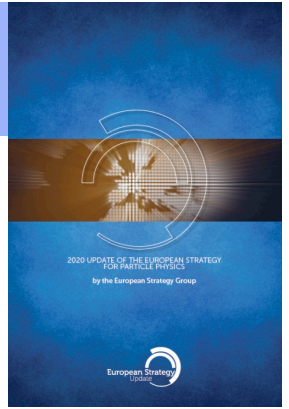
Paris Sphicas
CERN & NKUA
CERN - Ukraine 2024: "Past - Present – Future"
Kiyv, May 28-29, 2024

- **Introduction**
- **ECFA Detector Panel and DRD projects**
- **HET factory study**
- **The new process for the ESPP update**
- **ECR panel**
- **JENAA**
- **Outlook**

From the ECFA Detector R&D roadmap to DRD collaborations

DRDC and ECFA Detector Panel

European Strategy for Particle Physics



Continuous community-driven process

- **First started ESPP in 2006**
- **2013 update: HL-LHC decision**
- **2020 update: post-HL-LHC recommendations:**
  - ***An electron-positron Higgs factory is the highest-priority next collider. For the longer term, the European particle physics community has the ambition to operate a proton- proton collider at the highest achievable energy.***
  - ***Europe, together with its international partners, should investigate the technical and financial feasibility of a future hadron collider at CERN with a centre-of-mass energy of at least 100 TeV and with an electron-positron Higgs and electroweak factory as a possible first stage.***
  - ***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. [... The community should define a global detector R&D roadmap that should be used to support proposals at the European and national levels..***
  - **Successful completion of High-Luminosity LHC must remain key focus**
- **2026 update: just commenced; more on this, later in this talk**

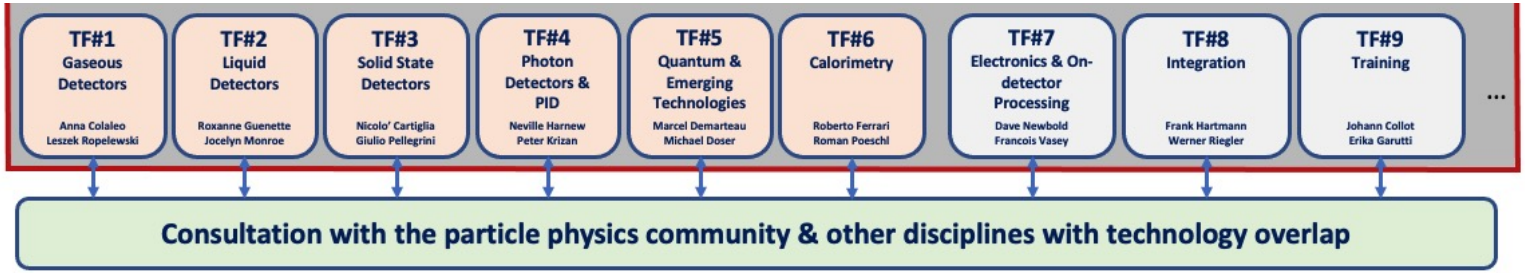
http://europeanstrategy.cern

http://dx.doi.org/10.17181/CERN.JSC6.W89E

ECFA Detector R&D Roadmap & Implementation plan

2021: ECFA released full roadmap (200 pages) and synopsis (~10 pages) based on a community-driven effort DOI: 10.17181/CERN.XDPL.W2EX

- **Overview of future facilities (EIC, ILC, CLIC, FCC-ee/hh, Muon collider) or major upgrades (ALICE, Belle-II, LHC-b,…) and their timelines**
- **Ten "General Strategic Recommendations" (full list in later slides)**
- **Nine Technology domains with Task Force areas**
  - **Most urgent R&D topics in each domain: Detector R&D Themes (DRDTs)**

