

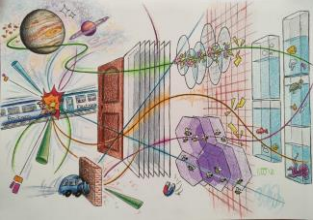


ECFA detector roadmap on Solid-State detectors and Implementation

From TF3 to DRD3

Giulio Pellegrini

IMB-CNM-CSIC

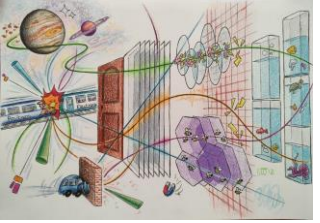


Questions that we should answer:

DRD3

During the 2 days of the meeting, with the talks and the discussions

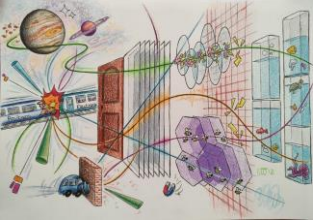
- What is the goal of this workshop?
- How did we get here?
- Which are the next steps?
- Work to do?
- What is the scope of the DRD3 collaboration?



Goals of the workshop (What?)

DRD3

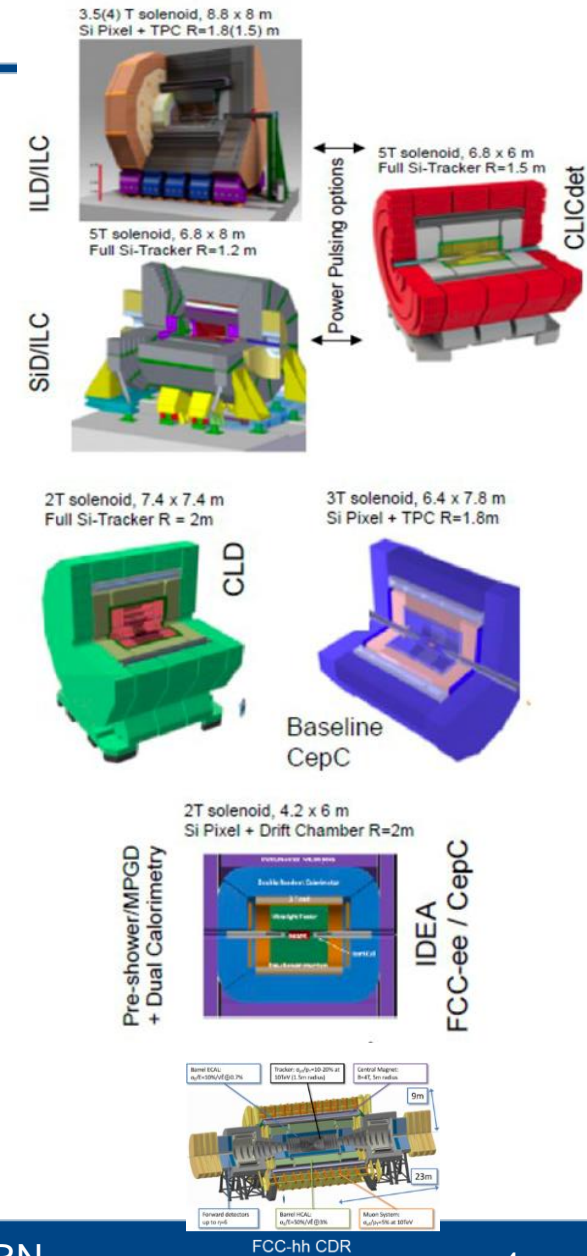
- ✓ Present the **initial proposal** of the implementation plan to organize the new DRD3 collaboration.
- ✓ It can be useful to **remind** and explain the Roadmap to the community.
- ✓ Different **talks** will present the proposed research lines, the milestones, a summary of the EoI, training and a preliminary organization schematic and rules -> Inputs from the community are welcome!
- ✓ DRD's are in phase of creation and this may be a **challenge** for the community but also a **risk** due to the change in the funding scheme.
- ✓ **Talented and committed people** are vital for future progress in experimental particle physics. They need to be retained and train new ones!
- ✓ A **discussion** is always useful, we will need to find synergies and new collaborations.
- ✓ Start the writing of the **proposal** document for the formation of DRD3 collaboration.

