EP-DT Group Meeting

DRD 1: Gaseous Detectros and EP-DT involvement

Djunes Janssens and Lucian Scharenberg

On behalf of the CERN EP-DT-DD GDD team

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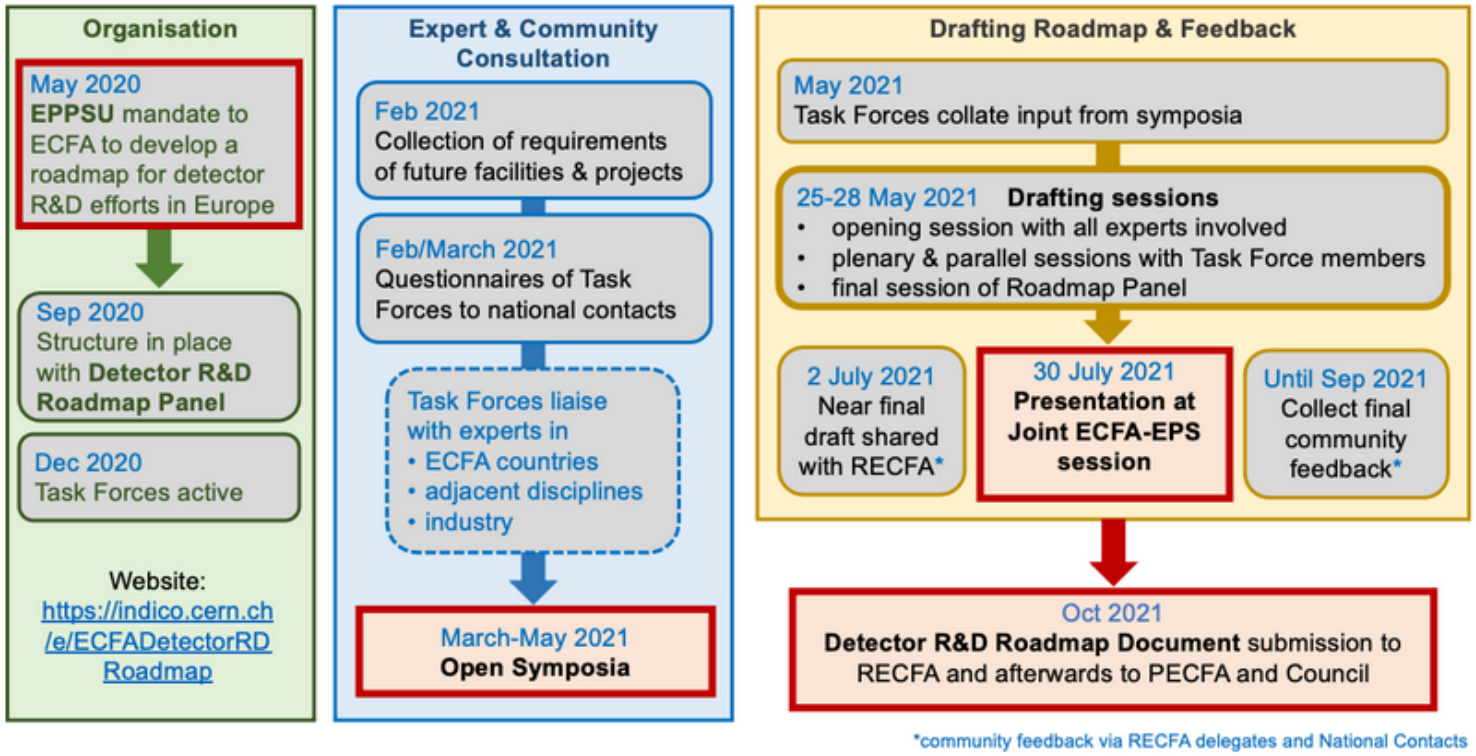
June 26th, 2024

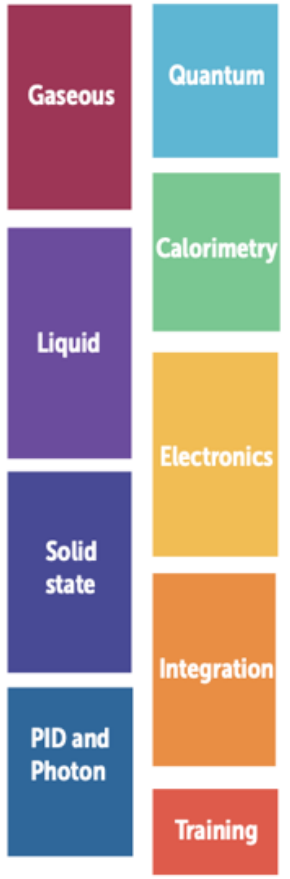
Timeline of the Roadmap process

The ESPPU calls upon **ECFA** to develop a global detector R&D roadmap that should be used to support proposals at the European and national levels.

ECFA Detector R&D Roadmap Process



Formation of task forces



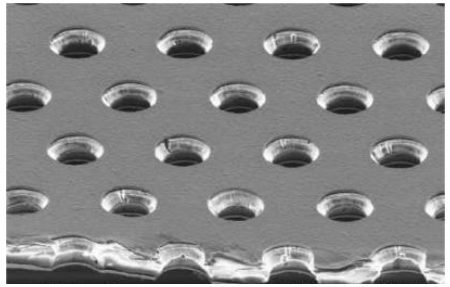
Timeline of the Roadmap process: https://indi.to/VfW7c
ECFA Detector R&D Roadmap Document: 10.17181/CERN.XDPL.W2EX

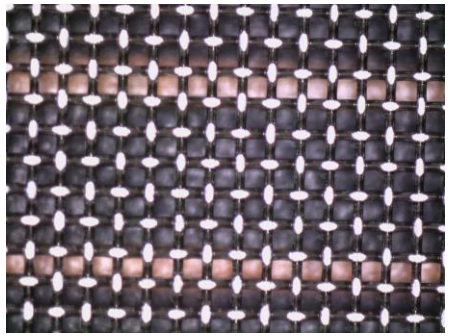
Formation of the DRD1 Collaboration

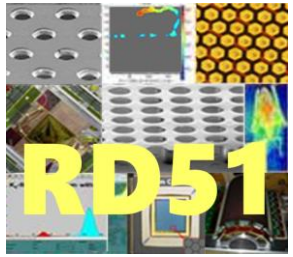
The DRD1 Collaboration aims at promoting the development, diffusion and applications of gaseous detectors, and is organized according to the General Strategic Recommendations outlined in the ECFA Detector R&D Roadmap Document.