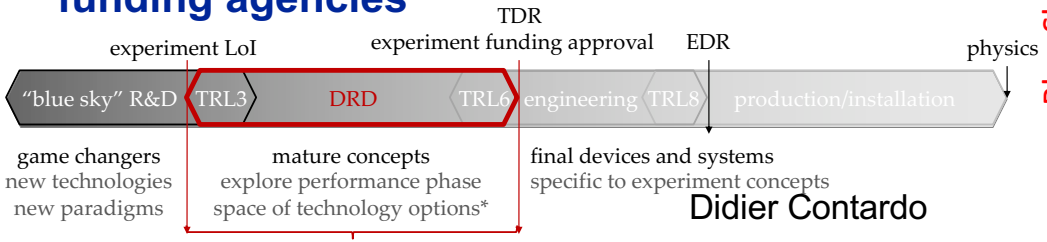


- **Implementation plan: Approved by CERN SPC and Council in Fall 2022 (CERN/SPC/1190 ; CERN/3679)**
  - **CERN to host DRD collaborations**
  - **DRD interface to CERN through DRDC**
  - **DRD interface to ECFA via ECFA Detector panel: https://ecfa-dp.desy.de.**

Strategic R&D

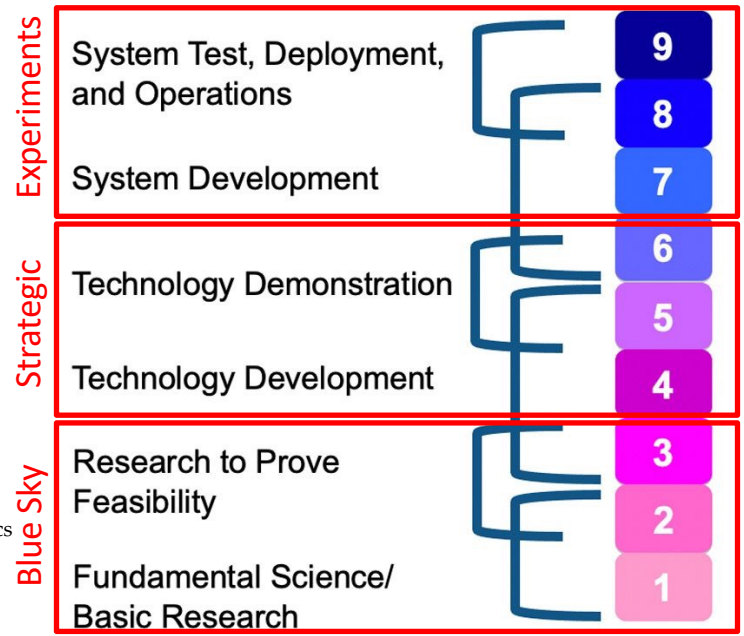
Strategic R&D bridges the gap between the idea ("blue sky research", TRL 1-3) and the deployment and use in a HEP experiment (TRL 8-9)

- **Detector R&D Collaboration should address TRLs from 3 to 7, before experiment-specific engineering takes over**
- **Covers the development and maturing of technologies, e.g.**
  - **Iterating different options**
  - **Improving radiation hardness**
  - **Scaling up detector area, number of layers,..**
- **Backed up by strategic funding, agreed with funding agencies**



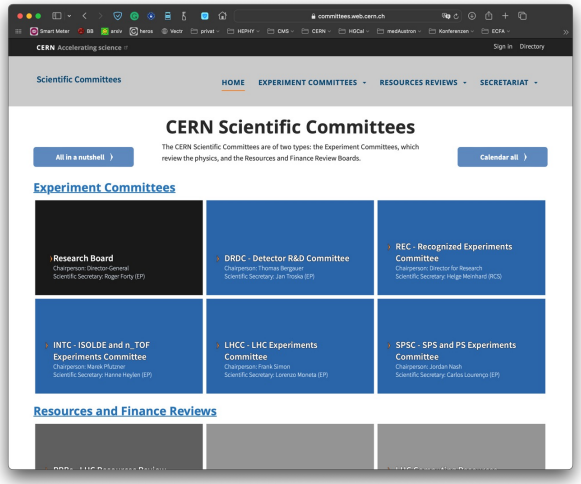
Technology Readiness Levels (TRLs) 1-9:

