Organisation of the DRD7 collaboration

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Purpose

DRD7 is a proposed R&D collaboration with the following objectives:

- Advance the state-of-the-art in performance and deliverability of detector electronics and data processing
- Build expertise, improve and develop further common standards, methodologies, and IP for implementation of electronic and data processing systems
- Increase efficiency and decrease duplication of effort in detector electronics development
- Provide facilities and tools for R&D in the community, with long-term continuity.

It will carry out the following activities:

- Oversee and coordinate strategic R&D in electronics for particle physics
- Support and maintain an active and well-connected R&D community
- Promote and maintain a connection between the developers and users of future electronic systems
- Coordinate cross-European access to technologies, tools, and knowledge
- Interface with other DRDs in areas of common interest, including joint projects

Structure and organisation

DRD7 will be a collaboration of **institutes**, organised as a number of **working groups** (defined in Appendix 1)**,** collectively pursuing a clearly identified set of approved **projects**, each addressing one or more of the agreed **R&D themes** expressed in the Detector R&D Roadmap. The collaboration will not own or manage the associated resources provided by funding agencies and laboratories; these will be allocated to and managed by the projects[1]. Rather, the collaboration will collectively:

- Organise the review of projects for inclusion in the DRD7 work plan, and propose rationalisation, combination, or re-scoping of projects where necessary
- Maintain an overview of the progress of R&D, and represent the electronics community to the DRDC and other bodies
- Contribute to the review of cross-DRD R&D projects, avoiding duplication or gaps, and carry out review of electronics developments in other DRDs as required

[1] An exception may be necessary in the Tools and Technologies theme, where common resources allocated under a Memorandum of Understanding between laboratories may be necessary to allow the necessary contracts and support services.

- Support and assist delivery of projects by coordinating access to tools, knowledge and intellectual property (IP)

DRD7 will be a formally-constituted collaboration with a well-defined membership. However, it will seek to minimise management and administration overhead, carrying out a 'light-touch' organising role. The collaboration will be managed by a **steering committee** representing the principal participating countries in the collaboration. A **technical committee** – appointed by the steering committee – will include expert **convenors** leading each working group, with the task of interfacing to and between projects. The participating institutes will be directly represented in a **collaboration board** that will meet at least annually as part of a regular series of DRD7 workshops. This body will approve inclusion of new projects or institutes, and approve all other major decisions.

Participating institutes will sign a Memorandum of Agreement, indicating their willingness to conform to appropriate collaborative practices, including adoption of an open development philosophy. Institutes with access to the necessary resources will be active participants in one or more projects. DRD7 will welcome participation in workshops and discussions by new institutes actively seeking future involvement in projects, and will be open to new R&D project proposals throughout its lifetime.

R&D Projects

R&D projects will:

- Address novel, ambitious, and transformative topics (consistent with the priorities of the Detector R&D Roadmap), with an appropriate risk appetite
- Have clearly presented objectives, scope, deliverables, and work plan
- Be pursued by a well-defined set of participating institutes, with clear responsibility assignments and an appropriate leadership and management structure
- Possess adequate resources and skills to conduct the proposed development over the entire project timeline
- Agree to report as required to allow an overview of progress to be maintained

Project deliverables may include: production of concrete hardware or software systems; training and development of expertise; testing and documentation of technology; or generation of publications or reports. All deliverables must be measurable and concrete, and sufficiently well-documented to be visible and of use to the wider community.

The duration of projects may be up to three (TBD) years in the first instance, with sufficient intermediate deliverables to allow progress to be demonstrated. It is assumed that some projects will continue beyond this duration as long-term developments. Projects carried out jointly with other DRD collaborations are encouraged, and the broad principles of the interaction between DRD7 and other DRDs are set down in Appendix 2.

