

DRD7 Call for Projects

V3, 27/5/23

Introduction

DRD7 is organised in seven R&D Working Groups, covering collectively the scope of the DRD themes expressed in the Roadmap (see **section 1**).

After the DRD7 kickoff workshop, each working group highlighted a set of projects which are likely to raise interest in the community. These so-called proto-projects are listed in **section 2** as examples of what future collaboration projects could cover. They are representative, but not exhaustive nor exclusive. Suggestions for more or different projects are encouraged at this stage, provided they are likely to meet the criteria for strategic R&D in DRD7 (see **section 3**).

*Interested scientists, groups or collaborations are invited to express their interest by contacting the WG conveners with their project intentions (see **section 4**). Conveners will collect the community feedback and aggregate it into a portfolio of projects in each WG. These preliminary project intentions will form the basis of a Letter of Intent to create the DRD7 collaboration, due to be submitted in July 2023.*

Please express your interest before 30 June 2023.

1. R&D Working Groups and Conveners

DRD7 is organised in seven R&D Working Groups, covering collectively the scope of the DRD themes expressed in the Roadmap.

WG 7.1: Data density and power efficiency

Szymon Kulis (CERN), Jeffrey Prinzie (KU Leuven), Jan Troska (CERN)

- High data-rate ASICs and systems
- New link technologies, including silicon photonics technology
- Power conversion and efficiency optimisation

WG 7.2: Intelligence on the detector

Davide Ceresa (CERN), Francesco Crescioli (IN2P3-LPNHE), Frédéric Magniette (IN2P3-LLR)

- Front-end programmability and modular design
- Intelligent power management
- Advanced data reduction techniques

WG 7.3: 4D and 5D techniques

Sophie Baron (CERN), Marek Idzik (AGH-Kracow), Adriano Lai (INFN-Cagliari)

- High-performance sampling
- High-precision timing distribution
- Novel on-chip architectures

WG 7.4: Extreme environments

Giulio Borghello (CERN), Oscar Francisco (Uni-Manchester), Manuel Rolo (INFN-Torino)

- Cryogenic technology and operation
- Thermal management of ASICs
- Radiation hardness

WG 7.5: Backend systems and COTS

Conor Fitzpatrick (Uni Manchester), Niko Neufeld (CERN), NN

- 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

Marlon Barbero (IN2P3-CPPM), Michele Caselle (KIT), Iain Sedgwick (RAL), Walter Snoeys (CERN)

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

WG 7.7: Tools and technologies

Kostas Kloukinas (CERN), Xavi Llopart (CERN), Mark Willoughby (RAL)

- 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

2. Proto-projects

DRD7 Working groups have highlighted sets of projects which are likely to raise interest in the community. These so-called proto-projects are examples of what future collaboration projects could cover. They are representative of interest expressed by the community, but not exhaustive nor exclusive.

WG 7.1: Data density and power efficiency

Data density and power efficiency are key to developing the next generation of front-end electronics. Projects being proposed so far include:

- 7.1.a: Si-photonics based links, including IP blocks for timing distribution
Contact: jan.k.troska@cern.ch
- 7.1.b: High efficiency DCDC converters
Contact: szymon.kulis@cern.ch, jeffrey.prinzie@kuleuven.be

WG 7.2: Intelligence on the detector

Two types of projects are envisaged in WG7.2: support projects based on tool or knowledge exchange, promoting collaboration between developers and users; and specific projects based on defined deliverables but with a potential for common and shared use in the community.

Four proto-projects are highlighted below to seed feedback:

- 7.2.a: Radiation tolerant processors
Contact: davide.ceresa@cern.ch
- 7.2.b: Evaluation of radiation tolerant design techniques
Contact: francesco.crescioli@lpnhe.in2p3.fr
- 7.2.c: System-level architectural modelling
Contact: davide.ceresa@cern.ch
- 7.2.d: Benchmarking platform for advanced reduction techniques (ML, AI), and associated hardware testing
Contact: frederic.magniette@llr.in2p3.fr

WG 7.3: 4D and 5D techniques

Two types of projects are considered by WG7.3: the design and architecture of ASIC macrocells on the one hand (7.3.a and 7.3.d) and time distribution techniques, tools and components on the other hand (7.3.b and 7.3.c).

