# After pulse and dark rate measurement status report

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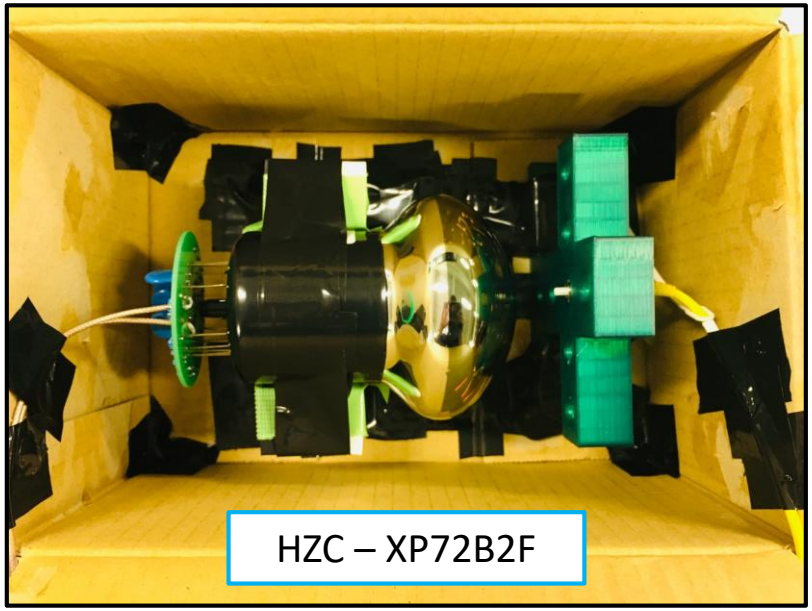
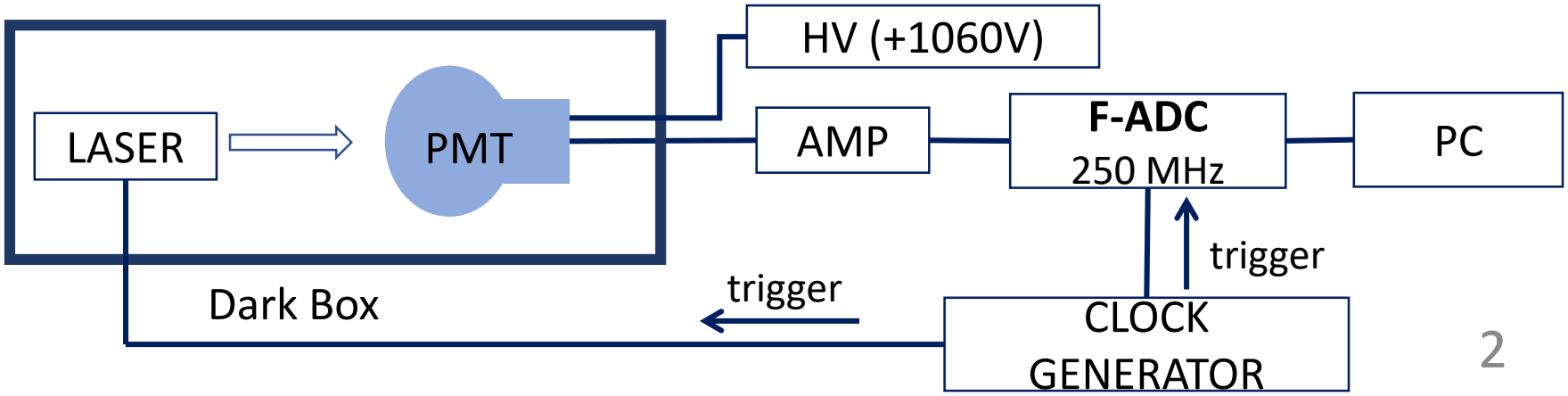
# After pulse measurement

