DRD7 Implementation Workshop

- DALL-E2: « Electronics experts in a workshop »
  - *In silico veritas*

DRD7

- DRD: "Detector Research and Development collaboration"
- 7: "Electronics and (on-detector) data processing", meaning:
  - ASIC development
  - Links, powering, cooling
  - Back-end systems ('near-detector' data processing)
- Goals of this workshop
  - Introduce the proposed scope of DRD7 and the route to approval
  - Recall the motivation and relevance of the R&D areas
  - Review selected key topics in each of seven work packages
  - Bring together the community to discuss and debate the next steps
  - Begin organisation of a Letter of Intent to the CERN DRDC, around July 2023
- Organisation
  - (Very) full agenda, but hopefully enough time for discussion
  - Convenors *will* rigorously keep the agenda moving
  - We may have to cut short some discussions, but we will note them and find ways to continue in dedicated follow-up meetings

How did we get here?

ECFA Detector R&D Roadmap Process

Organisation

May 2020
EPPSU mandate to ECFA to develop a roadmap for detector R&D efforts in Europe

Sep 2020
Structure in place with **Detector R&D Roadmap Panel**

Dec 2020
Task Forces active

Website:
https://indico.cern.ch/e/ECFADetectorRDRoadmap

Expert & Community Consultation

Feb 2021
Collection of requirements of future facilities & projects

Feb/March 2021
Questionnaires of Task Forces to national contacts

Task Forces liaise with experts in
- ECFA countries
- adjacent disciplines
- industry

March-May 2021
Open Symposia

Drafting Roadmap & Feedback

May 2021
Task Forces collate input from symposia

25-28 May 2021 **Drafting sessions**
- opening session with all experts involved
- plenary & parallel sessions with Task Force members
- final session of Roadmap Panel

