Strategic Detector R&D Proposal

- European Strategy
- Detector R&D Roadmap
- PPTAP review
- R&D proposal and outcomes
- Questions and next steps

- May thanks due to Phil Allport, who led the R&D Roadmap process

- Executive summary
  - A broad programme of 'Strategic detector R&D' is planned at European level
  - Enthusiasm in the UK community to participate, but STFC position on funding is unclear
  - Application to the Infrastructure Fund rejected by PPAP and PAAP
  - Next steps are not obvious, but need to be taken quickly
    - DRD collaborations are being set up in the coming months

European Strategy

ECFA
European Committee for Future Accelerators

Detector R&D Roadmap

European Particle Physics Strategy Update

"**Main report**: ***"Recent initiatives with a view towards strategic R&D on detectors are being taken by CERN's EP department and by the ECFA detector R&D panel, supported by EU-funded programmes such as AIDA and ATTRACT. Coordination of R&D activities is critical to maximise the scientific outcomes of these activities and to make the most efficient use of resources; as such, there is a clear need to strengthen existing R&D collaborative structures, and to create new ones, to address future experimental challenges of the field beyond the HL-LHC. 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."***

Deliberation document: ***"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."***

Extracted from the documents of 2020 EPPSU, https://europeanstrategyupdate.web.cern.ch/

More roadmap process details at: https://indico.cern.ch/e/ECFADetectorRDRoadmap

Detector R&D Roadmap Process

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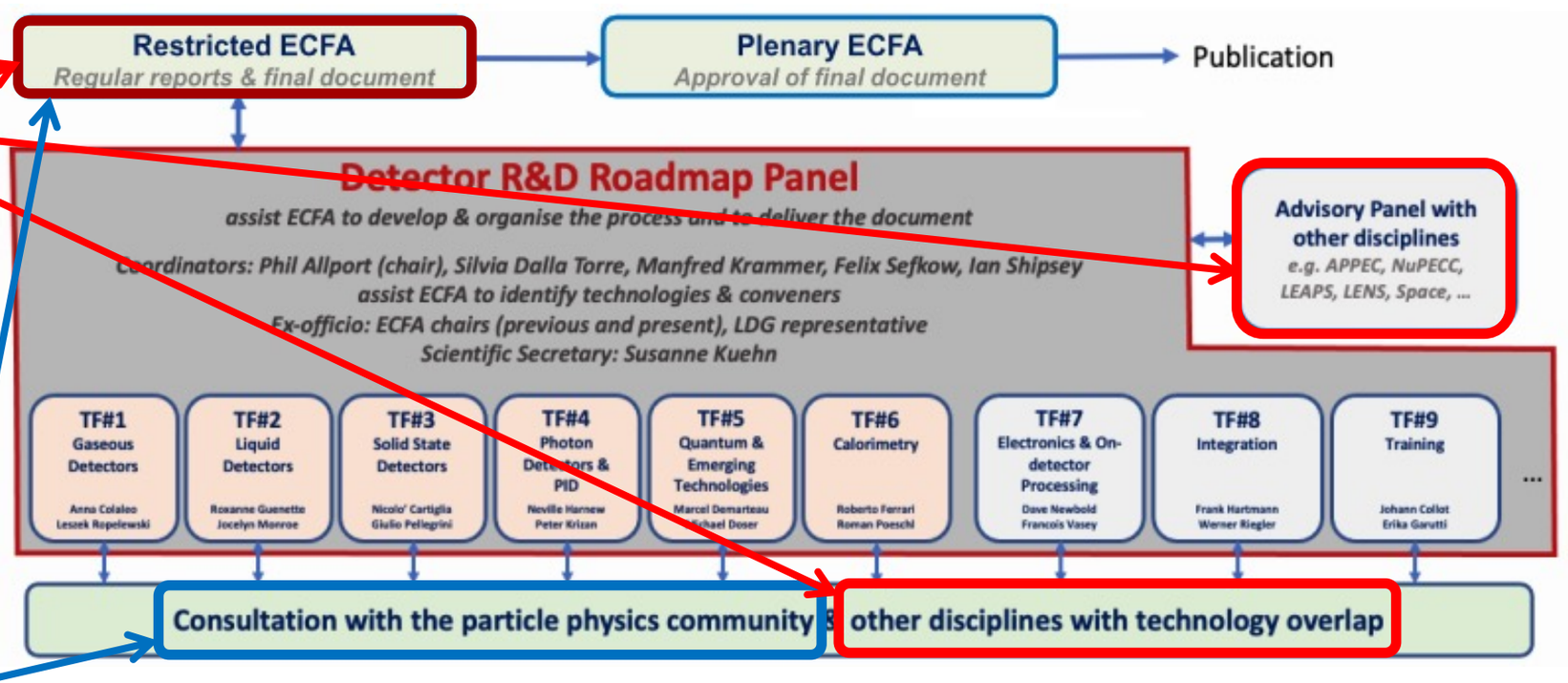
Roadmap Organisation

