

Instrumentation for the future of particle, nuclear and astroparticle physics & medical applications

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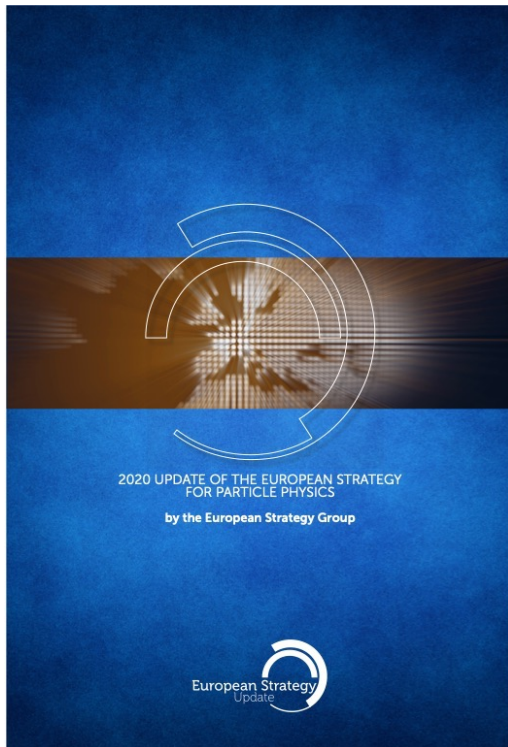
(Coordinator of FPN Programme@AEI)



Welcome

Detector R&D is the most creative side of instrumentation and an essential driver for innovation and cross-pollination: collaboration is fruitful

European Strategy for Particle Physics Recommendation



C. The success of particle physics experiments relies on innovative instrumentation and state-of-the-art infrastructures. To prepare and realise future experimental research programmes, the community must maintain a strong focus on instrumentation. ***Detector R&D programmes and associated infrastructures should be supported at CERN, national institutes, laboratories and universities. Synergies between the needs of different scientific fields and industry should be identified and exploited to boost efficiency in the development process and increase opportunities for more technology transfer benefiting society at large. Collaborative platforms and consortia must be adequately supported to provide coherence in these R&D activities. The community should define a global detector R&D roadmap that should be used to support proposals at the European and national levels.***

-> ECFA mandate to define a Detector R&D Roadmap

Detector R&D Roadmap

- Identify areas of detector R&D that are strategic not to compromise the physics programs in future facilities
- Strategic R&D to be distinguished from:

Experiment-specific R&D

Blue-sky research

(Although strategic R&D is often motivated by specific experiments and can benefit from blue-sky)

- Acknowledge the transversal impact of this R&D in related fields: future colliders, neutrino, dark matter, nuclear, astroparticle, etc



