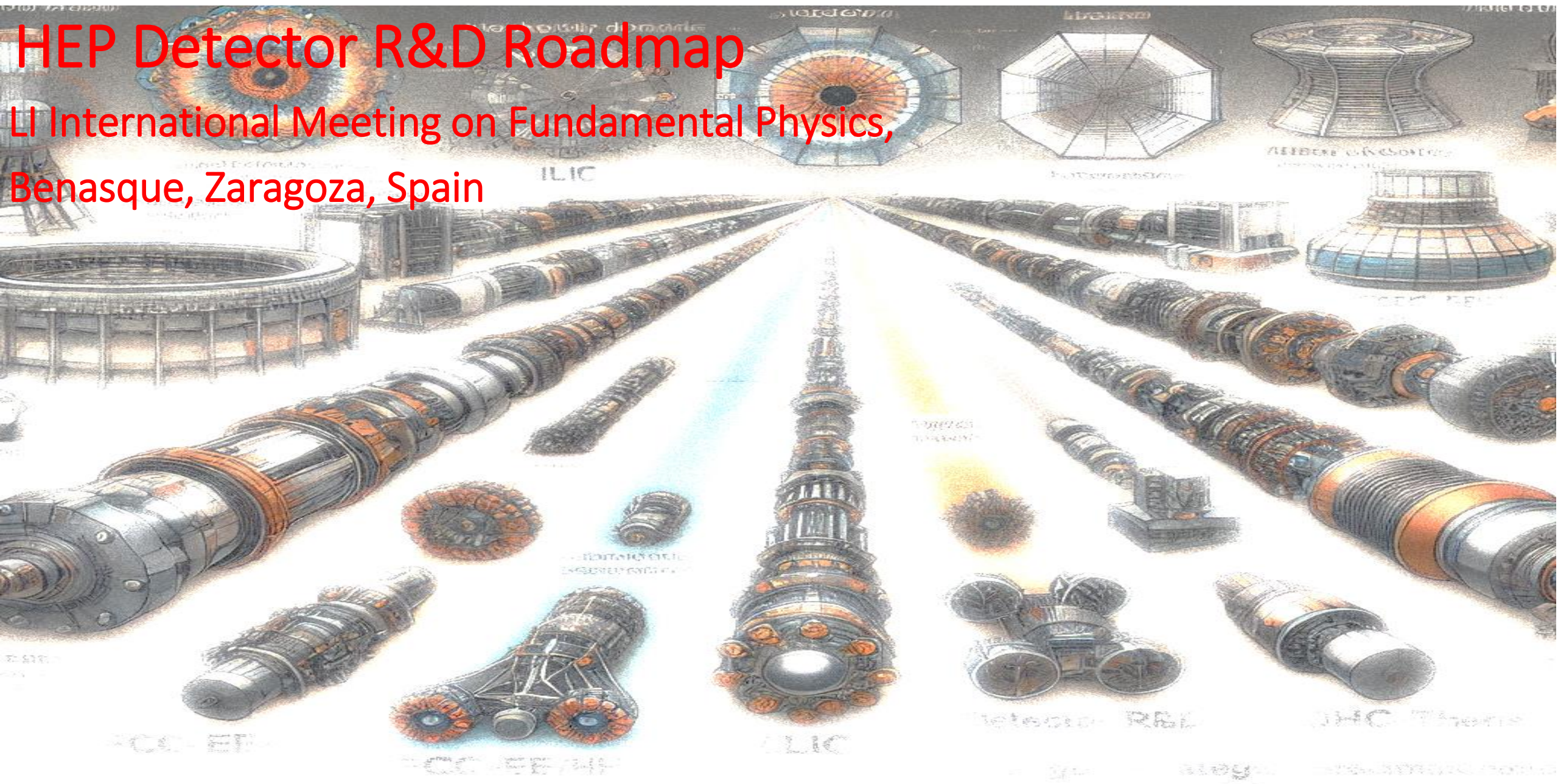


HEP Detector R&D Roadmap

II International Meeting on Fundamental Physics,
Benasque, Zaragoza, Spain



Iván Vila Álvarez
Instituto de Física de Cantabria (CSIC-UC)

Outline



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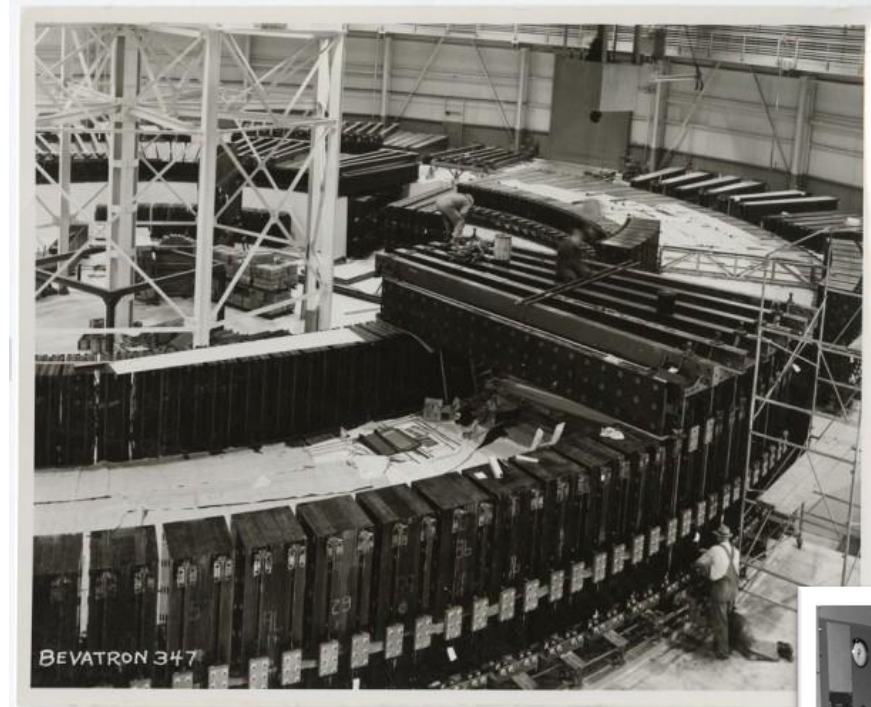
- The motivation for a Detector R&D roadmap.
- The European Strategy on Detector R&D.
- The DRDs Collaborations at a glance.
- CPAN R&D network on detectors and instrumentation.
- Summary

What is it so important to define a Dectector R&D roadmap?



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- The first particle discovered in a large accelerator was the antiproton, discovered in **1955** at the **Bevatron accelerator** at Lawrence Berkeley National Laboratory. physics discoveries.
- A first nobel prize: **Emilio Segrè** and **Owen Chamberlain**



Since then ... accelerators dominated the fundamental physics discoveries.



– Summary of Nobel Prizes Linked to Colliders:

- _ **1959:** Antiproton discovery at the Bevatron.
- _ **1976:** Charm quark (J/ψ) discovery at Brookhaven ISR (indirectly linked to accelerator advancements).
- _ **1984:** W and Z bosons discovery at CERN's SPS.
- _ **2008:** Theoretical contributions to CP violation and symmetry breaking (tested in colliders).
- _ **2013:** Higgs boson discovery at CERN's LHC.
- _ Surprisingly, the **discovery of the bottom quark in 1977**, the **top quark in 1995** and the **gluon in 1979** never received a Nobel Prize.

The Evolution of Flagship Colliders (1950s–Present)



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1950s:

Bevatron (Approved 1949, Operational 1954) First to produce high-energy particles, leading to the discovery of the antiproton.

1960s:

CERN Proton Synchrotron (PS) (Approved 1953, Operational 1959)
First European accelerator to reach multi-GeV energies.

Brookhaven Alternating Gradient Synchrotron (AGS) (Approved 1952, Operational 1960) Key discoveries include the muon neutrino and CP violation in kaons.

1970s:

CERN Intersecting Storage Rings (ISR) (Approved 1965, Operational 1971)
First hadron collider, proton-proton collisions.

Fermilab Main Ring (Approved 1967, Operational 1972)
Important for early high-energy fixed-target experiments.

DESY Positron-Electron Tandem Ring Accelerator (Approved 1974, Operational 1978) Discovery of the gluon in 1979

1980s:

CERN Super Proton Synchrotron (SPS) (Approved 1971, Operational 1976, Collider Mode 1981)
Enabled discovery of the W and Z bosons.

SLAC Linear Collider (SLC) (Approved 1983, Operational 1989)
First linear electron-positron collider, focused on precision electroweak measurements.

1990s:

CERN Large Electron-Positron Collider (LEP) (Approved 1981, Operational 1989) Precision tests of the Standard Model.

Fermilab Tevatron (Approved 1972, Collider Mode 1983). Led to the discovery of the top quark.

2000s:

Large Hadron Collider (LHC) (Approved 1994, Operational 2008)
The world's most powerful collider, discovery of the Higgs boson.

2010s:

High-Luminosity Large Hadron Collider (HL-LHC) (Approved 2016, Operational 2029) for precision Higgs measurements and searches beyond the Standard Model.

In the recent past, the next flagship accelerator defined the detector R&D topics (LHC the main motivation)



RD-1	SPACAL	Scintillating Fibre Calorimetry at the LHC	R&D	20-09-1990	Finished
RD-10	RADHARD	A St.to Improve the Radlat.Hardness of Gas.Detect.for Use at Very-H Luminosities	R&D	04-04-1991	Finished
RD-11	EAST	Embedded Architectures for Second-level Triggering in LHC Experiments (EAST)	R&D	04-04-1991	Finished
RD-12	TTC	Timing, Trigger and Control Systems for LHC Detectors	R&D	04-04-1991	Finished
RD-13	LHCTB	A Scalable Data Taking System at a Test Beam for LHC	R&D	04-04-1991	Finished
RD-14	XENON	Noble Liquid (Xenon or Krypton) Totally Active Calorimetry	R&D	04-04-1991	Finished
RD-15	PPC	The Prism Plastic Calorimeter (PPC)	R&D	04-04-1991	Finished
RD-16	FERMI	A digital Front-End and Readout Microsystem for calorimetry at LHC	R&D	04-04-1991	Finished
RD-17	FAROS	Ultrafast Readout of Scintill.Fibres Us.Upgr.Position-Sensitive Photomultipliers	R&D	04-04-1991	Finished
RD-18	CRYSTAL CLEAR	R&D on scintillation materials for novel ionizing radiation detectors for High Energy Physics, medical imaging and industrial applications	R&D	04-04-1991	In-Progre
RD-19	PIXEL	Development of Hybrid and Monolithic Silicon Micropattern Detectors	R&D	27-06-1991	Finished
RD-2	SITP	Study of a Tracking/Preshower Detector for the LHC	R&D	20-09-1990	Finished
RD-20	SI TRACKER	Dev.of High Resolution Si Strip Detectors for Exp.at High Luminosity at the LHC	R&D	27-06-1991	Finished
RD-3	ACCORDION	Liquid Argon Calorimetry with LHC-Performance Specifications	R&D	20-09-1990	Finished
RD-4	DOPANTS	Study of Liquid Argon Dopants for LHC Hadron Calorimetry	R&D	20-09-1990	Finished
RD-5	LHC-MUONS	St.of Muon Triggers & Momentum Rec.in a Str.Magn.Field x a Muon Detector at LHC	R&D	07-02-1991	Finished
RD-6	TRD-TRACKER	Integr.High-Rate Transition Radiation Detector & Tracking Chamber for the LHC	R&D	07-02-1991	Finished
RD-7	FITRACK	Central Tracking Detector Based on Scintillating Fibres	R&D	07-02-1991	Finished
RD-8	GAASWORKS	Development of GaAs Detectors for Physics at the LHC	R&D	07-02-1991	Finished
RD-9	SOI	A Demonstrator Analog Signal Process.Circuit in a Radiation Hard SOI-CMOS Techn.	R&D	07-02-1991	Finished
RD21	COLLIDER-BEAUTY	R&D for Collider Beauty Physics at the LHC	R&D	28-11-1991	Finished
RD22		Test of Beam Extr.by Crystal Chann.at the SPS:First Step towa LHC Extr.Beam	R&D	28-11-1991	Finished
RD23	OPTOELECTRONICS	Optoelectronic Analogue Signal Transfer for LHC Detectors	R&D	06-02-1992	Finished
RD24	SCI	Application of the Scalable Coherent Interface to Data Acquisition at LHC	R&D	06-02-1992	Finished
RD25	LFC	Continuing Studies on Lead/Scintillating Fibres Calorimetry (LFC)	R&D	16-04-1992	Finished
RD26	CSIRICH	Development of a Large Area Advanced Fast RICH Detector for Particle Identification at the Large Hadron Collider Operated with Heavy Ions	R&D	16-04-1992	Finished

