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The Trigger System in the NEXT-DEMO detector

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NEXT-DEMO is a large-scale prototype of NEXT, an experiment to search for neutrinoless double beta decays using a radiopure high-pressure gaseous xenon TPC with electroluminescence readout. Based on a PMT plane for energy measurements and a SiPM tracking plane for topological event filtering, front-end electronics, trigger and data-acquisition systems (DAQ) have been built. The DAQ is a low-scale implementation of the Scalable Readout System (RD51 collaboration). A reconfigurable hardware trigger system has been developed, allowing on-line triggering based on the detection of primary or secondary scintillation light, or a combination of both.

Summary

NEXT is an experiment designed to search for the neutrino-less double beta decay using a 100kg radio-pure, 90% enriched (136Xe isotope) high-pressure gaseous xenon TPC with electroluminescence readout. NEXT-DEMO is a large-scale prototype equipped with two sensor planes in opposite sides of the detector vessel. One plane will measure event energy with PMTs, detecting also the primary scintillation light. The other plane will use a SiPM array to follow the primary electron paths and to help in the discrimination of interesting events from the background.

NEXT-DEMO DAQ and Trigger Systems are based on the Scalable Readout System (SRS) jointly developed with CERN-PH in the framework of the RD51 collaboration. Specific adapter modules have been developed to interface the PMT and SiPM front-end electronics to the SRS Front-End Concentrator (FEC) card, which in turn is interfaced via Gigabit Ethernet to the DAQ PC farm.

The front-end electronics work in push mode. DAQ FEC cards readout, process and store data coming from the front-end in a reconfigurable-length circular buffer, which maximum size corresponds to the maximum detector drift time. The trigger module (an additional FEC card) receives trigger candidates from the DAQ FECs, runs the trigger algorithm and distributes trigger, clock, synchronization, and system configuration signals to the other FEC cards. Upon arrival of a trigger signal, data stored in the FEC cards are formatted and sent to the PC farm for off-line analysis.

Due to the extent size of events in gas detectors, secondary scintillation light provides much more diversity of signals than detectors based on liquid or solid state. In contrast with other low background experiments, where only a minimum amplitude threshold is enough, a flexible trigger system is needed to allow detecting any event with similar efficiency.

The Trigger System implements a reconfigurable hardware algorithm that is able to cope with three types of trigger candidates, one external, and two internal based on the early energy estimation of the events received from the front-end channels connected to the PMT plane to detect the primary and secondary scintillation light. The programmable trigger mode of operation allows triggering on the three sources independently, or on a combination of all of them. One more level of discrimination is available, since a coincidence of a programmable number of channels producing a trigger is required. Trigger candidates are generated by means of configurable thresholds on both amplitude and time combined with energy estimation of the events allowing an efficient rejection of background and non-interesting event.

First test runs using the Trigger System have allowed triggering on the primary scintillation light. To distinguish primary events from weak secondary events, an external NaI scintillator has been connected to the front-end. The system has been configured to trigger the external source in coincidence with Na22 gamma events produced in the chamber. Trigger configurations tested have allowed triggering on events as small as 5-6 photoelectrons per PMT.

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