Projects with the following characteristics will have high priority:

- Addressing multiple R&D themes in one development
- Involving multiple institutes, preferably supported by more than one funding agency
- Tackling system-level issues

The steering committee will organise independent, confidential refereeing of projects where appropriate. Once active, projects will provide annual reports, in the form of a contribution to a DRD7 workshop and an annual, public collaboration report. The steering committee will use this information as the basis of reporting to the DRDC.

Setting up the collaboration

Step 1a (March – June 2023): Following the DRD7 workshop, the convenors will seek expressions of interest in specific projects, and work with the relevant institutes to define a few initial priority projects with substantial community interest.

Step 1b (March – June 2023): The technical committee will work with other DRDs to define common plans and technical and organisational interfaces with DRD7, avoiding duplication or omission of work. The DRD7 work plan will therefore respond to the plans of other DRDs.

Step 2 (July 2023): A Letter of Intent will be submitted to the DRDC, indicating the broad scope of DRD7 activity, the internal organisation, and the list of researchers and institutes forming the supporting community.

Step 3 (September 2023): A second DRD7 workshop will be held to hear detailed proposals for the initial projects, and to discuss areas of common interest. This will be open to both LoI signatories and other institutes seeking to join the effort.

Step 4a (September – November 2023): Taking into account feedback from the DRDC, an initial set of projects will be planned and costed in detail.

Step 4b (September – November 2023): Discussions with national funding agencies will take place via the respective national communities, with the aim of defining the likely participation and resource envelope for the initial projects.

Step 5 (December 2023): A DRD7 Collaboration Proposal will be submitted to the DRDC, including resource-loaded plans for the initial projects.

Step 6 (from January 2024): Taking into account feedback from the DRDC, national communities will make proposals to their funding agencies, and projects will begin as resources are allocated.

Annual DRD7 workshops are foreseen from 2024 onwards.

Appendix 1: R&D Working Groups (Preliminary, under review)

Following the DRD7 workshop, a set of R&D Working Groups have been established, covering collectively the scope of the DRDTs expressed in the Roadmap:

WG 7.1: Data density and power efficiency
- High data-rate ASICs and systems
- New link technologies, including silicon photonics technology
- Power efficiency optimisation

WG 7.2: Intelligence on the detector
- Front-end programmability and modular design
- Intelligent power management
- Advanced data reduction techniques

WG 7.3: 4D and 5D techniques
- High-performance sampling
- High-precision timing distribution
- Novel on-chip architectures

WG 7.4: Extreme environments
- Cryogenic technology and operation
- Thermal management of ASICs
- Radiation hardness

WG 7.5: Backend systems and COTS
- Use and adaptation of advanced COTS technologies
- Real-time software and firmware development
- System-level control and readout

WG 7.6: Complex imaging ASICs and technologies
- Common access framework to selected imaging technologies
- Common IP for imaging ASICs
- 3D integration and interconnects

WG 7.7: Tools and technologies
- Access and support to qualified technologies and tools
- Investigation of emerging microelectronics technologies
- Support and training for device and systems development and verification
- Common IP and design reuse

Appendix 2: Interaction with other detector R&D activities

Introduction

It is clear that electronics and data processing are key elements of the activities of all other DRD collaborations, and there will naturally be an interaction with DRD7. In some cases, projects will be best delivered through close cooperation in the design of demonstrators, systems, and test devices. In others, developments will be initiated and pursued internally.

The physical interface between detector and readout is typically a custom ASIC, though electronics considerations affect many other aspects of detector system design including powering, communications, and material budget. In recognition of the challenges related to ASIC development, two working groups in DRD7 (WG 7.6, 7.7) will address common R&D issues related to complex imaging ASICs, and access to new technologies and tools for ASIC design and related developments.

Support and funding model

DRD7 is an R&D collaboration, and will not provide a design or fabrication service for ASICs or other components; this is the role of engineering teams at institutes and laboratories participating in the various DRD projects. Many such teams will also be active in DRD7, in pursuit of greater efficiency through coordinated exploration of new technologies, in order to build expertise and share unique and not commonly available skills, and in order to gain access to common IP and software. This will result in lower cost and risk for all DRDs.