RD27		First-Level Trigger Systems for LHC Experiments	R&D	30-06-1992	Finished
RD28	GAS MICROSTRIPS	Dev.of Gas Micro-Strip Chambers for Radiation Det.& Tracking at High Rates	R&D	30-06-1992	Finished
RD29	DMILL	A Mixed Analog-Digital Radiation Hard Technology for High Energy Physics Electronics: DMILL (Durci Mixte sur Isolant Logico-Lineaire)	R&D	30-06-1992	Finished
RD30	OPTICAL TRIGGER	St.of Impact-Par.Opt.Discrim.to be used x Beauty Sch in Fixed-Tgt Mode at LHC	R&D	26-11-1992	Finished
RD31	NEBULAS	NEBULAS.br H-PData-Dr.Event-Build.Arch.bas.on Asynch.Self-R.Pack-Switch.Netw.	R&D	26-11-1992	Finished
RD32	ALICE TPC	Dev.of a Time Projec.Chamber w.High Two Tr.Resol.Cap.x Exp.at Heavy Ion Collid.	R&D	26-11-1992	Finished
RD33	TGT	Study of a Novel Concept for a Liquid Argon Calorimeter The "Thin gap Turbine" (TGT)	R&D	11-02-1993	Finished
RD34	TILECAL	Constr.& Perf.of an Iron-Scintill.Hadron Calorim.w.Longitudinal Tile Configurat.	R&D	15-04-1993	Finished
RD35	SICAL	A Silicon Hadron Calorim. Module Op.in a Strong Magn.F.w.VLSI Readout for LHC	R&D	17-06-1993	Finished
RD36		Shashlik Calorimetry.br - A Combined Shashlik + Preshower Detector for LHC	R&D	25-11-1993	Finished
RD37		Very Forward Hadron Calorimetry at the LHC Using Parallel Plate Chambers	R&D	10-02-1994	Finished
RD38	CICERO	CICERO:Ctrl Inf.syst.Conc.b.on Enc.R-T.Obj.St.on Gen.Ctrl Syst.x Lge Sc.LHC Exp.	R&D	10-02-1994	Finished
RD39	SMSD	Cryogenic Tracking Detectors	R&D	10-02-1994	Finished
RD40	Q-CAL	Development of Quartz Fiber Calorimetry	R&D	21-04-1994	Finished
RD41	MOOSE	Object Oriented Approach to Software Development for LHC Experiments	R&D	16-06-1994	Finished
RD42		Development of Diamond Tracking Detectors for High Luminosity Experiments at the LHC	R&D	22-09-1994	In-Progress
RD43	BHCAL	Proposal for Research & Develop.of a Hadron Calorimeter for High Magnetic Fields	R&D	22-09-1994	Finished
RD44	GEANT4	GEANT 4: an Object-Oriented toolkit for simulation in HEP	R&D	24-11-1994	Finished
RD45		A Persistent Object Manager for HEP	R&D	09-02-1995	Finished
RD46		High Resolution Tracking Devices Based on Capillaries Filled with Liquid Scintillator	R&D	15-06-1995	Finished
RD47		High Energy Physics Processing using Commodity components (HEP PC)	R&D	08-02-1996	Finished
RD48	ROSE	Radiation Hardening of Silicon Detectors	R&D	13-06-1996	Finished
RD49	RADTOL	Studying Radiation Tolerant ICs for LHC	R&D	12-06-1997	Finished
RD50		Development of Radiation Hard Semiconductor Devices for Very High Luminosity Colliders	R&D	30-05-2002	In-Progress
RD51		Development of Micro-Pattern Gas Detectors Technologies	R&D	05-12-2008	In-Progress
RD52		Dual-Readout Calorimetry for High-Quality Energy Measurements	R&D	31-08-2011	Finished
RD53		Development of pixel readout integrated circuits for extreme rate and radiation	R&D	28-08-2013	In-Progress



R&D Collaborations at CERN many of then addressing the LHC and HL-LHC needs

2020s:



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The Answer



The Detector R&D colaboraciones (DRDs)

focused R&D collaboration that help guide and coordinate the development of advanced detector technologies. They ensure that the necessary innovations are ready for upcoming high-energy physics experiments
(to be fully operational in 2024)

The European strategy for Detector R&D



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- In 2021, the European Committee for Future Accelerators (released an extensive report (200 pages):
 - _ Comprehensive overview of prospective facilities (EIC, ILC, CLIC, FCC-ee/hh, Muon collider) and major upgrades (ALICE, Belle-II, LHC-b, etc.), along with their projected timelines.
 - _ Detailed examination of nine technology domains (Task Force areas).
 - _ Identification of the most pressing R&D priorities within each Task Force area.
 - _ Ten "General Strategic Recommendations."

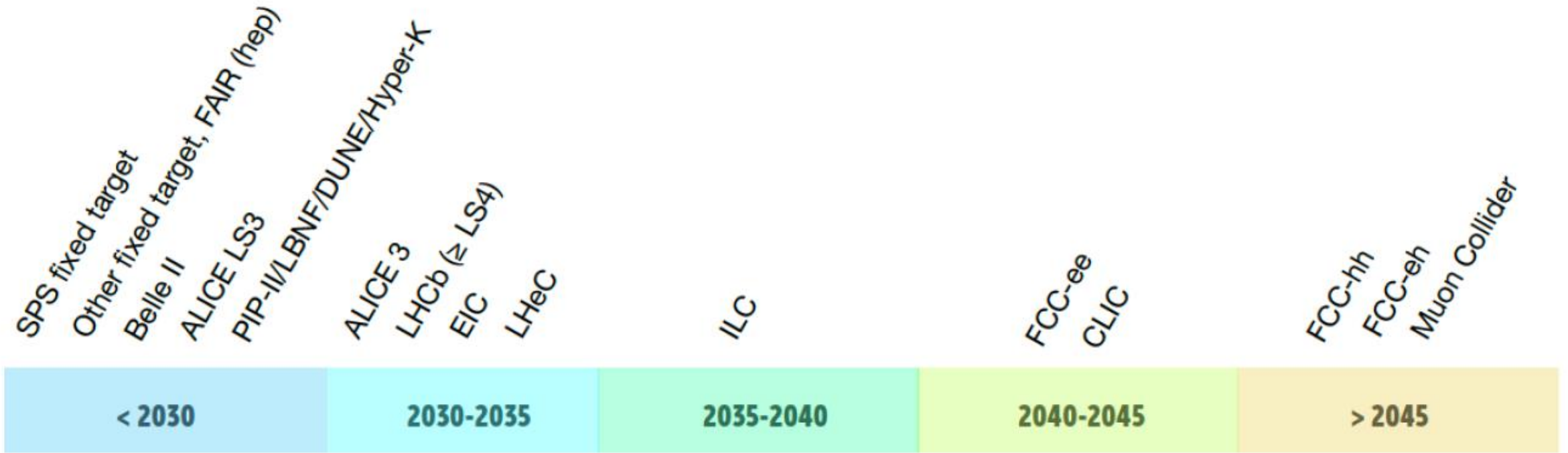


TF#1 Gaseous Detectors Anna Colaleo Leszek Ropelewski	TF#2 Liquid Detectors Roxanne Guenette Jocelyn Monroe	TF#3 Solid State Detectors Nicolò Cartiglia Giulio Pellegrini	TF#4 Photon Detectors & PID Neville Harnew Peter Krizan	TF#5 Quantum & Emerging Technologies Marcel Demarteau Michael Doser	TF#6 Calorimetry Roberto Ferrari Roman Poeschl	TF#7 Electronics & On-detector Processing Dave Newbold Francois Vasey	TF#8 Integration Frank Hartmann Werner Riegler	TF#9 Training Johann Collot Erika Garutti
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Earliest feasible start date for future colliders and...



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... non Accelerator too



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DRD Jargon 101: DRD Themes (DRDT) for each Taskforce

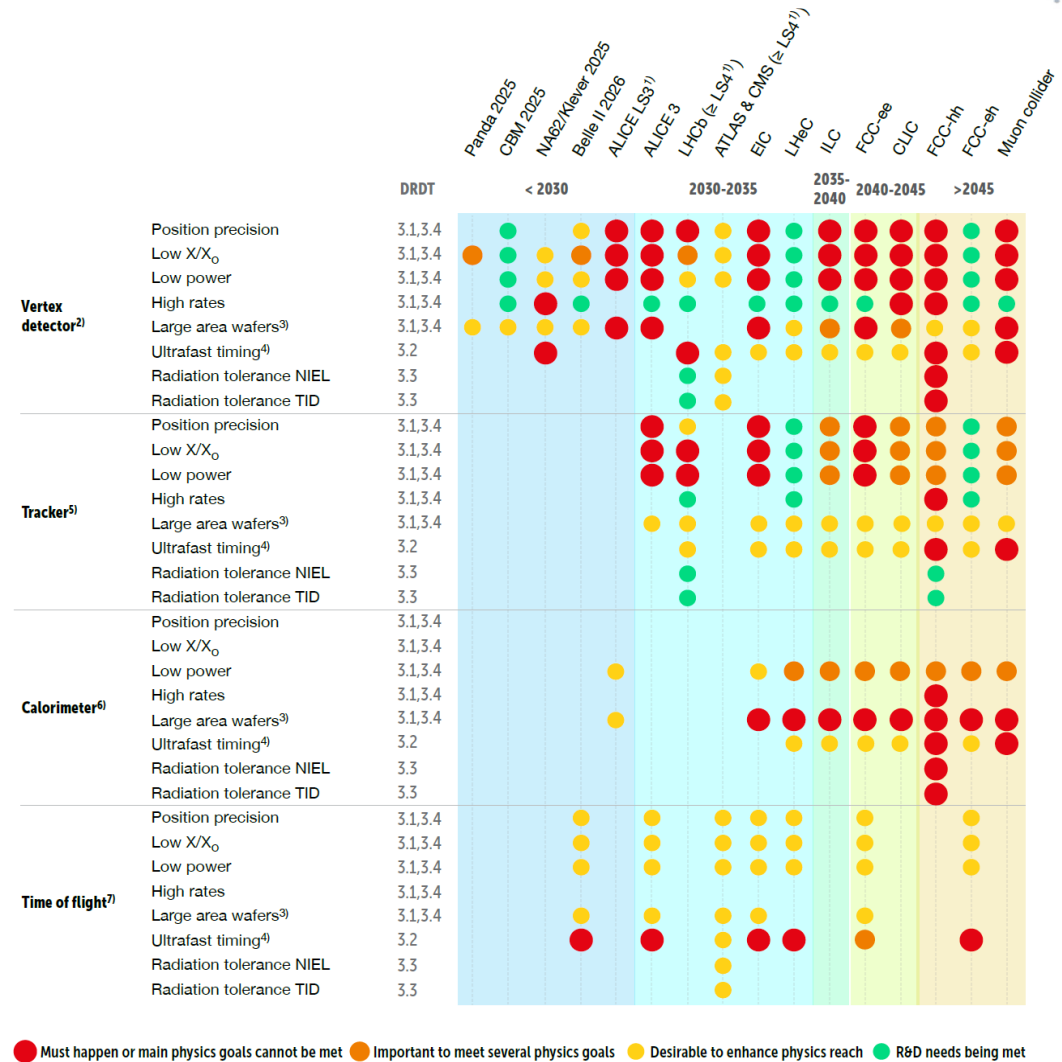


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- **Detector Readiness Matrix:** a framework used to evaluate the maturity of different detector technologies, for integration into particle physics experiments
- A **Detector R&D Theme (DRDT)** is a specific, high-priority research and development topic identified within each task force domain of the ECFA Detector R&D roadmap.
- DRDTs represent the most urgent technological challenges and opportunities that need to be addressed to advance particle detector technologies for future experiments.