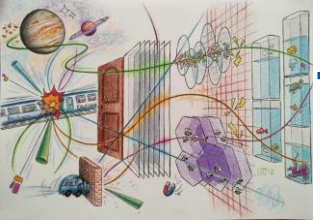


Physics and Detectors

DRD3

- The success of particle physics experiments relies on innovative instrumentation and state-of-the-art infrastructures.
- To prepare and realise future experimental research programmes, the community must maintain a **strong focus on instrumentation**.
- Detector R&D programmes and associated infrastructures should be **supported** at CERN, national institutes, laboratories and universities.
- **Synergies** between the needs of different scientific fields and industry should be identified and exploited to boost efficiency in the development process and increase opportunities for more technology transfer **benefiting society** at large.

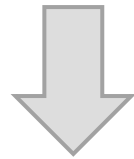




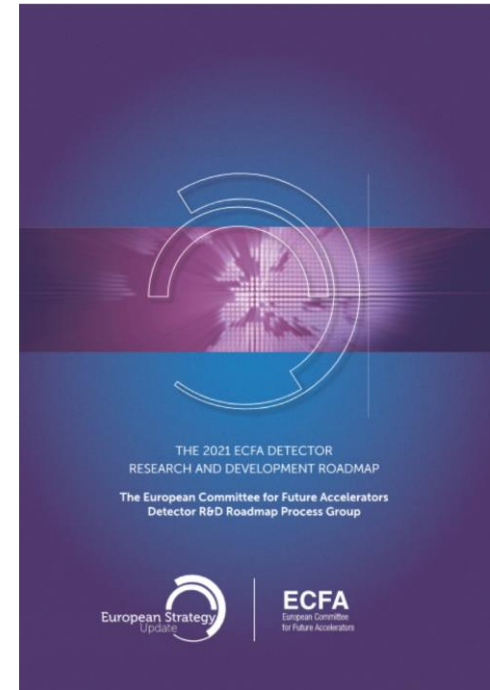
The 2021 ECFA Detector R&D Roadmap (How?) **DRD3**

Organized by **ECFA** (The European Committee for Future Accelerators), the **roadmap** is developed by the community to balance the **detector R&D effort in Europe**, taking into account progress with **emerging technologies** in adjacent field.

The roadmap should **identify and describe a diversified detector R&D portfolio** that has the largest potential to **enhance** the performance of the particle physics programme in the near and long term.



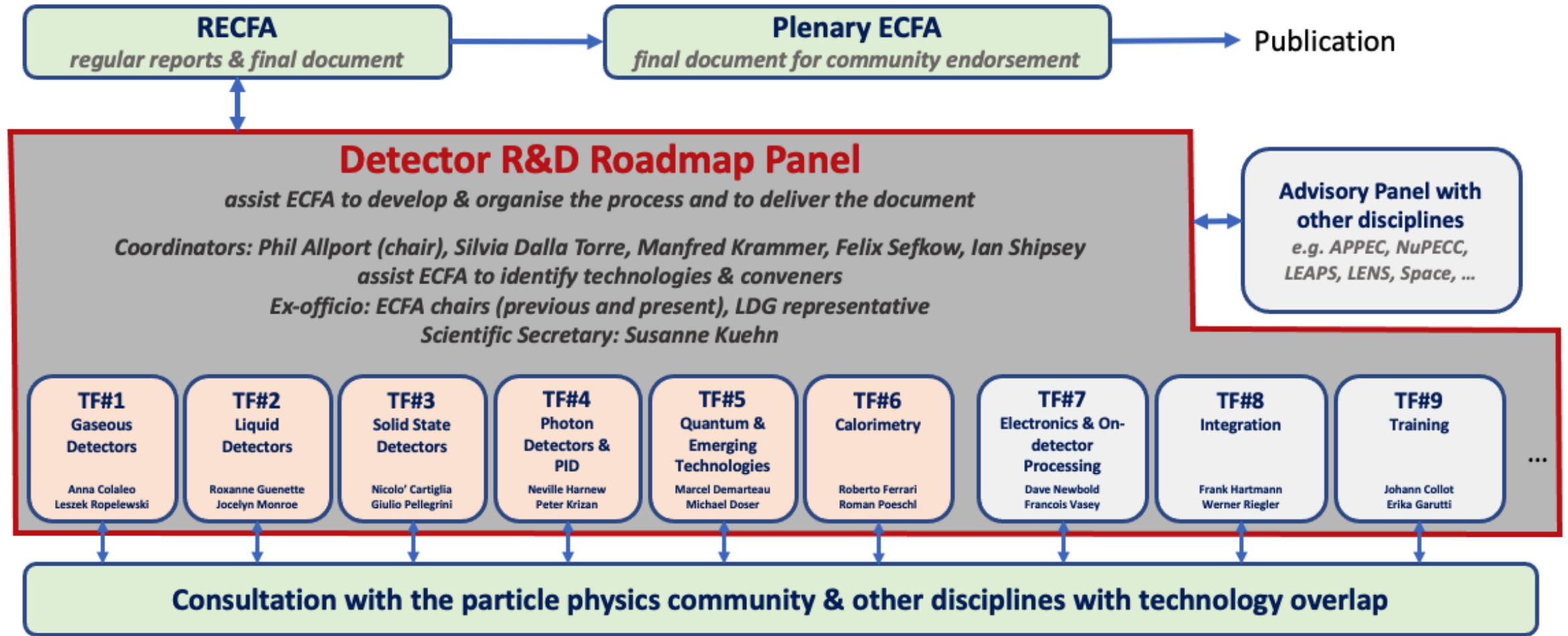
- Roadmap developed in 2021, approved by Plenary ECFA on 18 Nov 2021
- Released in December 2021, after presentation to CERN Council
- Documents available: <https://indico.cern.ch/event/957057/>



