Update:
ECFA Detector R&D Roadmap Implementation

Plenary ECFA Meeting

July 12, 2023

Felix Sefkow
DESY

Outline

This Talk

Reminder:

- **Roadmap Process, Outcome**
- **Implementation plan**

Status of individual DRD Proposals

Next steps: DRDC and MOUs

ECFA Detector R&D Roadmap and Implementation Plan

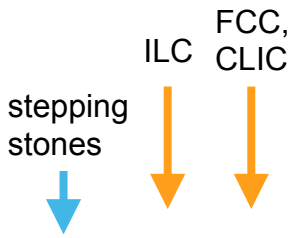
ECFA Detector Roadmap Summary

Relating Technology R&D to Major Drivers from Facilities

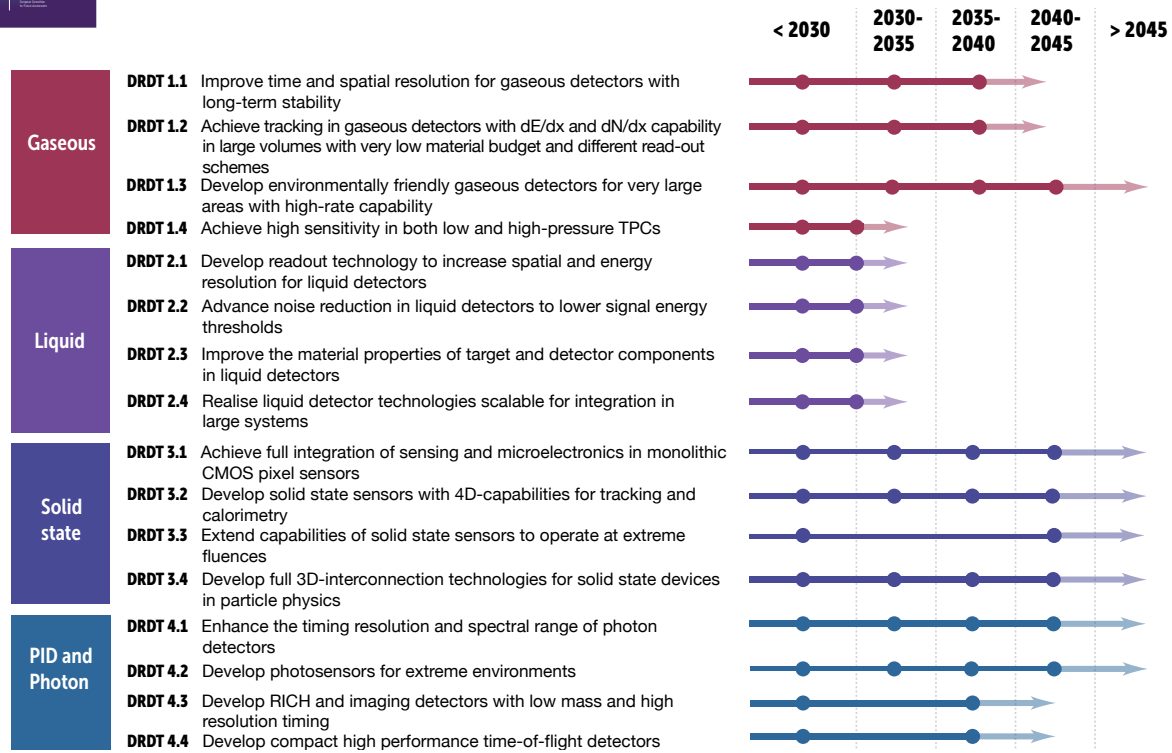
https://cds.cern.ch/record/2784893

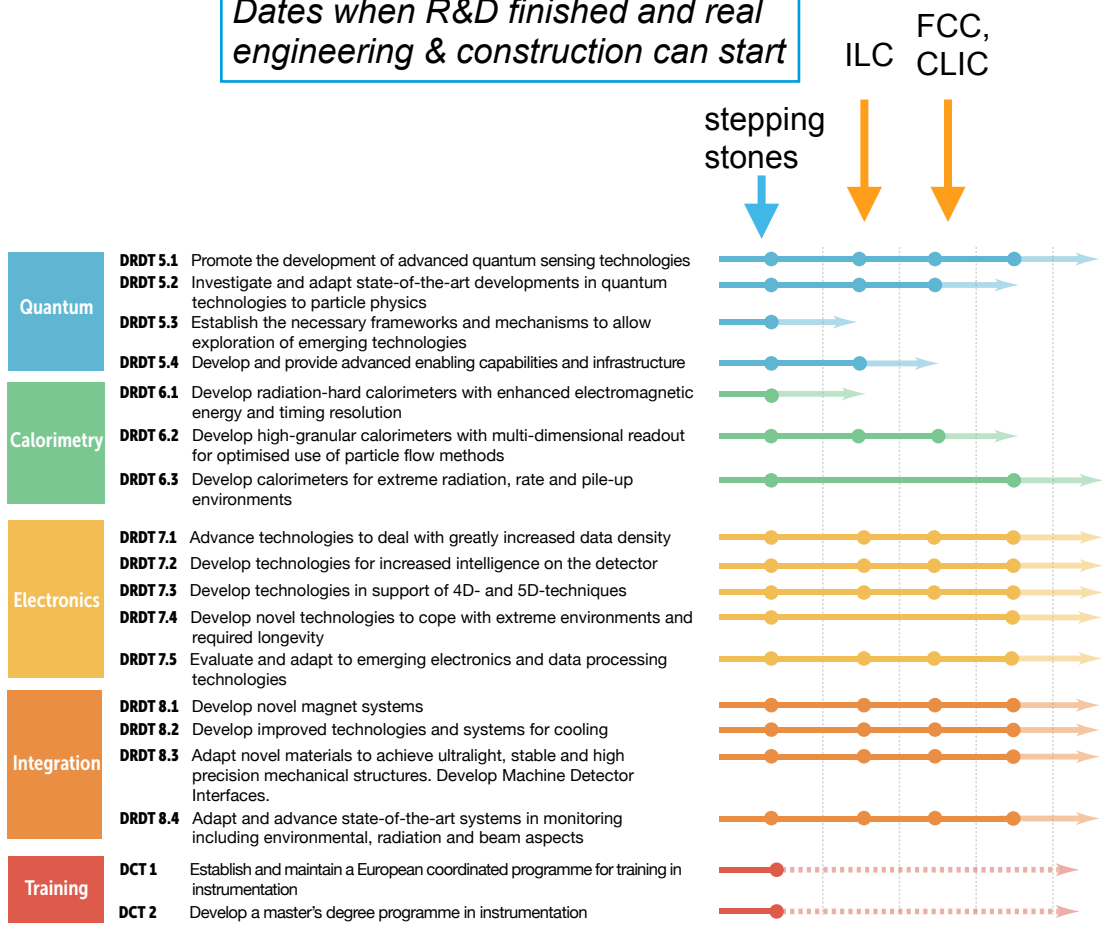
~ 200 pages
~ 1.5 year young

Dates when R&D finished and real engineering & construction can start



DETECTOR RESEARCH AND DEVELOPMENT THEMES (DRDTs) & DETECTOR COMMUNITY THEMES (DCTs)





Detector R&D Themes (DRDTs) and Detector Community Themes (DCTs). Here, except in the DCT case, the final dot position represents the target date for completion of the R&D required by the latest known future facility/experiment for which an R&D programme would still be needed in that area. The time from that dot to the end of the arrow represents the further time to be anticipated for experiment-specific prototyping, procurement, construction, installation and commissioning. Earlier dots represent the time-frame of intermediate "stepping stone" projects where dates for the corresponding facilities/experiments are known. (Note that R&D for Liquid Detectors will be needed far into the future, however the DRDT lines for these end in the period 2030-35 because developments in that field are rapid and it is not possible today to reasonably estimate the dates for projects requiring longer-term R&D. Similarly, dotted lines for the DCT case indicate that beyond the initial programmes, the activities will need to be sustained going forward in support of the instrumentation R&D activities).

How Much Time Do We Need to Prepare?

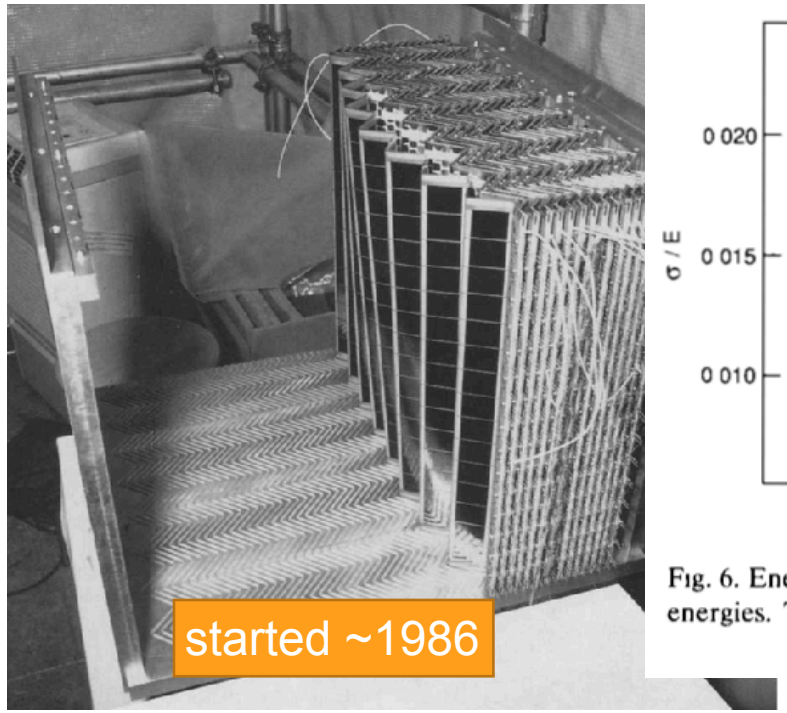
"Random" Examples

Nuclear Instruments and Methods in Physics Research A309 (1991) 438–449
North-Holland

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH
Section A

Performance of a liquid argon electromagnetic calorimeter with an "accordion" geometry

RD3 Collaboration



started ~1986

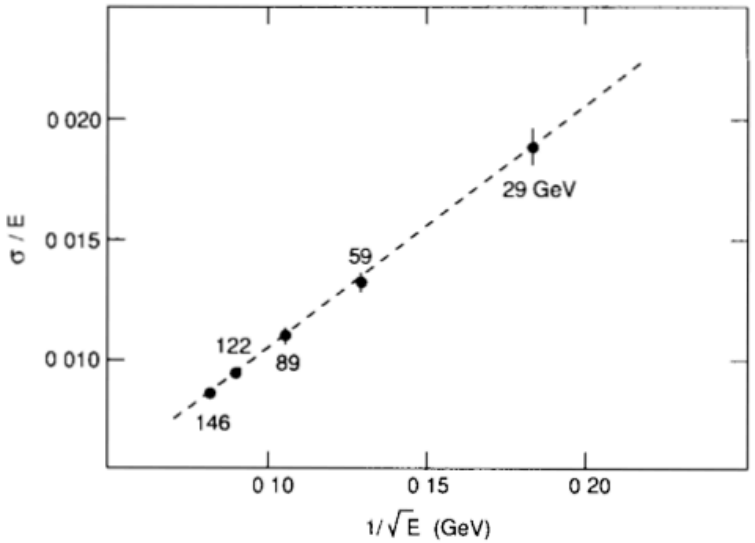
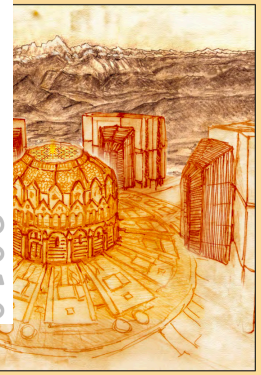


Fig. 6. Energy resolution of the prototype at different electron energies. The dashed line is a linear fit to the experimental points.