Method for estimating the maturity of technologies

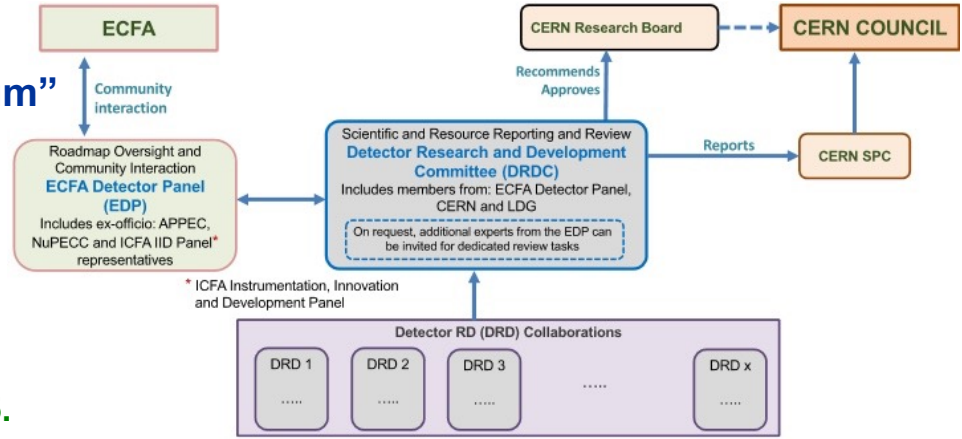


DRD Committee (DRDC)

- **Autumn 2023: DRDC**
  - Detector R&D Committee: new CERN committee, same level as SPSC and LHCC.
- **Detector R&D Committee (DRDC):**
  - "Reviewing body"
  - Monitoring milestones and deliverables
  - Embedded in "CERN hierarchy", reporting to RB



- **ECFA Detector Panel (EDP):**
  - "Advising body", full mandate here.
  - Organizes (recently) "DRD Managers Forum"
    - Organizing exchange across different DRDs
    - Define common terminology
    - Heritage from "full panel" meetings during proposal preparation
  - Providing input to European Strategy for Particle Physics Update 2026
    - Deadline: 31/3/2025, Symposium in Jun 2025.



DRD Collaborations

- Gaseous Detectors (DRD1) [ex RD51]
- Liquid Detectors (DRD2)
- Photodetectors & Particle ID (DRD4)
- Calorimetry (DRD6)

} Fully Approved for an initial period of 3 years by CERN Research Board in December 2023

Reports at open session of DRDC meeting; Full Proposals in CERN CDS.

- Semiconductor Detectors (DRD3) [ex RD50, RD42,..] } Conditionally approved

- Quantum Sensors (DRD5)
- Electronics (DRD7)

} Full proposals submitted beg April for review

Both aim for approval in June

- Integration (DRD8) } Letter of Intent submitted

Full Proposal by end 2024

- Draft MoUs for DRDs in progress.

Current status

- **Remaining from ECFA Detector R&D Roadmap:**
  - **Address remaining General Strategic Recommendations (GSRs):**

    GSR1 - Supporting R&D facilities
    GSR2 - Engineering support for detector R&D
    GSR3 - Specific software for instrumentation
    GSR4 - International coordination and organisation of R&D activities
    GSR5 - Distributed R&D activities with centralised facilities
    GSR6 - Establish long-term strategic funding programmes
    GSR7 - Blue-sky R&D
    GSR 8 - Attract, nurture, recognise and sustain the careers of R&D experts
    → ECFA Training Panel
    GSR 9 - Industrial partnerships
    GSR 10 - Open Science

  - **ECFA-LDG Working group for remaining GSRs (S. Bentvelsen (Nikhef) & M.Mikuz (Ljubljana))**
    - **Next report at PECFA meeting in Frascati (July 2024).**
    - **In addition: GSR5 needs to be addressed (DRD7 and LDG are working on a first proposal)**

Higgs-Electroweak-Top (HET) Factory study

ECFA Panels: HET Factory Study (I)

