

Light Scattering Measurement in the water using the Super-Kamiokande Detector

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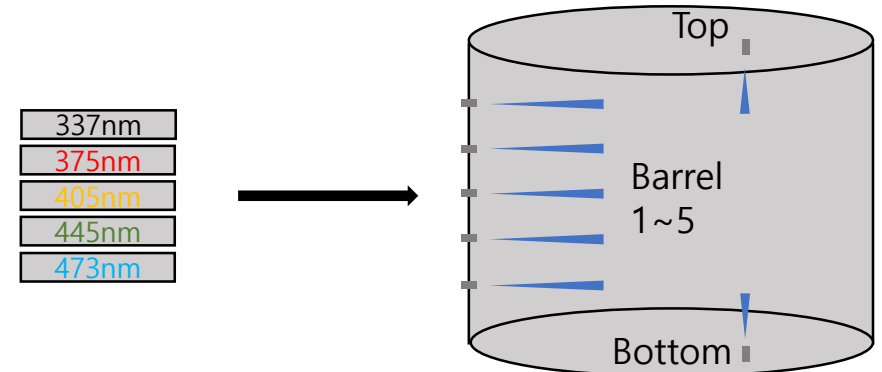
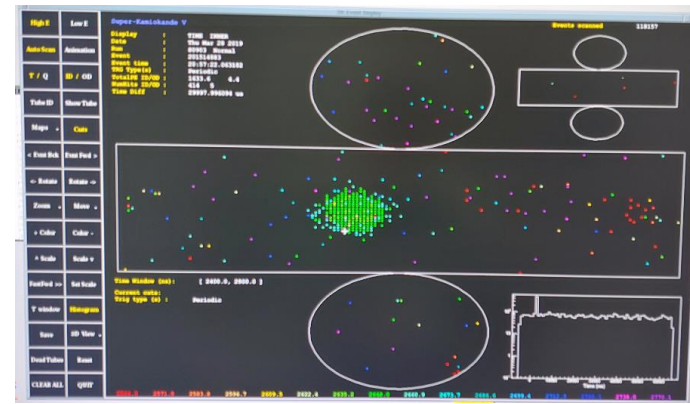
ICRR Inter-University Research Program Meeting
2023.02.21

Overview

- Title:
Light Scattering Measurement in the Water Using
the Super-Kamiokande Detector
- Principal Investigator
Intae Yu (Sungkyunkwan University, Korea)
- Budget
200,000 Yen

Introduction

- Using known wavelength laser source
- Measured how many photons are absorbed or scattered
- 7 injector position
- 5 laser wavelength
- Measure hit timing distribution of scattered photons



