

ECFA Detector R&D Roadmap

- Proposed Implementation steps -

RRB Meeting
CERN, 25th April 2022

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ECFA

European Committee for Future Accelerators





4. Other essential scientific activities for particle physics

...

- c) *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. Collaborative platforms and consortia must be adequately supported to provide coherence in these R&D activities. The community should define a **global detector R&D roadmap that should be used to support proposals at the European and national levels.***

Organised by ECFA, a roadmap should be developed by the community to balance the detector R&D efforts in Europe, taking into account progress with emerging technologies in adjacent fields. 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. ...

The 2021 ECFA Detector R&D Roadmap

- Roadmap developed in 2021, approved by Plenary ECFA on 18 Nov 2021
- Released in December 2021, after presentation to CERN Council

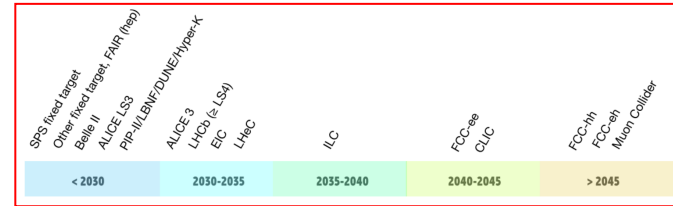
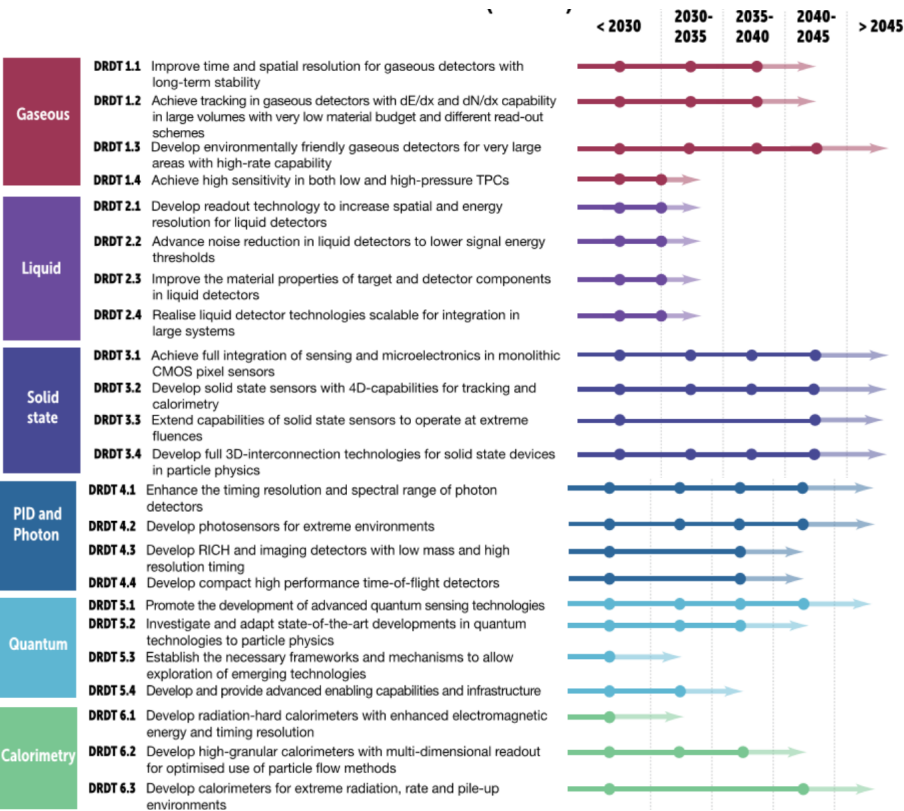
Documents available: <https://cds.cern.ch/record/2784893>
(incl. a short Synopsis Document)

- CERN Council has mandated ECFA to work out a detailed implementation plan
(in close collaboration with the SPC, the funding agencies and the relevant research organisations in Europe and beyond)
- Likewise, the European Lab Director Group (LDG) was mandated to work out an implementation plan for the **Accelerator R&D Roadmap**
- First concepts have been presented to Council in its March session, however, the important next step (discussion with funding agencies and research organisations in Europe and beyond) remains to be done;

