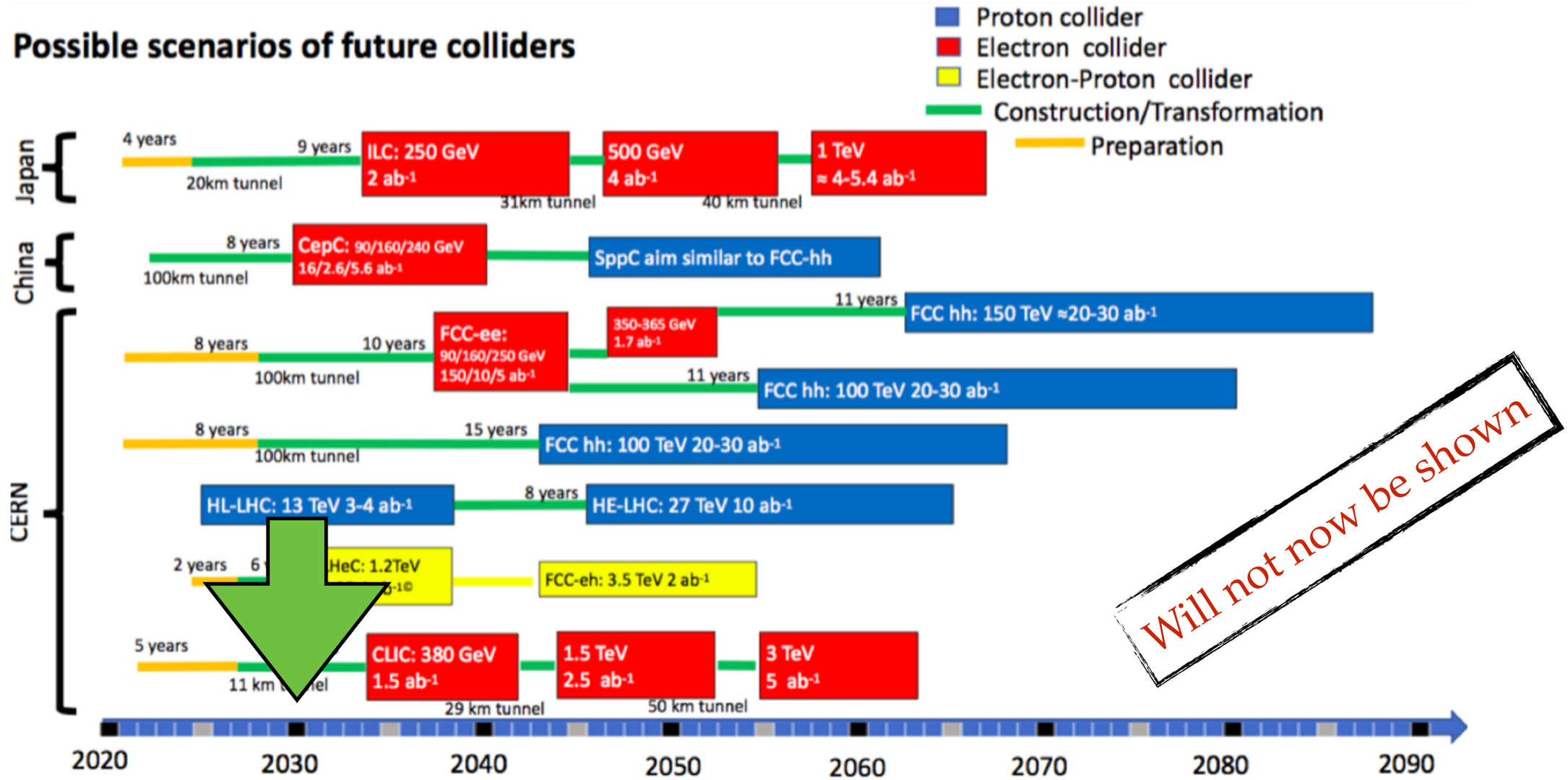
R&D: European and UK Context

- Executive summary
  - International community is examining the case for, and routes to, significantly greater levels of R&D activity in detectors and accelerators
  - Decisions in the next 6m (internationally and in the UK) have long-lasting consequences
  - No 'PP R&D strategy' in STFC, and until now no way of developing one
  - There is the opportunity to make the case for new funding in UKRI
  - Community needs to react to this, and urgently, to maximise opportunities
- UK position
  - Comment from European colleague: "Is R&D in the UK dead?"
  - He may have missed:
    - The decade-long R&D efforts leading to major contributions in the LHC upgrade projects
    - The new initiatives in quantum sensors and systems
  - But truly, there is a grain of truth here
    - R&D phases of major projects are now essentially over, and no non-project-specific R&D
    - No STFC funding scheme dedicated to basic technology R&D
    - Major issues with 'juste detour' and our *technological* / *industrial* engagement with CERN
- We are missing a huge scientific and impact opportunity
  - And we are here to today to continue the process of fixing that

European Strategy

- We produced, by consensus, an R&D-focussed strategy
  - *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.*
  - *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.*
  - *A vigorous new experimental programme in the long term, requires significant investment in detector and accelerator R&D in the medium term. The case for this investment should be clearly spelt out in the European Strategy. (STFC input)*
- It is up to us to follow up on these points
  - STFC / CERN / ECFA will not and cannot organise our R&D strategy
  - Nor will funding be allocated without a clear plan and structure
  - UK consultation process has been running for some months