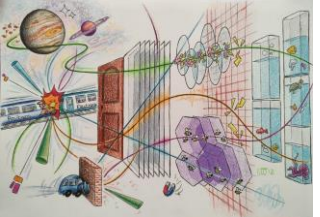
The European Strategy of Particle Physics is reviewed and updated every five to ten years.



Panel Organisation



Restricted ECFA (RECFA)



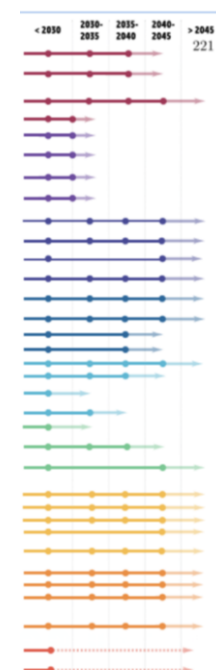
Detector R&D Themes

DRD3

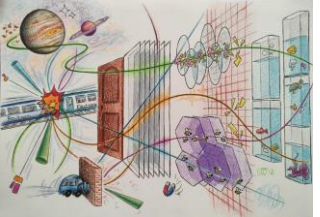
These themes, identified in the Roadmap, are **critical** to achieve the science programme outlined in the ESPP (The European Strategy for Particle Physics) and are **derived from the technological challenges** that need to be overcome for the scientific potential of the future facilities.

Gaseous	DRDT 1.1	Improve time and spatial resolution for gaseous detectors with long-term stability
	DRDT 1.2	Achieve tracking in gaseous detectors with dE/dx and dN/dx capability in large volumes with very low material budget and different read-out schemes
	DRDT 1.3	Develop environmentally friendly gaseous detectors for very large areas with high-rate capability
	DRDT 1.4	Achieve high sensitivity in both low and high-pressure TPCs
Liquid	DRDT 2.1	Develop readout technology to increase spatial and energy resolution for liquid detectors
	DRDT 2.2	Advance noise reduction in liquid detectors to lower signal energy thresholds
	DRDT 2.3	Improve the material properties of target and detector components in liquid detectors
	DRDT 2.4	Realise liquid detector technologies scalable for integration in large systems
Solid state	DRDT 3.1	Achieve full integration of sensing and microelectronics in monolithic CMOS pixel sensors
	DRDT 3.2	Develop solid state sensors with 4D-capabilities for tracking and calorimetry
	DRDT 3.3	Extend capabilities of solid state sensors to operate at extreme fluences
	DRDT 3.4	Develop full 3D-interconnection technologies for solid state devices in particle physics
PID and Photon	DRDT 4.1	Enhance the timing resolution and spectral range of photon detectors
	DRDT 4.2	Develop photosensors for extreme environments
	DRDT 4.3	Develop RICH and imaging detectors with low mass and high resolution timing
	DRDT 4.4	Develop compact high performance time-of-flight detectors
Quantum	DRDT 5.1	Promote the development of advanced quantum sensing technologies
	DRDT 5.2	Investigate and adapt state-of-the-art developments in quantum technologies to particle physics
	DRDT 5.3	Establish the necessary frameworks and mechanisms to allow exploration of emerging technologies
	DRDT 5.4	Develop and provide advanced enabling capabilities and infrastructure

