

<https://fccweek2024.web.cern.ch>

10 - 14 June  
**FCC  
WEEK  
2024**

**SAN  
FRANCISCO**

Venue: The Westin St. Francis



ECFA highlights and  
DRD collaboration progress  
FCC-week, San Francisco, 10-14 June 2024  
D. Contardo (IP2I), Paris Sphicas (CERN)

# Outline

ECFA highlights

DRD collaborations organization status

DRD programs and FCC-ee

# ESPP update process

see presentations of Fabiola Gianotti and Eliezer Rabinovici at this meeting

- Three bodies:
  - "Strategy Secretariat":
    - secretary (chair of secretariat), CERN SPC chair, **ECFA chair**, LDG chair
  - "Physics Prepeparatory Group" (PPG): collects community inputs, organizes symposium, prepares Briefing Book
    - 13 members appointed by Council (**4 on ECFA recommendation**) + secretariat; chaired by secretary
  - "European Strategy Group" (ESG): prepares the strategy document
    - secretariat (secretary chairs ESG); 1 rep per CERN member state; 1 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
- Timeline
  - 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

# Higgs-Electroweak-Top Factory study: [web page](#)

- Three working groups
  - WG1: Physics Potential ([focus topics](#))
    - Jorge de Blas (Univ. Granada), Patrick Koppenburg (Nikhef), Jenny List (DESY), Fabio Maltoni (UC Louvain/ Bologna)
  - WG2: Physics Analysis Methods:
    - Patrizia Azzi (INFN-Padova / CERN), Fulvio Piccinini (INFN Pavia), Dirk Zerwas (IJCLab/DMLab)
  - WG3: Detector R&D
    - Mary Cruz Fouz (CIEMAT Madrid), Giovanni Marchiori (APC Paris) , Felix Sefkow (DESY)
- ECFA workshops
  - [2022 @ DESY \(GE\)](#) & [2023 @ Paestum \(IT\)](#)
  - **3<sup>rd</sup> (and last) ECFA Workshop on e+e- HET Factories**
    - [2024 @ Paris \(FR\)](#), Wed-Fri, 9-11 Oct, 2024
      - last meeting prior to the submission of input to the ESPP

## Plan for ESPP update

finalizing the work until end-2024; compiling report: Oct. 2024 - Jan. 2025  
submission to ESPP end-March 2025

# ECFA Detector Panel : [web page](#)

- represents the community in the CERN DRD collaboration framework
- help organise discussion of the common issues through DRD collaborations Managers Forum
- follows R&D progress and project concept evolutions to advise DRDC on priorities wrt the Detector R&D roadmap
- helps plan future updates to the Detector R&D roadmap

## Plan for ESPP update

collecting feedback from DRDs and project concept groups;  
compiling input to ESPP by end-2024; submission end-March 2025  
updating detector roadmap as needed after ESPP conclusion

Felix Sefkow (DESY) proposed to replace Phil Allport  
Jens Dopke joining as mechanics & integration expert

## Members

### Detector Panel Members

Co-chairs:	Phil Allport (Birmingham) Didier Contardo (IP2I Lyon)
DRDC chair, ex-officio:	Thomas Bergauer (HEPHY Vienna (OEAW))
Scientific secretary:	Doris Eckstein (DESY)
Gaseous Detectors:	Silvia Dalla Torre (Torino)
Liquid Detectors:	Inés Gil Botella (CIEMAT, Madrid)
Solid State Detectors:	Doris Eckstein (DESY) Phil Allport (Birmingham)
PID & Photon Detectors:	Roger Forty (CERN)
Quantum and emerging Technologies.:	Steven Hoekstra (Groningen)
Calorimetry:	Laurent Serin (JCLab)
Electronics:	Valerio Re (Bergamo)
Ex Officio:	Paris Sphicas (ECFA Chair) Ian Shipsey (ICFA Detector Panel)
Observer for APPEC	Aldo Ianni (INFN, LNGS)
Observer for NuPECC	Eugenio Nappi (INFN, Unit of Bari)

## Remaining from ECFA Detector Roadmap

- GSR5 - distributed R&D activities with centralised facilities
  - ECFA- LDG working group (S. Bentvelsen (Nikhef) & M.Mikuz (Ljubljana))
    - Report at pECFA meeting in Frascati (July 2024)
- GSR8 - attract, nurture, recognise and sustain the careers of R&D experts
  - ECFA Early Career Researchers (ECR) panel (<https://ecfa.web.cern.ch/ecfa-early-career-researchers-panel>)
    - survey (career prospect, impact of large collab., main issues, how ECR panel can help...)
    - 760 answers and [report](#)
  - ESPP update and ECR involvement; from ECFA to national communities
    - with national, in-person events on future colliders, directing discussions to ECFA countries specific context (blueprint for meetings on [zenodo](#))
  - First national events have already taken place (Nordic event May 14, Austria event May 23)
  - ECFA Training Panel (<https://ecfa.web.cern.ch/ecfa-training-panel-collot-et-al>)
    - aim is to enhance the synergies between existing training programs and stimulate the creation of complementary ones where relevant. Effort still at a very early stage