Future Projects

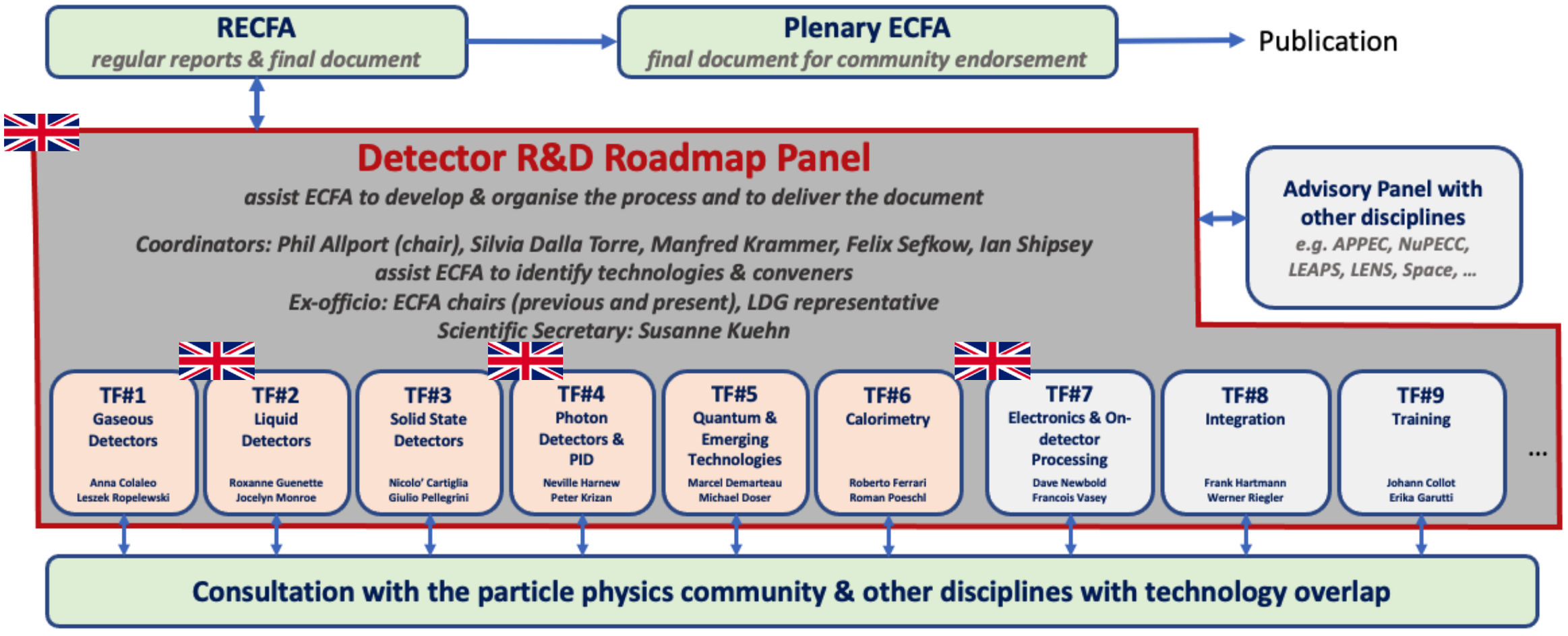


- Many areas of UK interest yet to be added
  - ERL; muon beams / collider; EIC; long-baseline neutrinos; dark matter
  - Many (not all) of these projects depend *fundamentally* on E&I developments
  - Today, we *cannot build* a detector for a high-energy, high-luminosity machine
    - Industry will not address (all) our issues; and the time to start is now

Roadmapping

- Large-scale basic R&D requires:
  - Significant investment in people and infrastructure
  - Cooperation across the international field (this is practically axiomatic)
  - Demonstrators, opportunities, and way markers
- R&D roadmaps currently being drawn up
  - Coordinated by ECFA / LDG for detectors / accelerators respectively
- Roadmap purpose (LDG phrasing, ECFA is very similar)
  - Provide an agreed structure for a coordinated and intensified programme of R&D including into new technologies, to be coordinated across institutes
  - Be compatible and commensurate with corresponding roadmaps in detectors, computing and other developments, with a compatible timeline and deliverables
  - Be based on the goals of the European Strategy, but defined in its implementation through consultation with the community and through the work of expert panels
  - Take into account, and coordinate with, international activities and work being carried out in other related scientific fields, including development of new large-scale facilities
  - Specify a series of concrete deliverables, including demonstrators, over the next decade
  - Inform, through its outcomes, subsequent updates to the European Strategy.

