

# DRD7 Implementation Workshop



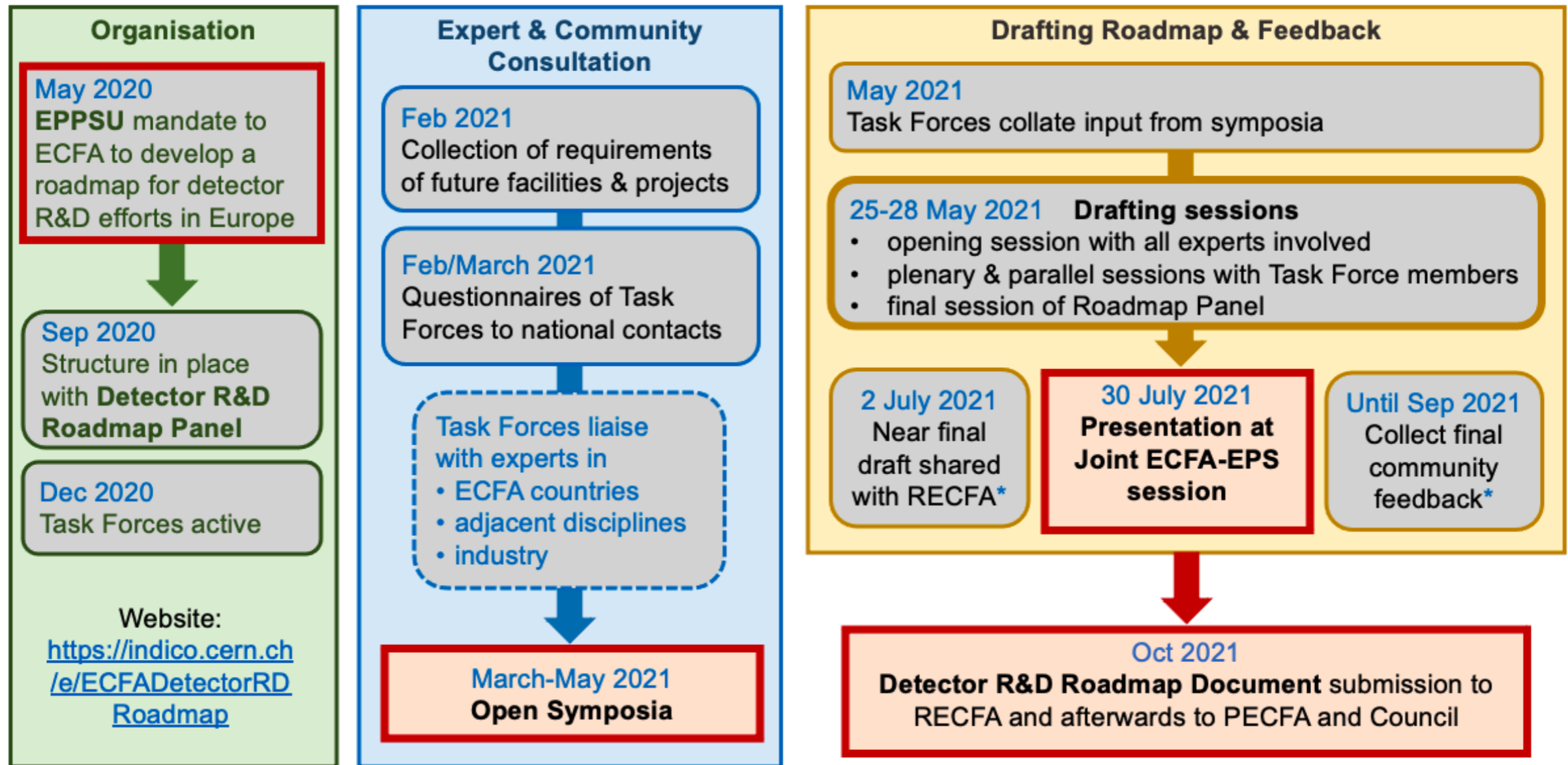
- ▶ DALL-E2: « Electronics experts in a workshop »
  - ▶ *In silico veritas*

