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Trigger architecture of the SuperNEMO experiment

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SuperNEMO is the next-generation (0νββ) experiment based on a tracking plus calorimetry technique. The demonstrator is made of a calorimeter (712 channels) and a tracking detector (6102 channels). These detectors front-end electronics use an unified architecture. The trigger system has for the calorimeter part 2 trigger thresholds, for the tracker part the possibility of a second triggering for a delayed particle. The calorimeter and tracker can operate separately. We have an overlap between the zoning of the calorimeter and the tracker. The final trigger decision is made considering spatial coincidences between hits from the calorimeter and tracker detectors.

Summary

Experimental search for the neutrinoless double beta decay (0νββ) is of major importance in particle physics because if observed, it will reveal the Majorana nature of the neutrino ($\nu = \bar{\nu}$) and may allow an access to the absolute neutrino mass scale.
SuperNEMO is the next-generation (0νββ) experiment based on the technique of tracking and calorimetry detector.
The construction of SuperNEMO demonstrator (one module) has started in 2012 and its installation is expected in 2015 in the Modane Underground Laboratory (LSM) located in the Frejus tunnel in France. Competitive results are expected by 2017.

The SuperNEMO demonstrator module is designed to measure both energy and time of flight of each beta particle emitted from ββ decays in the central source foil and to reconstruct their trajectories in order to guarantee the signature of 0νββ decays.
The demonstrator is made of a calorimeter (712 channels) and a tracking detector (6102 channels). These detectors front-end electronics use an unified architecture based on six similar crates that each host up to 20 Front-End Boards (FEB), one SuperNemo Control and ReadOut Board (SN_CROB) and a Trigger Board (TB) is plugged in one of the remaining empty slot of a calorimeter crate.
The Calorimeter Front-End Board (FEB) is a 16 channels board, which performs the acquisition of the calorimeter channels.
The Tracker FEB is a 108 channels board, it performs the acquisition of the tracker channels.
The SN_CROB board gathers the front-end data from the calorimeter or tracker FEBs and sends them through Ethernet link to the data acquisition (DAQ) system. It extracts the Trigger Primitive (TP) from the front-end data and sends them through serial link to the Trigger Board (SN_TB). The SN_TB is taking the trigger decision given the TP coming from the two parts of the detector.

The goal of the trigger system is to select only event of physical interest (electron, gamma, alpha ⋯), reject random events (self triggering of the tracker drift cells or PMTs) and reduce the general acquisition rate. At each clock tick (25ns), we collect Trigger Primitive (TP) signals associated to each tracker and calorimeter channels. The trigger system is designed to merge all these TP signals and make a decision from these informations within a central programmable SuperNemo Trigger Board (SN_TB).
The trigger system has several relevant part:
The calorimeter part integrates 2 trigger thresholds: a major high energy threshold and a low energy threshold in order to detect low energy particles.
The tracker part provides the possibility of a second triggering for a delayed particle.

The calorimeter or tracker part of the trigger system can operate separately.
We have an overlap between the zoning of the calorimeter and the tracker.
The final trigger decision is made considering spatial coincidences between hits from the calorimeter and tracker detectors. The special coincidence is done regarding the 10 bits of Tracker Triggering Zone (defined on each side of the tracking chamber) and the corresponding 10 bits of Calorimeter Triggering Zone.

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