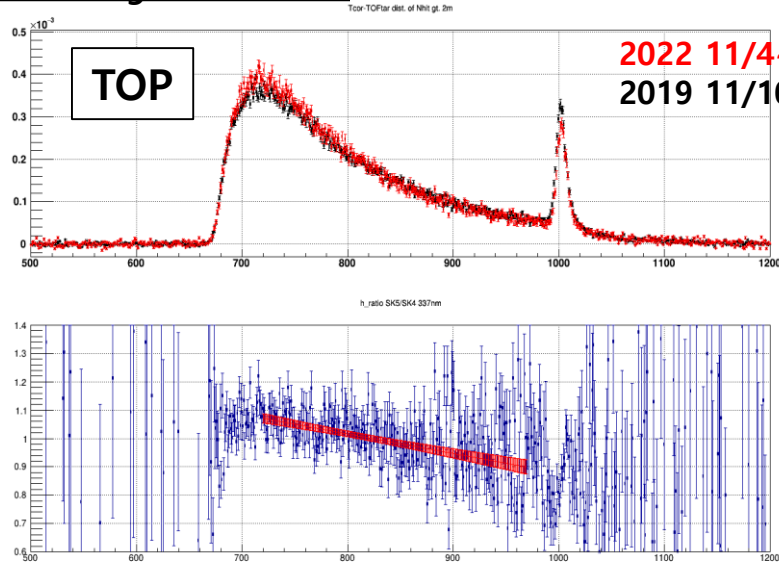
LASER
Injection
Position



Study on Effects of Gd loading

- 337nm – Top injector / Top PMTs

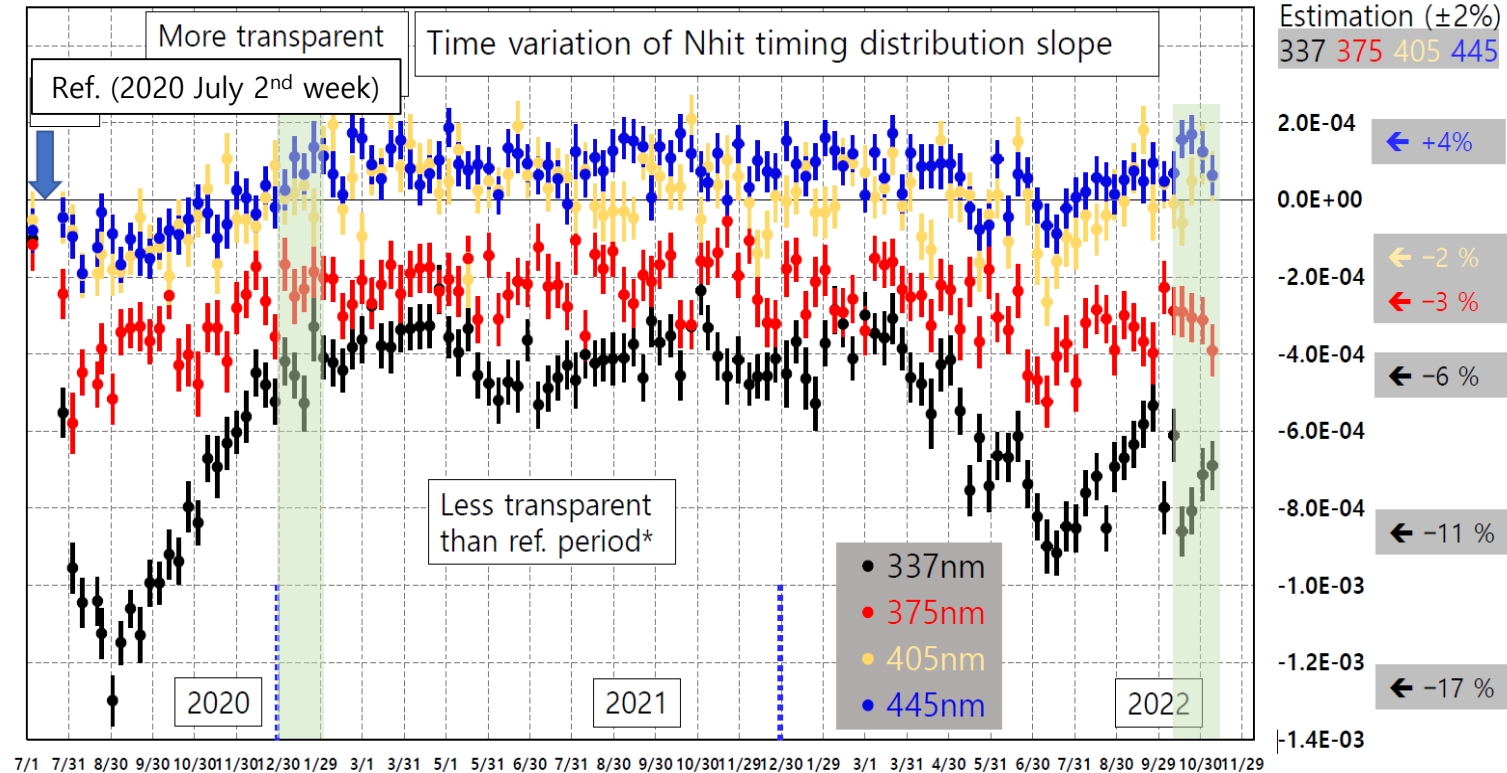
Total charge Normalized



	Fitting value	Error	N/Q	Scattering	Reflection
Intercept	1.567e+00	5.17e-02	Pre-loaded	0.0560375	0.0026155
Slope	-6.893e-04	6.36e-05	Loaded	0.0577319	0.00223418
			Diff(%)	3.02362	-14.5794

Slope > 0 : More transparent than ref. period
Slope < 0 : Less transparent than ref. period