Micro-Pattern Gaseous Detectors

(MPGD)







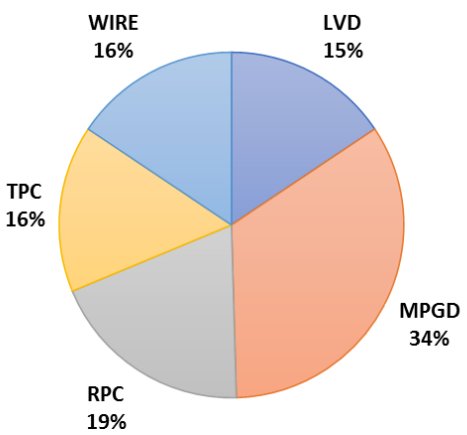
RD51 collaboration

Development of Micro-Pattern Gas Detectors Technologies

Formation of the DRD1 Collaboration

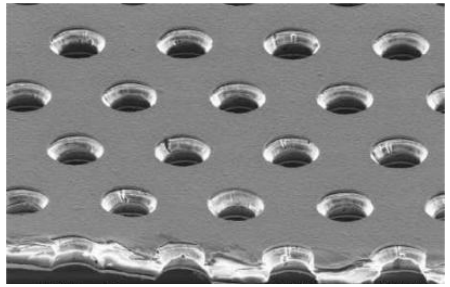
The DRD1 Collaboration aims at promoting the development, diffusion and applications of gaseous detectors, and is organized according to the General Strategic Recommendations outlined in the ECFA Detector R&D Roadmap Document.

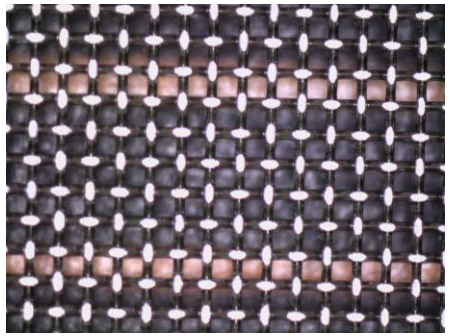
DRD1



Micro-Pattern Gaseous Detectors

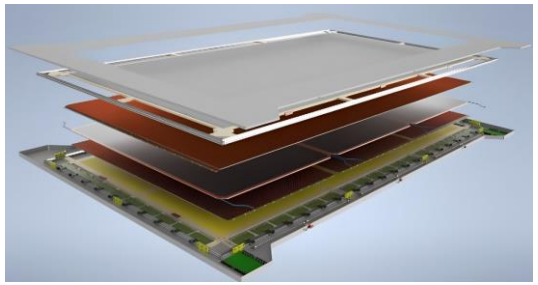
(MPGD)

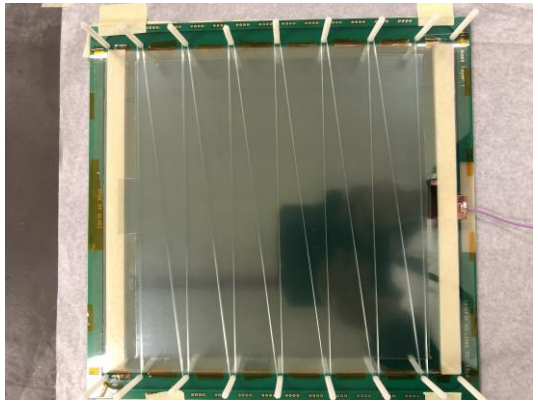




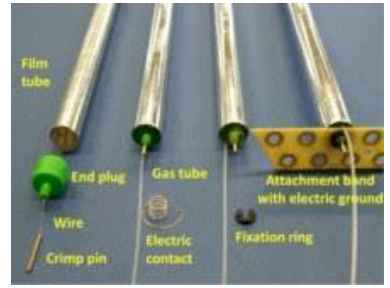
Resistive plate chamber

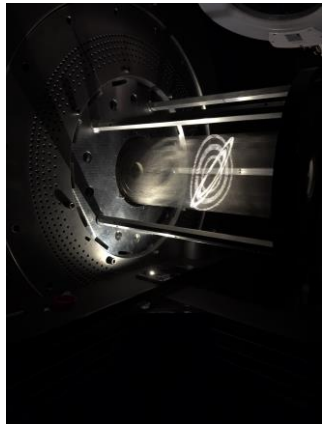
(RPC)