# Outline

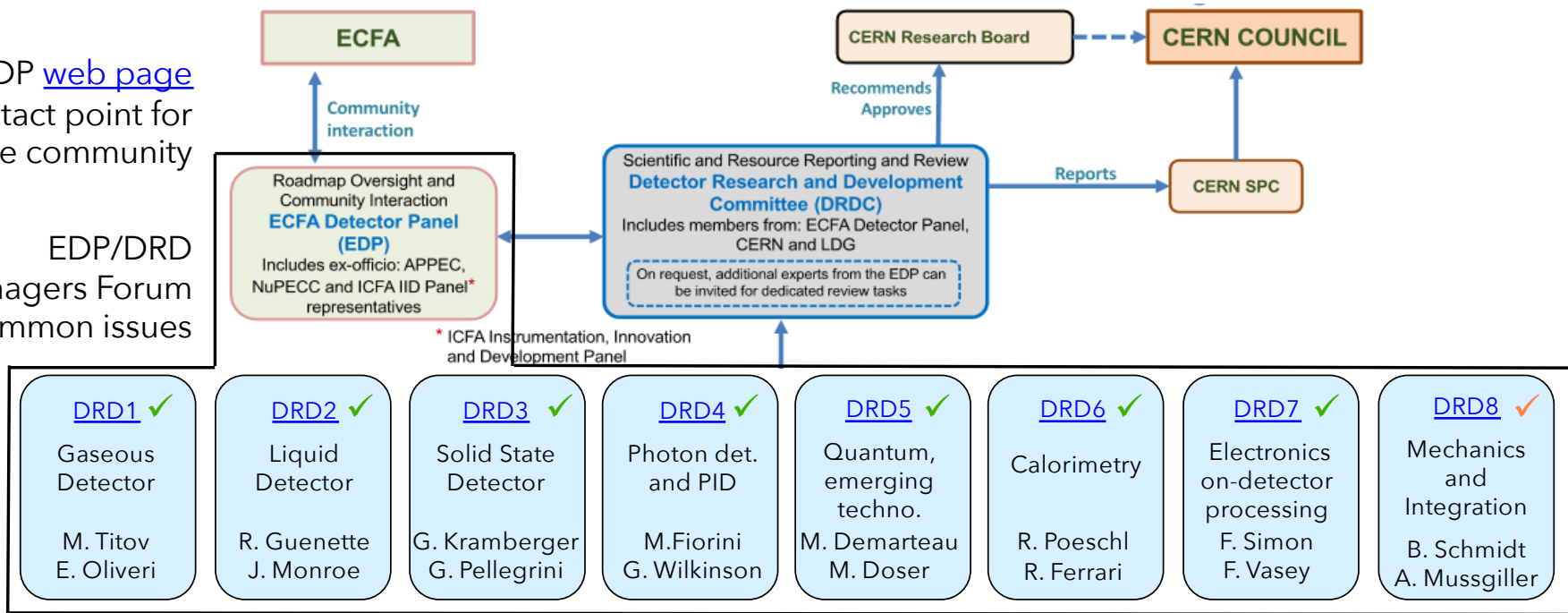
ECFA highlights

DRD collaborations - status of organization

DRD programs and FCC-ee

# New DRD collaborations hosted at CERN ([framework](#)) follows [general conditions](#) for execution of experiments at CERN

- EDP [web page](#)
- contact point for the community
- EDP/DRD Managers Forum
- common issues



✓ Approved by CERN RB\*, ✓ DRD8 Lol submitted to DRDC, proposal aims end-2024

DRDC [web page](#) and presentations of DRDs at [open sessions](#)

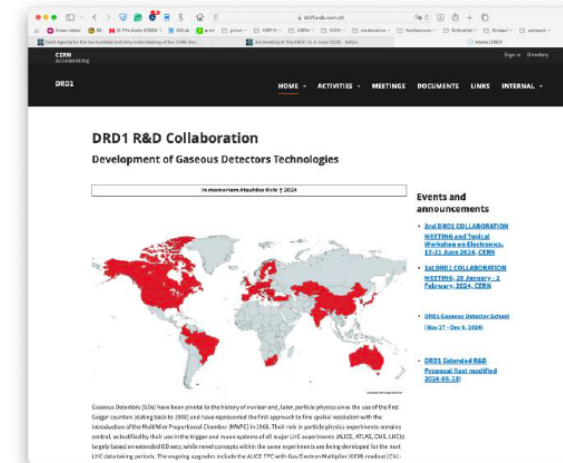
\* approvals cover a period of three years - to be renewed



DRD resources and contact information: T. Bergauer, DRDC [open session](#), June 3 - 2024

# Resources

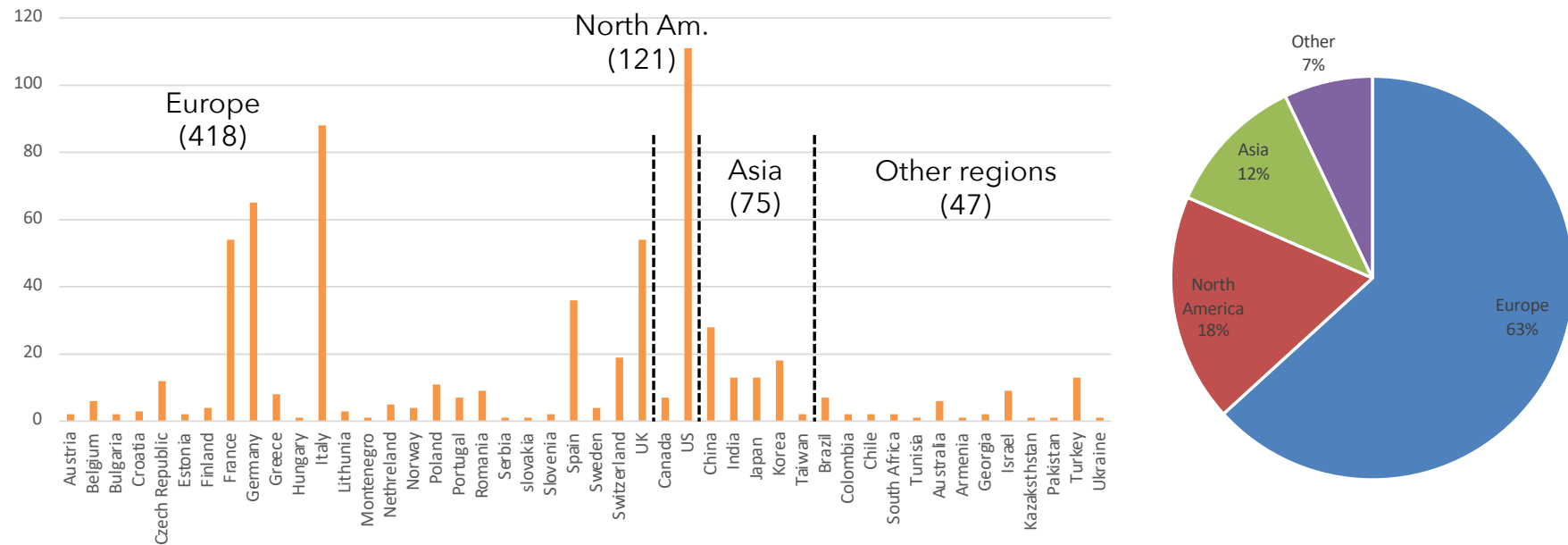
- Proposals of approved collaborations in [CERN CDS](#)
- Collaboration Webpages:
  - <https://drd1.web.cern.ch>
  - <https://drd3.web.cern.ch>
  - <https://drd4.web.cern.ch>
  - Remaining to follow...
- Indico: Category “Experiments / R&D”  
<https://indico.cern.ch/category/6805/>
  - Almost every collaboration had one or several collaboration meetings already
  - Week 17-21 June: DRD1,3 & 4
- Many Mailinglists:
  - Check [CERN Egroups](#) and search for “drd”



DRD1 Development of Gaseous Detectors	93 events	⇒
DRD2 Liquid Detectors	1 event	⇒
DRD3 Solid State Detectors	23 events	⇒
DRD4 Photon Detectors and Particle ID	26 events	⇒
DRD5 Quantum and Emerging Technologies	empty	⇒
DRD6 Calorimetry	14 events	⇒
DRD7 Electronic Systems	18 events	⇒
DRD National Coordination	8 events	⇒

