

# WG4 Status & Activities

## *Detector Physics Modeling and Simulation*

*2nd DRD1 Collaboration Meeting*

*20-06-2024*

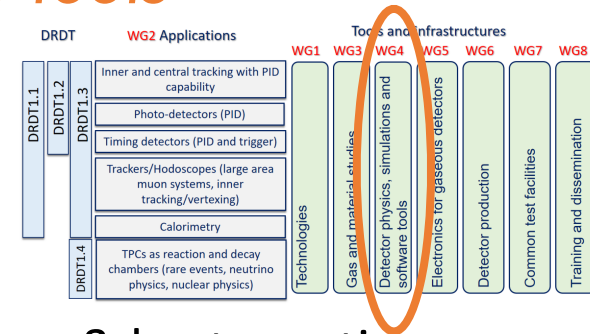
*WG4 Conveners:*

*Marcello Abbrescia, Maryna Borysova, Paulo Fonte, Supatik Mukhopadhyay, Ozkan Sahin, Rob Veenhof, Piet Verwilligen*

# Short Intro to WG4

## Detector Physics, Simulation & Software Tools

- **WG4 is a transversal working group:**
  - Groups of people working on simulations in various Work-Packages
  - We started creating the space to exchange progress & best practices
  - Work together to obtain solutions to common problems
- **WG4 Aims at:**
  - Understanding & Modeling Physical Processes in Gaseous Detectors (GD)
  - Development of Suitable Simulation & Software Tools
- **Importance within DRD1 & beyond:**
  - Advanced simulations are the cornerstone of R&D efforts for GD R&D
  - allows us to validate and refine our current understanding of detector physics
  - *Note: SW Tools developed within GD community are now transferred across various detection technologies, including Liquid and Solid State detectors*



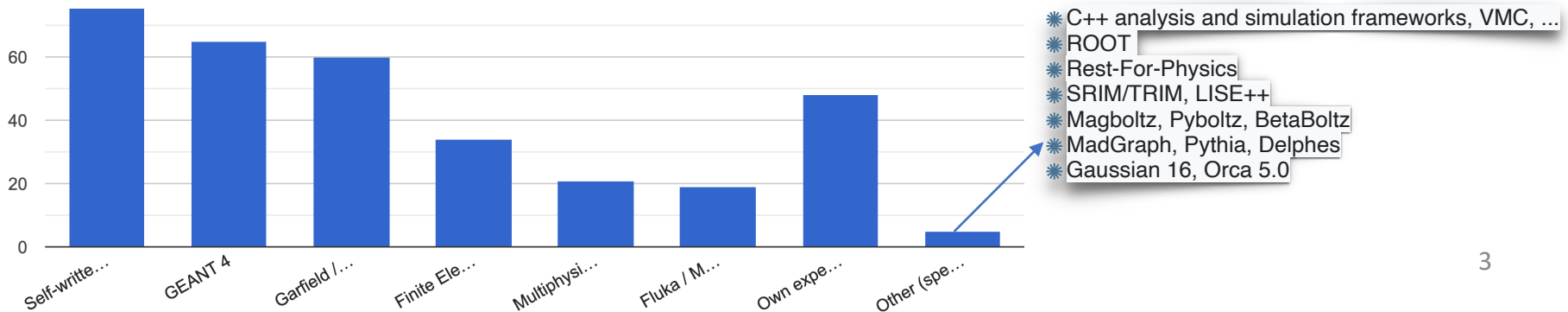
# WG4 Survey highlights

- E-group [drd1-wg4@cern.ch](mailto:drd1-wg4@cern.ch) : Group Memberships: 189
- Survey launched during 1st DRD1 Collaboration Meeting
- **Aim:**
  - Get to know who already works on software & simulations
  - Get suggestions for future software developments
  - Understand priorities from the community

Thank you for  
your active  
participation!