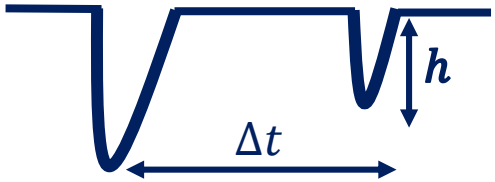


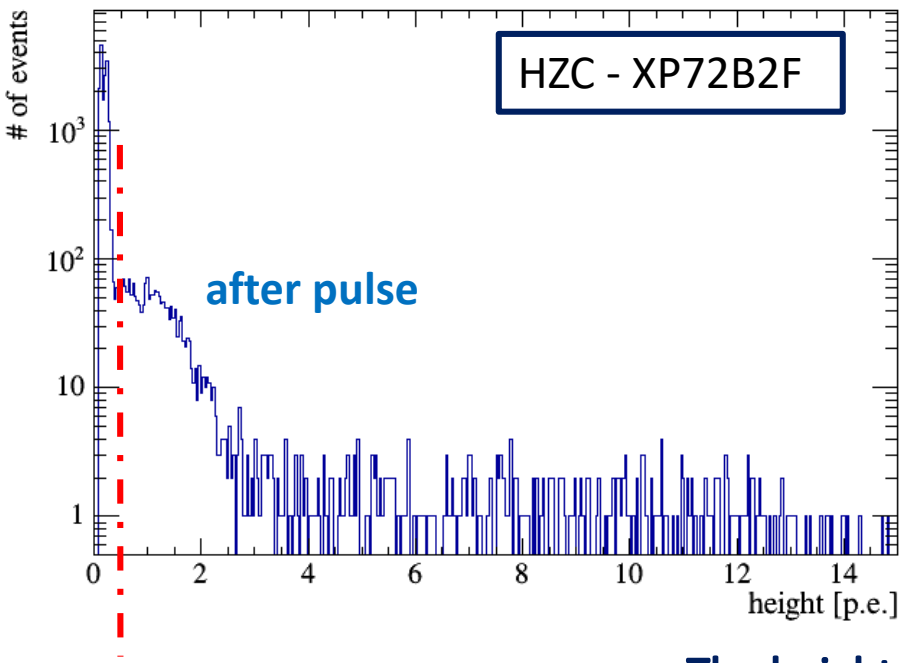

- We measured after pulse of Chinese PMT by F-ADC.
- We analyze,
  - the heights and time intervals
  - the relations between the probability of after pulse occurrence and the first pulse heights
- For this PMT, the signals were amplified twice because we couldn't see its gain clearly.

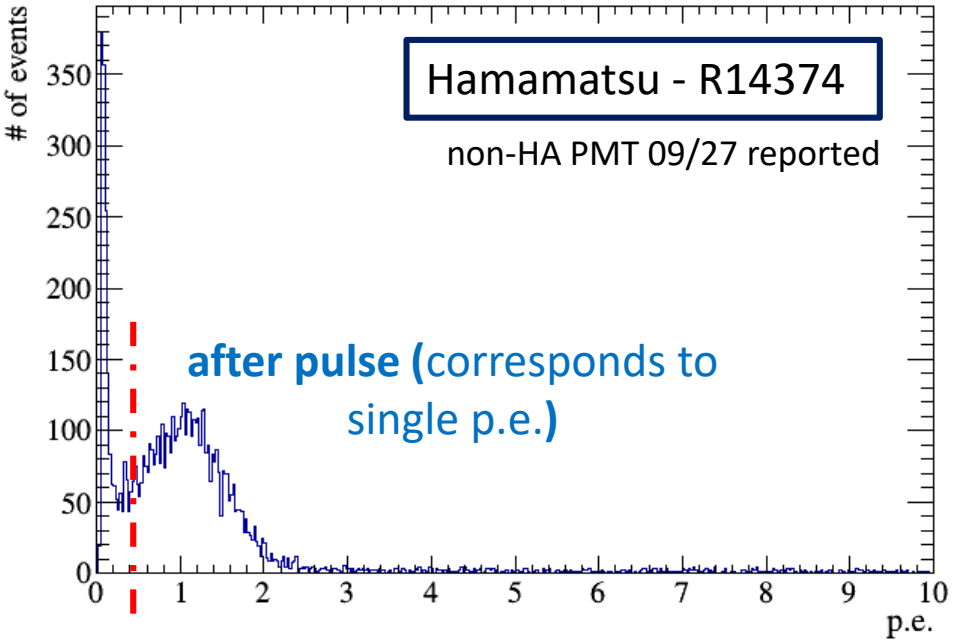
## setup (for after pulse measurement)