CERN-LHCC-2017-023
CMS-TDR-019
9 Apr 2018

CERN Euro
Organisation eu

CMS



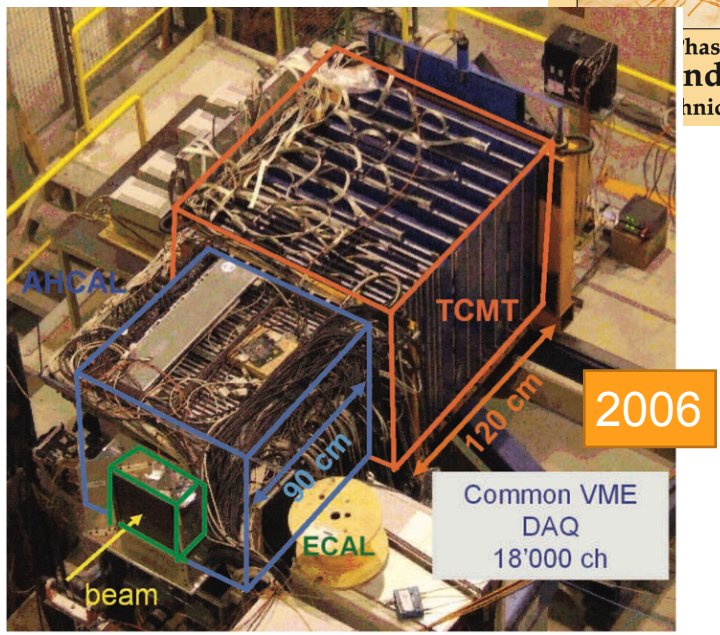
hase-2 Upgrade of the
ndcap Calorimeter
hnical Design Report

2010

JINST
PUBLISHED BY IOP PUBLISHING FOR SISSA
RECEIVED: December 29, 2009
REVISED: March 2, 2010
ACCEPTED: April 2, 2010
PUBLISHED: May 5, 2010

Construction and commissioning of the CALICE analog hadron calorimeter prototype

The CALICE collaboration



Implementation of the ECFA Detector R&D Roadmap

In a Nutshell

European Strategy stresses importance of a strong focus on instrumentation

- Relevant R&D issues must be addressed **in time**
- Common R&D lines with near- and mid-term projects - exploit **synergies and stepping stones**
- Offer **long-term perspectives** for instrumentation physicists / engineers

Successful completion of High-Luminosity LHC must remain key focus

- started the process now, but expect only gradual ramp-up
- larger involvement of many groups after phase II construction completed

Two components

- Establishment of **R&D collaborations** anchored at CERN
- Implementation of General Strategic Recommendations (not covered today)

DRD: Detector R&D Collaborations

Anchored at CERN

Follow the successful model of R&D collaborations for the LHC

- funding in place since ~1986, R&D collaborations established in 1990
- few large DRD collaborations, to keep it manageable

Take full account of existing, successful and well managed R&D coll.

- Integrate with CERN EP R&D, AIDAinnova, RDxy, CALICE,…
- invite world-wide participation

Reasonably dimensioned review process (ECFA and CERN)

- addressing needs of future experiments is important criterion
- worldwide perspective

Process approved by CERN Council (Sep 2022)

- following extensive consultations with funding agencies
- Document: https://indico.cern.ch/event/1197445/contributions/5034860/attachments/2517863/4329123/spc-e-1190-c-e-3679-Implementation_Detector_Roadmap.pdf

Implementation Timeline

Community-driven approach, supported by ECFA Roadmap Task Forces

Goal: Transition to new scheme during 2023

- approval of LHC-oriented RD50 (silicon), RD51 (gas detector) collaborations expires Dec 2023

Major Steps:

- **community input** (via existing R&D bodies where possible) by **Q1 2023**
- Written **proposals**, based on ECFA Detector Roadmap, by **July 2023**
  - 20 pages, concrete and realistic **plans**, deliverables, resource-loaded, for **period 2024-2026**
    - and - with less precision - beyond
- In parallel, **DRD Committee** mandate and membership defined
- **Review** (by DRDC, assisted by EDP) in **fall 23,** approval by **end 2023**
- R&D collaborations **operational**
- **MoU** signatures) through **2024**

Challenge

- funding not exactly known - but cost projections should be backed by Funding Agencies

Connection with ECFA Study on Future Higgs EW top Factories

Guidance and feedback

DRD to address needs of full spectrum of future facilities

- including near and far future, acceleration and non-accelerator

Higgs factory ranking very high in European Particle Physics Strategy Update

- next to HL-LHC
- one of the main “customers" for several DRDs

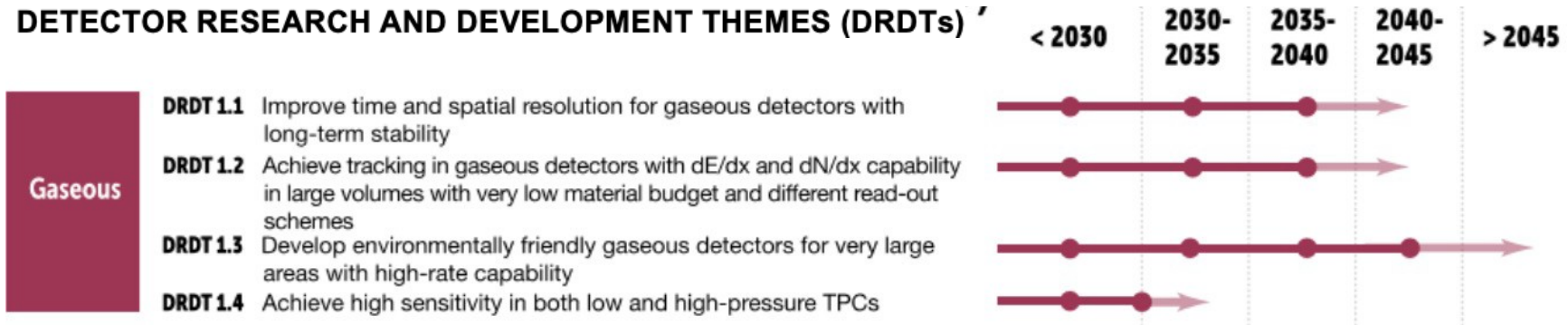
ECFA Study WG3 on detectors organised two compact workshops in May

- bring together studies of future facilities and detector R&D community
- review requirements from physics, conceptual design drivers and emerging R&D proposals
- Calorimetry and PD https://indico.cern.ch/event/1256374/timetable/?view=standard
- Tracking and vertexing https://indico.cern.ch/event/1264807/timetable/?view=standard

Status of DRD Proposals

DRD1: Gaseous Detectors

Successor and extension of RD51



Future Hadron Colliders: FCC-hh Muon System (MPGD - OK, particle rates are comparable with HL-LHC)
Future Lepton Colliders: Tracking (FCC-ee / CepC - Drift Chambers; ILC / CePC - TPC with MPGD readout)
Calorimetry (ILC, CepC – RPC or MPGD), Muon Systems (many gas det. are OK)

Future Election-Ion Collider: Tracking (GEM, μWELL; TPC/MPGD), RICH (THGEM), TRD (GEM)

TF Convenors: Anna Colaleo (INFN Bari (IT)), Leszek Ropelewski (CERN)

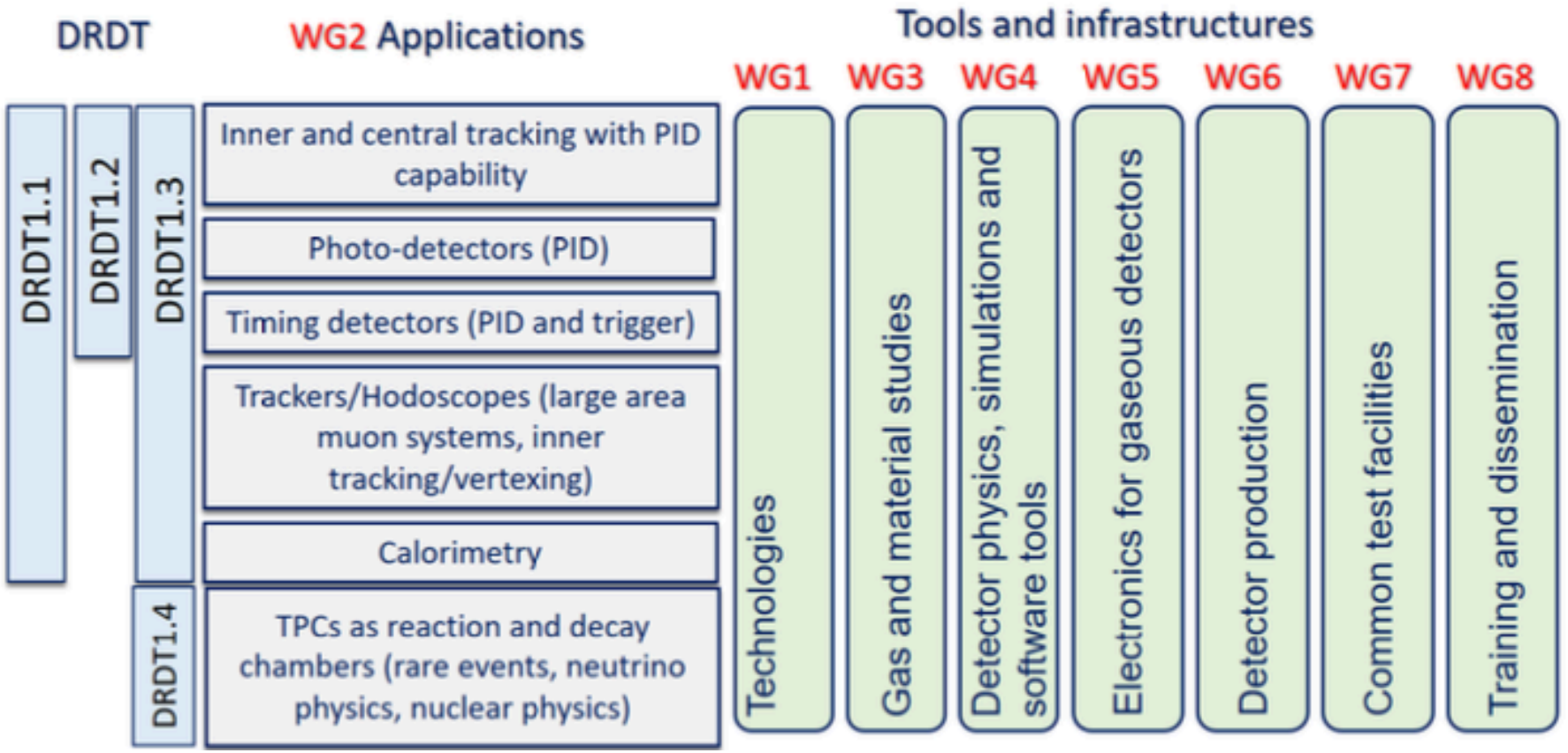
Proposal status: Draft released, on track for submission by end of July

- extended proposal (100p, executive summary in preparation)

Community Meeting: most recent June 23, https://indico.cern.ch/event/1273991/timetable/#20230622

DRD1 Structure and Community

Taking Shape



110 institutions

Web page: https://drd1.web.cern.ch/

DRD2: Liquid Detectors

New Collaboration

DETECTOR RESEARCH AND DEVELOPMENT THEMES (DRDTs)

Liquid

- **DRDT 2.1** Develop readout technology to increase spatial and energy resolution for liquid detectors
- **DRDT 2.2** Advance noise reduction in liquid detectors to lower signal energy thresholds
- **DRDT 2.3** Improve the material properties of target and detector components in liquid detectors
- **DRDT 2.4** Realise liquid detector technologies scalable for integration in large systems

Neutrinos	Dark Matter	0νββ
• Future generation: ✓DUNE modules 1 & 2 ✓DUNE near detectors ✓DUNE modules 3 & 4 ✓HK ✓Future neutrino telescopes	• Future generation: ✓XLZD ✓GADMC/Argo ✓HeRALD ✓SBC	• Future generation: ✓nEXO ✓KL-Z+ ✓Upgrades to SNO+

4

TF Convenors: J. Monroe (RHUL (GB)), R. Guenette (Manchester (GB))

