the PMTs

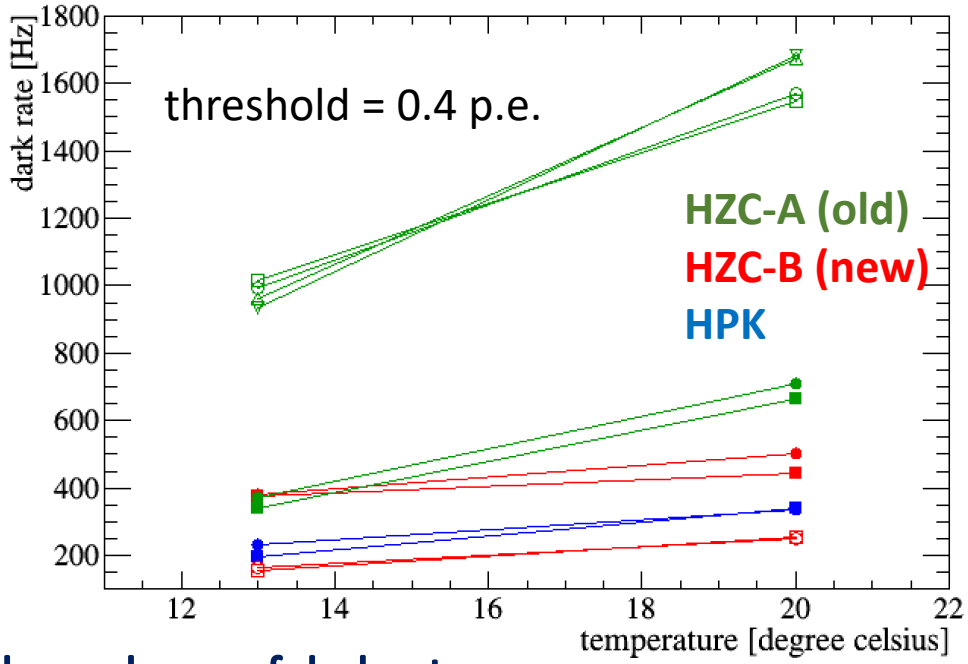
	ID	type	HV	Negative	positive
Hamamatsu	HPK	H14374	1250	✓	-
HZC new PMT	HZC-B1	XP72B2F	1100	-	✓
	HZC-B2	XP72B2F	1160	✓	-
HZC old PMT	HZC-A1	XP82B20	1050	✓	-
	HZC-A2	XP82B20	1160	✓	✓

HV values are not tuned to give the same gain

(gain: Hamamatsu > HZC old > HZC new)