# DRD international contributions

661 institute contributions in 46 countries  
summed over DRD1, DRD2, DRD3, DRD4, DRD6 and DRD7\*

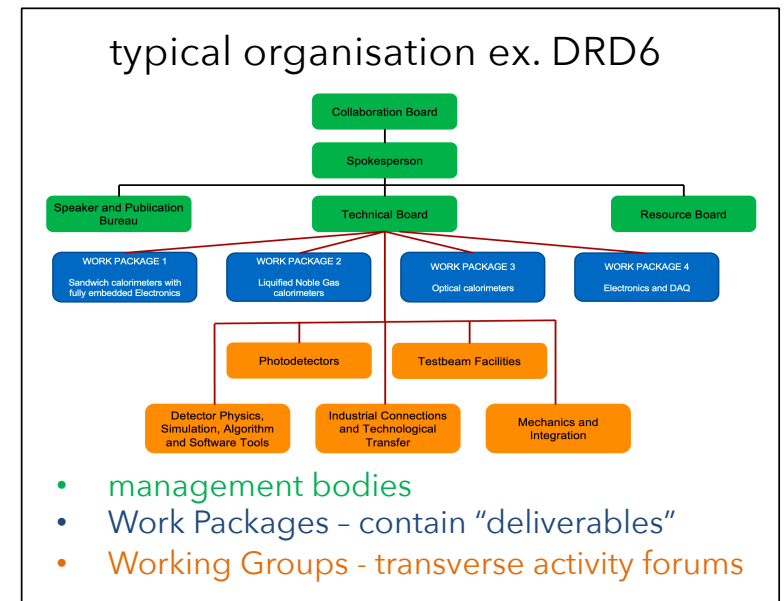


**Large participation for ambitious developments**  
available resources from initial estimates (bottom-up, not commitments)  
seem to be on low side  $\approx 2/3$  &  $1/2$  for manpower & funding  
some ramp-up expected with completion of current projects (HL-LHC upgrades...)

\* several institutes contribute to more than one DRD (multiple counting), also some industrial or other partners outside HEP included

# Progress of DRD collaborations implementation

- Most DRDs have established Collaboration Boards
  - endorsed organisation, SP team, WP/WG conveners
  - DRD2, DRD5, DRD7 still with interim managements
- WP/WG meetings started to establish collaborative work
  - consolidation of “deliverables” list and timeline; loaded with contributors and associated resource needs and availability
- Aim for MoU to be ready by end-2024
  - annexes will contain manpower and funding pledges associated to deliverables\* and possibly a common fund\*\*
    - expected to cover few years cycles with flexibility to close/open new lines within the cycles
- MoUs can be updated and will be vetted by FAs in a Finance Review Committee every year



\* can include non recurrent funding from national grants or international programs (ex. EU AIDAInnova...)

\*\* common fund can cover cost of running collaboration, common infrastructures and projects, dissemination...

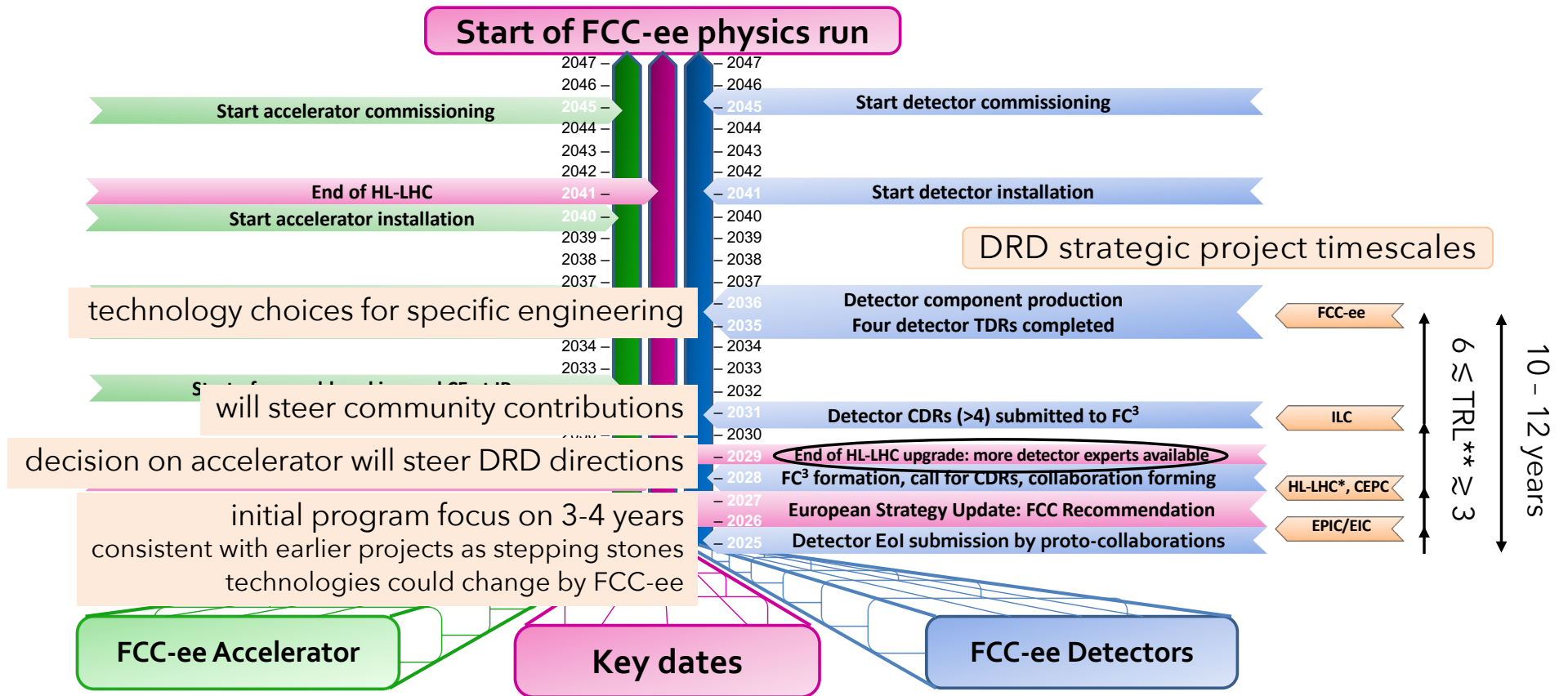
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# FCC-ee planning and related DRD broad brush steps