Proposal status: First full draft ready, on track for submission by end of July

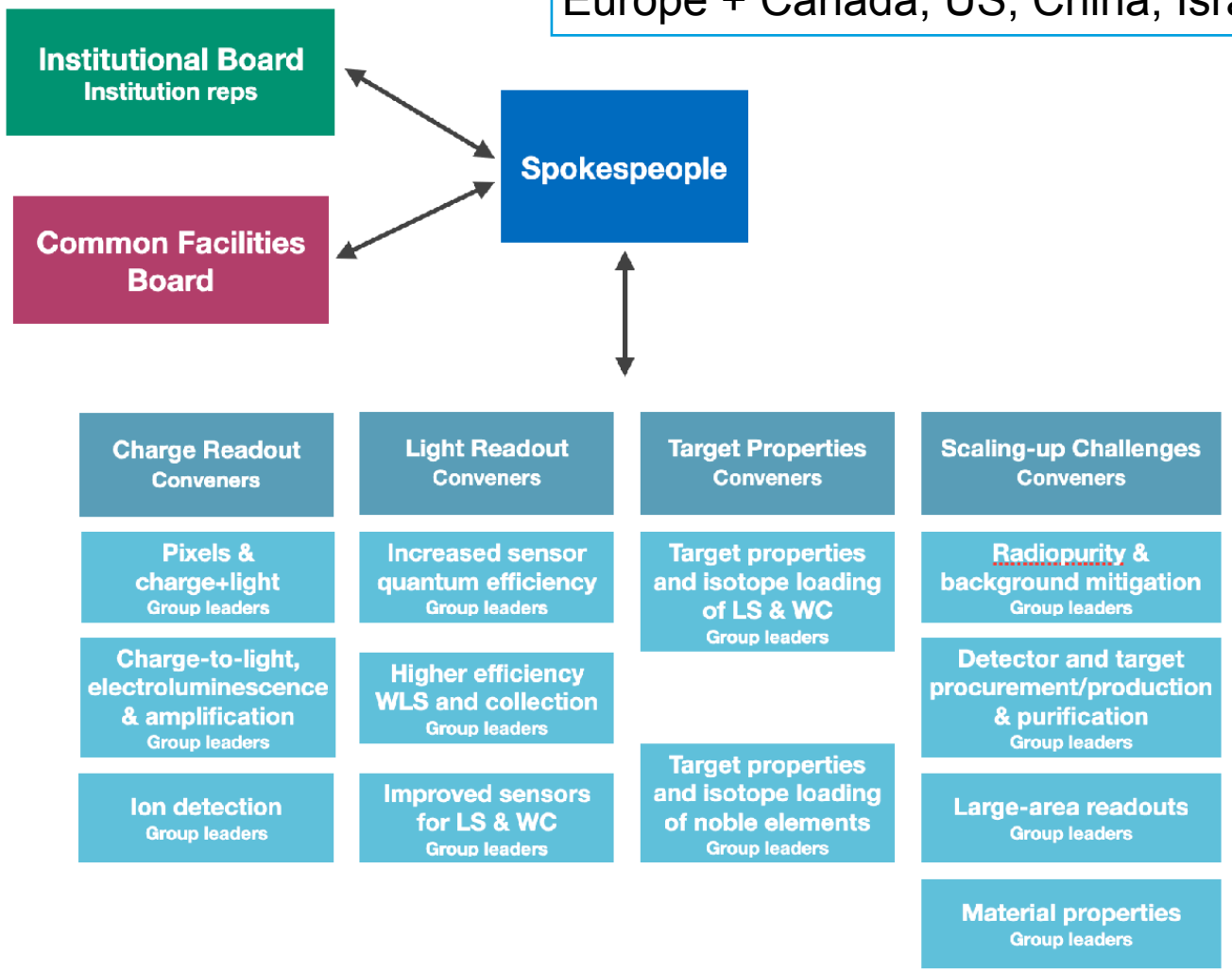
- proposal draft (20 p), to be posted to community; all tables complete

Community Meeting: April 20, https://indico.cern.ch/event/1214404/timetable/#20230420

DRD2 Structure and Community

Building up

~100 institutions
Europe + Canada, US, China, Israel



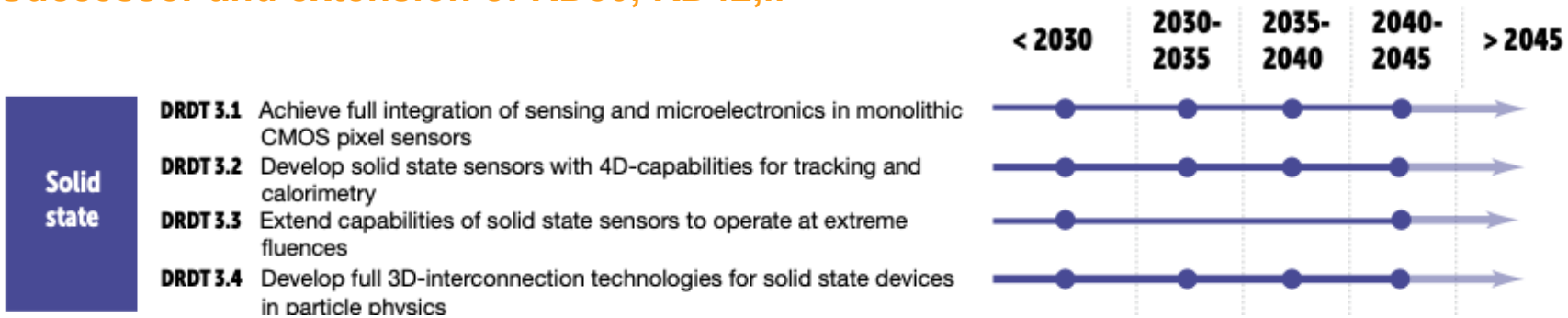
Contents

Deliverables	Milestone	Timeline of milestones and major deliverables 2024	2025	2026	2027-2030	>2030
TA1: Charge Readout						
TA1.1: Pixels and Charge + Light Readouts						
TA1.1.D1: Design a 3D charge sensing pixel readout optimized for low energy detection and minimizing power consumption.	D1.1.M1.1 Lower pixel thresholds to the limit of CMOS capabilities.	O(1000 ENC)	O(500 ENC)		O(<200 ENC)	O(<100 ENC)
	TA1.1.M1.2 Lower power consumption	~100 nW/ch	50-100 nW/ch		<50 nW/ch	
TA1.1.D2: Scaling pixel readout to O(100 million) channels		O(100k)	O(1million)		O(10million)	
TA1.1.D3: Design of an architecture capable of capturing multimodal signals	TA1.1.M1.1 Maximize photocathode coverage and QE in an integrated 3D charge and VUV light sensing scheme for pixel TPCs	- Complete simulation of embedded photodetector technology - Measurement low γ flux in ASr horizontal geometry - ASr vertical geometry viability - Integrated Pixel/SiPM demonstrations (SuLAr) - Organics viability - ZnO explorations	- Small scale prototyping for embedded photodetector technology - Simulation package for multiple modality pixels	- Joint readout scheme for ASr horizontal geo - Measurement Low γ flux in ASr vertical geo - Other material explorations (Perovskites, Nanoplatelets, etc)	- Performance assessment for embedded photodetector technology - Small scale prototyping ASr horizontal geo - Joint readout scheme & small scale prototyping for ASr vertical geo - Measurement Low γ flux in perovskites & nanoplatelets	- Mid-scale prototype for pixel embedded photodetectors (data taking and validation) - Mid-scale prototype for multiple modality (data taking and validation) Scalability
	TA1.1.M1.2 Novel fast (O(GHz)) clock/timing architectures for charge & Q+L readout	50 MHz	100 MHz	500 MHz	1 GHz	
TA1.2: Amplification structures, charge to Light conversion and granular light readout of dual phase detectors						
TA1.2.D1: Granular S2 light	TA1.2.M1.1: Camera-based particle tracking	first testing of photosensitive TPX4	testing TPX4 camera on prototype TPC; Design of VUV optics	testing integrate VUV image intensifier and TPX4 camera	test tracking, physics capability long TPX4 camera TPC runs	scalability implementation R&D
	TA1.2M1.2: SiPM-based particle tracking				demonstrate mm tracking resolution and sub-percent energy resolution	
	TA1.2.M1.3: Camera-based S1 detection				demonstrate S1 detection with TPX4cam using WLS-coated GEMs or S2 induced by S1 via photoelectric effect	
TA1.2.D2: Optimisation and characterisation of charge amplification structures	TA1.2.M2.1: dual phase	demonstrate single photoelectron sensitivity using novel amplification structures	demonstrate ER/NR discrimination; demonstrate feasibility of new techniques to generate intense proportional scintillation	optimisation of large-area cryogenic glass thick GEMs		
	TA1.2.M2.2a: single phase LXe	demonstrate single photoelectron sensitivity using novel electroluminescence structures	demonstrate ER/NR discrimination	developments for m²-scale testing device and integration techniques		
	TA1.2.M2.2b: single phase LAr		demonstrate stable charge amplification	demonstrate sub-keV detection threshold		
	TA1.2.M2.3: novel amplification strategies for single and mixed-phase detectors		report on the feasibility of LAr/LXe 10 l scale detector with bubble-assisted amplification/electroluminescence			
TA1.2.D3: Demonstration of scalability of D1 an D2	TA1.2.M3.1: LAr / dual phase Ar large scale tests			imaging large-area with TPX camera readout in protoDUNE	Evaluate tracking and physics capabilities in protoDUNE raw	
	TA1.2.M3.2: Single phase LXe / dual phase Xe large scale tests		m²-sized demonstrator of a dual-phase LXe electroluminescence stage	m²-sized demonstrator of a single-phase LXe electroluminescence stage	demonstrate scalability to m² scale	experimental implementation

Table 1: Deliverables and milestones of TA1: Charge Readout.

DRD3: Solid Detectors

Successor and extension of RD50, RD42,..



TF Convenors: Giulio Pellegrini (IMB-CNM-CSIC) (ES)), Nicolo Cartiglia (INFN Torino (IT))

Proposal status: First full draft completed, ready for submission in July (with estimated resources)

- draft (40p) circulated to the community questionnaires on resources sent today, feedback by end August

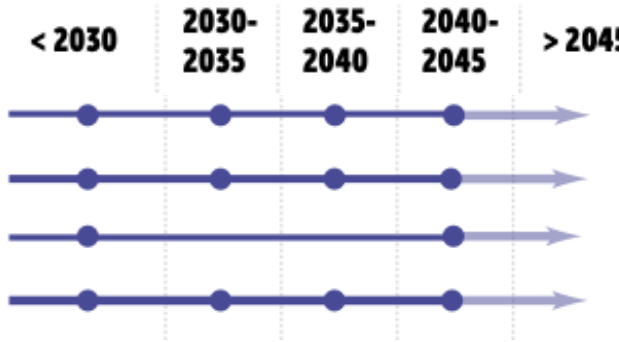
Community Meeting: March 22-23, https://indico.cern.ch/event/1214410/timetable/#20230322.detailed

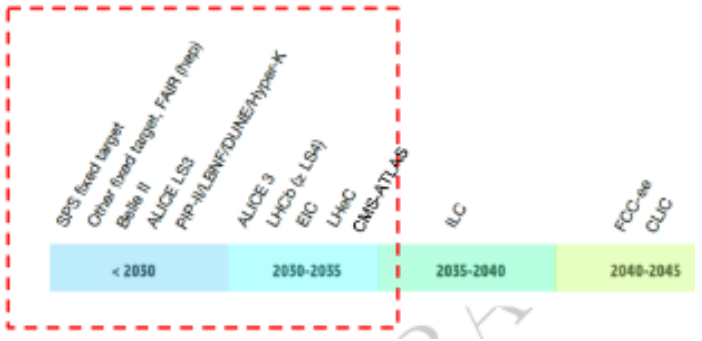
DRD3: Solid Detectors

Successor and extension of RD50, RD42,..