Dark rate measurement



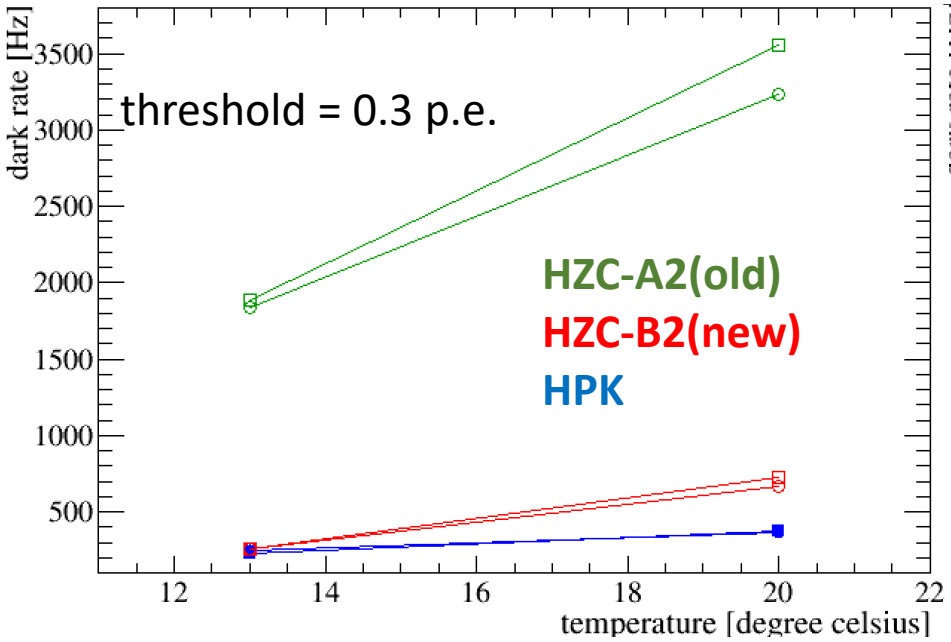


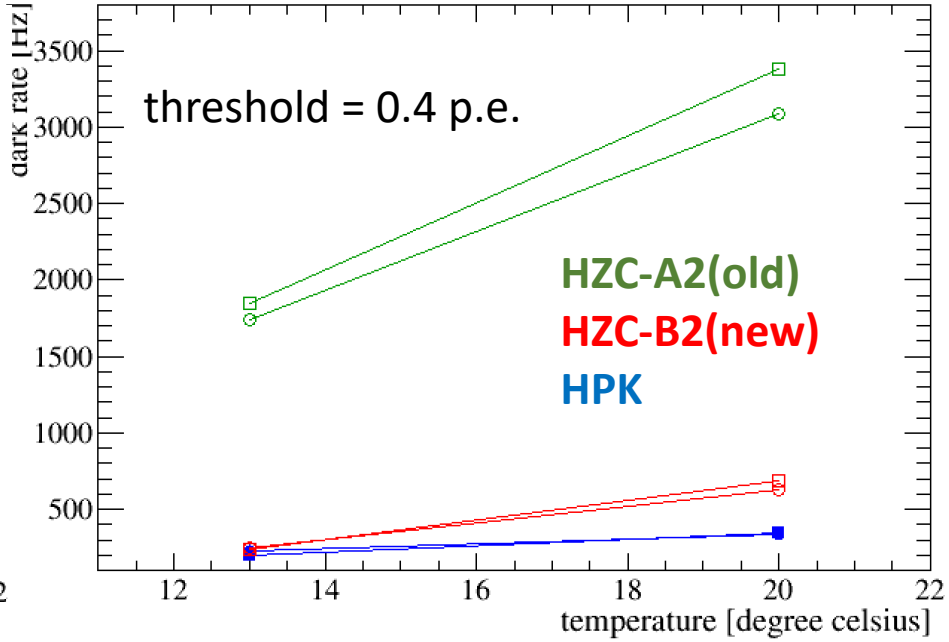
The temperature dependence of dark rate

■	- HZC-A1	1st time (negative)
●		2nd time
■	- HZC-B1	1st time (positive)
●		2nd time
■	- HPK	1st time (negative)
●		2nd time
□	- HZC-A2	1st time (negative)
○		2nd time
△	- HZC-A2	1st time (positive)
▽		2nd time
□	- HZC-B2	1st time (negative)
○		2nd time

- The dark rates are around 200 to 1000 Hz at 13 ℃
- No clear difference between positive and negative HV (HZC-A2) but, rates tends to be higher than those of HZC-B and HPK.

Dark rate measurement (gain tuned)