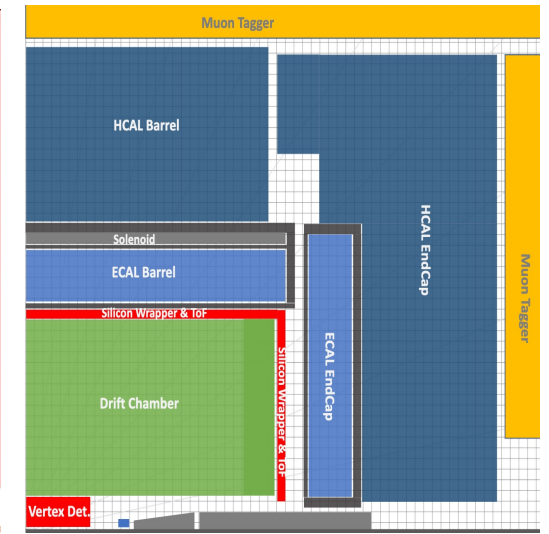
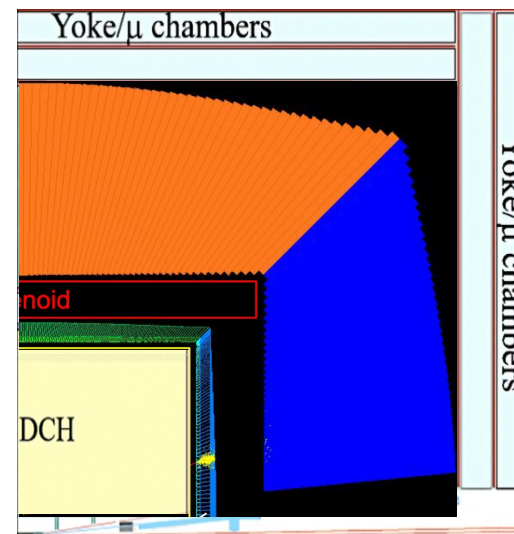
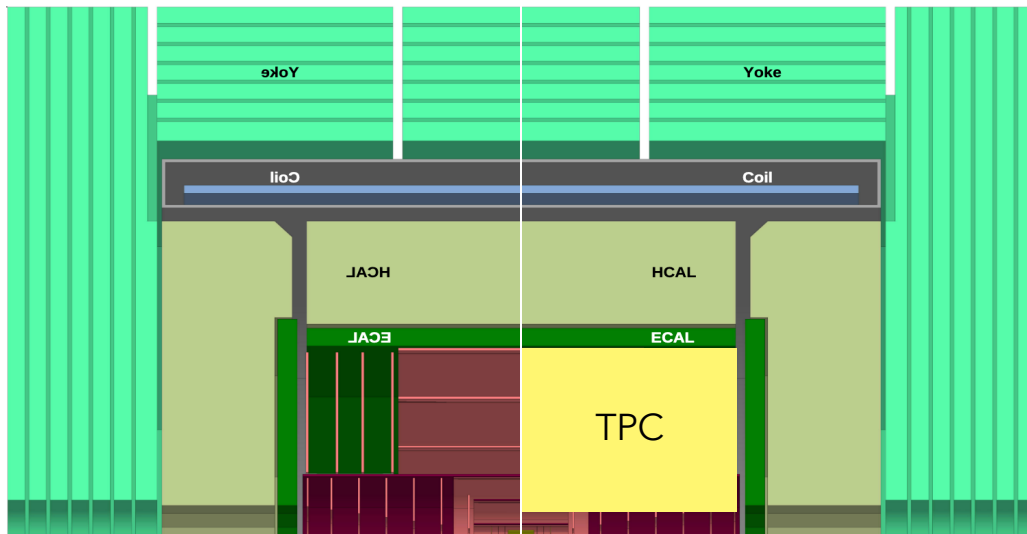


\* HL-LHC: ALICE-3, LHCb-II, possibly inner Vertex Detector layer and Timing ring replacements in ATLAS and CMS, on similar time scale possible upgrade of BELLE-2

\*\* Technology Readiness Level in between "blue sky" applicability demonstration and specific experiment designs which define when projects will escape DRD programs

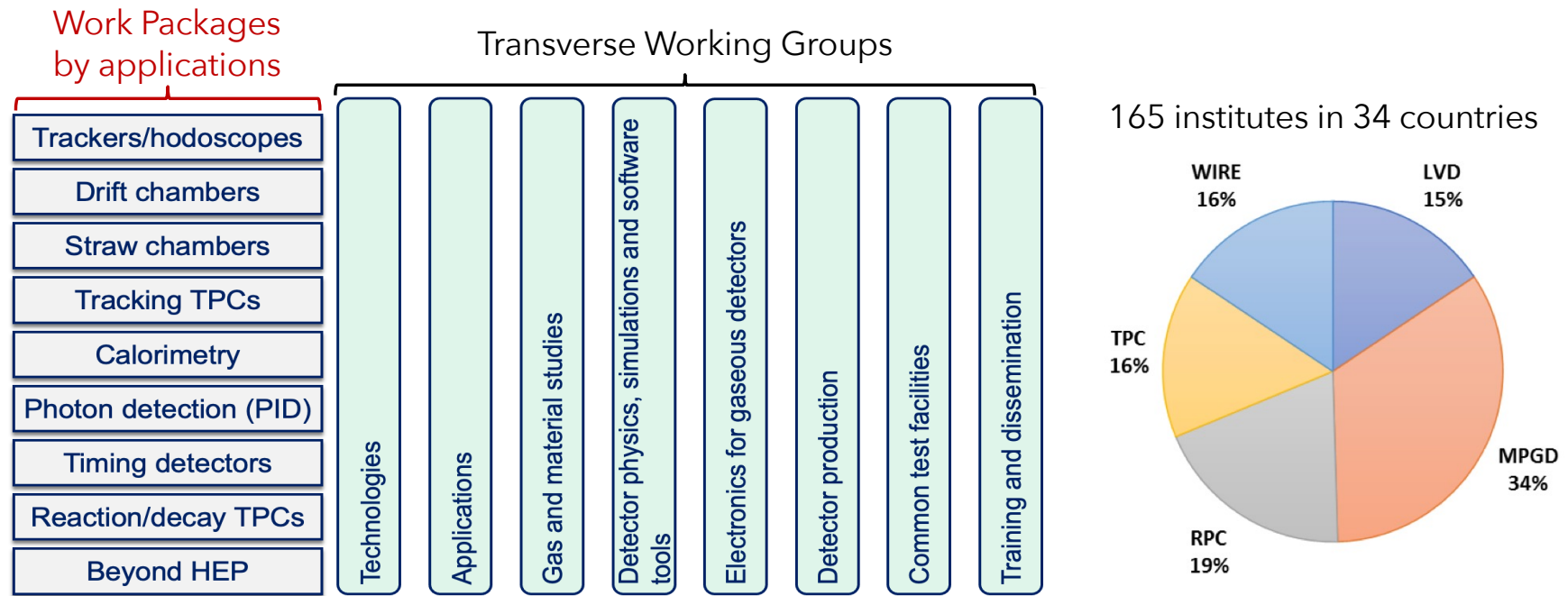
# DRDs address possible FCC-ee detector concepts benchmarked in current simulations and reconstruction software framework