- **Higgs-Electroweak-Top Factory study: Web page.**
- **Three working groups**
  - **WG 1, Physics Potential: Jorge de Blas (Univ. Granada), Patrick Koppenburg (Nikhef), Jenny List (DESY) and Fabio Maltoni (UC Louvain / Bologna)**
  - **WG 2, Physics Analysis Methods: Patrizia Azzi (INFN-Padova / CERN), Fulvio Piccinini (INFN Pavia) and Dirk Zerwas (IJCLab/DMLab)**
  - **WG 3: Detector R&D (WG3 web page): Mary Cruz Fouz (CIEMAT Madrid), Giovanni Marchiori (APC Paris) and Felix Sefkow (DESY)**
- **HET Factory Workshops:**
  - **First ECFA Workshop on e+e- HET Factories: 2022 @ DESY (GE).**
  - **Second ECFA Workshop on HET Factories: 2023 @ Paestum (IT).**
  - **Third (and last) ECFA Workshop on e+e- HET Factories: 2024 @ Paris (FR).**
    - **Wed-Fri, 9-11 Oct, 2024. Finishing at 16:00 on Friday to facilitate travel**
  - **This will be the *last meeting of the HET Factory study prior to the submission of its input to the EUSPP* (end March 2025)**
- **Plan:**
  - **Envisaging: finalizing the work until end 2024; compiling Report: Oct 2024-Jan 2025**
  - **Submission to ESPP update process: end March 2025**

ECFA Panels: HET Factory Study (II)

- **HET Factory study; focus topics in ArXiv report.**

1. **HtoSS** — $e^+e^- \to Zh$: $h \to s\bar{s}$ ($\sqrt{s} = 240/250\,\text{GeV}$)
2. **ZHang** — Zh angular distributions and CP studies
3. **Hself** — Determination of the Higgs self-coupling
4. **Wmass** — Mass and width of the W boson from the pair-production threshold cross section lineshape and from decay kinematics
5. **WWdiff** — Full studies of WW and $e\nu W$
6. **TTthres** — Top threshold: Detector-level simulation studies of $e^+e^- \to t\bar{t}$ and threshold scan optimisation
7. **LUMI** — Precision luminosity measurement
8. **EXscalar** — New exotic scalars
9. **LLPs** — Long-lived particles
10. **EXtt** — Exotic top decays
11. **CKMWW** — CKM matrix elements from W decays
12. **BKtautau** — $B^0 \to K^{0*}\tau^+\tau^-$
13. **TwoF** — EW precision: 2-fermion final states ($\sqrt{s} = M_Z$ and beyond)
14. **BCfrag** and **Gsplit** — Heavy quark fragmentation and hadronisation, gluon splitting and quark-gluon separation

Update of the ESPP
(European Strategy for Particle Physics)

Next ESPP (I): approved timeline

- **In March 2024 CERN Council launched the new ESPP process, with the following timeline:**
  - **Announcement, and call for contributions to the ESPP: End March 2024**
  - **Three bodies:**
    - **"Secretariat": secretary (chair of secretariat), CERN SPC chair, ECFA chair, LDG chair**
    - **"Physics Prepepatory Group" (PPG): 13 people + secretariat; chaired by secretary.**
    - **European Strategy Group (ESG): secretariat (secretary chairs ESG); One rep per CERN member state; One rep per lab in LDG; CERN DG, CERN DG-elect.**
      - **Invitees: PPG, President of Council, 1 rep from each Associate Member State and Observer State, 1 rep from EC; chairs of ApPEC, NuPECC, ESFRI**
  - **Appointments:**
    - **Jun 2024: selection of secretary of the ESPP update and establishment of ESG**
      - **Deadline for submitting country reps: May 20, 2024)**
    - **Sep 2024: appointment of PPG members; deadline for submitting ECFA, SPC and America/Asian reps: Aug 30, 2024.**
  - **Submission of contributions to the ESPP: deadline end March 2025**
  - **Symposium: end June 2025 (*call for proposals: out now; decision: Sep 24*)**
  - **Briefing Book: Sep 2025**
  - **Drafting session: Dec 2025**
  - **Final approval by CERN Council: June 2026**

Next ESPP (II): PPG membership

- **PPG composition as approved by Council: total of 19 people.**
  - Secretary (chair); ECFA, LDG, SPC chairs.
  - To be appointed by Council in Sep:
    - 4 members nominated by SPC (SPC chair)
    - 4 members nominated by ECFA (ECFA chair)
  - To be endorsed by Council in Sep:
    - 2 members the Americas (nominated by corresponding ICFA members)
    - 2 members from Asia (nominated by corresponding ICFA members);
    - 1 member from CERN.