Wire-based detectors

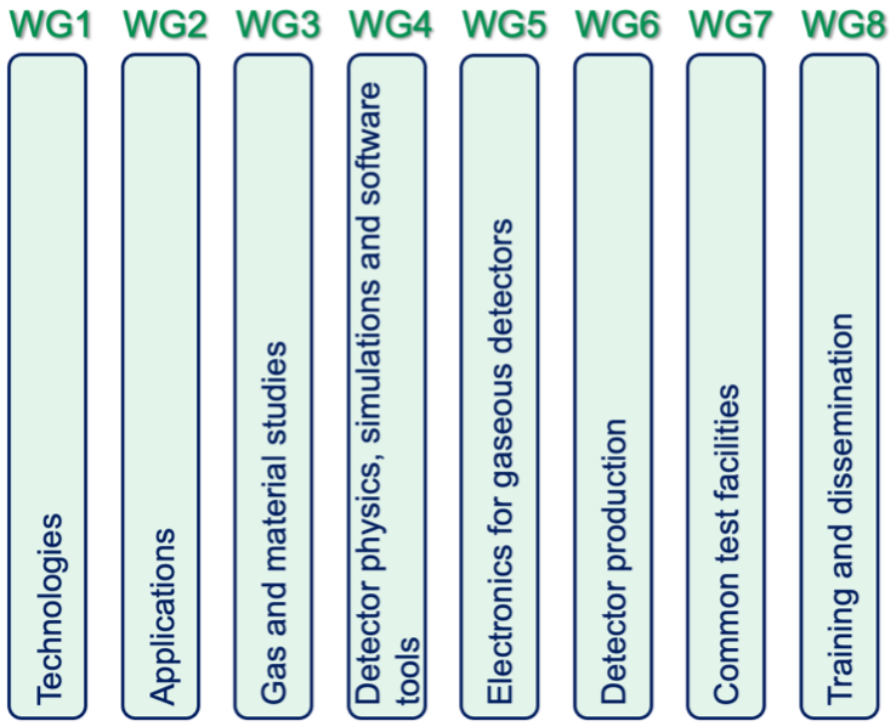


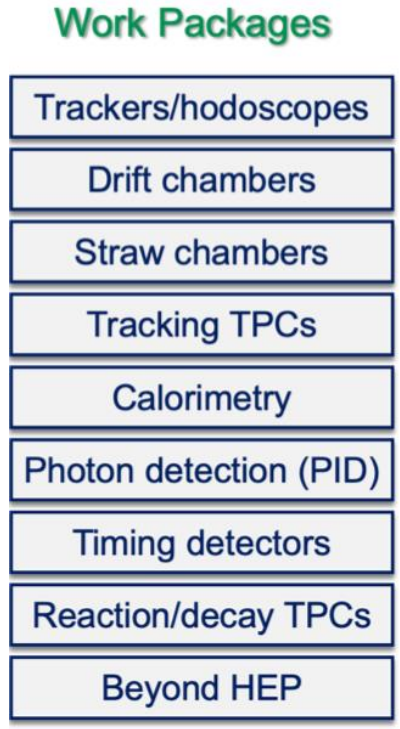


More than 160 institutes in the new collaboration!

Scientific organization

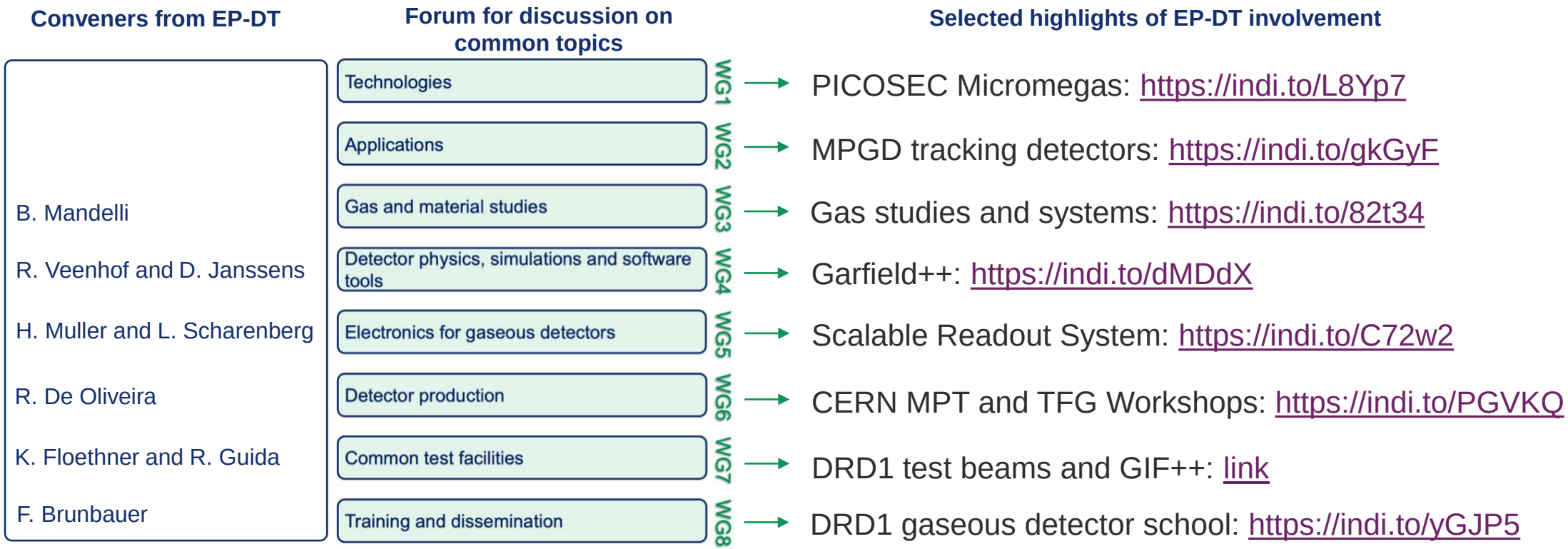
The Collaboration is organized into Working Groups (WGs) that guide strategic R&D efforts and encourage joint projects, including short-term Common Projects (CP) and long-term strategic Work Packages (WP).





Working groups (R&D framework)

The Working Group strongly contribute to the future strategic direction for gaseous detector R&D.