	CLD/ILD'	IDEA'	ALLEGRO
<b>Muons</b>		MPGD, MWPC, RPC <sup>1)</sup>	
<b>ECAL HCAL</b>	High Granularity Si/W <sup>3/6)</sup> Scint./MPGD/RPC <sup>1/6)</sup>	Crystal <sup>6)</sup> Dual Readout <sup>6)</sup>	Liquified Noble Gaz <sup>6)</sup> Scint. Tile <sup>6)</sup>
<b>Tracking</b>	full-Si <sup>3)</sup>	Si-VD <sup>3)</sup> + TPC <sup>1)</sup> + Si-layer <sup>3)</sup>	Si-VD <sup>3)</sup> + DCH <sup>1)</sup> + Si-layer <sup>3)</sup>
<b>PID</b>	RICH in front of ECAL <sup>4)</sup>	TPC <sup>1)</sup> + Timing Layer <sup>3)</sup>	DCH <sup>1)</sup> + Timing Layer <sup>3,4)</sup>



\* tracking is mostly interchangeable among concepts above, <sup>1)</sup>DRD1, <sup>3)</sup>DRD3, <sup>4)</sup>DRD4, <sup>6)</sup>DRD6

# DRD1 "Gaseous Detectors" work organization



## DRD1 "Gaseous Detectors" FCC-ee perspective

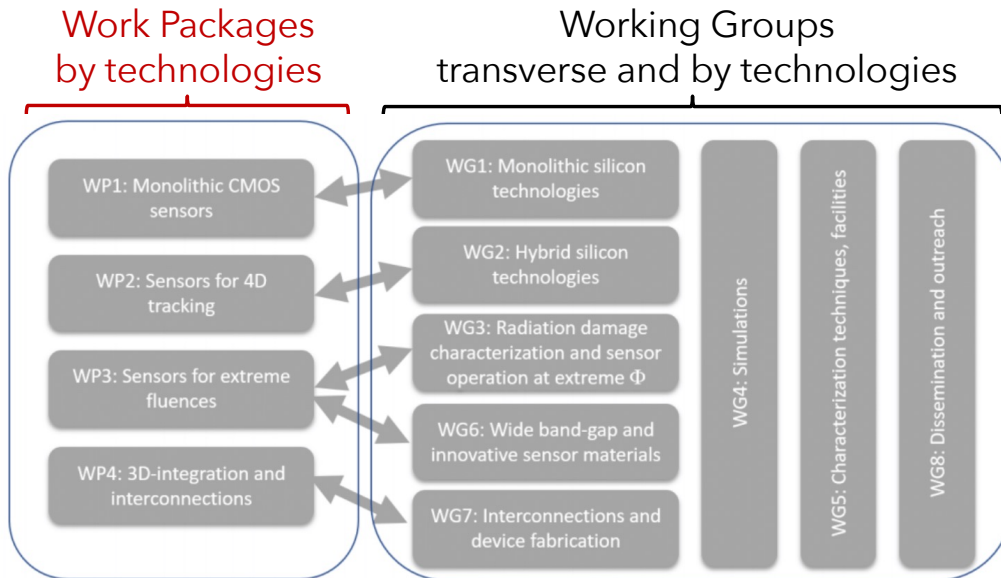
Trackers/hodoscopes	→ MPGD/MWPC/RPC: <b>new structures</b> - systems/environment aspects
Drift chambers	→ <b>large volume w/ light/stable wires, small cells, high gain</b> - pulse sampling dN/dx
Straw chambers	
Tracking TPCs	→ <b>Ion Back Flow</b> - MPGD readout dN/dx
Calorimetry	→ MPGD, RPC: <b>ecofriendly gas - hermetic, thin, uniform designs</b> - enable precise timing
Photon detection (PID)	
Timing detectors	
Reaction/decay TPCs	
Beyond HEP	

### **Broad brush program, 1<sup>st</sup> phase ( $\approx$ 3-4 years)**

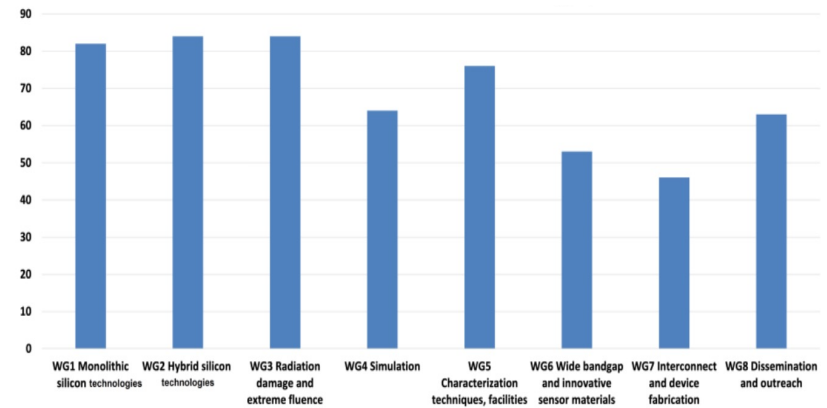
- review of SoA - small size demonstration of new sensing structures
- prepare new readout components
- produce, evaluate larger scale full prototypes



# DRD3 "Solid State Detectors" work organization



143 institutes in 30 countries



## DRD3 “Solid State Detectors” FCC-ee perspective

WP1: Monolithic CMOS sensors

→ granularity in large size at low power - precise timing - extend use to CT & HGC

WP2: Sensors for 4D tracking

→ LGAD: position precision - fill factor (high granularity) - extend use to VD, CT & HGC

WP3: Sensors for extreme fluences

WP4: 3D-integration and interconnections

→ light integrated systems, high mechanical precision, hermeticity, stability w/ DRD7/DRD8