- **Deadline for SPC/ECFA/Americas/Asia/CERN to submit nominations to Council: Aug 30, 2024.**

- **Call for nominations for the four ECFA slots sent to PECFA**
  - Nominations to be submitted via RECFA members
    - This is (essentially) what was done for the last EUSPP (2020) as well.
    - Deadline for receiving nominations: Monday, July 1st, 2024.
  - Endorsement at a special RECFA meeting near the end of August.

- **PPG to be formally put in place: Council Week in Sep (23-27)**

Membership in the PPG is a lot of work. Nominees should (really) be willing to invest heavily in the process.

Early Career Researchers’ (ECR) panel and activities

ECFA Early Career Researchers' (ECR) panel

- **Career Prospects and Diversity in Physics**
  - Launched survey to collect information on
    - Impact of collaboration size on ECRs?
    - Assess the career prospects of ECRs, how ECR panel help, what are the main problems?
  - Circulated to ECR community (760 responses!)
  - Analysis of answers: written report here.
- **ESPP update and ECR involvement; From ECFA to national communities**
  - Follow-up the ECFA-wide event with national, in-person events on future colliders, directing discussions into the ECFA countries as some issues are country-dependent

    → Blueprint ready on zenodo (link)
    - First events have already taken place

Example 1: Nordic event (May 14); Talks:
Physics Landscape and Motivation
Experimental overview of future colliders
Status and Physics of EIC
Report from ECFA ECR panel
Summary of activities in the Nordics
Panel Discussion

Example 2: Austria event (May 23)

JENAA
(Joint ECFA, NUPECC, APPEC Activities)

JEANAA: Expressions of Interest (EoIs)

- **Webpage: https://nupecc.org/jenaa/**
- **List of submitted EoIs:**
  - **Dark Matter - iDMEu (https://indico.cern.ch/event/869195/overview)**
  - **Gravitational Waves for fundamental physics (https://agenda.infn.it/event/22947/overview)**
  - **Machine-Learning Optimized Design of Experiments - MODE (https://mode-collaboration.github.io/#home)**
  - **Nuclear Physics at the LHC (https://indico.ph.tum.de/event/4492/)**
  - **Storage Rings for the Search of Charged-Particle Electric Dipole Moments (EDM) (https://indico.ph.tum.de/event/4482/overview)**
  - **Synergies between the Electron-Ion Collider and the Large Hadron Collider experiments (https://indico.ph.tum.de/event/7004/)**
  - **European Coalition for Artificial Intelligence (AI) in Fundamental Physics. (https://www.eucaif.org/)**
- **EoIs in the form of a brief letter are submitted to the chairs of the committees/consortia. The letter should elaborate on the synergy topic, the objectives, the initial thoughts and the potential communities involved.**
  - **Letter is not the end of the process, but potentially the start of further communications on the expressed interest.**

JENAA: Computing Initiative (I)

- **At JENA Symposium in May 2022 in Madrid: plenary presentations and closed session of funding agency representatives:**
  - **There is increased need for discussions on the strategy and implementation of European federated computing at future large-scale research facilities.**
- **The status, needs and plans on a European level for large infrastructures are diverse and not coherent, e.g.,**
  - **In particle physics, the concept for HL-LHC computing is being discussed, in particular how the WLCG concept can be adapted to cope with the increased demands**
  - **in nuclear physics, the computing is currently organized mainly facility based and the community has limited access to the national computing centers**
  - **in astroparticle physics, various totally different computing models for the distributed large-scale infrastructures exist**
- **For all these research areas, issues of scaling will be the challenge of the next decade. Within JENA, synergies and commonalities will be of utmost importance in this scaling.**