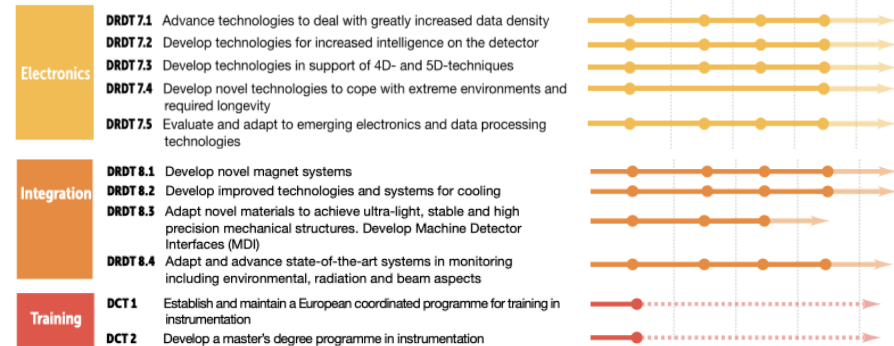
First presentation here today, followed by more in-depth discussion this Thursday



Detector R&D Roadmap: Detector R&D Themes (DRDTs)



Priorities defined in Roadmap's DRDTs



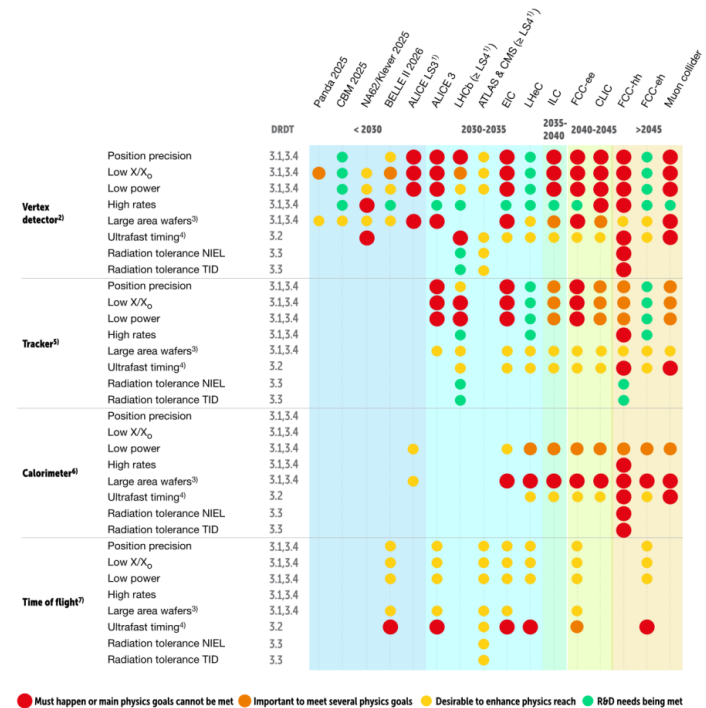
Implementation of the Detector R&D Roadmap

- The **urgent needs of some experiments** call for a timely realisation of an R&D structure (however, **gradual ramp-up is needed**, with larger involvement of many institutes after LHC Phase-II construction work will have been accomplished)
- Offers **longer-term prospects for those engaged in instrumentation work**, enhancing the attractiveness of this vital area.
- Synergies** in R&D work for different projects **can be exploited** → gain in efficiency, optimisation of resources

Implementation plan:

- Establishment of R&D collaborations at CERN** (covering the high-priority Detector R&D Themes identified in the roadmap)
- Implementation of the General Strategic Recommendations**

Example: Solid State Detectors (TF3)



1. Establishment of RD Collaborations at CERN

- We propose to organise long-term R&D efforts into **newly established Detector R&D (DRD) Collaborations**

Detector technology areas: larger DRD collaborations should be considered
(one for each of the six areas)

→ guarantees a critical mass of institutes and people involved;
avoids fragmentation and keeps the additional administrative support and reviewing requirements to a manageable level.

- For the cross-cutting areas of electronics and integration, further DRD collaborations picking up on specific topics should also be anticipated, potentially with an enhanced role for the national labs (involvement of LDG).
- **DRD Collaborations should be anchored at CERN** → CERN recognition, DRD label
(Does not imply that CERN must partake in all; major (national) labs or universities may take the lead in these collaborations)

Establishment of RD Collaborations (cont.)