Detector R&D Roadmap

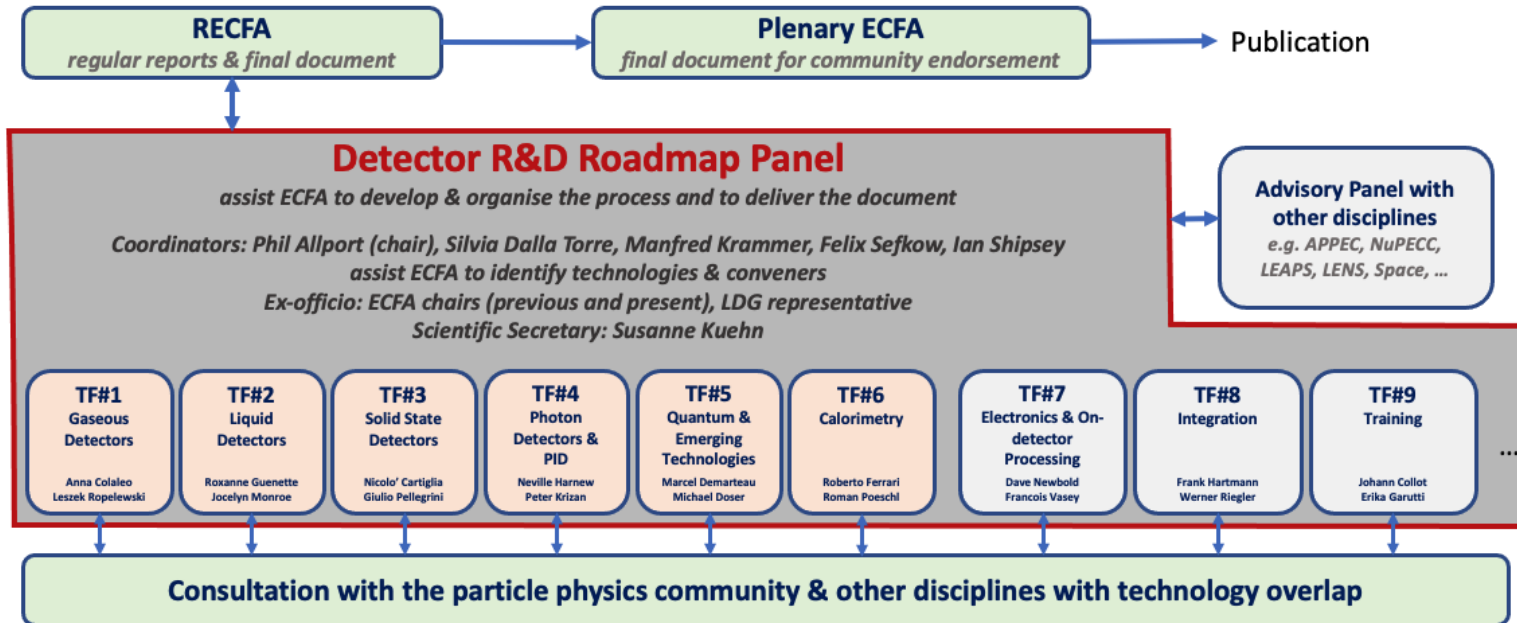


Figure 1: ECFA Detector R&D Roadmap Panel Organisation.

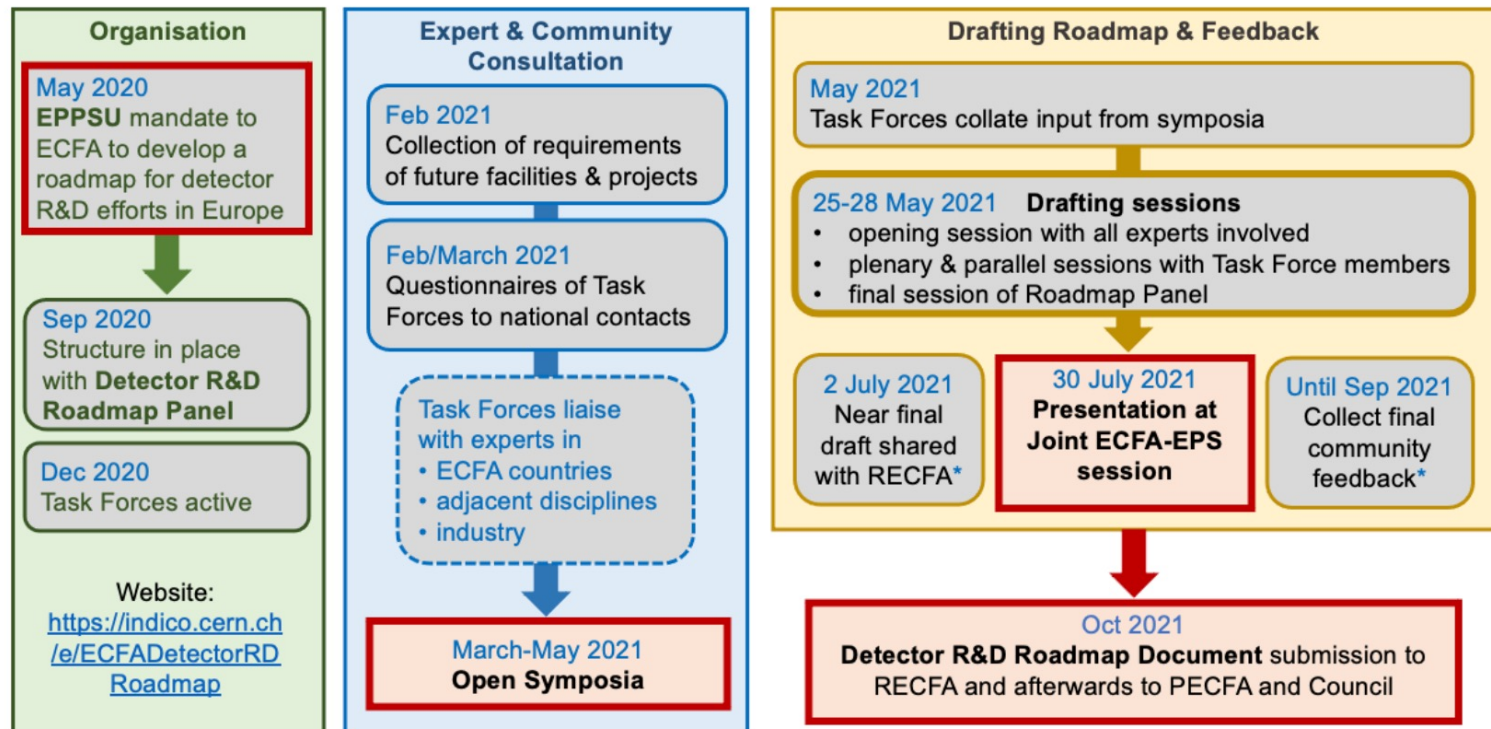
A number of broad task forces and challenges within each area were identified by broad community consultation