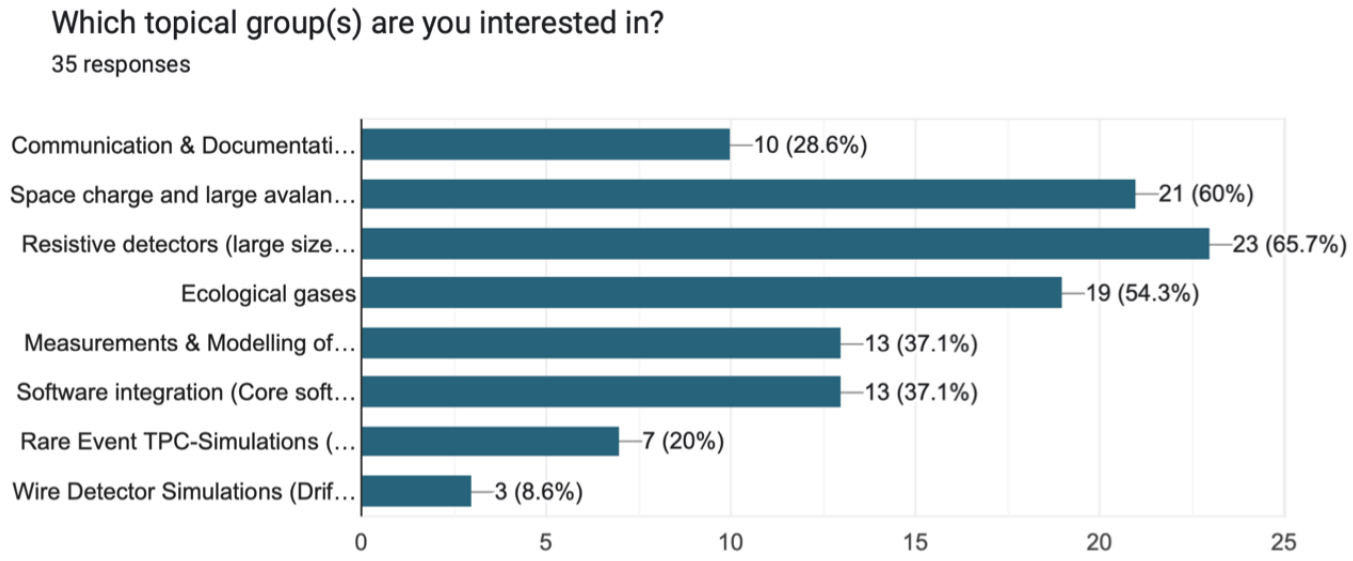
DRD1 extended R&D proposal: link.

WG4: Detector physics, simulations, and software tools
Overview

Working Group 4 (WG4) aims to understand and model the fundamental processes in gaseous detectors, and to develop simulation and software tools that accurately reproduce these processes and predict detector performance.

Topical groups with EP-DT involvement:

- Communication & documentation
- Space charge & large avalanches
  - Topical meeting: https://indi.to/9TWnL
- Resistive detectors
  - Topical meeting: https://indi.to/ZKDQg
- Ecological & new gasses
- Measurements and modeling of non-equilibrium and low-pressure effects
  - RD51 presentation: https://indi.to/6t6tn
- Software integration & development



WG4 survey results: https://indi.to/YGwr5

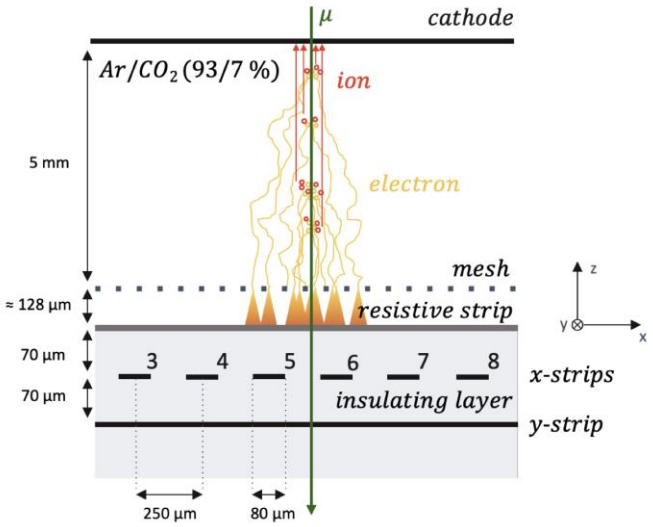
Garfield: https://garfield.web.cern.ch/garfield/
Garfield++: https://garfieldpp.web.cern.ch/garfieldpp/

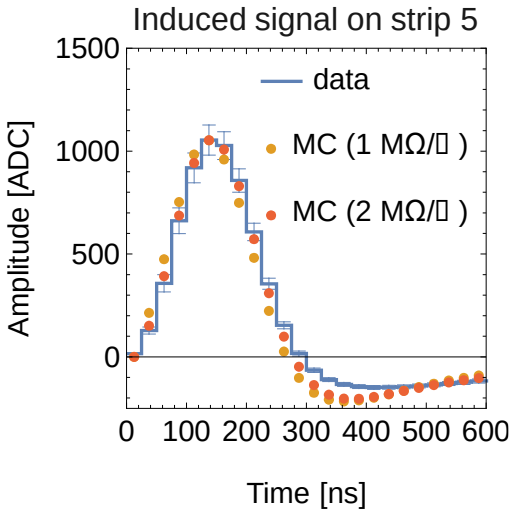
WG4: Detector physics, simulations, and software tools
Resistive detector modeling

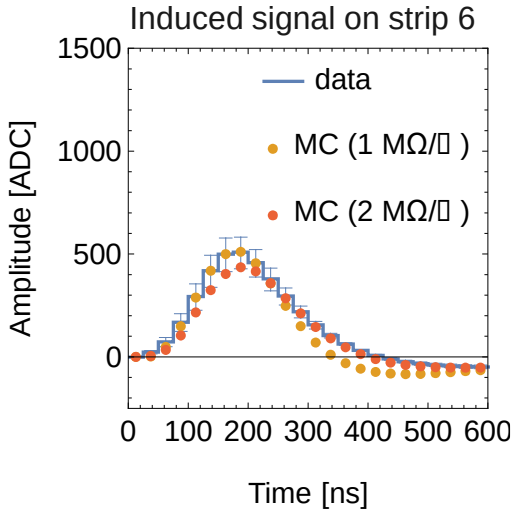
Using time-dependent weighting potentials, the signal induction can be obtained through Garfield++ for simulating resistive detector technologies. These simulations can be used to comprehend the detector's response and optimize it along with the front-end.

With some minor modifications, this approach can also be applied to solid-state detectors (DRD3).

