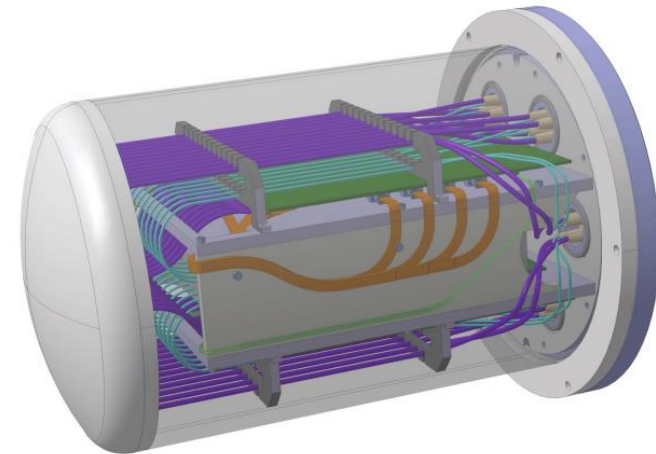
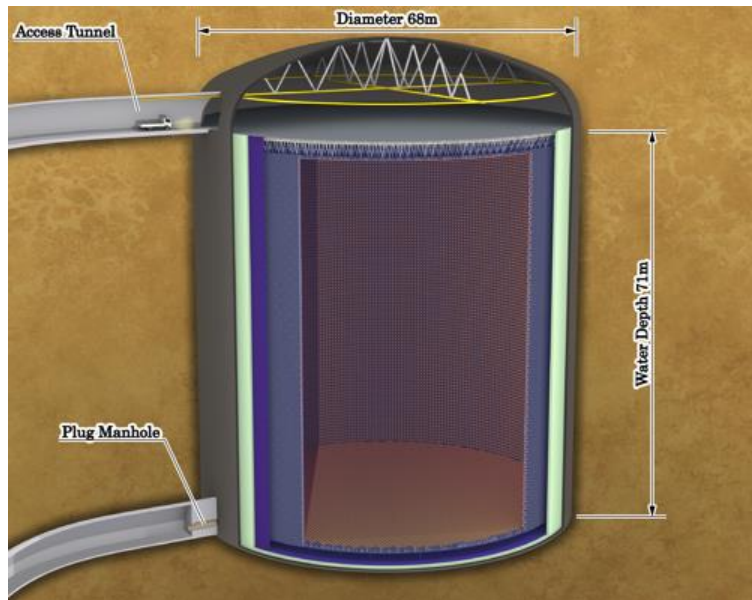


# Development of Front-End Electronics for Hyper-Kamiokande; Performance Evaluation of Digitizers

Ryota Kaneshima (ICRR)  
Short Talk @Neutrino Workshop  
2022/03/08

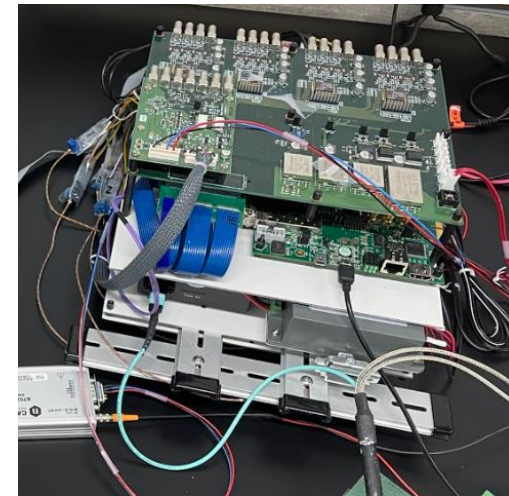
# Hyper-Kamiokande

- Future largest water Cherenkov detector
  - More sensitivity for neutrino, nucleon decay observation
- Front-end electronics will be installed in the water.
  - R&D of each component (digitizer, HV, etc.) in water-tight vessel is ongoing.



