

ECFA

European Committee for Future Accelerators



Detector R&D roadmap implementation

DRD7-electronics status and plans

Jerome Baudot,
on behalf of the DRD7 steering committee
F.Vasey, D.Newbold, J.B., M.French, A.Rivetti, F.Simon

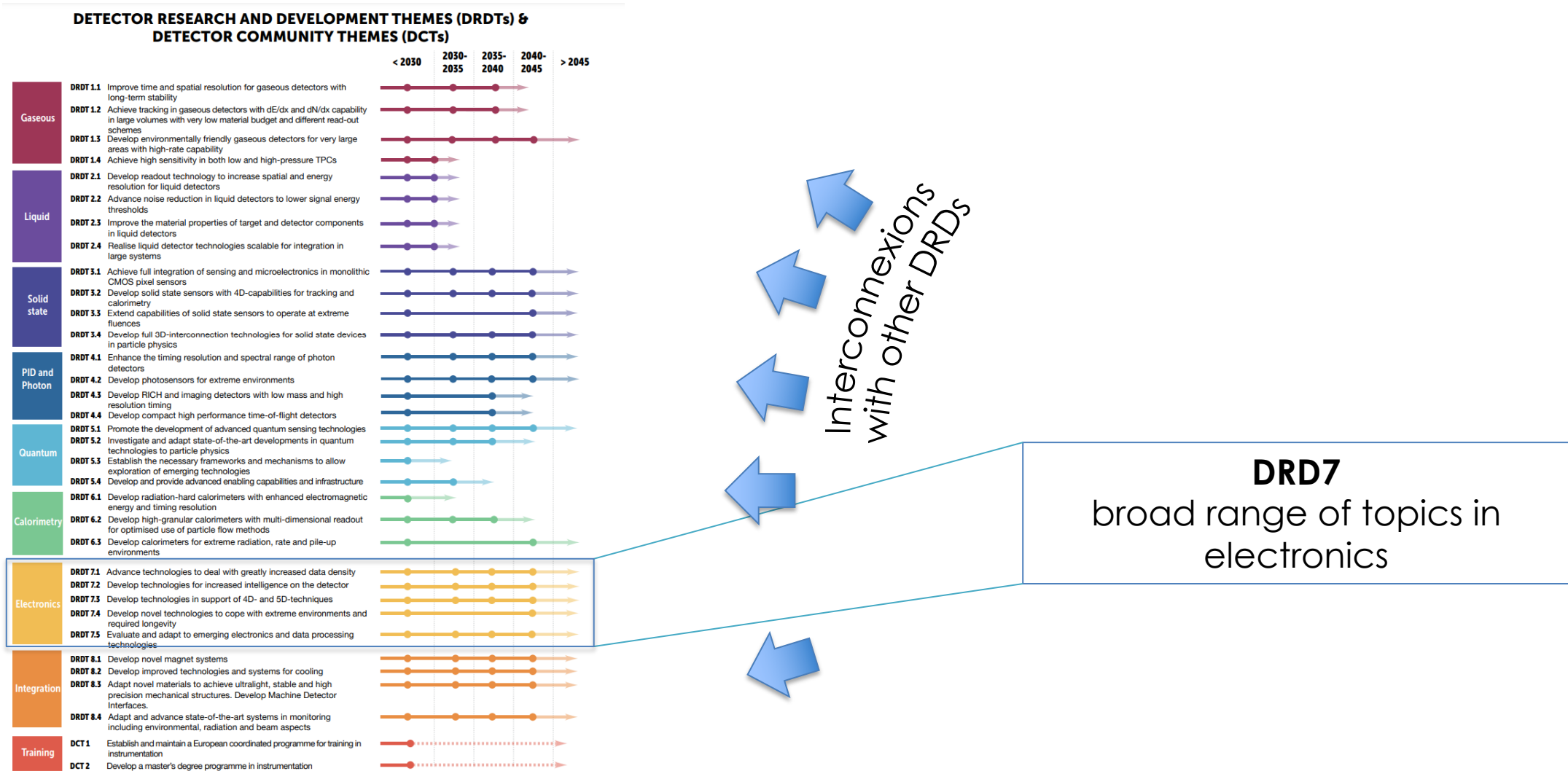


Connect with us:

ECFA-DetectorRDRoadmap-DRD7-
InterestGroup@cern.ch

- R&D topics, proto-projects
- Collaboration definition
- Interconnexions with other DRDs
- Call for projects

Overview from the roadmap document



■ Purpose

- 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.