Calorimetry	DRDT 6.1	Develop radiation-hard calorimeters with enhanced electromagnetic energy and timing resolution
	DRDT 6.2	Develop high-granular calorimeters with multi-dimensional readout for optimised use of particle flow methods
	DRDT 6.3	Develop calorimeters for extreme radiation, rate and pile-up environments
Electronics	DRDT 7.1	Advance technologies to deal with greatly increased data density
	DRDT 7.2	Develop technologies for increased intelligence on the detector
	DRDT 7.3	Develop technologies in support of 4D- and 5D-techniques
	DRDT 7.4	Develop novel technologies to cope with extreme environments and required longevity
	DRDT 7.5	Evaluate and adapt to emerging electronics and data processing technologies
Integration	DRDT 8.1	Develop novel magnet systems
	DRDT 8.2	Develop improved technologies and systems for cooling
	DRDT 8.3	Adapt novel materials to achieve ultralight, stable and high precision mechanical structures. Develop Machine Detector Interfaces.
	DRDT 8.4	Adapt and advance state-of-the-art systems in monitoring including environmental, radiation and beam aspects
Training	DCT 1	Establish and maintain a European coordinated programme for training in instrumentation
	DCT 2	Develop a master's degree programme in instrumentation



<https://cds.cern.ch/record/2784893>



Detector R&D Themes (DRDT) identified by the ECFA Detector R&D Roadmap

DRD3

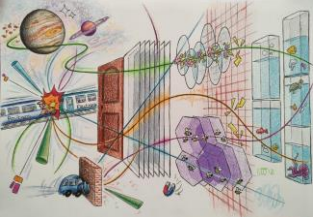
Solid state detectors chapter 3

- 3.1 - Achieve full integration of sensing and microelectronics in monolithic CMOS pixel sensors.
- 3.2 - Develop solid state sensors with 4D-capabilities for tracking and calorimetry.
- 3.3 - Extend capabilities of solid state sensors to operate at extreme fluences.
- 3.4 - Develop full 3D-interconnection technologies for solid state devices in particle physics.

Task Force 3 Solid State Detectors:

Nicolo Cartiglia, Giulio Pellegrini (*Conveners*)

Daniela Bortoletto, Didier Contardo, Ingrid-Maria Gregor;
Gregor Kramberger, Heinz Pernegger (*Expert Members*)



General Strategic Recommendations

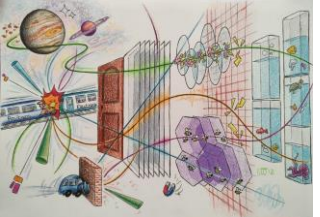
DRD3

- GSR 1 - Supporting R&D facilities
- GSR 2 - Engineering support for detector R&D
- GSR 3 - Specific software for instrumentation
- GSR 4 - International coordination and organisation of R&D activities
- GSR 5 - Distributed R&D activities with centralised facilities
- GSR 6 - Establish long-term strategic funding programmes
- GSR 7 - Blue-sky R&D
- GSR 8 - Attract, nurture, recognise and sustain the careers of R&D experts
- GSR 9 - Industrial partnerships
- GSR 10 - Open Science

Implementation started through the setting up of DRD collaboration

*Aim: * Propose mechanisms to achieve a greater coherence across Europe to better streamline the local and national activities and make these more effective.*

** Give the area greater visibility and voice at a European level to make the case for the additional resources needed for Europe to maintain a leading role in particle physics with all the associated scientific and societal benefits that will flow from this.*