- Care must be taken in the first instance to establish the proposed new structure **taking full account of existing, well-managed and successful ongoing R&D collaborations.**
(If their R&D programmes are aligned with one or more DRDTs, they can **either form the nucleus of a new DRD collaboration or be integrated into a new one** covering a broader range of topics).

First discussions with larger RD50 and RD51 Collaborations have been held

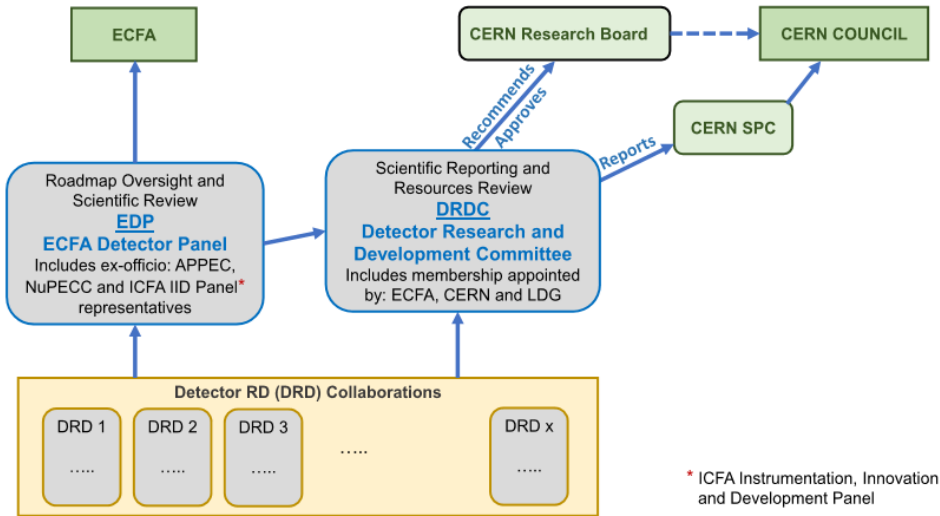
- At an early stage, it will also be important to integrate with other existing activities
(CERN EP R&D programme; relevant EU-funded instrumentation R&D initiatives; collaborations such as CALICE exploring particular technology areas for future facilities)
- The **formation of new DRD collaborations** should adopt a **community-driven approach**

Supported by existing ECFA Detector R&D Roadmap Task Forces;
Instigate calls for R&D activity proposals in the various areas and moderate the process

Goal: establish appropriate DRD collaborations with well-defined scopes, goals and milestones for the coming five years and help the DRD collaborations outline their potential required resources, including projections over longer timescales in terms of money, personnel (FTEs) and infrastructures.

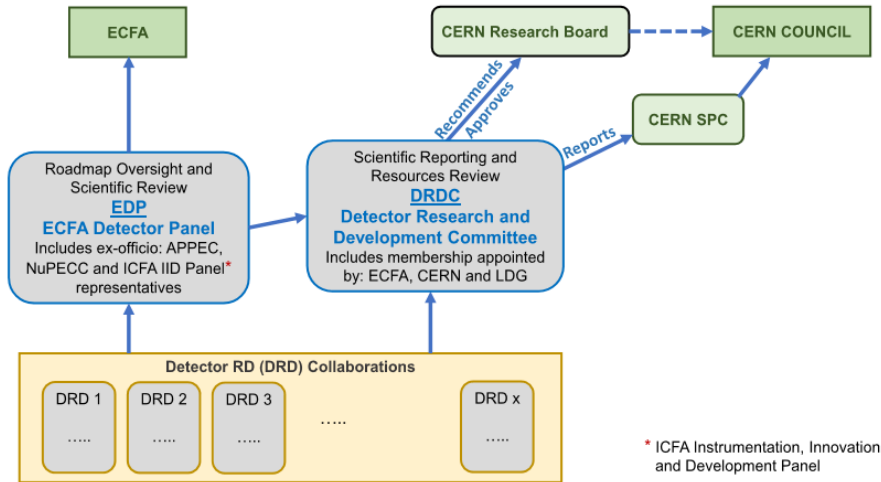
Timeline: 1 – 2 years, however, aim is to start this year

Review and Approval Process



1. ECFA Detector Panel (EDP): the scope, R&D goals, and milestones should be vetted against the vision encapsulated in the Roadmap. (EDP: <http://cds.cern.ch/record/2211641/files/>, exists, hosted at DESY)
2. The resources for detector R&D should be reviewed by an independent body, the Detector Research and Development Committee (**DRDC**), which should include members appointed by CERN, ECFA and the LDG.
The DRDC would make recommendations, while the final approval would lie with the CERN Research Board.