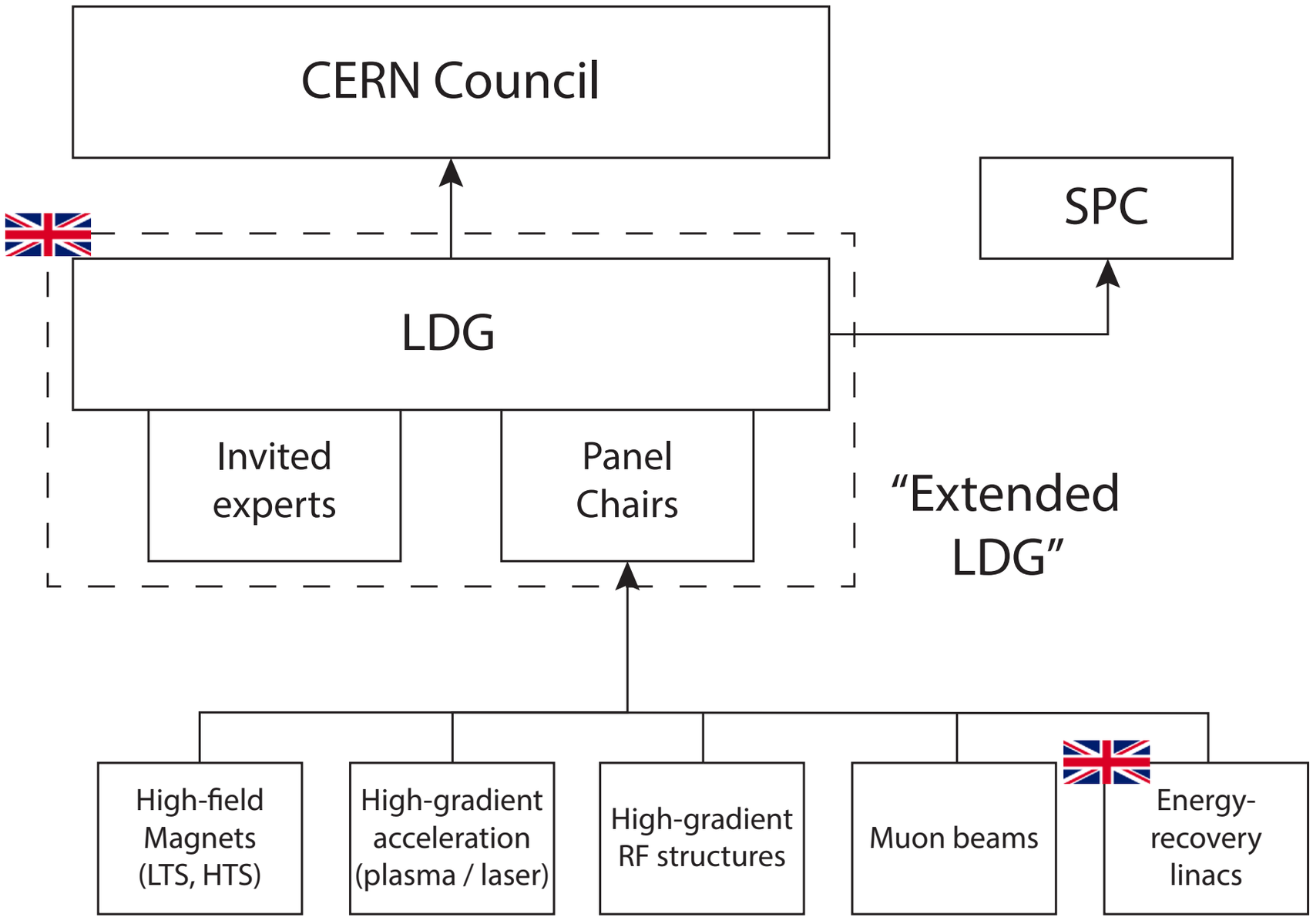
ECFA Roadmap Panel Structure



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

Science and Technology Facilities Council

LDG Roadmap Panel Structure



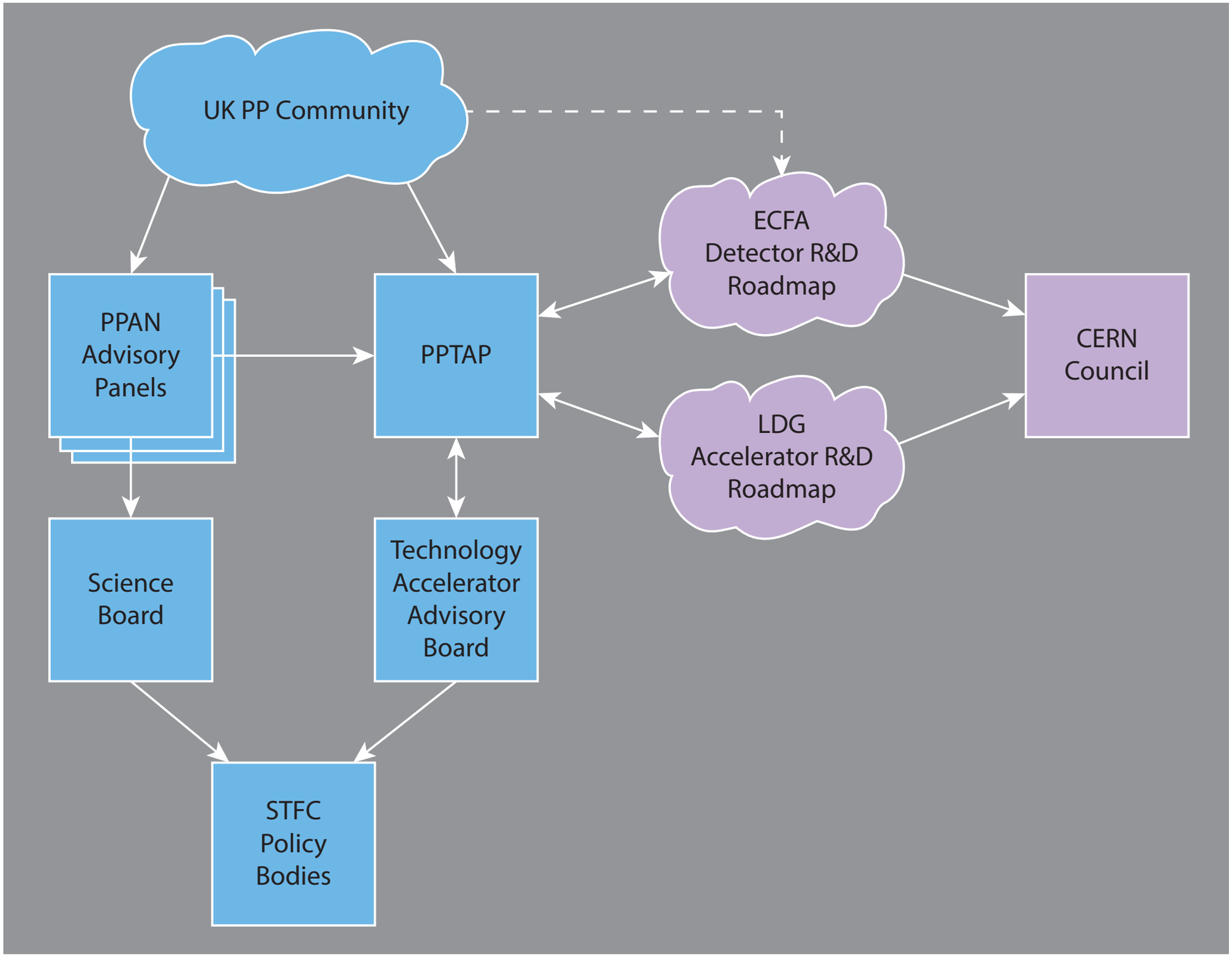
The Harangue

- We currently do not have a UK 'R&D strategy'
  - Even in past times, basic R&D funding was usually in responsive mode
    - i.e. basic fundamental developments - 'blue skies'
  - There was substantial funding into LHC construction / upgrade R&D phases
    - i.e. focussed at an increasing level on specific challenges
  - There was never much coverage of 'early systems-level R&D' for PP detectors
- This is a notable contrast to other countries
  - Typically a somewhat more 'managed' / 'prioritised' / top-down approach
- Input to the ECFA roadmapping process
  - UK has been extremely quiet in this process – despite us leading it!
    - ECFA process led by Phil Allport, LDG process by Dave Newbold
  - Of >350 participants in the ECFA electronics symposium, < 20 from the UK
  - No written inputs from university community to E&I panels
  - Difficulty in gathering input to PPTAP (see Paula's talk)
- We are in danger of letting others make our decisions for us
  - Both in detectors, and perhaps even more so in accelerators - but, crucially, in E&I
- These roadmaps *may* be directly relevant to future EC funding structures
  - Note also the inverse effect: 'Is your proposal on the European roadmap? No? Ah.'

The Goals of R&D

- In order of 'concreteness':
  - Generate, test and develop novel ideas
    - Demonstrating their feasibility for future experiments
    - Sometimes over an extended time period (10 years+)
  - Prepare directly for detector design and construction
  - Build collaboration and partnerships
  - Exploit PP detector technology in other areas
  - Engage early with industry and suppliers
  - Maintain skills base in our institutes
  - Provide societally-relevant training for young researchers
- My view: all aspects need to come into the 'case for R&D'
- These issues are well known to the UK community
  - Traction has so far been limited due to lack of sustained funding
  - We should think about how we want to address this whole list of topics