Nhit timing slope sensitive to relative absorption

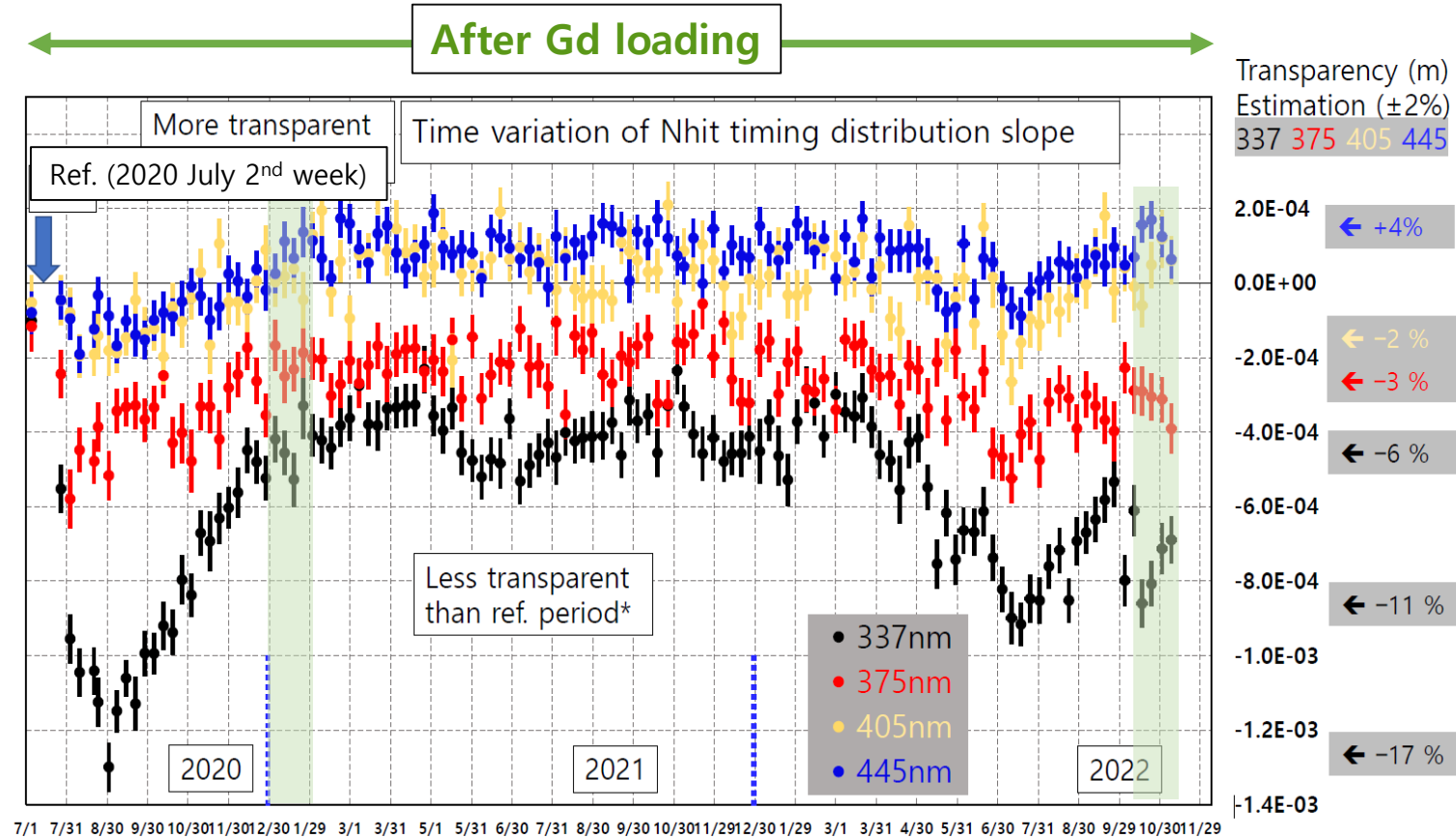
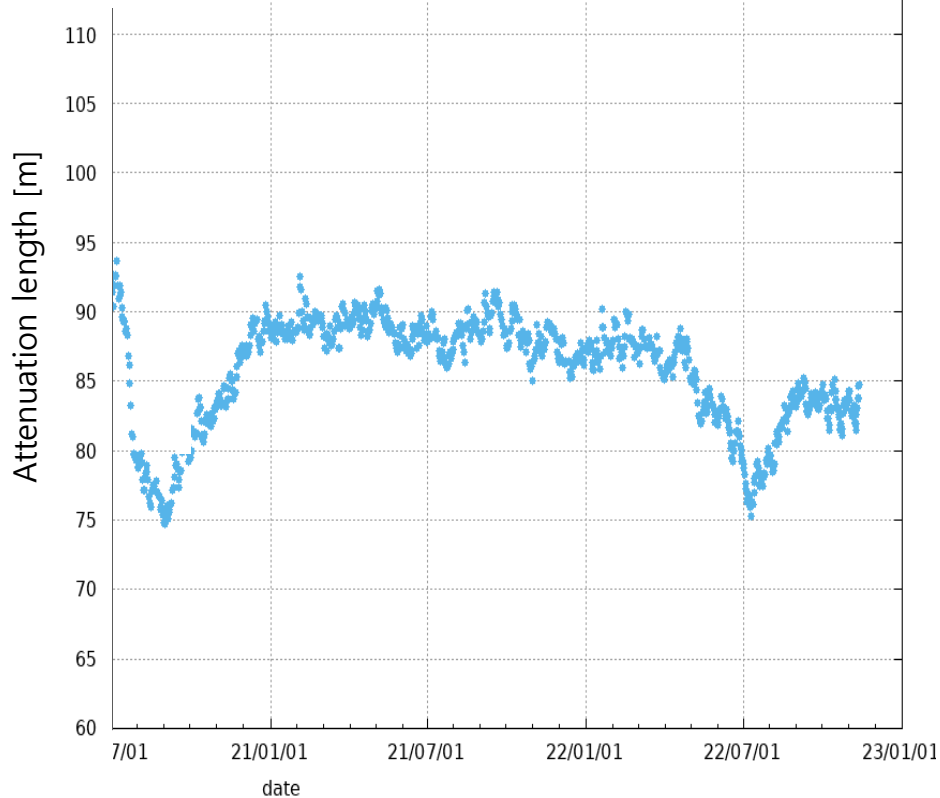