- 7.3.a: High performance TDC and ADC blocks at ultra-low power
 - Crucial blocks for high performance sampling, generic enough to cover many different developments (for instance large dynamic range, concurrent time and energy measurement, etc.)*Contact: idzik@ftj.agh.edu.pl*
- 7.3.b: Timing methodologies and infrastructures
 - Common, generic approach for simulating timing in detectors
 - Precise timing measurement and calibration*Contact: sophie.baron@cern.ch*
- 7.3.c: Timing distribution techniques
 - Components design and characterization (COTS and Custom)
 - Distribution architectures and systems*Contact: sophie.baron@cern.ch*
- 7.3.d: Novel architectural solutions for ASICs with precision timing capabilities
 - High precision timing requires deep control of clock distribution and power inside the ASIC. In this sense, novel dedicated solutions are to be developed and tested on silicon, both at the pixel and architectural level.*Contact: adriano.lai@ca.infn.it*

WG 7.4: Extreme environments

WG7.4 takes charge of projects related to the study of CMOS technologies operating at cryogenic temperatures (7.4.a) and/or in radiation environments (7.4.b and 7.4.c) and investigations on cooling technologies (7.4.d).

- 7.4.a: Modelling and development of an ASIC Process Design Kit (PDK) for operation at cryogenic temperatures
 - Modelling of selected CMOS technology nodes at cryogenic temperatures and development of cryo-qualified CMOS IP blocks suitable for integration in complex mixed-signal ASICs.
Contact: darochar@to.infn.it
- 7.4.b: Radiation resistance of advanced CMOS nodes
 - Study of TID and DD effects on CMOS nodes more advanced than the 28nm process.
 - Study, modelling and test of low dose rate effects, NIEL scaling, etc.
- 7.4.c: Survey and access to test facilities
 - long-term/high fluence (and/or high dose-rate) test campaigns will be needed to evaluate radiation effects at ultra-high fluences/TID.
Contact: giulio.borghello@cern.ch
- 7.4.d: *Silicon microchannels cooling plates*
 - *Investigation of alternative bonding techniques via thermocompression to reduce the cost of silicon based microchannels cooling plates. A similar technique can also be considered for the integration of the cooling connector.*
Contact: cogan@cppm.in2p3.fr and oleroy@cppm.in2p3.fr

WG 7.5: Backend systems and COTS

WG 7.5 covers backend data processing, connectivity and the need to keep pace with Commercial, off-the-shelf hardware as it evolves. Two general work packages related to data processing are envisaged as a starting point: In 7.5a, the need to capture frequently updated benchmarking of COTS processing technologies is considered. Related to this, in 7.5b, a method of hosting and maintaining benchmark algorithms as a resource for 7.5a and for the community in general is provided. Together these activities will allow the field to keep pace with an evolving hardware and software ecosystem and provide an experiment-agnostic set of off-the-shelf solutions for DAQ design so that experiments can make decisions based on total-cost-of-ownership. 7.5c proposes R&D into removing the need for dedicated backend hardware by, in close collaboration with frontend developers in other DRD areas, ensuring that the link from front-end to backend can be served by COTS solutions.

- 7.5.a: Benchmarking of Heterogeneous COTS Architectures for Physics (BOHCAP)
 - Identify experiment agnostic, common TDAQ activities, benchmark these on COTS hardware as it becomes available, think 'HEPScore/HEPSPEC' for DAQ
Contact: conor.fitzpatrick@cern.ch

- 7.5.b: DAQ Overflow
 - Host a common repo of algorithms and methods for TDAQ applications
 - Develop Code/IP blocks that do common tasks on as many hardware implementations as possible
 - Document and maintain/improve Code/IP blocks as technology and algorithms evolve (Eg: rad-hard/tolerant ethernet stack for on/near detector and corresponding off-detector version)