How it all Fits Together



ECFA: Roadmap Process

Summary of Detector R&D Roadmap Process

Expert & Community Consultation Phase completed

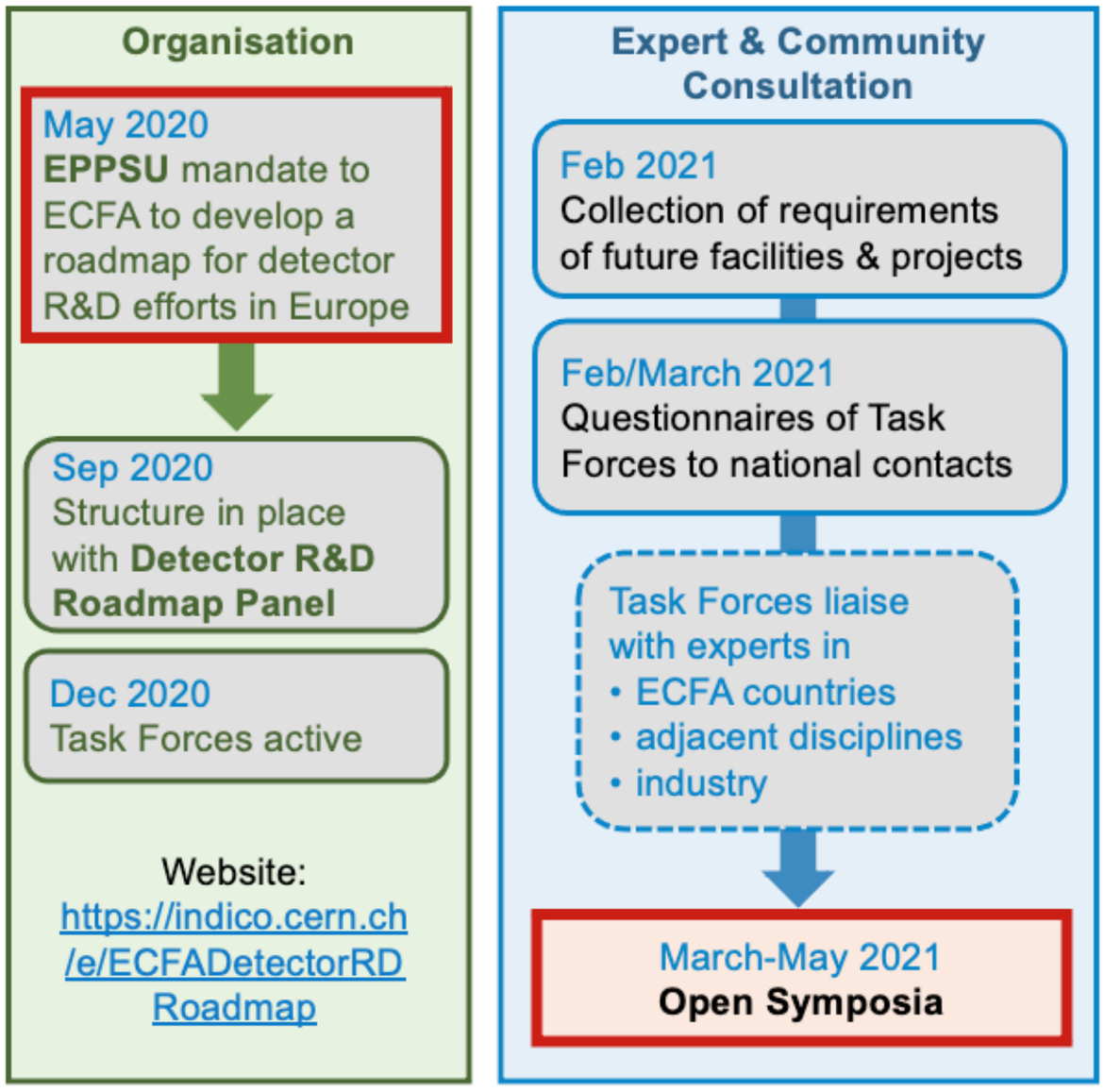
- All **Open Symposia** took place between 27th March and 7th May

  https://indico.cern.ch/event/957057/program

- In total 1366 registered participants

- "Most popular" sessions:
  TF3 (Solid state det.) (504 participants, 275 concurrent views)
  TF7 (Electronics) (492 participants, 353 concurrent views)