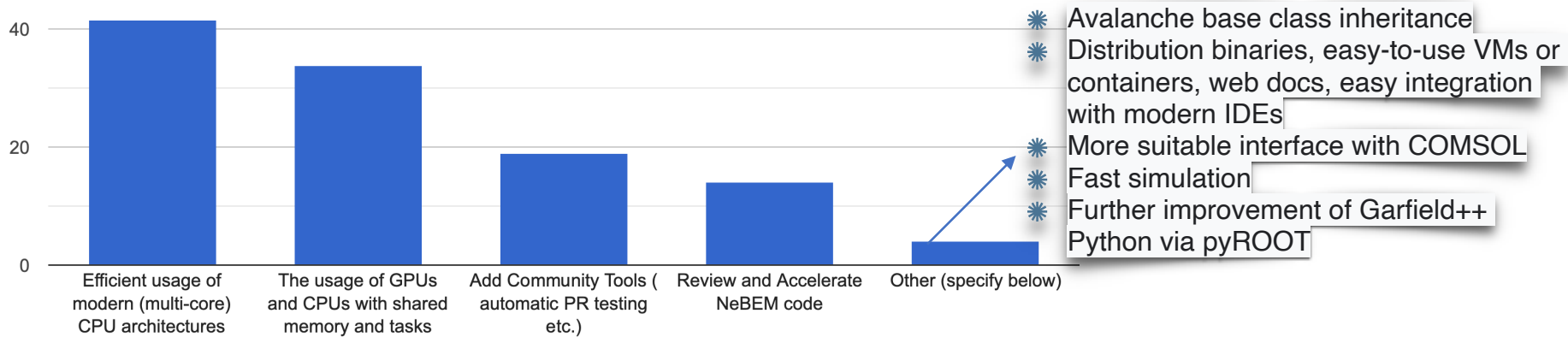
## Some stats:

- 89 responses, some of them on behalf of the groups
- 28 countries: 14 IT, 9 US, 9 GE, 8 ES, 6 FR&RO, 5 IN & BR, ..
- **74% have substantial experience in simulations**
- **We have a bunch of tools at hands:**

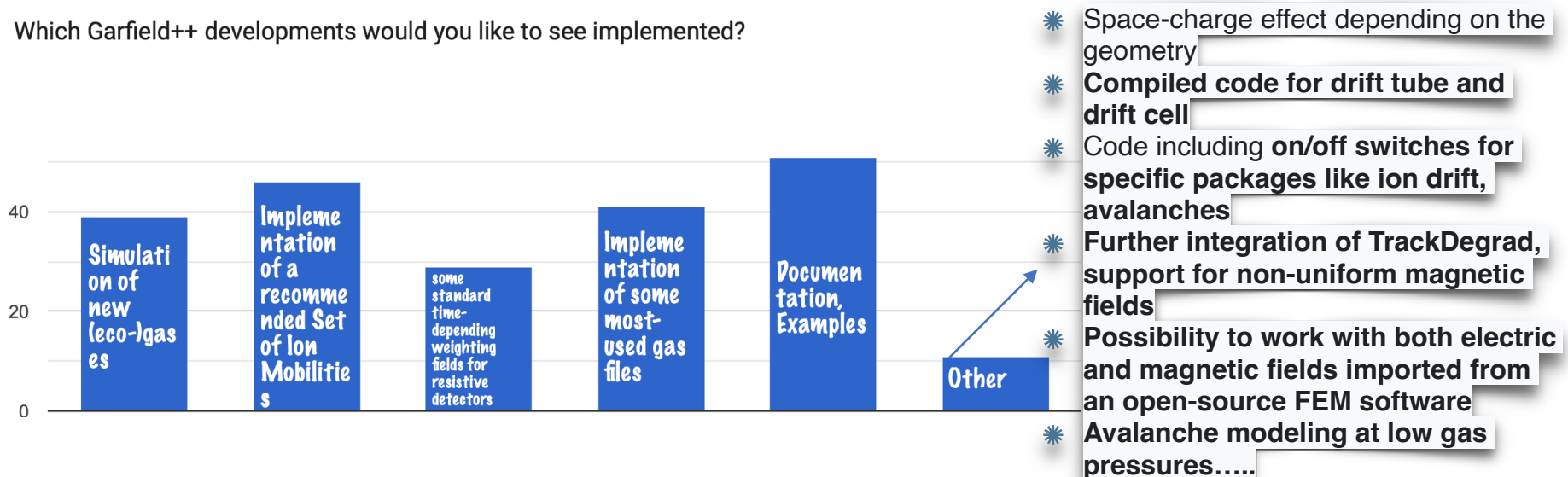


# WG4 Survey: Garfield++ Code Modernization

Which Garfield++ code modernization developments are the most relevant to you? (N.B. This means reviewing/rewriting the existing code and improve the resource usage - no new developments)