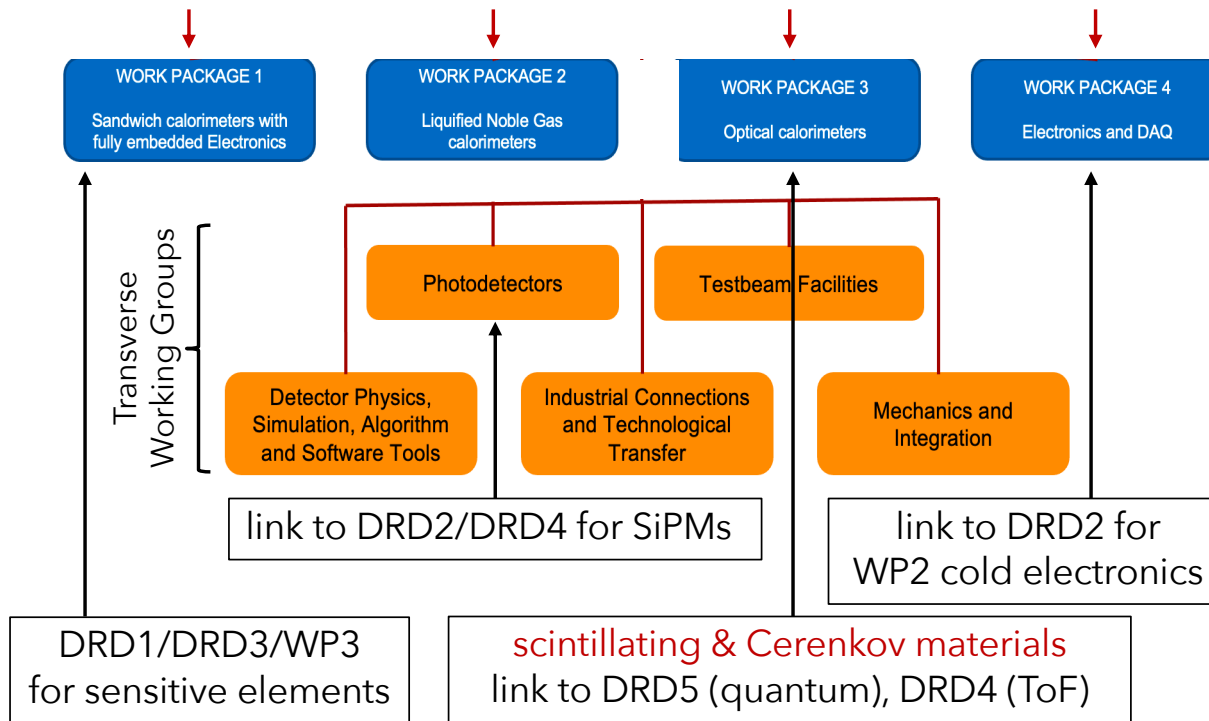
### Broad brush program 1<sup>st</sup> phase ( $\approx$ 3-4 years)

- evaluate foundry process phase space of parameters & performance ( $\approx$  2 submissions/foundry)
  - so far  $\neq$  process privileged for  $\neq$  applications in VD, CT, HGC, TL
  - targeting earlier projects - ITS3, EPIC, ALICE-3, LHCb-II, Belle-3, CMS/ATLAS LS4
- select process(es) for specific performance/application in 2<sup>nd</sup> phase
  - collapse best spatial/time precision in single monolithic low power devices
- prepare for 3D interconnection demonstrators in 2<sup>nd</sup> phase (w/ DRD7), consider process prospect

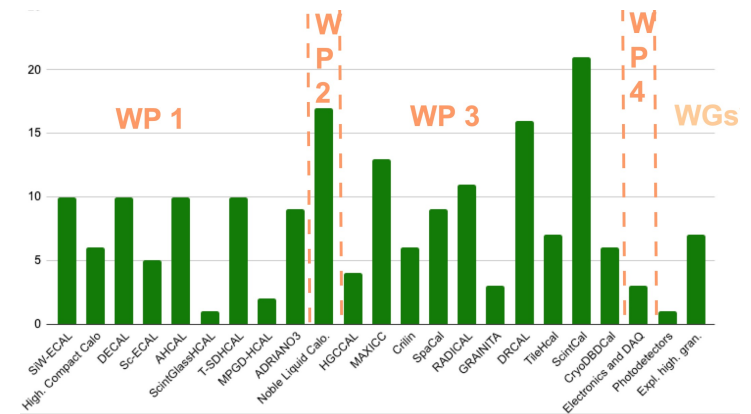
Upcoming workshop [MAPS detectors technologies for the FCC-ee vertex detector](#): CERN 1-2 July 2024