Detector R&D Roadmap

Timeline of the Roadmap process

The timeline of the roadmap process is anticipated to follow the key dates outlined below. Input of the community is especially encouraged through the nine all-day open symposia of the Task Forces, via [RECFA](#) and in the discussion around the presentation at the Joint ECFA-EPS session.

ECFA Detector R&D Roadmap Process



*community feedback via RECFA delegates and National Contacts

Detector R&D Roadmap

ECFA

European Committee for Future Accelerators

ECFA Detector R&D Roadmap

24 March 2021 to 30 July 2023

Europe/Zurich timezone

Enter your search term



Overview

Implementation of the
ECFA Detector R&D
Roadmap

Mandate for the
Preparation of the
Roadmap

The Roadmap Document

Panel members and Task
Forces

Input from future facilities

Symposia

Registration to the
symposia

ECFA Detector R&D
Roadmap Process

Timeline of the
Roadmap process

Questionnaires

Relevant documents

Internal

Questionnaires

A set of questions was sent by various Task Forces to national contacts. You can also find them below and provide replies to the related Task Force.

- Questionnaire of TF1 Gaseous Detectors: [LINK](#)
- Questionnaire of TF2 Liquid Detectors: [LINK](#)
- Questionnaire of TF3 Solid State Detectors: [LINK](#)
- Questionnaire of TF4 Photon Detectors and PID:
 - The agenda of the symposium is [here](#) – do you feel that there any topics that are missing that you would like to see included? A more complete list of major technologies can be found below:
 - Overview of Particle Identification technologies to be covered: RICH (novel optical elements, novel gases, aerogel, metamaterials), DIRC (radiator systems and geometries), TOF (DIRC-type techniques, RPCs, scintillators). Other technologies only summarised, since covered in other task forces – dE/dx, TRD, optical materials for fibre technologies, new scintillators, neutron detectors.
 - Overview of Photon Detector technologies to be covered: SiPM, MCP-PMT (large area and high granularity), large-area photomultipliers, multianode devices (MaPMT), hybrid HPDs, HAPDs, cryogenic photon detectors. Other, only to be summarised since covered in other task forces – LGADs, fast timing electronics.
 - What aspects of R&D are ongoing in your country in the areas of Particle Identification and Photon Detector technologies for Particle Physics applications? If you could include links to relevant references of recent work that would be helpful for the symposium speakers.
 - How do you feel the R&D work could be best facilitated, especially in the long term?
 - Are there any blue skies topics (including developments for neighbouring fields) that you feel should get attention?
- Questions of TF5 Quantum Sensors and Emerging technologies:
 - With a specific view towards both quantum technologies as well as the strategy group report, which communities would you consider essential to involve to ensure that their needs are appropriately incorporated into our detector R&D chapter?
 - Would you have specific names of individuals that we should particularly have discussions with?