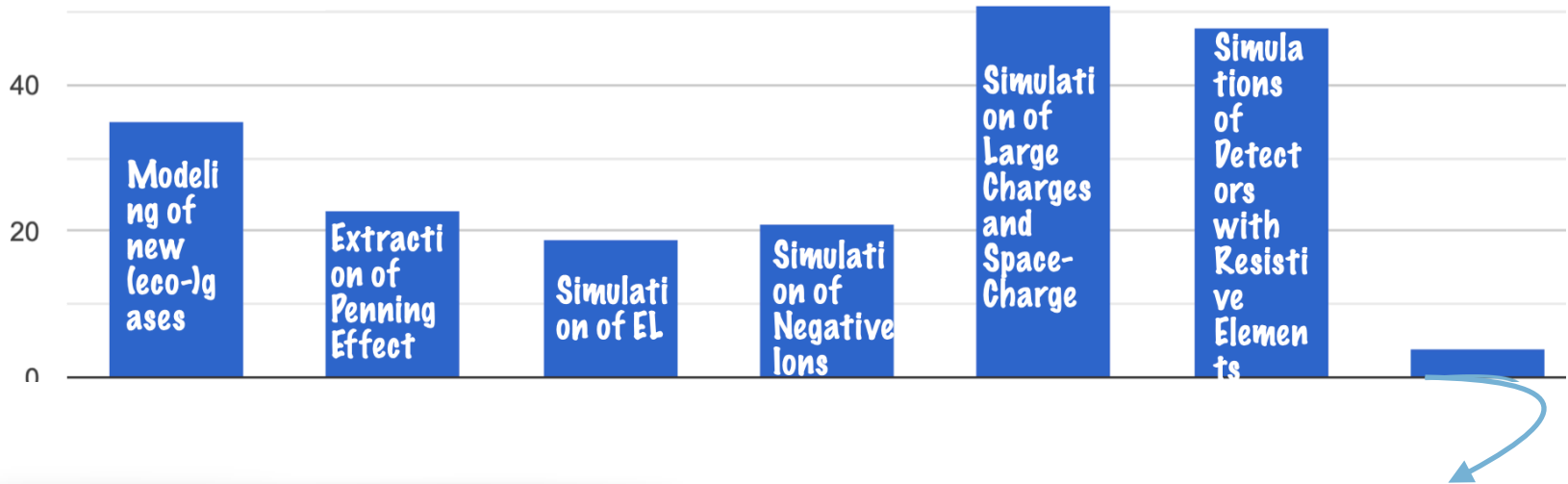


Which Garfield++ developments would you like to see implemented?



# WG4 Survey: Garfield++ Common Objectives

Which common objectives are the most relevant to you?

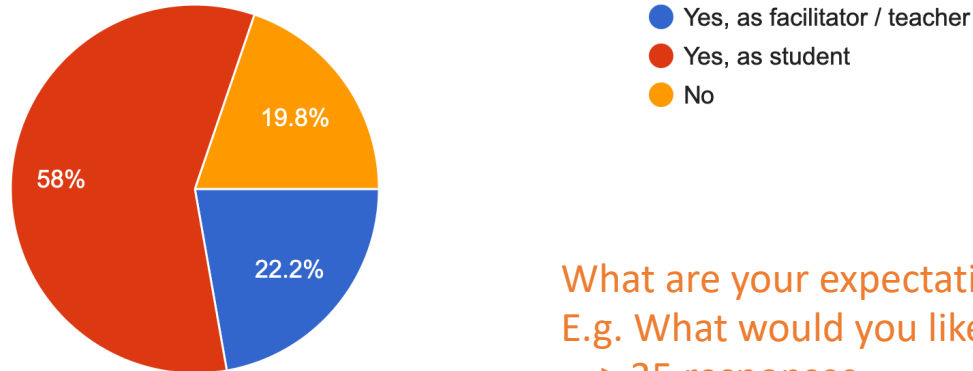


- \* Simulation/modelling of time response
- \* Simulation of signal induction
- \* Developments to the semiconductor part of Garfield++
- \* GEM and solid state detectors
- \* Simulation at low gas pressures
- \* implementation of more realistic micromeshes
- \* better interfacing between different programs (eg. Ansys -> Geant4 -> Garfield++)
- \* drift chamber and TPC readout development
- \* Ion interaction at low energy (<100 keV)
- \* feasibility studies for combining Garfield++ and chemical simulation approaches for the prediction of properties of new gases

# WG4 Survey: Simulation School

Would you like to participate in the simulation school if we will organize this in the future?