# After pulse measurement



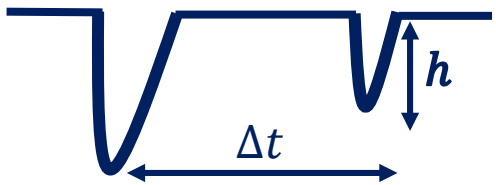



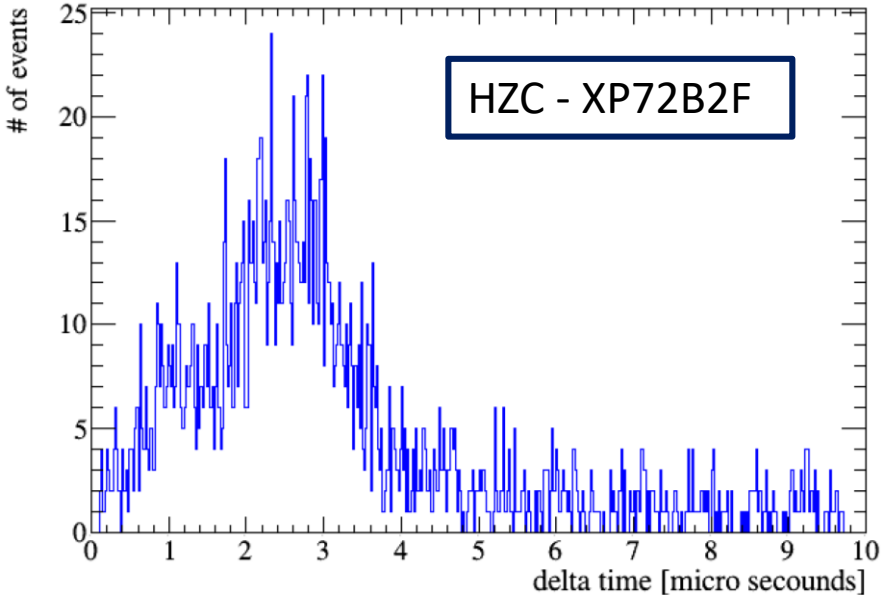



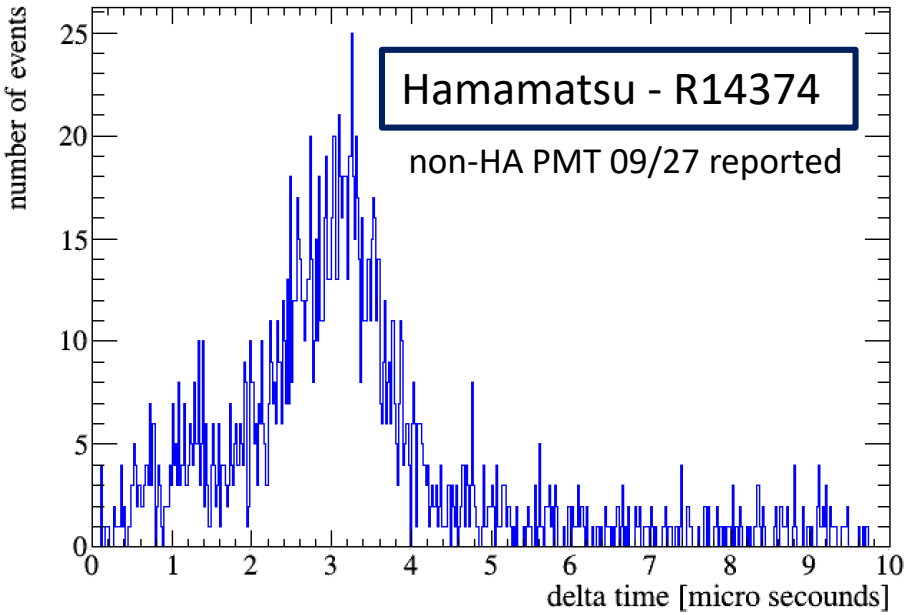

**The height of after pulse $h$**

- Left graph shows the heights of Chinese PMT, right one shows that of Hamamatsu's.
- Although we couldn't see clearly for Chinese PMT, each types of PMT has one p.e. level signals.