➤ Questionnaires were carried out

➤ ECFA Detector R&D Roadmap Symposium Meetings for each Task Spring 2021 (<https://indico.cern.ch/event/957057/program>)

Detector R&D Roadmap

General recommendations



GSR4: International coordination and organisation of R&D activities

- Refresh and enhance the existing CERN RDxx programmes

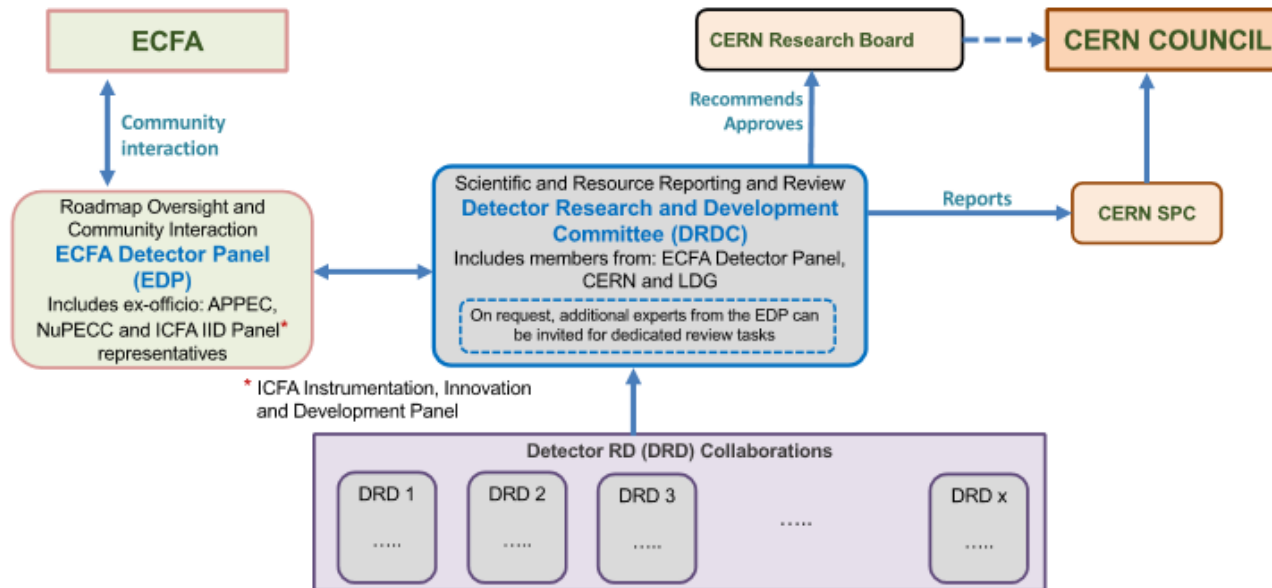
GSR 5: Distributed R&D activities with centralised facilities

- distributed yet connected system for R&D efforts across Europe

GSR 6 - Establish long-term strategic funding programmes

- additional to short-term funding programmes for the early proof of principle phase of R&D, also long-term strategic funding programmes