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

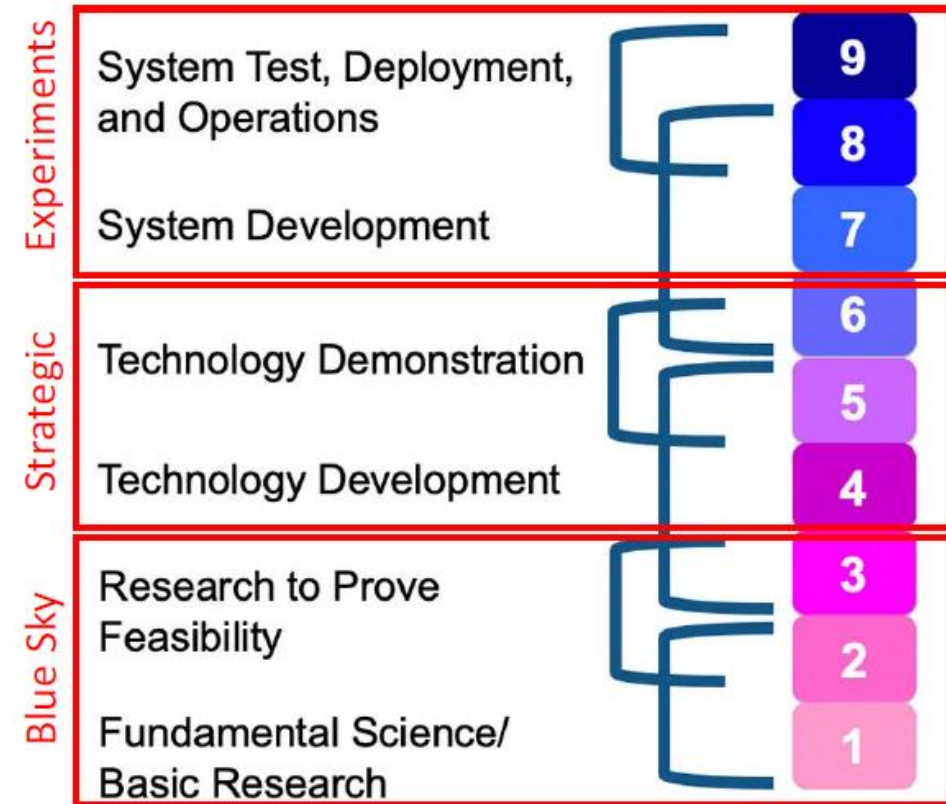


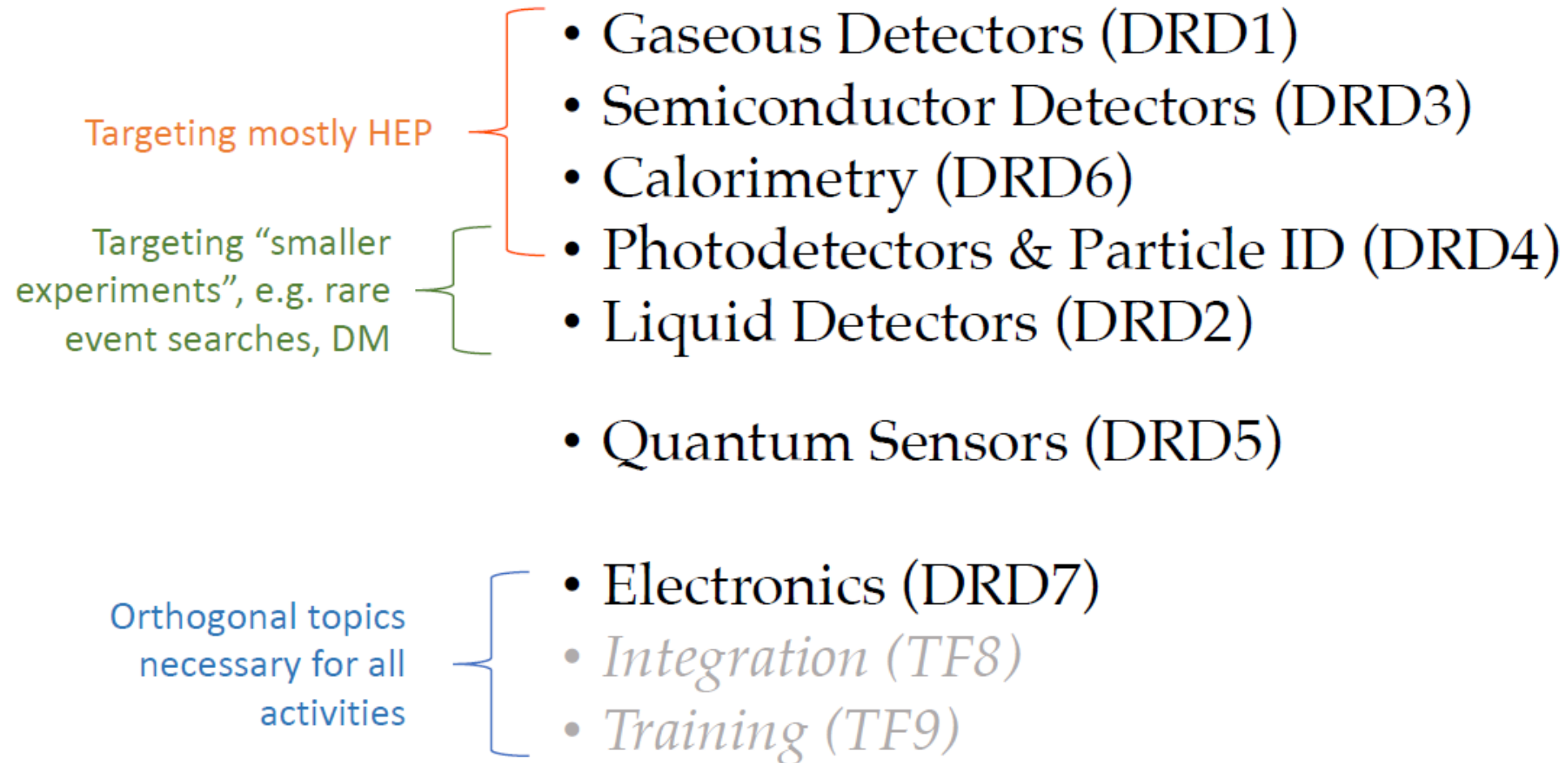
● Must happen or main physics goals cannot be met ● Important to meet several physics goals ● Desirable to enhance physics reach ● R&D needs being met

DRD Jagon 101: Strategic and Blue Sky R&D

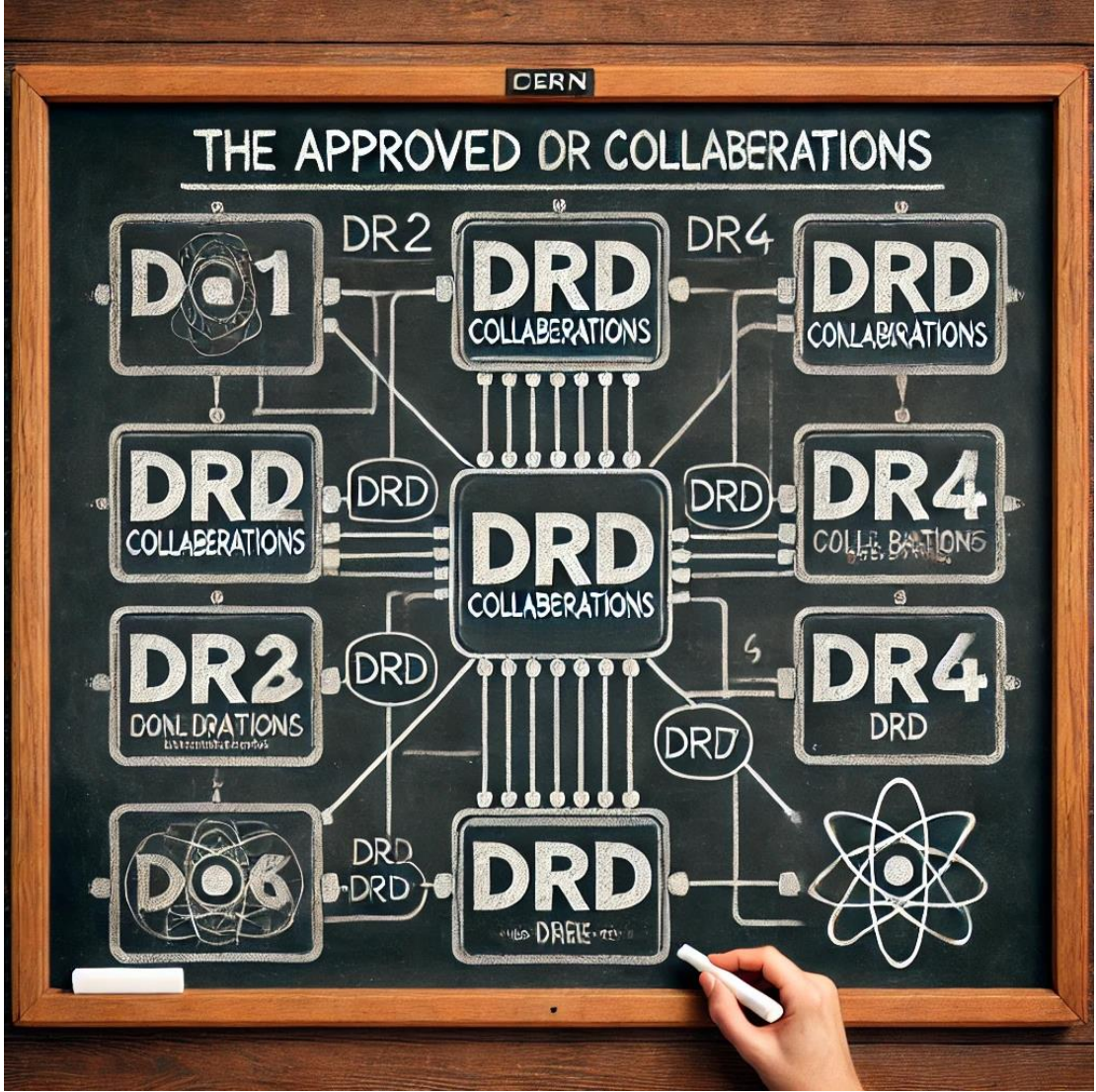


- **Strategic R&D towards necessary technologies to build future facilities and experiments**
 - _ Addresses the DRDTs in ECFA roadmap by defining suitable deliverables and milestones
 - _ Technology Readiness Levels (TRL) 3-6
 - _ Backed up by strategic funding, agreed with funding agencies (MoUs)
- **Exploratory "blue-sky" R&D towards new developments.**
 - _ Address TRL 1-3
 - _ Possibly financed by common fund + institute contributions (RD50/51 scheme)





Currently approved DRD collaboration



Gaseous detectors: current status

– Large Areas:

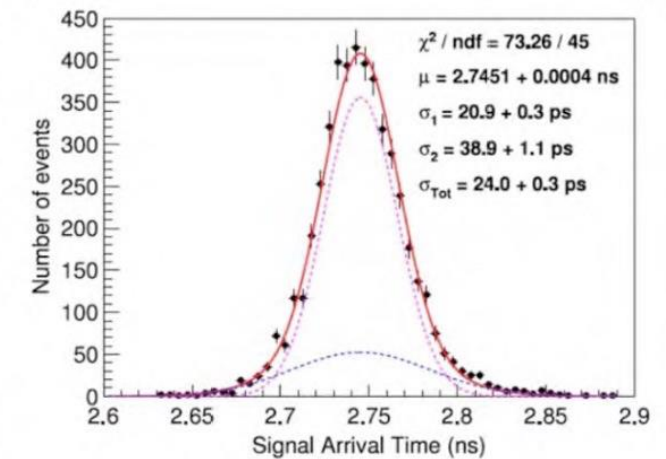
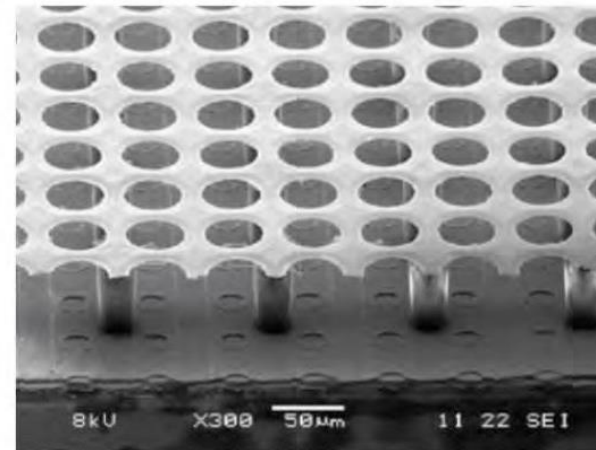
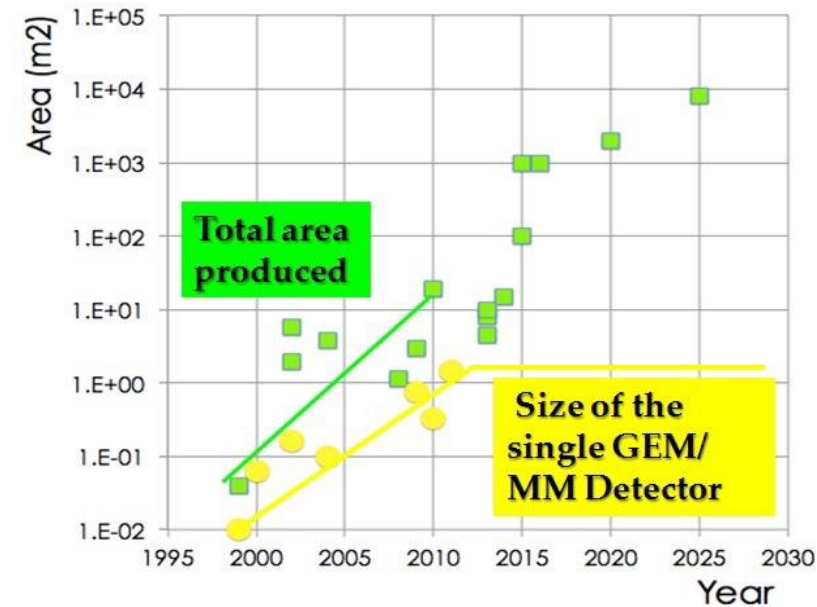
- Systems developed for LHC experiments led to unprecedented large systems, mostly based on MPGDs

– Fast Timing:

- Fast timing with Multi-Gap RPCs: achieved ~ 60 ps time resolution (ALICE TOF Detector, Z.Liu)
- Micromegas with timing (PICOSEC concept): 25ps

– Eco-friendly gas mixtures

- 92% of emissions at CERN are related to LHC experiments



PICOSEC: NIMA903 (2018) 317

Gaseous detectors: DRD1



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Gaseous

- DRDT 1.1** Improve time and spatial resolution for gaseous detectors with long-term stability
- DRDT 1.2** Achieve tracking in gaseous detectors with dE/dx and dN/dx capability in large volumes with very low material budget and different read-out schemes
- DRDT 1.3** Develop environmentally friendly gaseous detectors for very large areas with high-rate capability
- DRDT 1.4** Achieve high sensitivity in both low and high-pressure TPCs