***"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 community should define a global detector R&D roadmap that should be used to support proposals at the European and national levels"* ***

ECFA Detector R&D Roadmap Panel web pages at:
https://indico.cern.ch/e/ECFADetectorRDRoadmap

*** 2020 European Particle Physics Strategy Update**
https://europeanstrategyupdate.web.cern.ch/

- UK co-led three working groups, plus overall leadership (Phil)

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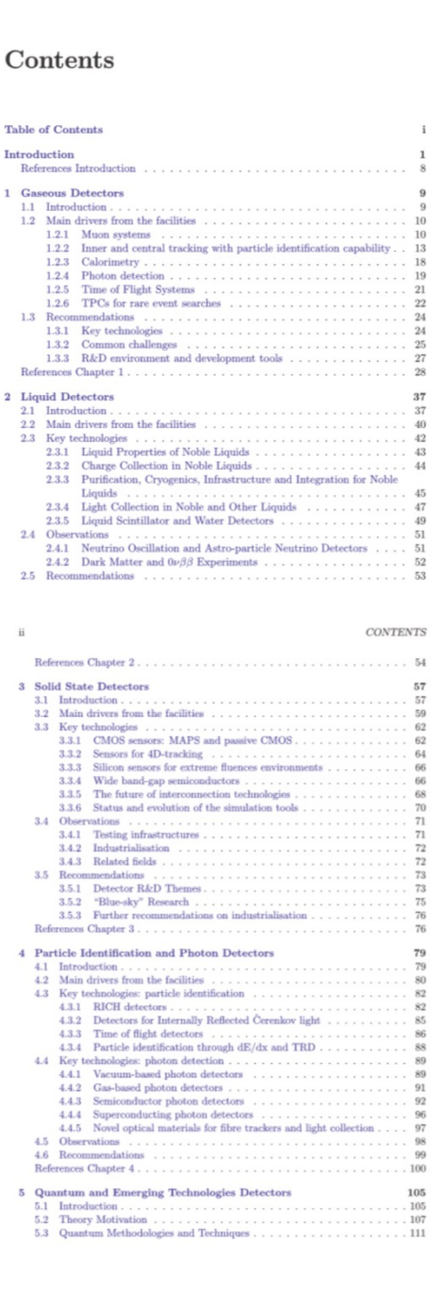
R&D Roadmap

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



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- Received by CERN Council, December 2021