2 July 2021
Near final draft shared with RECFA*

30 July 2021
Presentation at Joint ECFA-EPS session

Until Sep 2021
Collect final community feedback*

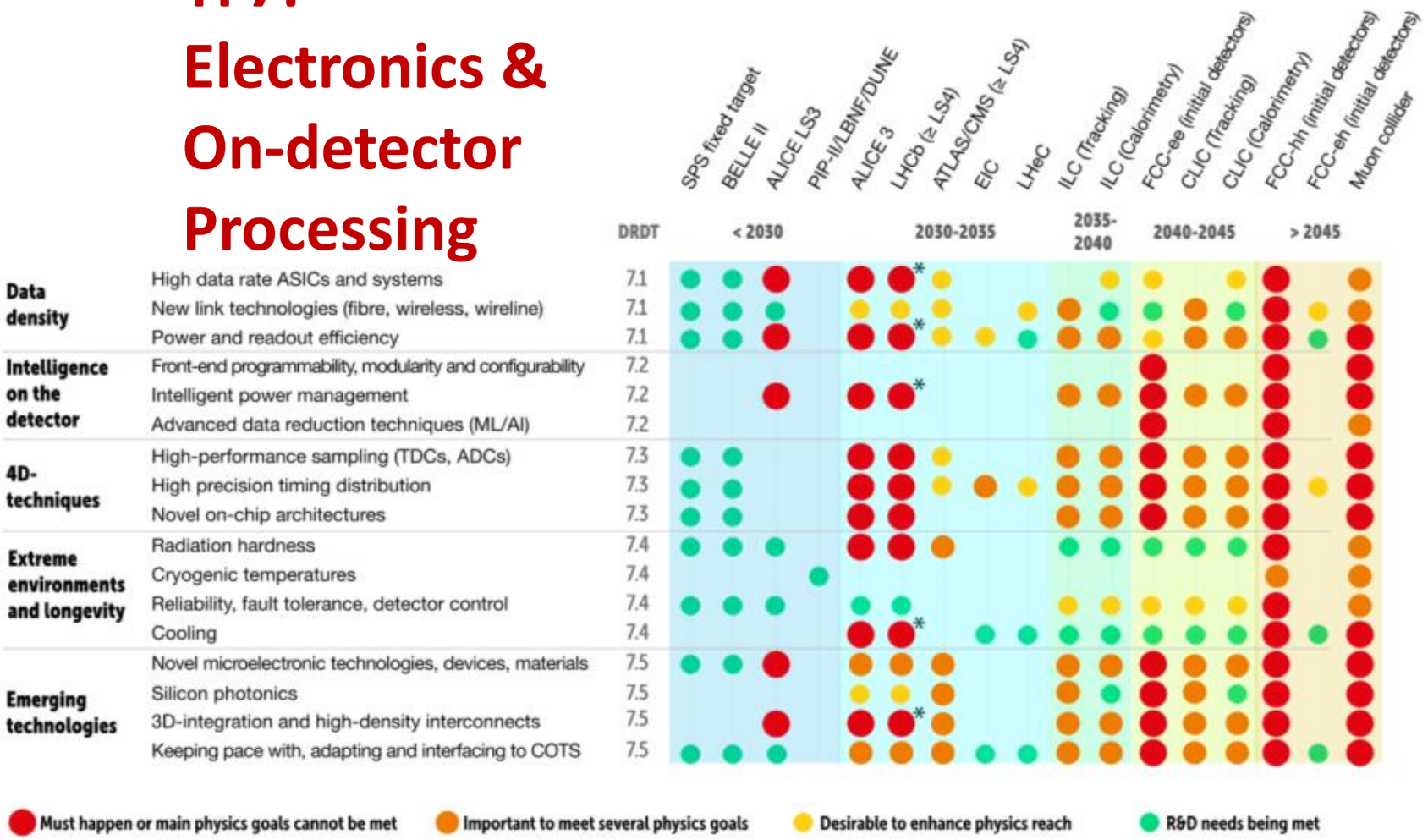
Oct 2021
Detector R&D Roadmap Document submission to RECFA and afterwards to PECFA and Council

*community feedback via RECFA delegates and National Contacts

- ESPPU expressed the need for an intensified and well-coordinated programme of detector R&D towards future detectors and facilities