# After pulse measurement



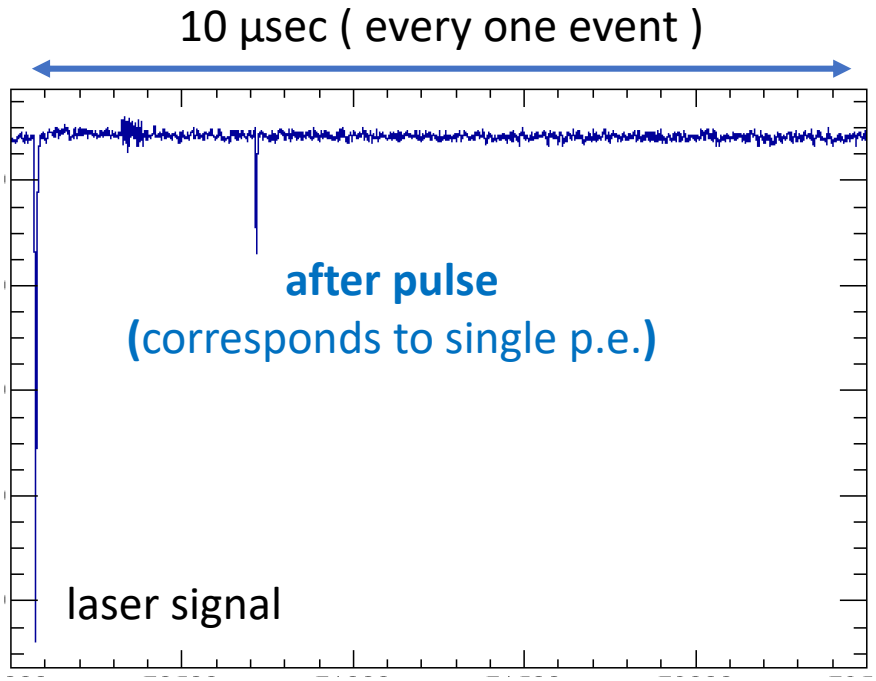



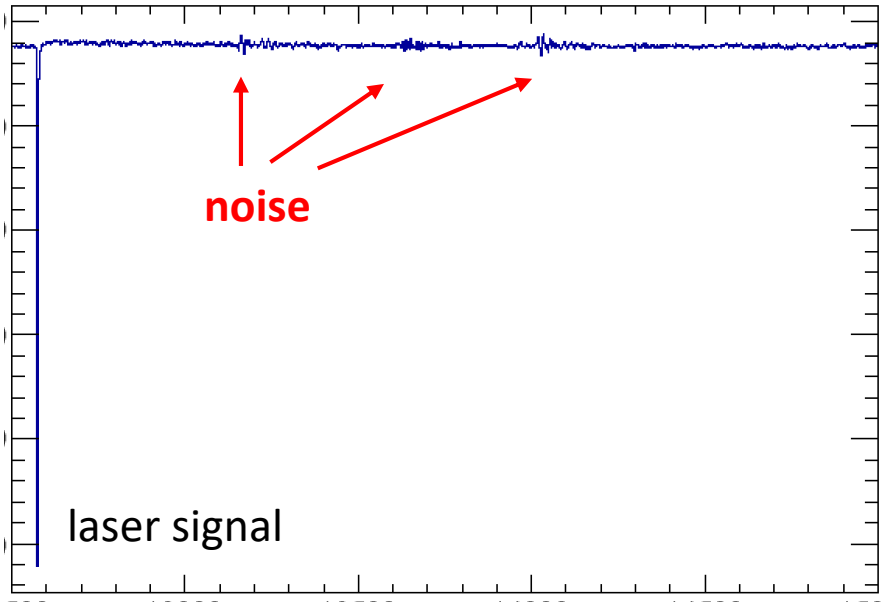

**The time intervals $\Delta t$**

- Left graph shows the time intervals of Chinese PMT, right one shows that of Hamamatsu's.
- The after pulses (one p.e. signals) were found at around 3 μs for each PMT.

