

# 2023 CPAD Workshop Summary and Closeout



# Overall Workshop Stats

246 in person  
participants

33 remote

54 students

33 parallel sessions with  
191 presentation

20 plenary presentations

29 posters



# RDC1: Noble Element Detectors

- 5 sessions (3 RDC1, 1 joint RDC1/RDC2/RDC7, 1 joint RDC1/RDC4), 24 presentations + 5 posters
- List of work packages already identified. Based on DRD2, but more packages added to adapt to US groups:
  - Heat Readout: Phonon Sensors
  - Charge Readout: Pixels; Charge+Light; Charge-to-light (EL and Amp.); Ion Detection (EL and Amp.)
  - Light Readout: Increased sensor Q.E./P.D.E; Wavelength Shifters/Expanded Wavelength; Increase Collection
  - Target Properties: Properties and Isotope and chemical; Chemical Purity; Target Response and Modeling; Low Energy / Spurious Signals
  - Scaling-Up Challenges: Radiopurity & Background Mitigation; Detector and Target Procurement/production; Large Area Readouts; Material Properties; In-situ Calibrations; High Voltage; Infrastructure
  - New Initiatives/Novel Architectures: Solid Nobles; Phase Changing Detectors
  - Cross RDC: Data Volume
  - Facility Coordination
- We will plan regular meetings

# RDC2: Photodetectors

- 3 sessions (2 RDC2, 1 joint RDC1/RDC2/RDC7) 20 oral and 9 poster
- List of work packages already identified:
  - **Innovative photosensor breakthrough:**
    - Blue skies research aiming to advance single photon detection, VUV sensitive, tunable spectral sensitivity, high granularity and fast timing, radiation tolerance and large area capability.
  - **Large Area Photodetector Systems and Scalability:**
    - Project-specific Research and Development (R&D) for Large Area Photodetector Systems, integrating photo-sensors with advanced readout technologies. Photodetector integration and deployment (overlap with RDC1, 4, 5, 10, 11)
- Planned quarterly meetings
  - Started a shared google drive to coordinate different universities lab capabilities, facilities to identify existing and potential areas for collaboration:  
[https://docs.google.com/presentation/d/1\\_5JCRbVtqJJkyK7p3A7z6Z8cLZ3TKLIokTJd\\_7cvs-M/edit?usp=sharing](https://docs.google.com/presentation/d/1_5JCRbVtqJJkyK7p3A7z6Z8cLZ3TKLIokTJd_7cvs-M/edit?usp=sharing)
  - Will send out survey to identify potential topics for virtual workshop

# RDC3: Solid State Tracking

- 3 sessions (1 RDC3, 1 joint RDC3/RDC4, 1 joint RDC3/RDC11), 17 presentations+ 1 poster
- List of work packages already identified
  - First suggested work packages based on BRN/Snowmass will need refinement based on community inputs in the near future:
    - Topic Area #1: Adapting non-silicon and novel-configuration sensors
    - Topic Area #2: Scalable, low-mass detector systems
    - Topic Area #3: Trackers for Lepton Colliders
    - Topic Area #4: Trackers for Hadronic Colliders
    - Topic Area #5: Advanced modeling
- Planned regular meetings or workshops
  - Plan general quarterly meetings across the whole workpackage
  - Additional ad-hoc meetings will be necessary to define and follow cross RDC work packages
- Next steps to get towards September 2024 FOA
  - At least 2 “Blue Skies” joint university-national lab partnerships presented
  - Larger cross RDC work package possible based on MAPs and LGAD technologies based on the critical mass of presentation (see next slide)

# RDC3/RDC4/RDC10/RDC11 Tracking Work Packages

## Common Projects:

- In the short term, we need special meeting in order to define tracking work package across RDCs
  - Do we have central proposals and a set of proposals?
  - Need roadmap technical milestones which are iterative and allow parallel development paths
- Understand the interaction with ECFA DRD3/DRD7 based on the understanding of what the US want to do
  - Do we work collaboratively, in competitions, or divide up needed developments?

## MAPs-based trackers

- Do we target general e+e- where most of current activity is OR by even more inclusive (muons/hh/blue sky ideas)?
  - What are the sensor sizes, scale of tracker?
  - What are generic specifications? Are there particular options we need to consider (like power-pulsing for LCs)?
- Do we want to include all system aspects or pick specific elements: some potential items brought up in presentations include pixel matrix, data/command systems, power management, services, mechanics

## LGAD-based trackers

- Is there a common general target we can work towards?
- How to we coordinate the ASIC, sensor and system elements?
- Is there common system aspects we want to address as a community?

