

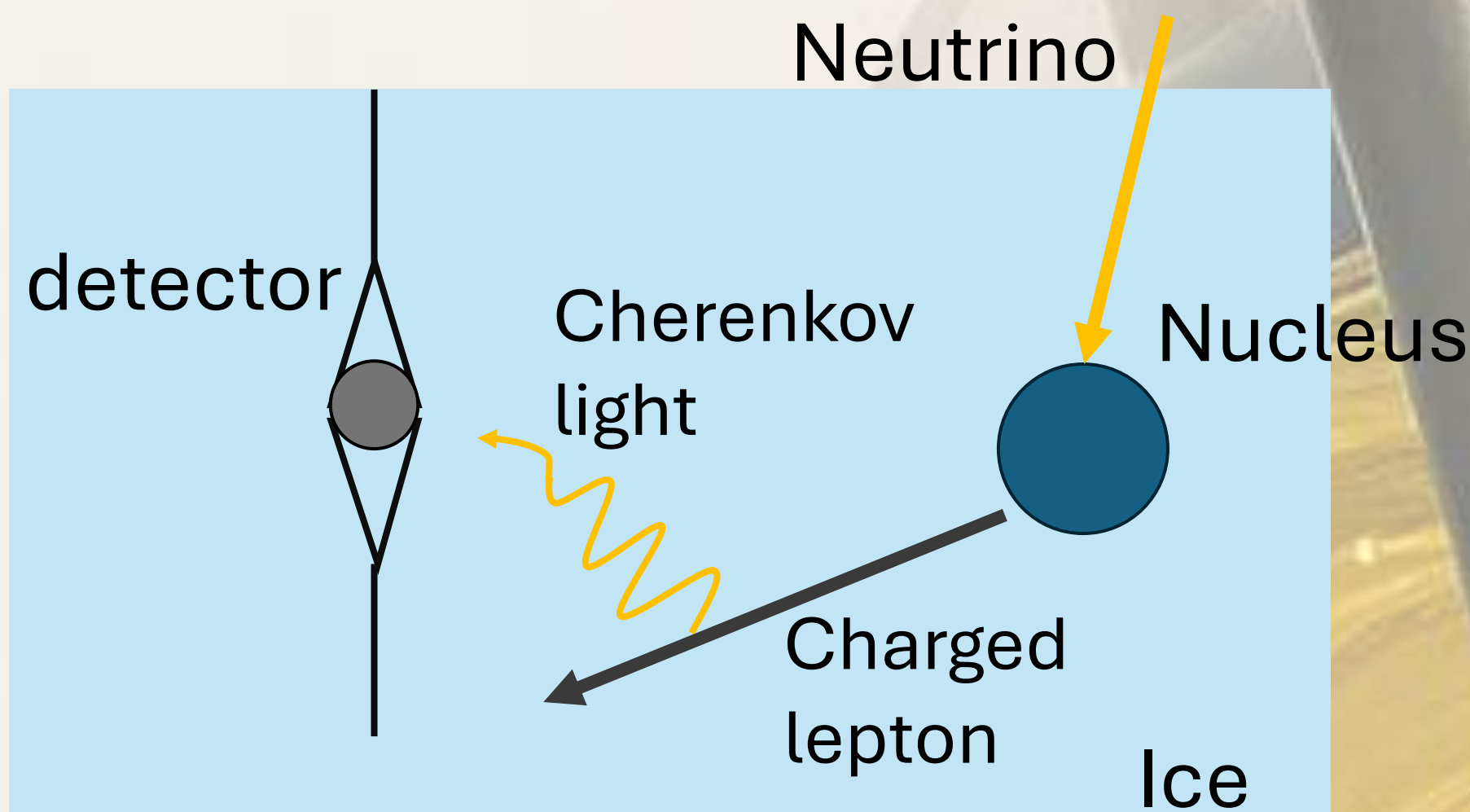
Mass Inspection of Photomultiplier Tubes for the IceCube Gen-2 Experiment