81 responses



What are your expectations for the simulation school ?  
E.g. What would you like to learn? Other expectations?  
—> 35 responses

- \* Basics of popular simulation tools and how to choose the right tool, **From Basics to advanced simulations.**
- \* To **have a better understanding of gaseous detectors** and gaseous detector simulations
- \* Most recent developments in gaseous detector simulations, an **overview of current challenges** in simulation developments
- \* The opportunity **to participate remotely**
- \* **Quantum chemistry** calculations
- \* To **learn how to use different geometries and doping substrates to simulate semiconductors.**
- \* To **learn GPU computing to accelerate the avalanche process**
- \* To see some **edge-case modeling**

• This will integrate into WG8 efforts

- Would like to form group to organize simulation school in 2025

# WG4 Survey: How can DRD1 WG4 give you the best support to help you start your simulation?

## 25 responses asking for better documentation

- \* Beginner tutorials and examples
- \* Better documentation
- \* A masterclass for beginners?
- \* Make Garfield REALLY easy to install and use
- \* Short course/workshop on the simulation of resistive element detectors
- \* Documentation
- \* The **online material and code that was prepared for MPGD detector school is a good starting point**
- \* Give a common starting point with properly defined environments and libraries. Also, some basic examples can be shared with students.
- \* Code sharing on Swan or even more examples or tutorial
- \* Already get the help
- \* Simulation with Resistive Elements
- \* A primer manual
- \* setup/make better accessible a 'garfield++.cern.ch' webspace for documentation, manuals, examples of 'standard' detectors/detector components (eg. Micromegas, GEMs, etc.), source code and class browser, community web page for garfield++, homogenize the many different garfield++ versions for improved backward compatibility (newly included vs. dropped but still used functions)
- \* Short courses or tutorials in common tools.
- \* Tutorials, bank of examples (documentations, codes, videos, etc.)
- \* Help start with Garfield++ which I have never used
- \* The knowledge sharing is crucial
- \* Lectures and hands-on in CERN
- \* To offer the best support for beginners, better documentation and provide examples
- \* I have students who could not start with Garfield++
- \* By providing a set of standard examples
- \* I think that beginners have a hard time starting simulations with the minimum needed documentation, the process less susceptible to errors
- \* Example, guides
- \* An online course at the beginner level can be organized.



Getting started

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

- [Installation](#)
- [Examples](#)
- [Documentation \(User Guide, Doxygen, FAQ\)](#)

Support

- If you have any questions, please send a mail to [garfield-support@cern.ch](mailto:garfield-support@cern.ch) (or contact [Heinrich Schindler](#) or [Rob Veenhof](#) directly).
- To receive (infrequent) announcements about updates of the code, please subscribe to the mailing list [garfield-users@cern.ch](mailto:garfield-users@cern.ch) on [E-Groups](#).
- Issues can be reported on [GitLab](#).

# Status & Activities (I)

Since 1st CM, we have held 4 WG4 Working Group meetings (2 of them - topical)

- “working” and “brainstorming” meetings
  - Regularly ~ once per month
  - Every 2nd Tuesday of the month, 15:00 – 17:00 (CERN time zone)
- Opportunity to meet and know other people’s work & make contacts for possible future collaborations
- The First Meeting - on February 13<sup>th</sup> - 30 participants
  - <https://indico.cern.ch/event/1376801/>
  - Introduction to the work we’d like to take on in WG4 in the next years
  - Round table of all participants
    - 8 presentations with slides
    - 4 oral presentations
    - 1 by email
  - The Second Meeting - on March 13<sup>th</sup> - 19 participants
  - <https://indico.cern.ch/event/1392024/>
  - First look at the results of the survey
  - Proposal for organization of WG4: 8 topical groups
  - *Not a lot of interaction – > decided to organize topical meetings with smaller groups of people with more similar research interest*
    - *Don’t lose time with technical discussions for people with different interest*
    - *The lower threshold to be an active participant*

