

# **4th DRD3 week on Solid State Detectors R&D**

## **Report of Contributions**

Contribution ID: 1

Type: **WG3 Radiation Damage - Extreme Fluence**

# Response of AC-coupled Low Gain Avalanche Detectors to Ionizing and Non-ionizing Radiation Damage

*Wednesday, 12 November 2025 16:50 (20 minutes)*

Low gain avalanche diodes with DC- and AC-coupled readout were exposed to ionizing and non-ionizing radiation at levels relevant to future experiments in particle, nuclear, and medical physics and to astrophysics. Damage-related change in their acceptor removal constants and in the resistivity of the region between the guard ring and the active area are reported, as is change in the leakage current and depletion voltages of the active volumes.

## Type of presentation (in-person/online)

online presentation (zoom)

## Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 2

Type: **WG2 - Hybrid silicon sensors**

## Observation of charge multiplication in a SiEM

*Tuesday, 11 November 2025 12:17 (16 minutes)*

The development of precision silicon sensors is a key area of advancement in high-energy physics, particularly for the innermost tracking devices of future collider experiments. These sensors require a timing resolution on the order of 50 ps, pixel pitches of 50  $\mu\text{m}$  or below, and radiation tolerance up to  $10^{16-17} \text{ n}_{eq} \cdot \text{cm}^{-2}$ . One such innovation is the Silicon Electron Multiplier (SiEM), which incorporates an internal gain mechanism via a metallic electrode embedded in the silicon bulk. As described in [1], the SiEM aims to offer greater radiation tolerance than existing gain sensors (e.g., LGADs), thanks to its inherently radiation-hard gain mechanism, while maintaining comparable timing performance. It also supports pixel pitches down to 5  $\mu\text{m}$ , a level of segmentation that is difficult to achieve with other silicon sensor technologies.

Between 2020 and 2021, the conceptual foundations of the SiEM were developed using TCAD simulations. The proposed device guides electrons generated by a minimum ionising particle (MIP) into narrow silicon pillars, where charge multiplication occurs via impact ionisation, driven by the high electric field produced by the embedded metallic electrodes. The motion of these multiplied charges then induces a signal on the readout electrode located at the top of each silicon pillar. Simulations showed gain factors well in excess of 10, encouraging further efforts to develop a suitable fabrication process. Since 2022, several approaches have been pursued to fabricate a prototype and demonstrate the validity of the proposed gain mechanism. The qualification of test structures recently produced by Hamamatsu confirmed the viability of the concept and will be presented here for the first time.

In this talk, the authors will describe the operating principles of the SiEM [1] as well as the various production approaches explored over the past couple of years, including both well-established microfabrication techniques, and more experimental methods used to produce structures with very high aspect ratio pillars [2]. Finally, the results of the characterisation of demonstrators produced by Hamamatsu will be presented. Both laser systems and minimum ionising particles from the SPS test beam were used in summer 2025 and it demonstrates amplification of charges inside the SiEM structure. Building on this result, the future development of this sensor technology will be discussed.

References:

[1] The Silicon Electron Multiplier, M. H. Halvorsen et. al., NIM A 1041 (2022) 167325

[2] Fabrication of a Silicon Electron Multiplier sensor using Metal Assisted Chemical Etching and its characterisation, M. H. Halvorsen et. al., NIM A 1060 (2024) 169046

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** COCO, Victor (CERN)

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 3

Type: **WG2 - Hybrid silicon sensors**

## Proton Energy Dependence of Gain Layer Degradation in LGADs

*Wednesday, 12 November 2025 10:30 (16 minutes)*

Low Gain Avalanche Detectors (LGADs) have proven their suitability for precise timing in high-energy physics experiments and are therefore foreseen for the HL-LHC upgrades of the ATLAS and CMS detectors at CERN. Their performance, however, is limited by radiation-induced gain layer degradation, mainly due to acceptor removal. This study investigates irradiation with 18MeV, 24MeV, 400MeV and 23GeV protons in order to explore deviations from the commonly assumed Non-Ionizing Energy Loss (NIEL) scaling hypothesis. The motivation for examining different proton energies is that lower energies are expected to produce predominantly point defects, while higher energies generate more clustered defects, leading to distinct degradation mechanisms that cannot be fully described by NIEL scaling.