# DRD6 "Calorimetry" work organization

Work Packages: 3 main classes of calorimeters + electronics

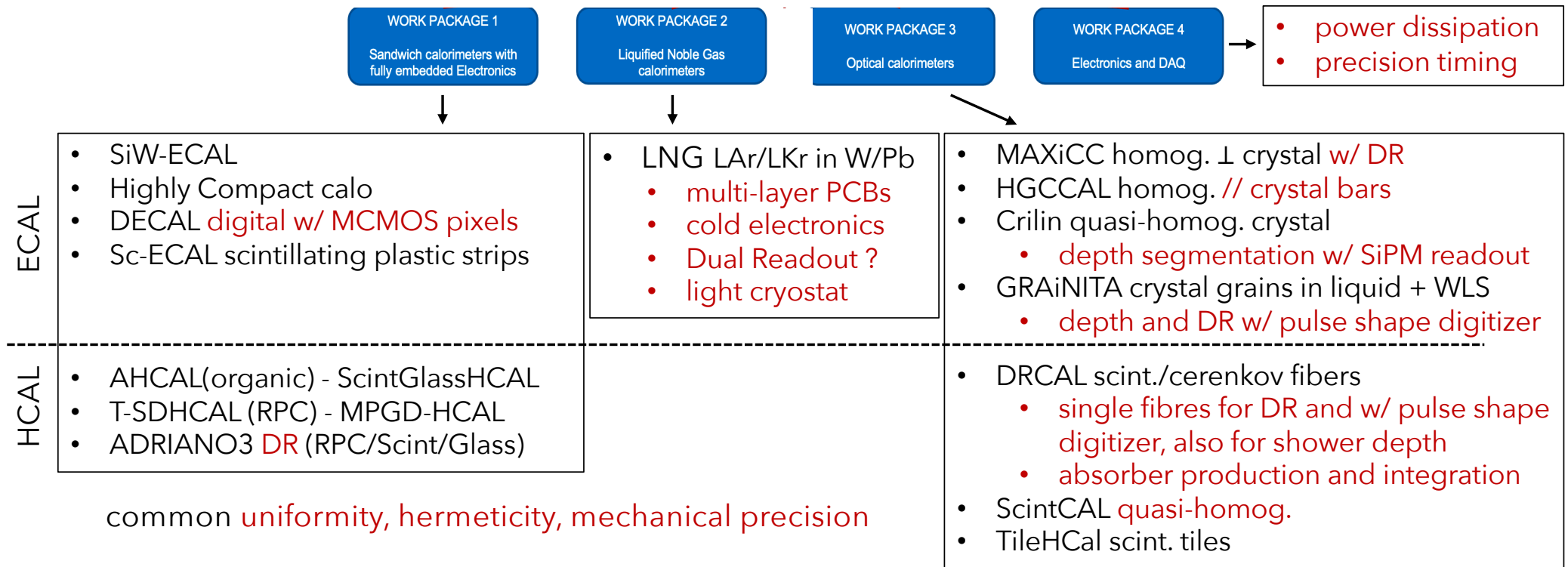


131 institutes in 28 countries



# DRD6 "Calorimetry" for FCC-ee perspective

15 projects of configuration options and sensing technologies

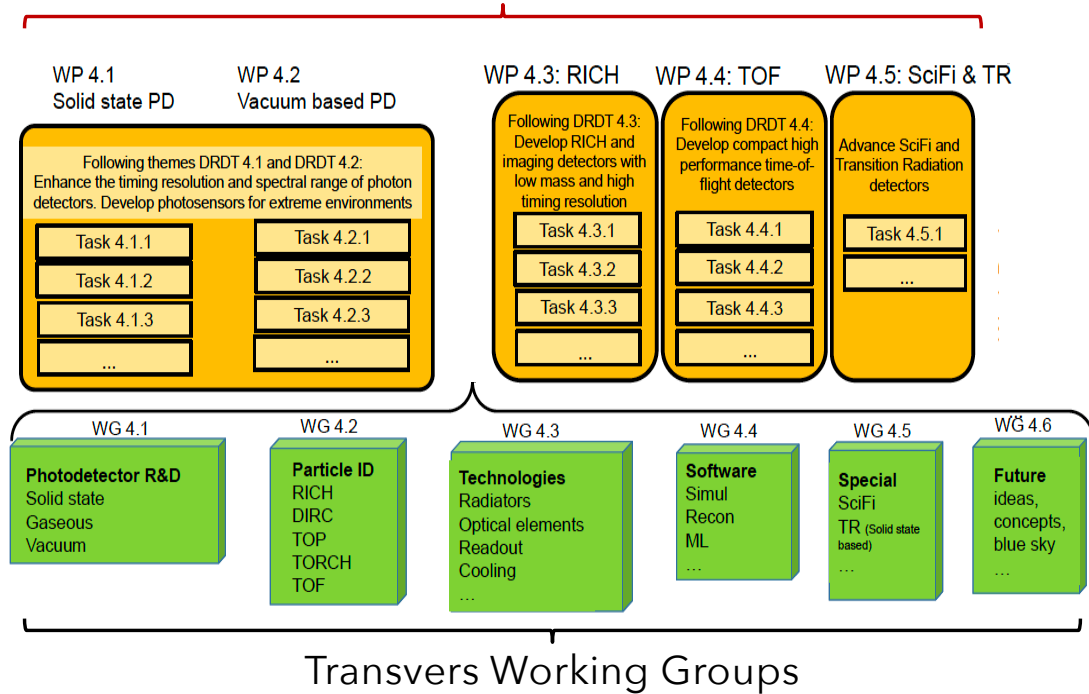


## Broad brush program 1<sup>st</sup> phase ( $\approx$ 3-4 years)

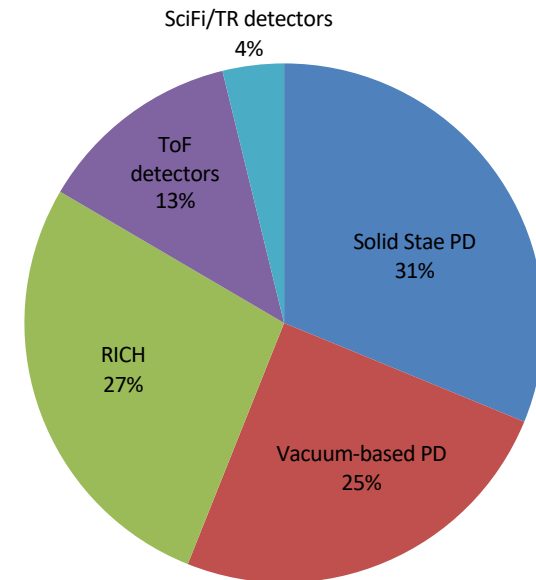
- performance demonstrators w/ SoA sensing and readout electronics
- prepare for "shower-scale" prototypes w/ new sensing elements (other DRDs) & new readout electronics

# DRD4 "Photon and PID" work organization

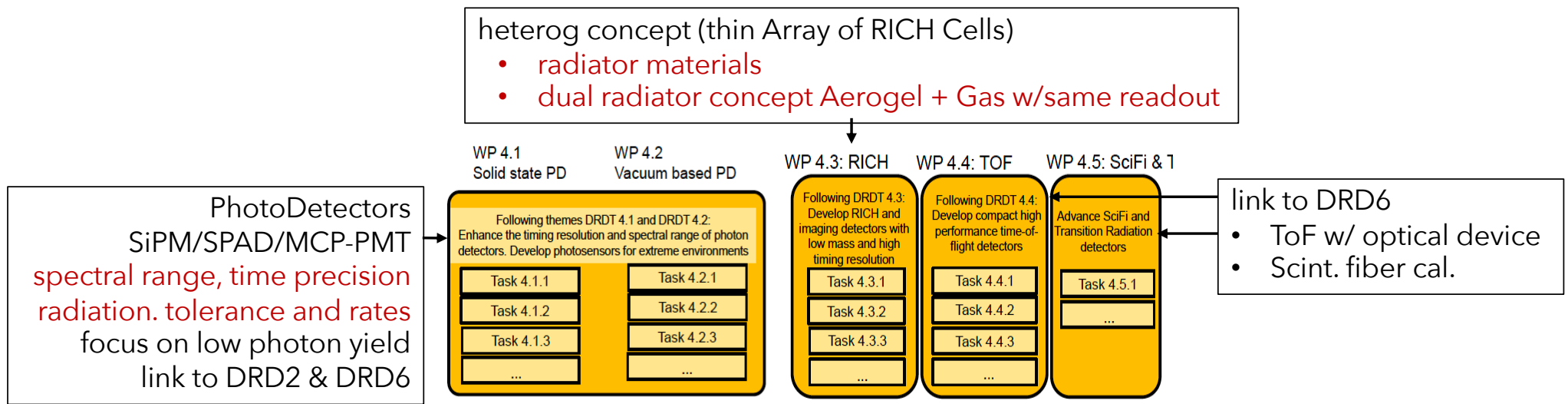
Work Packages: mix of technology and systems