Proposed Implementation plan

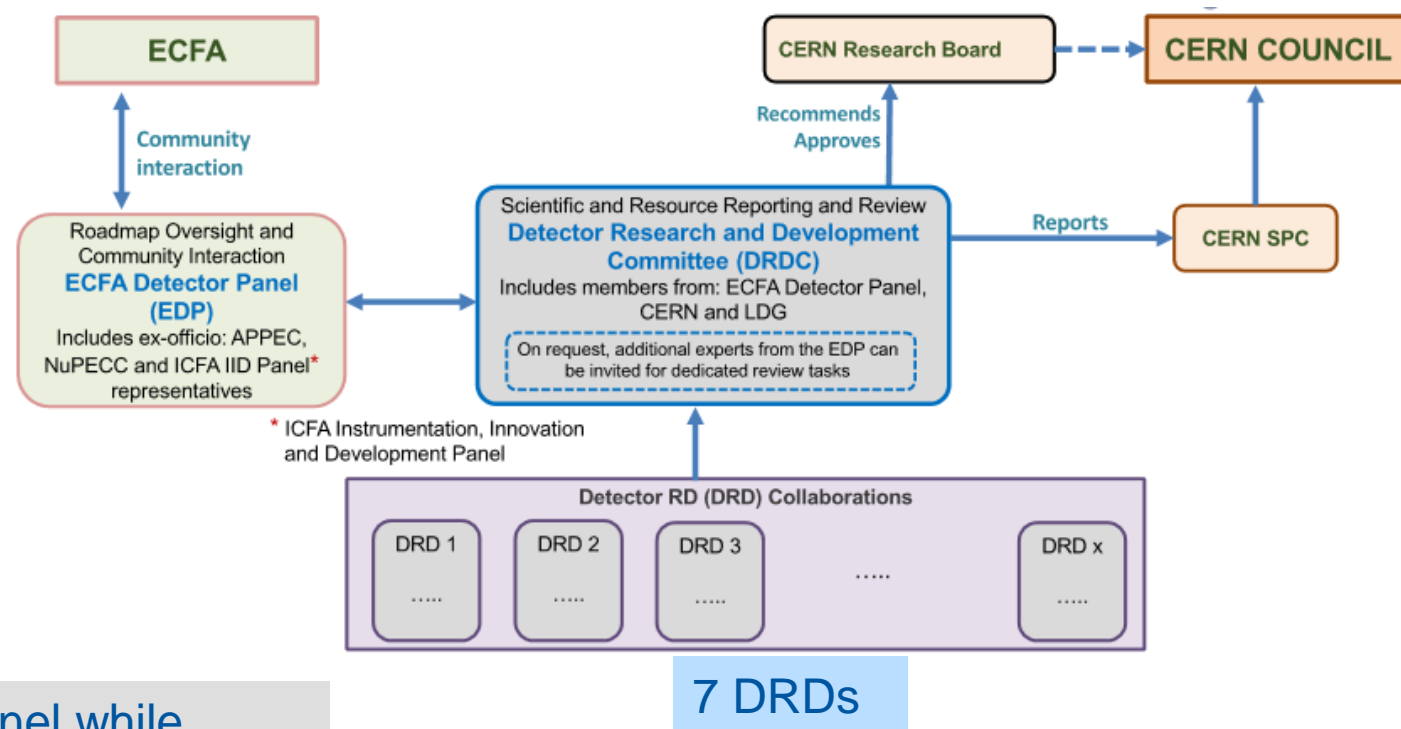
DRD3

ECFA Roadmap Coordination Group worked out a proposal to organise long-term R&D efforts into: **newly established Detector R&D (DRD) Collaborations anchored at CERN.**

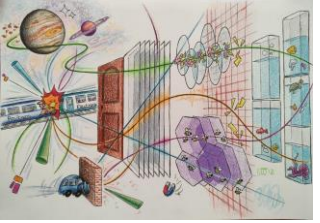
Three areas of Detector R&D:

1. **Strategic R&D via DRD Collaborations** (long-term strategic R&D lines) (address the high-priority items defined in the Roadmap via the DRDTs)
2. **"Blue-sky" R&D** (competitive, short-term responsive grants, nationally organised).
3. **Experiment-specific R&D** (with very well defined detector specifications) (funded outside of DRD programme, via experiments).

DRD9 is taken care of by a new ECFA Training Panel while **DRD8** felt their area is too experiment specific to be the topic of a "Strategic R&D" bid.



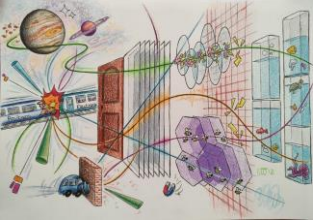
<https://cds.cern.ch/record/2838406?ln=en>



Proposed implementation plan (Next steps?)

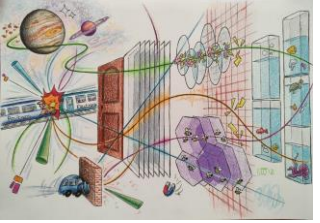
DRD3

- ✓ **Detector technology areas**: larger DRD collaborations should be considered, synergies can be better exploited by larger organisations and the advantages of scale in terms of dealing with external bodies.
- ✓ It is proposed that DRD Collaborations should be **anchored** at CERN → CERN recognition; DRD label. (Following CERN experiments -> open to all).
- ✓ The new DRDs should take full account of **existing, well-managed and successful ongoing R&D collaborations** and other existing activities (current RD50, RD51, etc., CERN EP R&D programme, EU-funded initiatives, collaborations exploring particular technology areas for future colliders, ...).
- ✓ The formation of the new DRD collaborations should adopt a **community-driven approach**.
 - Supported by existing ECFA Detector R&D Roadmap task Forces, with involvement of **managements** of existing R&D collaborations.