Where common developments across DRDs are agreed, either of IP, or of complete devices or subsystems, DRD7 is available to set up a review and coordination body. DRD7 also presents a natural forum for cross-laboratory coordination of the provision and support of tools and efficient interaction and negotiations with industrial suppliers.

This model implies three separate funding streams, and the importance of adequate support for each to ensure the success of the overall R&D programme must be conveyed to funding agencies.

- Funding for specific electronic developments and prototypes in DRDs should be allocated to the relevant collaborations, with prioritisation decisions made by the collaborations as part of their funding request and review. In case of complex electronics developments (and in particular of ASICs), a review coordinated by DRD7 will be instrumental in lowering the development risk and limiting duplication of effort.
- Funding for DRD7 R&D and coordination activities will be separately requested, including the costs of common tools, the costs of specialised personnel (for instance, verification experts), specific R&D developments at both device and system level, and the technical facilities necessary for R&D.

- Funding for engineering teams at institutes must be maintained, either as a dedicated funding line, or through a charging model linked to specific developments. This will typically be distinct from DRD7 funding, since teams work across disciplines and projects.

Participation of engineering groups in DRD7

The funding model implies that engineers and developers will participate in specific projects within DRDs, but will also be active participants in DRD7 discussions and developments. Not all groups may have the capacity to be involved in multiple DRDs, but it is important that engineers taking the lead of electronics projects are actively involved in DRD7.

The roadmap introduces the concept of a ‘Tiered’ model for the organisation of complex and distributed design activities. The ambition is to ensure that a useful engagement is possible for both large groups at national labs or institutes (where skills of individuals may be more specialised and spread across a number of simultaneous developments) and smaller groups or individuals in other institutes (where the engagement may be end-to-end on a specific development). Since future generations of technology will require increasing investments in a broad set of specialised tools and skills, this mode of working – whereby specific developments under the leadership of a small team can benefit from specialist support from across the field – will surely be necessary. Investigation of the next practical steps in this direction will be the responsibility of WG 7.7.

Responsibilities

As an illustration of how the above model will work in practice, the responsibility of an individual DRD in a specific development should include:

- Determination of system parameters and specifications
- Planning and costing of prototype development and production
- Production, verification, and integration of ASICs and other project-specific components
- Testing and operation of large-scale prototypes

The DRD7 responsibility will include:

- Review of system specifications and design as requested, possibly also on a rolling basis during the course of the project, and including analysis of engineering effort and specialised skills requirements
- Provision of access to tools and vendors
- Development and provision of common IP, components, and subsystems, encompassing hardware, firmware and software
- Development of common, generic, complete components or systems, when too big or too complex to be designed in one single DRD
- Provision of specialised or large-scale facilities for electronic development and testing

Proposals submission

Proposals for R&D projects involving electronics and data-processing can be included in either detector-related DRDs or in DRD7, taking into account the following guidelines:

- Projects in DRD7 will target common generic developments, or exploration of cutting-edge technologies requiring negotiated access to frameworks and complex design flows. They may involve high costs, expert coordination or unique expertise, and can possibly only be effectively delivered as a common community effort. They will follow design practices enabling later volume production in industry and/or using COTS components.

- Projects in individual DRDs will target developments driven by DRD-specific requirements. They will typically be smaller-scale prototypes exploring or benchmarking novel concepts or technologies and delivering demonstrators. They will focus on diversity and originality, but will not necessarily be suitable for large-scale production.

Although the most obvious application of these guidelines concerns ASIC development, they also apply to work on back-end aspects of systems including software-related or algorithmic work, where the importance of common developments across detector areas is also substantial.

It is an explicit goal of the DRD programme to avoid duplicated or parallel developments. Where overlapping or potentially conflicting proposals are made to different DRDs, the respective management teams of the collaborations concerned will work to establish the correct organisational model for the work.