RD51 successor, 118 institutes

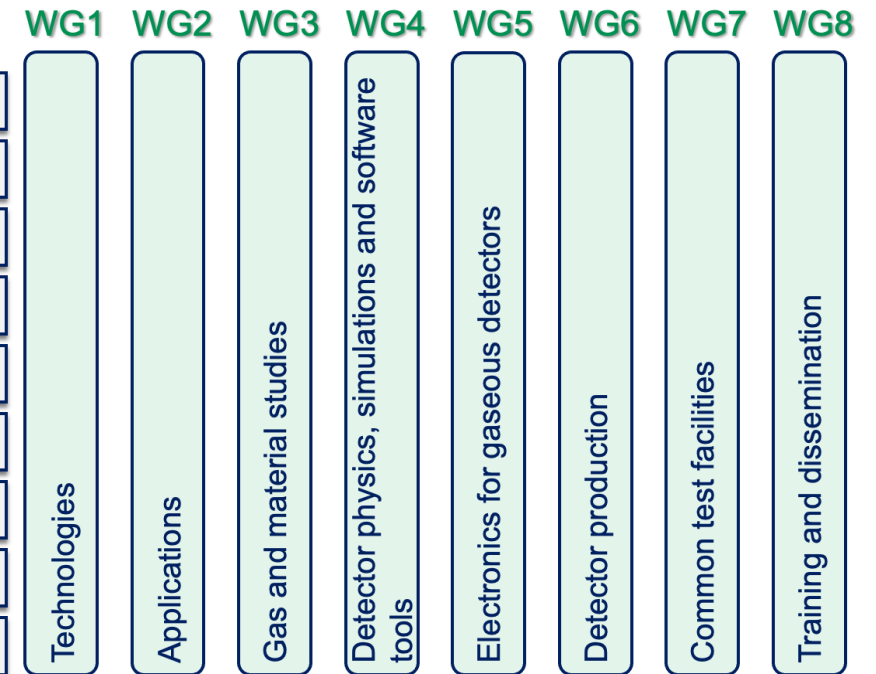


DRDTs

1.1	1.2	1.3	1.4	
●	●	●		Trackers/hodoscopes
●	●	●		Drift chambers
●	●	●		Straw chambers
●	●	●	●	Tracking TPCs
●		●		Calorimetry
●	●	●		Photon detection (PID)
●		●		Timing detectors
●	●	●	●	Reaction/decay TPCs
●		●		Beyond HEP

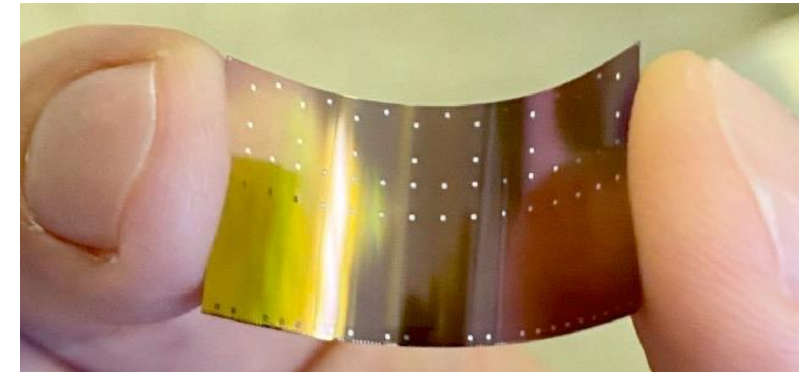
Work Packages

Forum for discussion on common topics

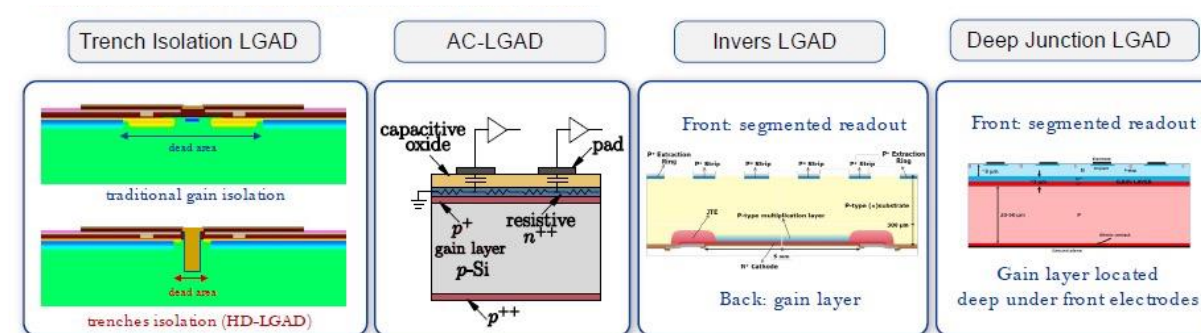


Semiconductor detectors: DRD3

- CMOS Monolithic sensors: combining sensing and readout elements
 - _ Sensor development becomes chip development, but typically with modifications to standard process, e.g. Towerjazz 180 nm
 - _ Overlap with DRD7 electronics
- 4D Tracking/ToF: Timing using LGAD sensors
 - _ Suppression of pile-ups
 - _ Foundries CNM, FBK, HPK
 - _ Timing performance (~ 25 ps for $50 \mu\text{m}$ sensors)
- Radiation hardness
 - _ Wide bandgap material (SiC, GaN)



CMOS MAPS for ALICE ITS3 (Run 4)
(LOI: CERN-LHCC-2019-018, M. Mager)

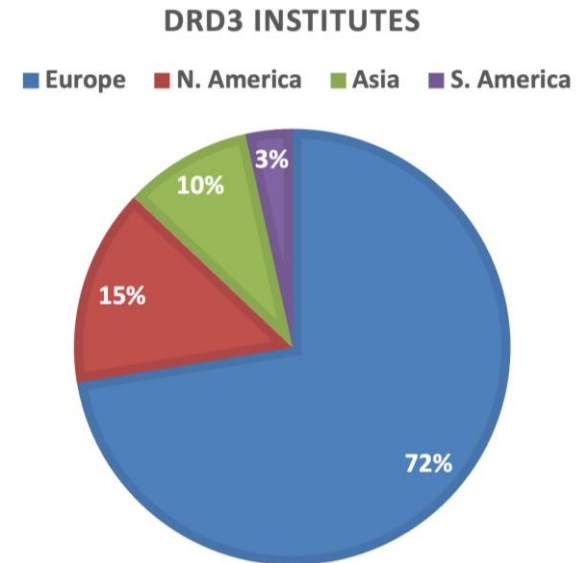
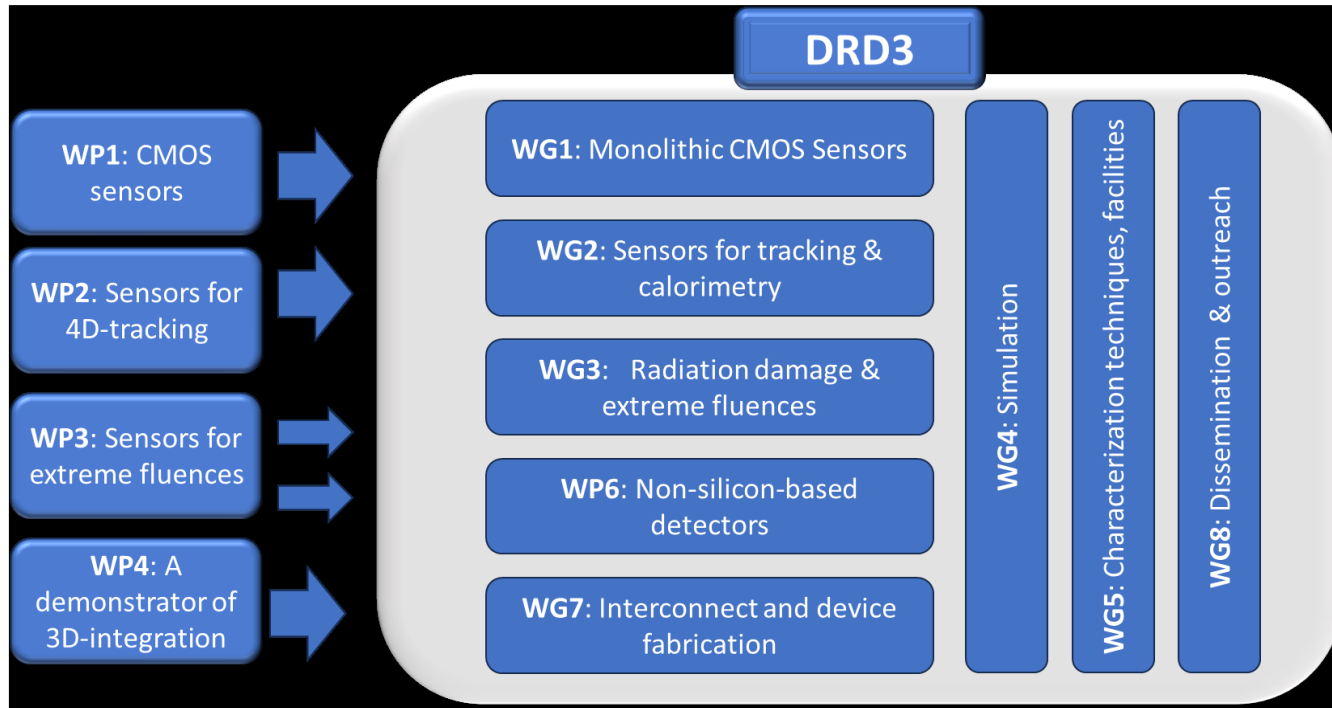


Semiconductor detectors: DRD3

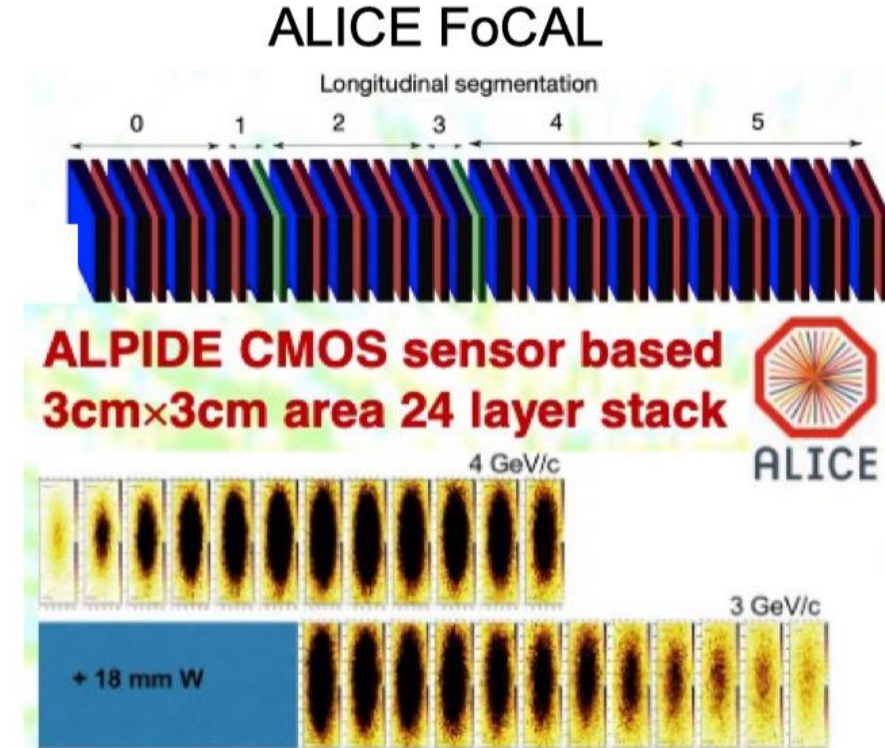
- ~129 institutes, 28 countries, ~900 interested people
- Merging RD50 and RD42 collaborations

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



- R&D in calorimetry has a particularly long lead-time due:
 - Many technology developments (gas, scintillator or Silicon-based readout)
 - Large and challenging prototype setups even in early stages.



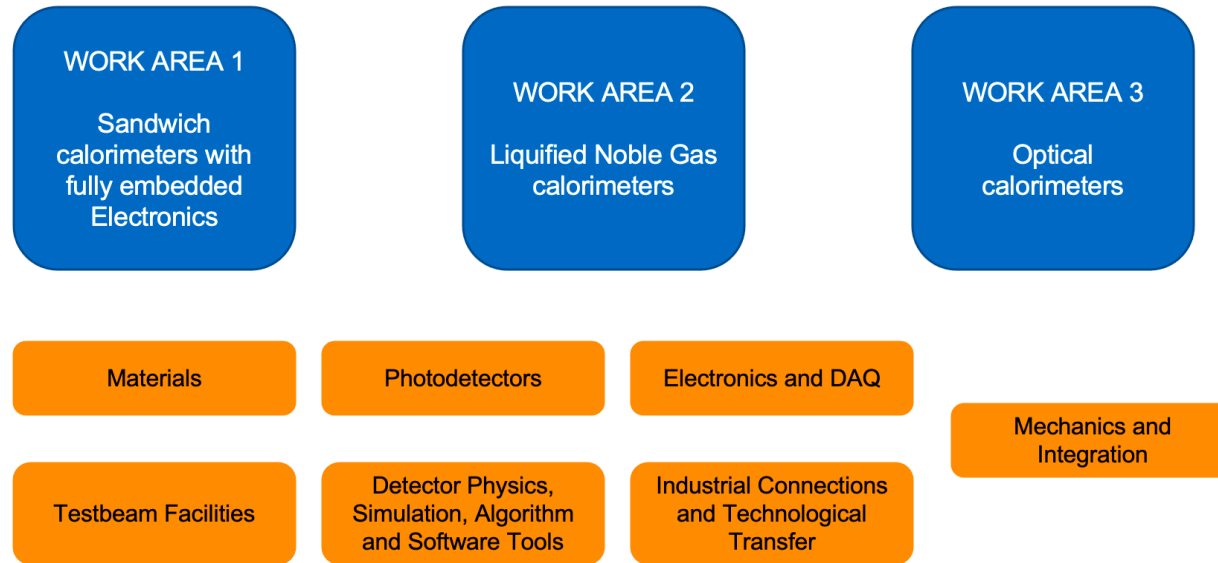
Calorimetry

- 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

Calorimetry: DRD6



- Collaboration emerged from CALICE and CrystalClear (RD18)
- Light-weight organization structure:
 - _ organized in three Work Areas
 - _ Several projects for different target application and calorimeter types
 - _ Several transversal activities