JENAA: Computing Initiative (II)

- **JENA Computing Workshop**
  - **First JENA Computing Workshop: held on June 12 - 14, 2023, in Bologna.**

- **Continued discussion led to the Executive Summary and next steps, featuring the formation of five Working Groups described in the document including the possibility to sign up.**
  - **HPC and HTC: WG1 web page.**
  - **Software and Heterogeneous Architectures (Software): WG2 web page.**
  - **Federate Data Management, Virtual Research Environments and FAIR/Open Data (Data): WG3 web page.**
  - **Machine Learning and Artificial Intelligence (AI): WG4 web page.**
  - **Training, Dissemination, Education (TDE): WG5 web page.**

- **Working groups are now in place; aiming for a draft summary report by end of the year**
  - **Please consider joining one of the Working Groups!**

Summary and Outlook

Summary & Outlook

- DRD collaborations up and running; DRD5, DRD7 soon; DRD8 by end 2024
- ECFA Detector Panel: providing advice, support
  - And synchronization via DRD Managers' Forum
- HET Factory panel: working on Focus topics, simulation/reconstruction for HET factory experiments and detectors for HET factory experiments
  - Next (and last!) HET factory workshop: Oct 9-11 in Paris, France. Register!
- ECR panel:
  - Survey on career prospects and diversity in physics
  - Organizing national events to disseminate info on future colliders.
- Joint ECFA-NuPECC-APPEC Activities:
  - Several "Expressions of Interest"
  - Computing Initiative: aiming at identifying synergies between E, N & A; in time for next JENA Symposium to be held in Spring 2025
- Biggest/major "project"/"task" ahead: participation in ESPP update

Next Plenary ECFA meeting: Frascati, July 4-5, 2024.

Backups

DRD5: Quantum Sensors

- **Quantum Technologies: rapidly emerging area of technology development to study fundamental physics**
  - **Development of HEP detectors on the long term**
- **Full proposal developed in the past year**
  - **Two community workshops [link]**
- **Re-structured Roadmap topics into WPs**
  - **Many reports and documents as deliverables, but this is in the nature of this proposal (early TRL)**
- **Draft proposal was submitted to DRDC end of February 2024 and sent to interested institutions; 67 signed up within two weeks**
  - **Aiming for approval in June 2024**

Roadmap topics

Proposal WP's

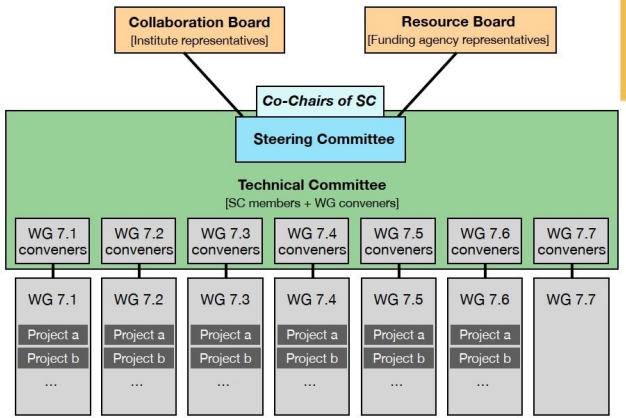
Sensor family → / Work Package ↓	clocks & clock networks	superconducting & spin-based sensors	kinetic detectors	atoms / ions / molecules & atom interferometry	opto-mechanical sensors	nano-engineered / low-dimensional / materials
WP1 *Atomic, Nuclear and Molecular Systems in traps & beams*	X			X	(X)	
WP2 *Quantum Materials (0-, 1-, 2-D)*		(X)	(X)		X	X
WP3 *Quantum superconducting devices*		X				(X)
WP4 *Scaled-up massive ensembles* (spin-sensitive devices, hybrid devices, mechanical sensors)		X	(X)	X	(X)	X
WP5 *Quantum Techniques for Sensing*	X	X	X	X	X	
WP6 *Capacity expansion*	X	X	X	X	X	X

WP-2 (0-,1- and 2-D materials)

