The Neutron Veto DAQ system for XENONnT experiment

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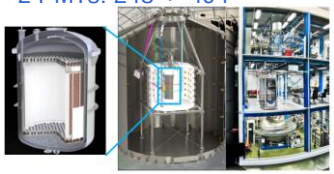
Fast upgrade to XENONnT

NEW LARGER TPC
× 3 LXe target mass: 2.0 t -> 5.9 t
8.6 t total LXe in the system
× 2 PMTs: 248 -> 494



NEUTRON VETO DETECTOR
Gd-doped water Cherenkov detector
120 PMTs, highly reflective
87% neutron tagging efficiency (exp.)

Nuclear recoil background reduction by a factor 6 with the NV operational

DAQ requirements

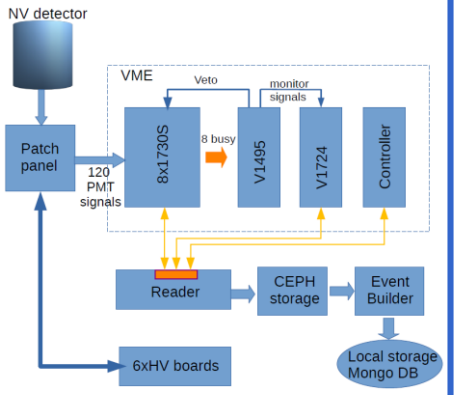
To tag the neutron events (> 87%) DAQ must cope with:

- **small signals** due to a low threshold (<0.5 PE) typically about 100−200 ns (mostly from dark rate)
- **high energy events** induced by radiogenic neutrons with long duration on many channels
- **fast response** (few ns) of PMTs requires fast waveform digitizer for signal sampling.

DAQ implementation

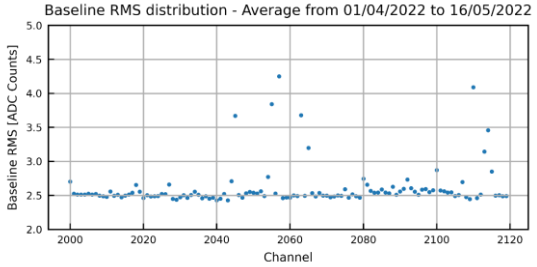
Triggerless data collection scheme:
- pulse shape and timestamp with fully independent channels
- event building in software to define events

- Digitizers (CAEN V1730S, 16-ch with 14-bit at 500 MHz) operated in self-trigger mode DPP-DAW fw
- PCIe interface to readout (4 links, up to 90 MB/s each)
- Frontend software to read data and transfer it to Ceph buffer for online processing



Commissioning and Science Runs

- During 2020 and early 2021 NV DAQ system successfully commissioned
- The DAQ system collected more than 6 months of data during the first Science Run (SR0, 2021).



- Noise levels in all the NV channels have been measured and monitored
- Most of the channels (apart 10/120) have an RMS of the baseline below 3 ADCcounts

Conclusions

NV DAQ for XENONnT experiment at LNGS has been designed around a triggerless data collection scheme allowing a continuous data stream of independent channels. The event building is then implemented in software.
It has been successfully commissioned at LNGS and integrated within the overall DAQ environment and is now in a stable data taking in preparation for SR1.