The SuperCDMS-SNOLAB Trigger System

Report of the Trigger Task Force

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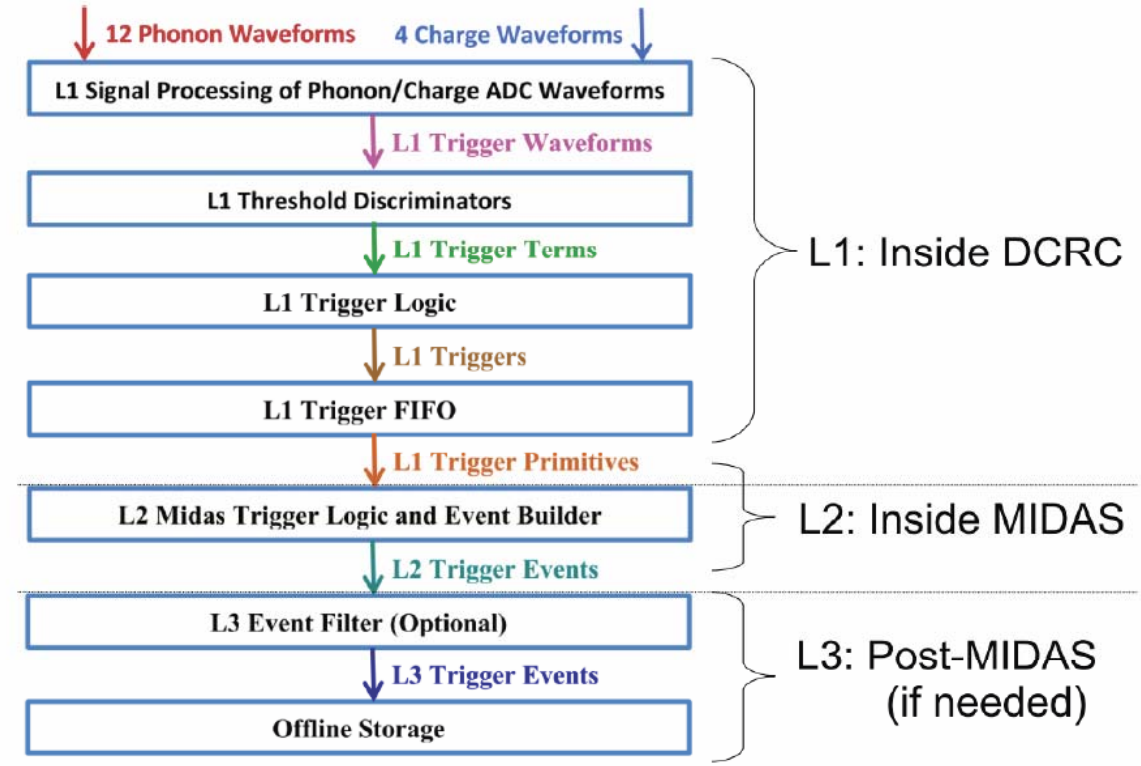
Overview

- The Trigger Taskforce was created in July 2014 to study all aspects of the CDMS Trigger for SNOLab and to make a series of Recommendations and list the set of Unresolved Issues for further Study
- We have now completed our work and submitted our Report
  https://confluence.slac.stanford.edu/download/attachments/176488487/ttf_report_2014nov17.pdf?version=3&modificationDate=1416424112504&api=v2

- In the next few slides I will outline the executive summary and an overview
- For more detail, see the report itself as it contains links to individual Wiki-pages which have more detail about each of the subsystems, as well as about some of the issues discussed

Quick Overview

- The trigger will be made of three cooperating systems known as Level 1, Level 2 and Level 3
- The structure is as shown to the right and is designed to be deadtimeless



Driving Issues 1: Different Running Modes and Different Detectors

The trigger must support running in a number of modes including:

- low-background running (WIMP search data),
- high-rate calibration runs, and
- acquisition of noise traces via random triggers.

It needs to take in data from a number of sources including:

- iZIP detectors,
- CDMSlite detectors, and
- Neutron veto detectors.

Driving Issues 2: Offline Analysis Needs

Need to take data in a way that efficiently triggers for our full set of expected analyses

WIMP search: energy deposition in a single detector

- Note: More on this soon

- LIPs analyses and Nearest-Neighbor searches
  - Note: Current plan is that every time there is a significant deposition of energy in a single detector during regular data-taking mode, we will read out all detectors. Thus, there is currently no need for special triggers for the LIPs and/or Nearest-Neighbor searches.

Driving Issues 3: Readout Requirements

We must be able to read out the experiment in a number of configurations that include:

- Reading out all the towers in the experiment for the same trigger time
- Reading out just a single detector or tower that passes the trigger
- Rejecting pileup events (events with multiple pulses within the readout window) during calibration data-taking, to ensure high efficiency for calibration data.

Notes

Won't go through the details of the system, just make some notes about the things most people wanted to know about

Level 1 Notes

- Here we concluded that the plan is to run a Finite Impulse Response (FIR) filter in the FPGA on the DCRC
- This allows us to choose between many choices like running an Optimal Filter, a Boxcar filter or a bandpass filter
- We need to get this working on the FPGA to see if our assumption that it is powerful enough and low-noise enough to work. Efforts are in progress

Level 1 Algorithm Details

Since the Level 1 Trigger is crucial to the experiment sensitivity, and it is currently under study, it is worth outlining the currently Recommended algorithm:

1. Sum the 12 phonon channels as input
2. Apply an FIR to the last *N* samples of the input to produce a "filtered" trigger waveform
   - Coefficients of FIR are chosen based on noise
   - Design FPGA to allow for easy changing
3. If result goes above threshold start a peak-search algorithm to find the peak and wait until waveform falls below a lower, "off" threshold
4. Check whether trigger is otherwise vetoed
5. Write peak time and value (and other info) to L1 trigger FIFO for readout by Level 2

Level 2 Notes

- Stay on track with the MIDAS DAQ/Trigger system
- Current polling rates of ~1 sec are important
- Will make the decisions here about how to deal with the high rate calibration data, by rejecting pile-up events

Level 3

- While this level has the possibility of rejecting events, our current estimates of the data rates/sizes out of Level 2 are just fine for our ability to store and analyze the data
- Will just leave L3 as a pass through for now
- Will need to focus on having enough storage in the mine, and the ability to get it out of the mine and to the offsite production locations

Conclusions

- The Trigger Task Force has completed its work
- The process of vetting the trigger system was very rigorous and produced many useful discussions
- We have a set of strong recommendations that will help us design the trigger moving forward, but have many unresolved issues that need to be answered soon for us to progress