Solid state

- **DRDT 3.1** Achieve full integration of sensing and microelectronics in monolithic CMOS pixel sensors
- **DRDT 3.2** Develop solid state sensors with 4D-capabilities for tracking and calorimetry
- **DRDT 3.3** Extend capabilities of solid state sensors to operate at extreme fluences
- **DRDT 3.4** Develop full 3D-interconnection technologies for solid state devices in particle physics





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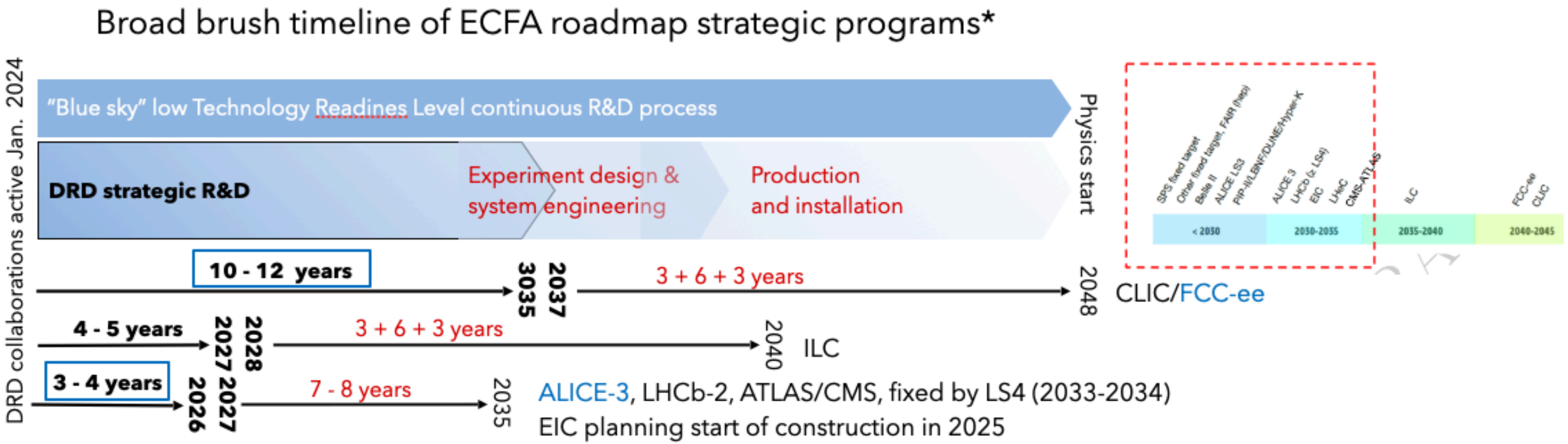
DRD3: Solid Detectors

Successor and extension of RD50, RD42,..



** Not exhaustive, now BELLE considering 3rd upgrade at high luminosity, Muon Collider new timeline from Snowmass, and also CEPC*

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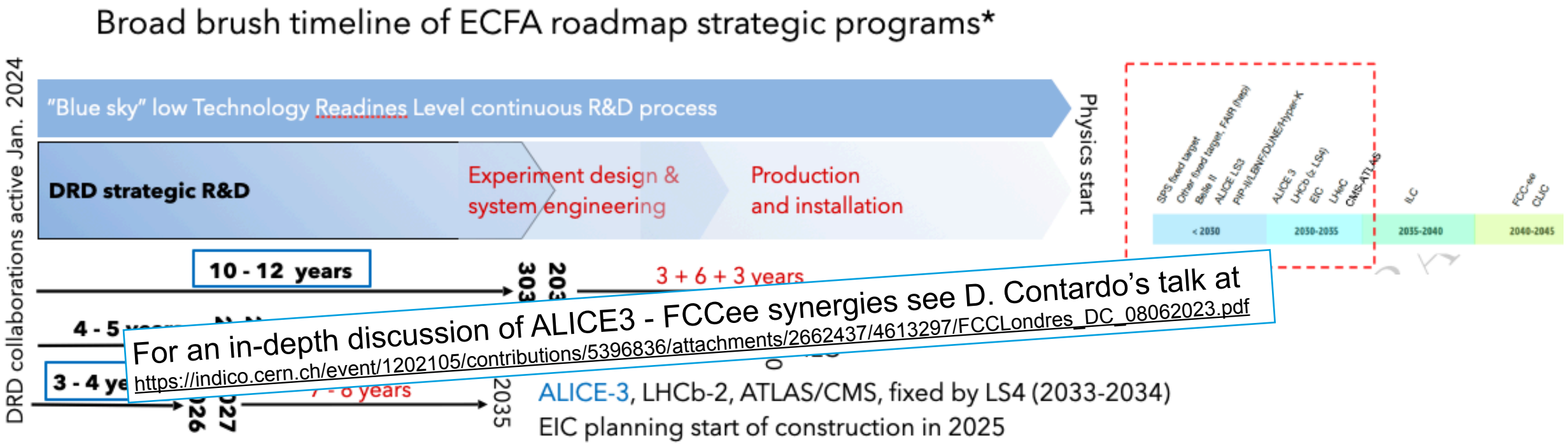
DRD3: Solid Detectors

Successor and extension of RD50, RD42,..



For an in-depth discussion of ALICE3 - FCCee synergies see D. Contardo's talk at https://indico.cern.ch/event/1202105/contributions/5396836/attachments/2662437/4613297/FCCLondres_DC_08062023.pdf

** Not exhaustive, now BELLE considering 3rd upgrade at high luminosity, Muon Collider new timeline from Snowmass, and also CEPC*

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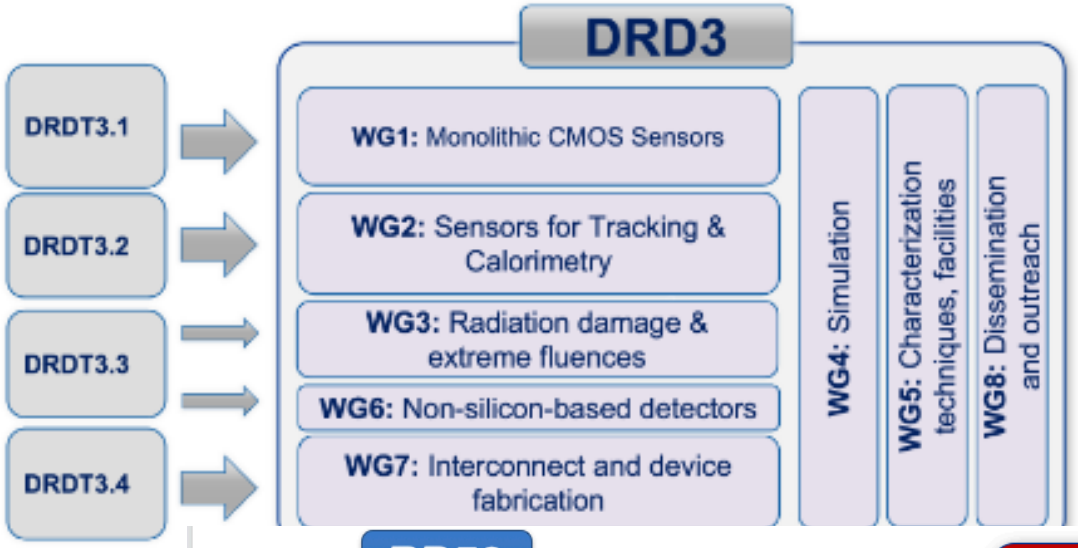
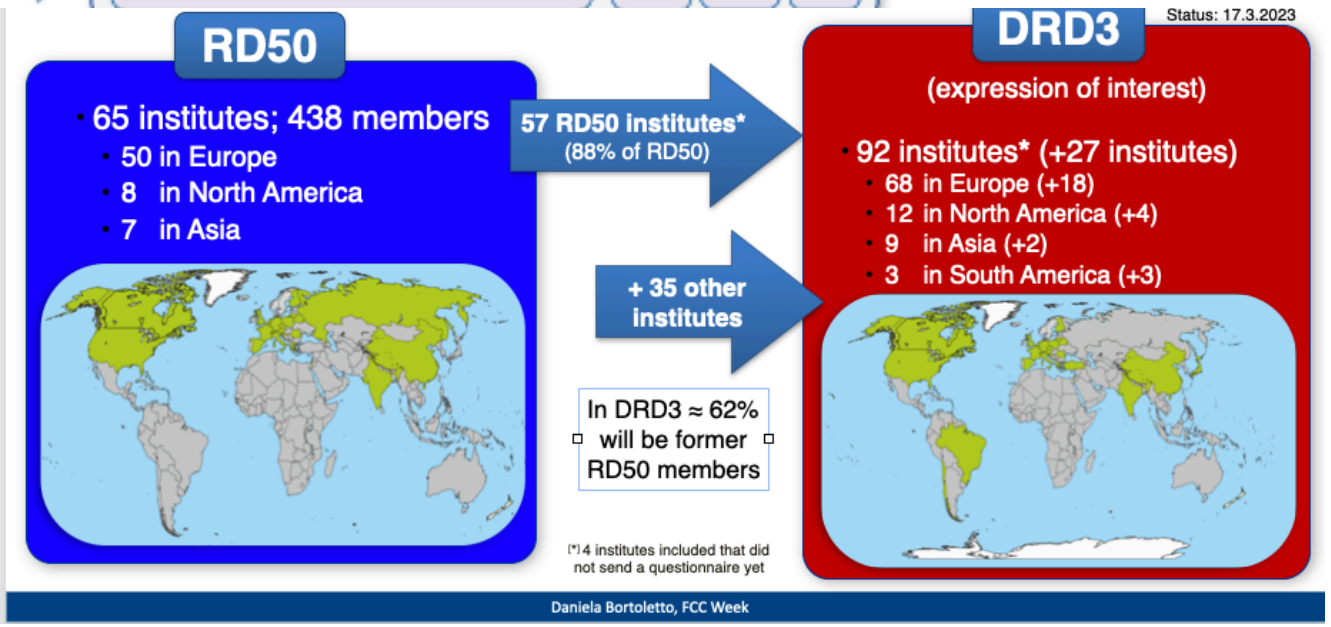
DRD3 Structure and Community

DRDT + GSR topics





DRD3 - Solid State Detectors
- Research Proposal -

DRD3 Proposal Team

July 11, 2023

Contents

DRD4: Photodetectors and Particle ID

New Collaboration

PID and Photon

- **DRDT 4.1** Enhance the timing resolution and spectral range of photon detectors
- **DRDT 4.2** Develop photosensors for extreme environments
- **DRDT 4.3** Develop RICH and imaging detectors with low mass and high resolution timing
- **DRDT 4.4** Develop compact high performance time-of-flight detectors

add
SciFi Tracking
Transition Radiation

Most groups focus on near-term projects
HL-LHC LS4 upgrades of **LHCb, ALICE, EIC,..**
Recently grown interest in hadron separation for e+e-

Z-Factories are great Flavour Factories

Working point	Lumi. / IP [10^{34} cm^{-2}.s^{-1}]	Total lumi. (2 IPs)	Run time	Physics goal
Z first phase	100	26 ab^{-1} /year	2	
Z second phase	200	52 ab^{-1} /year	2	150 ab^{-1}

Particle production (10^9)	B^0 / $\overline{B}^0$	B^+ / B^-	B_s^0 / $\overline{B}_s^0$	Λ_b / $\overline{\Lambda}_b$	$c\bar{c}$	τ^-/τ^+
Belle II	27.5	27.5	n/a	n/a	65	45
FCC-ee	1000	1000	250	250	1000	500

TF Convenors: Christian Joram (CERN), Peter Krizan (JSI (SI))