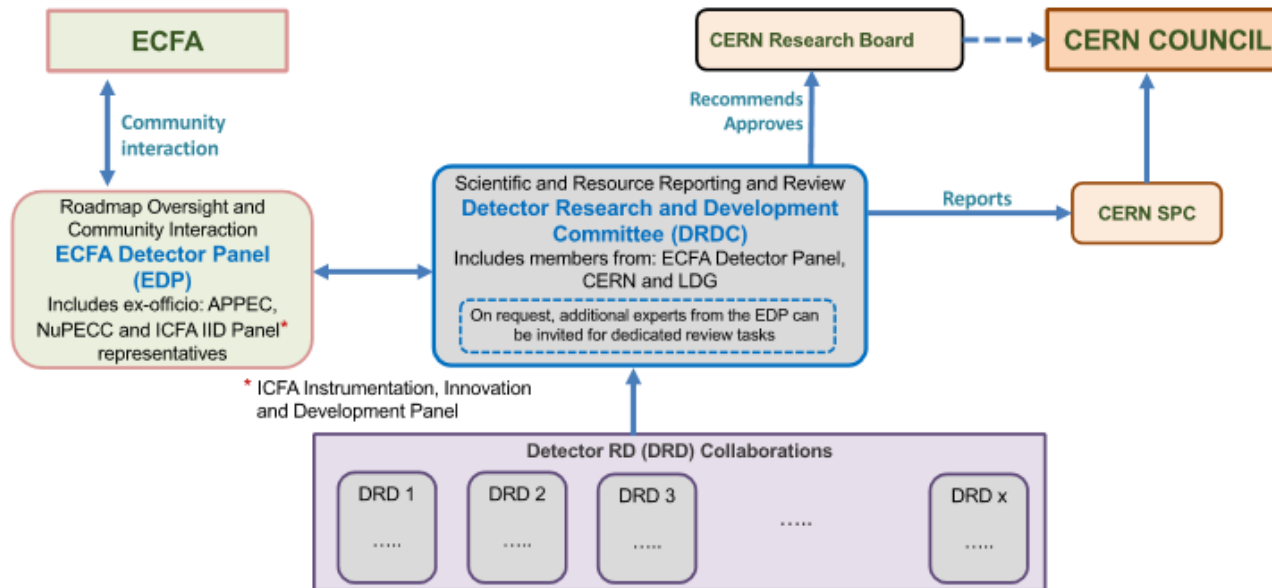
Detector R&D Roadmap Implementation



Building up on CERN RDxx success story (RD50, RD51, RD53, CALICE, ...)

- Very limited funding (2K/y/institute!)
- Very light management structures: self-organized to a large extent
- Collaborations have been fruitful and solved many challenges

Detector R&D Roadmap Implementation



RD50-> DRD3, RD51-> DRD1, RD53 -> DRD7, CALICE-> DRD6

DRD2, DRD4 no previous RD structures...

Detector R&D Roadmap Implementation

Implementation of the ECFA Detector R&D Roadmap

After the publication of the ECFA Detector R&D Roadmap, CERN Council requested ECFA to develop the plan for its implementation.

The document approved by the SPC and CERN Council in September 2022 can be found at https://indico.cern.ch/event/1197445/contributions/5034860/attachments/2517863/4329123/spc-e-1190-c-e-3679-Implementation_Detector_Roadmap.pdf.

As proposed in the document, topic specific community meetings will now be held in the course of the coming months. To sign up for these and to register your interest in participating on the corresponding R&D Collaborations being developed please see the links below.

- TF1 Gaseous Detectors <https://indico.cern.ch/event/1214405/> 1-3/3/2023
- TF2 Liquid Detectors <https://indico.cern.ch/event/1214404/>
- TF3 Solid State Detectors <https://indico.cern.ch/event/1214410/> 22-23/3/2023
- TF4 Photon Detectors and PID <https://indico.cern.ch/event/1214407/>
- TF5 Quantum and Emerging Technologies <https://indico.cern.ch/event/1214411/>
- TF6 Calorimetry <https://indico.cern.ch/event/1213733/> 12/1/2023 -> 20/4/2023
- TF7 Electronics and On-detector Processing <https://indico.cern.ch/event/1214423/> 12-15/3/2023
- TF8 Integration <https://indico.cern.ch/event/1214428/>
- TF9 Training <https://indico.cern.ch/event/1214429/>

Request to funding agencies to feedback on these plans

Why this meeting ?

- Gauge the involvement of spanish groups in Detector R&D efforts (answer to questionnaires done by groups, no clear national picture)
- Communication efficient within experiments but not across experiments: interesting synergies could be lost!

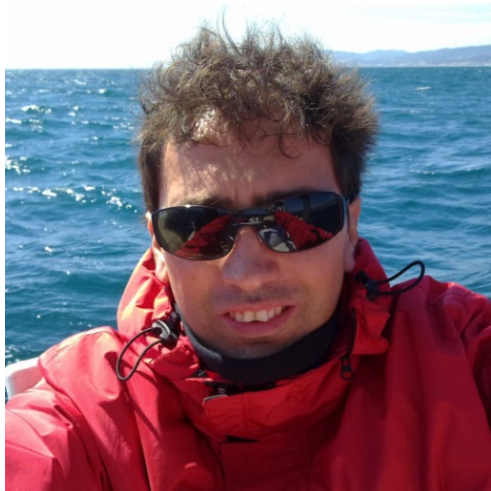
Settle a more efficient communication channel ?

- National funding for R&D within experiment-specific projects: difficult to estimate
- Innovative detector R&D is of high value and a more organized community could be more efficient in improving national funding for this area

Why this meeting ?

- Gather opinions regarding the utility of the proposed DRD schemes
 - Are the challenges defined in the roadmap of relevance to your activities ?
 - Is the structure in the form of DRD collaborations appropriate to achieve the goals ?
 - What do consider an appropriate funding scheme for detector R&D ? How has it been until here and how do you think it could be improved ?
 - How can we improve spanish contributions to this field ?
 - Training, engineer career path in academia, funding, infrastructure ...

Thank you to our host!