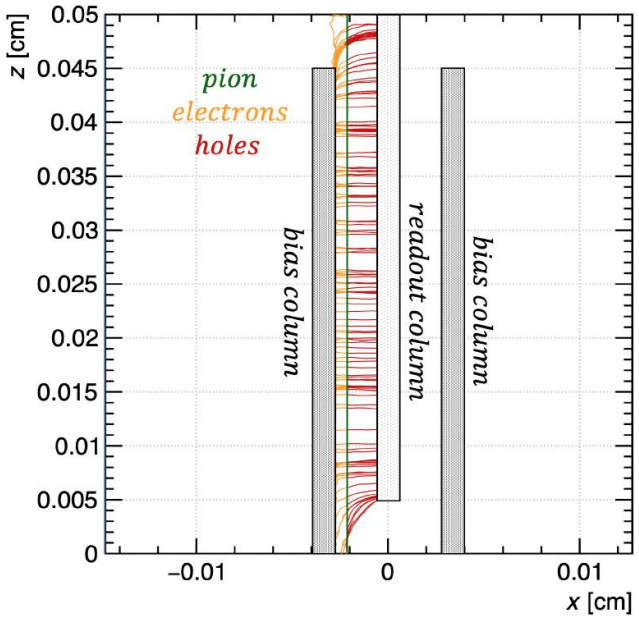
Resistive strip Micromegas







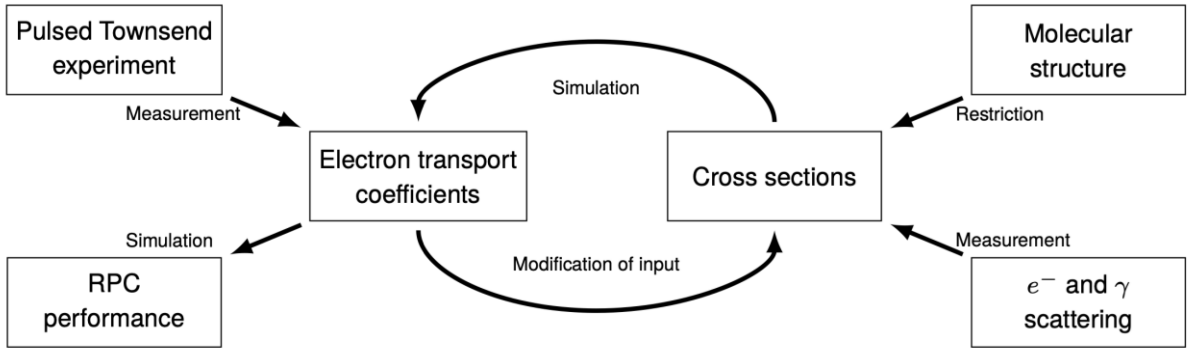
3D diamond sensor



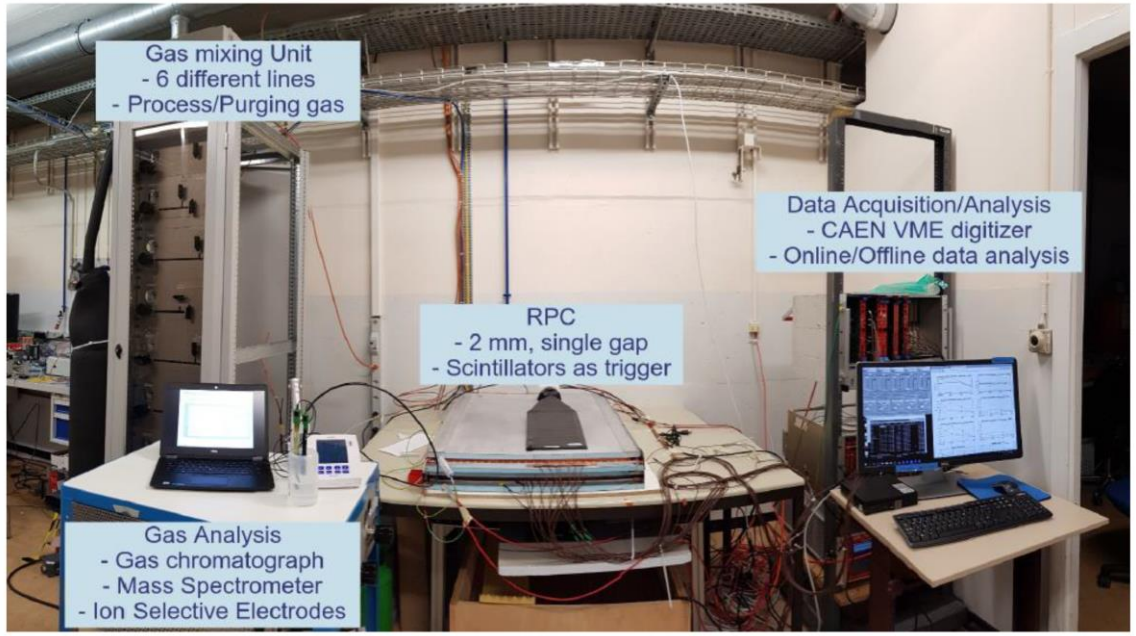
D. Janssens' presentation at the 1st DRD1 collab. meeting: https://indi.to/tbMvH
D. Janssens' presentation at the 1st DRD3 collab. meeting: https://indi.to/qrpg7
D. Janssens' PhD thesis (2024): https://cds.cern.ch/record/2890572

WG4: Detector physics, simulations, and software tools
Resistive detector modeling

In the context of finding suitable eco-friendly gasses, simulation efforts for Resistive Plate Chambers (RPCs) are used to systematically assess of the electron-molecule collision cross sections for key.



RPC Experimental Setup



This project involves Stephen Biagi, Christian Franck, Roberto Guida, Dario Stocco , Beatrice Mandelli, Marnik M. van Rijn, Rob Veenhof, Piet Verwilligen.