SK6, SK7 reference period for water parameter tuning

Water parameter Analysis with skdetsim
Comparison of SK5, SK6, and SK7 w.r.t reference
337nm & 375nm : more absorption due to Gd loading

Cosmic-ray analysis Korean LI analysis

Attenuation length measurement with cosmic-ray muon



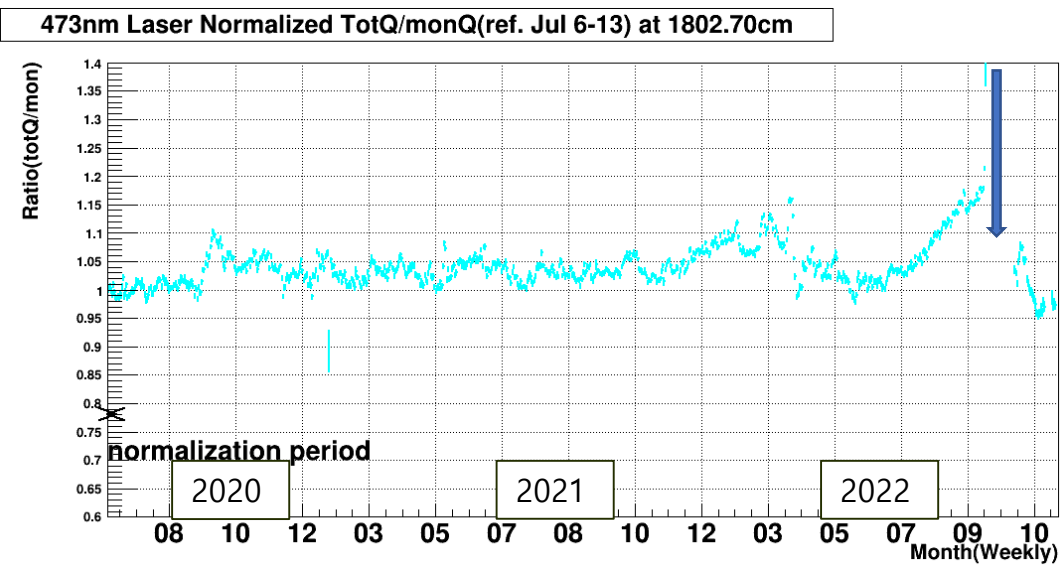
Cosmic-ray analysis and timing slope analysis show similar behavior