The temperature dependence of dark rate

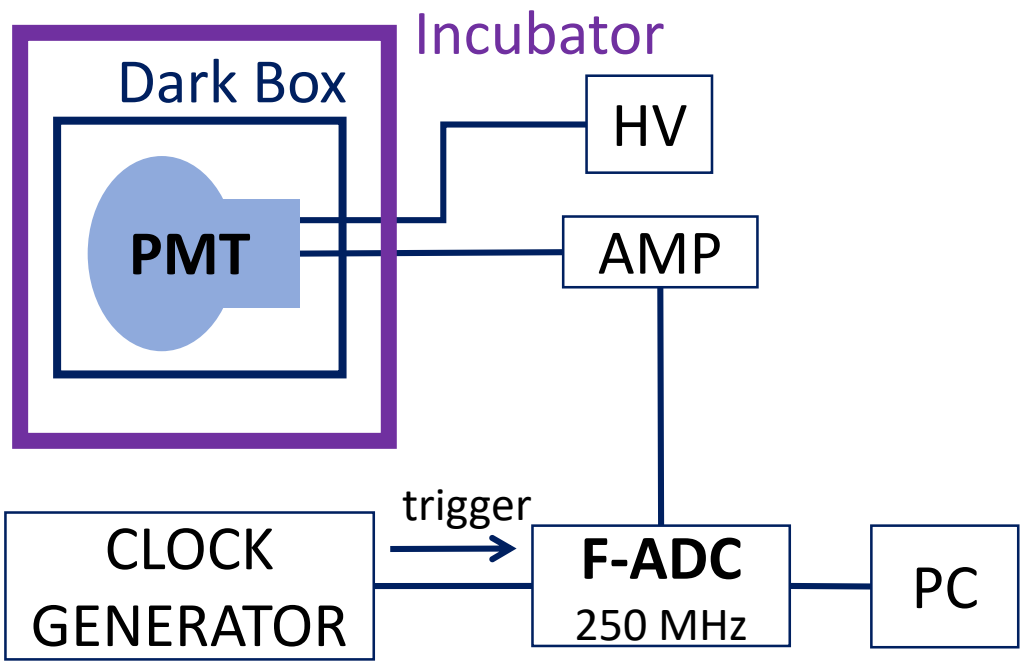
■ - HPK 1st time ● 2nd time

□ - HZC-B2 1st time ○ 2nd time

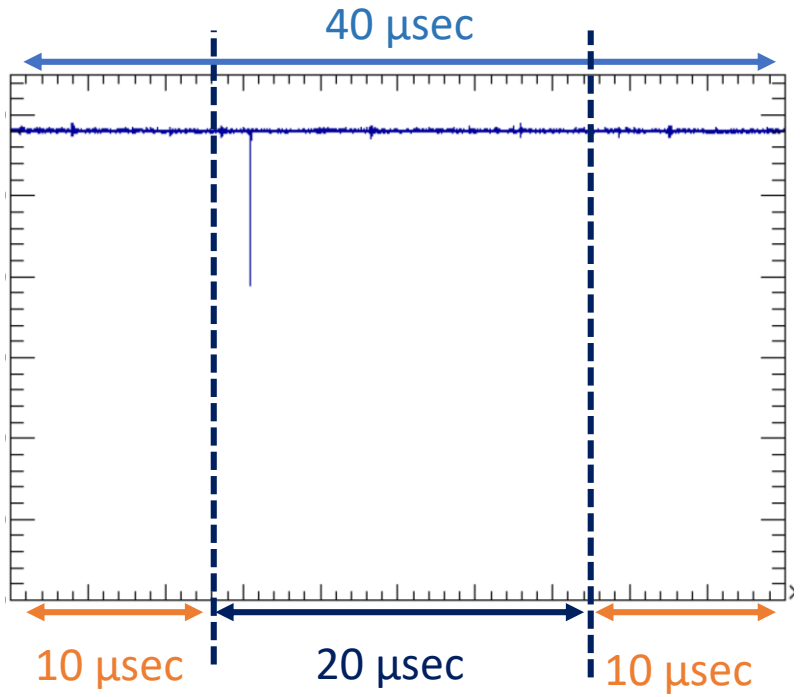
□ - HZC-A2 1st time ○ 2nd time

- In my measurement, the order of rate were HPK ≤ HZC-B2 ≪ HZC-A2 , but still more than 200 Hz at 13℃.

