

RDC9 Calorimetry @ CPAD

A snapshot of the community effort to answer the needs of current experiments & the ones planned for the next decade and beyond

Our program in a snapshot

- ❑ 16 contributions (and interesting posters) spanning HL-LHC, future high-luminosity colliders, neutrino experiments, as well as heavy-ion experiments
- ❑ A round table where we will discuss pathways to collaborative efforts toward addressing the basic research needs of future experiments

A lens to guide our discussion: our aspirations for the future

RDC9: Calorimetry

- **RDC9-WP1: Broad R&D on new materials**

The calorimeters of the future will require materials with properties optimized for energy, spatial, or time resolution, sometimes requiring optimization of a combination of these properties. The development of materials optimized for specific applications can exploit the progress of material science.

- **RDC9-WP2: Broad R&D on calorimetry with ps timing**

This initiative involves not only the study of ultrafast materials, but also photosensors and signal processors capable of delivering the desired performance.

- **RDC9-WP3: Large-scale system challenge**

The large-scale/small-feature-size detectors of the future include several challenges to maintain the performance at the single detector unit: large data rates to be processed in a fast and efficient manner, low mass interconnections and support, power distribution, and heat management.

- **RDC9-WP4: Scalable calorimetry optimized for large volumes and low cost**

Some applications, for example, future neutrino experiments, require large volumes of sensing material. The development of basic building blocks based on inexpensive materials that can be produced in large quantities provides a path to systematically improvable systems.



Some food for
thought while
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instersting
results
presented

Tasks for WP1 – Broad R&D on new materials

1. New materials for calorimetry, and how they can be tailored to a specific application (including prospects from nanotechnology); **develop industrial partners**

- a. Scale-up material (liquid scintillators)
- b. Inorganic scintillators
 - Bright, fast, rad hard
 - Ultrafast inorganic (quantum dots may help to break the ps timing barrier) [also medical industry] LuO:Yb can be o
 - Dense-UV transparent, cost-effective heavy inorganic scintillator [water-based liquid scintillator] (HHCAL)
- c. Maps for cost-effective large scale structures

2. Wavelength shifters to match scintillator (quantum dots, pTP, flavenols)

3. Photon detectors: SiPM

Tasks for WP2- Calorimetry with ps timing

- ❑ Ultrafast inorganic scintillators
- ❑ Ultrafast-Si-based calorimetry with fast TDCs/waveform sampling

Tasks for WP3-large scale system challenge

- ❑ Integration of high-granularity large system (eg. Digital calorimeters) - electronics and mechanics infrastructure
- ❑ Calorimeters with embedded electronics
- ❑ 5D-Calorimeter Design with Online and Offline AI/ML: integration of ML techniques in the design of the detector structure and integration with the tracking system, as well as development of optimized strategies for reconstruction and calibrations

Tasks for WP4: Scalable calorimeters for large volumes and low cost

- Modular design constructed with building block
- Low mass-low cost signal transmission/ mechanical and electrical infrastructure
- Optimization of the appropriate cooling system

Synergies with other 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 | Daniel Baxter, 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 |

Structure of our parallel sessions

This session

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| Opening remarks <i>Marina Artuso et al.</i> |
| Latest result from the BN... <i>Adam Baldoni</i> |
| Development and perform... <i>Praveen Ku...</i> |
| Water results from Eos <i>Tanner Kapt...</i> |
| WbLS results from Eos <i>Leon Pickard</i> |
| Gamma Ray Detection in  <i>Thomas Mur...</i> |
| Simulation and Design of  <i>Thomas Mur...</i> |

This afternoon at 4PM

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| A novel AmBe neutron so... <i>Ryan Wang</i> |
| Development of the FEB2 ... <i>Brian Kirby</i> |
| Operation and performan... <i>Gabriel Pinh...</i> |
| Simulation of the CalVisio  <i>Jon Wilson</i> |
| Cosmic Ray Muon Detecti... <i>Yongbin Feng</i> |
| Performance of High Gran... <i>Weijie Jin</i> |

Tomorrow at 11 AM

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| Results of Dual Readout s... <i>Grace Cum...</i> |
| Developing Digital Silicon... <i>Liangyu Wu</i> |
| The RADiCAL Platform: A... <i>James Willia...</i> |
| LFHCal for ePIC Detector ... <i>Prakhar Garg</i> |
| Round table discussion <i>Marina Artuso et al.</i> <i>Regent</i> 12:00 - 12:30 |

Note discussion to develop collaborative proposals

Conclusions

- ❑ We are excited to hear your accomplishments and chart our path towards the next chapter of calorimetry in experimental particle physics
- ❑ We are interested in forging a path towards applications outside the realm of HEP
- ❑ Looking forward to an excellent workshop!