# RDC4: Readout and ASICs

Angelo Dragone  
Mitch Newcomer

- **57 abstracts, 27 cross RDC abstracts** 4 Sessions, 4 combined sessions
- WP structure will consist of a portfolio of thrusts under an overarching theme. Members will share knowledge and build on shared results to define blue sky goals. Each work package will have a workforce training component.
- WP's yet to be finalized the ones below indicate thrust.(we will need to interface with DRD7 and understand which projects are collaborations and which are independent thrusts)
  - **Front End Control/ Readout techniques** TBD & likely merged with other RD's Calo Tracking Photon systems
  - **Tracking Readouts Feature Extraction for AC strip interpolation** 4D Maps
  - **Calorimetry readout...** 5D detectors SiPM on tile eFPGA or SMART processing on detector
  - **Fast Timing readout...** Clock/Calib distribution on detector through to ASIC front end
  - **HEP relevant Extreme environment models and digital libraries for ASICs**
  - **Sub 65nm and smaller SOC universal building blocks design/develop/submit/test/document for future chips**
  - **High Rate Data Management ( Big Data)**
    - Aggregation of on Detector Data
    - Data Driven routing
    - Rate/Power optimized Drivers / Receivers
  - **Workforce Training & Support -> Contribute input to a more horizontal service under a different umbrella.**
    - Mentored ASIC Project led by trainees
    - Instrumentation Specific Certificates/degree programs at Universities
  - **Intelligent Data processing (ASICs and Electronics)**
    - eFPGA
    - AI/ML
    - Edge Computing
  - **System Interfaces**
    - Interconnect technologies
  - **Powering / Management < may distributed into Front End Readout specific Topics**
  - Future ... System / Sub-system Aware Design/verification/project organization
- We will keep collecting input from the community until November 30th
- Planned regular meetings or workshops follow up with RDC 1, 9, 3, 11
  - Intention agreed Schedule TBD
- Next steps to get towards September 2024 FOA - Organize projects under Work Package Topics

# RDC5: Trigger and DAQ

- 11 abstracts, 2 sessions
- Work packages being discussed
  - Intelligent data reduction and processing (with RDC4)
    - Real-time / low-latency data reduction and feature extraction
    - Fast artificial intelligence and neuromorphic computing on real-time hardware
  - Link technology (with RDC4)
    - High-bandwidth, rad-hard, low-power optical link (>50Gbps)
    - Wireless readout
  - Integrating modern computing architecture and emerging technologies
  - Self-running DAQ system
  - Timing distribution with picosecond synchronization (1ps over 1 km) (with RDC4)
- Regular meetings being planned to further develop the work packages
- Aim consortium proposal(s) to respond September 2024 FOA



# RDC6: Gaseous Detectors

- 13 abstracts, 2 parallel sessions, 1 awards talk
- We plan to not replicated the large DRD1 structure in the US.
- Rather, we want to prepare work packages where US groups have specific expertise and strong interest, and then integrate these packages into the DRD1 plans.
- There are some obvious synergies between RDC6 groups working in different fields. For example, highly segmented MPGD-based charge readout schemes are foreseen at DUNE near detector, rare event searches, and at future collider detectors in HEP and NP.
- While specific work packages need proper discussion by the whole RDC6, preliminary ideas floated include:
  1. “Advancing gaseous TPC readout to the fundamental sensitivity limit”
  2. “Improved MPGD structures for nuclear physics and challenging environments”  
(for gases w/o quencher, negative ion drift, high charge density)
  3. “Achieving cost-effective scaling of gaseous TPCs”
- We will organize meetings to converge on 2-3 highest-priority work packages.
- Meetings will (only) be announced to the RDC6 mailing list. Sign up now! [https://cpad-dpf.org/?page\\_id=1549](https://cpad-dpf.org/?page_id=1549)

