Snowmass TDAQ Subgroup White Paper Organization

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Goals

- Get a sense of who will be submitting TDAQ white papers

- Facilitate common white papers on topics of broad interest
  - Allow contributions from those who may not be able to commit to a full stand-alone white paper
  - Show community-driven input on pressing needs
  - Need to identify (co)-editors for these efforts

Broad Timeline for white papers

- 19 Nov 2021: White paper kickoff for IF
  - Goal to share plans on white papers/advertise contributions
- 14-17 Feb 2022: White paper wrap-up
  - Part of CPAD workshop
  - Goal to get final push on white papers, particularly common efforts
- 15 March 2022: White paper final deadline

What happens after that

- Preliminary topical group reports: end of May 2022
- Preliminary frontier reports: end of June 2022
- Snowmass community summer study: 17-27 July 2022 @ UW-Seattle
    - This then leads into the final executive summaries and group/frontier reports, to be finished by ~Oct 2022

LOI overview

- We had a great selection of LOIs showing interest in innovating TDAQ for the future

- Along with specific thrusts, some general trends clearly emerged:

    - Artificial Intelligence and Machine Learning in TDAQ
    - Readout technologies for future detectors
    - General innovations in TDAQ for next generation detectors

(Dive into a bit more detail, and apologies if we've somehow missed an LOI ...)

TDAQ AI/ML

- Inference applications
  - Fast inference, heterogenous acceleration, ML as a service (Liu et al, Acosta Flechas et al.)
  - FPGA-based edge AI (R.Herbst et al.)
  - High speed instrumentation for front-end DAQ (Mostafanezhad et al)
- New techniques
  - Non Von-Neumann neuromorphic computing, non-volatile memory (Miryala et al.)
  - Self-driving trigger for automated/adaptive data selection (Miller et al)
  - Real-time adaptive deep-learning with embedded systems (Miller et al)
- And a number of experiment-focused needs...
  - (Sorry, too many to list!)

TDAQ techniques/algorithms

- Charged-particle track trigger algorithm in FPGA (Kotwal)
- Track-based triggers for exotic signatures (Holmes et al)
- Self-driving triggers for automated/adaptive data selection (Miller et al.)
- Real-time adaptive deep-learning with embedded systems (Miller et al.)
- Extending scalable readout systems (SRS) for better/more programmable triggering (Muller et al.)
- Asynchronous L1 triggers for Colliders (Acosta et al.)
- Non Von-Neumann neuromorphic computing (Miryala et al.)

- And again, a lot of items embedded in more experiment-specific LOIs (across EF, NF, RF, CF...)

Readout technologies

- Wireless data transfer for Colliders (Zhang et al.)
- Rad-hard photonics-based links (Zhang et al.)
- Wavelength division multiplexing (Garcia-Sciveres et al)

- And of course, also touches on a number of other LOIs (timing, electronics, etc.)

Coming back to Possible Common White Papers, Associated LOIs

“Artificial Intelligence and Machine Learning in Trigger and DAQ” **68, 189, 190, 191, 249, 251**

- Big and popular topic, so depending on community feedback consider split to two white papers? e.g. “AI/ML at the edge” and “AI/ML in High-level triggers, event-filtering, and detector control”
- Work closely with IF07 (especially on the former) and **computing frontier** (especially on the latter)

“Innovating Trigger and DAQ for the next generation of detectors” **184, 185, 186, 187, 251**

- Include TDAQ architecture and infrastructure (e.g. streaming DAQ), fast computation on heterogeneous computing, fast timing, trigger-aware ASIC development (work with IF07)
- Natural place for ideas not specific to AI/ML (e.g. fast tracking triggers, fast spectral analysis), and a way to tie-in needs of future experiments

“Readout technologies for future detectors” **168, 183, 188,**

- Include wireless readout, rad-hard links, multiplexed high-speed readout (with IF07)

Backup

Experiment/detector-specific DAQ needs

- Project 8 DAQ (Oblath)
  - Real-time spectral analysis and tracking for trigger/data reduction (compute-intensive)
- Low-energy events in DUNE (Karagiorgi et al.)
  - Largely improved algorithms and data compression to extend low-energy sensitivity
- Belle-II upgrades (Vahsen et al)
  - DAQ upgrades underway for increased rates, timing upgrades envisioned for long-lived particle triggers(?)
- Optical instrumentation for EM calorimeters (Rutchi et al)
- Muon Scintillator R&D for Higgs factory/long-lived particle searches (Wang et al)
- Large Scintillator Arrays (Young et al)
  - Signal coincidence and >100 ps timing resolution (for position reco)

- TRACK-BASED TRIGGERS FOR EXOTIC SIGNATURES (Holmes et al., 8)

Real-time processing hardware

- System on chip/readout-integrated ASICs for triggering, feature extraction, self-calibration, etc. (Mostafanezhad et al., Miryala et al., Miller et al 132)
  - Miryala discusses some specific issues, like non-volatile memory and co-design
  - Miller highlights need for Multi-Processor SoC and FPGA for DL/AI needs

- FPGAs for ML inference (Miller et al 132, Herbst et al)

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