Review and Approval Process



- Final step: approval by a dedicated DRD Resources Review Board, where the funding agencies involved would commit and sign off on any additional required resources, followed by the signing of memoranda of understanding
(a RRB meeting every two years seem reasonable)
- Regular follow-up to monitor the achievements of each DRD collaboration should be carried out on a roughly annual basis by the EDP.
DRDC would utilise these in-depth reviews to report progress on the overall R&D programme once per year to the SPC, whose Chair would in turn report to the Council.

Review and Approval Process

- Budget, milestones, etc., would have to be **adapted as rolling grants for long-term R&D lines**. Budget adaptations every four to five years should be expected, subject to successful review outcomes.
- It should also be possible to adapt research topics, based on the results achieved, or to inject new ideas resulting from emerging developments (e.g. from “blue-sky” research not covered within the DRD collaborations).

EDP would be well placed to approve any justified changes of research topics.

(Roadmap is used as a starting point but adapted based on updated requirements of future experiments, emerging new ideas, etc.)

- As projects develop, **some aspects should be expected to transition into approved experiment specific R&D** (outside the DRD programme)
- The status quo in 2026/27 (and beyond) could immediately provide input for a new Strategy or Roadmap discussion.

2. Detector R&D Roadmap: General Strategic Recommendations

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

First ideas on how to address them have been developed (see backup material);
National Labs should be involved in several aspects, discussions started as well

Next Steps

- We would appreciate to get **your feedback on the proposed structure:**
 - Proposed DRD Collaborations
 - Review, approval and funding process
 - Implementation of the General Recommendations
- Available for (one-to-one) discussions throughout this week

Dedicated discussion meeting with Funding Agencies on Thursday, 28th April at CERN / online

<https://indico.cern.ch/event/1154156/>
- Further discussion with Scientific Policy Committee (SPC) on 2nd May and in June Council week

Backup Slides

2. Implementation of the General Strategic Recommendations

GSR 1: Supporting R&D Facilities

Approved R&D activities should define their **needs in terms of test beams, irradiation facilities and infrastructures for large scale prototyping.**

A **working group** from members of the **EDP and LGD** should consider to what extent this can be fulfilled by existing facilities, what facilities can be consolidated and where new investments need to be made.

Costs should be covered by the major European Labs (or associated University Institutes) and CERN. This working group should be mandated to develop a coherent plan over the next 1-2 years. EU funding programmes for infrastructures should be exploited as much as possible.

GSR 2: Engineering support for detector R&D

A **working group** composed of **LDG and EDP** members could work out how needs could best be covered, what can be taken on by CERN and other major European labs and universities and thereby what level of support could be asked of the respective funding agencies.

RECFA should assess the level of engineering support country by country and encourage appropriate measures, if needed (→ country visits)

GSR 3: Specific software for instrumentation

Software maintenance, updates and further developments should be linked to the suggested **R&D activities**;

These activities need supported positions to carry out such tasks, and it should be explored to what extent this could be jointly accommodated within the major laboratories.

GSR 4: International coordination and organisation of R&D activities

Essentially addressed by the **implementation of a coordinated and coherent R&D structure**.

Collaboration with neighbouring fields can be fostered by **ECFA / RECFA** (where they are represented) as well as via the already established JOINT ECFA-NuPECC-APPEC Seminars (JENAS) (dedicated session on detector R&D)

GRS 5: Distributed R&D activities with centralised facilities

Setting up such a structure is vital and may be integrated for some topics into the DRD programmes to be set up. However, for several important areas and transversal activities, e.g. electronics (ASICs or others) a **dedicated backbone structure** is needed and should be defined under leadership of **LDG** and have involvement of ECFA via the **EDP** and/or other dedicated appointed experts.

The major concern to be addressed is that for several R&D areas (particularly those linked to solid-state devices, microelectronics and on-detector data handling) costs to exploit, adapt and further develop cutting-edge technologies are rising rapidly while the field remains by commercial standards a low volume niche market. Increasingly, costs can only be met through a significant pooling of resources, particularly given the growing complexity and degree of specialisation required of those involved in the device design and the need to negotiate as larger-scale organisations. The proposed new structures would need to have the necessary critical mass to meet these challenges while still sustaining the creativity at smaller institutes.