# RDC7: Low-Background Detectors

- 26 abstracts w/ 23 presentations and 2 posters across 2 (+2 joint) sessions
- Infrequently-held meetings on Tuesdays at noon EST
  - Get on RDC7 mailing list to know when one is happening
- Work with RDCs 1/2/8 to distill suggestions into a viable number of WPs and collaborations to move forward
  - Clearly need to break up WP7 into smaller pieces, some of which may get absorbed into RDC8
  - Some identified WP's are under-represented at CPAD2023

| WP | Topic                                | Overlap | Talks | Poll |
|----|--------------------------------------|---------|-------|------|
| 1  | Ultra-Pure Material Production       |         | 0     | 6    |
| 2  | GEANT4/G4CMP Development             |         | 1     | 4    |
| 3  | Radioassay Facilities and Techniques |         | 1.5   | 5    |
| 4  | Noble Element Purification           | RDC1    | 1.5   | 4    |
| 5  | Phenomenology of Materials           |         | 3.5   | 2    |
| 6  | Low-Threshold Calibration Techniques |         | 4     | 4    |
| 7  | Low-Background Device Fabrication    | RDC8    | 9.5   | 9    |
| 8  | Supporting Technologies              |         | 1     | 10   |
| 9  | Radon-Mitigation Strategies          |         | 1     | 5    |

# RDC8: Quantum and Superconducting Sensors

- Wide range of interests
  - 30 abstracts, 6 sessions, 1 joint sessions with RDC 7
  - 5 subgroup talks w/ discussions, 2 round table discussions, 24 contributed talks
- Planned meetings: ~(bi)monthly meetings to discuss work packages
  - Mailing list + Slack (?) communication
  - Second survey (collaborate with RDC7?) to gather more information
- Workshops (to be confirmed through second survey)
  - Best practices for cryostat setup → handbook → summer school?
  - Amplifiers: How to meet demand by the community. Spec, supply, test facility
  - Simulation packages: Share how packages such as G4CMP, COMSOL, HFSS are used
- Work packages
  - Review BRN. Update with the latest developments and inputs
  - Set milestones → map work package ideas on to it
  - Collect ideas through discussions and surveys

# RDC9: Calorimetry

- 24 abstracts, 2 sessions, and 1 round table discussion
- List of work packages already identified
  - New materials for calorimetry: Scale-up material (liquid scintillators and water-based liquid scintillators) and Inorganic crystals/glass that are bright, fast, rad hard, dense-UV transparent, and cost-effective
  - Optical coupling and light extraction (WLS)
  - Photon detectors
  - Front-end electronics needs for high energy resolution and picosec timing calorimetry
  - System aspects (mechanical for low mass support & cooling; (electronics) for powering scheme & interconnections; (data processing) for intelligent calorimeter
  - Concepts from the above lines of investigation adapted to hadron identification (TOF, RICH...)
- Infrastructure needs to support our work: improvement of simulation packages with respect to GEANT; Test beam for near-future; and early career support.
- Planned regular meetings or workshops: continue monthly community meeting and cross-RDCs conversations
- Next steps to get towards September 2024 FOA
  - Identify R&D drivers; open for community inputs/comments; final report posted in August

# RDC10: Detector Mechanics

- 11 abstracts, 6 Presentations, 3 Joint, +3 Posters, 2 sessions
- List of work packages already identified
  - Will solicit work packages in community survey.
  - Likely to include 'Ultra-low mass support', Cooling, Services--intend to grow
- Planned regular meetings or workshops
  - Kick-off meeting in January with initial monthly/bi-monthly meetings to establish and build a community
  - Occasional joint meetings with other RDC or RDC WP with similar cross-cutting needs.
  - DRD Kickoff in December (shared interests at CERN), and FTDM in May 2024 at Purdue
- Next steps to get towards September 2024 FOA
  - Circulate community survey in coming days
  - Identify cross-cut work-packages identified in other RDC's
  - Grow and diversify mechanics community to reach beyond typical Tracking detector mechanics subjects relevant to other RDC's e.g. cryo, materials

# RDC11: Fast Timing

- One session pure RDC11 (4 talks), two 3/4/11 sessions: one with 7 talks about LGADs, one with 5 talks on MAPS. Other talks could fit.
- Work packages:
  - Clock distribution and sync
  - LGADs
  - LAPPD
  - TOF/PID techniques
  - Non-silicon/new materials fast sensors
  - MAPS (3D, monolithic LGADs)
  - ASICs (fast digitizer, ...)
- Online meetings every second month + one in person - next meeting in early December (TBA next week)
- Next steps to get towards September 2024 FOA:
  - Coordination with other RDCs
  - Collect inputs from parties

