CPAD RDC 5: Trigger and DAQ Kick Off Meeting

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CPAD RDC Introduction

- The Coordinating Panel for Advanced Detectors (CPAD)
  - to promote, coordinate and assist in the research and development of instrumentation and detectors for high energy physics experiments.
  - https://cpad-dpf.org/
- US R&D Collaborations (RDCs)
  - These Collaborations will be created covering major technology areas in line with the 2019 BRN. The goal is to bring together the community in a more persistent way than the annual CPAD workshops alone, to coordinate R&D efforts and to forge collaboration.
  - https://cpad-dpf.org/?page_id=1549
- Overall RDC kick off meeting on July 5
  - Presentation with detailed information by the CPAD chairs
  - https://indico.fnal.gov/event/60315/

RDCs

RDC#	TOPIC	COORDINATORS	MAILING LIST
1	Noble Element Detectors	Jonathan Asaadi, Carmen Carmona	cpad_rdc1@fnal.gov
2	Photodetectors	Shiva Abbaszadeh, Flavio Cavanna	cpad_rdc2@fnal.gov
3	Solid State Tracking	Anthony Affolder, Sally Seidel	cpad_rdc3@fnal.gov
4	Readout and ASICs	Angelo Dragone, Mitch Newcomer	cpad_rdc4@fnal.gov
5	Trigger and DAQ	Zeynep Demiragli, Jinlong Zhang	cpad_rdc5@fnal.gov
6	Gaseous Detectors	Prakhar Garg, Sven Vahsen	cpad_rdc6@fnal.gov
7	Low-Background Detectors	Guillermo Fernandez-Moroni, Noah Kurinsky	cpad_rdc7@fnal.gov
8	Quantum and Superconducting Sensors	Rakshya Khatiwada, Aritoki Suzuki	cpad_rdc8@fnal.gov
9	Calorimetry	Marina Artuso, Minfang Yeh	cpad_rdc9@fnal.gov
10	Detector Mechanics	Eric Anderssen, Andreas Jung	cpad_rdc10@fnal.gov
11	Fast Timing	Gabriele Giacomini, Matt Wetstein	cpad_rdc11@fnal.gov

- We will use the mailing list to communicate. Please sign up
  - cpad_rdc5@fnal.gov
- Please spread words to our community

What will the RDCs do and not do

Long term goal:

- Provide a collaboration which can link together facilities, expertise, people, and experience to tackle technology challenges across HEP/NP
- Facilitate new funding mechanisms for R&D related to a specific technology area which will take place as part of the collaborations' activities
- Work with the CPAD executive committee, ECFA DRDs, and the broader R&D community to foster a collaborative, supportive, and coordinated environment for new ideas, blue sky efforts, and non-project specific R&D

The RDC's will NOT:

- **Discourage single/small team efforts in R&D**
  - We still need for individual PI's to be able to work in their labs on their favorite ideas and leave room for innovation and unexpected solutions
- **Break up existing collaborations / structures**
  - We already have communities within HEP/NP which coordinate on specific technological challenges (e.g. HEP-IC) and we want to utilize/leverage these efforts and communities to help make the CPAD-RDC's successful
- **Discourage project specific R&D**
  - There is some R&D which will/has reach(ed) a level of maturity that it is time to realize it for a specific implementation and the RDCs should encourage this transition from generic to specific R&D

Comments on Funding

Some comments on funding

- **CPAD and the DOE (e.g. Helmut) recognize that realizing these collaborations will require funding**
  - This is the "carrot" which will help attract the community to participate and engage
- **However, the timing for all this isn't ideal**
  - P5 is still in process and won't release its recommendations until later in the year
  - The European effort (ECFA DRDs) is proceeding NOW with the aim to have things kick off in 2024
  - The DOE budget exercise for 2024 is already in progress, so no new funding mechanisms can show up before 2025
  - ***But, we can't wait for the perfect time…we have to start now***
- **We hope to target some small number (2-3) test cases for collaboration proposals we might consider putting together for this fall**
  - FOA anticipated Oct 2023
  - Great opportunity for some 3 year, university-led efforts

- **This means we need to get the organization and structure for the RDCs in place over the next few months**

The Big Picture

- ECFA Detector Research and Development collaboration (DRDs)
  - The implementation of ECFA Detector R&D Roadmap (2021) is to organize long-term R&D efforts into newly established Detector R&D (DRD) Collaborations
  - The TDAQ relevant DRD is DRD7: Electronics and On-detector Processing
  - US community has been actively engaging DRD 7 activities
  - We need work with other RDCs, particularly RDC4, for the coherent US involvement
- Generic vs Targeted
  - RDC work packages and proposal(s) will focus on generic items
  - To communicate and work with the relevant teams to ensure the appropriate coverage of the targeted R&D items (US-FCC, US-μC, etc)
- National initiatives
  - Utilize effectively the national initiatives relevant to HEP instrumentation, such as microelectronics, AI, etc

RDC 5 Next Steps

- First meeting (09/29)
  - To discuss key R&D areas and survey questions
- Circulate Survey (early Oct)
  - To identify and organize subgroups/subareas through survey
  - To understand relevant teams, existing activities, facilities/infrastructures
- Second meeting (late Oct)
  - To formulate and discuss work packages
- CPAD workshop at SLAC (Nov 7-10)
  - https://indico.slac.stanford.edu/event/8288/registrations/539/
  - Present RDC 5 status at CPAD
  - In-person discussion to advance our preparation for proposal(s)

TDAQ R&D Goals (Snowmass IF)

- Pursue innovations in the application of Machine Learning (ML) to TDAQ systems, particularly in the co-design of hardware and software to apply ML algorithms to real-time hardware and in other novel uses to improve the operational efficiency and sensitivity to new physics of future experiments;
- Invest in the design of TDAQ system architectures that leverage new technologies, techniques, and partnerships to enable more intelligent aggregation, reduction, and streaming of data from detectors to higher-level trigger systems and offline data processing;
- Develop improved readout technologies that increase data bandwidth and are capable of operating in extreme environments, while fitting the material and power constraints of future experiments.

TDAQ PRDs in the BRN Report

- 3 PRDs, with 8 thrusts total
  - PRD 21: Achieve on-detector real-time, continuous data processing and transmission to reach the exascale
    - Thrust 1: High-bandwidth, rad-hard, low-power data links
    - Thrust 2: Real-time processing hardware
    - Thrust 3: Online data processing on heterogeneous hardware
    - Thrust 4: Fast artificial intelligence and neuromorphic computing on real-time hardware
    - Thrust 5: Advanced feature extraction for trigger
  - PRD 22: Develop technologies for autonomous detector systems
    - Thrust 1: Autonomous operations
    - Thrust 2: Self-calibration and alignment
  - PRD 23: Develop timing distribution with picosecond synchronization
    - Thrust 1: Develop timing distribution with picosecond synchronization

Ideas for Work Packages

- PRD 21
  - Real-time / low-latency data reduction and feature extraction
  - Fast artificial intelligence and neuromorphic computing on real-time hardware
  - High-bandwidth, rad-hard, low-power optical link (>50Gbps)
  - Wireless readout
- PRD 22
  - Intergrading modern computing architecture and emerging technologies
  - Self-running DAQ system
- PRD 23
  - Timing distribution with picosecond synchronization (1ps over 1 km)