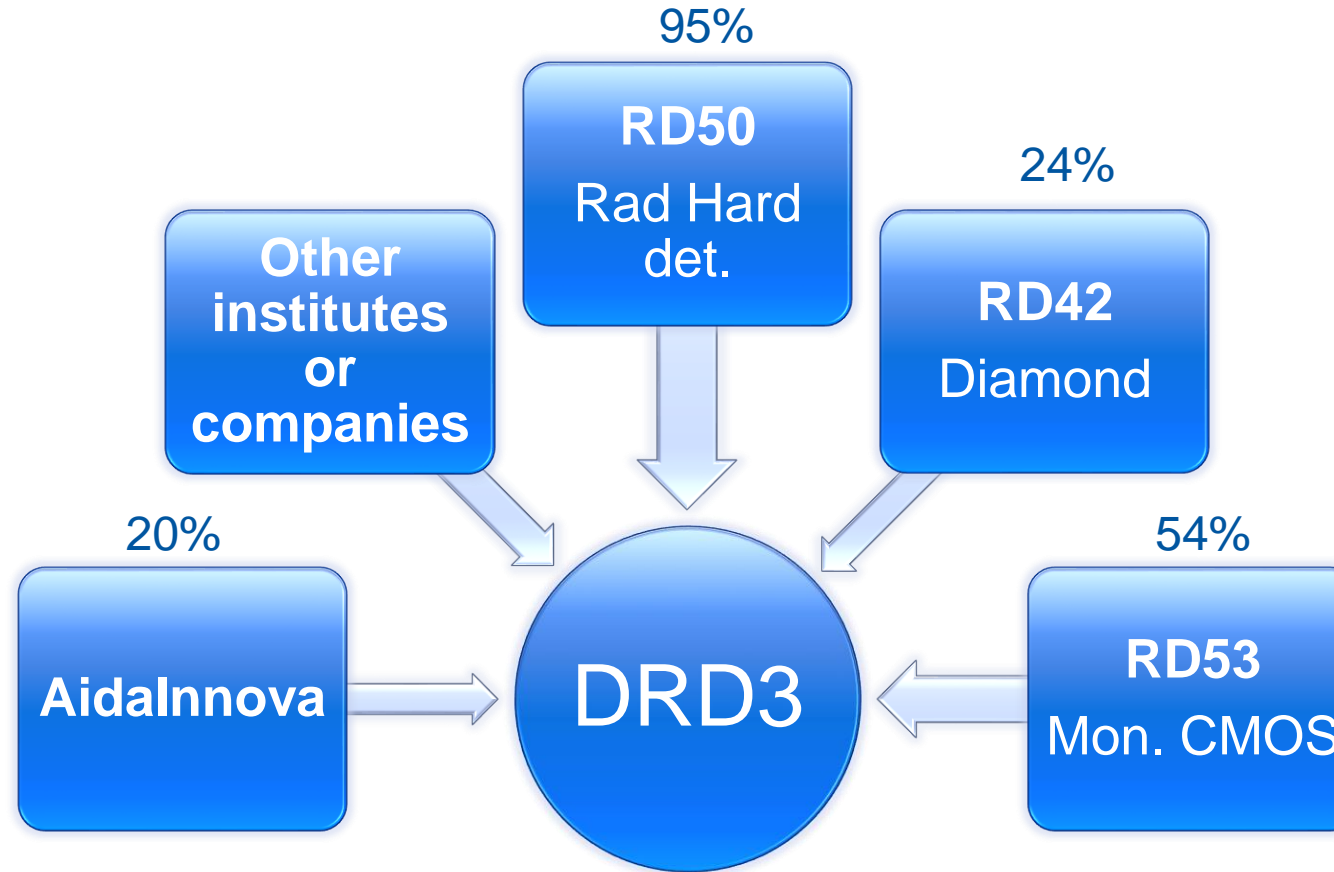
Given the diverse funding and costing models for different Funding Agencies it was decided to utilise the existing understood framework for funding long-term investments in particle physics experiments at CERN as the basis for supporting **Detector R&D (DRD) Collaborations** to deliver the multi-decadal Strategic R&D programmes to meet requirements identified by the DRDTs in the Roadmap documents.

- The clear need for “strategic” R&D was emphasised as separate from, but additional to, that for “blue-sky” and “experiment-specific” activities.
- Such funding should be expected to continue being sought by participating researchers where it is more appropriate (=**National funding!**).



Who is composing DRD3?

