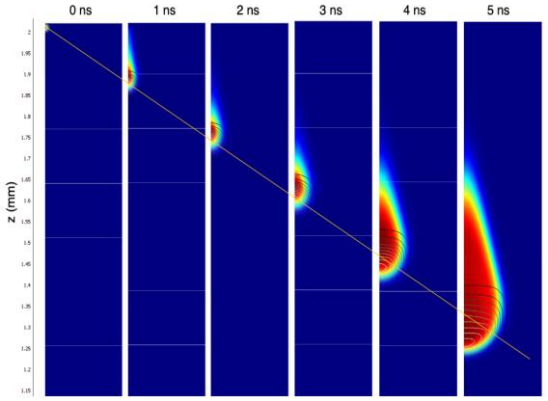
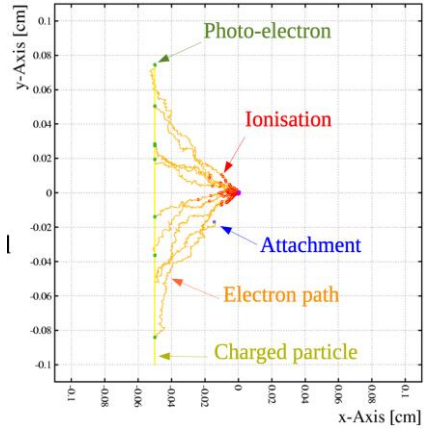
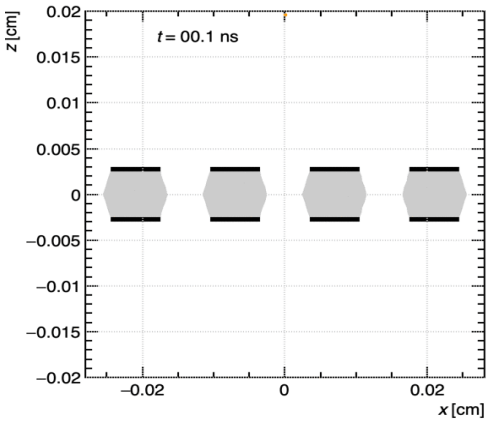






DRD1 WG4

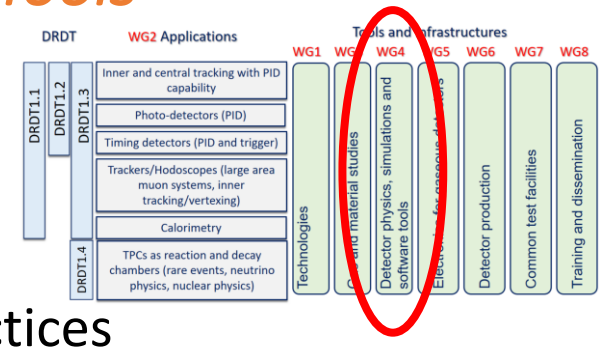
Detector Physics Modelling and Simulation

WG4 Conveners:

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

Short Introduction to WG4

Detector Physics, Simulation & Software Tools

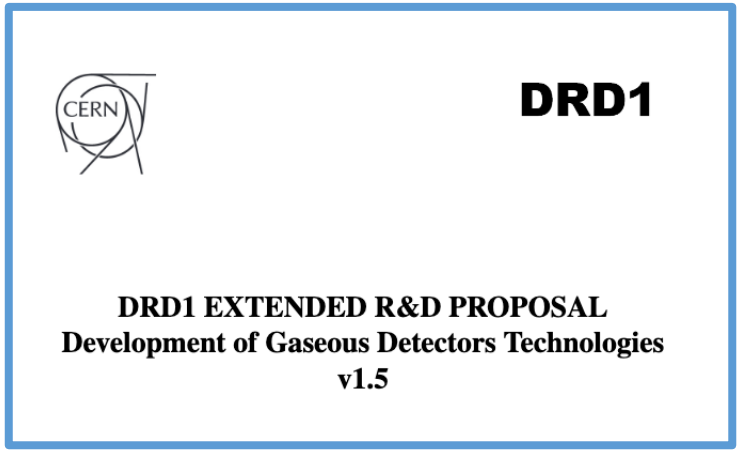


- **WG4 is transversal workgroup:**
  - *Groups people working on simulations in various Work-Packages*
  - Platform to exchange progress & best practices
  - In a sense a ”Service” to the community … *but only if there is input*
  - *Work together to obtain solutions to common problems*
- **WG4 Aims at:**
  - Understanding & modelling Physical Processes in Gaseous Det (GD)
  - *Development of Suitable Simulation & Software Tools*
- **Importance within DRD1:**
  - Advanced simulations indispensable for GD Detector R&D
  - *Confirm* / *Challenge* current understanding of Detector Physics
  - *Note:* SW Tools developed within GD community now used for other detection technologies (Liquid / Solid State)

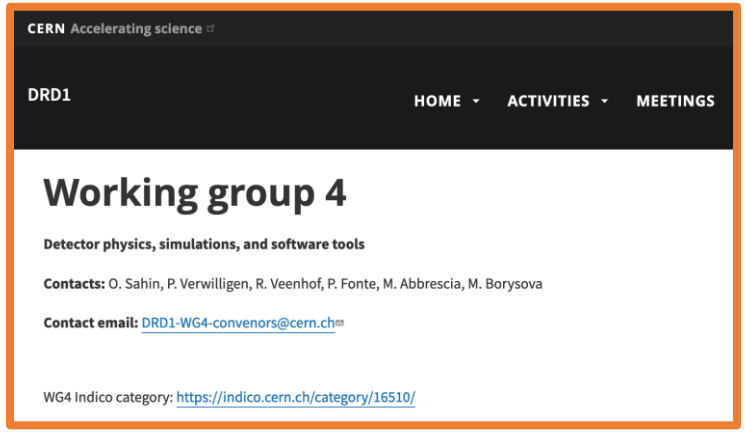
Description WG4 in DRD1 Ext Proposal

Detector Physics, Simulation & Software Tools

- 8 p in the Extended proposal (p72-80)
- Introduction – Motivation
- State of the Art:
  - What has been simulated in the past
  - What are the current limitations in the physics modelling and simulation
- Needs of the communities:
  - Maintenance & Improvement Garfield++
  - Simulation Large Charges & Space-Charge
  - Detectors with Resistive materials
  - ECO-gases, Penning, Ion mobility
  - Electroluminescence, Negative Ions
  - Fast / Parametrized Simulations