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Roadmap Content

ECFA

European Committee for Future Accelerators

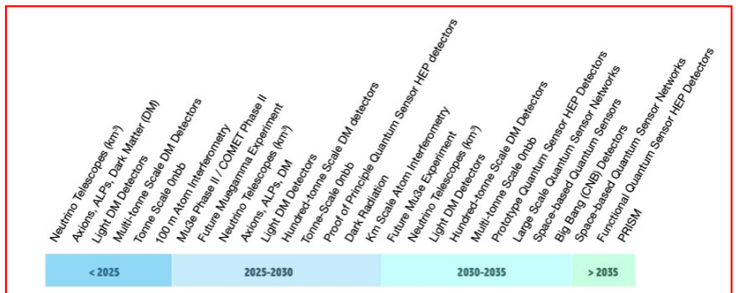
Detector R&D Roadmap

Roadmap process involved: 67 authors; 12 expert Input Session speakers; ECFA National Contacts; respondents to the Task Force surveys; 121 Symposia presenters; 1359 Symposia attendees as well as 44 APOD (Advisory Panel with Other Disciplines) Task Force topic specific contacts.

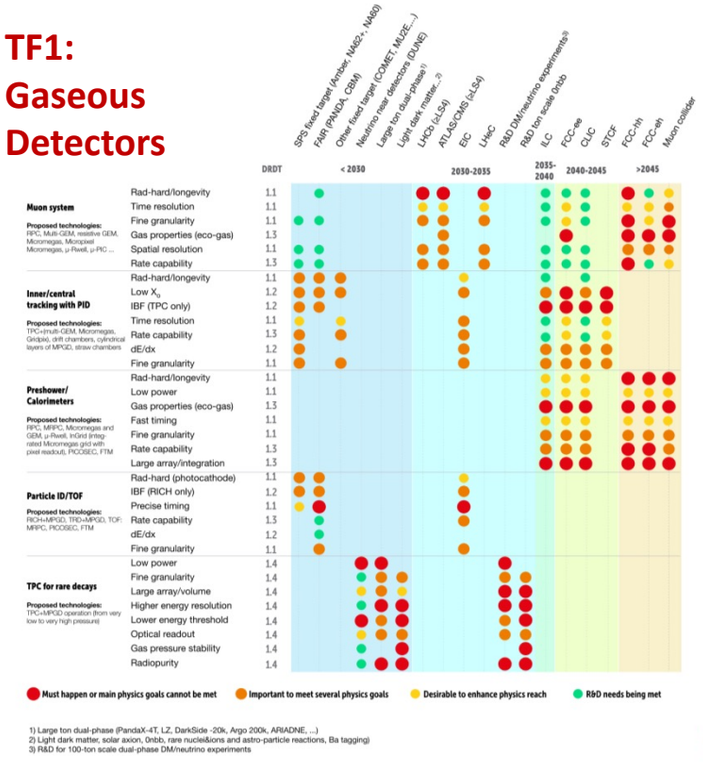
248 page report and 8 page synopsis document identifying the most urgent R&D topics or activities for meeting the EPPSU listed programme in the 9 Task Force Areas.

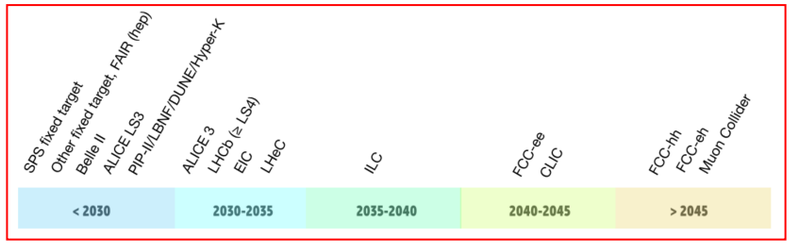
(https://cds.cern.ch/record/2784893)

Example non-accelerator dates (not complete)