Target applications : e+e- collider FCC-hh Muon collider other

Calorimeter types : Electromagnetic Hadronic Electromagnetic + Hadronic

Project maturity : +++ exists a large prototype ++ exists a small prototype + at level of proof of principle

WA1	WA2	WA3
SiW Ecal (+) ++	EM LAr Calo +	EM HGICAL +
DECAL ++		EM MAXICC +
Highly compact calorimeter +		EM CRILIN +
Sc Ecal ++		EM GRAINITA +
AHCAL +++		EM SPACAL (LHCb Phase 2) ++
ScintGlassHCAL +		EM RADICAL +
T-DHCAL +++		EM + HAD DRCAL (+)++
MGPSD-HCAL +		HAD TILECAL +
ADRIANO3 ++		

- Particle Identification (PID) essential to identify decays when heavy flavor are present
- Developments on **MCP-PMTs, SiPMs, Vacuum and gaseous** photon detectors
- Applications in **Ring Imaging Cherenkov Detectors (RICH), Time-of-Flight (ToF), TRD**
- Challenges for example for SiPMs: the high dark count rate and moderate radiation hardness prevented their use in RICH detectors where single photon detector required at low noise, but also new ideas emerge (e.g. backside illumination)

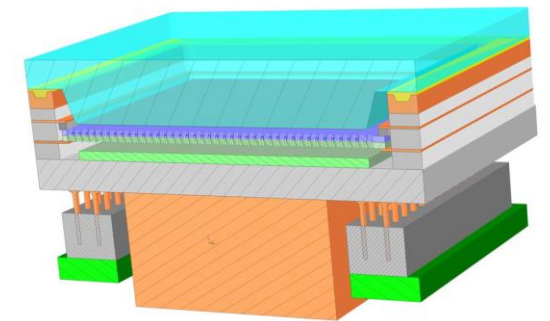
PID and Photon

- 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



(b)

MCP with 64 x 64 anode pads (Photek)



R&D to develop an MCP with integrated Timepix4 chip (55 x 55 μm^2 pixels)

Photodetection and Particle ID: DRD4



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- About 50 institutes
- 36 EU + 6 US, 2 China, 2 Japan, 2 Australia, 1 S.Korea, 1 Armenia
- 7 industrial partners
- Connection to almost every other DRD collaboration (gas, Silicon, calo, electronics, SiPM at cryogenic temp.)

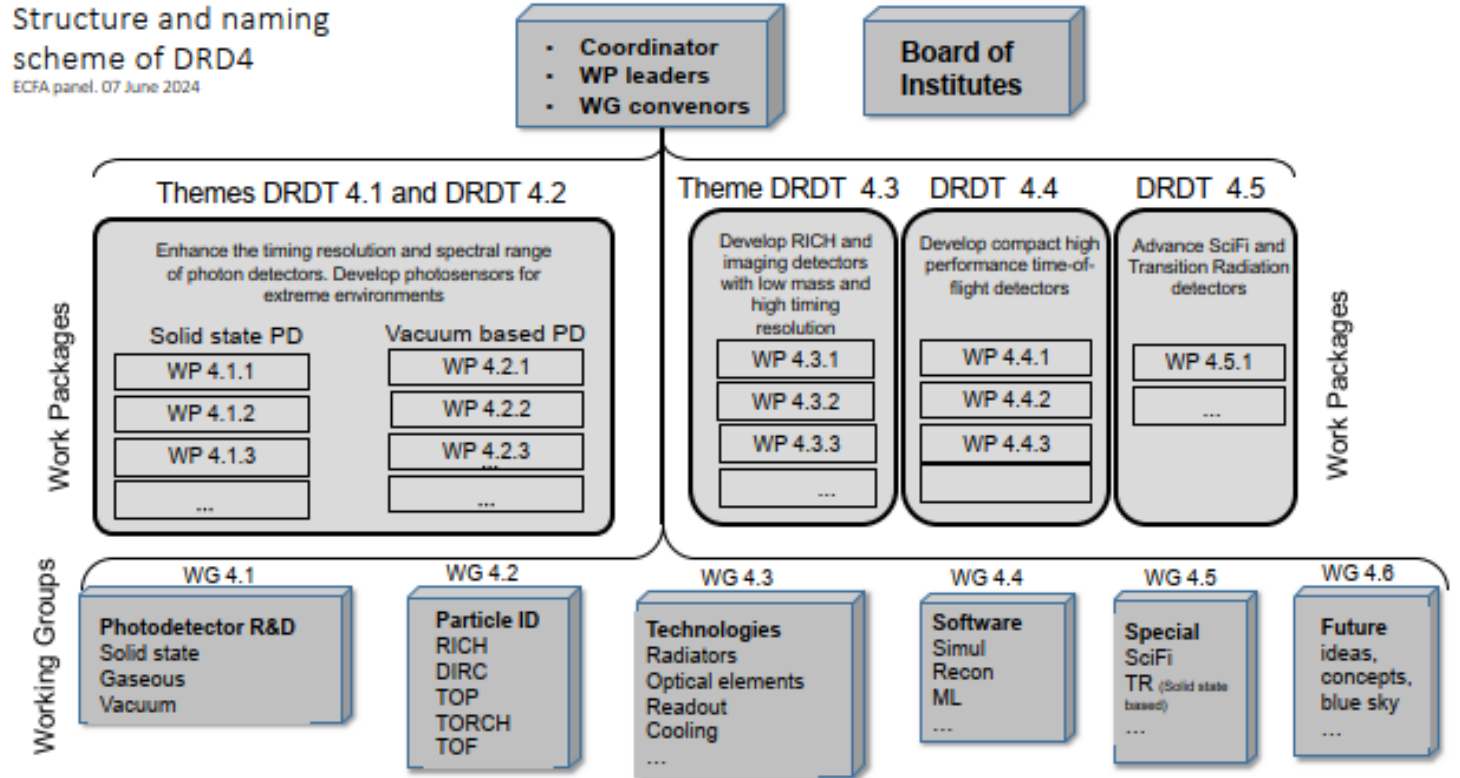


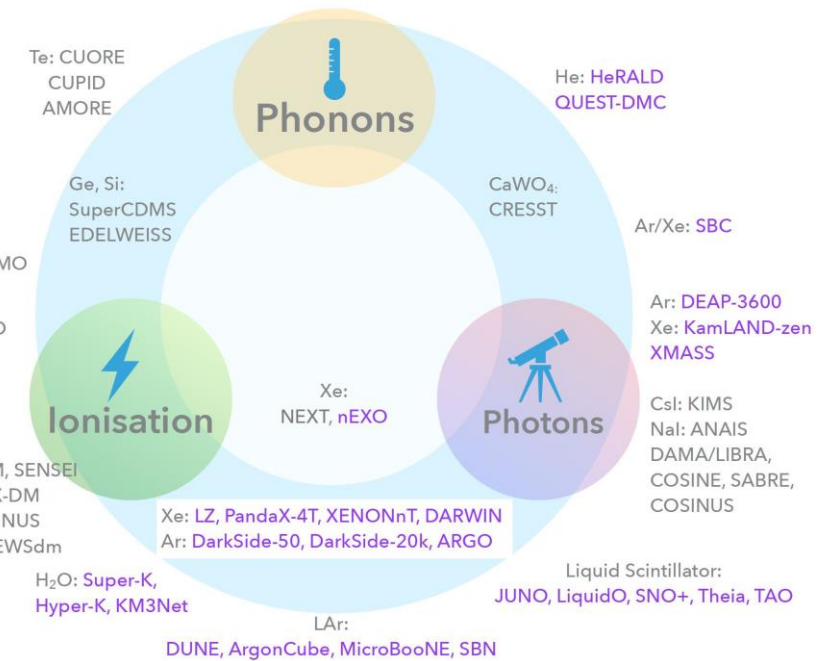
Figure 1: Organigram of DRD4 collaboration.

Liquid detectors: DRD2

- Covers Dark Matter and Neutrino experiments, accelerator and non-accelerator-based
- Several large-scale and many small-scale experiments running or foreseen with liquid detectors
- Technology: Noble Liquids (e.g. DUNE), Water Cherenkov (e.g. Super/Hyper-K) and Liquid Scintillator with light and ionization readout
- Underground Dark Matter Experiments – small and rare signals, R&D for multi-ton scale noble liquids:
 - _ Target doping and purification
 - _ Detector components radiopurity and background mitigation

Liquid

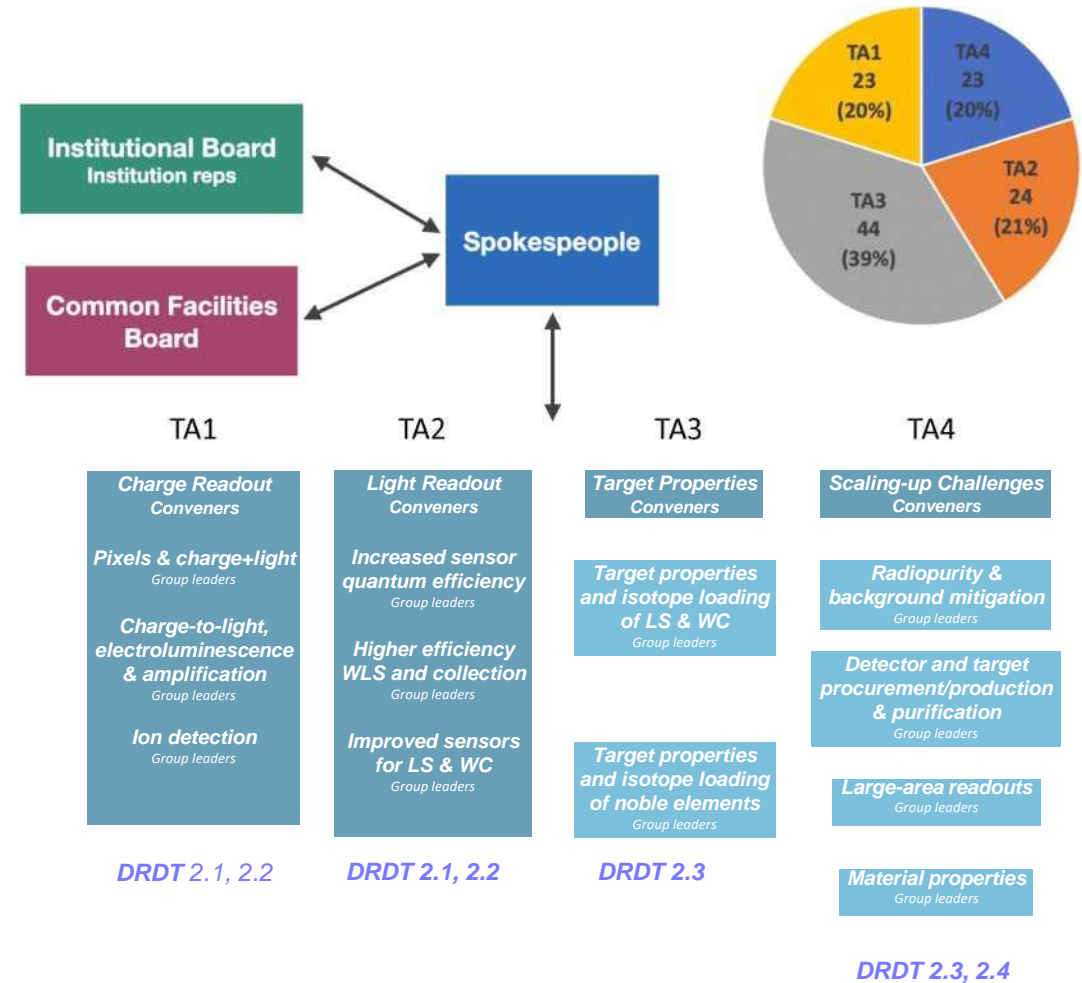
- DRDT 2.1** Develop readout technology to increase spatial and energy resolution for liquid detectors
- DRDT 2.2** Advance noise reduction in liquid detectors to lower signal energy thresholds
- DRDT 2.3** Improve the material properties of target and detector components in liquid detectors
- DRDT 2.4**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