Contact: conor.fitzpatrick@cern.ch
- 7.5.c: No Backend
 - Backend translates custom front-end links into COTS. Versatile LInk+ / IpGBT are very similar in many respects to Ethernet already. If Front-ends could send a form of Ethernet compatible with COTS (esp. switches), could do away with custom backend hardware. Would need some cross DRD7 collab to develop FE and test on COTS

Contact: Niko.Neufeld@cern.ch

WG 7.6: Complex imaging ASICs and technologies

WG 7.6 is a transverse activity, providing support to other areas in the broader DRD programme. To support these high level goals, DRD 7.6 is interested in receiving submissions in the following areas:

- 7.6.a: Setting up joint access to selected imaging technologies
 - Candidate technologies might include but are not limited to:
 - Tower Semiconductor (65 and 180nm)
 - LFoundry
 - TSI
 - Proposals for IP blocks developed in the above technologies such as pixels, ADCs, data transmission blocks, bias circuits etc

Contact: : Walter Snoeys, Marlon Barbero
- 7.6.b: Shared access to 3D technologies
 - Modelling of 3D chips
 - Establishing 3D capabilities – simulation, assembly, multi-node and high density integration and packaging for processing, powering and readout.

Contact: Michele Caselle, Walter Snoeys
- 7.6.c: Development of a common QA/ASIC development framework
 - creation of designers fora promoting greater interaction between institutes
 - Development of standardised test set-ups and readout architectures and systems

Contact: Marlon Barbero, Iain Sedgwick

WG 7.7: Tools and technologies

WG 7.7 is a transverse activity providing support to foundry, process, tools and design related tasks. Its importance is such that the community is encouraged to engage with the experts into common projects to develop and spread this crucial expertise. Projects may include dedicated funding schemes for recruiting and training specialists working for the community.

- 7.7.a: Expand existing ASIC and Foundry support service to advanced nodes, develop and distribute IP blocks (fitting digital on top flows)
Contact: Kostas.kloukinas@cern.ch
- 7.7.b: Support EDA tools, develop seamless IP exchange across community
Contact: mark.willoughby@stfc.ac.uk
- 7.7.c: Complex digital on top design and verification: develop and implement a model for supporting the community and disseminating the expertise
Contact: Xavier.Llopart@cern.ch
- 7.7.d: Survey 3D wafer stacking options, explore access possibilities, implement framework for community
Contact: Kostas.kloukinas@cern.ch

3. Criteria for strategic R&D projects in DRD7

As DRD7 is presently in a formation state, project proposals are not yet expected to be mature. The criteria listed below are thus aspirational and will only apply to final projects.

The final DRD7 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 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.

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

4. Expressions of interest

The forming DRD7 collaboration will present in July 2023 a Letter of Intent based on a portfolio of project intentions. The present call for projects aims at establishing this portfolio based on expressions of interest which will be received from the community.

A second DRD7 workshop will take place after the summer to present, discuss and review the project intentions. After a consolidation phase, the resulting final projects will constitute the work program of the Collaboration, set for approval by end-2023/beginning-2024.

Subsequent calls for projects will be issued on a regular basis, and latecomers or newcomers will have an opportunity to join at these moments.

Interested scientists, groups or collaborations are invited to express their interest in participating to R&D projects in DRD7 by contacting the conveners of the relevant Working Group:

- If interested in joining one of the **proto-projects** highlighted in section 2, please describe:
 - Contributor and area of competence
 - Available material and human resources
 - Existing R&D framework and available funding
 - Rough estimate and time profile of to be requested resources, if needed in addition to existing resources

- If interested in proposing a **new project**, please submit your proto-project as a group, as conveners will not be able to organise projects based on individual suggestions. The following elements will be needed to evaluate your proposal:
 - Proto-project description
 - Innovative/strategic vision
 - Performance target, deliverables and timeline
 - Multi-disciplinary, transversal content
 - Contributors and area of competence
 - Available material and human resources
 - Existing R&D framework and available funding
 - Rough estimate and time profile of to be requested resources, if needed in addition to existing resources

Please express your interest before 30 June 2023.