

DRD8: R&D on Mechanics & Cooling of Future Vertex and Tracking Systems

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Discussions at the FTDM 2023

- In the context of implementing the ECFA R&D strategy, DRD collaborations have been suggested for the various Task Forces.
- At the FTDM 2023 in Tübingen we discussed about an DRD collaboration on Detector Mechanics and Cooling.

Our conclusions:

- We agreed to launch another survey between the participants of the FTDM during the last 5 years.

A. No: 7 (30.43%)

(Individuals)

B. Institute: 3 (13.04%)

C. Group: 13 (56.52%)



- **The outcome has been rather positive**

Community Meeting and Lol

- Based on the outcome of the 2nd survey we organized a Community Meeting on December 6, with the following goals:
 - Presentation of institutes on intended contributions to the R&D on Tracking Detector Mechanics and Cooling, including possible contributions in terms of resources.
 - Discuss about the way forward, keeping in mind what is done in other DRDs already.
- **We agreed to go ahead and to prepare a Letter of Intent, which has been submitted for the 2nd DRDC on March 4, 2024.**
 - 22 institutes from 7 countries agreed to participate to the effort, others expressed interest since
 - They intent to contribute to the four suggested Working Groups with an aggregated yearly effort of about 32 FTEs
 - Some institutes expressed interest to join the effort but are unable to make a commitment at the present time due to their strong involvement in other projects.
 - The proposed R&D collaboration will be open to new participants and projects and will continue to evolve in the long term.

What we intent to do

- The Lol proposes 4 Working Groups (WGs):

	FTEs
• WG 8.1: Global/System Design and Integration	5.3
• WG 8.2: Low Mass Mechanics and thermal management:	16.0
• WG 8.3: Detector Cooling	7.3
• WG8.4 Design and Qualification Tools	3.8
- The interest to contribute is largest for WG 8.2 and 8.3
- Mailing lists have been created for the 4 WGs:
 - WG 8.1: [DRD8-WG1 mailing list](#)
 - WG 8.2: [DRD8-WG2 mailing list](#)
 - WG 8.3: [DRD8-WG3 mailing list](#)
 - WG 8.4: [DRD8-WG4 mailing list](#)
- Please, subscribe, if you haven't done so yet and if you are interested to contribute! Subscribe also to: [DRD8-all](#).

Proposed Working Group Structure

WG 8.1: Global/System Design and Integration:

- Mechanics for advanced layouts, including curved and tilted sensors, low radii vertex systems and retractable detectors;
 - Service integration;
 - Environmental and structural health monitoring;
 - Life-Cycle design of trackers;
 - Fostering links with the accelerator community to understand the Machine Detector Interface (MDI) for future colliders;
 - Robotics and remote operation, maintenance and handling;
 - Scalability and industrialisation.
- **We have asked Corrado Gargiulo and Fabrizio Palla to act for time being as conveners for this WG**
- **Corrado will present details about the R&D topics in the following presentation.**

Proposed Working Group Structure

WG 8.2: Low Mass Mechanics and thermal management:

- Novel materials for structural and thermal management applications, including qualification for operation in harsh environments;
 - Advanced manufacturing techniques, including additive manufacturing;
 - Support structures with integrated cooling circuits, including silicon or ceramic substrates with embedded microchannels, composite substrates with embedded pipe-less networks and cold plates with thin-walled pipes;
 - Modular, scalable designs for detectors with large surface areas;
 - Vacuum-tight composite structures.
- **We have asked Sushrut Karmarka and Adam Lowe to act for time being as conveners for this WG**
 - **Sushrut will present details about the R&D topics in the following presentation.**
 - **The topic of microchannel cooling might move to WG 8.3**

Proposed Working Group Structure

WG 8.3: Detector Cooling:

- Evaporative and liquid cooling for both low and warm temperatures, based on natural or eco-friendly refrigerants and new cycles;
- Gas cooling solutions for detectors, including flow design and heat transfer through porous media;
- Connection technologies for cooling circuits, including leak repair methods;
- Instrumentation, including flow measurements for gases and liquids.
- **We have asked Bart Verlaat and Oscar Augusto to act for time being as conveners for this WG**
- **Bart will present details about the R&D topics in the following presentation.**
- **The topic of microchannel cooling could be included here.**

Proposed Working Group Structure

WG8.4 Design and Qualification Tools:

- Open-source software and high-performance parallel computing numerical simulation tools for structures and fluids;
 - Machine learning enhanced topology optimisation;
 - Virtual reality aided design;
 - Methods for using 3D design of complex service geometries and linking of schematics and 3D models;
 - Connection of CAD tools and GEANT.
- **We have asked Joao Batista to present some details on the R&D topics of this WG.**
- **It would be important that the institutes which expressed interest in the R&D topics of this WG get involved.**
- **This WG is very weak at present.**

Demonstrators

The Lol mentions also **targeted and collaborative R&D work** which includes (besides mechanics and cooling) sensors, front-end electronics, and electrical and readout services, for two application frameworks

1. **Low intensity (LI):** In this framework the mechanics and cooling will support sensors and electronics that have been designed for low power densities. The number and cross-section of electrical services will be small. Radiation damage levels will be low, and thus there will be no need to operate these systems cold ($< 15\text{ }^{\circ}\text{C}$). Where possible, gas cooling will be an appealing solution. Radiation hardness levels of materials will be moderate.
2. **High intensity (HI):** Detector systems within this framework will have to cope with large fluxes of signal and background particles. The high channel density and complexity of the front-end electronics will result in high power densities, which will need to be supplied by advanced powering systems. For the removal of the dissipated power further developments of evaporative cooling systems will be needed. Significant radiation damage will require cold ($< -35\text{ }^{\circ}\text{C}$) operation to keep leakage currents under control. Materials will need to be qualified for the high radiation environment.

➤ **We should discuss about this topic further after the presentations of the WGs**

Timeline for the next steps

- To have the DRD8 Proposal ready for submission in autumn, we need a team of people drafting the contents of the proposed R&D for each WG.
 - **This could be naturally the WG conveners, supported by 1-2 members of the Steering Committee for each WG.**
 - **We should finalize the nominate WG conveners asap, ideally 2 per WG.**
- We certainly need at least one more meeting in autumn before submission of the Proposal.
- Details to be discussed after the WG presentations