Calibration-DAQ update

S. Gollapinni, J. Klein, K. Mahn, J. Maniera

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Expected event rates: 10 kton SP TPC

(DUNE doc-db#9240 has more details)

Event Type	Data Volume (PB/ year)	Assumptions
Radioactive source calibration	0.2	Source rate <= 10 Hz; single fragment readout; lossless readout, 4 times/year
Laser Calibration	0.184	800,000 total laser pulses, lossy readout
Neutron Generator	Negligible? (6.22 GB x #pulses)	All neutrons collected in a single DUNE event? Need to know the total #pulses.
External Muon Tagger	1.8E-11	Rock muons only, 4 hit counters, 4 12-bit words/ hit
Trigger Primitives (for Ar-39)	~2	Only collection wires; 12 bits per primitive word; 4 primitive quantities;

(only including systems that fall under the scope of the Calibration Consortium and Task Force)

Data Volume for Laser

- Calibration proposal: 800k pulses/run
- Can “zero suppress” around laser track. Assume 100 us around the pulse on the wire
- Assume a laser track traverses about half of APAs
- [800,000 pulses/run x 100 us x 2 MHz x 1.5 B x (150 x 2560) channels] = 92 TB/run for 10 kton
- Assume, under stable operations, we run laser twice a year, i.e., a total of 184 TB/run for 10 kton

Laser run duration & triggering

Duration of the laser run:

- Assuming 800k pulses, 10 Hz laser rate, 100% efficiency, it will take 1 day — likely too optimistic

- Conservative estimate: 800k pulses, 4 Hz rate, 80% efficiency gives 3 to 4 days

    - If efficiency is higher, or if we can run lasers in parallel in 4 drift volumes, the time needed will be less.

Triggering: Laser firing would be best if DAQ can decide when to fire (better control e.g. to hold off if supernova is happening)

    - Currently investigating if laser can be run in the slave mode to be triggered by DAQ. Perhaps the laser power supply has some smart electronics built into it!?

    - If this is not possible, we will feed DAQ with a digitized signal that can be used for triggering

DAQ for Ar-39

- From Mooney's Ar-39 collaboration talk:
  - DAQ will be a challenge with nominal approach to forming trigger primitives – rate very high!
  - Instead: consider doing prompt analysis on FPGA, and read out only shape/energy "histogram" (one per wire)
  - Use round-robin approach to decrease bandwidth
- What are the next steps towards developing and testing this implementation?

Other items

ProtoDUNE

- Calibration systems planned for DUNE FD will be implemented in ProtoDUNE run 2 post-LS2
- DAQ and calibration should coordinate so DAQ scheme for calibration can be tested at ProtoDUNE in Run 2 — perhaps a dedicated meeting planning this would be useful?

- Are there any other important questions from DAQ that are yet to be answered by calibration?
  - Especially, what is needed for DAQ from calibration for the final draft of the TDR?

- Naive question: If DAQ were to go with the proposed FELIX system, any implications for calibration DAQ requirements? Perhaps not?

Backup

- **Radioactive sources**

Gamma source requires special handling.
We *assume* rate in detector is 10 Hz and it illuminates just 1 APA (2560 channels)
So we localize readout to just 1 APA. For an 8 hour run in 4 feedthroughs, so

$$8\ \text{hours} \times 4\ \text{FTs} \times 10\ Hz \times 1.5\ \text{Bytes} \times 2\ \text{MHz} \times 5.4\ \text{ms} \times 2560\ \text{channels} = 50\ \text{TB/run}.$$

If this is done 4x/year it is **200 TB/year**

- **External Muon Tracker**

If we limit ourselves to just the rock muons and assume that four counters are hit resulting in 4 12-bit words/counter (one charge and one time each, plus the counter ID and a local timestamp, then we get a yearly total data volume of

$$735\text{year}/10\text{ktonne} \times 24\ \text{B/event} = 17.6\ \text{kB/year}$$