TF7 Relevance

TF7: Electronics & On-detector Processing

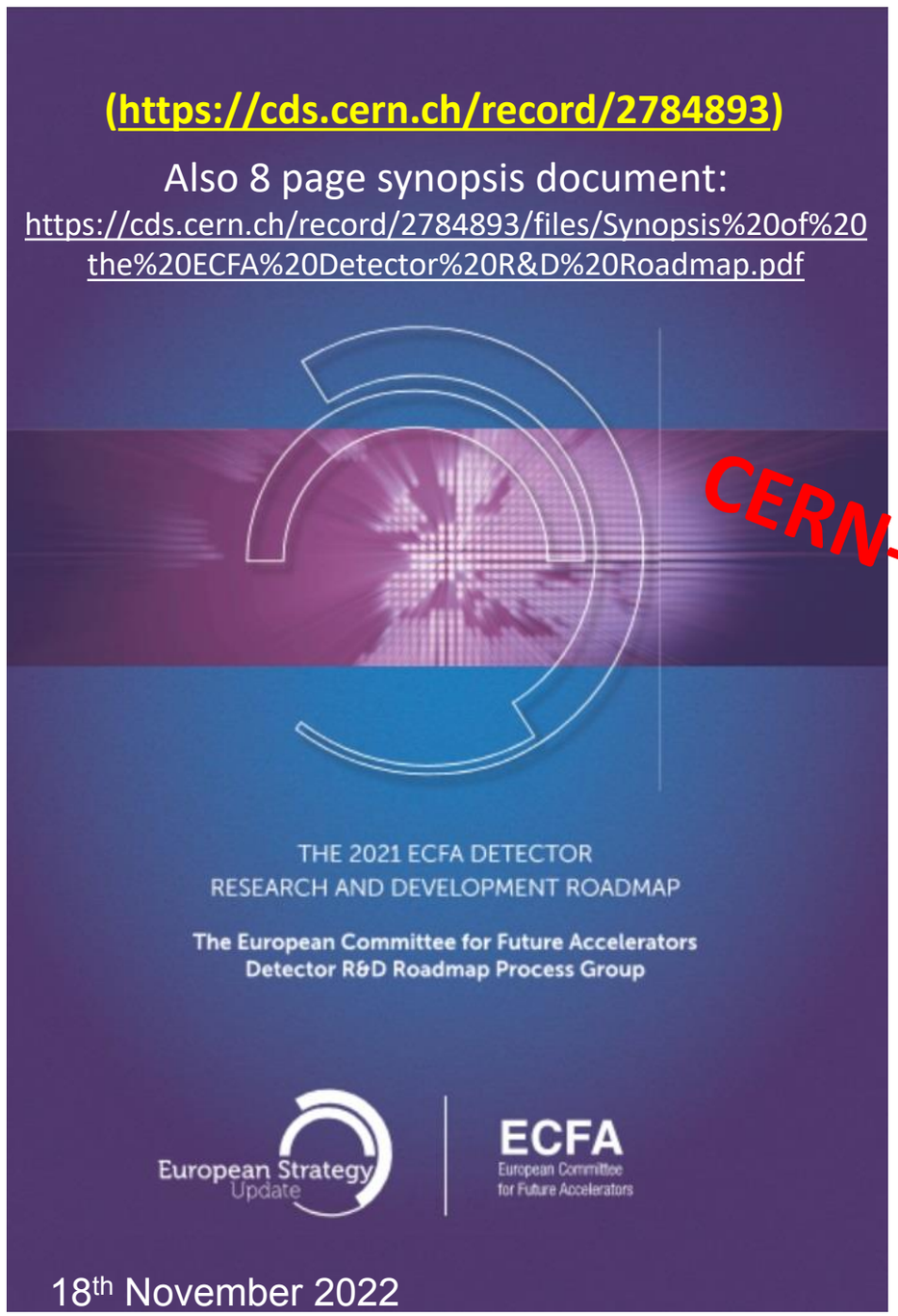


Task Force	TF7	TF8	TF2	TF5	TF3	TF1	TF9	TF4	TF6
Dates	25/3/21	31/3/21	9/4/21	12/4/21	23/4/21	29/4/21	30/4/21	6/5/21	7/5/21
Unique users	369 + 123 (webcast)	154 + 17 (webcast)	197 + 5 (webcast)	220	504	339	105	207	201
Max. number of concurrent viewers	230 + 123 (webcast)	76 + 17 (webcast)	130 + 5 (webcast)	100	275	191	59	110	115

The Roadmap

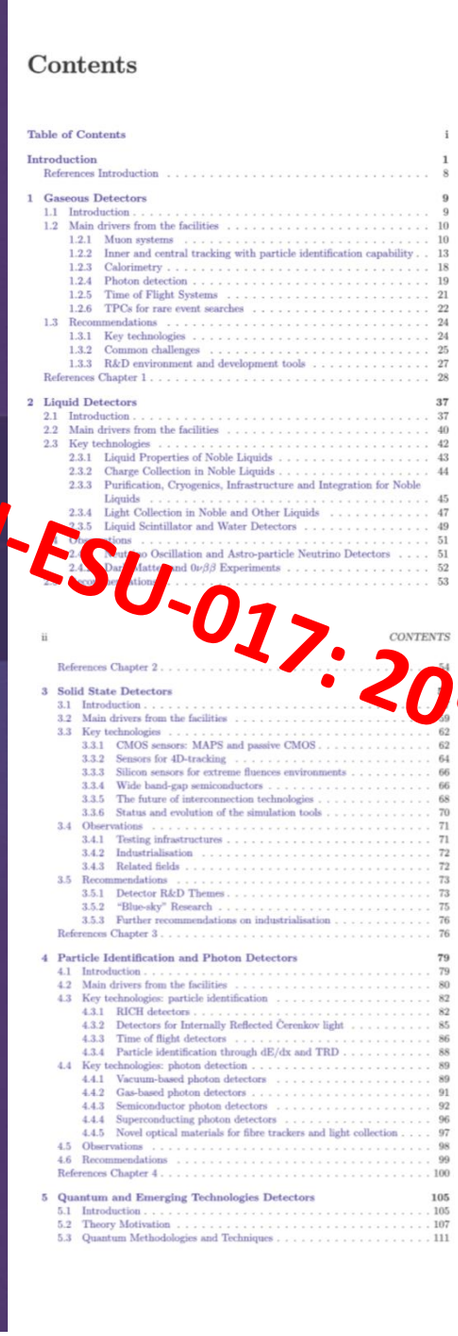
(https://cds.cern.ch/record/2784893)