GRS 6: Establish long-term strategic funding programmes

Essentially addressed by the **implementation of a coordinated and coherent R&D structure.**

GRS 7: “Blue-sky” R&D

“Blue-sky R&D” is essential and should be funded as part of “generic” or short-term funding lines.

The investments in more strategic R&D needs to be in addition to the continued “responsive mode” support of more exploratory proposals through rigorous peer reviewed funding streams.

GRS 8: Attract, nurture, recognise and sustain the careers of R&D experts

On ECFA: stress importance of sustained careers in instrumentation R&D;
A mindset change of physics faculties to hire and funding agencies to finance more technical positions is needed;
ECFA Early Career Researchers panel should be involved in these deliberations.

Improve coordination of training;

Propose core curriculum at Masters level in instrumentation.

GSR 9: Industrial partnerships

To be followed by the **EDP** with the involvement of the present Task Force leaders of the Roadmap Panel.

Will need to build links with existing knowledge transfer units, such as those of CERN, CNRS, Helmholtz Germany, INFN, STFC, etc.

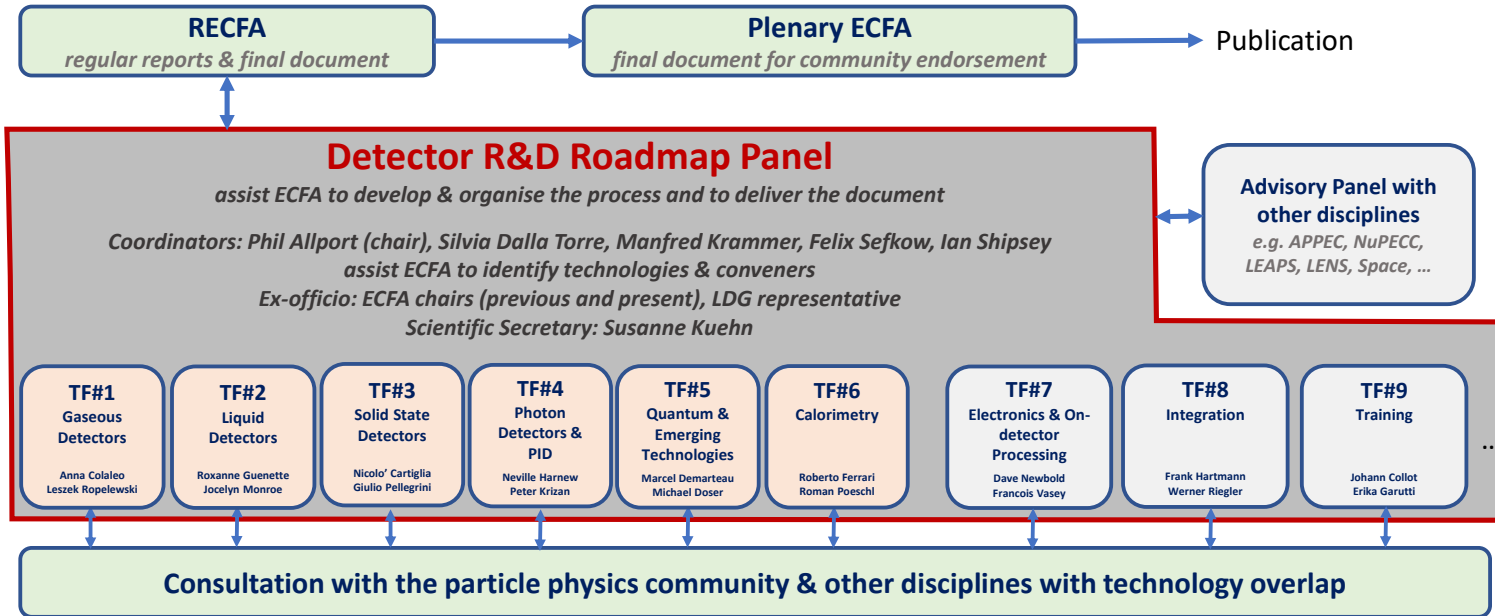
Methods of establishing meaningful longer-term relationships with industrial partners should be explored and barriers due to IP issues, confidentiality and competition rules investigated with help from these bodies, the LDG and national funding agencies.