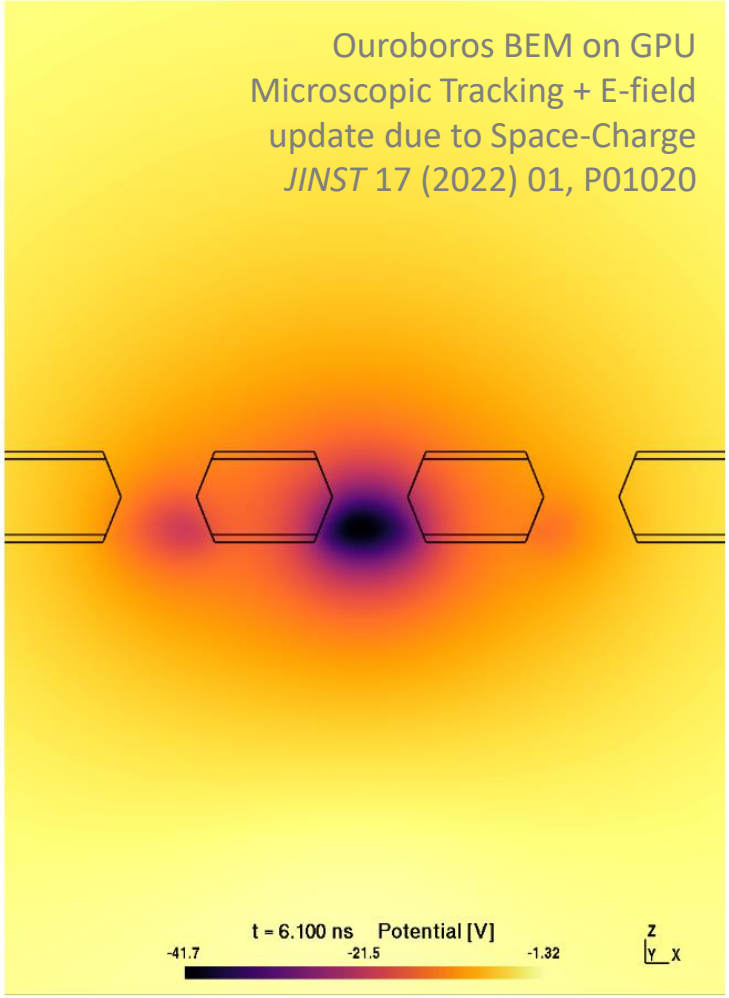
drd1.web.cern.ch/activities-wg4



Description WG4 in DRD1 Ext Proposal

Main Limitations of the current simulation Tools

- Long computing times / Prohibitive resource use of precise and realistic simulations
  - Large Gains, Large Rates
  - Space-Charge effects (see also GEMs)
- Non-correct signal shape simulation
  - Need correct ion species & ion mobilities
- Dynamic behaviour (Rate => V-drop)
- Unknown effects
  - Discharge transition
  - Ageing effects
- New / Innovative Gases
  - Simulation is ideal tool to survey multi-dimensional Parameter space – but need cross-sections of candidate gas components
- New concepts:
  - Neg Ion drift & amplification
  - Electroluminescence & optical readout



Common Objectives WG4 I

Common "Core" Software Development

WP1	Large area Tracking	WP5	Calorimetry
WP2	Drift Ch, Trk & PID	WP6	Photon Det
WP3	Straws, Trk & PID	WP7	Timing Det
WP4	TPCs, Trk & PID	WP8	Act Targ TPC

Many *possible* Tasks:

	Ref.	Description	Link to WP
4.1.X GARFIELD Modernization	4.1.1	*Review Core code for Multi-Threading and Heterogeneous Computing (CPU – GPU), optimized C++ code for modern CPUs, …*	*All WPs*
	4.1.2	*Add Community Tools (Validation, Automatic Pull-Request Tests, Builds, …)*	*All WPs*
	4.1.3	*Review & Accelerate G++ integrated neBEM*	*All WPs*
4.2.X GARFIELD Framework Improvement	4.2.1	*Recommended Set of Ion Mobilities*	*All WPs*
	4.2.2	*Secure long-term solution for Magboltz*	*All WPs, WG3*
	4.2.3	*Miscellaneous: better Event Displays, Improve Documentation, Provide Examples*	*All WPs*

We would like / need to collaborate with CERN IT department for Core Code and for the deployment of modern software tools. ***We would need people willing to push these developments forward*** *and can follow PhD students (partly) working on these topics …*

Common Objectives WG4 II

Application Specific Software Development

WP1	Large area Tracking	WP5	Calorimetry
WP2	Drift Ch, Trk & PID	WP6	Photon Det
WP3	Straws, Trk & PID	WP7	Timing Det
WP4	TPCs, Trk & PID	WP8	Act Targ TPC

Many *possible* Tasks:

	Ref.	Description	Link to WP
4.3.X Simulation of Large Avalanches / Space Charge Effects	4.3.a.1	*Implementation of Space-Charge*	*WP 1,6,7*
	4.3.a.2	*Implementation of E-Field update (on the fly)*	*WP 1,6,7*
	4.3.a.3	*Clustering of particles for Large Avalanches*	*WP 1,6,7*
	4.3.b.1	*Simulate Discharges using code 4.3.a*	*WP 1,6,7*
4.4.X Simulation of Resistive GDs	4.4.a.1	*Signals: Time-dependent weighting fields*	*WP 1,2,4,5,7*
	4.4.b.1	*Rate-Capability simulation (Equiv. Network)*	*WP 1,4,5,7*
	4.4.b.2	*Framework for large-size detectors (cells)*	*WP 1,7*
	4.4.c.1	*Model / Sim Dark Count Rate and Ageing*	*WP 1,2,7*

Very important Software development required and once in place several (most) applications will benefit. Community will be allowed to simulate / compare / study effects that could not be studied before … ***Still funding & manpower should be driven inside Application WPs***

Common Objectives WG4 III

Application Specific Software Development

WP1	Large area Tracking	WP5	Calorimetry
WP2	Drift Ch, Trk & PID	WP6	Photon Det
WP3	Straws, Trk & PID	WP7	Timing Det
WP4	TPCs, Trk & PID	WP8	Act Targ TPC

Many *possible* Tasks:

	Ref.	Description	Deliverable
4.5.1 Large Vol	4.5.1	*Simulation of Large Gas Volumes (Distortions – TPC)*	*WP 2,3,4*
4.6.1 Eco-Gas	4.6.1	*Modelling and Simulation of Eco-Gases (X-sections)*	*WP 1,2,5,8 …*
4.7.1 Penning	4.7.1	*Meas & Extraction Penning coeff (Ternary Mixtures)*	*WP 1,2,3, 8 …*
4.8.1 Fast-Sim	4.8.1	*Parametrized Fast Simulation*	*WP 1,2,5,7,…*
4.9.1 Luminesc	4.9.1	*γ-x-section & Simulation of Electroluminescence*	*WP 8*
4.10.1 Neg Ion	4.10.1	*Simulation of Negative Ions (Drift – Detachment)*	*WP 8*
4.11.1 Quench	4.11.1	*Simulation Ionization Quenching Factors Nuclei*	*WP 8*

Here these tasks fit naturally into the various Work Packages for the Applications. Funding and (Wo)manpower to work on these tasks should be included in the WP proposals. WG4 acting as a platform for exchange of expertise, coordination and help.

National P.I.s & WP leaders … everybody … please feel responsabilized ☺

Common Objectives WG4 IV

Summary – Call to arms

- Lots of (possible) work
  - We have envisioned a dream
  - work for next 10 years
  - Now need to decide what is priority
  - *=> will see what is priority by which projects will dedicate manpower*
  - *=> need all of you*
- If WPs are not going to identify persons to work on certain topics, then these simulation / physics modelling targets will not be reached – even not get started
- Remember: we are the community

WG4 Survey

Who are we? What does the DRD1 wants?

- **We will launch a quick survey**
  - 10 questions – 5’ of your time
  - LINK: survey
  - Please fill out by 16/02
- **Aim:**
  - Get to know who already works on software & simulations
  - Get suggestions for future software developments
  - Understand priorities from community

WG4 Organization

Who are we? What do we want? How will we work?

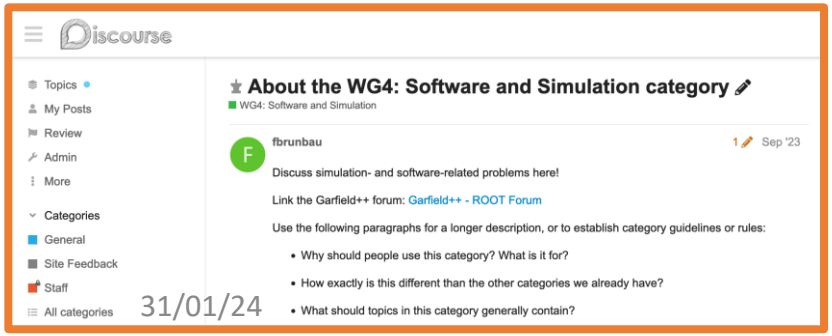
- We would like to bring people together working on same/similar topics
- We will start with monthly WG4 – meetings
  - Every 2nd Tuesday of the Month 15:00 – 17:00
- Idea: short presentations of ongoing / future work
  - *Find synergies and get people to start working together*
  - *Easy environment for new persons to start working on tasks*
- Another Idea:
  - *WP Task leaders presenting the simulation work they will take up?*