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Neutrino detection by ice



IceCube Experiment

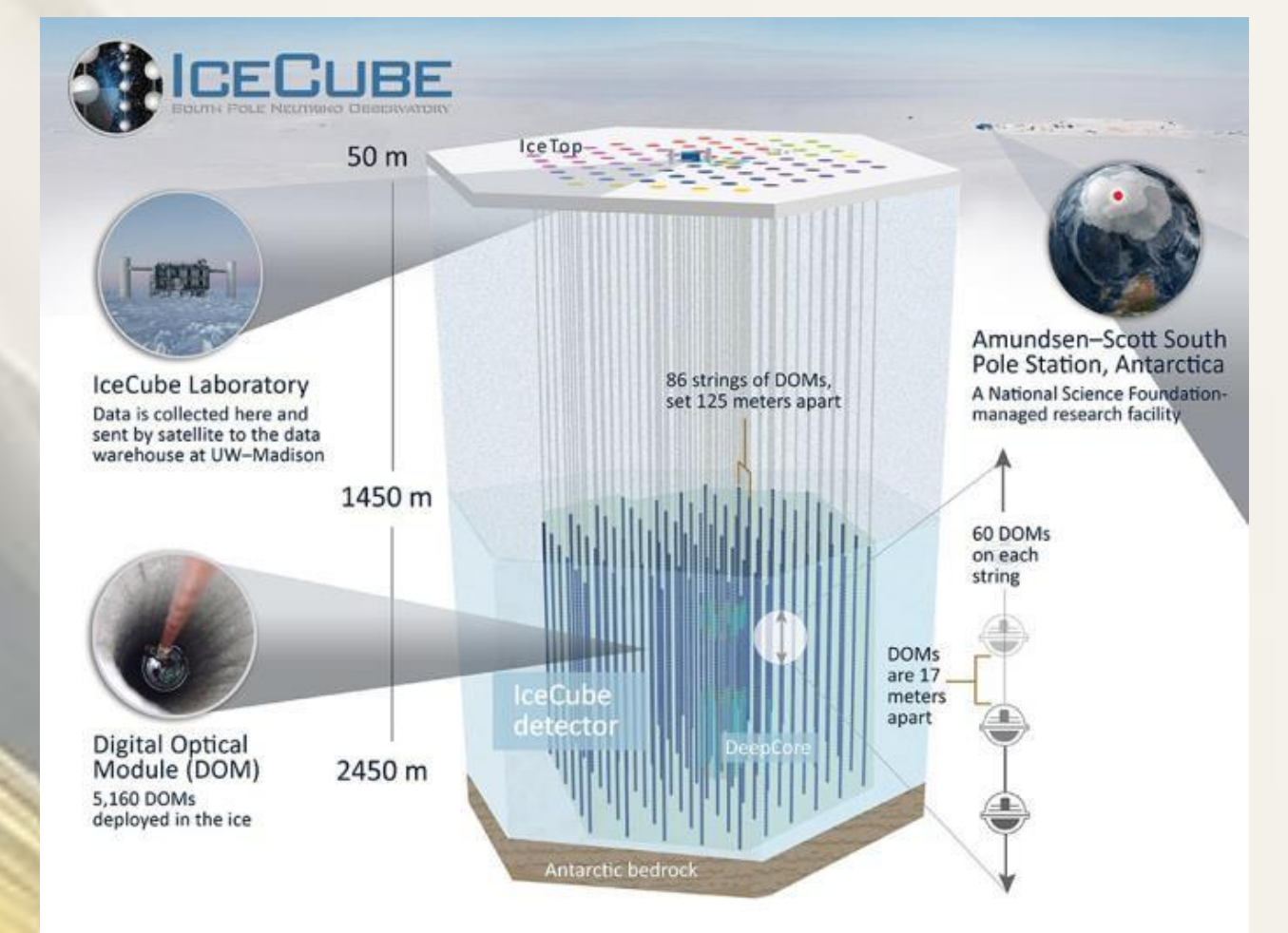
IceCube

- 5,160 detectors in 1 km³

IceCube-Gen2

- Approximately 10,000 detectors
- The detection volume \Rightarrow x8
- Target energy range : GeV \sim PeV
- 2 times larger horizontal displacement than IceCube-Gen1

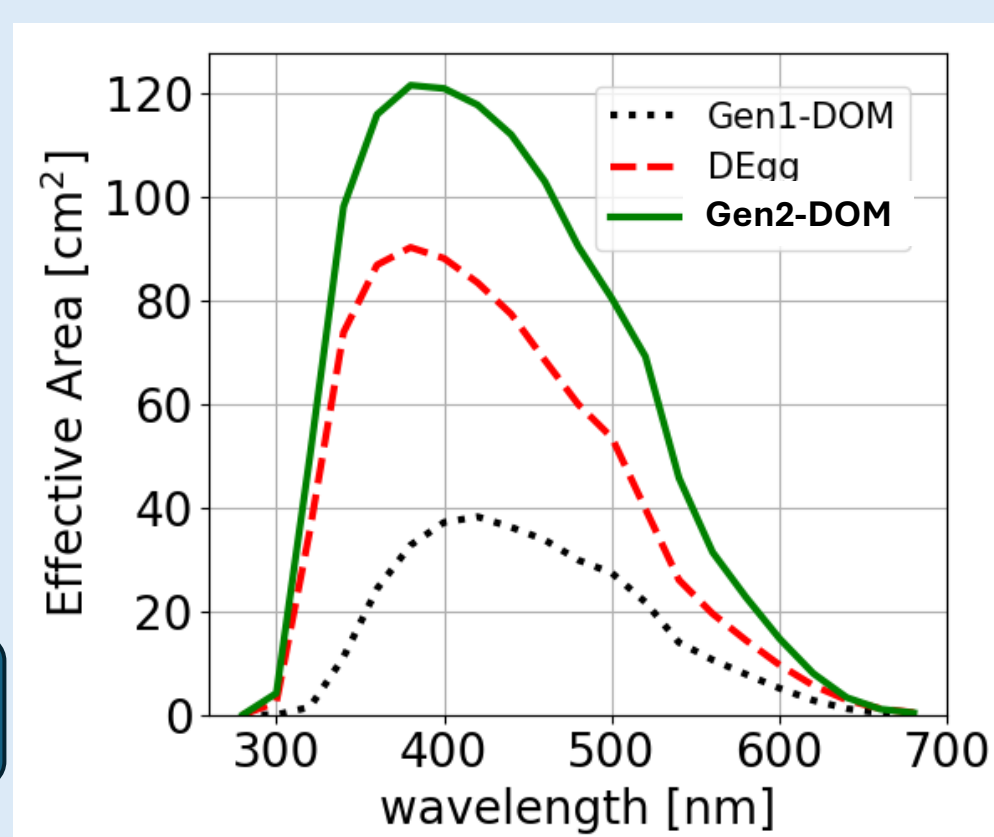
\Rightarrow Need detectors with higher detection performance and wider dynamic range



