Strategic Detector R&D Proposal

History to date: Europe

- European roadmap 2020 mandated new programme of strategic R&D
- ▶ Substantial work in 2021/22 to define an R&D roadmap
- Roadmap accepted by Council and new DRDC panel set up to evaluate proposals to form new collaborations – now under way

History to date: UK

- PPTAP reported to TAAB on the scope and motivation of future R&D
- Proposal for strategic R&D presented to STFC via PPAP in September 2022
 - ▶ Deemed relevant / plausible, but not suitable for Infrastructure Fund submission
 - ▶ Broad community support for the proposal from both PP and PA communities
- After extensive discussion, there is opportunity for SoI in September 2023
 - ▶ Money *potentially* available in FY24/25, but we will need to make a very strong case
 - ▶ STFC will require an organised project that can be reviewed / tensioned by the PPRP

DRD7 discussion points for today

- There is a problem to be solved: do we agree?
- There is likely to be money in the UK; do we have a community to access it?
- What are our priorities and focal points? What do we want to do?
- How do we get organised?



UK 'Electronics' Situation

- Historically, this area is a UK strength
 - Evidence: we lead / have led TDAQ for countless experiments
 - ▶ Today: CMS, ATLAS, DUNE, Hyper-K, plus substantial contributions to others
 - Genuine 'strength in depth' at UK universities and labs
 - Good cross-over with other big science activities (e.g. astro, light sources)
- Very little 'top down' organisation in recent years
 - Tends to be somewhat project-focussed
 - ▶ Exception may be FE ASICs, where capabilities at RAL and elsewhere are used across projects
 - ▶ Even here, the future prospects / needs are not well established
 - UK leads support (via Europractice) of CAD tools across the field
 - Age profile is worrying, new skills (e.g. online SW-HW interface) needed
- What can we do? What should we do?
 - Limited UK participation in TF7, but people have stepped up for DRD7
 - Urgently need a discussion on these topics before the coming DRD7 workshop
 - Not least because we will need to support developments in other DRDs



Strategic R&D

- A spectrum of R&D is 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
- This proposal does not replace or reproduce PRD
 - ▶ Blue skies R&D will be supported via other means
- Collective and coordinated work is 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, R&D is in tension with construction projects
 - ▶ However, these projects are now ending their R&D / setup phase and experts will need new roles
 - ▶ A ramp-up rather than a big bang is needed though planning cannot wait
 - With tight resources, the value of a well-coordinated programme is evident



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 industry, 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 (other than the R&D deliverables themselves)
 - 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