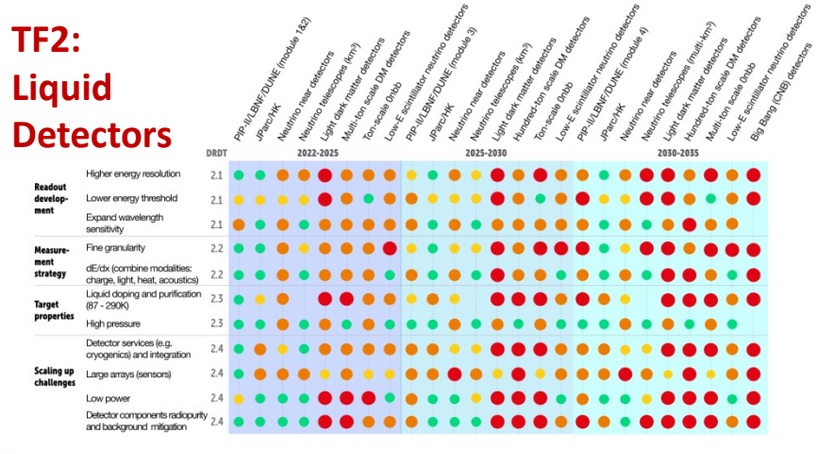


TF1: Gaseous Detectors

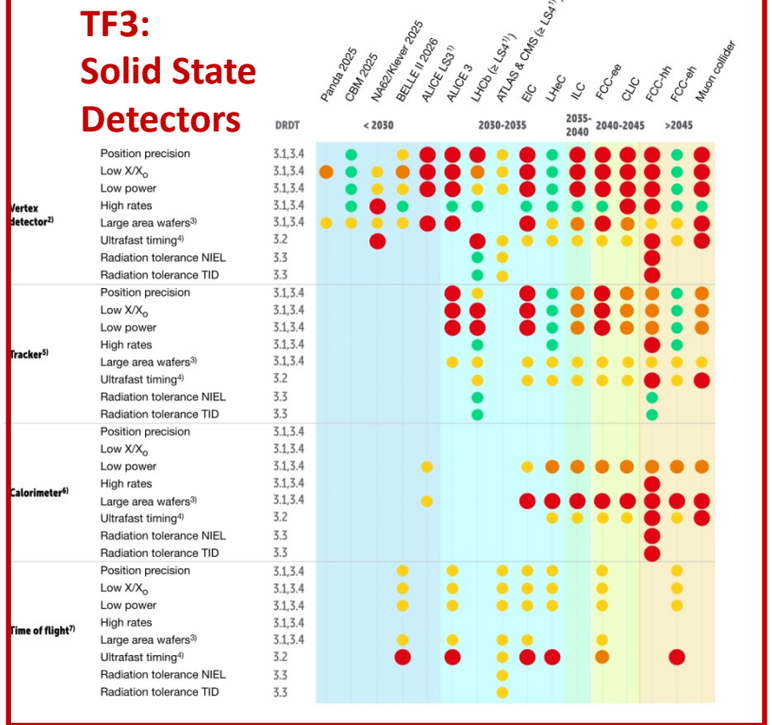




TF2: Liquid Detectors



TF3: Solid State Detectors



Must happen or main physics goals cannot be met
Important to meet several physics goals
Desirable to enhance physics reach
R&D needs being met

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Outcomes – Broad Brush

- The new focus needs to be on 'Strategic R&D'
- All varieties of R&D are needed to deliver projects
  - 'Blue skies R&D' (low TRL): new concepts, small demonstrators, small teams (with good support)
  - 'Strategic R&D' (mid TRL): developing systems and prototypes, investigating cost / performance, larger teams with involvement of industry
  - 'Project R&D' (high TRL): developing detector for specific experiments / applications, full collaborations with substantial funding, industry as suppliers
- Collective and coordinated work will be needed
  - Cost / scale / complexity is growing beyond the capacities of any group
  - Effective / efficient access to specialised tools and facilities is needed
- We need to begin 'now'
  - Yes, this is 'in tension' with current construction projects
    - These projects will soon end their R&D phase and experts will naturally become available
  - A ramp-up rather than a big bang is needed
  - With tight resources, the value of a well-coordinated programme is manifest

