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Development of New Data Acquisition System for Nearby Supernova Bursts at Super-Kamiokande

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Super-Kamiokande (SK), a 50-kiloton water Cherenkov detector, is one of the most sensitive neutrino detectors. SK can be used also for supernova observations by detecting neutrinos generated at supernova. In order to improve the performance of the detector for supernovae, we are developing two new features, one for recording all information within one minute and the other for recording calorimetrical information for nearby supernovae.

The current SK data acquisition (DAQ) system reads out all the photomultiplier tube (PMT) hits, including the dark noise, and applies software trigger to select events to record. Therefore, the PMT hits caused by very low energy events below the threshold are not stored. Since supernova burst is a very rare phenomenon and details of the burst mechanism are not known yet, all possible data should be recorded without any bias in the trigger system. To accomplish this, we are adding a new feature to the DAQ system to record all the PMT hit information before and after the burst occurs for about one minute.

The neutrino burst from a supernova farther than about 1300 light years can be recorded without loss of data by the current DAQ system. However, if a supernova burst occurred within a few hundreds of light years, the neutrino event rate can be more than 30 MHz and the system can record only about 20% of the events. To overcome this inefficiency, we are developing a new DAQ system that can handle such high-rate neutrino events. This new DAQ system records the number of hit PMTs so that we can count the neutrinos and obtain a time profile of the number of neutrinos emitted at the supernova.

We will present the implementation of these improvements and show the results of the tests with the prototype.

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