Liquid Detectors: DRD4



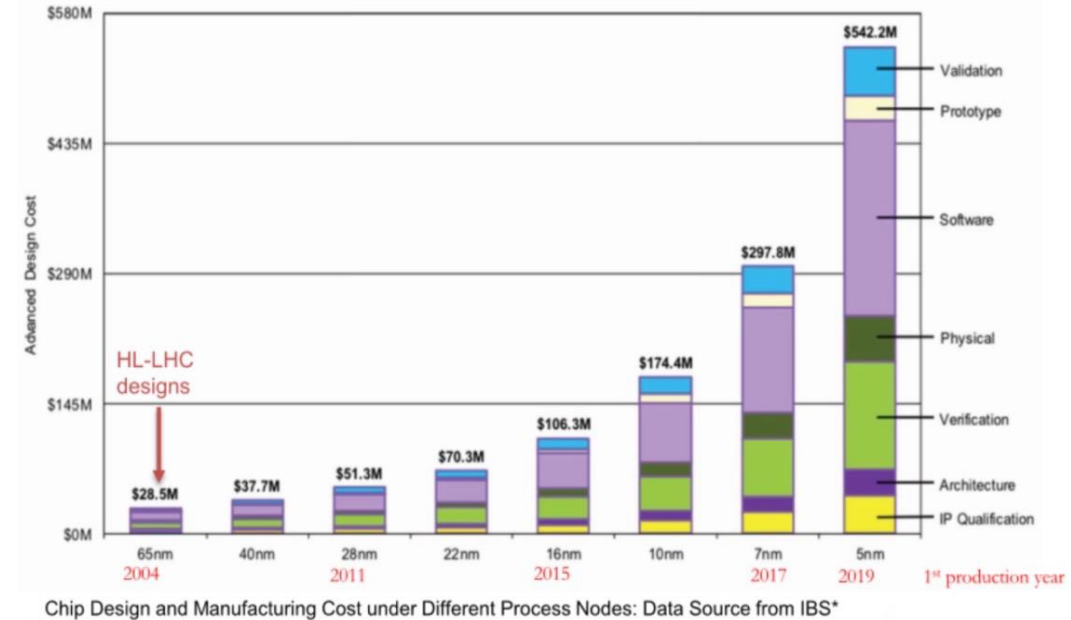
- DRD2 proposal, divided in four Technology Areas (TA), well aligned to DRDTs
- DRD2 Collaboration from 114 institutes in 15 countries
- Significant US contribution (1/ 4)
- Liaisons to DRD1,4 and 7
- list of companies associated to different TA is included



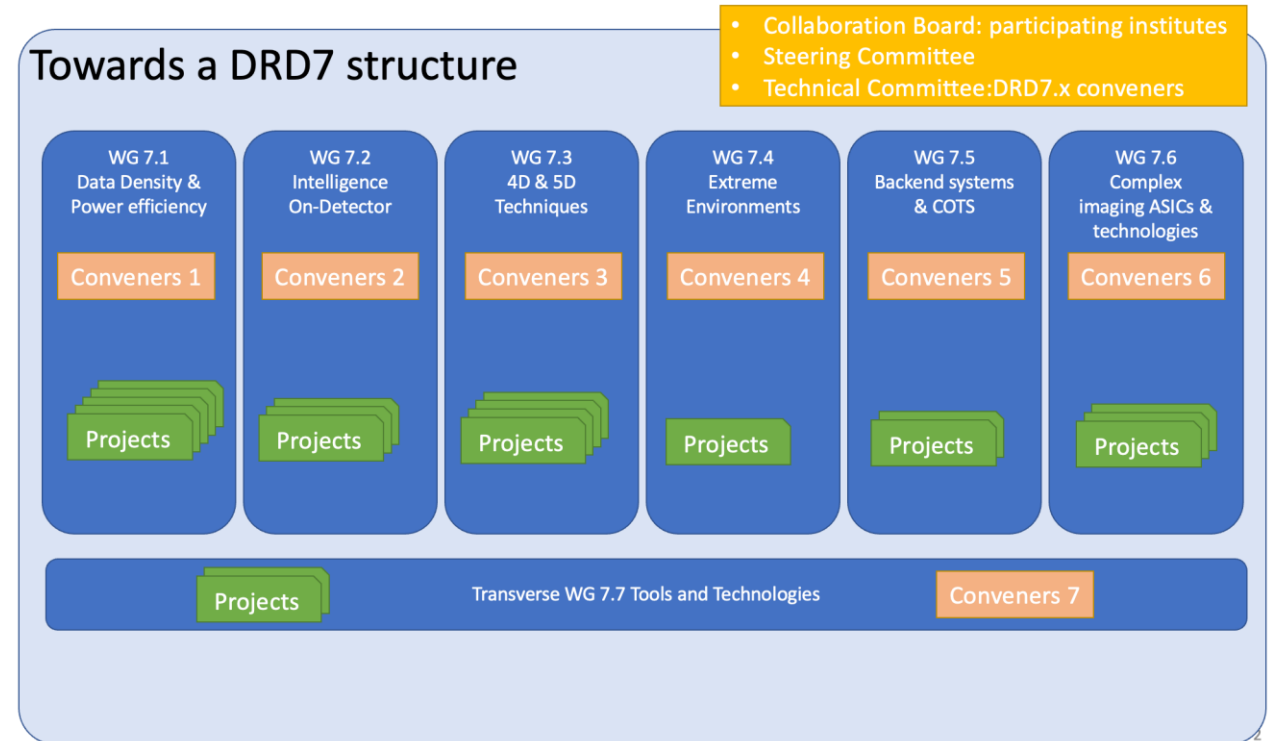
Electronic Systems: DRD7



- All new techniques (Precision timing, ultra-high granularity and improved signal resolution) need more sophisticated data handling, processing, complexity and power.
 - Requires exploiting the latest advances in commercial microelectronics and high-speed links.
 - Additional HEP requirements: Radiation and magnetic fields (niche and low volume market only)
- Core topic: ASIC development
 - Community now looks into 28 nm CMOS nodes for the future and dedicated 130 /110/65 nm technologies for monolithic pixels (DRD3 overlap!)
 - Each new node imposes significantly higher funds necessary
 - Legal topics (NDAs, design sharing agreements, software licenses,..)
 - Organization of multi-project wafer runs
- Strategic developments necessary for systems to be used in large-scale experiments, with synergy across many domains (e.g. DC-DC powering, FMC boards like FC7, GLIB)
 - All DRD collaborations have demands in electronics, from ASICs specific to certain detector technologies to small-scale readout systems
 - expert persons needed to be members of both, original DRD collaboration and electronics (see Annex B in this document)



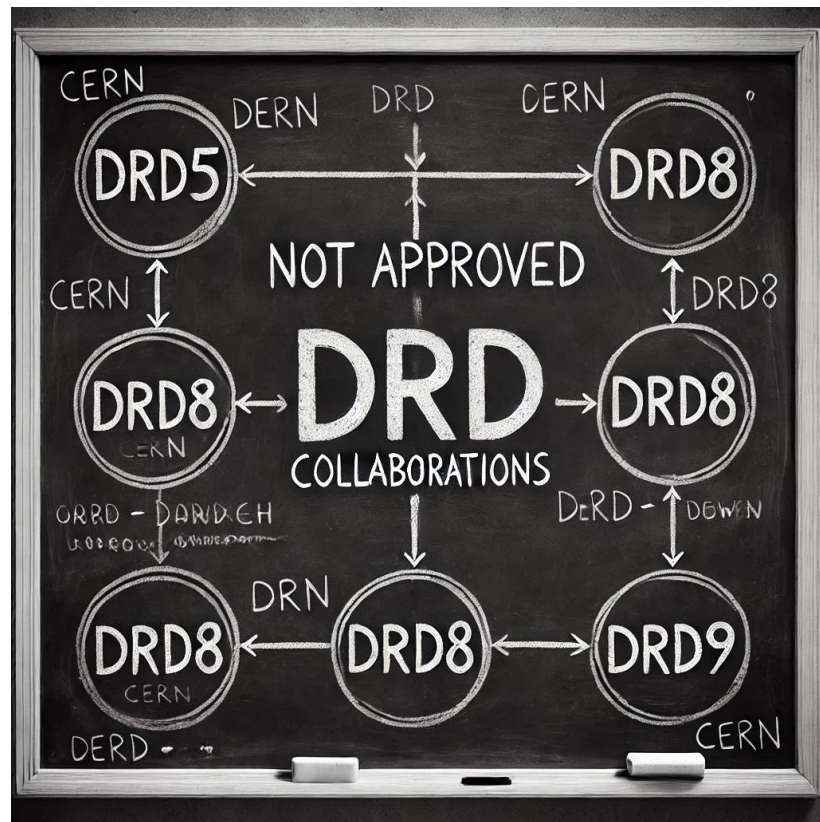
- Organization:
 - 50 Institutes, 18 countries
 - Six Development areas (WG)
- 16 projects in a bottom-up approach, but ensured that all are above certain threshold and fit the WGs



Electronics

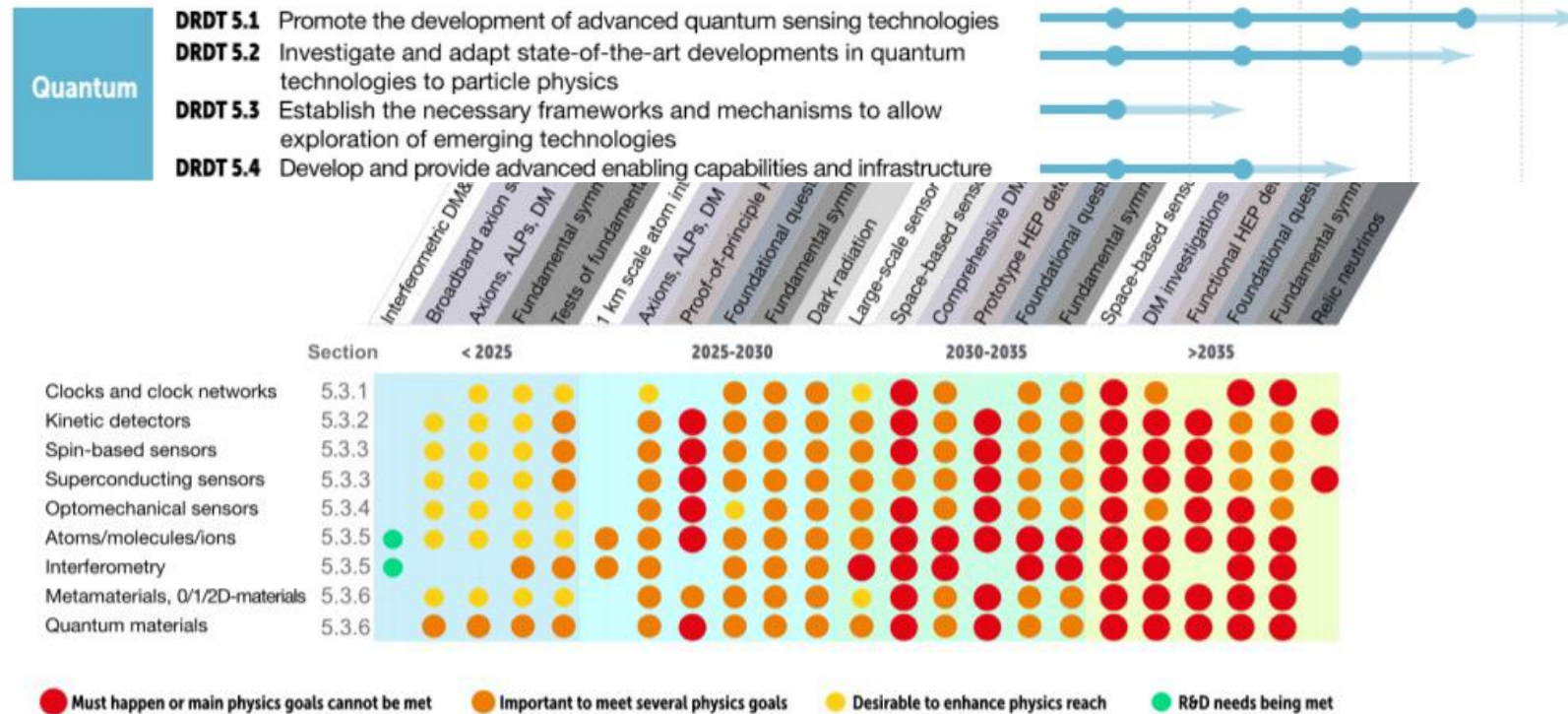
- DRDT 7.1** Advance technologies to deal with greatly increased data density
- DRDT 7.2** Develop technologies for increased intelligence on the detector
- DRDT 7.3** Develop technologies in support of 4D- and 5D-techniques
- DRDT 7.4** Develop novel technologies to cope with extreme environments and required longevity
- DRDT 7.5** Evaluate and adapt to emerging electronics and data processing technologies

Not approved (yet) collaborations



Quantum sensors: DRD5

- Quantum Technologies are a rapidly emerging area of technology development to study fundamental physics
 - _ Targeting Gravitational Wave, Axion, DM detection
 - _ development of HEP detectors on the long term
- Many different sensor and technologies being investigated: clocks and clock networks, kinetic detectors, spin-based, superconducting, optomechanical sensors, atoms / molecules/ ions, interferometry, ...