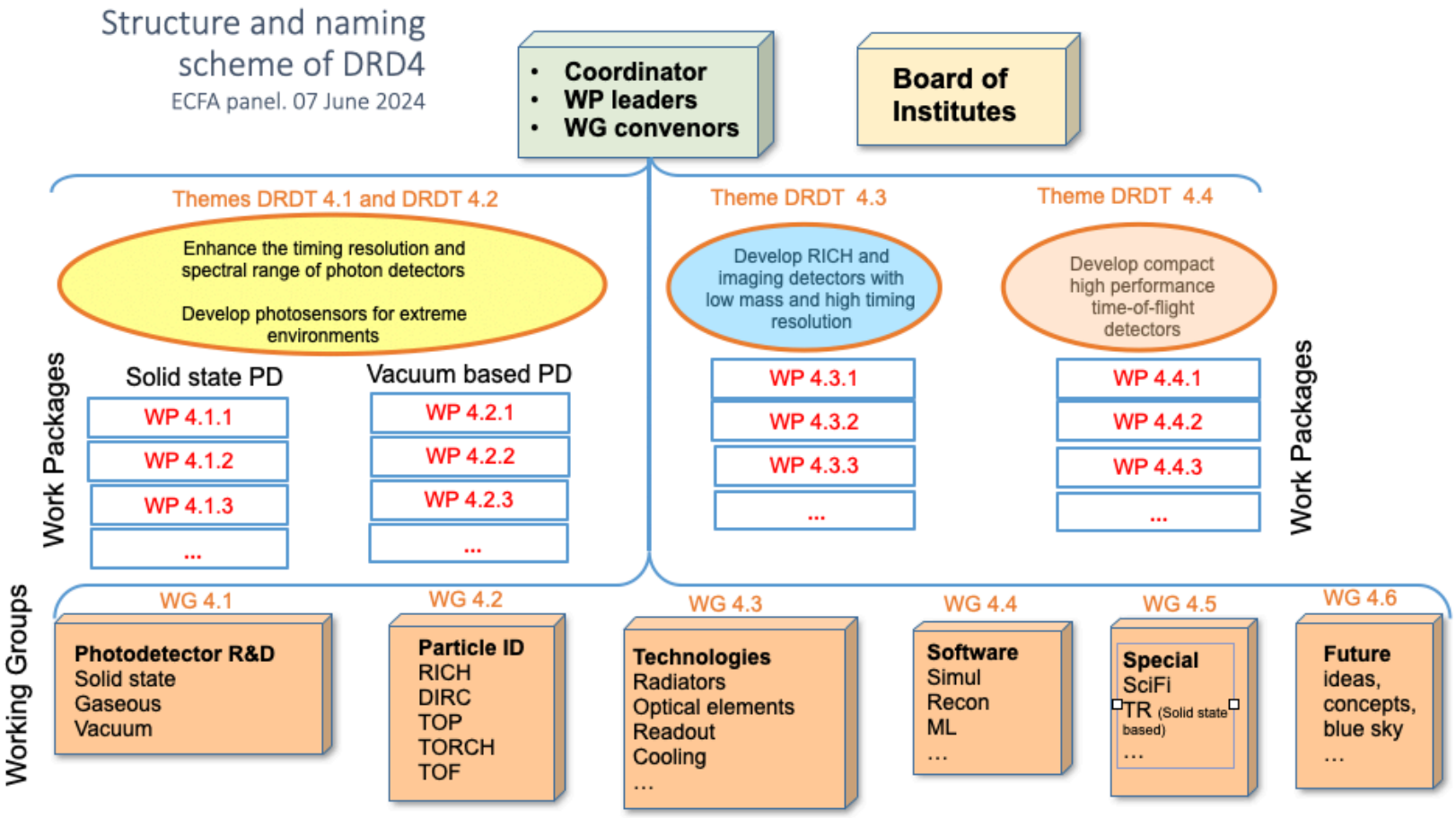
Proposal status: Draft underway for preliminary submission in July (with estimated resources)

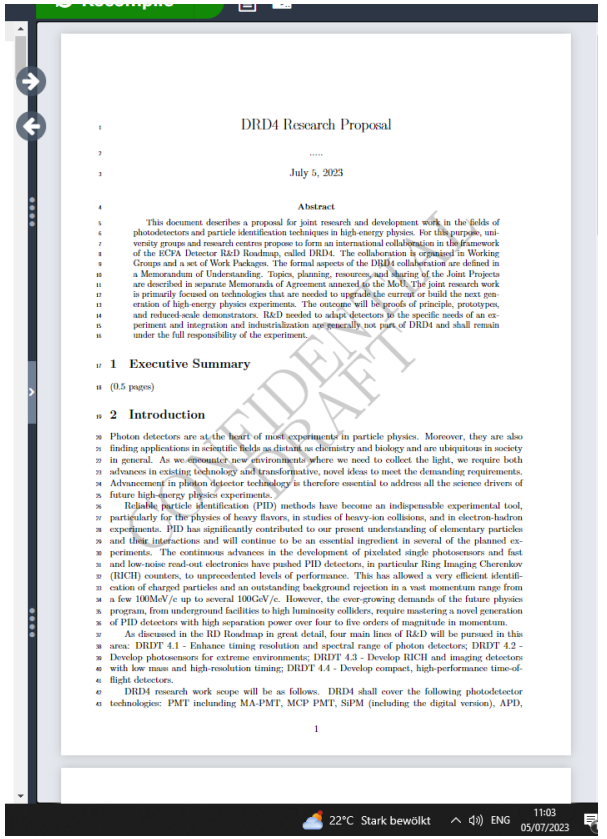
- following 4 online surveys; aim at 20p, polished version with final resource tables after summer break

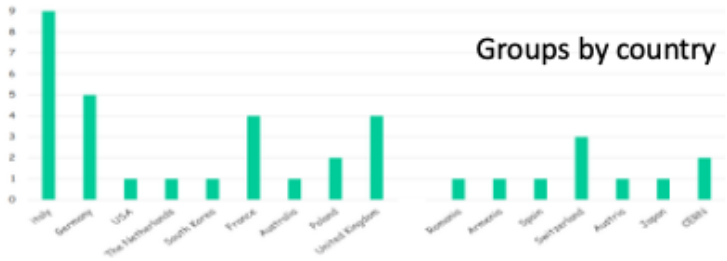
Community Meeting: Update on June 15, https://indico.cern.ch/event/1294239/

DRD4 Structure and Community

Strong interest



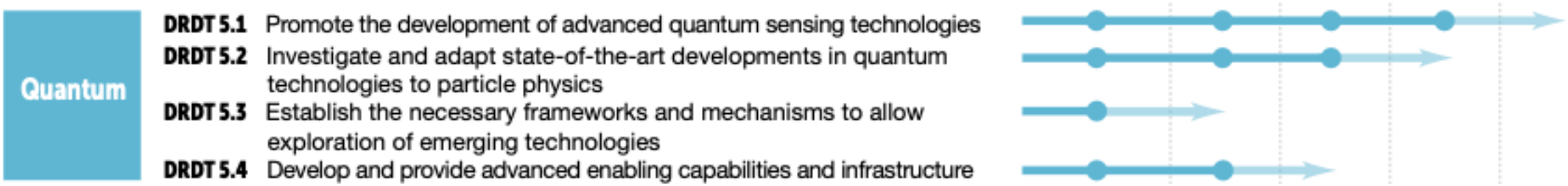




55 groups
including US and Japan

DRD5: Quantum Technologies

Complex Community of Communities



TF Convenors: Marcel Demarteaau (ORNL (US)), Michael Doser (CERN)

Proposal status: White paper evolving draft at http://doser.web.cern.ch/

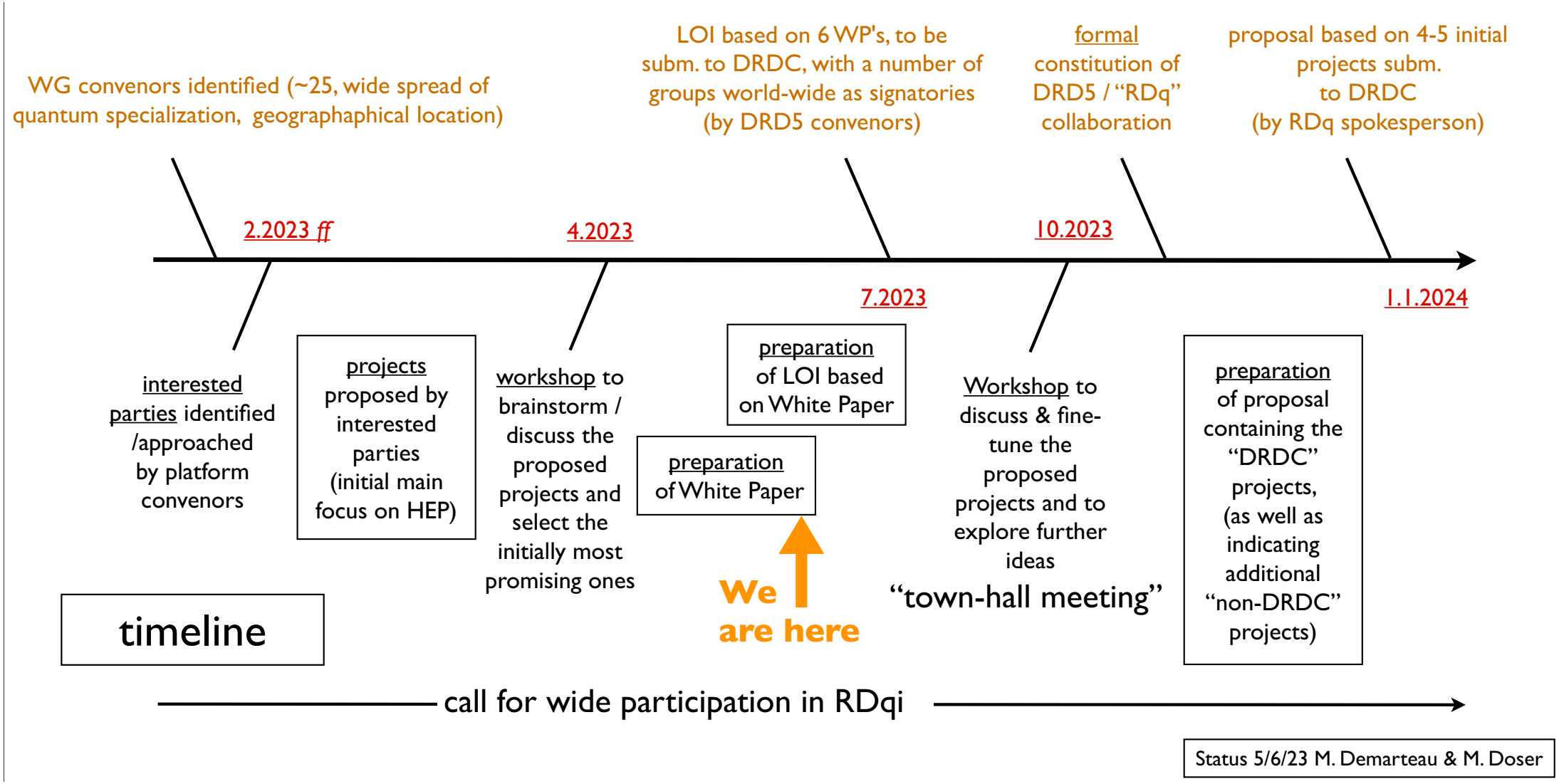
Community Meeting: Convenor level, minutes at http://doser.web.cern.ch/

Status of DRD5 / RDq efforts

- *contacted* wide range of communities worldwide (also in fields not involved with collider-based particle physics)
- determined interest by groups, suitability of technologies, biggest challenges for *those*
- *Trying to grow a community of communities* (there are no pre-existing such global communities)
- Additional challenge: no single host lab, many university labs; distributed platforms (2 in Europe, 2 in US, 2 in Asia, each a "steward" for a WG / WP
- Each "WP" is a high level set of activities consisting of sub-WP's
- Have been in touch with several other DRD's to discuss overlaps / sharing (e.g. cryo-electronics, superconducting calorimetry, ...). Contact with industry will evolve naturally via activities of the individual WG participants
- Collaboration structure is part of the discussion; initial model being polished

DRD5: Proceeding on a Different Timeline

In Touch with Other DRDs



DRD6: Calorimetry

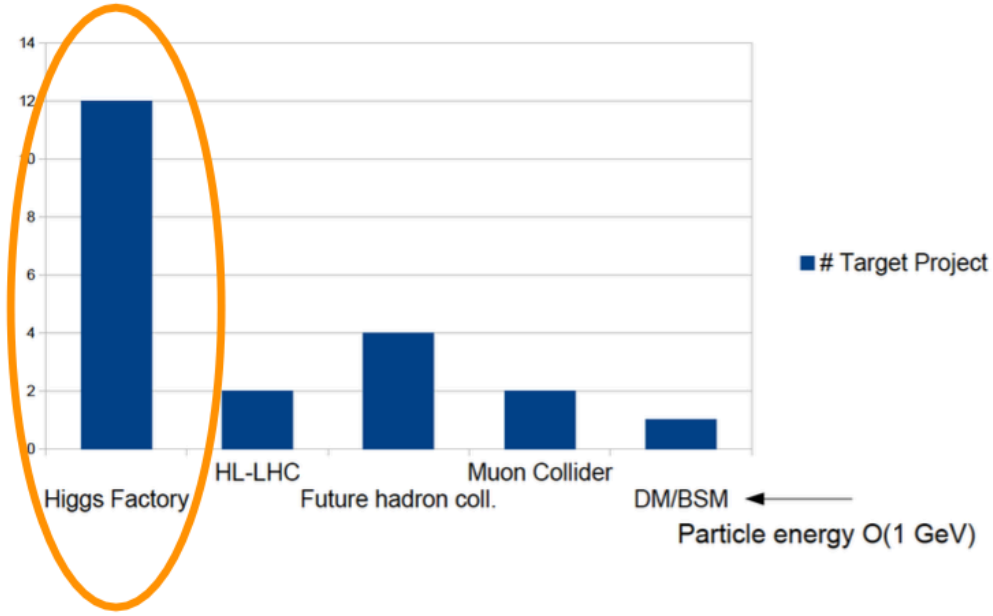
Integrating CALICE, LAr, Dual Readout, CrystalClear Collaborations