# 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

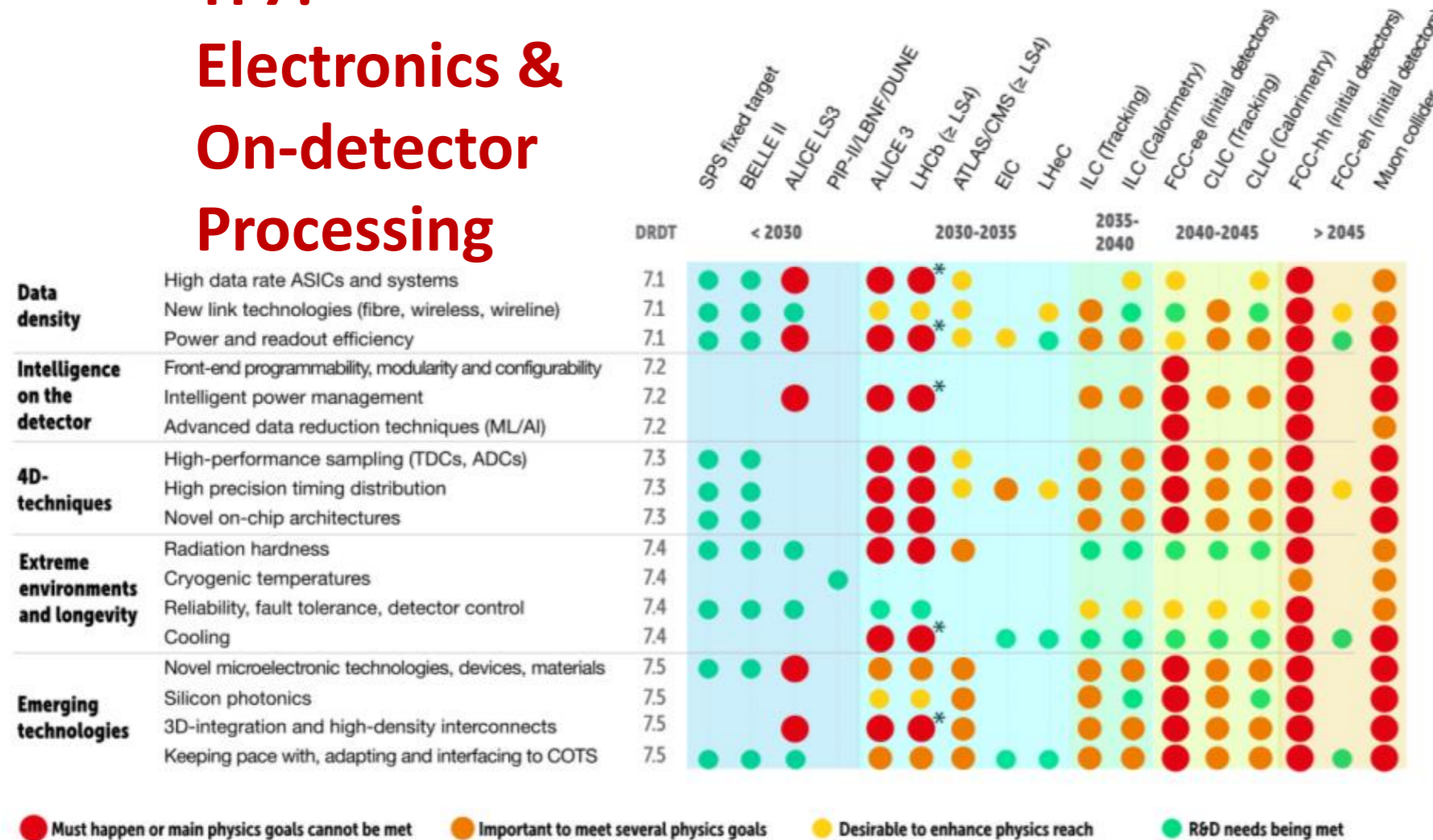


\*community feedback via RECFA delegates and National Contacts

- ▶ 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>



THE 2021 ECFA DETECTOR  
RESEARCH AND DEVELOPMENT ROADMAP  
The European Committee for Future Accelerators  
Detector R&D Roadmap Process Group



**ECFA**  
European Committee  
for Future Accelerators

18<sup>th</sup> November 2022

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# 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

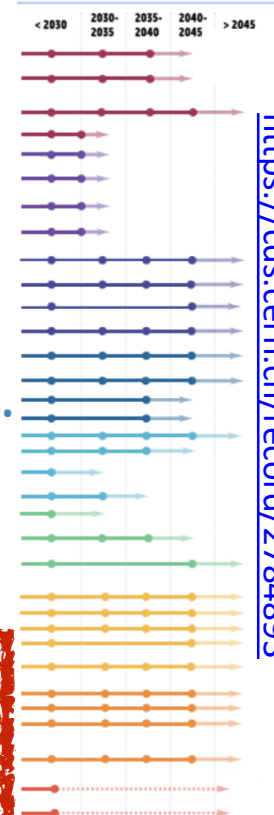


## Detector R&D Themes

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

- 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.