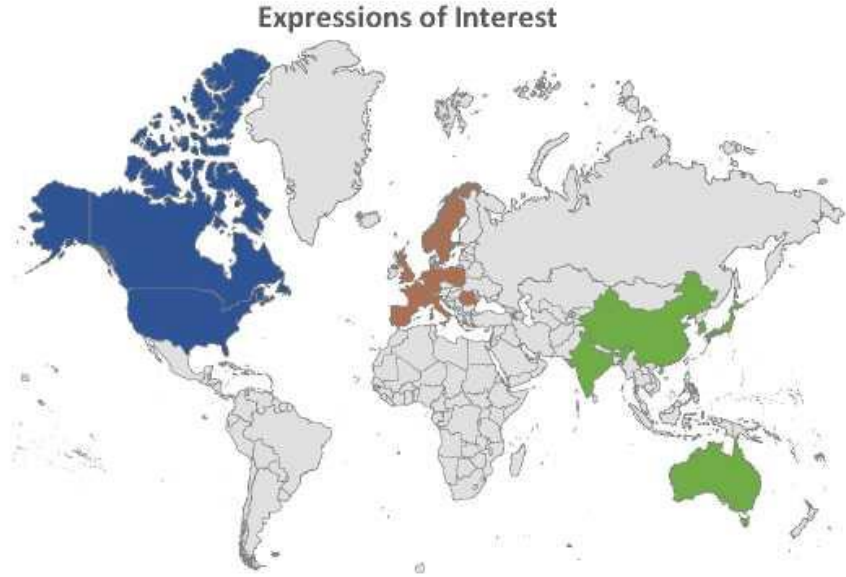
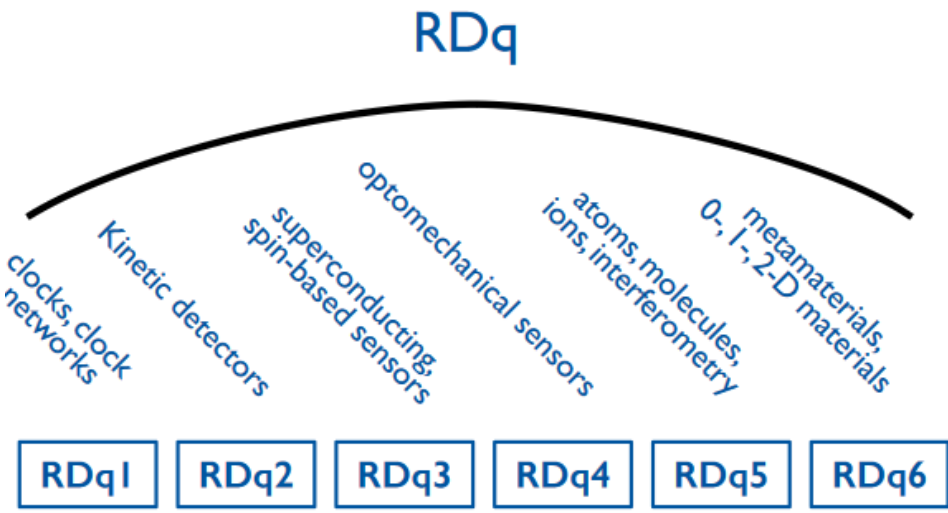


Quantum sensors: DRD5



- DRDT 5.1** Promote the development of advanced quantum sensing technologies
- DRDT 5.2** Investigate and adapt state-of-the-art developments in quantum technologies to particle physics
- DRDT 5.3** Establish the necessary frameworks and mechanisms to allow exploration of emerging technologies
- DRDT 5.4** Develop and provide advanced enabling capabilities and infrastructure

- 40 institutes in 15 countries:
- 25 proposed contributions



Task force 7: Integration

- Target: Mechanical support and structures, cooling, magnets and management of radiation environment
- DRDTs are quite diverse
- Some topics are very closely connected to the genuine DRDs, where the technology is developed (e.g. DRDT 8.3)
- No DRD collaboration has been proposed yet, but 16 institutions replied favourably to a community survey

- Topics:
 - Gas cooling development
 - Single- and two-phase liquid cooling R&D
 - Humidity control
 - Temperature control
 - Thermal management
 - Thermal performance verification
 - Thermal interface materials and expansion differences
 - Pipe materials, pipe connection techniques and fittings
 - Choices and characterisation of construction materials
 - 3D printing
 - Radiation and mechanics: Materials and issues like access constraints
 - FEA and its comparison to real objects
 - Structure design and optimisation
 - Application of machine learning for design issues



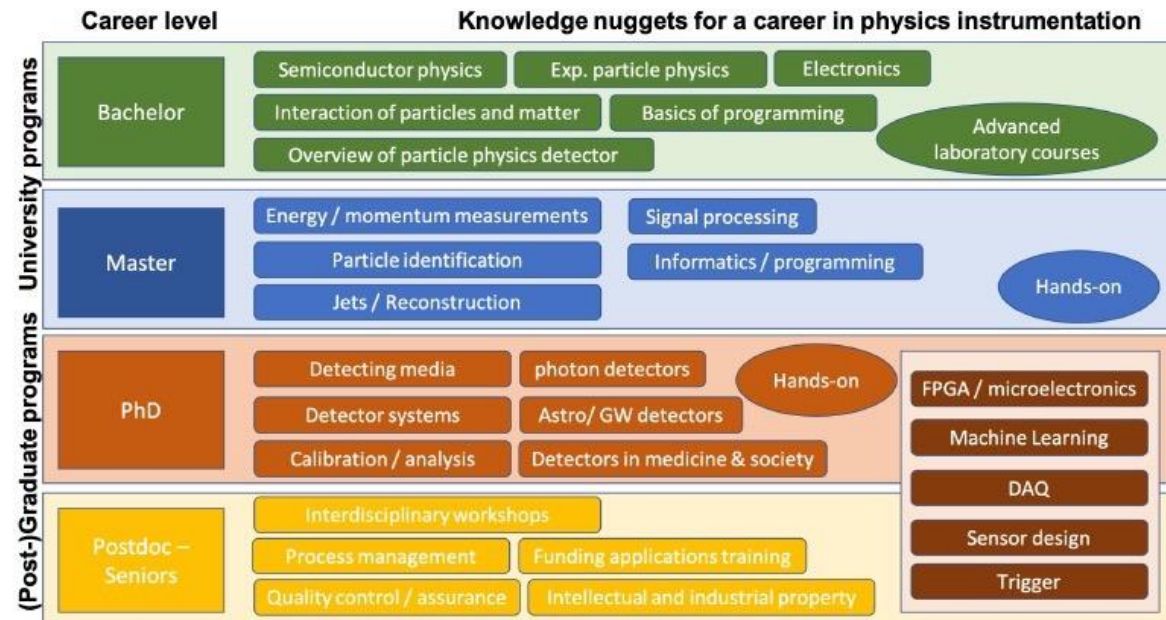
IFCA

Task Force 9: Training



- A structured training program shall support the scientists in their career
- Increase participation of young scientists, in particular graduate students, in leading-edge instrumentation R&D, and foster growth of future HEP instrumentation experts who can compete for permanent positions
- Establish a master's degree curriculum
- TF9 Training will not become a DRD collaboration, but an ECFA Training Panel has been founded to pursue these activities

- Training**
- DCT 1** Establish and maintain a European coordinated programme for training in instrumentation
 - DCT 2** Develop a master's degree programme in instrumentation



General Strategic Recommendations



IFCA

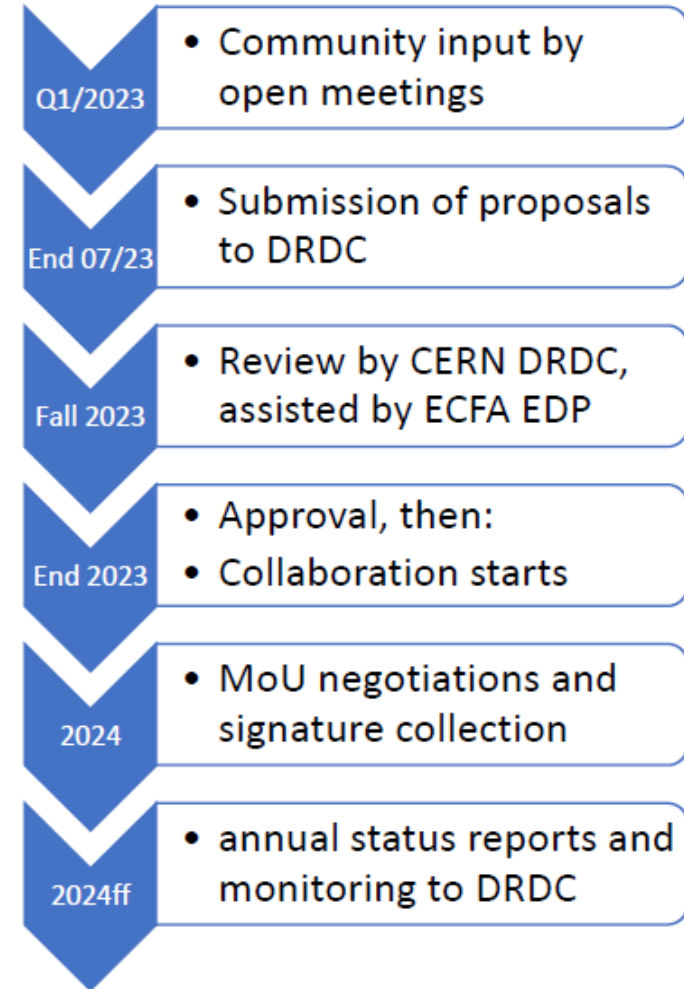
- The General Strategic Recommendations (GSR) topics are:
 - GSR 1: Supporting R&D facilities (test beams, large-scale generic prototyping and irradiation)
 - GSR 2: Engineering support for detector R&D
 - GSR 3: Specific software for instrumentation
 - GSR 4: International coordination and organisation 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

Approval and Reviewing : DRDC Committee



F (A

- New committee at CERN on the same level as SPSC and LHCC:
 - _ Reviewed submitted DRD proposals
 - _ Monitoring the progress of each DRD collaboration by requesting
 - _ Annual status reports
- Assisted by ECFA detector Panel



We are not alone...



IFA

- In parallel, the US HEP community, at the 2022 Coordinating Panel for Advanced Detectors (CPAD) annual workshop launched a network of US Detector R&D Collaborations.

RDC	Topic
1	Noble Element Detectors
2	Photodetectors
3	Solid State Tracking
4	Readout and ASICs
5	Trigger and DAQ

RDC	Topic
6	Gaseous Detectors
7	Low-Background Detectors (incl. CCDs)
8	Quantum and superconducting Detectors
9	Calorimetry
10	Detector Mechanics
11	Fast Timing

In Spain: CPAN network on Instrumentation and Detectors



IFCA

- Proposal for a network on Instrumentation and Detectors, XV CPAN Days, October 2023, Santander (spin-off of a previous meeting in February 2023 at IMB-CNM).
<https://indico.cern.ch/event/1283224/contributions/5612901/>
- Goals:
 - _ Building a Community of Experts in Instrumentation and Detectors.
 - _ Platform for sharing and exchanging knowledge, technologies, practices, and research findings in instrumentation across different fields and disciplines → Annual Workshop
 - _ Promoting collaboration among groups that may lead to joint research projects.
 - _ Representing the community to influence and advise scientific leadership (as in case of the DRD collaborations or the coming update of European Strategy for Particle Physics).
 - _ Capacity development: training activities → Schools, courses, and/or topical mini-workshops.
 - _ Recognition of excellence → Awards for students



CNID: Kick-off meeting in Valencia



IFCA

CNID CPAN Ingenio 2010
 CPAN Network on Instrumentation and Detectors (CNID)
 8-10 May 2024
 Colegio Mayor Rector Peset
 Castellón de la Plana

- Overview
- Call for Abstracts
- Timetable**
- Registration
- Participant List
- Venue
- Workshop Dinner
- ZOOM link
- Gallery

Timetable

Wed 08/05 Thu 09/05 Fri 10/05 All days

Print PDF Full screen Detailed view Filter

Wed 8/5

12:00	Registra	Sesión de Actos, Colegio Mayor Rector Peset	12:30 - 13:00
13:00	Comida		
14:00	Comida	Comida, Colegio Mayor Rector Peset	13:00 - 14:00
14:00	Welcome	Carlos Martínez	14:00 - 14:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	Introduction to the CNID Kick-off meeting	Ivan Vila Alvarez	14:30 - 14:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	Instrumentation & Detector R&D in Particle physics: CRD Collaborations Status	Jesús Gil Durruti	14:45 - 15:00
	Sesión de Actos, Colegio Mayor Rector Peset		
15:00	Instrumentation and Detector R&D in Nuclear physics	Cesar Domingo-Planas	15:00 - 15:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	Instrumentation and Detector R&D in Astroparticles	Cristóbal Padilla	15:15 - 15:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	R&D on noble element scintillation detectors at IFIC	Justo Martín-Aldo	15:30 - 15:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	Liquid ⁴ organic light detection technology	Diana Neves Novais	15:45 - 16:00
	Sesión de Actos, Colegio Mayor Rector Peset		
16:00	Spectroscopy of the Ar scintillation light for rare event searches	Vicente Pardo Portes	16:00 - 16:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	R&D on VUV photon detection for cryogenic liquid detectors	Jesús Gil Durruti	16:15 - 16:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	Cafe		
	Sesión de Actos, Colegio Mayor Rector Peset		
17:00	R&D on High Resolution Temperature Sensing for Cryogenics Applications	Jordi Capó	16:30 - 17:00
	Sesión de Actos, Colegio Mayor Rector Peset		
	Governance Proposal	pluto peltgrin	17:00 - 17:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	Sesión de Actos, Colegio Mayor Rector Peset		
18:00	Assessment of the future accelerator network meeting in Valencia	Marc Vea	17:15 - 18:00
	Sesión de Actos, Colegio Mayor Rector Peset		
	Training Discussion		
	Sesión de Actos, Colegio Mayor Rector Peset		