Calorimetry

DRDT 6.1 Develop radiation-hard calorimeters with enhanced electromagnetic energy and timing resolution

DRDT 6.2 Develop high-granular calorimeters with multi-dimensional readout for optimised use of particle flow methods

DRDT 6.3 Develop calorimeters for extreme radiation, rate and pile-up environments



TF Convenors: Roberto Ferrari (INFN Pavia (IT), Roman Poeschl (Université Paris-Saclay (FR))

Proposal status: Draft underway for submission in July

- Aim at 20p, first fairly complete version circulating in the community

Community Meeting: 2nd meeting reviewing input on April 20: https://indico.cern.ch/event/1246381/

DRD6: Structure and Community

Many technologies in each “box", several communities

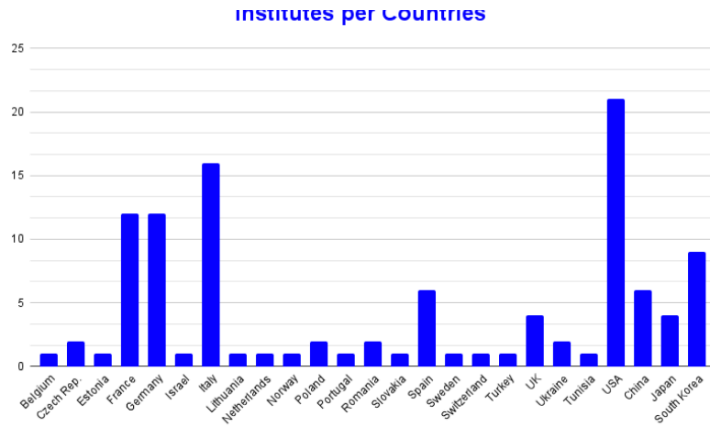
WORK AREAS:

- TRACK 1: Sandwich calorimeters with fully embedded electronics
- TRACK 2: Liquified Noble Gas calorimeters
- TRACK 3: Optical calorimeters

TRANSVERSAL ACTIVITIES: (common collaboration interest & liaison with other DRD)

- Materials
- Photodetectors, Electronics and DAQ
- Testbeam Facilities
- Detector Physics, simulation, algorithm and software tools
- Industrial Connections and technological transfer

110 institutes strong US and Asian participation



DRD 6: Calorimetry

July 6, 2023

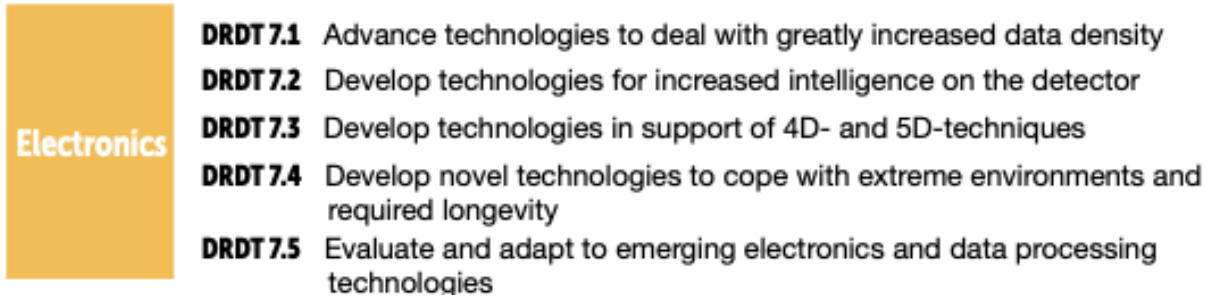
Contents

Table 2: Overview of R&D activities on optical calorimeter concepts.

Name	Calorimeter type	Application	Scintillator/WLS	Photodetector
HGCCAL	EM / Homogeneous	e^+e^- collider	BGO, LYSO	SiPMs
MAXICC	EM / Homogeneous	e^+e^- collider	PWO, BGO, BSO	SiPMs
CRILIN	EM / Quasi-Homog.	$\mu^+\mu^-$ collider	PbF_2, PWO-UF	SiPMs
GRAINITA	EM / Quasi-Homog.	e^+e^- collider	$ZnWO_4$, BGO	SiPMs
SPACAL	EM / Sampling	e^+e^-/hh collider	GAGG, organic	MCD-PMTs, SiPMs
RADICAL	EM / Sampling	hh collider	LYSO, LuAG	SiPMs
DRCAL	EM+HAD / Sampling	e^+e^- collider	PMMA, plastic	SiPMs, MCP
TILECAL	HAD / Sampling	e^+e^-/hh collider	PEN, PET	SiPMs

DRD7: Electronics

Transversal Activity



Criteria

- Address novel, ambitious, and transformative topics (consistent with the priorities of the Detector R&D Roadmap), with an appropriate risk appetite
- Adequate resources, skills, partners, structure

Desirable

- Addressing multiple R&D themes in one development
- Involving multiple institutes, preferably supported by more than one funding agency
- Tackling system-level issues

TF Convenors: Dave Newbold (STFC (GB), Francois Vasey (CERN)

Proposal status: LoI underway for submission in July , with ballpark resource estimates

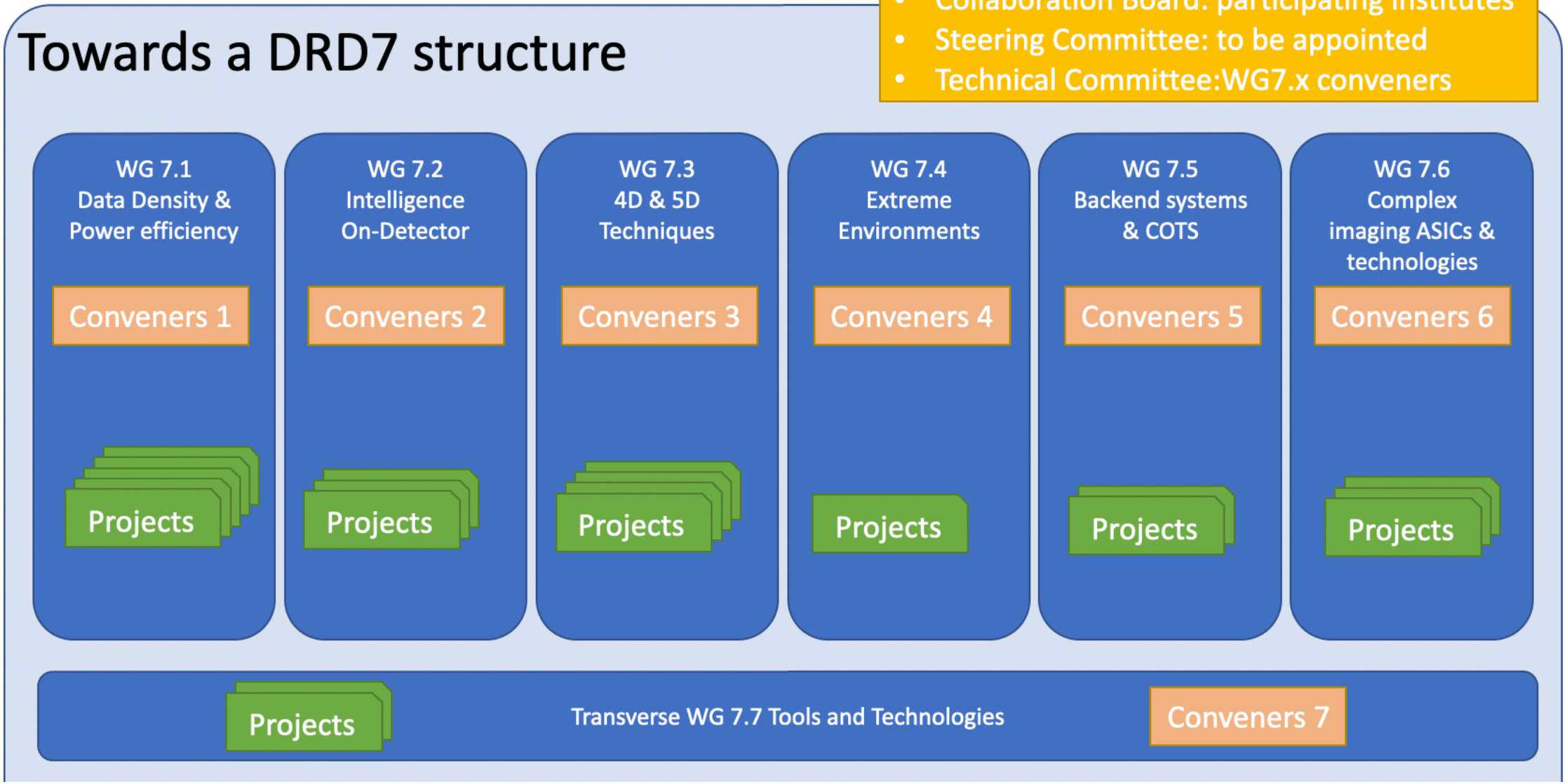
- call for expressions of interest launched, deadline end of June
- second community meeting in September
- full proposal towards end of the year, depends on activities in other DRDs
- relationship defined in “Organisation of DRD7"

Community Meeting: March 14-15: https://indico.cern.ch/event/1214423/timetable/#20230314

DRD7: Structure

Convenors defined

- Collaboration Board: participating institutes
- Steering Committee: to be appointed
- Technical Committee:WG7.x conveners



TF8: Integration

Broad scope

DRDT 8.1 Develop novel magnet systems

DRDT 8.2 Develop improved technologies and systems for cooling

DRDT 8.3 Adapt novel materials to achieve ultralight, stable and high precision mechanical structures. Develop Machine Detector Interfaces.

DRDT 8.4 Adapt and advance state-of-the-art systems in monitoring including environmental, radiation and beam aspects

Scope turned out to be too broad and diverse for a DRD

- given smaller community interest when compared with other DRDs

Advanced mechanics, materials and cooling (8.2, 8.3): still being considered for future DRD

- for the time being, include these topics in DRD3 (Solid detectors) and possibly DRD6 (Calo)