Measurements were carried out on LGADs from HPK and IMB-CNM, covering devices with variations such as carbon co-implantation aimed at mitigating defect formation. From the initial electrical characterization (I-V and C-V), acceptor removal coefficients were extracted, which quantify the degradation of the gain layer as a function of fluence. The results show enhanced degradation at low proton energies compared to higher energies. However, the dependence does not follow a simple monotonic relation between energy and damage, but instead points to a more complex energy dependence. Complementary laser and radioactive source measurements were performed to further investigate these trends and to probe the gain and timing performance of the irradiated samples. The results of this study provide first insights into the complex energy dependence of gain layer degradation under proton irradiation and can deliver valuable input for future LGAD design and radiation damage modeling.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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Contribution ID: 4

Type: **WG4 - Simulations**

# Garfield++: New Features and Ongoing Development

*Thursday, 13 November 2025 09:40 (20 minutes)*

Accurate simulations of modern particle detectors are essential for understanding their operation and optimizing their performance. Garfield++ is an open-source Monte Carlo toolkit designed for detailed simulations of detectors based on ionization measurements in gases and semiconductors.

Using Monte Carlo integration techniques, Garfield++ simulates the drift of charge carriers in an applied electric field. In addition to supporting electric fields obtained from analytical methods or the Finite Element Method via Synopsys TCAD, it now also allows the import of solutions from COMSOL Multiphysics. However, at high gains, large numbers of initial charges or high event rates the distribution of charge carriers can significantly alter the field configuration, leading, for example, to gain modifications in LGADs. Ongoing work focuses on developing semi-analytical and numerical methods to dynamically update the field during carrier transport.

This contribution presents a comprehensive overview of recent additions to Garfield++, ongoing developments, and examples related to the simulation of solid-state detectors. Furthermore, specific use cases will be highlighted from its current applications within the DRD1 and DRD3 communities.

## Type of presentation (in-person/online)

in-person presentation

## Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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Contribution ID: 5

Type: **WG2 - Hybrid silicon sensors**

## 55 $\mu\text{m}$ thick NLGAD sensors from FBK

*Tuesday, 11 November 2025 17:46 (16 minutes)*

The preliminary characterisation of thin LGAD sensors on n-type substrate will be presented. Electrical performances from I-V and C-V measurements on the wafer will be shown, along with the gain behaviour using red and blue LEDs.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 6

Type: **WG3 Radiation Damage - Extreme Fluence**

## Gain-Layer Project

*Wednesday, 12 November 2025 11:25 (30 minutes)*

The study of radiation damage created inside the gain-layer of LGADs is nearly impossible with defect spectroscopy techniques.

To investigate the gain-layer degradation at the defect level, the Gain-Layer Project has produced an extensive set of *p*-type pad diodes (19050 in total), whose bulk properties replicate the high doping concentrations of a gain layer.

Across 25 FZ wafers, various “flavours” of GLPDs (Gain-Layer Project Diodes) were fabricated to study the impact of different Carbon doses, Phosphorus co-doping, oxygenation and bulk resistivity.

The GLPDs have been specifically designed for defect spectroscopy and will serve as the primary tool for defect studies in the coming years.

In this presentation, the project will be introduced alongside results from the initial characterisation measurements (IV, CV, SIMS).

The first irradiation campaign was carried out using 23 GeV protons at CERN PS-IRRAD to a fluence of  $2E14$  p/cm<sup>2</sup>.

This initial campaign aimed to establish whether the chosen fluence is suitable for Deep-Level Transient Spectroscopy (DLTS) measurements.

Further irradiation campaigns with neutrons and protons are currently in preparation to systematically study fluence effects.