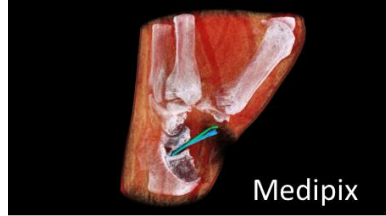
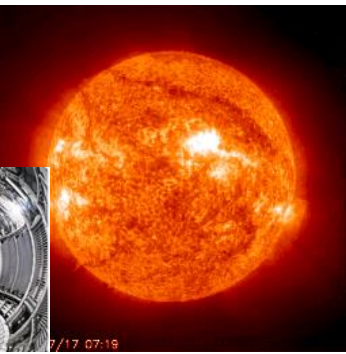
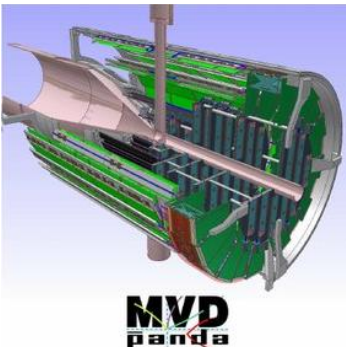
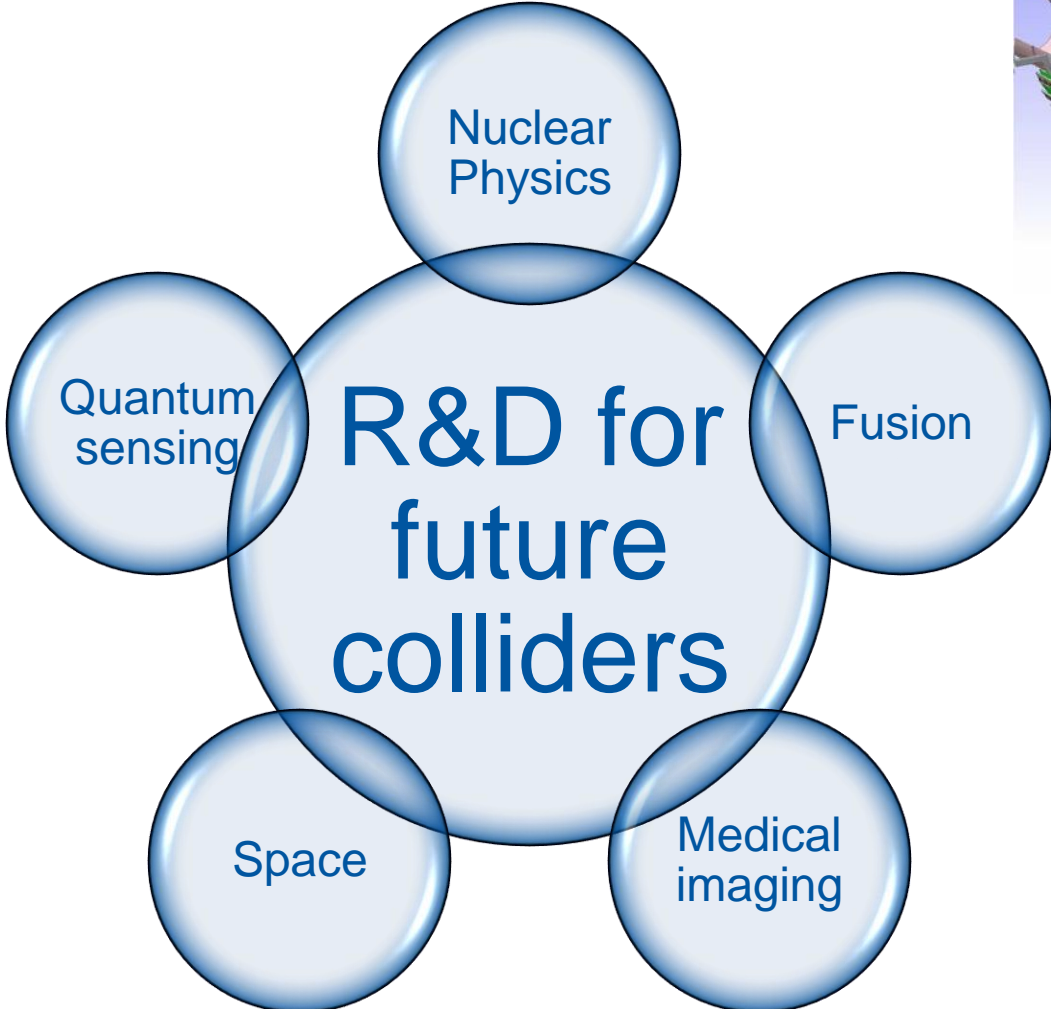
DRD3



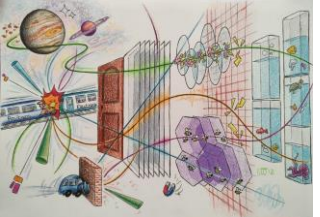
EoI collected from many institutes around the world.
See details in next talks.