■ 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

■ 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 technos
- 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)

- 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 technos

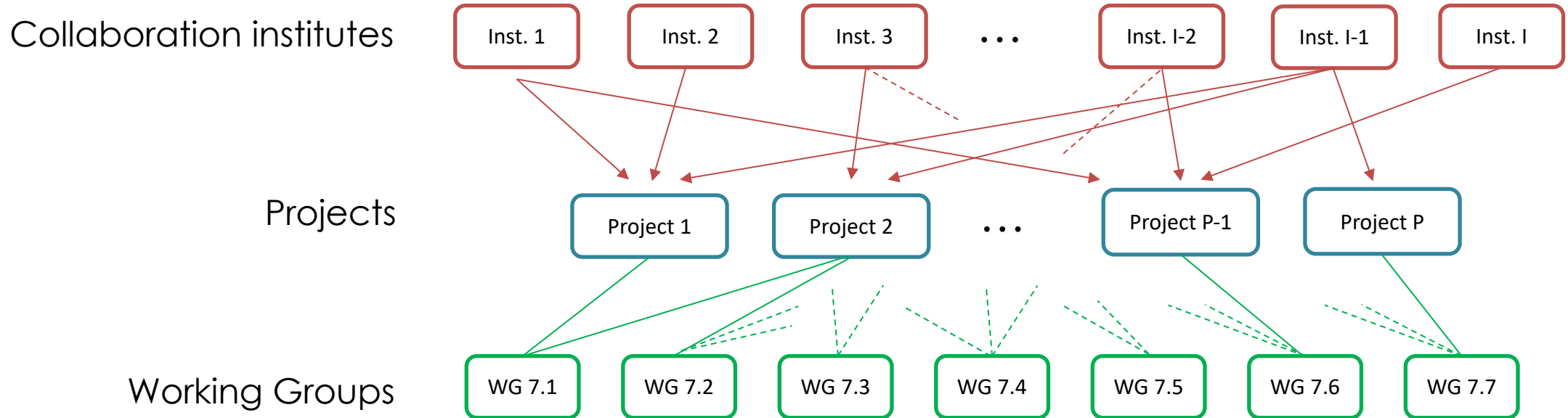
Marlon Barbero (IN2P3-CPPM), Michele Caselle (KIT), Iain Sedgwick (RAL), Walter Snoeys (CERN)

- Common access framework to selected imaging technos
- 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



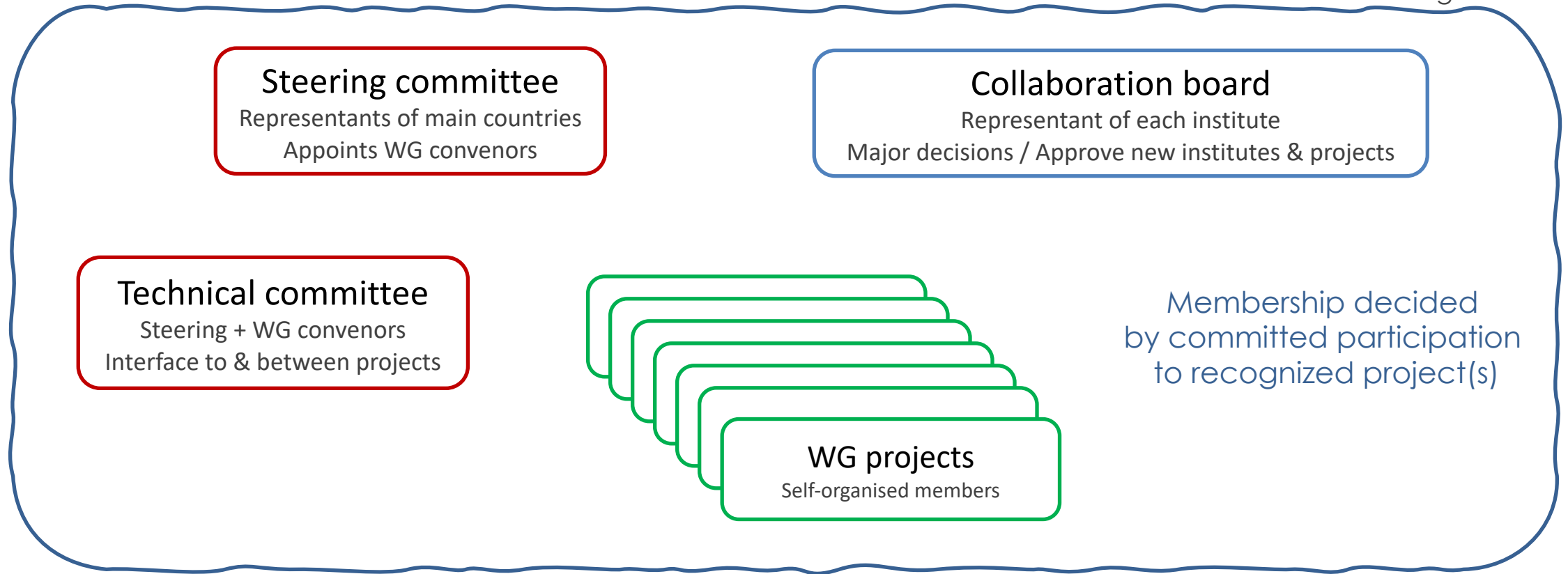
■ Projects:

- Address one or more **R&D themes** expressed in the roadmap
- **Own & manage their resources** NOT the DRD7collab.
 - Except for WG7.7, MOU for services needed

■ DRD7 collaboration:

- **Reviews** project proposal {
 - decides inclusion in DRD7
 - proposes rationalisation, combination, re-scoping
 - Will happen over time beyond initial proposals
- Maintains **overview** of all R&D
- **Represents** electronics community to the DRDC
- Contributes to **review cross-DRD** projects
- **Coordinates** access to tools, knowledge, IPs

The light-touch way



■ Memorandum of Agreement to

- Signed by each institute

- conform to collaboration practices
- **adopt open development** philosophy
- commit existing resources to WG projects

■ WG 7.1: Data density and power efficiency

- 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 7.5: Backend systems and COTS

- 7.5.a: Benchmarking of Heterogeneous COTS Architectures for Physics (BOHCAP)
 - Contact: conor.fitzpatrick@cern.ch
- 7.5.b: DAQ Overflow (code/IP)
 - Contact: conor.fitzpatrick@cern.ch
- 7.5.c: No Backend (direct front-end link to COTS)
 - Contact: Niko.Neufeld@cern.ch

■ WG 7.2: Intelligence on the detector

- 7.2.a: Radiation tolerant processors
Contact: davide.ceresa@cern.ch
- 7.2.b: Evaluation of radiation tolerant design techniques
Contact: francesco.crescioli@lpinhe.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

Many relevant to tracking

■ WG 7.3: 4D and 5D techniques

- 7.3.a: High performance TDC and ADC blocks at ultra-low power
Contact: idzik@ftj.agh.edu.pl
- 7.3.b: Timing methodologies and infrastructures
Contact: sophie.baron@cern.ch
- 7.3.c: Timing distribution techniques
Contact: sophie.baron@cern.ch
- 7.3.d: Novel architectural solutions for ASICs with precision timing capabilities
Contact: adriano.lai@ca.infn.it

■ WG 7.4: Extreme environments

- 7.4.a: Modelling and development of an ASIC Process Design Kit (PDK) for operation at cryogenic temperatures
Contact: darochar@to.infn.it
- 7.4.b: Radiation resistance of advanced CMOS nodes
- 7.4.c: Survey and access to test facilities
Contact: giulio.borghello@cern.ch
- 7.4.d: Silicon microchannels cooling plates
Contact: cogan@cppm.in2p3.fr,
oleroy@cppm.in2p3.fr

Many relevant to tracking

■ WG 7.6: Complex imaging ASICs and technologies

- 7.6.a: Setting up joint access to selected imaging technologies
 - Contact: : walter.snoeys@cern.ch, barbero@cppm.in2p3.fr
- 7.6.b: Shared access to 3D technologies
 - Contact: michele.caselle@kit.edu, walter.snoeys@cern.ch
- 7.6.c: Development of a common QA/ASIC development framework
 - Contact: barbero@cppm.in2p3.fr, iain.sedgwick@stfc.ac.uk