First results from the proton-irradiated samples will be presented, along with an initial discussion on the origins of the Acceptor Removal Effect, which is presently considered the most probable mechanism behind the gain-layer degradation in LGADs.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 7

Type: **WG1 - Monolithic Sensors**

## Limits of Spatial Resolution in TJ-65nm — How Much Charge Information Do We Need?

*Monday, 10 November 2025 16:45 (20 minutes)*

The Analog Pixel Test Structures (APTS) are a family of sensor prototypes produced in the TP-SCo CMOS 65 nm ISC technology. They contain 4x4 pixels of varying pitches between 10 and 25  $\mu\text{m}$ , implement different diode designs, namely standard, n-blanket and n-gap, to tailor charge collection, and further design variations to optimize the sensor layout in the given process. The structures have been designed and submitted in the scope of CERN EP R&D and the ALICE ITS3 upgrade, and a subset of them has been investigated at DESY in the scope of the TANGERINE project.

The analog readout scheme of the APTS allows measuring the collected charge with a high resolution, while future sensors will most likely provide much coarser charge measurements or even no charge information at all. Test-beam data, acquired on APTS at the DESY II test-beam facility, is used to study how the granularity of the charge measurement will affect the spatial resolution of these future sensors. To achieve this, the digitization will be emulated offline, scanning different numbers of bins, bin widths, and thresholds. The results will be interpreted in the context of the OCTOPUS project.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Session Classification:** WG/WP1 - CMOS technologies

Contribution ID: 8

Type: **WG3 Radiation Damage - Extreme Fluence**

## **Leakage current evolution in LHCb VELO sensors during Run 1-2 LHC data taking period.**

*Wednesday, 12 November 2025 16:10 (20 minutes)*

The data-taking period of LHC Run 2 was finished at the end of 2018, providing an opportunity to study radiation damage effects in the LHC's most heavily irradiated silicon devices. In this presentation, we discuss new analyses of the evolution of the leakage current in the LHCb VELO sensors, accompanied by predictions from the Hamburg model. The leakage current's radial and longitudinal (z-axis) dependencies will be discussed and compared with FLUKA simulations and results from other LHC experiments.

### **Type of presentation (in-person/online)**

in-person presentation

### **Type of presentation (I. scientific results or II. project proposal)**

I. Presentation on scientific results

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**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 9

Type: **WG2 - Hybrid silicon sensors**

## Development of 3D Pixel Sensors via an 8-inch CMOS-Compatible Process

*Tuesday, 11 November 2025 10:35 (16 minutes)*

In the construction of High-Luminosity Large Hadron Collider (HL-LHC) and Future Circular Collider (FCC) experiments, 3D pixel sensors have become indispensable components due to their superior radiation hardness, fast response, and low power consumption. However, there are still significant challenges in the process of 3D sensors manufacturing. In this work, single devices and arrays of 3D sensors based on 30  $\mu\text{m}$  epitaxial silicon wafer have been designed, simulated, fabricated, and tested. This process was developed on the 8-inch CMOS process platform of the Institute of Microelectronics of the Chinese Academy of Sciences (IMECAS). The key processes include Deep Reactive Ion Etching (DRIE) with the Bosch process, in-situ doping, and an innovative back-etching. After testing the 3D pixel sensors, we have summarized the leakage current and capacitance of devices with different sizes with respect to bias voltages. We also found that the fabricated devices were almost all successfully produced, which laid a strong foundation for subsequent large-scale mass production.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 10

Type: **WG5 - Characterization techniques - facilities**

# Towards Constellation 1.0: Autonomous Control Systems for Laboratory, Testbeams & Beyond

*Thursday, 13 November 2025 12:10 (20 minutes)*

The operation of instruments and detectors in laboratory or beamline environments presents a complex challenge, requiring stable and simultaneous operation of multiple devices, often controlled by separate hardware and software solutions.

Constellation is a flexible and network-distributed control and data acquisition software framework tailored to laboratory and beamline environments that addresses the requirements. The framework is designed with a focus on extensibility, providing a streamlined interface for instrument integration. It supports efficient system setup via network discovery mechanisms, promotes stability through autonomous operational features, and provides comprehensive documentation and supporting tools for operators and application developers such as controllers and logging interfaces.