< setup >



< event example >

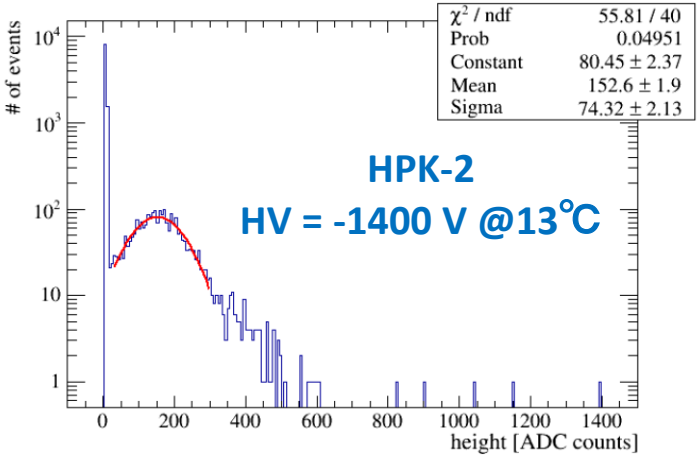


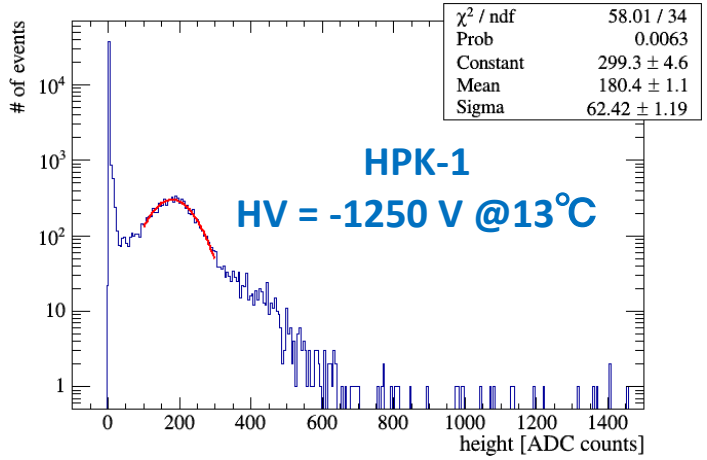
- 13℃
- Threshold = 0.4 p.e.

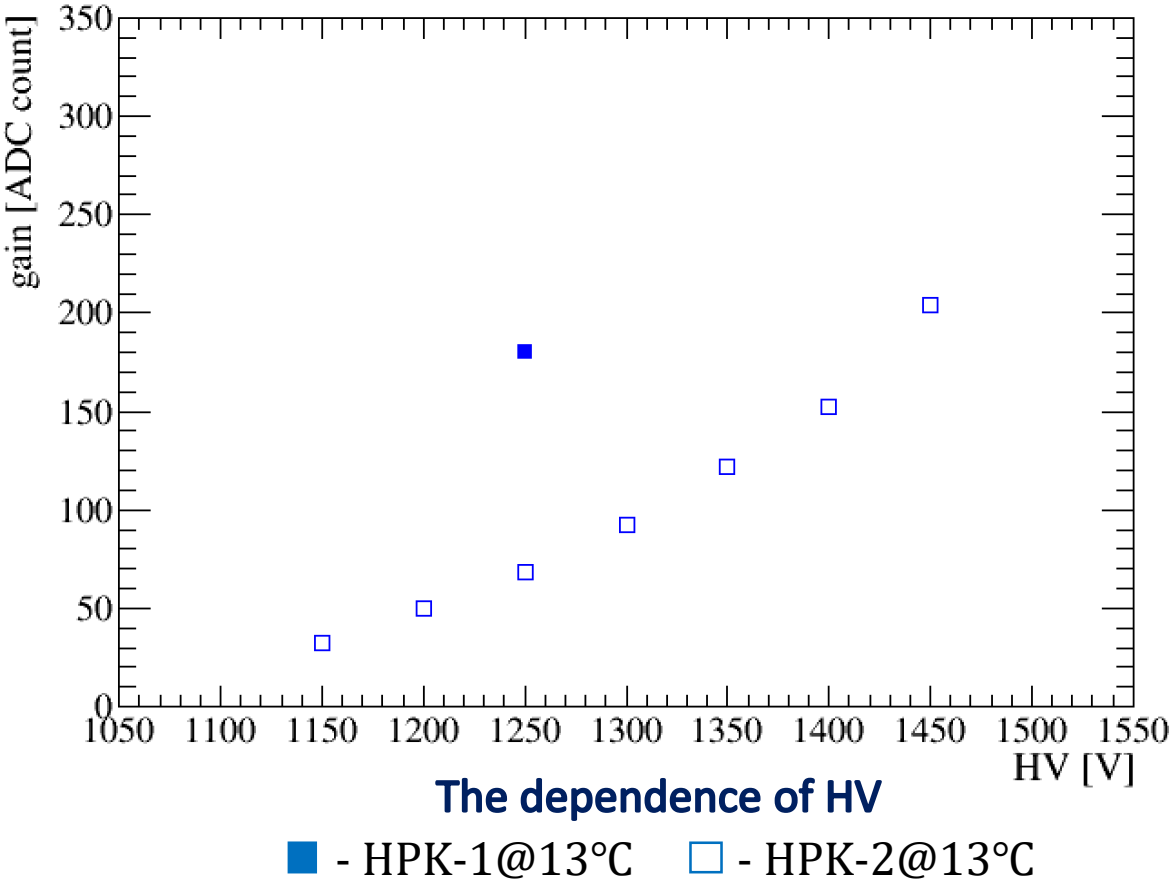
- I measured each event for 40 µsec, but calculated the rate in 20 µsec to check if there is signal at just before or after the both end of time window.