Thu 9/5

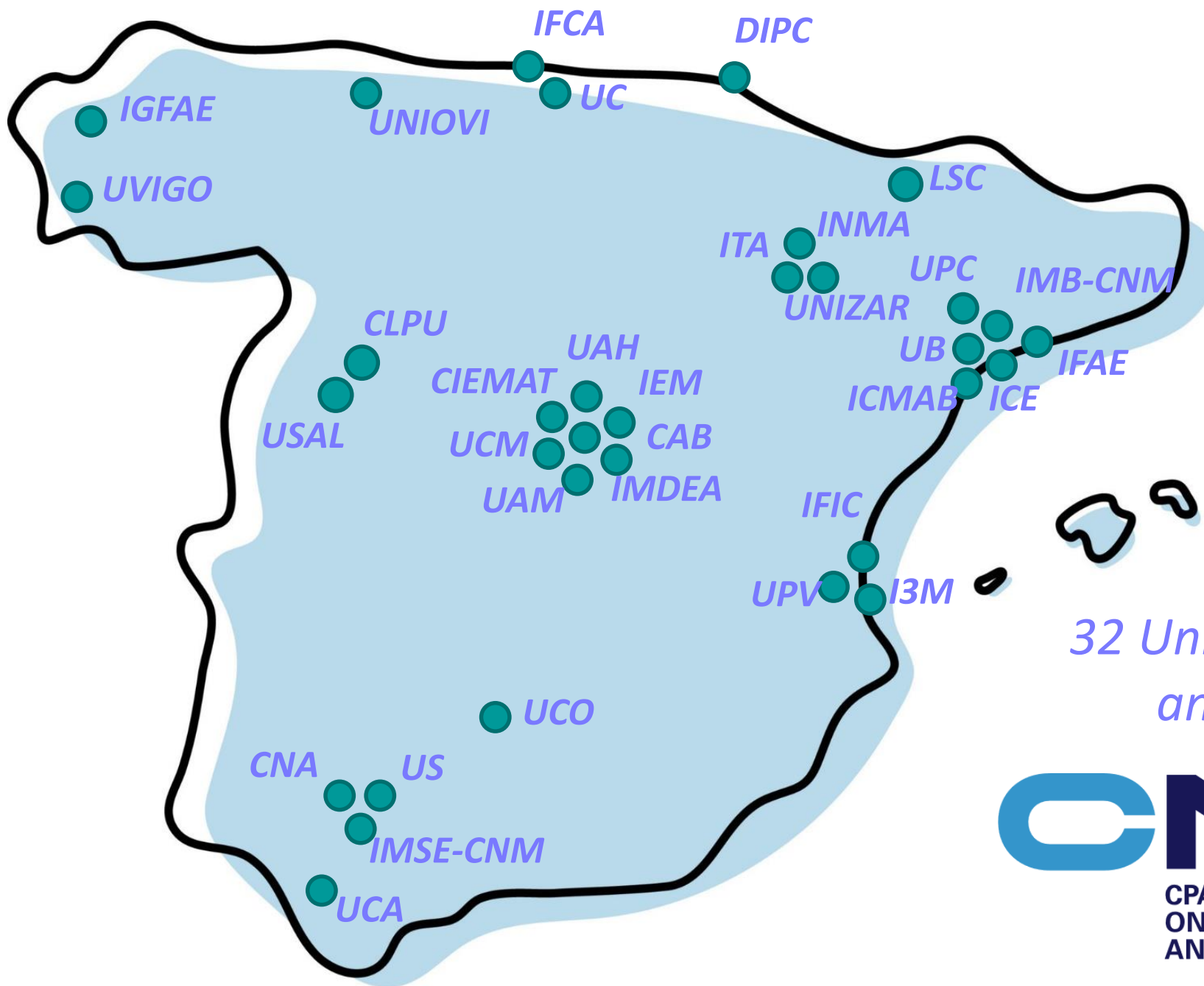
09:00	ITx activities in BRD7: Power efficiency & Testing	Dr. Ferruccio Ancher	09:00 - 09:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	Triggering on main showers in the Barrel Muon Trigger of the CMS experiment for the HL-LHC upgrades	Javier Prado Polo	09:30 - 09:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	Research and development of the acquisition electronics for the KM2Net neutrino telescope	Dr. Diego Real Muñoz	09:30 - 09:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	Enhancing Data Processing in the CMS Trigger System for HL-LHC with HLS	Pelayo Legarua	09:45 - 10:00
	Sesión de Actos, Colegio Mayor Rector Peset		
10:00	Programmable readout electronics for radiation environments	Rolando Paz Herrera	10:00 - 10:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	The Energy Measurement ASIC for the Upgrade II in the LHC's Calorimeter Detector	Alberto López-Gullón	10:15 - 10:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	Precision & deterministic timing distribution study with Microsemi FPGA	Dr. Javier Santos Alvaro et al.	10:30 - 10:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	Development of an AI based Central Trigger Processor board for the advanced SPM based camera of the CTA Large Size Telescopes	Alejandro Pérez Aguilera	10:30 - 10:45
	Sesión de Actos, Colegio Mayor Rector Peset		
11:00	The PrefProcessor system for the ATLAS Tile Hadronic Calorimeter at the HL-LHC	Alberto Vea	11:00 - 11:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	Cafe		
	Sesión de Actos, Colegio Mayor Rector Peset		
	Mechanical design and integration at RDS-FABR experiment	M. Pablo Garcia-Gil	11:15 - 12:00
	Sesión de Actos, Colegio Mayor Rector Peset		
12:00	Microchannel Cooling Developments at IMB-CNM	Miguel Ullán	12:00 - 12:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	The global and local support structures of the endcap for the ATLAS Hb-Strips	Cristian Zilberberg Sotomayor	12:15 - 12:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	Integration of the Fibre Wheel Assembly for the Euclid Satellite	Cristóbal Padilla	12:30 - 12:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	Test bench for the SOLiD Superconducting Recoil Separator SRS	Dr. Sergio Sánchez-Núñez	12:45 - 13:00
	Sesión de Actos, Colegio Mayor Rector Peset		
13:00	Comida		
	Comida, Colegio Mayor Rector Peset		
	Comida		
	Comida, Colegio Mayor Rector Peset		
14:00	The readout and joints of the endcap of the ATLAS inner tracker for the HL-LHC	Ulrich Schmitt	14:00 - 14:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	Detector developments for the ATLAS phase II upgrades at IFIC	Diego Torro	14:15 - 14:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	Characterization of 3D pixel sensors for the CMS Tracker Upgrade at the High Luminosity LHC	M. Clara Luaces García	14:30 - 14:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	Instrumented baffles for Advanced Virgo	Laura Mesa M	14:45 - 15:00
	Sesión de Actos, Colegio Mayor Rector Peset		
15:00	Detectors and instrumentation for astronomical space and ground telescope missions	Prof. Cristóbal Padilla	15:00 - 15:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	LHC development at IMB-CNM	Alberto Vea	15:15 - 15:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	Micro vertex detection systems for the WAA-COS Hyper-C experiments	Christophe Roggero	15:30 - 15:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	HEP a pixel Si Tracker for RDS-FABR	Dolores Corrao Gil	15:45 - 16:00
	Sesión de Actos, Colegio Mayor Rector Peset		
16:00	The DMAPS upgrade of the Belle II Vertex Detector	Carlos Martínez	16:00 - 16:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	High efficiency neutron spectrometry for underground physics, space weather and environmental dosimetry	Dr. Arac Toral-García	16:15 - 16:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	Cafe		
	Sesión de Actos, Colegio Mayor Rector Peset		
17:00	Transmission detectors of protons with thin organic scintillators	Michael Semzer	16:30 - 17:00
	Sesión de Actos, Colegio Mayor Rector Peset		
	Advances in high-repetition-rate metrology of laser-driven ion beams and electromagnetic pulses at the CLARA	Michael Ehrer	17:00 - 17:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	X-ray optics for Particle, Astrophysics and Nuclear Physics	Jaime Ruiz	17:15 - 17:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	Moon tomography status and applications	Pablo Martínez	17:45 - 18:00
	Sesión de Actos, Colegio Mayor Rector Peset		
18:00	Development of dosimetry and monitoring applications with CLYC detectors for nuclear technology	Alberto Pérez de Rada Faj	18:00 - 18:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	Advanced semiconductor dosimeters for new radiotherapies	Cristina Pina	18:15 - 18:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	RES Innovative detectors for medical applications	Gabriela Lloza	18:30 - 18:45
	Sesión de Actos, Colegio Mayor Rector Peset		

Fri 10/5

09:00	T-SOICAL, a 3D calorimeter for future Higgs Factories	Dr. Mery Cruz Pezo	09:00 - 09:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	Technological challenges on sensor-electronics hybridization for compact silicon tungsten electromagnetic calorimeters	Adrian Eric	09:15 - 09:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	Test beam measurements of instrumented sector planes for a high compact and granular electromagnetic calorimeter	Rafael Amador Cruz	09:30 - 09:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	PixelCal: processed timing calorimeter for LHCb Upgrade II	Alex Mironov de Cea	09:45 - 10:00
	Sesión de Actos, Colegio Mayor Rector Peset		
10:00	Caracterización de detectores altamente segmentados en la mesa de escaneado SALSA	Gala González Buj	10:00 - 10:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	EMC characterization of physics detectors	M. Akbari Prasad	10:15 - 10:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	The SPAC-TCT method for semiconductor sensors characterization	Marcos Fernandez Garcia	10:30 - 10:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	Integration of high temporal resolution planes into ADA-type telescopes for Sensor Characterization	Dr. Jordi Duarte-Carpintero	10:45 - 11:00
	Sesión de Actos, Colegio Mayor Rector Peset		
11:00	Characterization of detectors using MeV ion beams at the CNM	Dr. M ^o Carmen Jiménez-Rodríguez	11:00 - 11:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	Cafe		
	Sesión de Actos, Colegio Mayor Rector Peset		
	Direct detection of ultra-light particles like dark neutrons	Ivan Vila Alvarez	11:15 - 11:30
	Sesión de Actos, Colegio Mayor Rector Peset		
12:00	Development of new generation Active Targets and Subdetectors for reactions with radioactive beams	Yessir Ayari	12:00 - 12:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	Using Monogegapixels for direct dark matter searches, challenges and perspectives	Dr. Gökhan Lüdtke	12:15 - 12:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	Development of scintillation detectors for nuclear physics research	Alberto Pérez de Rada Faj	12:30 - 12:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	Test of a pure LArSiC scintillator crystal for proton range verification	Dr. Marcos Martínez-Rodríguez	12:45 - 13:00
	Sesión de Actos, Colegio Mayor Rector Peset		
13:00	New scintillation materials with excellent gamma discrimination capability for nuclear research	Javier Belmonte-Ceballos	13:00 - 13:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	Instrumentation developments for beta decay studies	Alejandro Aguilera	13:15 - 13:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	Fast scintillator detectors for nuclear structure and applications	Prof. Luis María Fraile	13:30 - 13:45
	Sesión de Actos, Colegio Mayor Rector Peset		
	Understanding the nonlinear response of SiPMs	Alejandro Pérez-Aguilera	13:45 - 14:00
	Sesión de Actos, Colegio Mayor Rector Peset		
14:00	Design and expected performance of the LISA Radiation Monitor	Marta Olea Toral	14:00 - 14:15
	Sesión de Actos, Colegio Mayor Rector Peset		
	The RES CALISA hybrid spectrometer at CARB	Diego Tringali	14:15 - 14:30
	Sesión de Actos, Colegio Mayor Rector Peset		
	Final Remarks	Ivan Vila Alvarez et al.	14:30 - 14:45
	Sesión de Actos, Colegio Mayor Rector Peset		

80 participants
 67 contributions

<https://indico.ific.uv.es/event/7477/overview>



*32 University centers
and Institutes*

CND
CPAN NETWORK
ON INSTRUMENTATION
AND DETECTORS

Working Groups and coordinators



IFCA

- **WG1 Gaseous detectors:** Yassid Ayyad (IGFAE) + Cristina Fernández (Ciemat)
- **WG2 Liquid detectors:** Clara Cuesta (Ciemat) + Justo Martín (IFIC)
- **WG3 Solid state:** Sebastian Grinstein (IFAE) + Carlos Mariñas (IFIC) + Teresa Kurtukian (IEM)
- **WG4 Calorimetry:** Mary-Cruz Fouz (Ciemat) + Héctor Alvarez-Pol (IGFAE)
- **WG5 Quantum/Superconductor sensors:** Gemma Rius (IMB-CNM) + Igor García Irastorza (IUNIZAR)
- **WG6 Electronics:** Santiago Folgeras (UNIOVI) + Fernando Arteché (ITA) + Diego Real (IFIC)
- **WG7 Mechanics & Integration:** Cristobal Padilla (IFAE) + Enrique Casarejos (UV)
- **WG8 Applications:** Carlos Guerrero (US) + Gabriela Llosá (IFIC)
- **WG9 Scintillators and photodetectors:** Luis Mario Fraile (UCM) + David Gascon (UB)
- **WG10 Characterization Techniques:** Carmen Jiménez (CNA) + Jordi Duarte Campderrós (IFCA)
- **WG11 Training:** to be appointed (dependent of the institution leading the school organization)
- **WG12 Low-Background experiments:** Susana Cebrián (IUNIZAR) + Francesc Monrabal (DIPC) + Roberto Santorelli (CIEMAT)
- **Coordinator:** Iván Vila (IFCA); **Deputy Coordinators:** Cesar Domingo (IFIC) + Inés Gil (Ciemat)

Several conveners are also playing coordinating roles in the DRD WG and WP MC. Fouz (deputy spoke DRD6), I. Gil (DRDC member), G. Pellegrini (Chair DRD3)



- The ECFA Roadmap defined the **strategic detector R&D themes** that should address enable the future HEP experiments.
- To implement the strategic detector R&D, Detector R&D Collaborations (DRD) at CERN on the relevant technological domains have started in 2024 (a few are still under creation).
- The Spanish network on instrumentation (CNID) shall be a tool to promote the participation of the HEP Spanish groups in the strategic R&D projects at the DRDs, increase the awareness of the community and, fostering inter-group collaboration to increase the impact of their activities.