DRD1: Gaseous Detectors

(Meeting 1-3/3/2023)

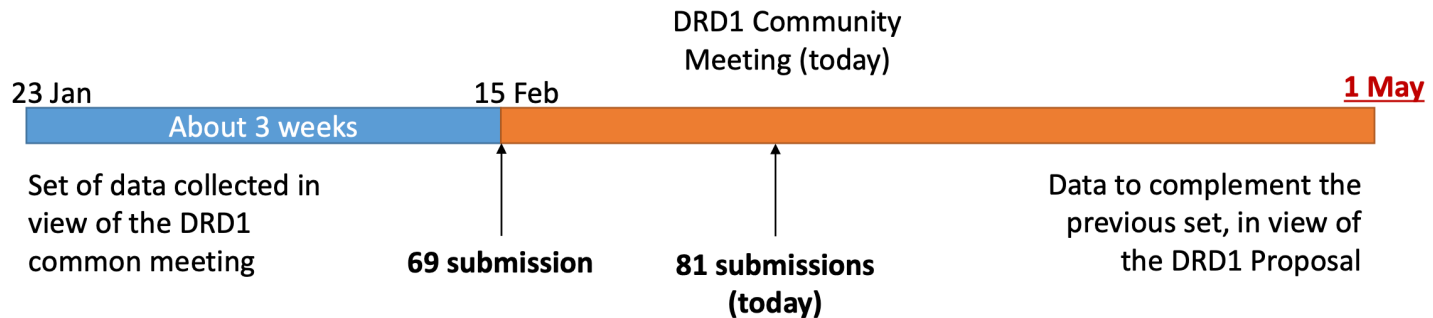
Survey schedule

- Opening date: 23 January
- Intermediate closing date: 15 February
- DRD1 Community Meeting: 1-3 March
- **Final closing date: 1 May 2023**

Institute contacts that did not submit yet but want to provide information in view of the proposal will have time till the 1st of May (though earlier you do better it is)

IF YOU WANT TO PROVIDE YOUR INPUTS, SUBMIT (*)

<https://indico.cern.ch/event/1235070/>



***) Representatives on institutes can submit.
Please contact us if you have no access**

Towards a DRD1 Structure: WGs and conveners

Keep RD51 structure in WGs including alignment with the scientific program of the ECFA roadmap, looking more generally to future facilities challenges and specifically to the Detector RD Themes (DRDT), but also to the GSRs

WG1: Technologies (P.Colas, F. Resnati, P. Wintz, I. Deppner, M. Tytgat, L. Moleri)

Includes experimental detector physics aspects

- MPGDs
- RPCs, MRPCs
- Large Volume Detectors (drift chambers, TPCs)
- Straw tubes, TGC, CSC, drift chambers, and other wire detectors
- New amplifying structures

WG2: Applications (F. Garcia, P. Gasik, F. Grancagnolo, D. Gonzalez Diaz, G. Aielli, G. Pugliese; A. Colaleo, M. Titov for the ECFA part)

Full alignment with the ECFA detector R&D roadmap Themes

- Muon systems
- Inner and central tracking with particle identification capability
- Calorimetry
- Photon detection
- Time of Flight systems
- TPCs for rare event searches
- Precision experiments
- Straw chambers in vacuum
- Fundamental research applications beyond HEP
- Medical and industrial applications

WG3: Gas and material studies (B. Mandelli, G. Morello, F. Renga, K. Dehmelt, S. Roth, D. Piccolo, A. Pastore, B. A. Gonzalez)

- Eco-gases searches
- Light emission in gases
- Ageing
- Radiation hardness
- Light (low material budget) materials
- Resistive electrodes
- Precise mechanics
- Photocathodes (novel, ageing, protection)
- New types of wires (coated carbon monofilaments)
- Solid converters
- Novel materials (nanomaterials)

WG4: Detector physics, simulations, and software tools (M. Abbrescia, M. Borysova, P. Fonte, O. Sahin, P. Verwilligen, R. Veenhof,)

- Detector Physics (modeling and simulations)
- Detector Performance Studies (modeling and simulations)
- Software development and maintenance
- Gas Properties Databases (e.g. cross-sections) - Use and/or Maintenance; Detector design

Towards a DRD1 Structure: WGs and conveners

Keep RD51 structure in WGs including alignment with the scientific program of the ECFA roadmap, looking more generally to future facilities challenges and specifically to the Detector RD Themes (DRDT), but also to the GSRs