Synergies with other fields



Radiotherapy



Timeline for Establishing DRD Collaborations

DRD3

Q4 2022

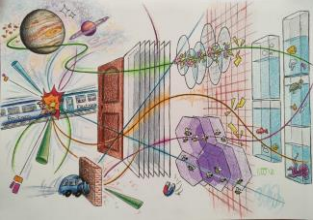
- Identify **key players and stakeholders** from the wider international community.
- Where current relevant detector R&D collaborations exist, their **managements** need to be fully involved from the beginning of this process.
- **DRD proposal teams**, to lead the preparation of the more detailed DRD proposals in each area, should be identified as a result of this process.

Q1 2023:

- Outcomes of **community workshops** are collated and each DRD proposal team calls for expressions of interest from institutes.
- **DRDC mandate formally defined and agreed with the CERN Management**; DRDC membership appointments begin; EDP mandate plus membership updated to reflect additional roles .
- **Develop the new DRD proposals** based of the detector roadmap and community interest in participation, and ramp up to a steady state in 2026.

Q2 2023:

- “Strategic R&D” proposals (**materials and total FTE**). The primary aim is to create a dedicated funding line for *Strategic R&D*.
- Mechanisms **agreed with funding agencies** for structuring country-specific DRD collaboration funding requests.



Timeline for Establishing DRD Collaborations

DRD3

Q3 2023

- **The DRD proposal teams submit full DRD proposals** , indicating estimates of the resources needed (including both those requested and those that are already available, as well as details of who covers what, i.e. pledges by institutes/ funding agencies).

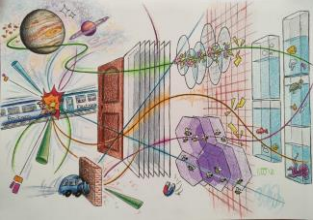
Q4 2023:

- Following the review and revision (if required) of proposals, the DRDC recommends the formal establishment of the DRD collaborations.
- Formal **approval** is given by the CERN Research Board

2024

Collection of MoU signatures. The areas of interest per institute and the expected support for the long-term commitments involved should be specified in the MoUs.

Formal start of the DRD collaborations (01/01/2024).
(-> End of actual RD's)



Work to do! -> proposal document

DRD3

- For each DRDT, we should highlight the following:
- Technologies to be studied and performances to be expected with respect of the set goals
- Key R&D deliverables in the coming three years
- Estimated costing
- List of institutes
- Resources available:
 - Manpower (FTE)
 - Estimated available budget
 - Additional budget

Suggested proposal lengths are ~20 pages (case for R&D provided by the Roadmap itself) and the request is for *reasonable estimates informed by discussions with the Funding Agencies.*

More details in next talks.

CERN/SPC/1190
CERN/3679
Original: English
29 September 2022

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Action to be taken		Voting Procedure
For information	SCIENTIFIC POLICY COMMITTEE 330 th Meeting 26-27 September 2022	-
For information	RESTRICTED COUNCIL 209 th Session 29 September 2022	-

EUROPEAN STRATEGY FOR PARTICLE PHYSICS
DETECTOR R&D ROADMAP

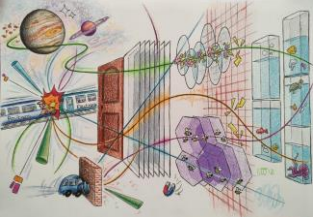
In the context of the implementation of the 2020 update of the European Strategy for Particle Physics, the European Committee for Future Accelerators (ECFA) was mandated by the CERN Council in 2020 to develop a detector R&D roadmap. The 2021 ECFA Detector Research and Development Roadmap was presented to the Council at its meeting in December 2021 and the Council invited ECFA to elaborate a detailed implementation plan.

ECFA hereby invites the Council to take note of the implementation plan that has been developed, as set out in annex 1 of this document.



Thank you for your attention





What DRD3 might bring in addition to the present situation

DRD3

- Support to young students (travel scholarships? I think this would be very useful, maybe paying 50% of the accommodation, not all students have the possibility to travel abroad)
- More interchange with other fields of applications
- Funding -> commitments for long term (5 years?) from national funding agencies.
- Possibility to finance large projects (presently too expensive).
- Administrative support (i.e. the support for the RD50 administration 5% of a staff person, clearly not enough)
- Coordination to participate in international projects (for instance: EU but any other idea is welcome)
- Contact companies interested in R&D on sensors.