Next Steps

Review and Approval Process

Lightweight and commensurate with effort

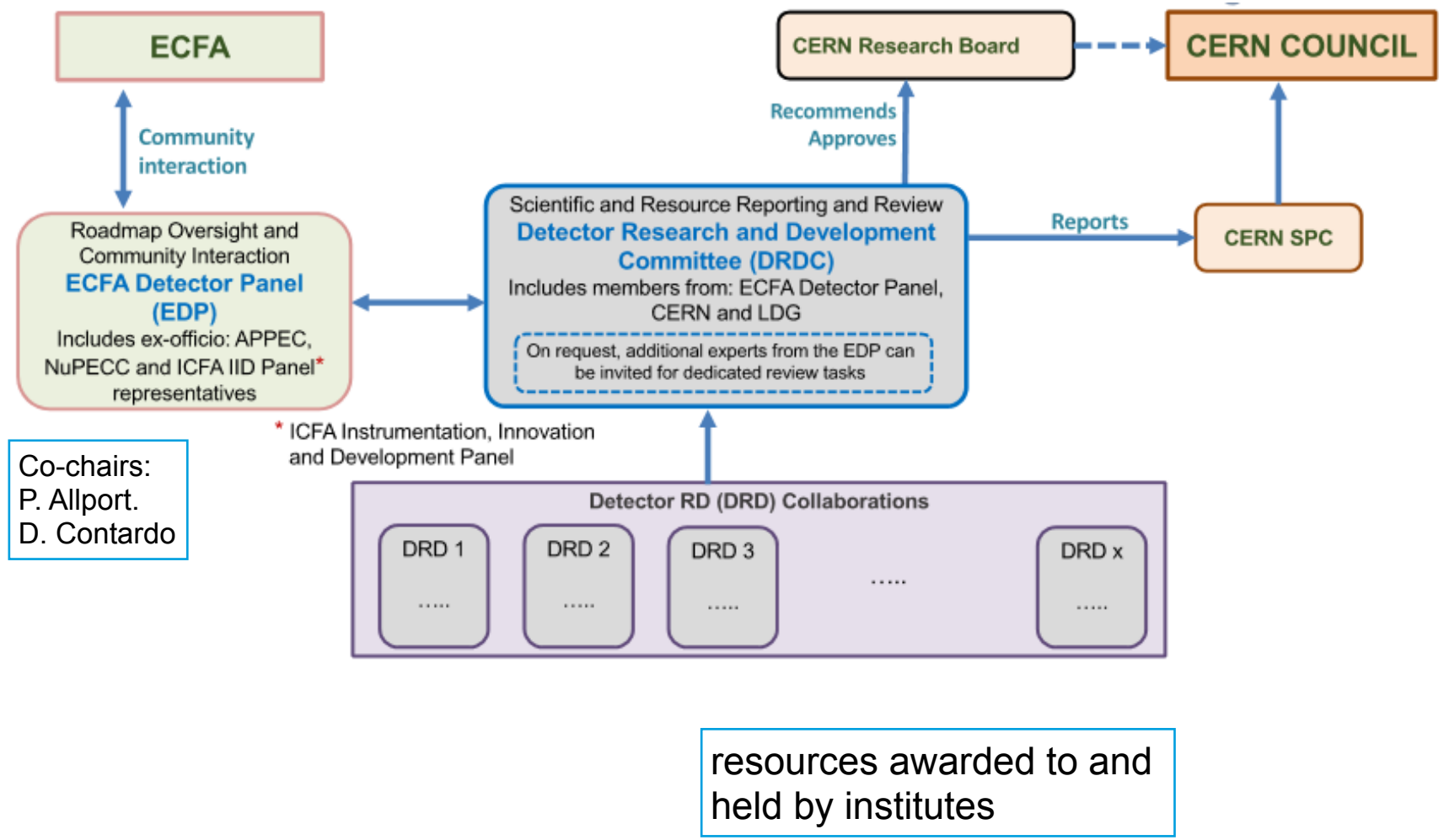
Scientific and Resource Reporting and Review by a Detector Research and Development Committee (DRDC)

- report via SPC to Council

Assisted by the ECFA Detector Panel (EDP):

- the scope, R&D goals, and milestones should be vetted against the vision encapsulated in the Roadmap

Funding Agency involvement via dedicated Finance Review Committees



Status DRDC

Status given by J.Mnich last week

Thomas Bergauer (HEPHY, Vienna) kindly accepted to become chair person of the DRDC

- Experts are being invited as members to the committee
- Hope to complete in the next week(s)

DRDC will play the role of the LHCC for the old RD collaborations

- Mandate is being worked on
- Idea: keep it light-weight, e.g. 2 meetings per year rather than 4

MoUs

In preparation

CERN considers multilateral collaborations for research purposes like experiments

- Was already the case for the R&D Collaborations
- Basis: CERN general conditions applicable to the execution of experiments (“GC”)
- https://cds.cern.ch/record/2728154/files/General-Conditions_CERN_experiments.pdf

Based on GC, a template MoU will be provided based on experience with “small” experiments

- Try to keep things simple and the MoUs as uniform as possible across DRD collaborations
  - adapted only where necessary to the specific needs of a given DRD collaboration

Special properties of DRD collaborations with respect to small experiments

- Working groups: reflect internal structure of the collaboration
  - Collaborators and their funding agencies sign up for one or several working groups
- Work packages: resource-loaded time-limited units of work, possibly across working groups
  - Collaborators and their funding agencies may sign up for work packages

Guiding principle

- Reduce signature cycles to a minimum
- Still make funding agencies agree if they undergo a commitment

Summary

Formation of DRDs is timely

- given big HL-LHC upgrades are finishing, and in view of future collider scenarios

Impressive response by the R&D community

- formidable amount of work being done - **overall on schedule**
- structure and combine the efforts, uncover synergies

Strengthen the link between physics needs and technology development

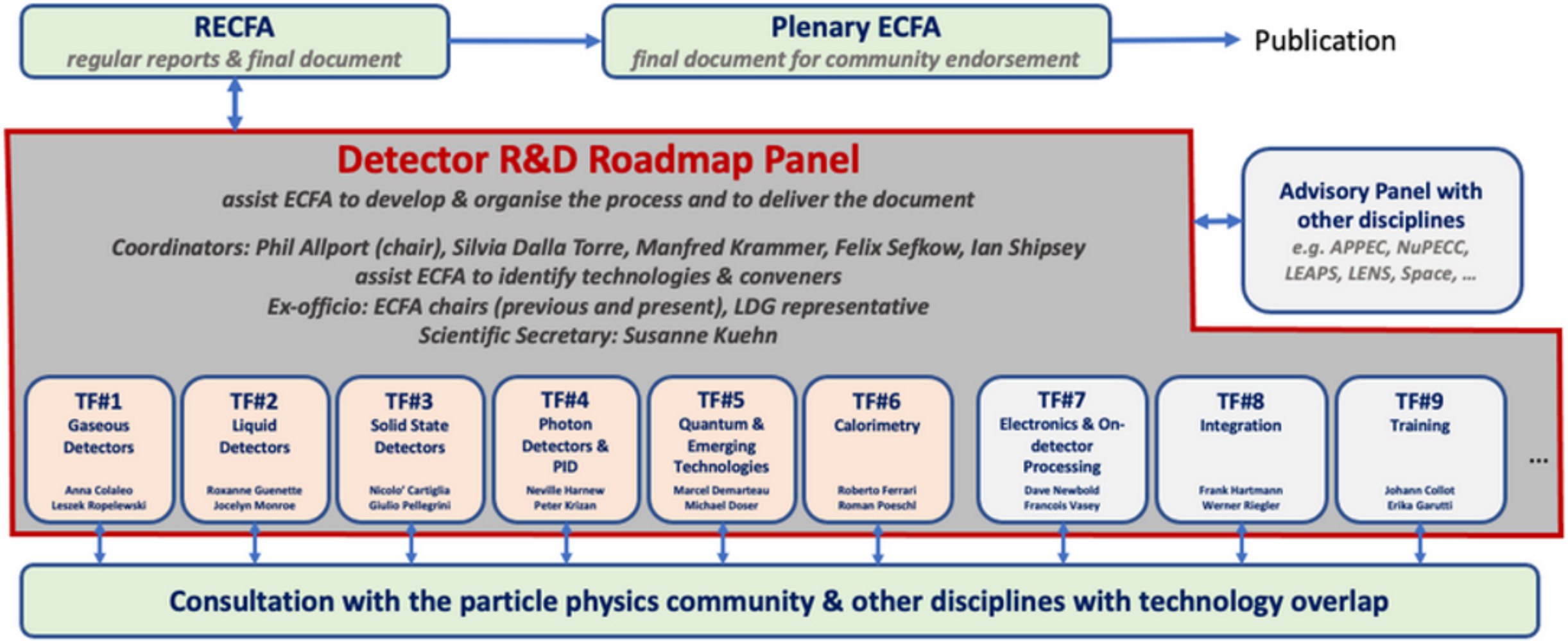
- nothing more motivating than that for the instrumentation scientist
- align detector R&D with European Strategy

Unique moment and opportunity for our field

- to keep the momentum, initially positive feedback from funding agencies will have to materialise

Back-up

Organization to structure the consultation with the community



Information on the full process: [ECFA Detector R&D Roadmap]

Future Projects Timeline (Accelerator Roadmap)

Future Projects Roadmap - as seen by the Lab Directors Group

still correct within 2-3 years

SPS fixed target
Other fixed target, FAIR (hep)
BELLE II
ALICE LS3
PIP-II/LBNF/DUNE/Hyper-K
ALICE 3
LHCb (≥ LS4)
EIC
LHeC
ILC
FCC-ee
CLIC
FCC-hh
FCC-eh
Muon Collider

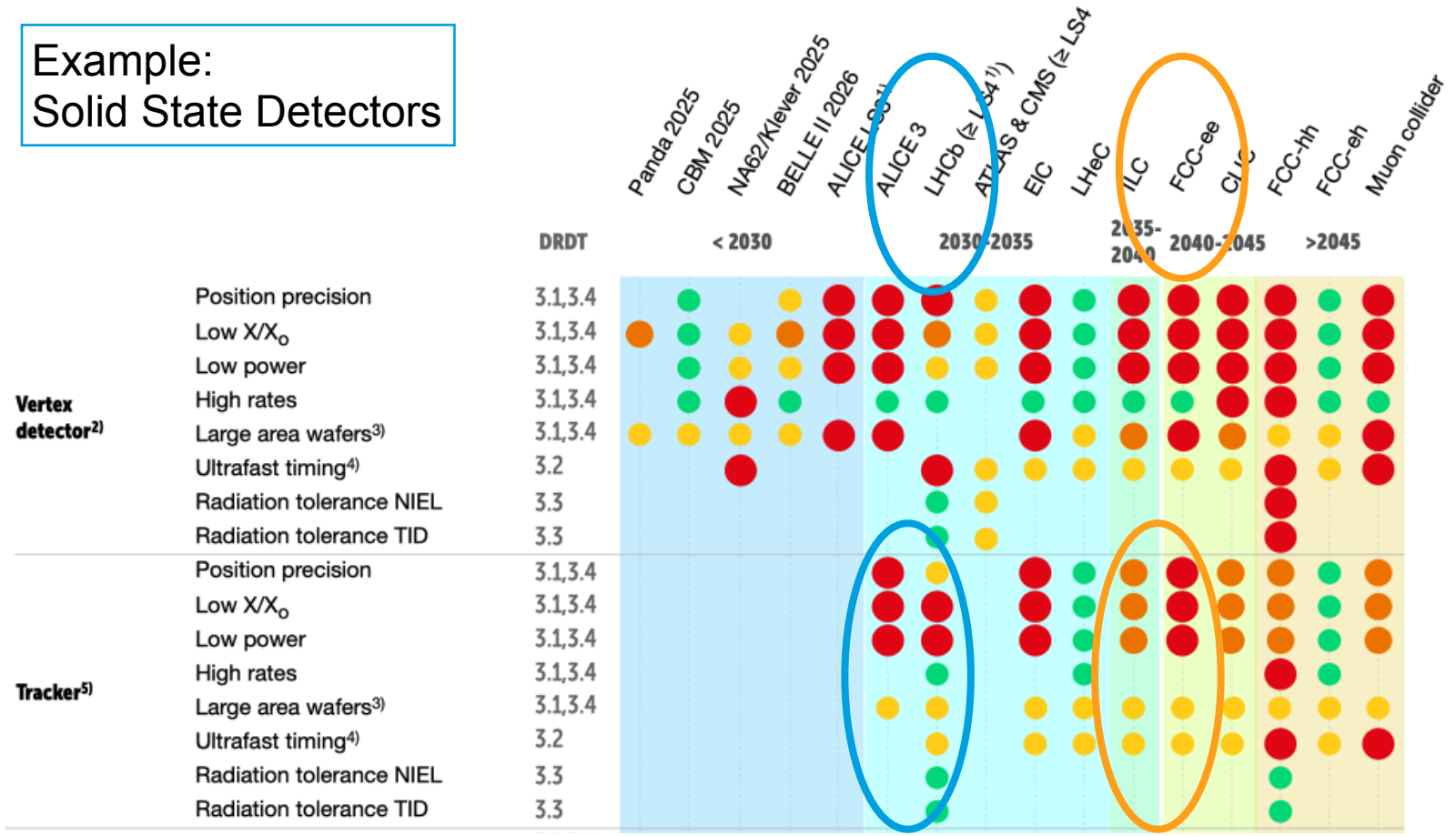
< 2030	2030-2035	2035-2040	2040-2045	> 2045

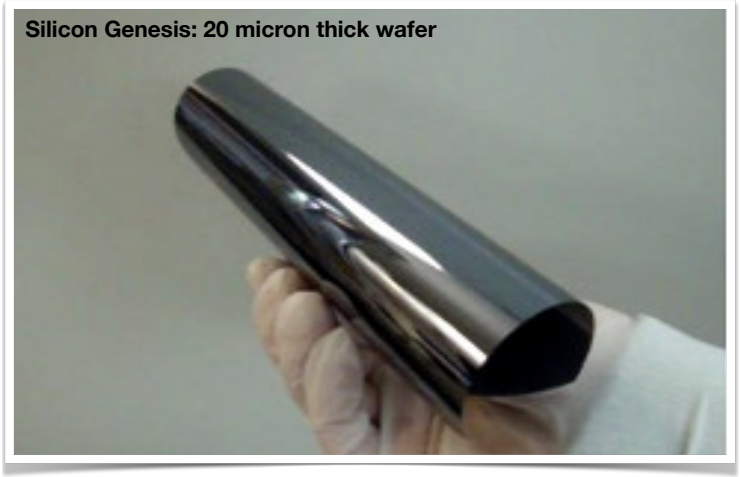
The dates shown in the diagram have low precision, and are intended to represent the earliest "feasible start date" (where a schedule is not already defined), taking into account the necessary steps of approval, development and construction for machine and civil engineering.