# Purpose of My Study

“50 cm B&L PMT characteristics study”  
&  
“Performance Evaluation of Digitizers”  
for Hyper-K Electronics



# Motivation




- We have 3 candidates of HK digitizer.
- Each digitizer needs to evaluate in the same condition.

Reference waveform  
for  
Arbitrary function generator

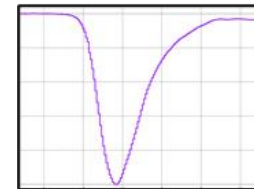
## **1<sup>st</sup> STEP**

**⊗** Prepare reference waveform

## Candidates

- QTC + TDC digitizer 
- Discrete digitizer 
- HKROC 

reference  
waveform



function  
generator

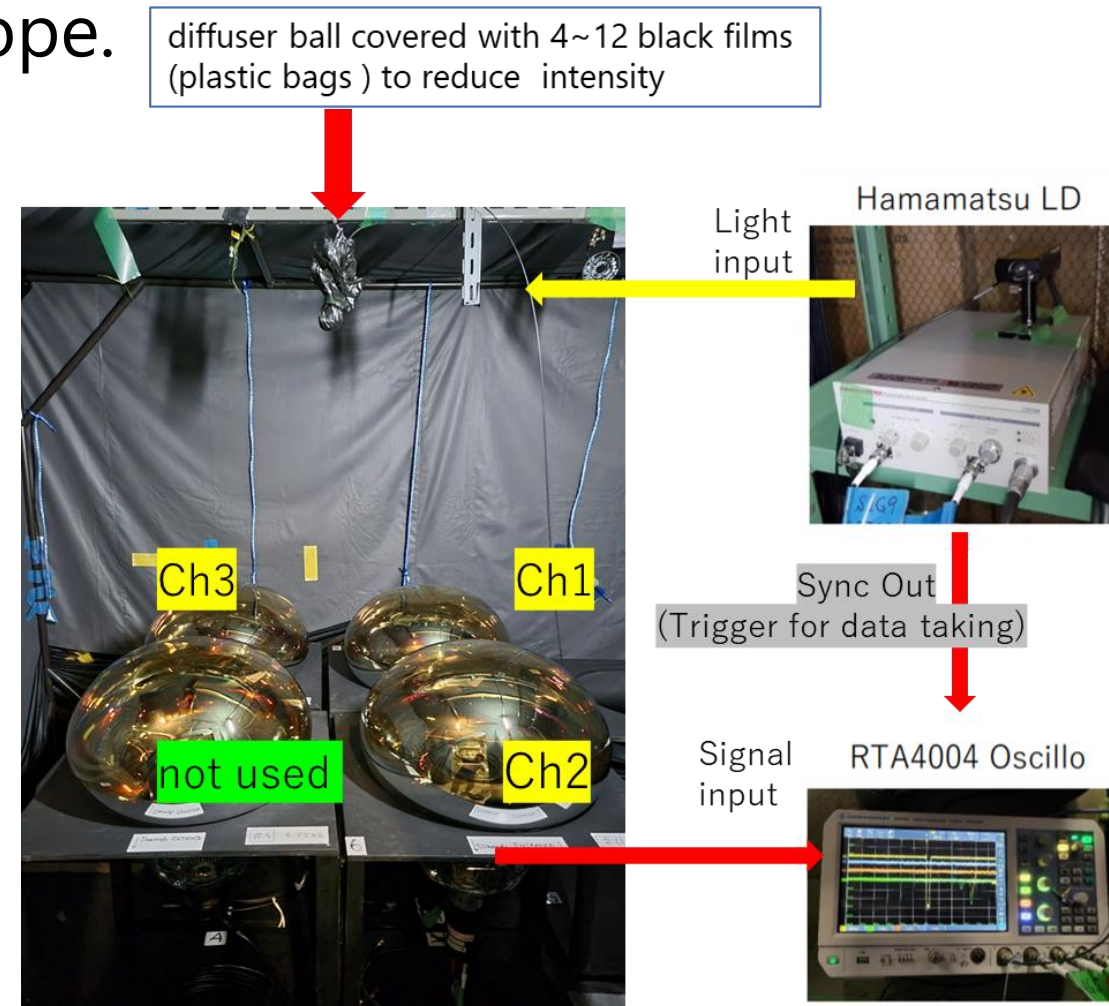