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



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

# 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**

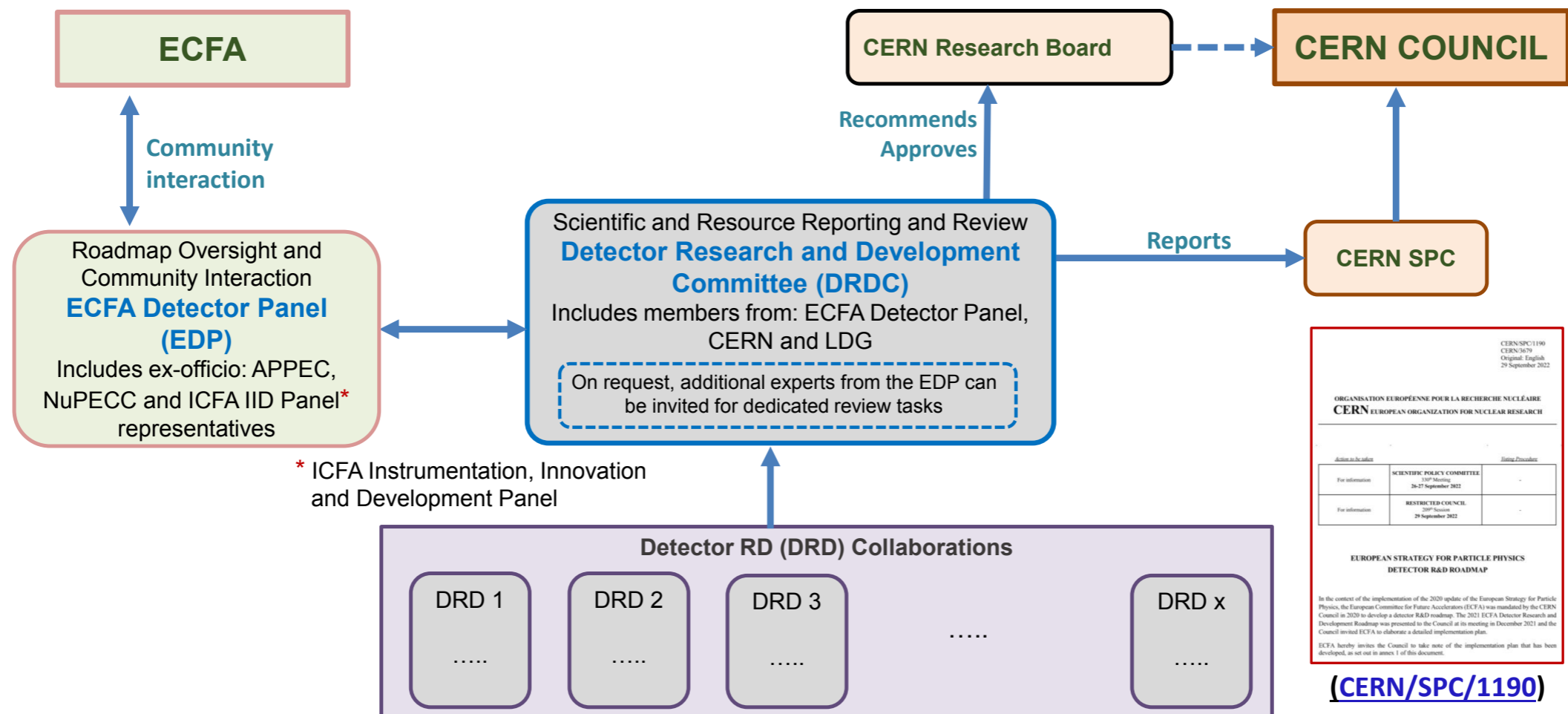
- ▶ Several of these are specifically relevant to electronics
  - ▶ Noting that electronics underpins all other roadmap activities
  - ▶ Need support and coordination both in our own community...
  - ▶ ... and with other interest areas (e.g. silicon, calorimetry, etc)

# 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



# 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
- ▶ Administration
  - ▶ Cinzia Pinzoni
- ▶ Session convenors
  - ▶ Marlon Barbero, Sophie Baron, Giulio 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