Calibration of Monitor PMT of laser injector

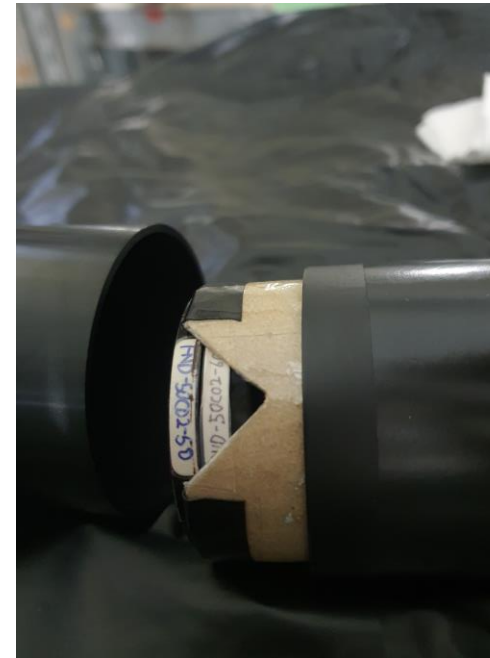
- Visited Kamioka in 2022/9/29 – 2022/10/14
- Linearity calibration of monitor PMT

Maintenance of laser injector

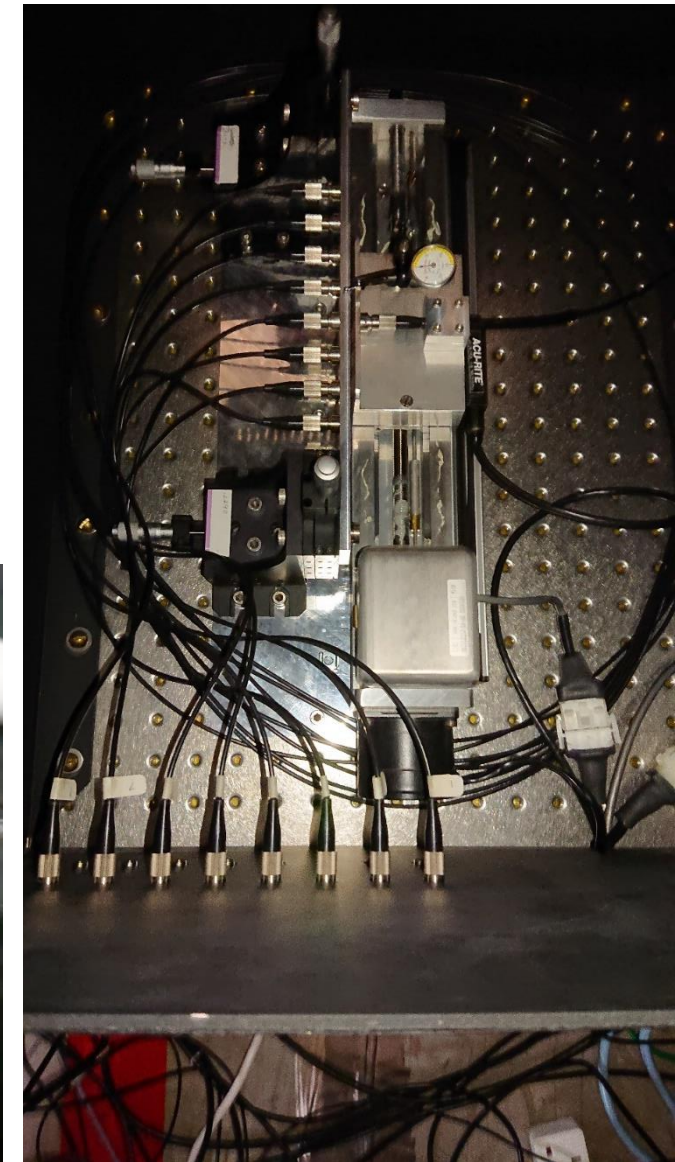
- Overhaul the optical switching box
- Attenuating 473 nm laser intensity using ND filters