Gen2-DOM prototype



18 PMTs are installed inside.
The detectable area : 4 times



Pressure-resistant glass

4 inch-PMT

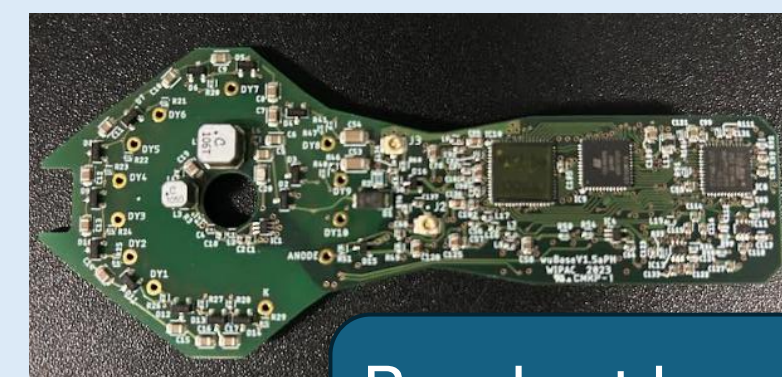
Dynamic range enhancement

Strong light incident

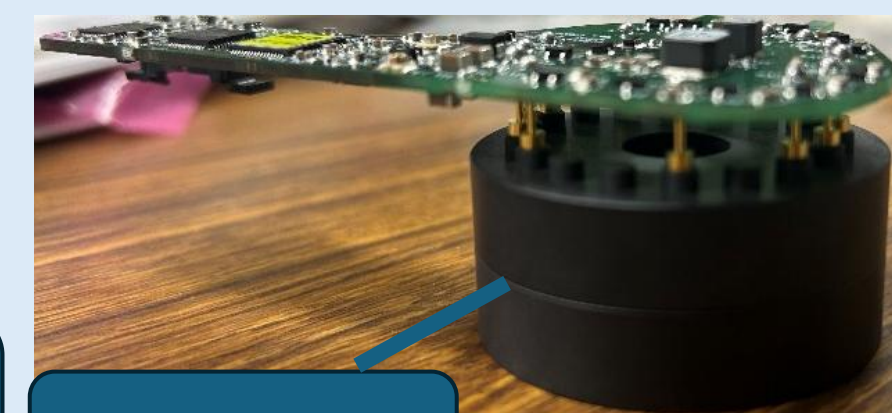
Saturation happened

Solution : Reading data from dynode 8

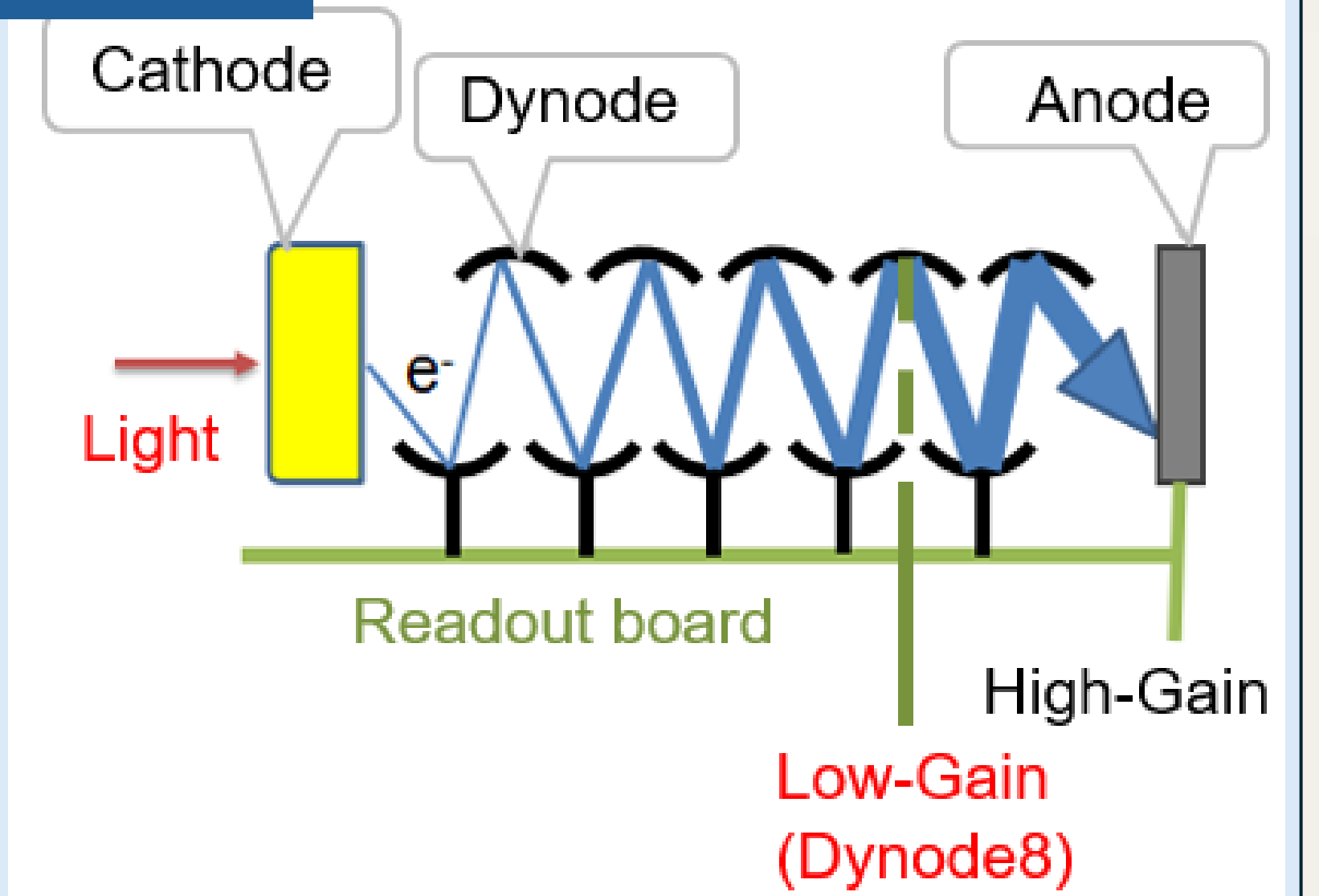
Calculation LG/HG ratio



Readout board (WuBase)



