Form 8

Research Result Report
ICRR Inter-University Research Program 2023

Research Subject: Hyper-Kamiokande OD PMTs QA
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Summary of Research Result:

The Hyper-Kamkiokande OD PMTs QA station has been designed to process several PMTs at a time, and the footprint of the system allows it to be deployed on a tabletop and operated by a single person. The PMTs will be powered up and readout by VME64 modules, which allow for easy deployment at different sites and repurposing at the end of the project.

To streamline cable management, splitters will be installed inside the boxes, allowing for direct loading and unloading of cables. Ensuring continuity, cables from the outside feedthrough panels to the readout electronics and power supply will remain connected to prevent potential issues. A sample feedthrough has already been installed on the box. Additionally, there are plans to design a high voltage lock to prevent opening the box when PMTs are operational.

For production efficiency, a 3D printer has been procured at KCL and configured to produce 30 mounts. Extensive testing has been conducted with CAD prototypes to ensure durability and material optimization. Modular designs with separate mount and legs have been chosen for adaptability. To accommodate potential light measurement needs, a pocket has been integrated on top of the photocathode for inserting caps which hold optical fibers mount at several locations. The design footprint is 20x20cm^2, and leg length will be adjusted based on the type of PMTs procured. NNVT PMTs require shorter potting for cables and do not necessitate long legs, while Hamamatsu PMTs require an average of 30cm legs. The modular design allows for easy adjustment of leg length during printing.

All necessary components for instrumenting and testing one box have been procured. This includes a 405nm LED butt-coupled to an SMA optic fiber with a width of 400 microns and 0.22 NA. Testing has confirmed that the system produces sufficient light to be coupled into a 1-7 fiber bundle. A 3mm nylon gland is utilized for feedthrough in the dark box, with black mastic/tapes ensuring light-tightness. Operators will not need to remove cables inside. As part of the setup, light output will be mounted with aspherical lenses diffuser at strategic points within the box. A sample has been procured and is ready for testing. The objective is to illuminate the box at various points, with PMTs being internally triggered.

Samples of MCX cables and BNC to MCX adapters have been obtained for testing readout from a waveform generator, also sourced from KCL. These components will be instrumental in future calibration of the QA system. Additionally, the DAQ board has been flashed to waveform dump firmware to facilitate offline analysis. Plans are underway to develop custom software for waveform processing. This will involve setting an internal trigger in the PMTs noise at -10mV, determining the constant fraction discriminator time to set the integration window for charge calculation (with an 80ns width), and displaying the charge histogram directly through front-end software. Subsequent analysis will involve fitting photo-electron peaks and measuring gain automatically.

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