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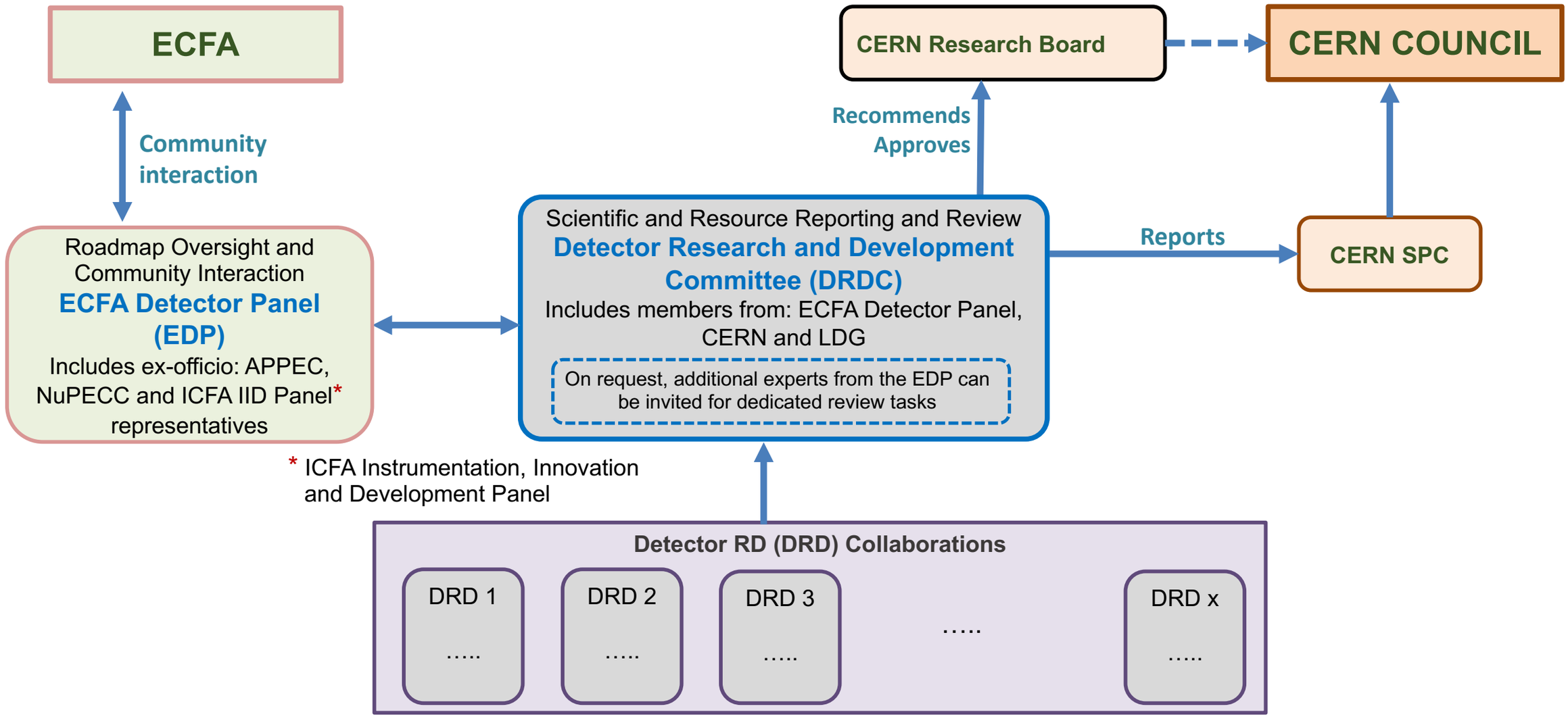
CERN DRD Collaborations