# After pulse measurement

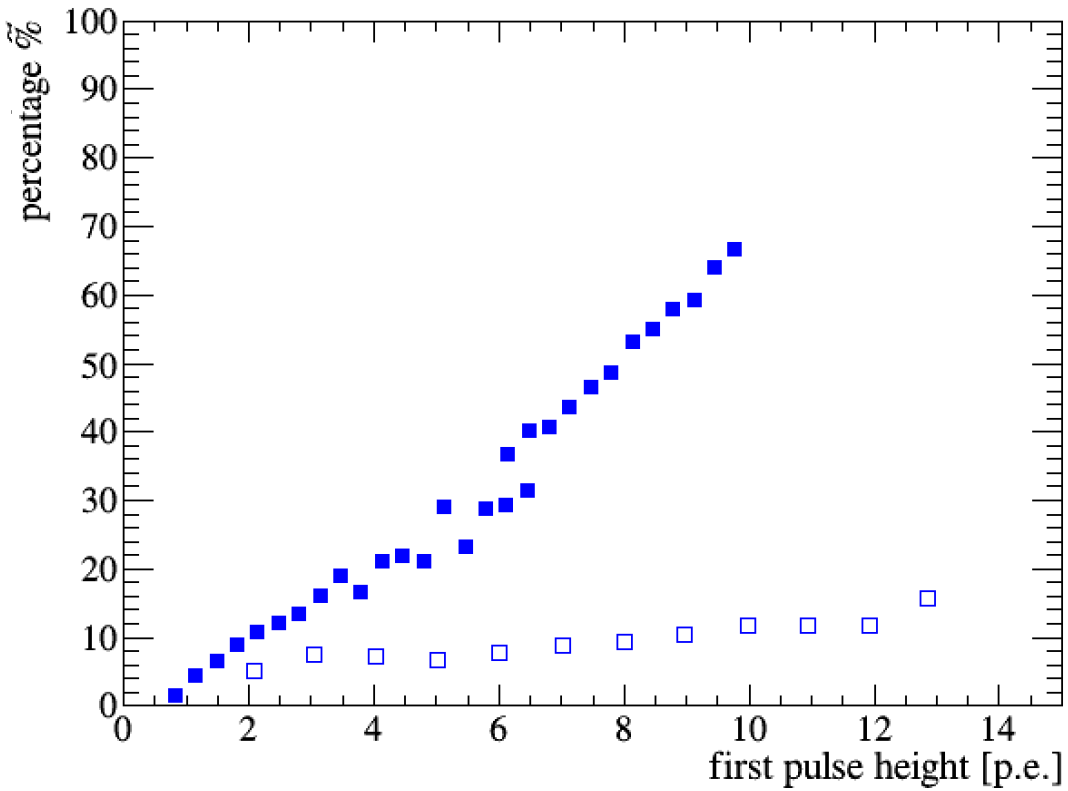
## Signal examples (Chinese PMT)




- Right graph shows the noise signals. The heights were well below single photo-electron.
- But, we checked that Chinese PMT has many noises than Hamamatsu's has.