Decreasing
473nm laser
intensity



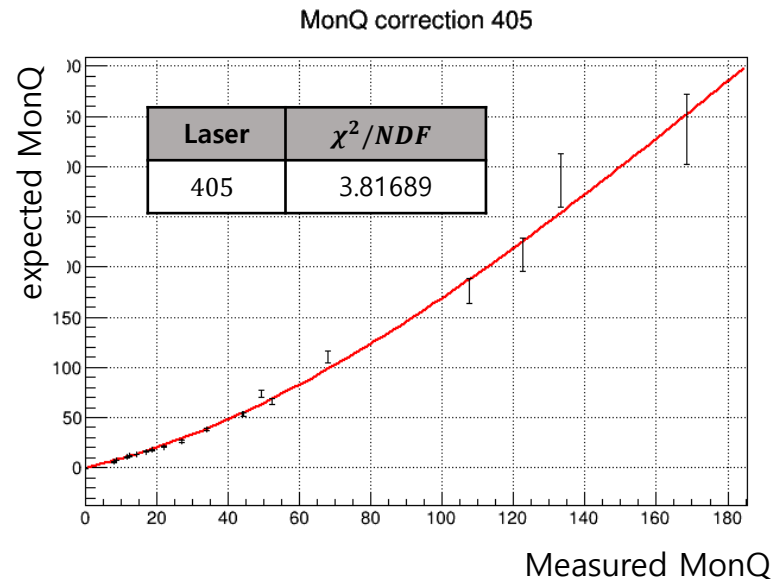
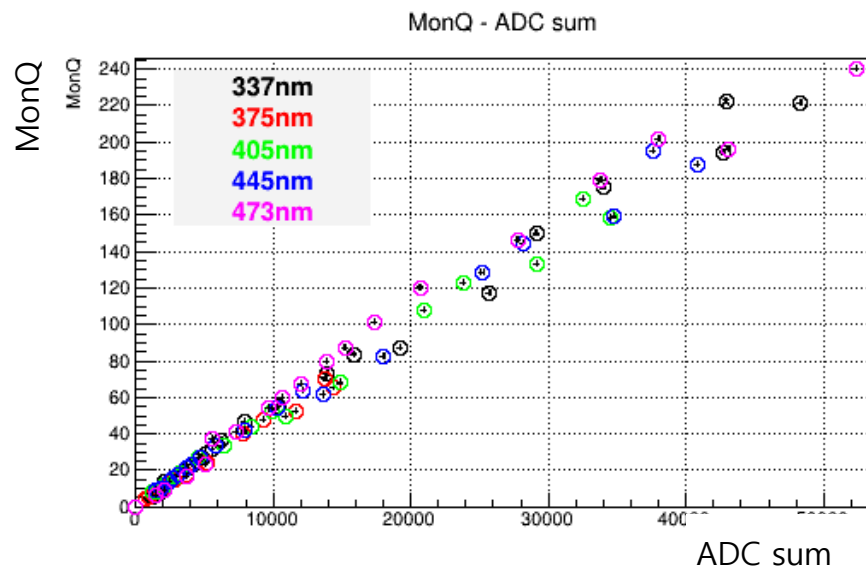
ND filters



Optical switching box

Monitor PMT calibration

- Simultaneous measurement of MonQ (QBEE) and ADC sum (CAEN):
check the linear correlation
- ADC sum data is used to obtain the correction function from measured PMT charge to expected PMT charge:
correction function $y = ax^3 + bx^2 + cx + d$ ($y =$ expected MonQ, $x =$ measured MonQ)
- Measurement of TotQ/expected MonQ