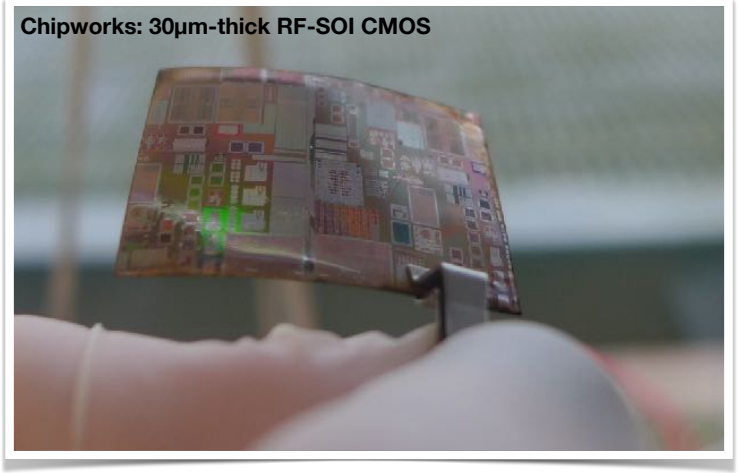
Synergies, Stepping Stones, R&D collaborations

Looking Across the Fence, and Beyond Tomorrow

Example:
Solid State Detectors







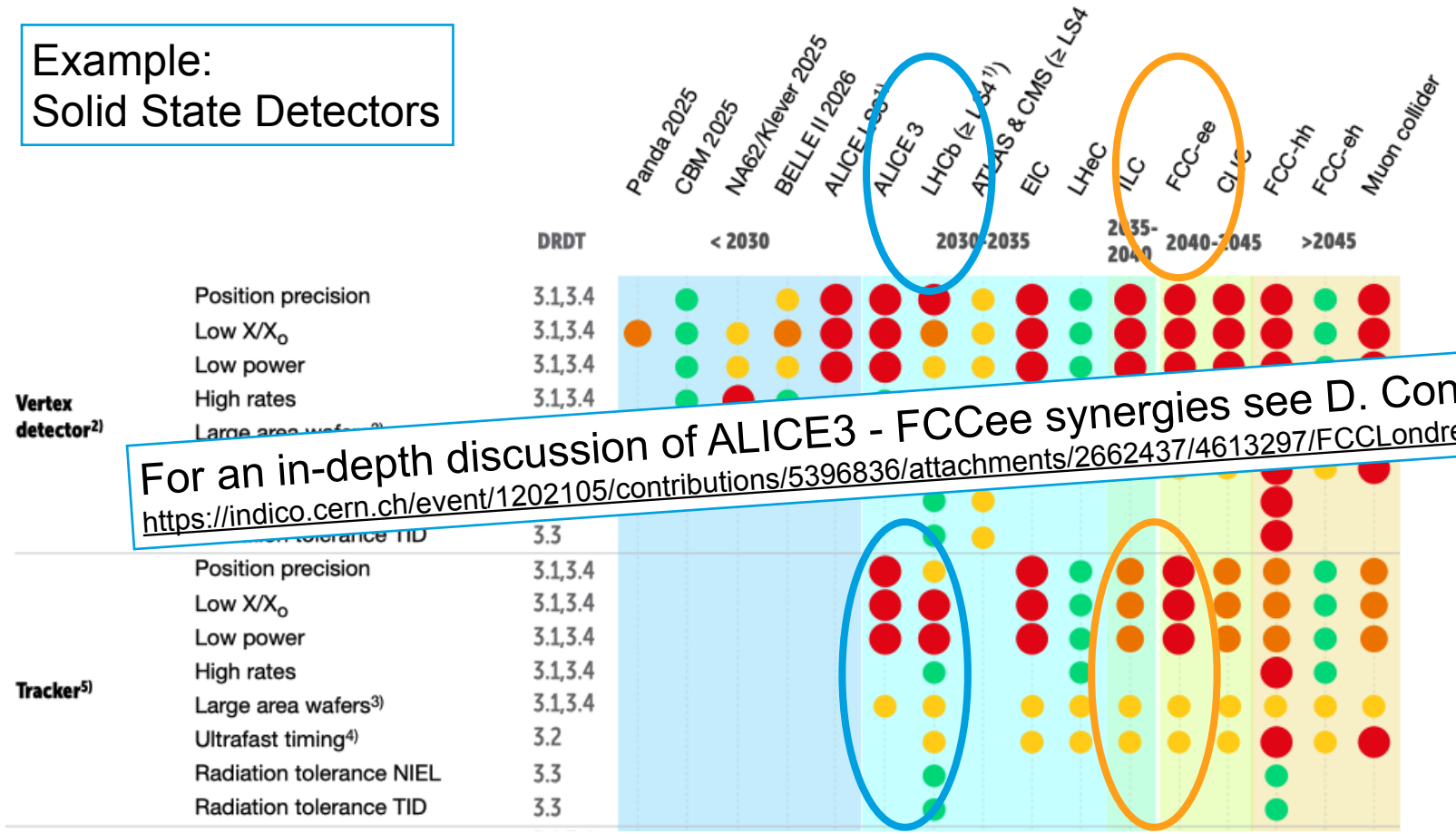
Magnus Mager (CERN) | ALICE ITS3 | CERN detector seminar | 24.09.2021 | 9

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

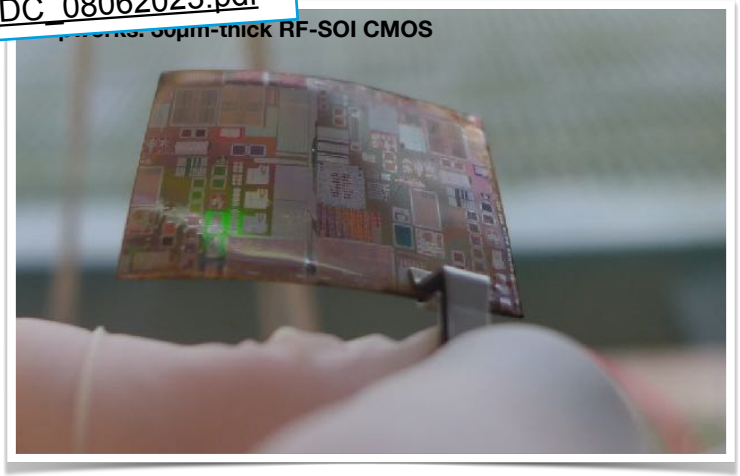
Synergies, Stepping Stones, R&D collaborations

Looking Across the Fence, and Beyond Tomorrow

Example:
Solid State Detectors



For an in-depth discussion of ALICE3 - FCCee synergies see D. Contardo's talk at
https://indico.cern.ch/event/1202105/contributions/5396836/attachments/2662437/4613297/FCCLondres_DC_08062023.pdf



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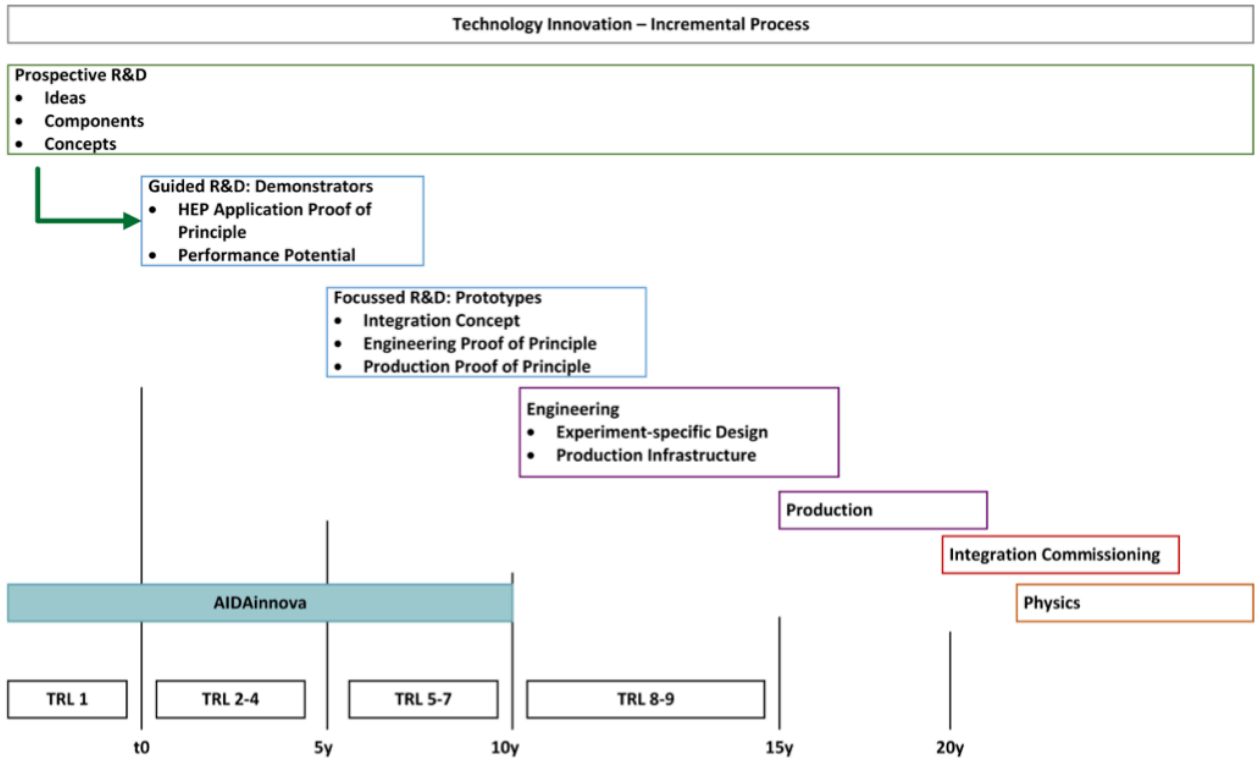
Must happen or main physics goals cannot be met | Important to meet several physics goals | Desirable to enhance physics reach | R&D needs being met

Categories of R&D

And Sources of Funding

1. Strategic R&D via DRD Collaborations
   (long-term strategic R&D lines)
   (address the high-priority items defined in the Roadmap via the DRDTs)
   vision
2. Experiment-specific R&D
   (with very well defined detector specifications)
   (funded outside of DRD programme, via experiments, usually not yet covered within the projected budgets for the final deliverables)
   focus
3. ”Blue-sky” R&D
   (competitive, short-term responsive grants, nationally organised)
   agility

Transitions Blue-sky → Strategic → Specific expected
Cross-fertilisation desired



From the AIDAinnova proposal

Detector Roadmap: Strategic Recommendations

General Needs of the Field

GSR 1 - Supporting R&D facilities
GSR 2 - Engineering support for detector R&D
GSR 3 - Specific software for instrumentation
GSR 4 - International coordination and organisation of R&D activities
GSR 5 - Distributed R&D activities with centralised facilities
GSR 6 - Establish long-term strategic funding programmes
GSR 7 - Blue-sky R&D
GSR 8 - Attract, nurture, recognise and sustain the careers of R&D experts
GSR 9 - Industrial partnerships
GSR 10 - Open Science

R&D Collaborations

Capture many of the guiding principles of AIDA projects

***Aim**: Propose mechanisms to achieve a **greater coherence across Europe** to better streamline the local and national activities and make these more effective.*

*Give the area **greater visibility and voice** at a European level to make the **case for the additional resources** needed for **Europe to maintain a leading role in particle physics** with all the associated **scientific and societal benefits** that will flow from this.*