M. van Rijn's presentation at the 2nd DRD1 collab. meeting https://indi.to/wvFFP
G. Rigoletti, Doctoral Thesis, 2022

Work packages (research activities)

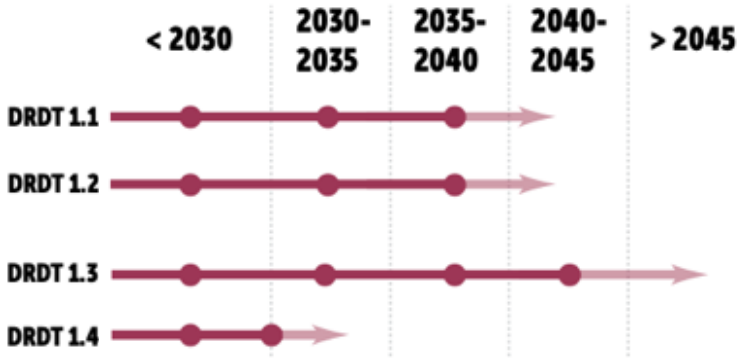
Each strategic R&D initiative becomes a Working Package that shares research interests with a focus on specific tasks […]. The Working Group connects these tasks to milestones and institutes.

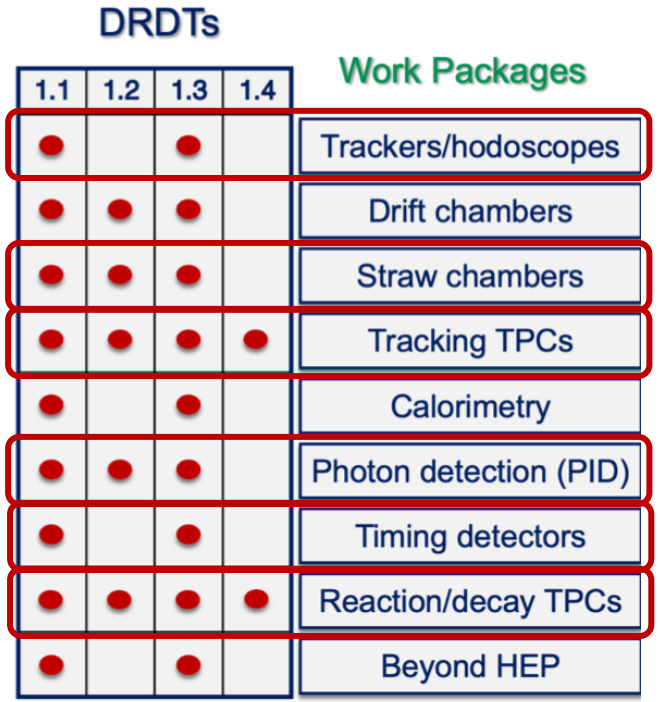
DRDT 1.1 Improve time and spatial resolution for gaseous detectors with long-term stability

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





DRD1 extended R&D proposal: link.

DT members and facilities involved in 6 out of 9 work packages

WP1: Genuine trackers/hodoscopes
Large area muon systems, inner tracking/vertexing

Various subtasks with strong involvement from GDD and Gas Group teams, the irradiation facilities (in particular GIF++), as well as the MPT and TFG workshops

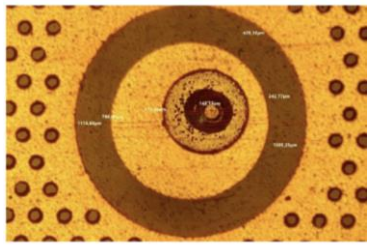
- **T2: new resistive MPGD structures**
- **T3: new front-end electronics**
- **T4: optimisation of scalable multichannel readout systems**
- **T5: eco-friendly gases**
- **T7: longevity on large detector areas**

Too many tasks and deliverables within the tasks to show everything in the given time frame → **focus on T2 and T5**

WP1: Genuine trackers/hodoscopes
T2: new resistive MPGD structures

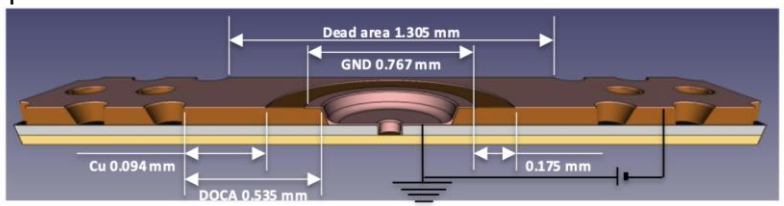
Task 2 focusses on the development of large area resistive MPGD capable of efficient and stable operation under conditions of high rates as well as low/medium rates

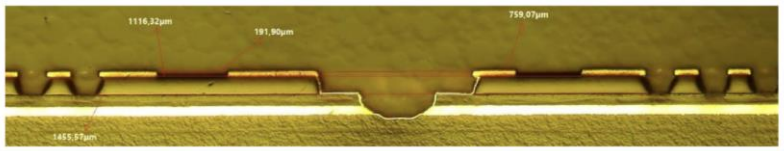
MPT workshop is key for the development of novel solutions.
The new sputtering machine is crucial to keep the R&D lines running!