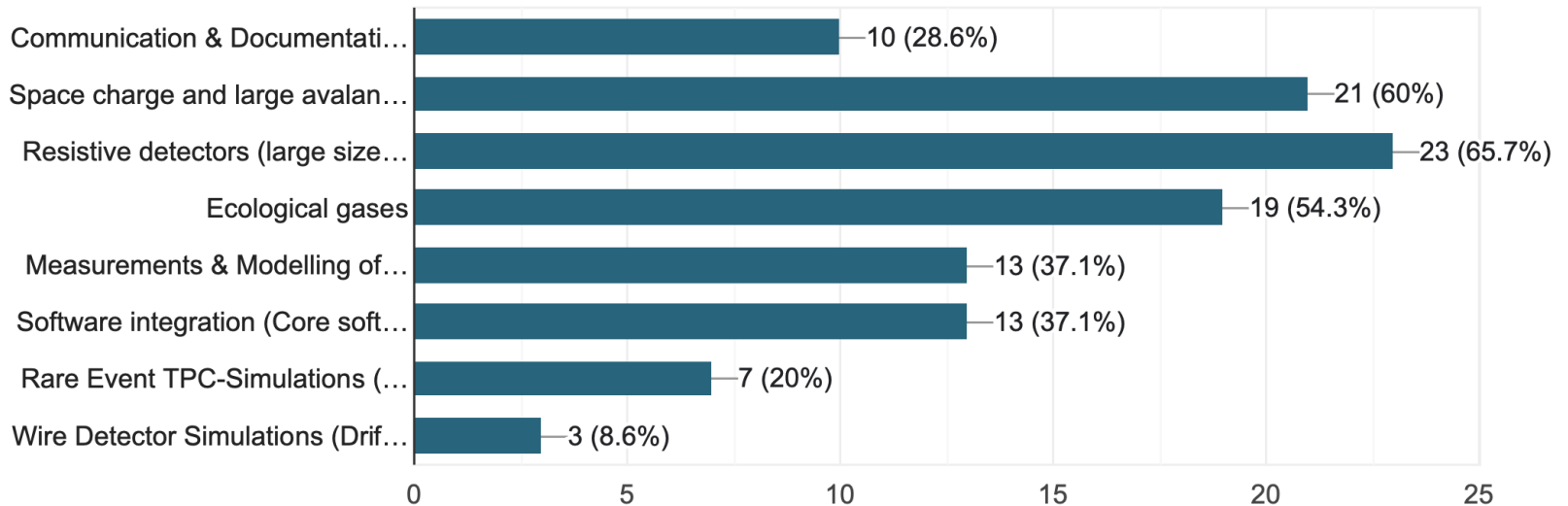


# WG4 Survey (II)

- Small survey for topical groups

Which topical group(s) are you interested in?

35 responses



# Organization: Topical Groups

- Topical groups to be organized by 1-2 conveners
1. **Communication & Documentation** (Piet V. & Maryna B)
    - Develop website, develop documentation, Prepare examples (and publish), simulation school
    - Translate C++ to Python, SWAN / Collab notebooks
  2. **Space Charge & Large Avalanches** (Paulo F. & Piet V.)
    - New – hybrid – algorithms: CPU & memory efficient
    - Electric field update for large space-charge, Investigate use of GPU
  3. **Resistive Detectors** (Paulo F. & Marcello A.)
    - Signal induction in detectors with resistive layers
    - Simulate / model large-size effects (distance to GND)
    - Transmission line/signal transmission over large distances
  4. **Ecological / New gases** (Marcello A.) (incl x-sections, Py- / Beta- / Magboltz / Methes ...)
  5. **Measurements and modeling of non-equilibrium and low-pressure effects** (Oskan S. & Rob V.)
    - Measurement and extraction of Penning effect, feedback, ion mobilities, ion-clusters
  6. **Software Integration & Development** (Supratik M. & Piet V.)
    - Core software development, Software maintenance, Software optimization (reduce mem)
    - Parallelization, use of heterogeneous computing (GPU), pioneer ML?
    - Integration of different SW to work smoother together...
  7. **Rare-event TPC simulations** (Maryna B)
    - Development of electroluminescence, Negative ions, ....
  8. **Wire Detectors** (Piet V.) (discussing Data/MC comparisons, outstanding issues, ...)