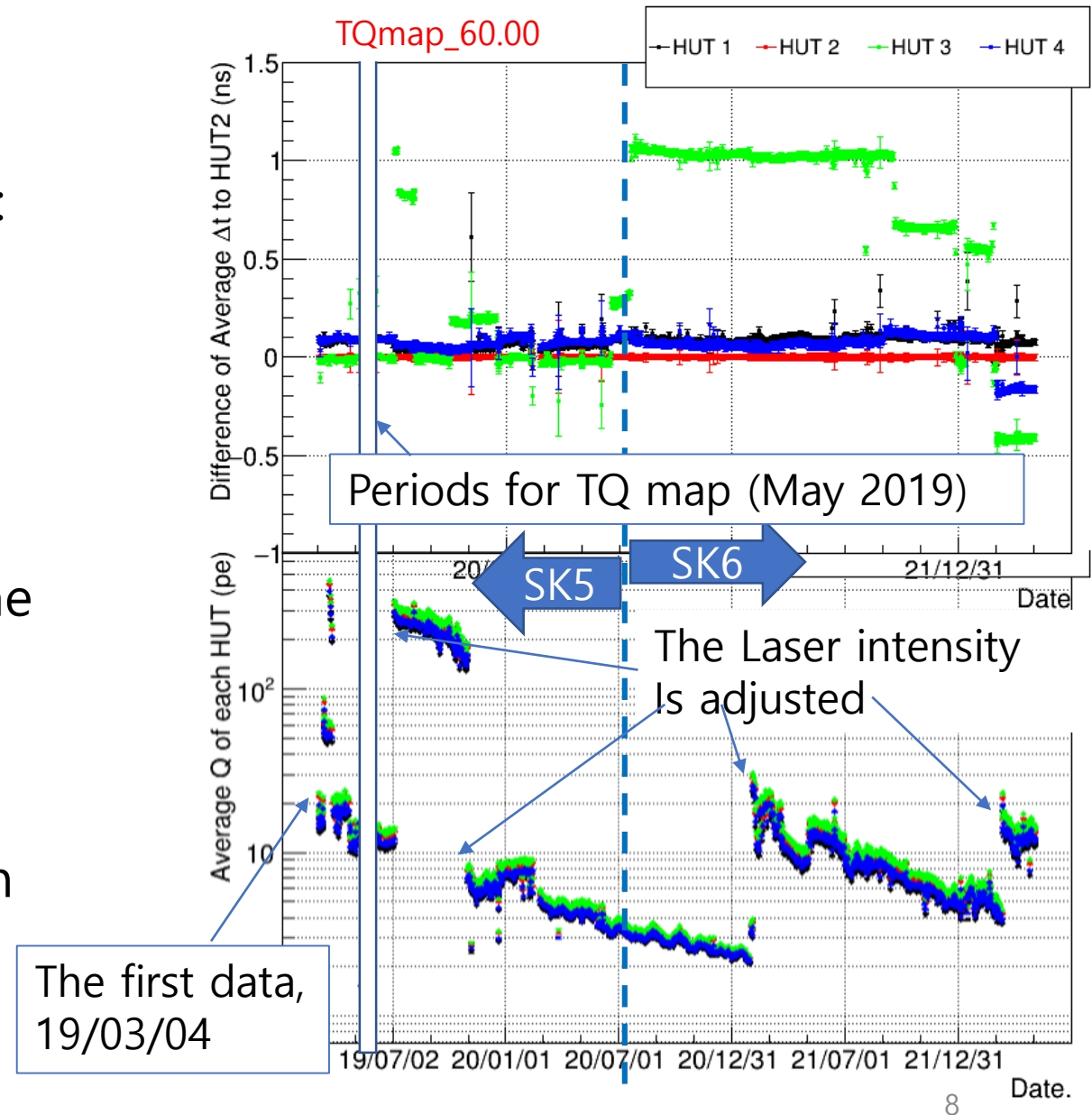


Fit parameters:

a	b
$(-1.875 \pm 1.05)e - 05$	0.0108 ± 0.00127
c	d
0.793 ± 0.0267	-0.598 ± 0.142

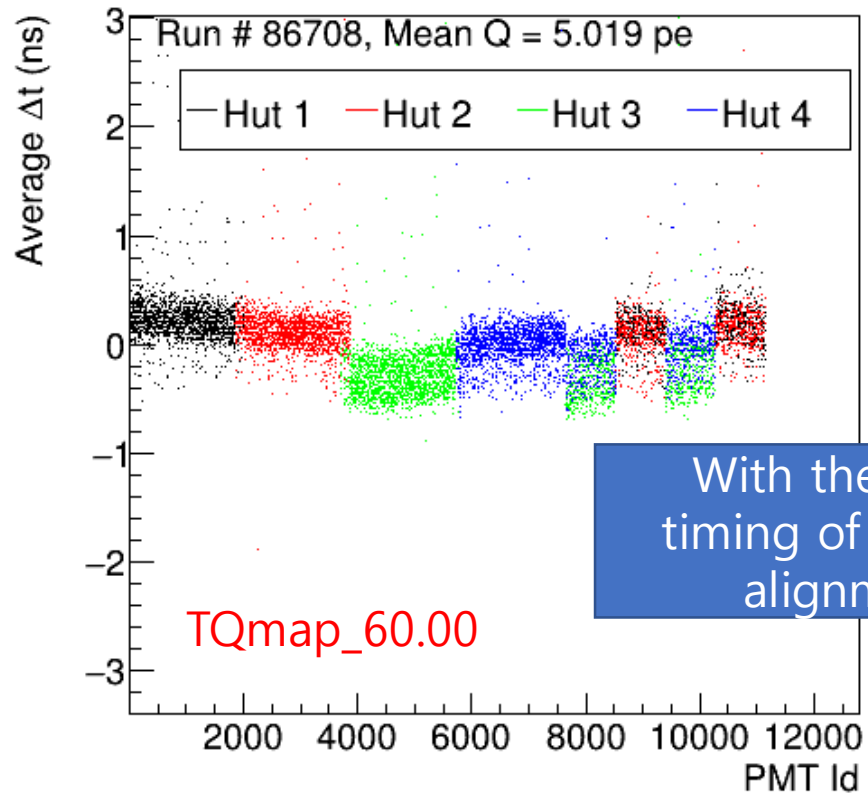
Stability check using laser injector (SK5-SK6)

- Top plot : timing stability
- Definition of the vertical axis in the top figure:
(Average timing for a HUT) - (Average timing for HUT 2)
- Several timing shifts for HUT3 PMTs. (top)
- Bottom plot : charge stability
- The laser intensity gradually decreases over the entire period.
- Several jumps of charge are caused by laser intensity adjustment. No significant correlation was found between charge and timing shift.

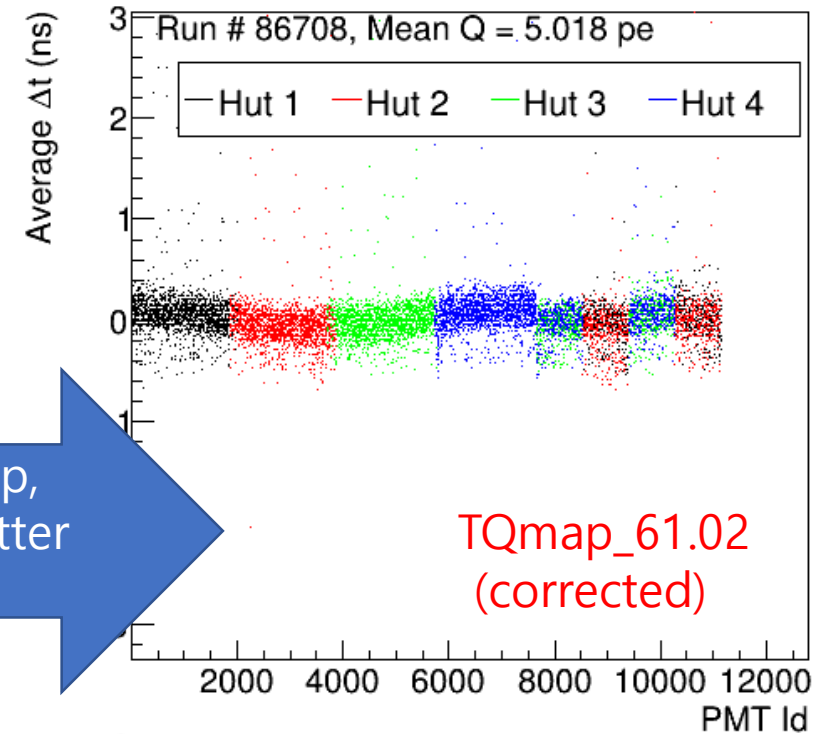


Average Δt VS PMT Id.

A test run taken in Mar. 12 2022.



With the corrected TQ map,
timing of all PMTs show better
alignment around 0 ns.



- Impacts on physics analyses are expected to be negligible

Summary

- Monitoring of SK detector water quality using laser injector system after Gd-loading
- Work on Korean laser system maintenance and monitor PMT calibration on-site
- Correction of timing shifts for HUT-3 PMTs in SK5 and SK6 periods