This presentation will highlight recent advancements in development, and will outline the road towards the upcoming release of Constellation 1.0 as a stable, production-ready framework. Several applications will be discussed, including deployments at beamlines, in spent nuclear fuel characterization, and in the BL4S program.

## Type of presentation (in-person/online)

in-person presentation

## Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Session Classification:** WG5 - Characterization techniques, facilities

Contribution ID: 11

Type: **WG2 - Hybrid silicon sensors**

## Results from iLGAD sensors bump bonded to Timepix4

*Tuesday, 11 November 2025 11:59 (16 minutes)*

This presentation will show results of an inverse Low-Gain Avalanche Detector (iLGAD) with a pitch of 55  $\mu\text{m}$ , a thickness of 250  $\mu\text{m}$  and a large-area (2  $\text{cm}^2$ ), bump bonded to a Timepix4 ASIC. The Timepix4 ASIC is the latest hybrid pixel detector of the Medipix collaboration. It consists of 448 by 512 pixels with a pixel pitch of 55  $\mu\text{m}$ . The best obtained time resolution for a 100  $\mu\text{m}$  planar n-on-p type sensor on Timepix4 with test beam is O (150 ps).

A new sensor design with a small pitch and a good fill factor is the inverse Low Gain Avalanche detector (iLGAD). By placing the gain layer on the opposite side of the pixel electrodes iLGADs have a uniform gain layer over the whole sensor area. This presentation shows the timing performance of a 250  $\mu\text{m}$  iLGAD produced by Micron, which is bump bonded to a Timepix4 ASIC.

The iLGAD shows an almost uniform gain of around 4 and an efficiency of  $99.6 \pm 0.1\%$ . Before corrections the obtained time resolution is about 750 ps. After timewalk and clock corrections the time resolution becomes 358 ps. To understand the details of the modest time resolution also grazing angle and TPA laser measurements have been done, which allow to measure the time resolution as function of depth of the charge deposition in the sensor. This provides more insight in the time resolution, also for the perpendicular case.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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Contribution ID: 12

Type: **WG2 - Hybrid silicon sensors**

## Advancements in Low-Gain Avalanche Diodes (LGADs) for the ALICE 3 timing layers

*Tuesday, 11 November 2025 17:10 (16 minutes)*

The proposed ALICE 3 experiment requires outstanding Particle Identification (PID) based on Time-of-Flight (TOF), setting a highly ambitious timing resolution target of 20 ps. Achieving this goal necessitates intensive Research and Development (R&D) into next-generation silicon sensor technology for large-area systems.

Low-Gain Avalanche Diodes (LGADs) are primary candidates due to their excellent timing performance. Our R&D, conducted within the ALICE 3 collaboration, investigates the potential of optimizing these sensors through the exploration of very thin substrates, ranging from 15 to 50  $\mu\text{m}$ . This study particularly focuses on the innovative concept of double-LGADs, where two sensors are coupled to generate an enhanced signal.

We present a comprehensive performance comparison between single and double LGAD configurations across tested thicknesses. The results obtained from beam tests and laboratory characterization demonstrate a significant advantage of the double-LGAD structure: a substantial enhancement in the output charge signal compared to single sensors (crucial for front-end electronics optimization) and the benefit of an improvement in time resolution, approaching or meeting (depending on the thickness) the 20 ps requirement.

These findings validate the double-LGAD configuration as a first proof of concept and make it a highly promising technology to meet the demanding timing specifications of future experiments.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 13

Type: **WG6 - Wide bandgap materials**

## First Results from the Second Planar Run of the RD50-SiC-LGAD Common Project

*Thursday, 13 November 2025 15:20 (20 minutes)*

The second production of planar 4H-SiC device wafers (CNM 17560) from the RD50 SiC LGAD common project was completed in summer 2025 at CNM Barcelona, consisting of two wafers — one with a 50 $\mu\text{m}$  and one with a 100 $\mu\text{m}$  epitaxial layer. The high yield of PAD diodes from this production now enables statistically robust, cross-institutional studies of radiation damage effects in 4H-SiC. In addition, the inclusion of specialized structures such as MOSCAPs and DC-coupled resistive detectors allow for advanced detector studies and material characterization.