Also 8 page synopsis document:
https://cds.cern.ch/record/2784893/files/Synopsis%20of%20the%20ECFA%20Detector%20R&D%20Roadmap.pdf



18th November 2022

CERN-ESU-017: 20th December 2021



Contents

Science and Technology Facilities Council

TF7 Section of Roadmap

- Analysis of current situation
- Reflection on recent experiences
- Summary of the state-of-art in three key areas
  - Front-end ASICs; links, powering and integration; back-end systems
- Recommendations of priority R&D areas
  - Five ‘detector R&D themes’
  - Seventeen work areas within the themes
- Discussion on organisational / sociological aspects
- Key conclusions
  - Electronics (broad sense) is vital for everything we will do in the future
  - There are serious challenges ahead of us in all areas
  - Organisation, efficiency, and cost are key areas to be addressed
  - Industry engagement is vital, but industry will not solve our problems

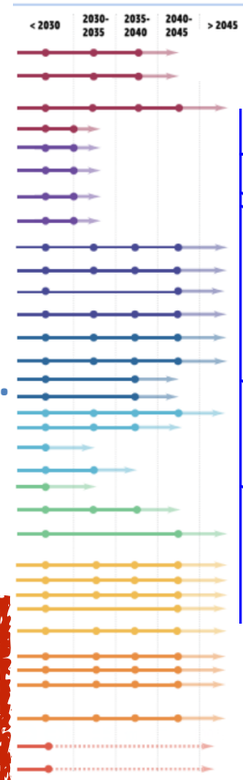
Roadmap DRDTs

ECFA

European Committee for Future Accelerators

Detector R&D Themes

- **The most urgent R&D topics in each Task Force area are identified as Detector R&D Themes.**
- **The timeframe illustration for requirements in each DRDT area, in both the brochure and the main document, are based on the more detailed information and charts in the individual chapters.**



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

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

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 8.2** 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

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Updated DRDTs

- Seven detector research and development themes
  - DRDT 7.1: Data density
  - DRDT 7.2: Intelligence on detector
  - DRDT 7.3: 4D techniques
  - DRDT 7.4: Extreme environments and longevity
  - DRDT 7.5: Emerging technologies
  - "DRDT" 7.6: Monolithic sensor ASICs (new)
  - "DRDT" 7.7: Technologies and tools (new)
- Starting proposal is that these map onto WPs of DRD7
  - The optimal organisation of topics will hopefully emerge in the workshop
  - Challenge and opinions are needed and expected
- Clearly many links / overlaps between areas
- There are many interesting topics not covered here
  - 'Blue skies' R&D is vital, but not in the scope of DRD7
  - Engineering and design of project-specific systems covered elsewhere
  - But of course, a strong overlap in people and institutes

General Recommendations

In addition to the Detector R&D Themes described above and discussed in each chapter the following General Strategic Recommendations were made under the following headings.