ECFA

European Committee for Future Accelerators

Suggested Implementation and Review Organisation



- DRD collaborations will be setup during 2023, begin work in 2024

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PPTAP

- STFC set up an advisory panel to consider our response
  - Ably chaired by Paula Chadwick, ~12 particle physicists involved
  - "The purpose of the Particle Physics Technology Advisory Panel (PPTAP) is to …produce a coherent UK position on the development of the R&D roadmaps related to the European Strategy for Particle Physics Update. … the UK will benefit from a coherent and strategic approach to future R&D in these fields"
- Key recommendations
  - The UK must respond to complement the implementation of the … R&D roadmaps by undertaking an STFC-funded programme of long-term ADSC technology R&D
  - A funded framework be implemented by STFC to both direct and respond to community and STFC requirements… with a selection of directed responsive mode funding opportunities available for HEIs, National Laboratories, and other PSREs, and encourage low-TRL co-development with industry.
  - Any funding … should be in addition to funding allocated to current and future activities within the broader PP programme
- TAAB (on a par with Science Board, for Technology)
  - TAAB urges STFC to initiate a call in the coming months for R&D specifically targeted at the roadmaps and participating in European or global R&D programmes, aimed at (re)directing future funds (in-house and programmes directorate) in a more strategic manner.

What do the UK Roadmaps Say?

- PPAP
  - Essential to have a broad portfolio of projects to efficiently balance R&D phases for future programmes from the dedicated production builds
  - Maintaining a balanced portfolio is key to enabling technology and skills exchange
  - The R&D activities relevant for the HL-LHC should serve as a basis for the detector development relevant for future colliders
  - Investment in appropriate R&D on detector and accelerator technologies/systems … will position us to take a leading role in e +e − collider physics
  - Should maintain leadership during R&D, construction and exploitation of Direct DM Detectors
  - STFC should facilitate access to funding opportunities for [basic R&D], where possible using external funding streams
- PAAP
  - An effective and cost efficient mechanism could be to provide funding for long-term technology development in areas applicable to a larger number of the upcoming projects… larger, technology-focussed grants which could fund centres of excellence comprising either single or a distributed network of institutes.
  - A new mode of larger scale technology programmes which would assemble expertise to develop high impact technologies with application across multiple projects and fields

What Happened Next?

- FCC and ILC meetings in ~July
  - Broad consensus that generic (strategic) R&D is a key part of the preparations for whichever collider project comes next
  - Agreement to construct a position paper
- Funding
  - Clear that to make an impact, funding at the £Ms per year is needed
  - Infrastructure Fund is the only current game in town for this type of funding
  - Decision to speculatively submit a proposal for an 'R&D programme' to the IF call
    - The fit to IF (which is usually for large capital projects) is not clear
    - We effectively asked PPAP and PAAP to make a judgement on that and provide feedback
    - Note that non-STFC Councils have received funding for 'research networks' that look quite different to our traditional projects
- Proposal is attached to the agenda
  - Draws somewhat on the PPDTC proposal of 2018
  - Around 60 authors, almost all UK institutes represented
- Result: proposal rejected as an IF priority by PPAP and PAAP 😐
  - On reasonable grounds in both cases – not here to question the prioritisation decision
  - We have therefore missed Waves 3 /4 of IF -> no funding from this source until 2025

R&D Proposal: Objectives

- Develop and sustain a world-leading capability for advanced detector technology R&D in the STFC research community
- Facilitate continued UK leadership in the European R&D programme, and subsequent resulting leadership in next-generation experiments
- Construct and support specialised facilities at UK institutes, supporting international capability in detector development
- Identify routes for rapid application of new detector technologies across national facilities, academic disciplines, and industry
- Support co-development of technologies with UK companies, leading to enhanced economic return from international investments
- Transform skills development, training and career prospects for technology-focussed early career researchers in STFC core science

R&D Proposal: Scope and Outcomes

- Scope
  - Matched (in principle) to the scope of the European Roadmap
  - Accepts that some prioritisation will be needed, but does not make recommendations on which R&D topics are the priorities
    - This is for peer review, look at a wide range of practical and strategic criteria
    - Clearly the question of focus and 'critical mass' comes into this – this is not PRD
  - Explicitly covers both PP (collider, flavour, neutrinos) and PA (DM, quantum)
  - Focussed on both people and the required facilities in labs and institutes

- Outcomes
  - Proposals via the STFC Visions process for follow-up project R&D and construction of new instruments
  - Supply of high-technology deliverables to international projects, either as UK buy in or via contracts
  - Interdisciplinary proposals for application of technology in non-STFC areas, either via the UK's national facilities or within institutes
  - Exploitation of IP within industry via licenses and other agreements
  - Direct employment of trained people in industry.