WG5: Electronics for gaseous detectors (H. Muller, J. Kaminski, M. Gouzevitch, R. Cardarelli)

- Analog/Digital Electronics
- Discrete Readout Front End Electronics and ASICs
- Charge/Photon readout
- FE input protection & spark quenching
- Waveforms and Digitizer; Signal Processing
- Cluster Counting
- Specific needs: Timing, High rate, Low noise, Wide Dynamic Range, ...)
- Grounding and Shielding; Calibration
- SoC based sensor readout
- General purpose DAQ, FPGA based readout/trigger and Trigger-less systems
- HV Systems and HV distribution schemes
- LV Powering, Cooling
- Laboratory instrumentation (High resolution floating ammeters, Monitoring and control systems)

WG8: Training and dissemination (F. Brunbauer, M. Iodice, E. Baracchini, B. Liberti, A. Paoloni)

- Schools and trainings
- Topical workshops
- Knowledge transfer
- (Young) Researcher Career
- Strategies to recognize and sustain the careers of R&D experts

WG6: Detector production (R. De Oliveira, F. Jeanneau, A. Delbart, G. Iaselli, I. Laktineh, G. Charles)

- CERN EP-DT Micro Pattern Technology (MPT) Workshop
- Saclay MPGD workshop
- RPC/MRPC workshop
- Wire chambers workshop
- Novel detector production methods
- CERN EP Thin Film & Glass service (photocathodes, coatings, ceramic)
- Technology and knowledge transfer (to industry and within the collaboration)
- Relationship with Industry

WG7: Common test facilities (Y. Tsipolitis, E. Oliveri, R. Guida, G. Iaselli, A. Ferretti)

Includes development of common detector characterization standards:

- General purpose detector development labs
- Ageing Study Facility
- Gas studies facility
- Irradiation facility
- Test beam facility
- Chemistry and material laboratory
- Clean Room
- Instrumentation for common detector characterization (e.g. gas, DAQ, HV systems)

DRD6: Calorimetry

(Meeting 12/1/2023 -> 20/4/2023)

ECFA

very short wrap-up



Nice overview of ongoing calorimetry R&D -> very interesting and positive - not exhaustive (it could not be)

Many thanks for the lively discussion!

Not going over any details

Lots of open challenges over different time scales -> they depend on physics case and machine

Many common issues (not exhaustive):

- high granularity
- timing -> from O(100) ps downto O(10) ps
- sensors and readout elx
- connectors, mechanical integration, ...
- infrastructures/facilities (beam test lines, ...)

Many different specific issues

Many synergies with (or dependence on) other Tfs -> need transversal collaboration(s)
calorimeters are at the top and bottom of the chain

DRD6: Calorimetry

(Meeting 12/1/2023 -> 20/4/2023)

Track 1: Sandwich calorimeters with fully embedded Electronics – Main and forward calorimeters

Track conveners: Adrian Irlles (IFIC, adrian.irlles@ific.uv.es), Frank Simon (KIT, frank.simon@kit.edu)

Track 2: Liquified Noble Gas Calorimeters

Track Conveners: Martin Aleksa (CERN, martin.aleksa@cern.ch), Nicolas Morange (IJCLab, nicolas.morange@ijclab.in2p3.fr)

Track 3: Optical calorimeters: Scintillating based sampling and homogenous calorimeters

Track Conveners: Etiennette Auffray (CERN, etiennette.auffray@cern.ch), Gabriella Gaudio (INFN-Pavia, gabriella.gaudio@pv.infn.it), Macro Lucchini (University and INFN Milano-Bicocca, marco.toliman.lucchini@cern.ch), Philipp Roloff (CERN, philipp.roloff@cern.ch)

Track 4: Alternatives or transversal proposals. This track has no conveners at the moment and will be used to cover topics not covered elsewhere. The entire proposal team will jointly look at this track.

DRD6: Calorimetry

(Meeting 12/1/2023 -> 20/4/2023)

If you have not been contacted during the preparation phase of the 1st Community Meeting and would like to join one of the first three tracks with a proposal, please get in touch, possibly by March 1st, 2023, with the corresponding track conveners. In case you would like to make a proposal that does not fit in any of the first three tracks introduced above, please contact Roberto (roberto.ferrari@pv.infn.it) and Roman (roman.poeschl@ijclab.in2p3.fr), possibly by March 1st, as well.

The deadline for the submission of the input proposals is set to March 24th, 2023.