Real-Time Processing Systems

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About me

2005 BA: Princeton, Physics
2011 PhD: JHU, Physics
2011- 2017: Postdoc - FNAL
2017-2022: Wilson Fellow - FNAL
2022 - present: Scientist

At FNAL:

2019 → SCD, AISP/ARA group leader;
→ Fermilab AI project coordinator

- Awards: DOE Early Career, APS Primakoff, URA Tollestrop

Not ES&H approved,
luckily my wife is a nurse

Misc:

- Avid sports practitioner & watcher (all kinds)
  - Back into tennis during the pandemic after a long layoff; ninja warrior obstacle courses with kids
  - Missed getting back into FNAL softball this year :(

Relevant technical work

- **CMS**
  - Track Trigger Associative Memory ASIC design and testing
  - FPGA trigger development (e.g. particle flow, PU mitigation, ML)
  - Trigger L3 project manager (2018-2019)
  - Developed several new LHC data processing algorithms, ML and non-ML
- Co-creator of **SONIC** - as-a-service coprocessor for HEP
  - Implemented for LHC, ProtoDUNE, gravitational waves
- Co-creator of **hls4ml** - ML on FPGA/ASIC workflow
  - LHC FPGA trigger applications; CMS ECON-T autoencoder ASIC
  - New applications and techniques;
    - Accelerator controls; DUNE readout; magnet quench detection; sPHENIX/EIC AI controls; 4D TEM (electron microscopy); quantum controls; industry including IoT and Industry 4.0 (MLPerf Tiny)
    - Developing techniques for efficient algorithm optimization, implementation, and codesign
- Co-coordinator of the **fastmachinelearning.org** research collective
- LDMX (Light Dark Matter eXperiment) **TDAQ** coordinator

Motivation

Physics discovery comes from advances in sensing at increasingly finer spatial and temporal resolution, often in extreme high radiation or cryogenic environments, and at large scales

Far beyond the point of saving “everything” - readout is a complex task of lossy data compression

Efficient and optimal extraction and compression of information in real-time can enable or significantly accelerate discovery

Usability and accessibility (OS/software interface) is as key to successful operation as hardware technology and architecture

Mission

Develop and operate readout and control systems to support the lab's experiments to achieve its scientific mission

- Currently supporting energy, intensity, neutrino, cosmic experiments as well as accelerators

Identify and develop technologies synergistic with our capabilities and science that can further advance the broader scientific community and even beyond

- Including emerging opportunity areas such as quantum, microelectronics, and AI

Division vision

Continue exciting and successful program of activities

Enable effective communication and coordination within our division, across the divisions in our directorate, and to other directorates/divisions

- Our work is highly interdisciplinary
- Spans a portfolio of small projects and large projects
- For emerging lab-wide and DOE-wide initiatives

Have fun!

Next steps

I have started reaching out to folks and hope to meet with everyone by zoom or in person within the next week or so

- Reach out if you haven't heard from me! (email or slack)

My thoughts on how we interact within the division and across the division are preliminary and evolving - your input helps!

- We are currently 33 people

A note on the AI Office and strategy

You may notice I'm wearing two hats; I consider them somewhat complementary

- AI office as conceived in 2019 will continue largely in the same capacity

Early part of the lab AI strategy was to identify areas where we could significantly contribute to the AI landscape

- The ASCR/LCF labs have significant advantage in large scale HPC
  - Not to say that we can't play an important role (e.g. HTC)
- One unique area of strength we have is 'edge', near-sensor compute
  - RTPS can/is/will play an important role in the development of these technologies
    - For science and beyond
  - Can complement other applications and AI strengths at lab