76 institutes in 18 countries



# DRD4 "Photon and PID" FCC-ee perspective



**Broad brush program, 1<sup>st</sup> phase (≈ 3-4 years)**

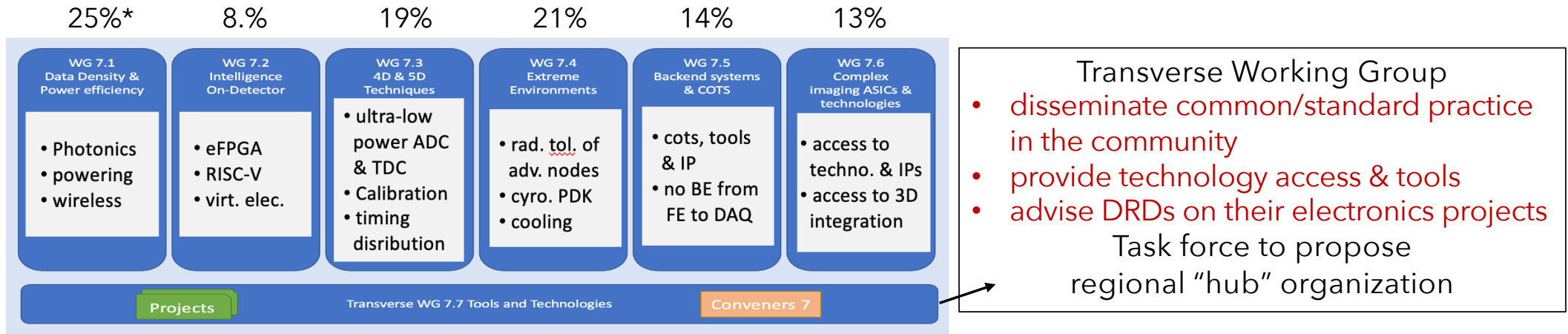
- PD: evaluation of SoA materials & designs, demonstrators new generation, including SPTR
- RICH: evaluation of SoA radiators and refractive index monitoring, new concept demonstrators
- ToF: mm<sup>2</sup> segmented SiPM arrays

# DRD7 “electronics and on-detector processing” program highlights

68 institutes in 19 countries

## Work Packages - new generation of components

enabling 5D at high channel density & rates, w/ low power dissipation



## Broad brush program, 1<sup>st</sup> phase ( $\approx$ 3-4 years)

- target relatively low TRL technologies (for HEP), prepare components, IP blocks in 16 projects
- prepare use of new technologies by other DRDs in 2<sup>nd</sup> phase
- watch technology (commercial) trends

\* % of total number of contributions

## DRD8 Mechanics & Cooling of future Vertex and Tracking systems

LoI submitted to DRDC in March 2023, proposal aims end-2024

22 institutes expressed interest so far (some outside DRD3)

### Proposed Work Packages

- Global/System Design and Integration
  - structures, services, environmental aspects, MDI, scalability, robotics
- Low Mass Mechanics and thermal management
  - materials, advanced manufacturing techniques, embedded cooling
- Detector Cooling
  - evaporative and liquid, gas, connexions and instrumentation
- Design and Qualification Tools
  - open-source software, ML assisted topology optimization, virtual reality, methods for complex 3D integration, connection of CAD tools to Geant

light and compact systems, high mechanical precision, uniformity, hermeticity, stability

key to measurement precision and to systematic errors  
program of deliverables can extend to calorimetry aspects...



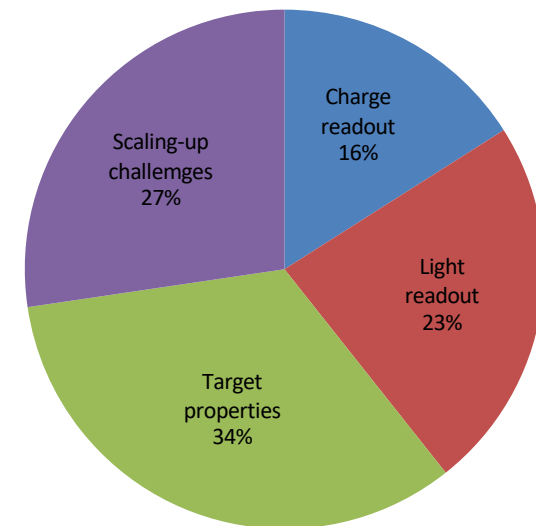
## DRD2 “Liquid Detectors” work organization\*

Water Cerenkov, Noble Liquids, Liquid Scintillators for DM, Neutrino,  $0\nu\beta\beta$ , rare decays

### Work Packages



78 institutes in 15 countries



Links to FCC-ee through synergies with DRD4 and DRD6

Photo-Detectors for optical calorimetry; NGL concept cold electronics and cryostat

\* further resource <https://indico.cern.ch/event/1367848/timetable/#20240205>

## DRD5 “Quantum Sensors” work organization

high sensitivity sensors, nano/meta/heterogenous materials  
so far applications in EDM, DM, neutrino,  $0\nu\beta\beta$  searches, fundamental forces  
96 institutes in 23 countries\*, considering platform/hub organization

Technology areas	Clocks and clock networks
	Kinetic detectors
	Spin-based sensors
	Superconducting sensors
	Optomechanical sensors
	Atoms/molecules/ions
	Atom interferometry
	Metamaterials, 0/1/2D-materials
	Quantum materials

**Work Packages** (defined considering and HEP collaborative model)

- atomic, nuclear & molecular systems in traps & beams
- quantum materials
- cryogenic materials, device and systems
- scaled-up quantum
- quantum techniques for sensing
- networking, training, shared expertise and infrastructure

low TRL, some potential applications identified,  
particularly for quantum materials  
possible synergies for common projects with other DRDs  
(to enter their strategic program when  $TRL \approx 3$ )  
**windows for new detector concepts at FCC-ee ?**

\*  $\approx 1/3$  HEP +  $1/3$  outside HEP +  $1/3$  dual

# Outlook

- DRD collaborations are becoming active
  - new institutes can join through established Collaboration Boards
  - organization of common work within DRDs is taking shape
  - resource needs and funding will clarify with preparation of MoU
    - keep close communication for proper integration of national or EU programs (ex. CPAD, AIDAInnova)
- Timelines across DRDs and their matching to strategic project
  - are monitored through EDP DRD Collaborations Managers Forum
    - ESPP update is an opportunity to assess the situation and prepare next steps
- Developing understanding of key requirements and constraints at the FCC-ee
  - a “must” to develop a well balanced effort in R&D areas, possibly with complementarity
- Developing understanding of the timeline for technology components, demonstrators and eventually prototype developments
  - another “must”, to develop a well balanced R&D effort w/o missing technical progress opportunities