WG4 Updates

4 December, 2024

[Marco Mandurrino](#)
Håkan Wennlöf

2nd DRD3 Collaboration Week
CERN, 2–6 December, 2024

Updates on WG4

DRD3 – WG4 –

WG 4 - Simulation

The simulation working group will be dedicated to the development of common simulation packages, tools, and radiation models. There will be two lines of activities that will be pursued: TCAD tools and so-called Monte Carlo (MC) tools. While the former is commonly used in sensor design, process simulation, and radiation damage modeling the latter are extensively tested in sensor performance evaluation benefiting from much faster code and integration of other software packages.

Another important activity in WG4 will be the continuation of radiation hardness (bulk and surface) modeling, starting from the defect level using mainly TCAD, but also MC tools. Radiation hardness models for wide bandgap semiconductors (WBS) will be explored and developed. The WG4 will be an important part of many working groups and work packages: it will contribute to the simulations of sensor development and performance in WG1 and WG2, it will collaborate with WG3 to incorporate in the simulation the latest understanding of radiation damage, it will be used to optimize the developments of common tools (WG5), and will facilitate the use of WBS (WG6) by incorporating their properties in the simulation package.

Conveners:

Marco Mandurrino (marco.mandurrino@cern.ch)
Håkan Wennlöf (h.wennlof@cern.ch)

Documents

DRD3 Scientific Proposal (v3.1): pdf
WG4 list of involved institutes and contact persons (accessible only to "drd3-community-subscribers" members): pdf

6th Allpix Squared User Workshop (7–9 May, 2025) at Nikhef announcement just added today

Next Events

2nd DRD3 Collaboration Week (in person), CERN, Dec 2–6, 2024: Indico Agenda

Past Events

1.

WG4 General Meeting #07 (online), Nov 11, 2024, 15:00 (CET): Indico Agenda | Meeting Recording
WG4 General Meeting #06 (online), Oct 21, 2024, 15:00 (CEST): Indico Agenda | Meeting Recording
WG4 General Meeting #05 (online), Oct 7, 2024, 15:00 (CEST): Indico Agenda | Meeting Recording
WG4 General Meeting #04 (online), Sep 16, 2024, 15:00 (CEST): Indico Agenda
WG4 General Meeting #03 (online), Sep 2, 2024, 15:00 (CEST): Indico Agenda
WG4 General Meeting #02 (online), Aug 5, 2024, 15:00 (CEST): Indico Agenda
WG4 General Meeting #01 (online), Jul 22, 2024, 15:00 (CEST): Indico Agenda
1st DRD3 Collaboration Week (in person), CERN, Jun 17–21, 2024: Indico Agenda
1st WG4 Scientific Preparatory Meeting (online), Jun 3, 2024, 10:00 AM (CEST): Indico Agenda
5th Allpix Squared User Workshop, May 22–24, 2024: Indico Agenda

2.

Research Results

Literature review on 4H-SiC TCAD parameters (J. Burin *et al.* from HEPHY, Austria):
- ch.1 (permittivity)
- ch.2 (impact ionization)
- ch.3 (incomplete ionization)
- ch.4 (DOS mass)
- ch.5 (bandgap)

Open Positions

two-year "Scientist for Device Simulation" postdoc position at DESY (expired on Sep 8, 2024)

Useful Links and Tools

WG4 contact email: drd3-wg4-conveners
WG4 meetings: Indico Page
WG4 e-group (self subscription with admin approval): drd3-wg4-simulations
WG4 Mattermost channel: link

3.

1. **Meeting Recordings** available for each WG4 General Meeting
2. section on **Research Results** listing the progresses towards the RGs
3. remember to subscribe to our **e-group** and **Mattermost** channel

backup

WG4 Research Goals (2024-2026)

RG 4.1 Flexible **CMOS simulation** adaptable to different technology nodes and development of **connections** between tools for **device-level simulation** and **electronic circuit design/validation**

RG 4.2 Implementation of **newly measured semiconductor properties** into TCAD and MC simulations tools

RG 4.3 Definition of **benchmark** for validating the **radiation damage models** with measurements and different benchmark models

RG 4.4 Developing of **bulk and surface model** for 10^{16} cm^{-2} $< \Phi_{eq} < 10^{17}$ cm^{-2}

RG 4.5 **Collate** solutions from **different MC tools** and develop an algorithm to **include adaptive electric and weighting fields**

WG4 Activities 1/2 (2024-2026)

- **TCAD** activities will focus on providing **verification of tools** (mainly Silvaco and Synopsys, but also looking to other tools emerging) implementation of **new physics models** (impact ionization, mobility parametrization etc.), **exporting tools**, **communication with software companies** (e.g. implementation of WGs) and keeping the implementation of **common solutions to device simulations**.

- TCAD simulations will be complemented with **charge transport simulation tools** - **Monte Carlo tools** - allowing detailed studies of **complex sensor performance**. Different tools have been developed so far, but currently, the most supported and advanced tools are **Allpix Squared** and **Garfield++**, which will form the main/production framework, while other tools will continue to be used as verification and development tools. It is foreseen that **improvements in MC simulations will eventually be integrated into AllPix2 and Garfield++**. One obstacle for Monte-Carlo tools is currently the **lack of implementing adaptive/time-dependent weighting and electric fields** in induced current simulations.

- **Modeling of the radiation damage** in simulations has been evolving over the last two decades, but **there is not a general model** that, starting from the defect levels, comprehensively describes all the macroscopic properties of silicon, especially at extreme fluences (WG3). This is why it is important to define a **common framework for process simulation**, aimed at evaluating the **impact** of such model **on innovative devices**, **technologies** or **materials**.

WG4 Activities 2/2 (2024-2026)

- Development of **signal processing tools** that can be used with MC and TCAD tools and **general digitization models** for different sensors technologies.

- Owing to the emerging technology requirements of near future high-energy physics experiments, the present WG has to adopt long-term strategies to **promote/initiate discussion with designers of future experiments**, involved in the development of new detector concepts, to create a link between current expertise and next requirements.

- Last important item is – since the interdisciplinary nature of simulation – the establishment of a **cooperation framework among the different WGs and WPs**, as well as with other synergistic DRD collaborations.