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

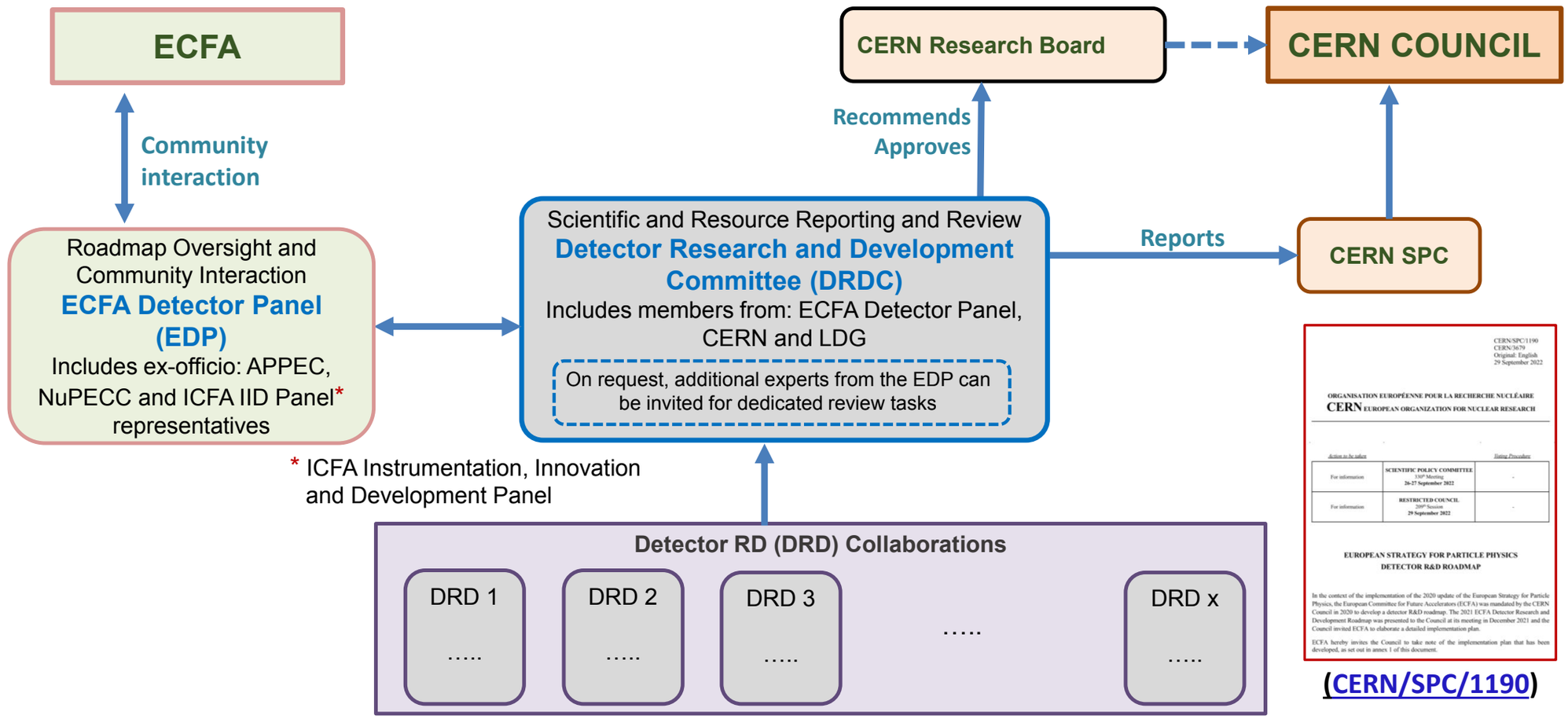
- Several of these are specifically relevant to electronics
  - Noting that electronics underpins all other roadmap activities
  - Need support and coordination both in our own community…
  - … and with other interest areas (e.g. silicon, calorimetry, etc)