- Registration will be used to get future updates (asked for consent of people)
  https://indico.cern.ch/event/957057/registrations/70781/



ECFA: Roadmap Process

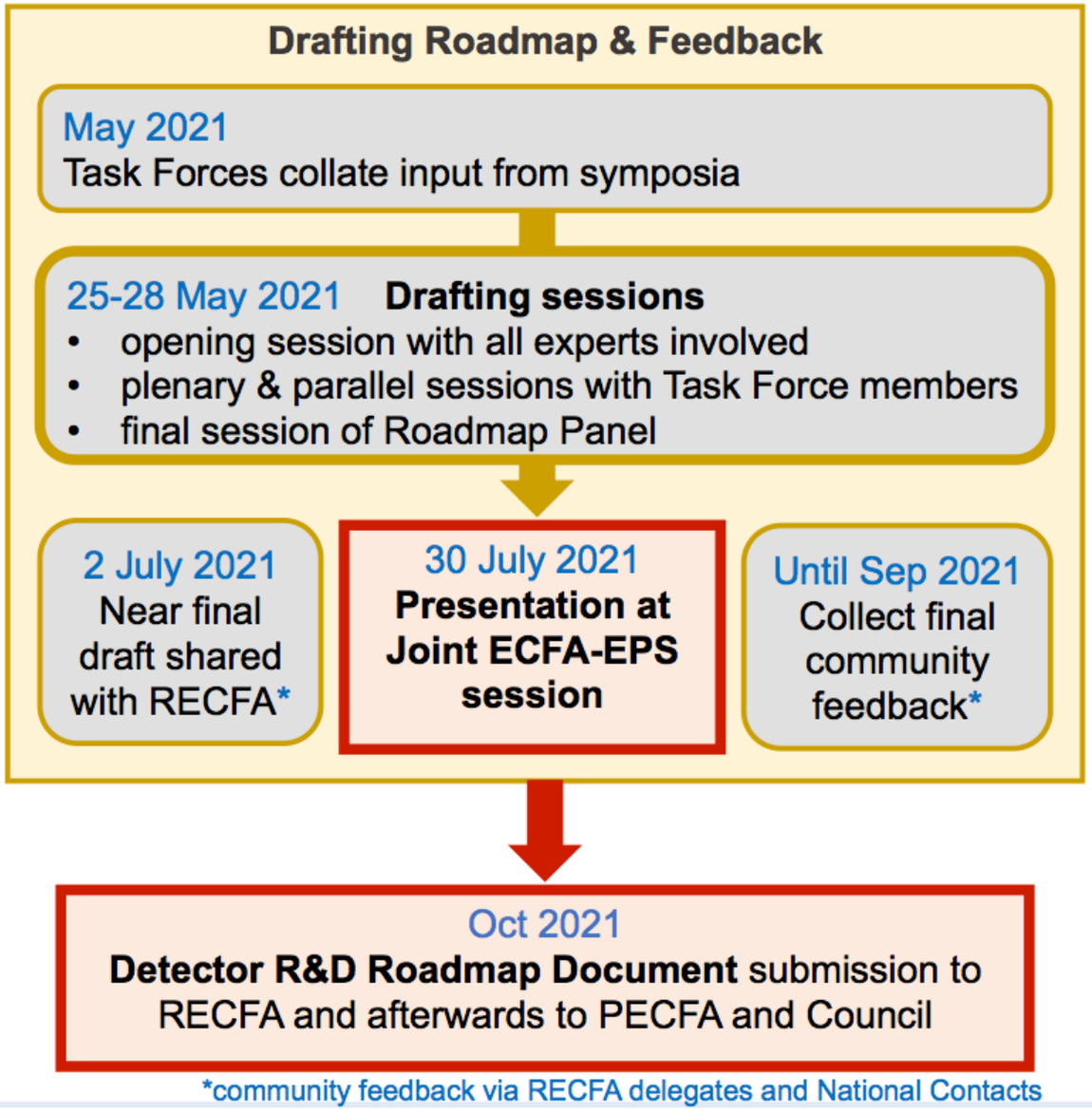
Summary of Detector R&D Roadmap Process (cont.)