PMT socket



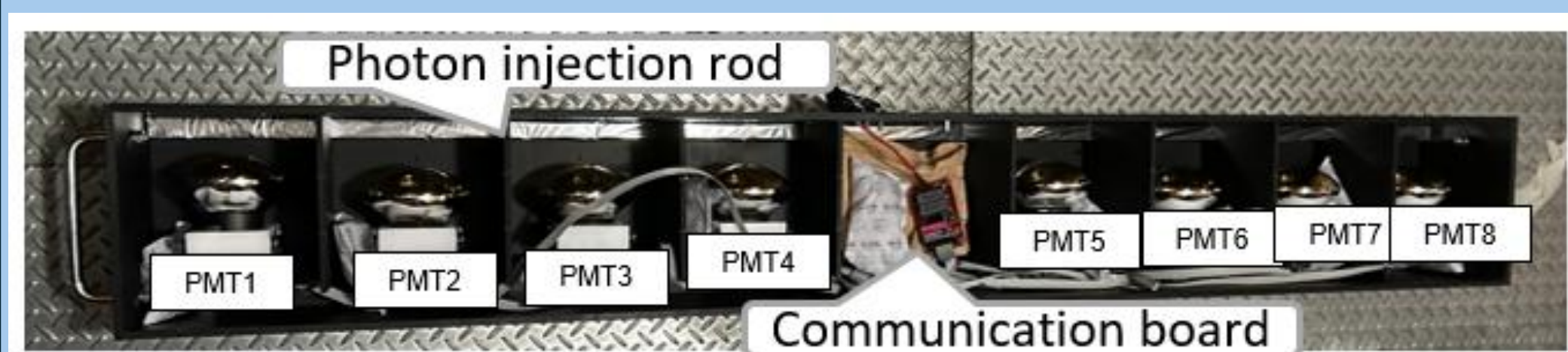
Mass Inspection of PMTs

Motivation

Need numbers of PMTs : 10,000 x 18 = 180,000

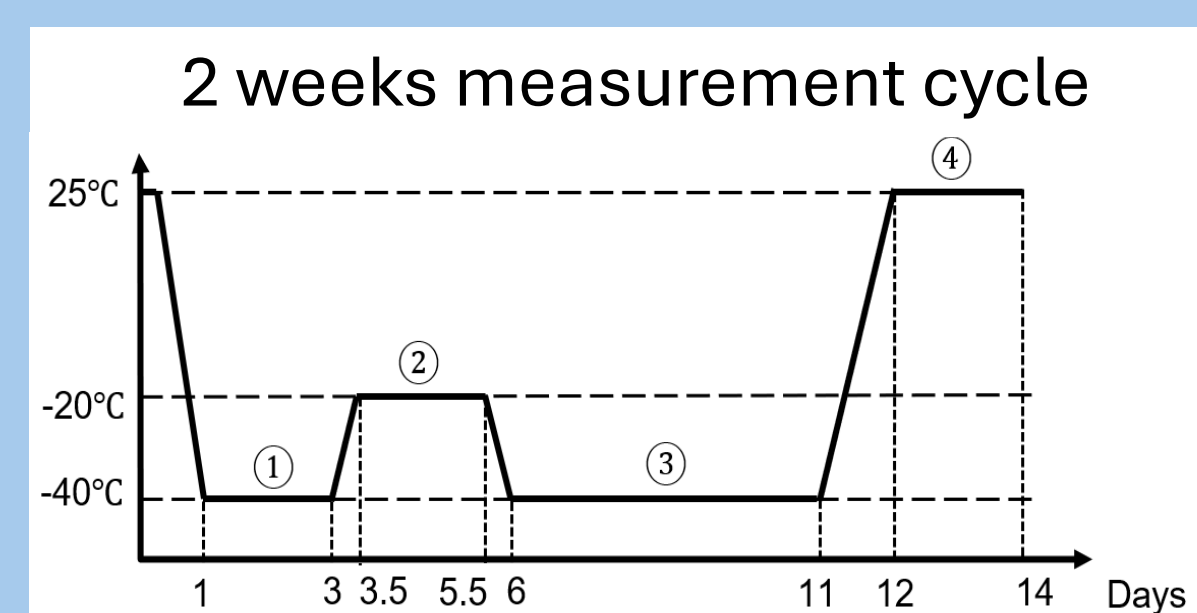
Need to performance test for 2 weeks.