WP-2a (application-specific tailoring)	characterization protocol	*protocol*	database definition *Database prototype*	populated db *Functional database*
WP-2ab (extended functionalities)	workshop/conference *Device concepts*		device designs *Prototype devices*	novel hybrid devices *Functional devices*
WP-2c (simulations)	status & desiderata *Report*		prototype model *Simulation SW designs*	benchmarked simulations *Validation report*

DRD7: Electronics

- **Objectives: Carry out strategic R&D in electronics, fulfilling DRDTs, Coordinate cross-European access to technologies, tools and knowledge, Interface with other DRDs**
- **Full proposal received end February 2024; aiming approval in June 2024**
- **Organization: 19 countries, 68 institutes; at present, somewhat CERN-centric (9/19 WG conveners)**
  - **1st workshop happened in March, 2nd workshop 25-27 September 2023**



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

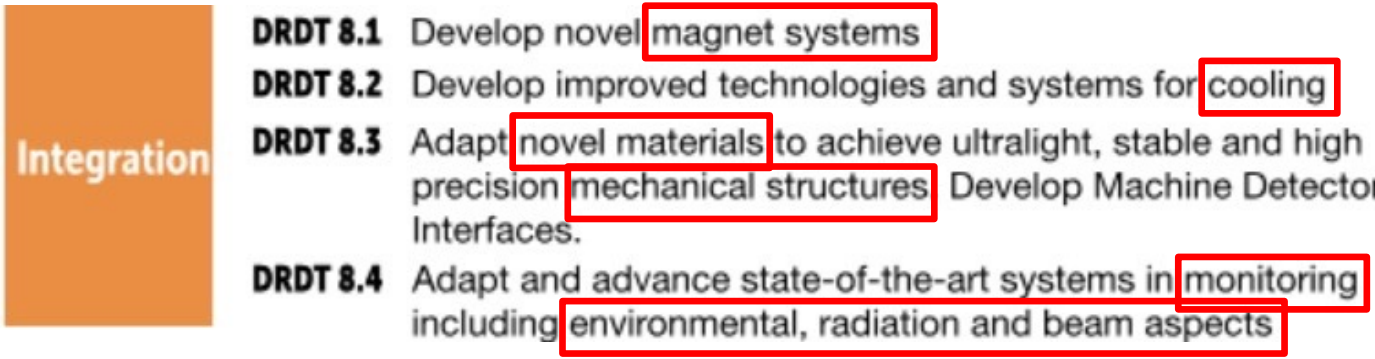
DRDT 7.4 Develop novel technologies to cope with extreme environments and required longevity

DRDT 7.5 Evaluate and adapt to emerging electronics and data processing technologies

WG 7.6 Complex imaging ASICs and technologies
WG 7.7. Transversal Tools and Technologies

DRD8: Integration

- Initial TF convenors did not continue as proposal preparation team
- New proponents had to be searched for, which were found by the group around the "Forum on Tracker Mechanics" workshop organizers
- Community survey replied that there is an interest in going forward
- Community Meeting on December 6, 2023
- LoI received by end February 2024; aiming to write a full proposal by end 2024
  - LoI does not cover all DRDTs, as they are quite diverse
  - Focus on vertex detector mechanics and cooling
  - 22 institutes in 7 countries, 32 FTE at the moment



Next ESPP (III): PPG membership (contd)

- **Organization from 2020 Update:**
- **2020 EUSPP process: seven (7) physics groups:**
  - **Electroweak Physics: Richard Keith Ellis, Beate Heinemann**
  - **Strong Interactions: Jorgen D'Hondt, Krzysztof Redlich**
  - **Flavour Physics: Belen Gavela, Antonio Zoccoli**
  - **Neutrino Physics & Cosmic Messengers: Stan Bentvelsen, Marco Zito**
  - **Beyond the Standard Model: Gian Giudice, Paris Sphicas**
  - **Accelerator Science and Technology: Caterina Biscari, Leonid Rivkin**
  - **Instrumentation and Computing: Xinchou Lou, Brigitte Vachon**

- **Editors of "Briefing Book" :**
  - **Halina Abramowicz, Roger Forty, and the Conveners**