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P3.019 Development and performance evaluation of large-aperture hybrid photo-detector for Hyper-Kamiokande

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on behalf of Hyper-Kamiokande collaboration

Hyper-Kamiokande (HK) is a next generation large water Cherenkov detector. HK consists of two cylindrical tanks with the total fiducial mass of 0.38 Mton, which is 17 times of that of Super-Kamiokande (SK). HK aims to observe the CP violation in the lepton sector and to discover the proton decay.

Because HK is a water Cherenkov detector, the performance of photosensors will be important. We have been developing a large-aperture Hybrid Photo-Detector (HPD) for HK to improve the performance to detect Cherenkov photons compared to a Photomultiplier Tube (PMT) used in SK.

The HPD is a sensor using an Avalanche Diode (AD) instead of dynodes of the PMT. Because of its simple internal structure, it is easier to be mass-produced than PMT. It is also expected to be superior to PMT in the time resolution and single photon sensitivity. Those performances have been confirmed with an 8-inch HPD using a 5 mm diameter AD.

A 20-inch HPD with a 20 mm diameter AD is now being developed. The size of the 20 mm AD diameter is necessary in order to keep the collection efficiency. However, due to the large area of AD, the S/N becomes worse because of the increase of the junction capacitance of AD. To solve this problem, multi-segmented AD and low capacitance AD have been developed.

We studied two types of HPDs. One uses a 5 channel AD and the other uses 2 channel AD with reduced capacitance. We evaluate the performance of these HPDs by measuring high voltage dependence of gain, signal response of single photo-electron, transit time spread, dark count rate, rate tolerance and linearity with multi-photoelectron input. We will report the result of the evaluation.