HV dependence of gain

- Changing HV supplied to HPK-2, I measured 1 p.e. pulse height by illuminating low intensity laser.



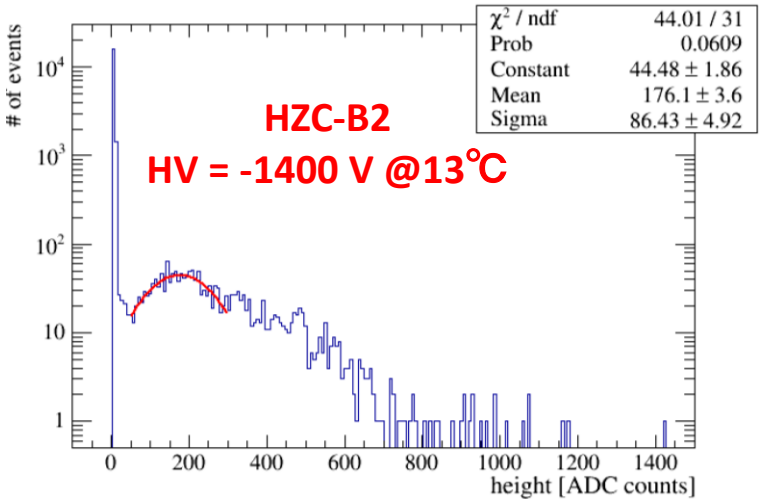


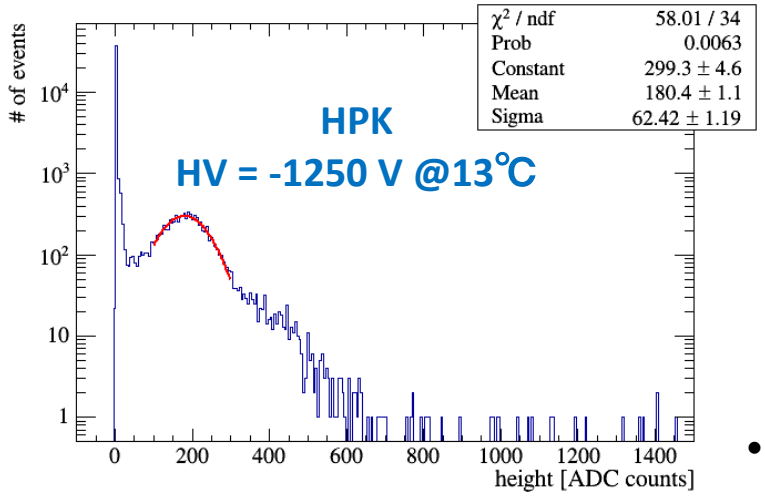


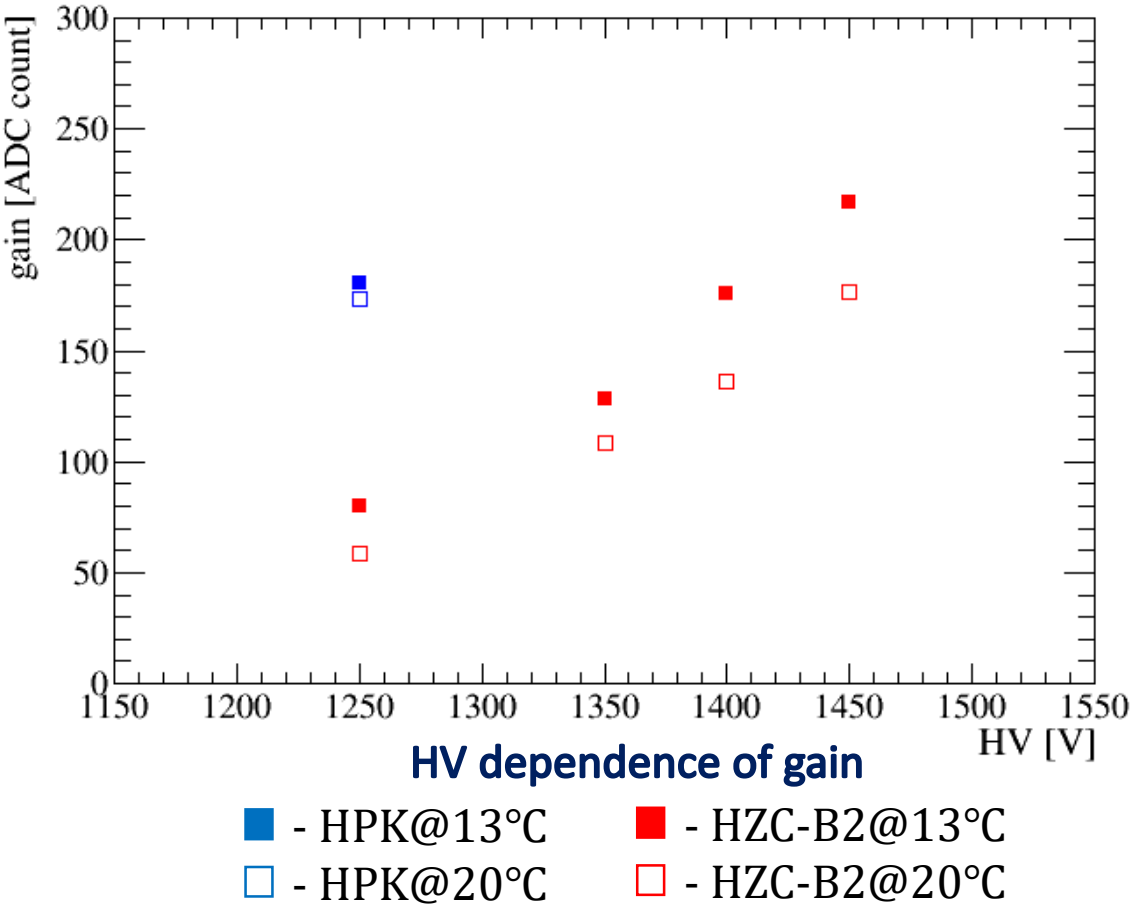
- HV = -1400V for almost same gain

HV dependence of gain

- Changing HV supplied to Chinese PMT, I measured 1 p.e. pulse height by illuminating low intensity laser.
- Right graph shows the HV dependence of gain at 13 and 20 degree Celsius.







- -1400V at 13℃ and -1450V at 20℃ give almost the same gain with HPK.

Height of dark noises