# After pulse measurement




non-HA PMT 09/27 reported

- Hamamatsu_R14374
- HZC_XP72B2F

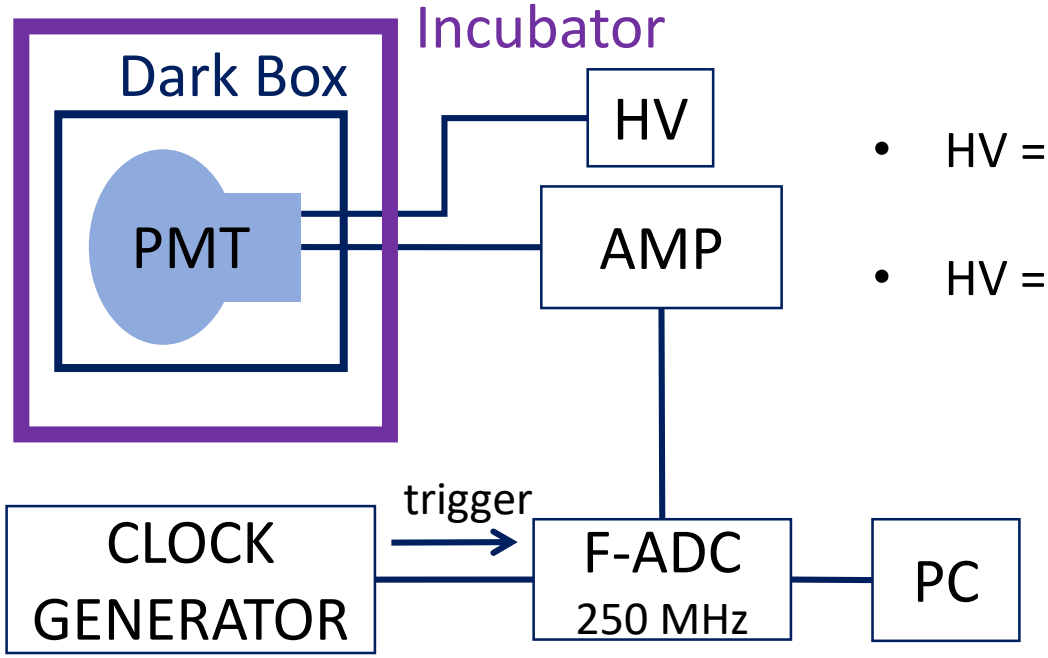
**Fraction of after pulse occurrence**

- The plot shows the fraction of events with after pulse as a function of the heights of the first pulses.
- The fraction of Hamamatsu's was increased, but that of Chinese was not increased.