- **Drafting Session during week 25 – 28 May**
  Worked very well, stressful due to full online format,
  but interactions between TFs really needed and fruitful

- Major issues addressed:

  - Agreed on main priorities (“Detector Research Themes”) in the different technology areas
  - Identified overlap, transversal activities
  - Finalise layout of the various chapters
  - Discussion of common timeline with LDG for large high-priority projects

- **Finalisation of “near final draft” during June**, will be shared with RECFA by 2nd July



ECFA: Roadmap Process

Timeline of major accelerator projects

- Given large uncertainties in collider timelines we have decided (also in agreement with LDG) to use a coarse granularity and we do not want to give a precise timeline
  (timeline will also be largely determined by accelerator R&D)

- List of current understanding for a number of in-construction, planned and possible future accelerator based programmes in terms of the earliest technically feasible start time. This should not be understood as an actual plan for the future as several options presented are mutually exclusive. For each of the relevant Task Forces, a set of detector R&D aspects are identified which are required if the physics programmes of the corresponding experiments are not to be compromised.

"Technical" Start Date of Facility (This means, where the dates are not known, the earliest technically feasible start date is indicated - such that detector R&D readiness is not the delaying factor)	**< 2030**	**2030-2035**	**2035-2040**	**2040-2045**	**> 2045**
	SPS Fixed Traget FAIR (hep) BELLE-II ALICE LS3 PIP-II/LBNF/DUNE	ALICE/LHCb (>LS4) ATLAS/CMS (≥ LS4) EIC LHeC	ILC CLIC	FCC-ee (Initial Detectors)	FCC-hh (Initial Detectors) FCC-eh (Initial Detector) Muon Collider

LDG: Roadmap Status and Timeline

- Process is now fully under way
  - Several panel meetings already, full open workshops being held
  - Key questions and issues now identified and prioritised
  - Processes for development of costed 5- / 10-year options now being developed
- Timeline
  - March Council: presentation of roadmap scope and process
  - June SPC: preview of final report structure, scope and style
  - June Council: final approval of LDG mandate and roadmap scope
  - Early July: Open workshop for PP community to seek input / feedback
  - Late July: July EPS-HEP: presentation in ECFA session of interim findings
    - Note : we will present findings only, not the roadmap planning itself
  - September Council: presentation of interim report (findings, but no planning)
  - September – October: 'closed' definition of draft roadmap and scoped plans
  - November: Review and feedback by SPC subcommittee - last chance to change
  - December Council: approval of the final roadmap
- Outcome
  - Public summary report covering findings plus a scoped roadmap
  - SPC / Council recommendations on priorities and next steps in the process

What Next?

- ECFA and LDG now winding up public parts of process…
  - Summary presentations of findings at EPS-HEP in July
  - A few last opportunities to give input / feedback via RECFA delegate
- … but PPTAP now getting going in earnest
  - Paula will say more in her talk
- Lots of 'new thinking' on detector and systems design
  - e.g. ECFA-APPEC project on ML-Optimized Design of Experiments (MODE)
    - https://mode-collaboration.github.io/
- ECFA Higgs factory studies (physics, experiments, detectors)
  - https://indico.cern.ch/event/1033941
- Detector (and accelerator) R&D is not dead, or even resting
  - But in the UK, it needs a major shot in the arm – today's business