We report on the activities at MBI (formerly HEPHY) related to this production, including completed, ongoing, and planned device characterization and irradiation campaigns. The presented results include electrical characterization of PAD diodes at both wafer and device level, capacitance–voltage (C–V) measurements on MOSCAPs, and laser-based studies of DC-coupled resistive detectors to assess position resolution. Furthermore, we discuss observed production issues affecting the passivation, which have rendered a subset of structures, such as Van der Pauw structures, non-functional. Irradiation campaigns at low to high fluences with protons and neutrons are currently ongoing.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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Contribution ID: 14

Type: **WG5 - Characterization techniques - facilities**

## FAST3-Amplifier –Project update

*Thursday, 13 November 2025 11:50 (20 minutes)*

In this contribution, I will present the status of the RD50/DRD3 project “16-channel amplifier for thin Low Gain Avalanche Diodes based on the FAST3 ASIC.”

The objective of the project is to design and produce 16-channel amplification boards for LGAD sensors, based on the packaged FAST3 ASIC.

The project involves: (i) the design and fabrication of a custom FAST3 package using Multi-Chip Module (MCM) technology, and (ii) its integration onto a dedicated readout board through a Ball Grid Array (BGA) interface.

A total of 35 boards are foreseen in two production batches; the first batch of 10 boards has been fabricated, delivered, and is currently undergoing testing.

The ongoing characterization campaign aims to validate the basic performance of the packaged ASIC in terms of noise, channel gain, and temporal jitter. A pulser setup is used to inject a well-defined charge into the FAST3 input channels for these measurements. Subsequently, the timing performance of the amplifier will be evaluated in combination with a well-characterized LGAD sensor using a  $\beta$ -source setup.

The results from this characterization will be compared with the expected temporal jitter and resolution targets of approximately 15 ps and 35 ps, respectively.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

III. other (please specify in comment field)

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**Presenter:** FERRERO, Marco (Universita e INFN Torino (IT))

**Session Classification:** WG5 - Characterization techniques, facilities

Contribution ID: 15

Type: **WG2 - Hybrid silicon sensors**

## 3D detectors with gain for 4D tracking

*Tuesday, 11 November 2025 09:59 (16 minutes)*

Small pixel 3D sensors were produced by IME-CAS on 8 inch p type wafers of 700  $\Omega\text{cm}$ . The 30  $\mu\text{m}$  thick silicon detectors have trench walls (ohmic p+) and very narrow n-column columns with diameter of only 0.5  $\mu\text{m}$ . A  $5 \times 5$  matrix of  $35 \times 35 \mu\text{m}^2$  was measured with Two Photon Absorption Transient Current Technique. At higher voltages the devices show stable operation with high gain originating from impact ionization close to the n+ junction column in a similar way in gas proportional chambers without any specially dedicated gain layer doping. The devices were fully characterized in terms of charge collection uniformity and time resolution performance across the cell at different bias voltages. The measured performance was also simulated with good agreement between both.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** KRAMBERGER, Gregor (Jozef Stefan Institute (SI))

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 16

Type: **WG7 - Interconnect**

## In-house plating at CERN

*Friday, 14 November 2025 09:30 (20 minutes)*

As part of the CERN EP R&D programme and the DRD3 collaboration, innovative and scalable concepts for hybridisation and module integration are being developed for pixel detector applications in future colliders. Most interconnect processes require specific surface properties and topologies of the bonding pads. An in-house Electroless Nickel Gold (ENIG) plating process is therefore under development that can be performed at the single-die level and adapted to a wide range of pad geometries and bonding techniques. This presentation shows the results of a detailed parameter study of nickel deposition in the ENIG process. For this purpose, the height and uniformity of the nickel bumps in representative areas of the pixel matrix were measured and compared for different ENIG processing parameters.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** LAUSER, Moritz (KIT - Karlsruhe Institute of Technology (DE))