\Rightarrow Need to test many PMTs simultaneously



Setup

Test items



Measurement contents

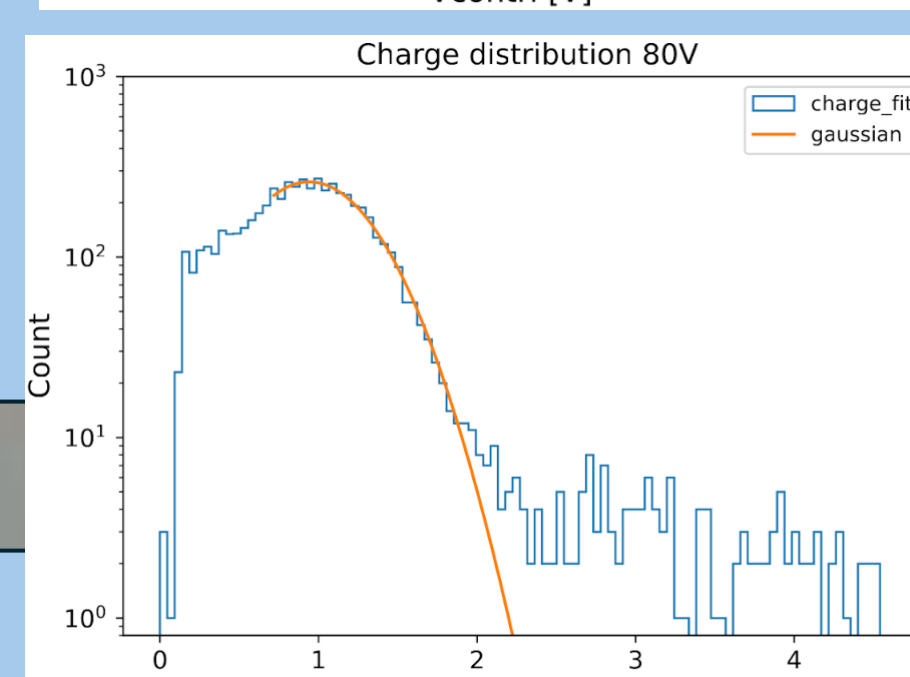
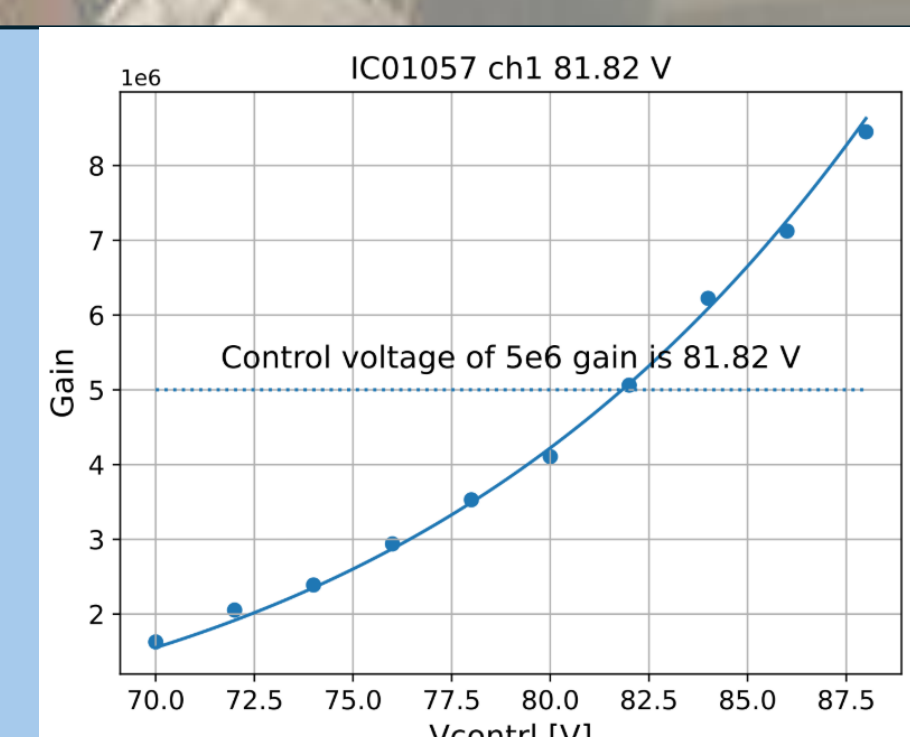
- ① 2 days(-40°C)
 - Gain calibration
 - Calculation LG/HG ratio
 - Dark rate measurement (300s, 50 times)
- ② 2 days(-20°C)
- ③ 5 days(-40°C)
 - Long term dark rate measurement
- ④ Replace the PMTs