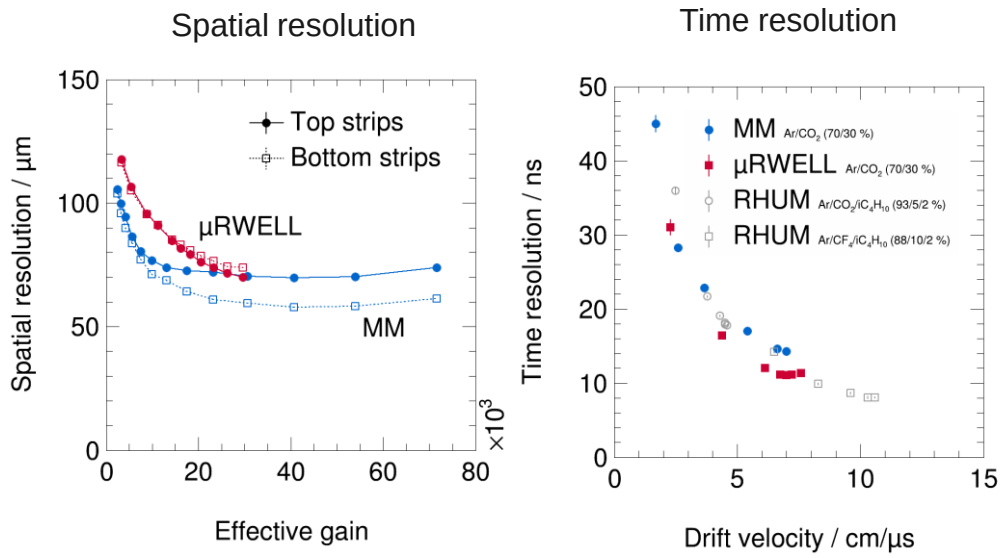
DOT → plated blind vias

µRWELL





GDD team performs R&D studies for a wide range of resistive MPGD technologies.



DLC machine: https://indi.to/Tr7YQ
µRWell for LHCb upgrade: https://indi.to/h2854

WP1: Genuine trackers/hodoscopes
T5: eco-friendly gases

HPL-RPC gas mixture LHC ⇒ ~95% R-134a, 5% iso, 0.3% SF6

2022 - Studies on replacing 95% R-134a with 64% R-134a + 30% CO2

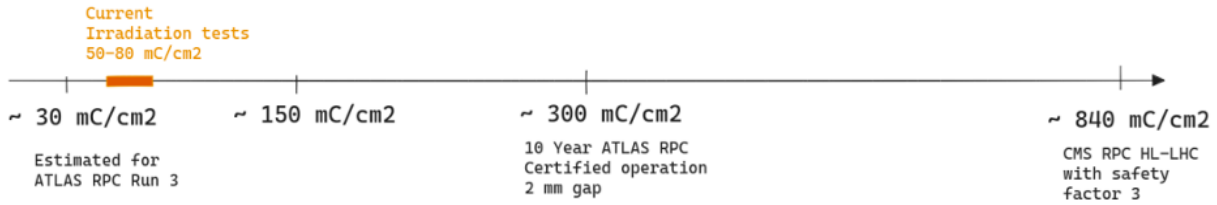
- **SF6 increased** to 1% added to suppress streamers
- R-134a reduction of **30%**
- GHG reduction of ~15%

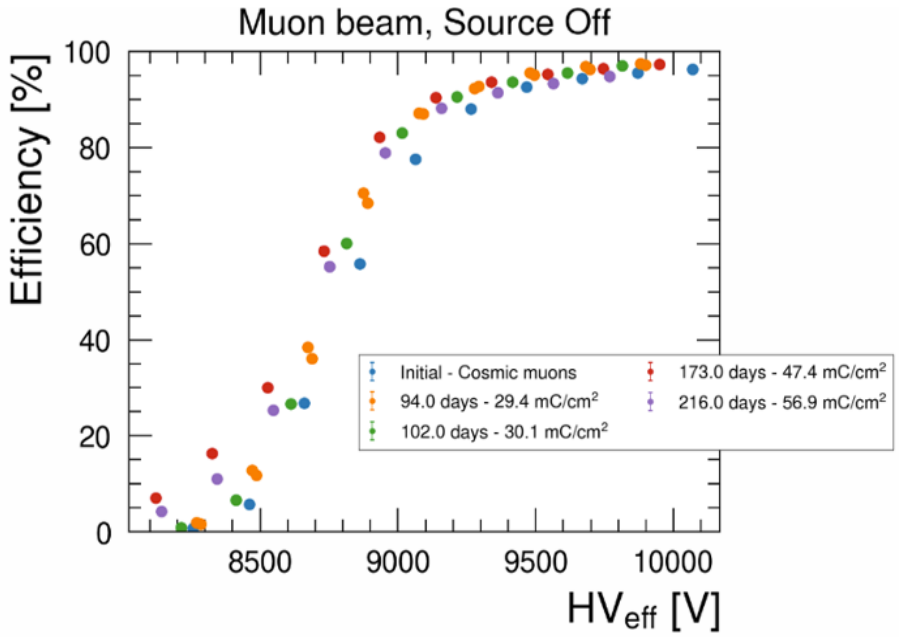
Nucl.Instrum.Meth.A 1049

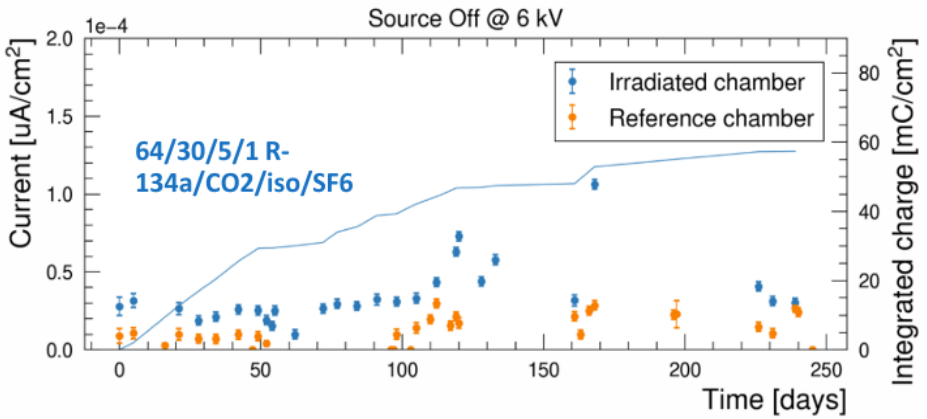
Gas mixture is now used in ATLAS RPC!