Next Meetings:
Feb 13
Mar 12
Apr 9

WG4 Tools

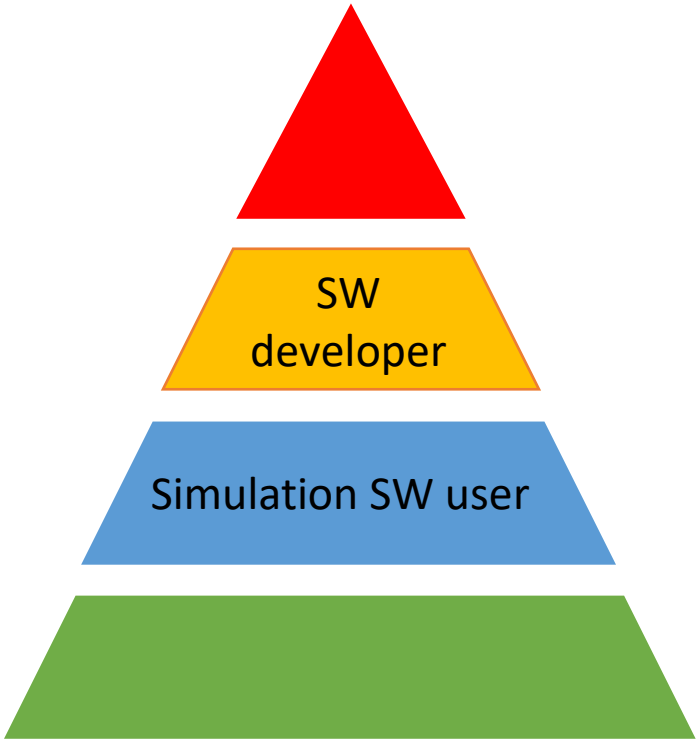
What will we use?

- DRD1 Website & DRD1 email list – *please subscribe!*
  - *drd1-wg4@cern.ch => all persons interested*
  - *drd1-wg4-conveners@cern.ch => conveners*
- DRD1 Discourse - Forum for WG4
  - https://drd1-forum.web.cern.ch/t/about-the-wg4-software-and-simulation-category/19
- Garfield++ website
  - ROOT Forum dedicated to garfield++
  - https://root-forum.cern.ch/c/garfieldxx/25
- CERN computing resources:
  - LXPLUS / LXBATCH / SWAN / …
  - *Need to verify whether we need non-experiment quota*



Interface with WG8

Knowledge transfer, Training, Career



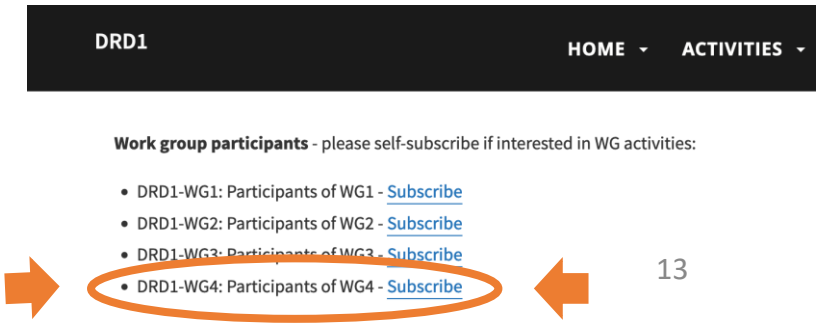
- We would like to increase the base of the pyramid
  - More people using simulation SW
  - => to more people developing SW
- Will integrate into WG8 efforts
  - Contribute to eventual detector school in 2024 by
    - Developing simulation exercises
    - Lecture on simulation “theory” and best practices ….
  - Would like to form group to organize simulation school in 2025

Summary & Homework

What can you do for us – and for yourself?