Gain calibration

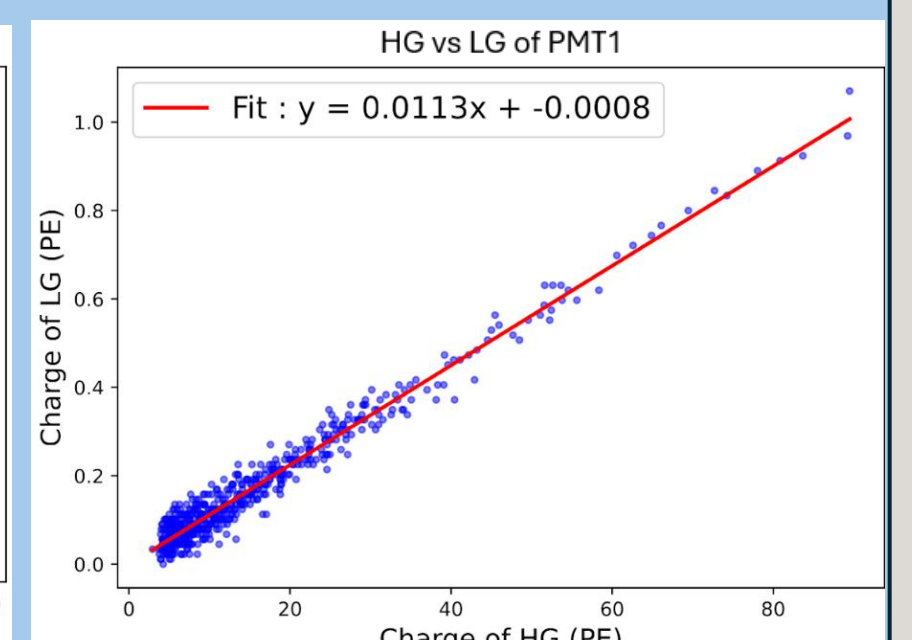
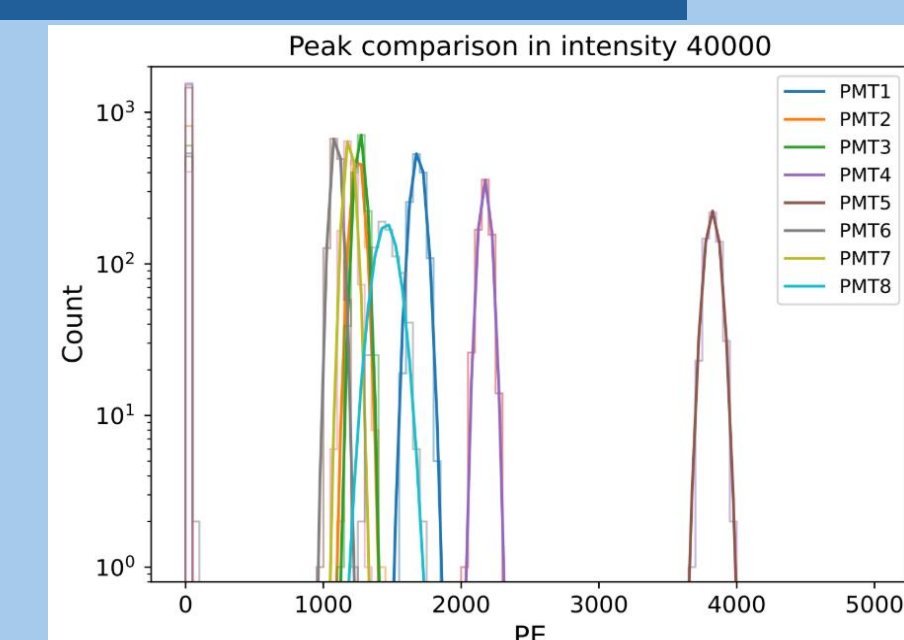
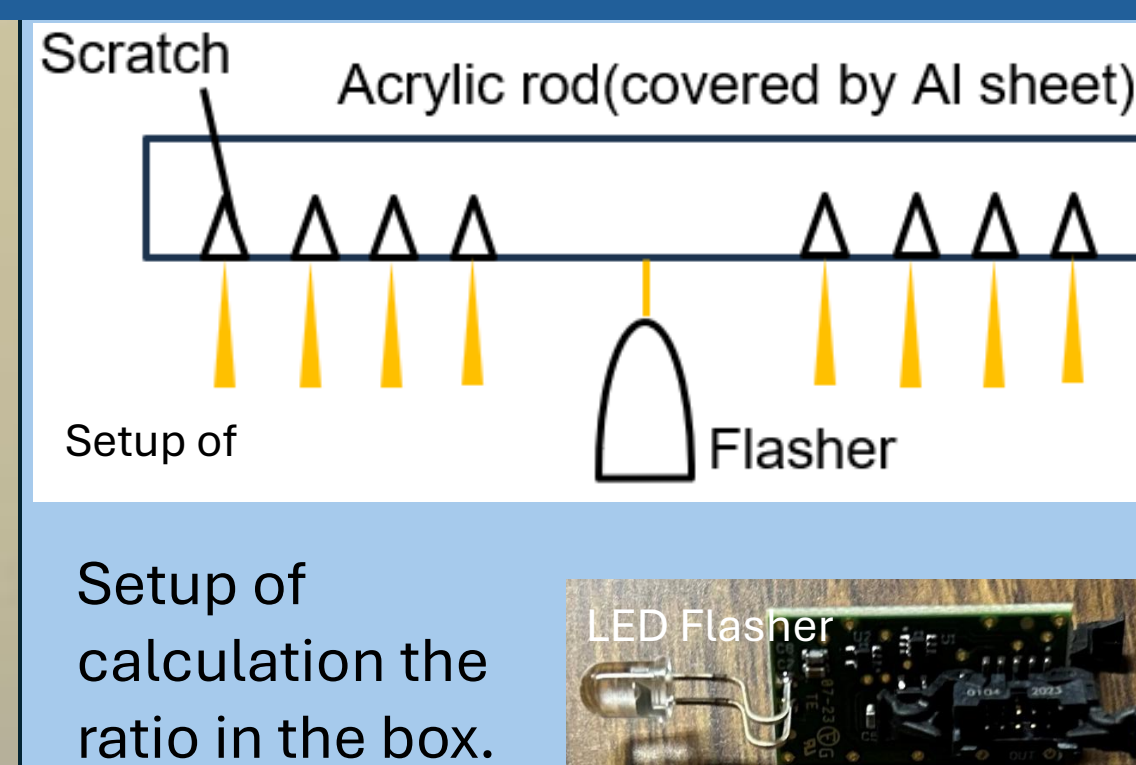
Gain: Gain of 4 inch-PMT(5.0×10^6)

Apply various voltages to PMTs, and calculate Gain with the charge distribution.