**Digitizer**



# PMT Waveform Measurement

## Setup @ Kamioka mine

- Recorded PMT waveforms with oscilloscope.
- Light source:
  - Laser Diode + diffuser ball  
(Hamamatsu C10196 + M10306-30 ( $\lambda = 405.6\text{nm}$ ))
- Magnetic field compensation coils
  - To minimize effects from geomagnetic field  
**450 mG  $\rightarrow$  90 mG**
- Scanned light intensity and supply HV
  - To evaluate each dependence on PMT signal



# Supply HV Setting

- First of all, we defined supply HV setting.
  - With nominal HV (Ebb) given by Hamamatsu, measured gain is higher than expected.
  - Reduced supply HV

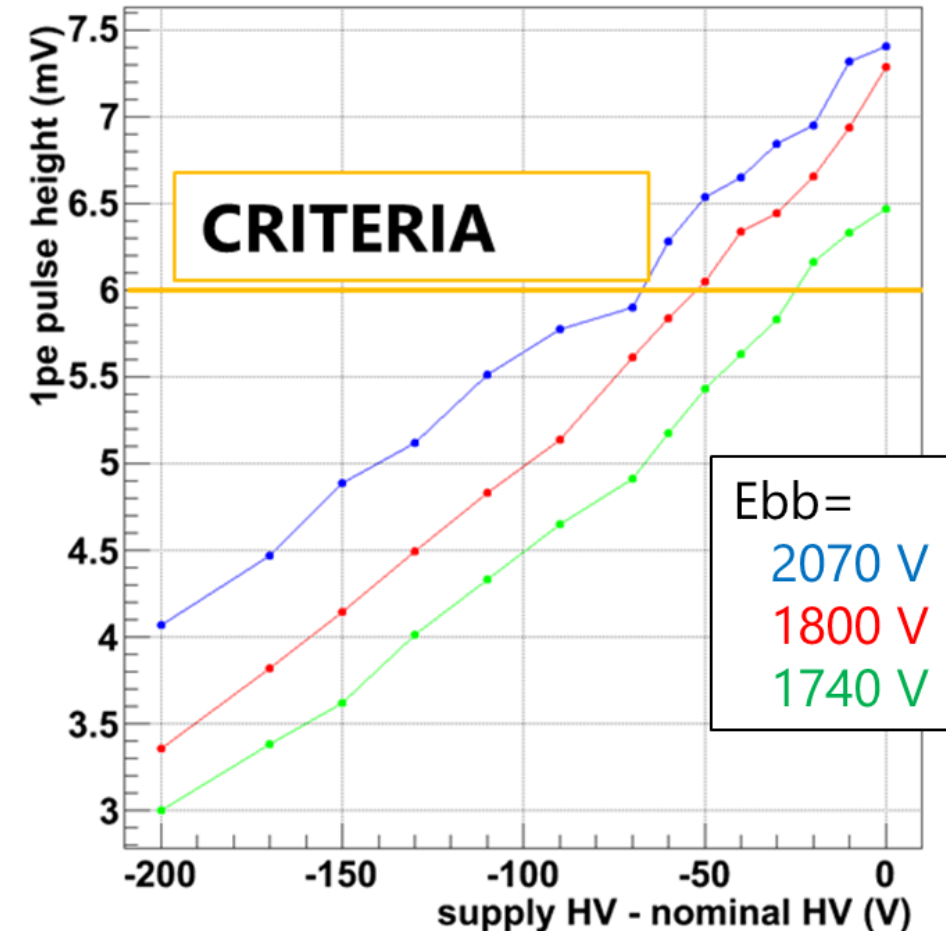
## Criteria:

HV setting which gives 6 mV for 1 p.e. pulse height

- In our measurement, the HV setting of each PMT are ↘

Ebb (V)	HV (V)
2070	2000
1800	1750
1740	1710

1 p.e. pulse height v.s. HV





# Reference PMT Waveforms

- Prepared reference waveforms by averaging recorded waveforms
- Selected various light intensity in dynamic range of digitizer

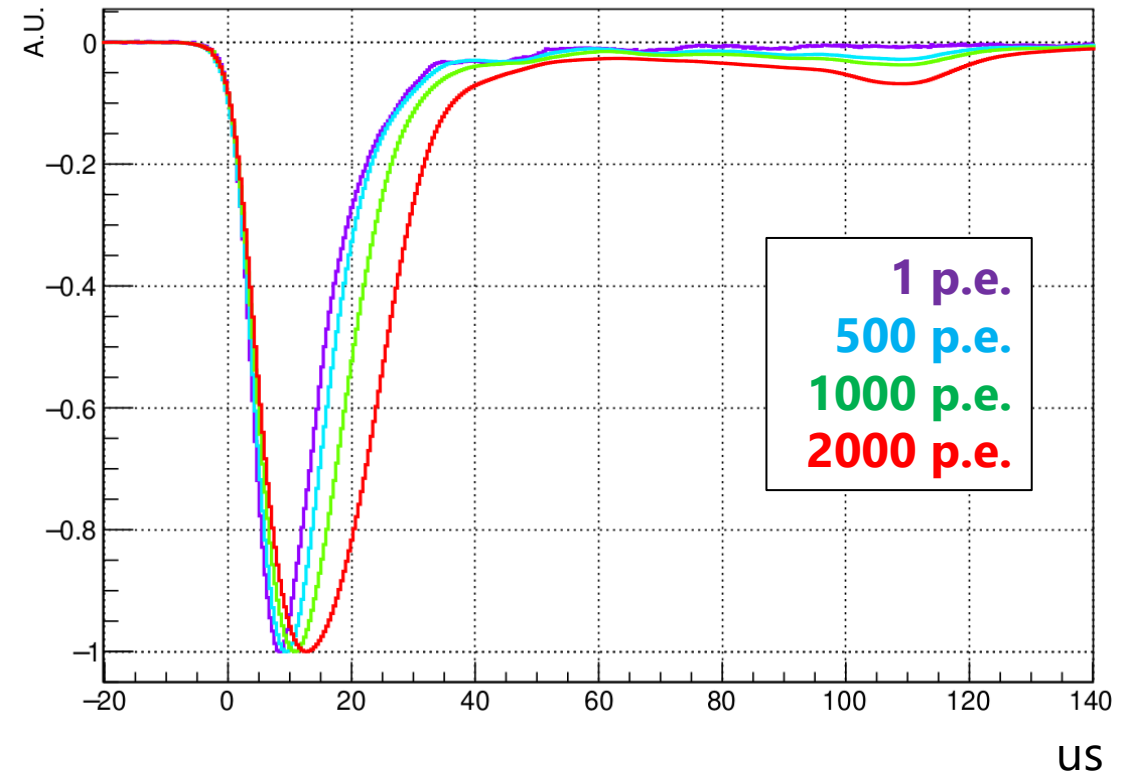


☒ Distributed to each digitizer R&D group

## ***2<sup>nd</sup> STEP***

☐ Evaluate QTC based digitizer with reference waveforms and FG

Normalized Reference Waveforms



# Performance Evaluation of Digitizer

- Evaluation of digitizer with function generator is now ongoing
- Testing function generator performance.
- Establish evaluation system including digitizer.





# Summary and Prospects

- Prepared reference PMT waveforms to evaluate candidates for digitizer of Hyper-K

*1<sup>st</sup> STEP* : Measure PMT waveform to prepare reference waveform

**Completed !**

*2<sup>nd</sup> STEP* : Evaluate QTC based digitizer with reference waveforms and FG

**Ongoing**

*3<sup>rd</sup> STEP* : Build a full-assessment system for mass-production of digitizer  
: Investigate PMT waveform in detail

→ **Planning**