- **Summary**
  - Presented WG4 – Objectives & open Tasks
  - Presented WG4 – Organization - Communication

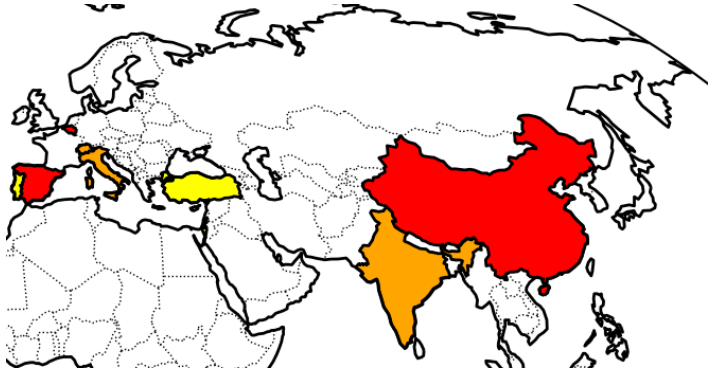
- **Your homework**
  - Read the DRD1 proposal – *if you did not do so already*
  - Subscribe to DRD1 WG4 Mailing list
  - Fill in WG4 survey
  - Present yourself / your institute in WG4 working meetings
    - Past, present & future work
    - Simulation / SW interests
    - Relaxed environment …



Today's agenda of WG4 session

and now let's go to work!

Geographical distribution today:



WG4 conveners

WG4 conveners + speakers

WG4 speakers

Today's agenda:

11:40 → 12:45 **Working Group 4: Detector physics, simulations, and software tools** — 6/2-024 BE Auditorium Meyrin

PRELIMINARY

- Crucial needs and available or potential tools able to reproduce the physical processes and predict detector performance
- Working Group Objectives and plan

Conveners: Marcello Abbrescia (Bari Physics Department and INFN), Dr Maryna Borysova (Weizmann Institute of Science & KINR, NAS of Ukraine), Ozkan Sahin (Uludag University (TR)), Paulo Fonte, Piet Verwilligen (Universita e INFN, Bari (IT)), Rob Veenhof (CERN)

11:40	**Introduction to WG4 - Objectives - Organization (15' +5')**	20m
12:00	**Simulation of RPC detectors with updated R134 cross sections and future prospects (15' + 5')** **Speaker**: Dario Stocco (ETH Zürich)	20m
12:20	**Simulation of Resistive Detectors (15' + 5')** **Speaker**: Djunes Janssens (Vrije Universiteit Brussel (BE))	20m

12:45 → 14:00 **lunch break** — 1h 15m — 6/2-024 BE Auditorium Meyrin

14:00 → 15:00 **Working Group 4: Detector physics, simulations, and software tools** — 6/2-024 BE Auditorium Meyrin

PRELIMINARY

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14:00	**Simulation of signal progagation in small-gap RPCs (12' + 5')** **Speaker**: Yongjie Sun (University of Science and Technology of China (CN))	15m
14:15	**Overview of simulation activities at SINP and future prospects (12' + 3')** **Speakers**: Supratik Mukhopadhyay (Saha Institute of Nuclear Physics (IN)), Supratik Mukhopadhyay (Saha Institute of Nuclear Physics (IN))	15m
14:30	**Simulation and physics modelling of Active Target TPCs (12' + 3')** **Speaker**: Dr Yassid Ayyad (Facility for rare Isotope Beams)	15m
14:45	**Simulation of the radiation field in GIF++ (12' + 3')** **Speaker**: Nicola Ferrara (Universita e INFN, Bari (IT))	15m