# Status & Activities (II)

We started organizing WG4 Topical meetings:

- Third Meeting April 9<sup>th</sup> - 38 participants
  - <https://indico.cern.ch/event/1402710/>
  - Centered on Resistive detectors
  - 1<sup>st</sup> talk – P.Fonte - Reflections towards a general framework
  - 2<sup>nd</sup> talk – D. Janssens – Simulation tutorial COMSOL + Garfield++
- Forth Meeting June 11<sup>th</sup> - 44(!) participants
  - <https://indico.cern.ch/event/1420266/>
  - Focused on Space Charge & Large Avalanches
  - 1<sup>st</sup> talk – P.Verwilligen & P.Fonte - Large Avalanches & Space Charge - an Introduction & possible goals
  - 2<sup>nd</sup> talk – S. Mukhopadhyay – Algorithm for Electric Field calculation in Garfield++ with neBEM
  - 1<sup>st</sup> talk – Davide Pinci - Algorithm for large gain in Triple-GEM detectors for the Cygno Experiment
  - 2<sup>nd</sup> talk – Dario Stocco – Algorithm for large gain in RPC detectors: adoption of Riegler-Lippman 2D algorithm in Garfield++

Potential cooperation with DRD3 on Garfield++ simulation for solid states detectors

# Summary & Outlook

## • Summary

- Presented – WG4 Status & Current Activities
- Presented – WG4Surveys: We have collected substantial feedback from our community, and it will guide us in setting the priorities

## • Outlook

- The [DRD1 proposal](#)
- [Subscribe](#) to DRD1 WG4 Mailing list
- Join our next Topical meeting -> Rare-event TPC simulations
- Contact conveners [drd1-wg4-convenors@cern.ch](mailto:drd1-wg4-convenors@cern.ch)
  - Past, present & future work
  - Simulation / SW interests



Work group participants - please self-subscribe if interested in WG activities:

- DRD1-WG1: Participants of WG1 - [Subscribe](#)
- DRD1-WG2: Participants of WG2 - [Subscribe](#)
- DRD1-WG3: Participants of WG3 - [Subscribe](#)
- DRD1-WG4: Participants of WG4 - [Subscribe](#)



# Today's agenda of WG4 session

< Mon 17/06 Tue 18/06 Wed 19/06 **Thu 20/06** Fri 21/06 All days >

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Session legend

● Collaboration Board ● Working Group 4: Detector physics, simulations, and software tools ● Working Group 6: Detector production ✕

09:00	<b>WG4 News</b> <i>13/2-005, CERN</i>	<i>Maryna Borysova</i> 09:00 - 09:20
	<b>Modelling and extraction of HFO1234z cross-sections</b> <i>13/2-005, CERN</i>	<i>Marnik Metting van Rijn et al.</i> 09:30 - 09:50
10:00	<b>Integration of CUDA GPU code in Garfield++</b> <i>13/2-005, CERN</i>	<i>Tom Neep</i> 09:50 - 10:10
	<b>Integrated Simulation Fwk for MIGDAL experiment</b> <i>13/2-005, CERN</i>	<i>Lex Millins</i> 10:10 - 10:30
	<b>short break - coffee</b> <i>13/2-005, CERN</i>	10:30 - 10:50
11:00	<b>Improving interoperability in gaseous simulation software</b> <i>13/2-005, CERN</i>	<i>Michele Renda</i> 10:50 - 11:10
	<b>Validation of the Simulated radiation field in GIF++</b> <i>13/2-005, CERN</i>	<i>Nicola Ferrara</i> 11:10 - 11:30
	<b>Garfield++ / LTSpice for modelling response of Straw Tubes with custom readout</b> <i>13/2-005, CERN</i>	<i>Assel Mukhamejanova</i> 11:30 - 11:50

# Backup