# Transversal Forum on Training and Workforce

- Discussions throughout this week indicated it might be useful to create a transversal forum dedicated to training and workforce development
- Mandate could include:
  - Assisting the RDCs with including training aspects in their work packages and in funding proposals
  - Organization of instrumentation schools, perhaps adjacent to CPAD workshop? Or enhancement of existing school
  - Increased training collaborations funded through DOE Traineeship funds
  - Assist with networking between institutes participating in RDCs to match students and supervisors at labs
  - Etc.
- Need to find volunteers who want to take this on

# Workshop Banquet





# Thanks to the Local Organizing Team for a great Workshop!

Contact [cpad2023@slac.stanford.edu](mailto:cpad2023@slac.stanford.edu) and we will help!

## LOC Contacts:

- Noah Kurinsky
- Sander Breuer
- Lorenzo Rota
- Caterina Vernieri
- Kelly Stifter
- Chelsea Bartram

THANK YOU TO OUR INDUSTRY PARTNERS:



**ROHDE & SCHWARZ**

Thanks to our admins for making this happen: Jack Heyer, Samantha Thurman, Martha Siegel, Maria Herraes, and Glenna Paige

# CPAD 2024 Knoxville, Tennessee



THE UNIVERSITY OF  
TENNESSEE  
KNOXVILLE

 **OAK RIDGE**  
National Laboratory



# CPAD 2024 in Knoxville, Tennessee

At University of Tennessee Knoxville (UTK)

- In beautiful downtown Knoxville
- Right next to the Great Smokie Mountains

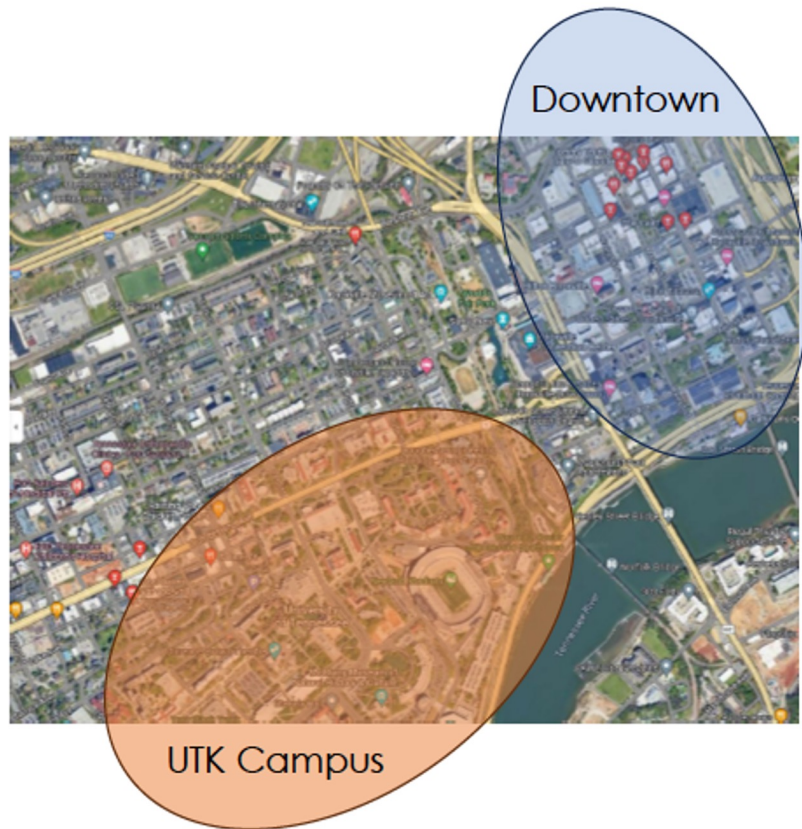
Around November to December 2024 (tbc)

- Dodging the college football schedule...

Co-hosted by UTK and ORNL:

- Tova Holmes (UTK)
- Lawrence Lee (UTK)
- Mathieu Benoit (ORNL)
- Friederike Bock (ORNL)
- Marcel Demarteau (ORNL)
- Oskar Hartbrich (ORNL)

**Hope to see you there!**



*Thanks for your participation  
and have a safe trip home!*