- 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

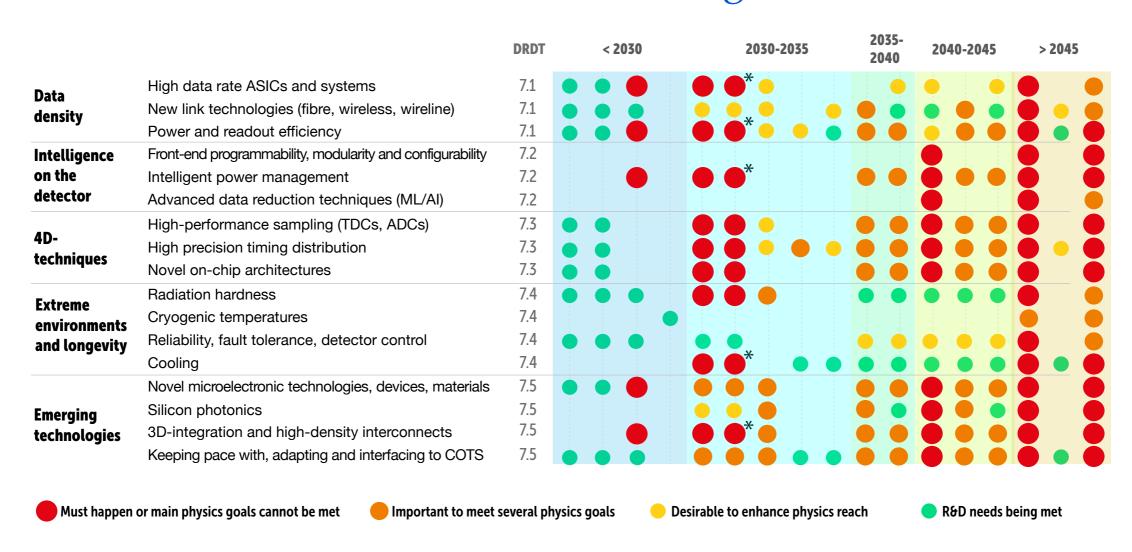


Pause



DRD7 Outlook

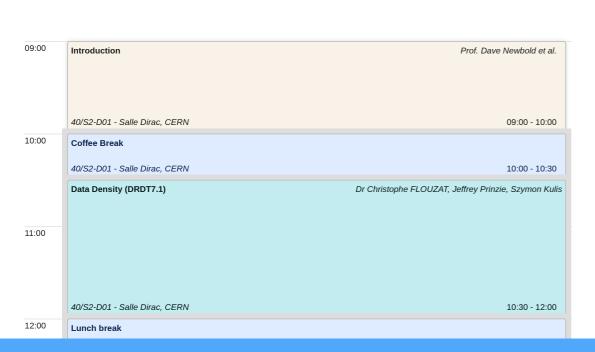
DRD7 = Electronics and Data Processing

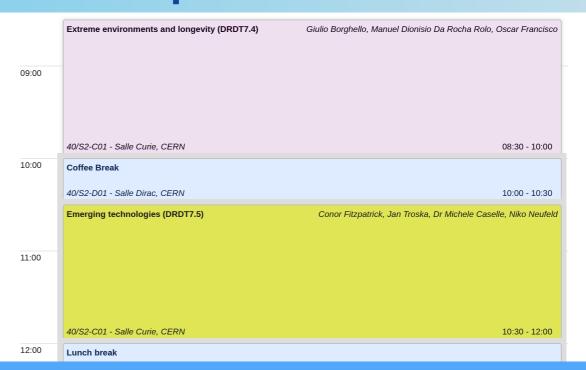


- Electronics is needed for everything, everywhere
 - But: the technologies, systems, and the way we build them may look quite different in the future
 - Combination of short-term, medium-term, and long-term R&D

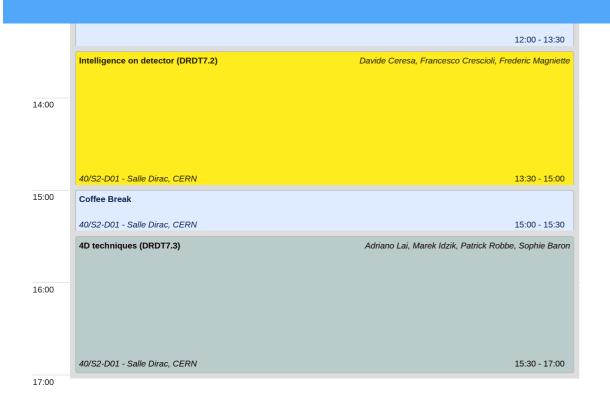


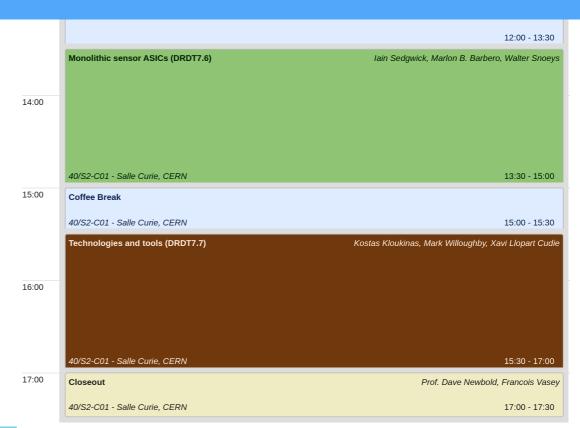
DRD7 Workshop





https://indico.cern.ch/event/1214423/, 14th-15th March 2023





What Next?

- Engage wider UK community
 - Find those in the 'next generation' who want to play a part
 - Encourage analysis and questioning of the roadmap
 - Ask people to attend (preferably in person) the DRD7 workshop
- UK preparatory workshop needed before 14th March
- Identify a UK set of strategic priorities
 - Which capabilities and skills do we have? Which do we want?
 - What are the needs of future UK R&D activities and experiments?
 - Why are developments so difficult and expensive? How must we work together?
 - ▶ DMN view: more explicit cooperation and sharing of IP needed across groups / projects
 - Is there crossover with other projects of interest to universities and labs?

Goal

- UK leadership in a few key selected areas
- World-class support via engineering, facilities and tools
- Full integration with parallel DRD activities (as for DRD7 itself)
- Perhaps important: development and support of the next generation of experts



Backup



What Now?

Current events

- DRD collaborations starting to take shape
- Workshops and surveys being conducted to establish a work plan
- ECFA seeking input on 'funding agency positions'

Chicken and egg

- UK cannot seek to define a leading contribution without commitment from STFC
- STFC cannot commit funding until the scope and scale of the programme is known
- SoI invitation is designed to break this cycle, allowing us to proceed

• What we need to do in the UK in the next six months

- ▶ Debate / agree the broad intent of the R&D proposal and the timeline
- Review our interests and interactions with DRD collaborations today
- Establish coordination structures and seek volunteers to take leadership
 - Both at 'WP level' <-> DRDs and 'Steering level'
- Set up task forces on training (CDT) and industry engagement
- Provide an initial update to STFC Programmes before the town meeting (April)
 - And allow our ECFA contacts to report back on our planning / progress



Discussion Points

Breadth vs depth

- Focus efforts on a few areas or maintain a broad scope?
- Which DRDs does we plan to engage in? Critical mass?

Interaction with DRDs

Do we present ourselves as 'the UK project' or as institutes?

Organisation

- Are we happy with the 'classic' STFC project organisation: i.e. parallel WPs with thin top layer?
- How do we achieve a costed outline plan by September?
- What is the interaction of UK approval steps with the DRDC process?

• What is the specific role of the national labs?

- Do we wish to propose / request new facilities or engineering capabilities?
- Are we happy with the proposed training model?
 - How much emphasis should be put on this vs PDRAs and engineers?
- How should we organise ourselves?
 - A lot of work to do in the next few weeks / months need people to take responsibility
 - This is the opportunity for a new generation of experts to come forward and take leadership
 - ▶ But we also need to incorporate the wisdom / experience of the generation that built the LHC detectors





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 codevelopment with industry.
- Any funding ... should be in addition to funding allocated to current and future activities within the broader PP programme

TAAB endorsement (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.



UK Roadmaps

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