Relationship to Other Developments

- Important to identify a common position on sharing of the work
- What DRD7 must do:
  - Provide a forum for discussion of common topics in electronics, and a funded route to develop common tools, methods, and IP
  - Pursue R&D towards future technology nodes
  - Sponsor, encourage, and facilitate common approaches
  - Provide facilities and effort towards full-system demonstrators beyond the scope of individual projects
  - Coordinate cross-European access to the necessary tools, vendors, and knowledge
  - Apply collective knowledge to review major developments across the R&D landscape, as requested and required
- What DRD7 cannot do:
  - Act as a 'design service' for project-specific developments
  - Make prioritisation decisions on electronics in other projects
  - Own the specialised design requirements from advanced R&D in sensors or detectors
- Important note: DRD7 is not just ASICs
  - A huge amount of effort, skill, and attention needed for common 'back-end' also

Next Steps

- The DRD7 collaboration seems viable and necessary
  - Step 1: Community engagement and workshop
  - Step 2: Letter of Intent to DRDC
  - Step 3: Full costed proposal for an R&D collaboration
  - Step 4: An open door to new ideas and proposals



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 130th Meeting 26-27 September 2022	-
For information	RESTRICTED COUNCIL 205th 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.

(CERN/SPC/1190)

Funding and National Picture

- How will funding arrive for electronics R&D?
  - Through DRD7 specifically, for stand-alone R&D and support
  - Through other DRDs for specific developments
  - From labs and institutes to support their engineering teams
  - These routes are all important, all need support, all need attention of the FAs
- Interplay with national funding processes
  - FAs have indicated broad approval for a coordinated R&D programme
  - DRD7 underpins ~everything else, need to make a clear case for support
  - DRDC approval important as evidence for national support
  - The 'Tier model' may be an important route here
    - National labs: large teams of specialists, working across a range of projects and technologies
    - Institutes: smaller teams, with long-term leadership of specific R&D developments
    - Users: access to the latest technologies, devices and engineering expertise
- Our primary job is to ensure a coherent, organised, well-funded electronics community for the benefit of all
  - Now we have to collectively address the practical steps

Finally…

- Thanks from Francois and Dave to all organisers and participants
- Coordinating team
  - Jerome Baudot, Marcus French, Angelo Rivetti, Frank Simon
- Adminstration
  - Cinzia Pinzoni
- Session convenors
  - Marlon Barbero, Sophie Baron, Guilio Borghello, Michele Casella, Davide Ceresa, Francesco Crescioli, Manuel Da Rocha Rolo, Oscar Augusto de Aguiar Francisco, Conor Fitzpatrick, Marek Idzik, Kostas Kloukinas, Szymon Kulis, Adriano Lai, Xavi Llopart Cudie, Frederic Magniette, Irakli Mandjavidze, Niko Neufeld, Jeffrey Prinzie, Patrick Robbe, Ian Sedgwick, Walter Snoeys, Jan Troska, Mark Willoughby
- Final remarks
  - Please keep to time!
  - Please bear in mind our immediate goal!
    - To define a structure, working model, and initial set of R&D topics for our Letter of Intent
  - Please have a great workshop!

Backup

TF7 Input

- Survey to the community, January 2021:
  - https://drive.google.com/file/d/1m7ltXMF85lQFSTtT8s2DQMAMfwJzG3RR/view
- Input sessions from future facilities, February 2021:
  - https://indico.cern.ch/event/994685/
  - https://indico.cern.ch/event/994687/
- Day-long community symposium, March 2021:
  - https://indico.cern.ch/event/1001692/
- TF7 engagement
  - Second largest number of participants in the symposium (#1: TF3, silicon)
  - The largest number of written submissions
  - The largest number of 'red dots' in the mapping to future facilities
- Conclusion: community is able, waiting, and required to engage!
  - Gives some confidence that a substantive and useful collaboration can be formed
  - But: the challenges of electronics are as much organisational as technical