GRS 10: Open Science

ECFA should get in touch with **SCOAP³** and explore the possibilities to address the issues around instrumentation journals.

Involvement of the knowledge transfer units mentioned above (CERN, CNRS, Helmholtz Germany, INFN, STFC, etc) in facilitating this should also be investigated.

The Detector R&D Roadmap Process



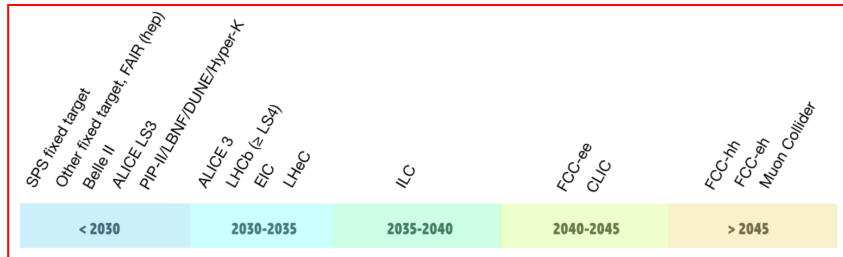
- **Task forces** were composed of experts from the community covering key sub-topics in the relevant technology areas, including **two conveners** (who are part of the Roadmap Panel)
- Progress with emerging technologies in adjacent fields is provided through an **Advisory Panel with Other Disciplines** (→ expert contacts by Task Forces area)

Information on the full process: [ECFA Detector R&D Roadmap](#)

Roadmap recommendations

- **Major Detector R&D Themes (DRDTs)** for each technology area, where **longer-term research** has to be carried out, in most cases directed towards experiments at large future facilities with earlier experiments as important “stepping stones”.

A major guideline was to define the requirements and milestones such that the detector R&D would not be the limiting factor in establishing the next large research projects.

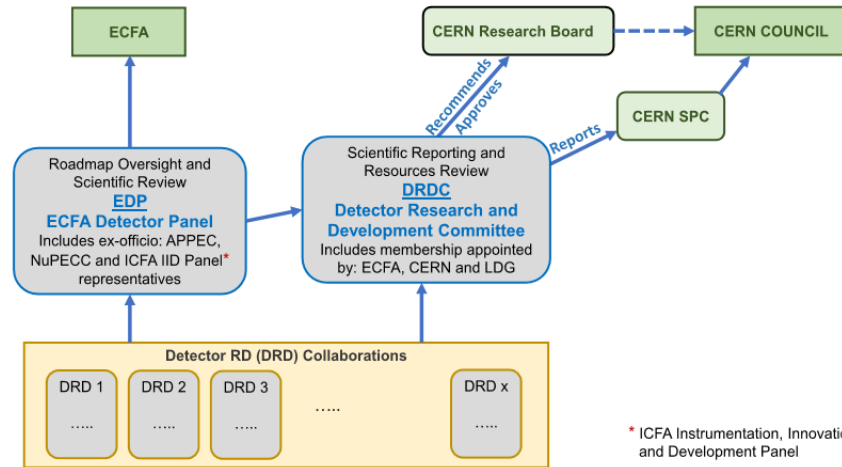


- In addition, community themes have been developed, which finally led to major **General Strategic Recommendations** that must be addressed as well over the forthcoming years.

Implementation:

- In order to carry out the anticipated research programme successfully and in an efficient way both **organisational structures** and **adequate resources** are required.

Summary of EDP and DRDC roles:



EDP:

- Scrutinise the new DRD collaborations' R&D priorities;
- Produce annually updated, in-depth scientific progress reviews;
- Monitor how the goals and achievements reflect the vision encapsulated in the Roadmap DRDTs;
- Keep abreast of the evolving specifications from experiment concept groups as well as proto-collaborations targeting future facilities;
- Link to neighbouring fields (APPEC, NuPECC) and ICFA

DRDC:

- Provide strategic and financial oversight;
- Single body that interacts for approvals, reporting, etc., with the existing CERN committee structure
- Evaluate the initial DRD collaborations' resource requests with a focus on evaluating whether the effort required can be matched by the available effort pledged by the participating institutes;
- Decides on recommendation of approval;
- Scientific summaries of full R&D programme, based on input from EDP