# Dark rate measurement

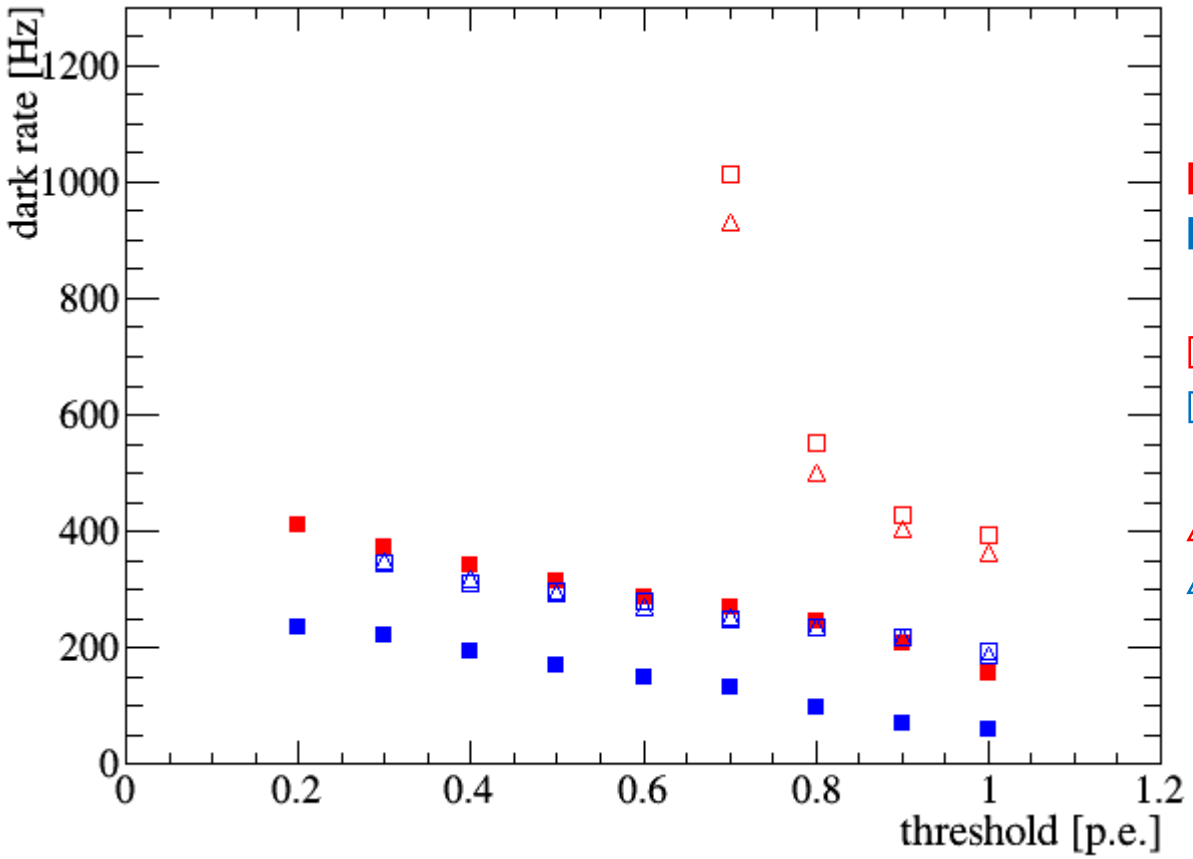
- We also measured dark rate of Hamamatsu's PMT and Chinese PMT by F-ADC, keeping the temperature at 13 and 20 ℃ with incubator.
- Trigger is generated by clock signals, and we counted the PMT signals synchronized with them (40 μs time window).
- We counted the dark noise signals above the threshold from 0.2 p.e. to 1 p.e.

## setup (for dark rate measurement)




- HV = -1250 V for Hamamatsu's PMT (non-HA)
- HV = +1060 V for Chinese PMT

# Dark rate measurement




20℃ - Hamamatsu_R14374
13℃ - Hamamatsu_R14374

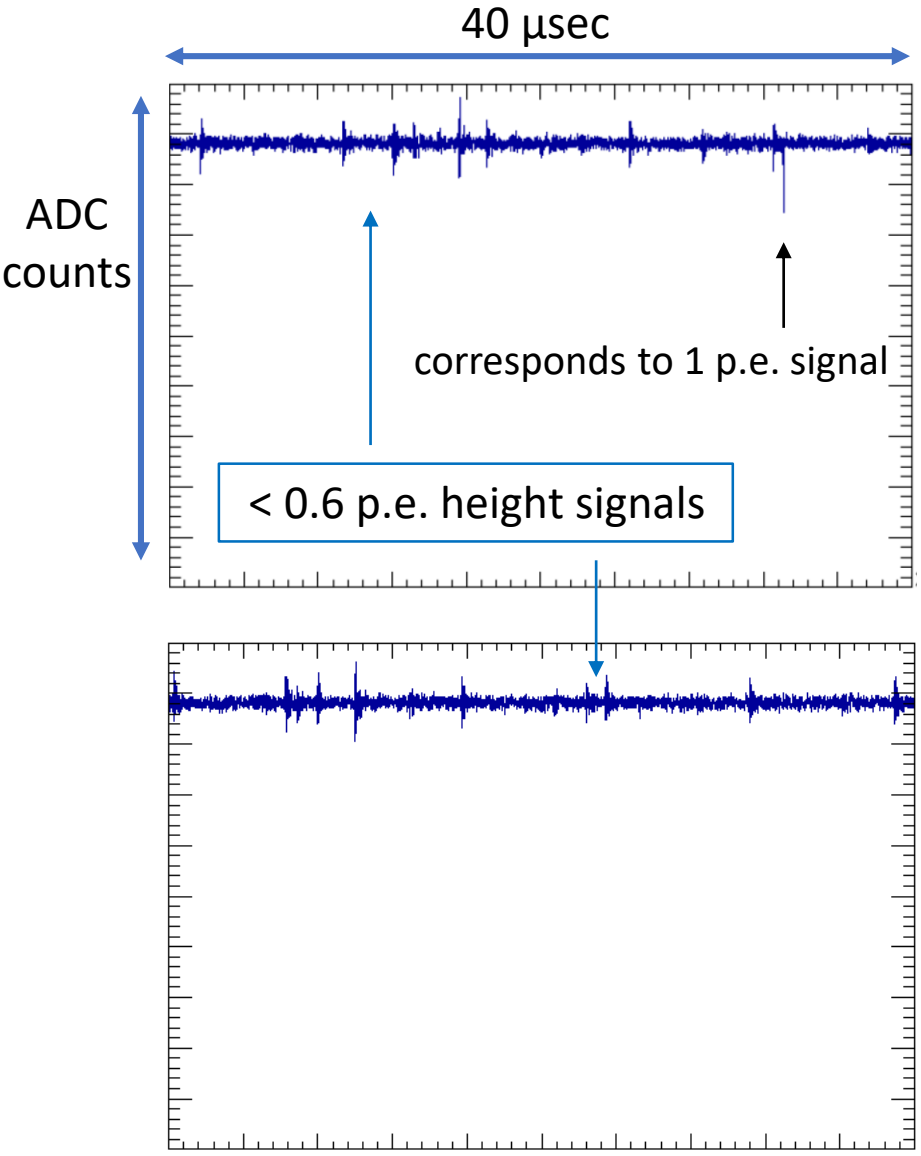
20℃ - HZC_XP72B2F
13℃ - HZC_XP72B2F 1st time

