

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

The topics that we would like to discuss today

- ❑ Can we identify lines of investigations that we can pursue in the generic R&D framework that is inherent to our structure?
- ❑ Related to this: in the changing scientific landscape where we are operating, we need to revisit the basic research needs in calorimetry, ideas and thoughts?
- ❑ Can we leverage the interest in AI to pursue meaningful lines of investigation (e.g. intelligent calorimeters, codesigns including AI-aware hardware)

A quick reminder of our broad goals

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.

Do we have a
community that
can support all
these goals?

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
- ❑ Aggregation and filtering of large data sets: distributed intelligence
- ❑ 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	Area	Conveners	Institution
RDC1	Noble Element Detectors	Jonathan Asaadi; Carmen Carmona	UT Arlington; Penn State
RDC2	Photodetectors	Shiva Abbaszadeh; Flavio Cavanna	UC Santa Cruz; Fermilab
RDC3	Solid-State Tracking	Douglas Berry; Sally Seidel	Fermilab; University of New Mexico
RDC4	Readout and ASICs	Lorenzo Rota; Mitch Newcomer	SLAC; UPenn
RDC5	Trigger and DAQ	Zeynep Demiragli; Alexander Paramonov	Boston University; Argonne
RDC6	Gaseous Detectors	Bob Azmoun; Sven Vahsen	BNL; University of Hawai'i
RDC7	Low-Background Detectors	Daniel Baxter; Laura di Vacri	Fermilab; PNNL
RDC8	Quantum & Superconducting Sensors	Rakshya Khatiwada; Caleb Fink	Illinois Tech; Syracuse
RDC9	Calorimetry	Marina Artuso; Minfang Yeh	Syracuse; BNL
RDC10	Detector Mechanics	Eric Anderssen; Andy Jung	LBNL; Purdue
RDC11	Fast Timing	Roger Rusack; Matt Wetstein	University of Minnesota; Iowa State