2023- Muon beam tests and long term tests at GIF++

- ~60 mC/cm2 integrated ⇒ validated for **ATLAS Run 3**
- Detector performance **not significantly affected**
- Further tests needed:
  - Integrate expected HL-LHC charge
  - Longer tests with lower SF6 or higher CO2



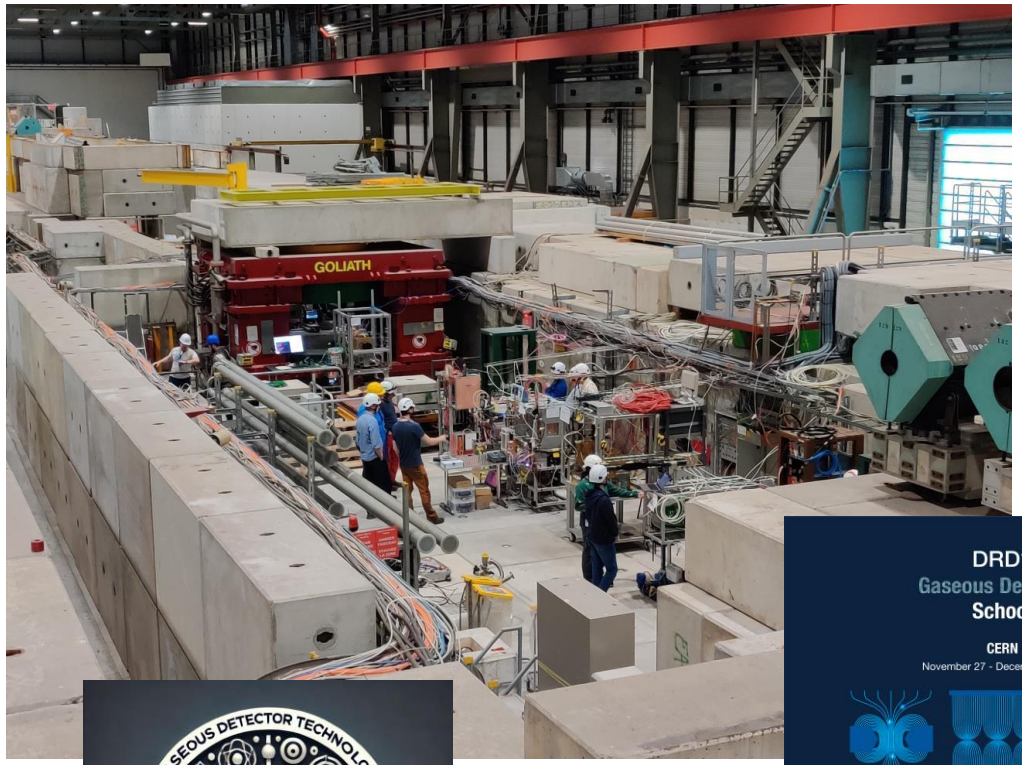


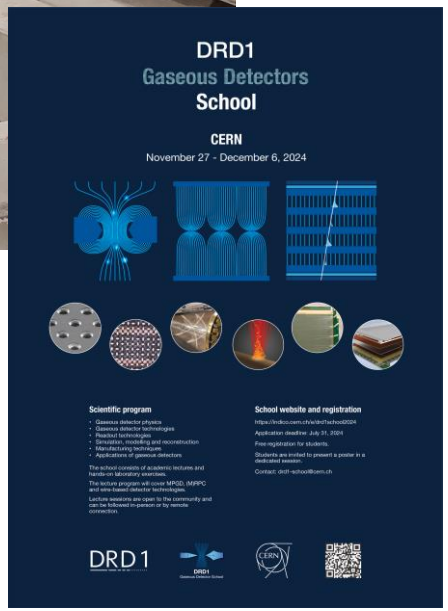


Summary (1/3): full throttle collaboration

Collaboration approved in December 2023 (**6 months ago**). Since then:

- 1st DRD1 collaboration meeting (29/01 to 02/02/2024)
- 1st DRD1 test beam (10/04 to 24/04/2024)
- 2nd DRD1 collaboration meeting (17/06 to 21/06/2024)
- Topical workshop on electronics for gaseous detectors
- Approval of all the collaborations management (central management, working group conveners, work package leaders) by the collaboration board
- Introduction of DRD1 awards and DRD1 logo
- 2nd DRD1 test beam **(ongoing right now)**
- Organisation of RPC and MPGD conferences in 2024
- Establishement of DRD1 gaseous detector school





Summary (2/3): checklist

We are working our way through the checklist:

- ✓ Co-Spokesperson and Collaboration Board Chair Elected (Dec. 2023)
- ✓ Full Management and Scientific Coordination endorsed by CB (June 2024)
- JUN 26 Draft of the MoU is available and being assessed
- The MoU needs to be signed by the member institutes

Management from EP-DT

Florian Brunbauer (TC), Beatrice Mandelli (WGs Coordinator), Eraldo Oliveri (co-SP), Leszek Ropelewki (deputy CB Chair), Hans Taureg (Deputy Resource Coordinator)

Working Group Conveners from EP-DT

Beatrice Mandelli (WG3), Djunes Janssens (WG4), Rob Veenhof (WG4), Hans Muller (WG5), Lucian Scharenberg (WG5), Rui De Oliveira (WG6), Karl Jonathan Floethner (WG7), Roberto Guida (WG7), Florian Brunbauer (WG8)

Work Package Leaders from EP-DT

Florian Brunbauer (WP7)

Summary (3/3): overview

The DRD1 Collaboration aims to promote the further development and applications of all gaseous detectors, following the recommendations of the ECFA Detector R&D Roadmap.

The collaboration spans all gaseous detector technologies:

(i) Resistive Plate Chambers (RPCs)

(ii) Micro-Pattern Gaseous Detectors (MPGDs)

(iii) Wire-based detectors such as Drift Chambers or Straw Tubes

→ This results in a collaboration that is twice the size of the former RD51 collaboration!

The scientific organization has two pillars:

(i) Work Packages (WPs), which organize the activities of the community to achieve long-term goals, supporting the outlined DRDTs.

(ii) Working Groups (WGs), forming the core collaborative effort.

Thank you for your attention!

Thank you, Veronique, for being our anchor!