R&D Proposal: Plan and Resources

- Three main threads
  - A number of medium-scale R&D projects, within the context of the European Roadmap
    - i.e. facilitating and supporting UK leadership in the DRD collaborations
    - 'Medium scale' means £1M+ per year per project, sustained in the long term
  - Funding stream explicitly for interaction with industry
    - Including development of a coherent and focussed 'offer' to UK industry
  - Distributed CDT in detector technology and data-handling
    - CDT in the sense of cohort training and industry involvement; but across many institutes

- Resources
  - Some new money is clearly needed to get going – estimate £3M pa
    - Note that we do NOT need money in the coming year other than travel, etc
  - Since there are no new core-funded construction projects on the roadmap, addition resources will become available post-2026
  - Estimate that a sustained level of £10M per year would allow UK leadership in targeted areas
  - Note that other comparable countries are already spending far more than this
    - And planning additional investment in the context of the European Roadmap

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UK Future Silicon R&D Workshop

- Ably convened by Laura and Jens… wide UK attendance
  - Genuine cross-section of the community from both universities and labs
  - https://indico.stfc.ac.uk/e/UKTrackerRnD

Future UK Silicon Vertex & Tracker R&D

- Earlier this month, we got together in Birmingham to scope out what is currently being done in the UK and where we want to go with tracking seeking:
  - Strategic R&D funding
  - Industry support
  - UK leadership
- The (rather large) UK tracker community wants (and needs) to transition into strategic R&D, rather than project driven specific development
  - Retaining expertise
  - Better opportunity for generic IP generation
  - Future proof - we do currently **NOT** know what the next big project is specifically
- All discussion seemed very much in line with the Detector R&D proposal that has been around for a bit

UK Future Silicon R&D Workshop

Workshop Summary

- As a whole the UK wants to work on all aspects of a future tracker/vertexer system, with the goal of being able to deliver, largely unaffected by external inputs
  - Frontend
  - Mechanics/Cooling
  - Services/DAQ
  - Software
- We need to keep this discussion alive!
- General agreement with the idea of pushing for strategic R&D funding to be made available (Remember, neither blue skies, nor project bound)
  - Scope/branching points along a strategic R&D route still need to be firmed up
- Specific directions that we agreed on:
  - 28nm IP developments
  - 3D integration

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Questions and Comments

- Do we actually have a consensus behind this approach?
  - Strategic R&D programme *will* be in tension with other projects in the medium term
- Do we agree on the points made in the proposal?
  - Well aware that this was done in a hurry, with limited consultation; other points have come up
  - UK test infrastructure; channelling of grants to mid-career people; link with 'blue skies' R&D
- Is this really a good fit for IF?
  - The 'new standard model' of funding would suggest that R&D lives within the core programme
- Do we have ideas or preferences on what to do next?
- My current thinking
  - Ask STFC (Science Board) to clearly re-state its position on strategic R&D and the funding for it
    - Even if no immediate $, this could provide backing for UK to begin carving out roles / leadership in DRD collaborations
  - Ensure that (a new) proposal is brought to the attention of Science Board / TAAB (via an SoI?)
    - Although we are not prioritised for IF, this could still move the discussion forward a little
  - Push for inclusion in the STFC Visions Process for consideration in future IF rounds
    - Could be via 'SB route' or the 'National labs route' – either way, it will need prioritisation by advisory panels
    - Note: no money until >2025 via this route, and no certainty even of that – but other routes may open up
  - Begin fleshing out in the community our priorities and potential projects
- But: we have about three months before DRD setup begins in earnest