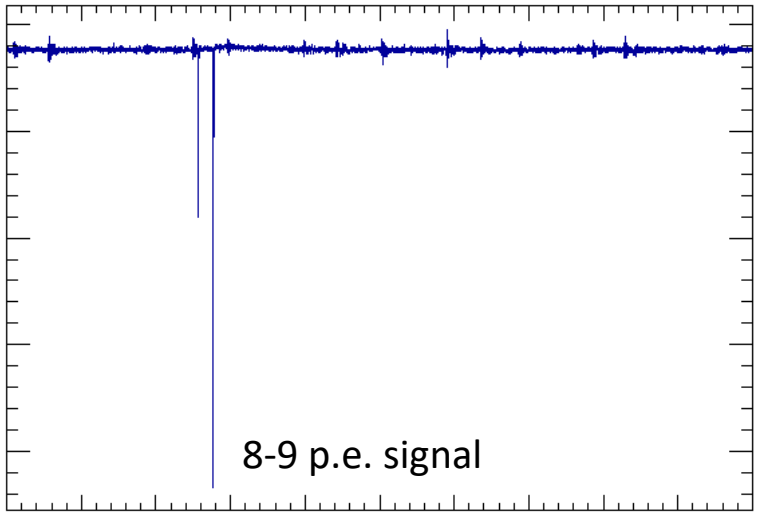
20℃ - HZC_XP72B2F
13℃ - HZC_XP72B2F 2nd time

- The dark rate of Hamamatsu's PMT were reasonable rate at both 13℃ and 20℃.
- For Chinese PMT at 20℃, the rates suddenly increased for the threshold below 0.6 p.e.
  - Same rates were confirmed when we took the data again.

# Dark rate measurement

## Signal examples (Chinese PMT)




- We found noise signals for almost all events at 20℃.
- The high rates were caused by these noise signals.

# Summary

## After pulse

- We found both Hamamatsu and Chinese PMT had same height and time intervals of after pulse, but the probability was not same.

## Dark rate

- The rate of Hamamatsu's was lower than that of Chinese.
- For Chinese PMT, the high rates were caused by 0.6 p.e. signals at 20℃.

# Future plan

- I will measure with another type of Chinese PMT (XP82B20) for dark rate and after pulse.

# Back up