Real voltage : Control voltage x12



Calculation LG/HG ratio



Investigation of the position dependence of light intensity

Result of calculation the ratio

Dark rate measurement

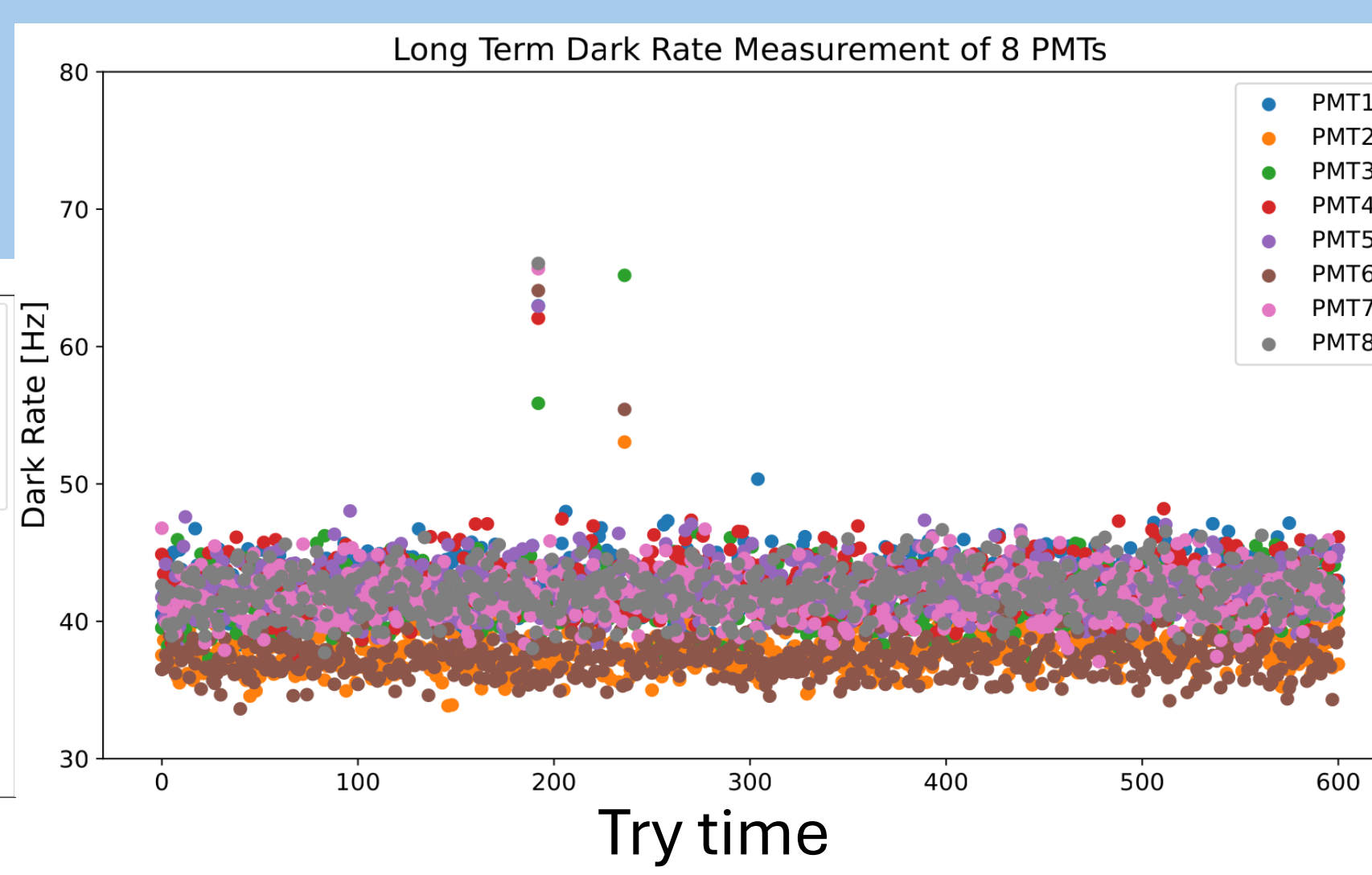
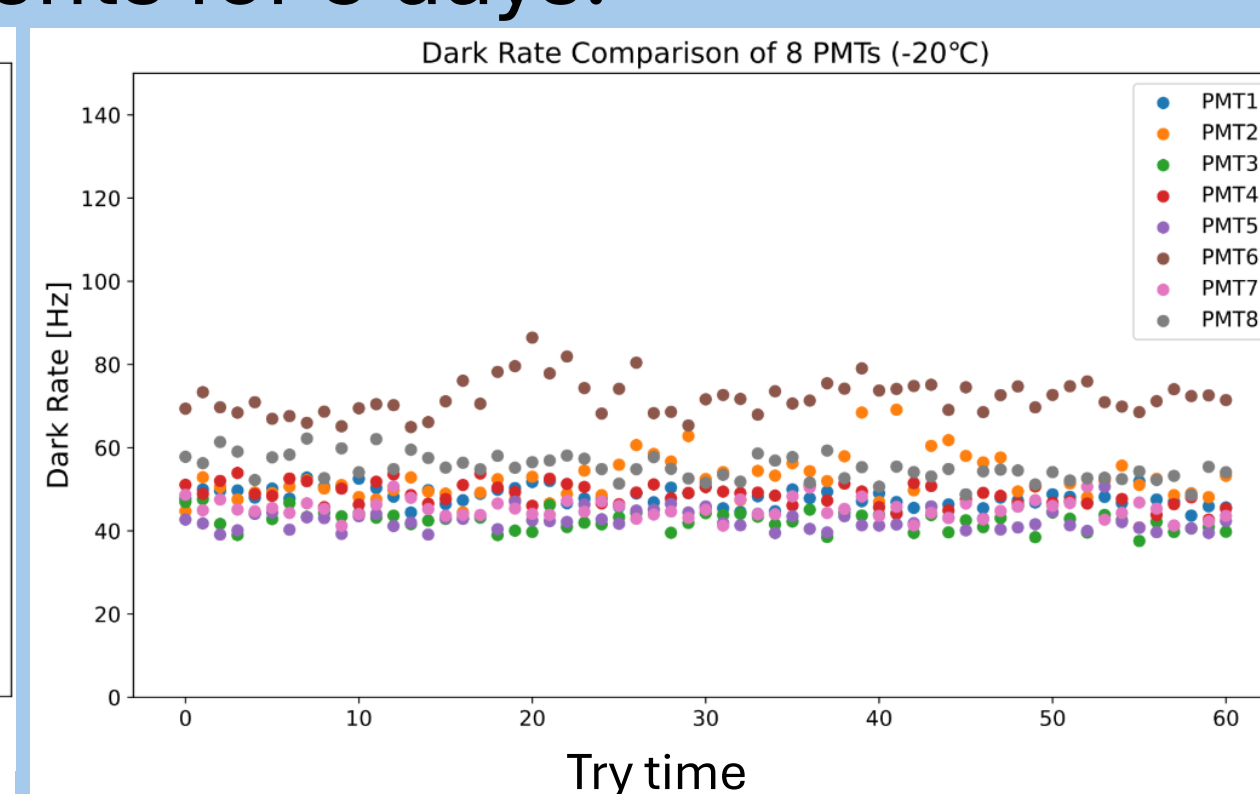
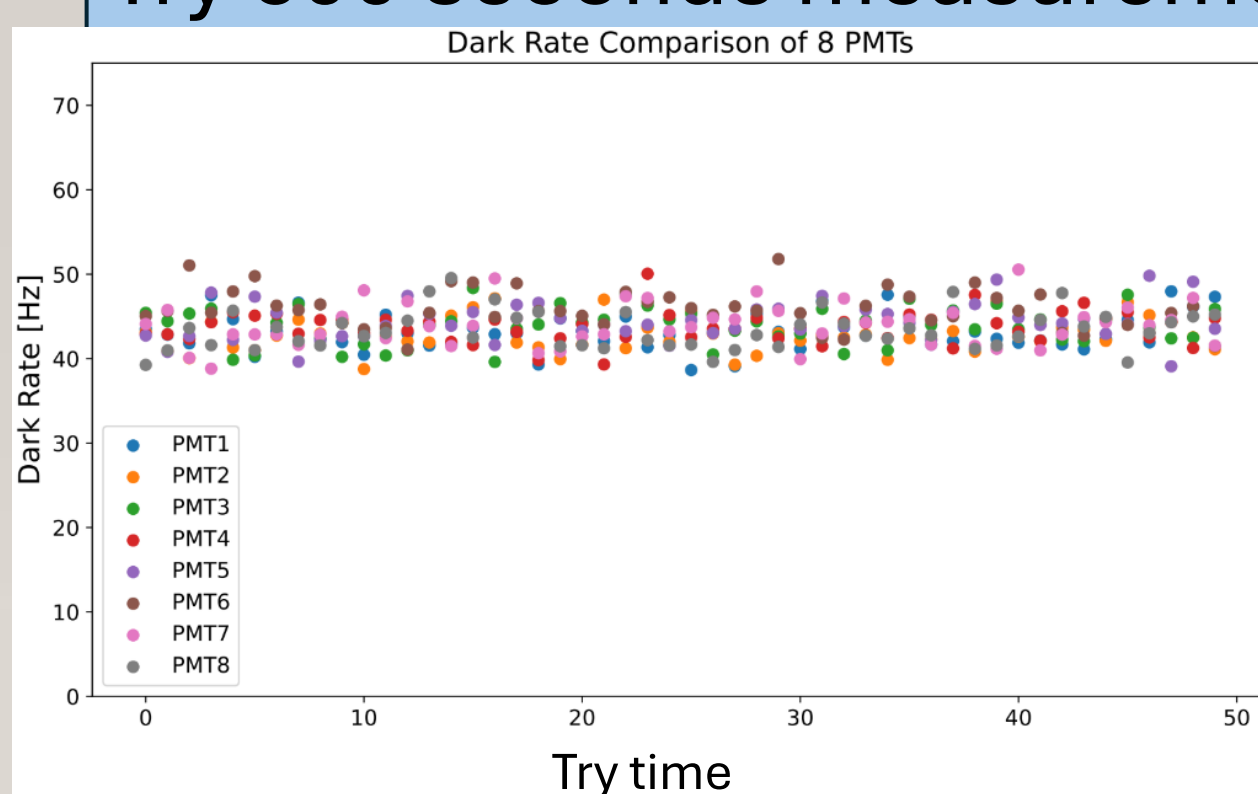
Dark rate measurement (-40°C / -20°C)

Try 50 measurements for 300 seconds

Long-term dark rate measurement

Purpose: Check whether the dark rate remains stable over the long term.

Try 600 seconds measurements for 5 days.



Conclusion & next

Conclusion

We could create the equipment to measure 8 PMTs.

In addition, we established the equipment established the ratio with ratio.

Next

I plan system upgrade quickly.

\Rightarrow Scale up to x8 (enabling characterization of 64 PMTs).

Improves the stability of DAQ.