**Session Classification:** WG7/WP4

Contribution ID: 17

Type: **WG2 - Hybrid silicon sensors**

## Properties of DC-RSD with different surface resistivities and pixel sizes

*Tuesday, 11 November 2025 16:52 (16 minutes)*

In this contribution, I will present new studies on the properties of DC-RSD. These sensors, manufactured at FBK, have been tested at 2 test beams at the DESY beam line. The performance of prototypes with different surface resistivities and pixel sizes will be presented. This study also focuses on the determination of the relationship between surface resistivity and pixel size, identifying a metric to determine the optimal combination.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 18

Type: **WG2 - Hybrid silicon sensors**

## Performance of AC-LGADs for ePIC and beyond

*Tuesday, 11 November 2025 16:34 (16 minutes)*

Low Gain Avalanche Detectors (LGADs) are characterized by a fast rise time (~500ps) and extremely good time resolution (down to 17ps), and potential for a very high repetition rate with ~1 ns full charge collection. For the application of this technology to near future experiments such as e+e-Higgs factories (FCC-ee), the ePIC detector at the Electron-Ion Collider, or smaller experiments (e.g., the PIONEER experiment), the intrinsic low granularity of LGADs and the large power consumption of readout chips for precise timing is problematic. AC-coupled LGADs, where the readout metal is AC-coupled through an insulating oxide layer, could solve both issues at the same time thanks to the 100% fill factor and charge-sharing capabilities. Charge sharing between electrodes allows a hit position resolution well below the pitch/sqrt(12) of standard segmented detectors. At the same time, it relaxes the channel density and power consumption requirement of readout chips. Extensive characterization of AC-LGAD devices from the first full size (up to 3x4 cm) production from HPK for ePIC will be shown in this contribution. We will present the first results on AC-LGADs irradiated with 1 MeV reactor neutrons and protons as well. We'll also present a look into the future development of AC-LGADs for the improvement of production yield and performance.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** SEIDEN, Abraham (University of California,Santa Cruz (US)); MOLNAR, Adam; UNKNOWN, Bruce Schumm; SADROZINSKI, Hartmut (SCIPP, UC santa Cruz); Dr MAZZA, Simone Michele (University of California,Santa Cruz (US))

**Presenter:** Dr MAZZA, Simone Michele (University of California,Santa Cruz (US))

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 19

Type: **WG6 - Wide bandgap materials**

## Update on SICAR

*Thursday, 13 November 2025 14:40 (20 minutes)*

This talk outlines the fabrication progress of the second-generation 4H-SiC Low-Gain Avalanche Diode (SICAR2), designed for a nominal gain of 10–15. Fabricated using 350nm stepper lithography and substrate thinning for improved timing resolution, the 2mm × 2mm die includes devices with 1.4mm and 0.55mm active areas, along with AC-pixelated (2×2) and AC-strip (4-strip) test structures. All devices feature an etched termination with field plate to reduce leakage current, though this limits the active area. SICAR2 establishes a critical foundation for next-generation SiC LGAD development —SICAR3 which will introduce a high-temperature ion-implanted Junction Termination Extension (JTE) to enable larger active areas with low leakage.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Author:** ZHANG, Xiyuan (Chinese Academy of Sciences (CN))**Presenter:** ZHANG, Xiyuan (Chinese Academy of Sciences (CN))**Session Classification:** WG6/WP3 - Wide bandgap detectors

Contribution ID: 20

Type: WG3 Radiation Damage - Extreme Fluence

## Optical detected magnetic resonance (ODMR) of $A_{Si}$ -Si<sub>i</sub>-defects: case of acceptor indium

Wednesday, 12 November 2025 12:15 (20 minutes)

Kevin Lauer,<sup>1,2</sup> Bernd Hähnlein,<sup>1</sup> Mario Bähr,<sup>1</sup> Kai Kühnlenz,<sup>1</sup> Phillipp Kellner,<sup>1</sup> Dirk Schulze,<sup>2</sup> Stefan Krischok,<sup>2</sup> Alexander Rolapp,<sup>3</sup> Christian Möller<sup>1</sup> and Thomas Ortlepp<sup>1</sup>