■ WG 7.7: Tools and technologies

- 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

Many relevant to tracking

- Work case (most probable) : complex or new technos ASICs
=> WG 7.6 and 7.7
- **Overlaps of teams in DRD7 and other DRDs are beneficial:**
 - greater efficiency through coordination
 - faster expertise building
 - sharing of not commonly available skills
 - access to common IPs and SW
- Note: DRD7 is not an ASIC design service

■ Model for agreed common developments

- Object: **IPs or complete devices or sub-systems**
- DRD7 offers
 - review and coordination body
 - provision and support of tools
 - negotiations with industrial partners
- 3 separate funding streams (adequately balanced)
 - **From DRDs:** for specific electronic developments
 - **From DRD7:** for tools, specialized personnel, R&D
 - **From Institutes:** for engineering teams

■ Proposed guidelines to steer projects

- DRD-specific requirements, small-scale prototypes, novel concepts, delivery = **demonstrator**
- **No large-scale** production

=> driven by individual DRDs

- **Generic** development, community effort, high cost, **complex** design flow, expert coordination
- cutting-edge techno with **negotiated access**
- **Volume** production

=> driven by DRD7

■ Participation of engineering groups

- Desirable that developers involved in both specific DRD & DRD7
 - May not always be possible for all group, depending on size
 - **Lead engineers should be involved in DRD7**
- **Tiered** model
 - **Ensure useful contributions from groups of various sizes**
 - smaller groups focus their expertise on single project end-to-end
 - larger groups share their broad skills in a nb of projects
 - Allows increasing range of specialized tools and skills to be available even for small teams
 - Under responsibility of DRD7-WG7.7

■ Responsibility sharing


- DRDs
 - 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
- DRD7
 - Review of system specs and design
 - 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

- **Step 1a (March – June 2023):** convenors
 - seeks expressions of interest in specific projects
 - defines few initial priority projects with relevant institutes and substantial community interest
- **Step 1b (March – June 2023):** technical committee
 - defines common plans & interfaces with other DRDs
 - avoids duplication or omission of work
 - set DRD7 work plan responding to other DRDs plans
- **Step 2 (July 2023):** Letter of Intent
 - submitted to the DRDC
 - with scope of DRD7 + internal organisation + list of researchers and institutes
- **Step 3 (September 2023):** second DRD7 workshop
 - to hear detailed proposals for the initial projects
 - to discuss areas of common interest.
 - open to both Lol signatories and other institutes seeking to join the effort
- **Step 4a (September – Nov. 2023):** initial set of projects
 - take into account feedback from the DRDC
 - planned and costed in detail
- **Step 4b (September – Nov. 2023):** national communities
 - discuss with national funding agencies
 - define likely participation and resource envelope for the initial projects
- **Step 5 (December 2023):** DRD7 Collaboration Proposal
 - submitted to the DRDC
 - includes resource-loaded plans for the initial projects
- **Step 6 (from January 2024):** national communities
 - take into account feedback from the DRDC,
 - make proposals to their funding agencies
 - start projects as resources are allocated

=> from 2024 onwards: annual DRD7 workshops

- Existing set of proto-projects identified during March workshop
- **More or different projects are encouraged**
=> Interested scientists, groups or collaborations are invited to express their interest by contacting the WG conveners
- Altogether = basis for Letter of Intent, July 2023, then discussed at second workshop for consolidation

■ Criteria for strategic R&D projects

- Maturity is not a criteria (at this stage)
- Novel, ambitious, and transformative topics
- Clear objectives, scope, deliverables, and work plan
- Deliverables = hw or sw or training or report BUT measurable & useful to the wider community
- well-defined set of participating institutes, clear responsibility assignments, appropriate management
- Possess adequate resources and skills over the entire project timeline
- Agree to reporting
- Duration up to 3 years, with milestones (some will be renewed after initial period)
- High priority when 
 - multiple R&D themes
 - multiple institutes
 - system-level issues

(Initial) Call for projects

Subsequent calls on regular basis

- Existing set of proto-projects identified during March workshop
- **More or different projects are encouraged**
=> Interested scientists, groups or collaborations are invited to express their interest by contacting the WG conveners
- Altogether = basis for Letter of Intent, July 2023, then discussed at second workshop for consolidation

■ Expressions of Interest content

- From scientists, groups, collaborations
- For **joining one of the proto-projects**
 - 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
- For **proposing a new project**
 - 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

Mail sent by F.Vasey on May 27
ECFA Detector R&D in Electronics : DRD7. Call for projects

=> Proposals received before 30 June 2023