Form 8

Research Result Report
ICRR Inter-University Research Program 2025

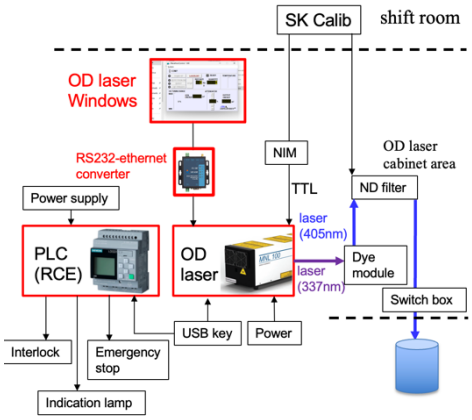
Research Subject: Installation of Super-Kamiokande outer detector laser system

Principal Investigator: Teppei Katori (King's College London)

Participating Researchers: Karen Hayrapetyan (King's College London)
Shunichi Mine (Kamioka Observatory)
Takatomi Yano (Kamioka Observatory)

Summary of Research Result : This is a project to install a new laser calibration system for the Super-Kamiokande (SuperK) outer detector (OD) photo-multiplier tubes (PMTs). In the SuperK, laser light is distributed through optical fibers to monitor the performance of PMTs. This laser has been in use for over 15 years, and its intensity is gradually decreasing. A new laser needs to be installed with a full operation system including a new interlock system, utilizing existing calibration systems such as 52 optical fibers laid in the detector tank to distribute laser light.

Figure 1: New outer detector (OD) laser calibration system. Things with red are new devices installed at this time. The new OD laser has an internal shutter only open by software control. Also, there is a PLC-based interlock system to shut down for emergency.



During 2025, the installation of a new OD laser system was completed. The new OD laser system diagram is shown in Figure 1. It features various new safety aspects. First, the OD laser has an internal shutter that is closed by default. One can open it only with a software command. Since this operation is through a serial cable, we also installed a serial-LAN converter so that one could send this command through Ethernet. The second safety feature is a PLC-based interlock system. This controls features: an LED indicator of operation (picture), an emergency stop button, and an interlock activated by opening the cabinet door where the laser is located.

Inside of the cabinet, we also refurbished the dye laser. Since the laser and the dye module are fiber-coupled, we attached an adaptor to the dye module to connect fibers. Unfortunately, this coupling is not perfect and it seems a huge loss of laser at here.

So far, the new OD laser system is running smoothly with a few known stability issues. The first one was the interruption due to Windows update, and now the software update of the PC we use is stopped. Second one is laser timeout. This can be improved by a small code and this is our immediate next plan. In 2026, we want to improve the aforementioned fiber coupling by fixing lenses on the dye module. This will increase the laser intensity and that would be sufficient to test the new optical fibers we installed in 2024.

Figure 2: OD laser cabinet. A green LED lamp is on during the operation. This is off if the cabinet door is open.

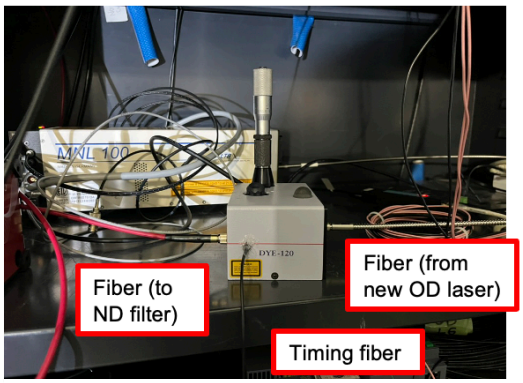


Figure 3: Inside of the laser cabinet. Laser is sent to the dye module through a fiber, then the output will be sent to the ND filter.

Figure 4: The project was supported by the Super-Kamiokande calibration group, from left to right, Mine, Nakahata, Yang (CNU, Korea)

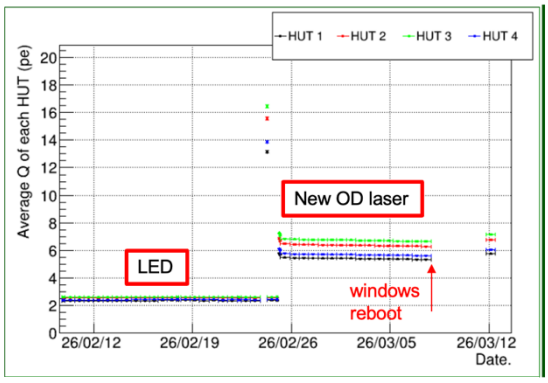


Figure 5: Average charge from the new laser system. It is running fine but some stability issues are unsolved.

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