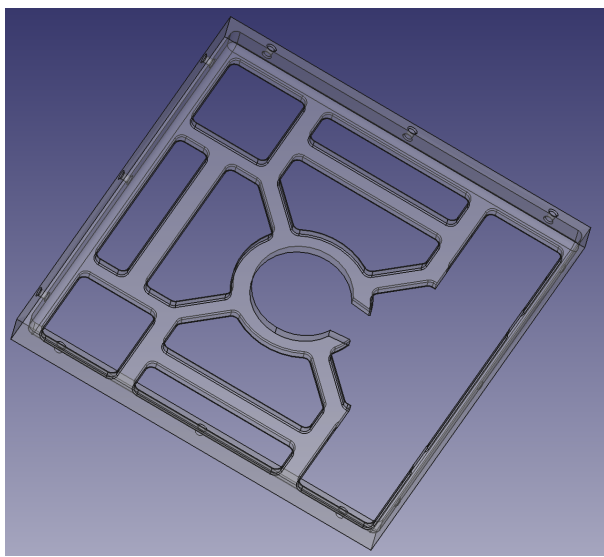


**Research Result Report**  
**ICRR Inter-University Research Program 2022**

Research Subject: Hyper-Kamiokande OD PMTs QA
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Summary of Research Result :  <p>The Hyper-Kamiokande OD PMTs selection is ongoing, and tendering is expected to start in Q3/2023. While the Hamamatsu R14374 3" PMT is the strongest candidate, a system has been designed regardless of the PMT model that will be selected. The 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.</p> <p>The QA station consists of two dark boxes, each holding 3x5 PMTs on a 3D printed frame, with a design that considers the requirement for processing the QA and the expected production rate. The PMTs would be delivered already cabled with a 20m single cable allowing simultaneously the power supply and the readout of each PMT, connected with an AXON trademarked device. Upstream a custom splitter device has been designed to decouple all 3x5 channels for each dark box. The frame has been designed with CAD, consisting of an atomic unit of a 30x30 square and two collars to hold the PMT base and rest the PMT photocathode. The PMTs are delivered connected to the 20m cables, which are rolled in a 30cm diameter and laid to rest between each frame unit.</p>



*Figure 1: view of the atomic frame holding the PMT*

The workflow for the QA has been defined, including 'light' and 'dark' measurements. The QA proceeds as follows: an operator unloads the previous QA PMTs batch and loads the new one. The PMTs are powered and left to warm up for a minimum of 2 hours. The PMT gain is assessed by measuring the charges collected by a light source at several predefined intensity levels. The relative QE can be inferred from a reference value by comparing the

number of charges collected from each PMT. Lastly, the dark rates are measured overnight continuously to ensure their stability. The overall process takes 24 hours, and 15 PMTs per station can be processed per day.

The UK funds have allowed the purchase of the electronics for the QA station, including a CAEN VME64x 4U Mini crate 8 Slot, 2 CAEN 16 Ch. 14 bit 500 MS/s Digitizer, and 5 CAEN 6 Channel VME Programmable High Voltage Power Supply. The light injection system is under ongoing development, consisting of LEDs enclosed facing a bundle of optical fibers, which are feedthrough the dark box.

The QA site and logistics are under determination. A 2-sites scenario has been kept where the PMT QA and its assembly with a wavelength shifting plate will be performed and then stored at another site. Both sites are expected to be located nearby Kamioka. The QA testing will be deployed first at Kashiwa where the required power and space are available.

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