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Defects from the  $A_{Si}$ -Si<sub>i</sub>-defect category [1] were proposed to be responsible for the acceptor removal phenomenon (ARP) in low gain avalanche detectors (LGAD).[2] On the way to physically understand the  $A_{Si}$ -Si<sub>i</sub>-defect category low temperature photoluminescence measurements are performed on quenched indium doped silicon samples. Additionally, the samples are irradiated by microwaves. By sweeping the microwaves over a frequency range optically detected magnetic resonance (ODMR) signals are found. Some ODMR correlate with resonances in the sample temperature, which are called temperature detected magnetic resonances (TDMR). ODMR and TDMR signals are shown and discussed within the  $A_{Si}$ -Si<sub>i</sub>-defect model with indium as acceptor species.

[1] K. Lauer, K. Peh, D. Schulze, T. Ortlepp, E. Runge, and S. Krischok, 'The  $A_{Si}$ -Si<sub>i</sub> Defect Model of Light-Induced Degradation (LID) in Silicon: A Discussion and Review', Phys. Status Solidi A, vol. 219, no. 19, p. 2200099, 2022, doi: 10.1002/pssa.202200099.

[2] K. Lauer, K. Peh, S. Krischok, S. Reiß, E. Hiller, and T. Ortlepp, 'Development of Low-Gain Avalanche Detectors in the Frame of the Acceptor Removal Phenomenon', Phys. Status Solidi A, vol. 219, no. 17, p. 2200177, Jun. 2022, doi: 10.1002/pssa.202200177.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Author:** LAUER, Kevin (CIS Institut fuer Mikrosensorik GmbH (DE))

**Presenter:** LAUER, Kevin (CIS Institut fuer Mikrosensorik GmbH (DE))

**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 21

Type: **WG7 - Interconnect**

## DRD 7.6b Shared Access to 3D Integration –Progress Report

*Friday, 14 November 2025 09:10 (20 minutes)*

The DRD 7.6b activity focuses on establishing a coordinated and sustainable strategy for shared access to advanced 2.5D and 3D integration technologies within the DRD7 framework. This initiative aims to enable detector R&D groups to exploit key enabling technologies, such as Through-Silicon Vias (TSVs), Redistribution Layers (RDLs), silicon interposers, and wafer-to-wafer (W2W) bonding, for next-generation readout and sensing systems.

This progress report presents the overall strategy, technological milestones, and implementation roadmap of DRD 7.6b. It summarizes recent advances in TSV and RDL process integration, including the design and realization of a full silicon-based interposer wafer developed and fabricated entirely with in-house technologies, and the associated packaging approaches that support dense and heterogeneous detector assemblies. A brief overview of the status at the main European facilities engaged in these activities is also provided, highlighting process capabilities, access mechanisms, and collaborative developments.

Building on the establishment of interposer-based integration, the next step will focus on wafer-to-wafer (W2W) bonding technologies, which represent a key enabler for fully vertical 3D integration and high-throughput heterogeneous stacking. This evolution will strengthen the shared infrastructure and promote a common design and process ecosystem for future detector innovations.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

III. other (please specify in comment field)

**Author:** Dr CASELLE, Michele (KIT - Karlsruhe Institute of Technology (DE))

**Co-authors:** NOVEL, David; Dr NGUYEN, Hoang-Vu (University of South-Eastern Norway (NO)); AN-DRICEK, Laci (MPG HLL); KARAGOUNIS, Michael (Fachhochschule Dortmund Univ. of Applied Sciences and Arts (DE)); ULLAN, Miguel (CNM-Barcelona (ES))

**Presenter:** Dr CASELLE, Michele (KIT - Karlsruhe Institute of Technology (DE))

**Session Classification:** WG7/WP4

Contribution ID: 22

Type: **WG2 - Hybrid silicon sensors**

## Towards Active Edge Silicon Sensors Fabricated with Edge Ion Implantation And Microwave Anneal Activation

*Tuesday, 11 November 2025 17:28 (16 minutes)*

Silicon detectors typically require a large inactive region surrounding the sensitive region, to accommodate guard rings, which help maintain the electric field uniformity around peripheral pixels, and isolate high current generation due to defects at the physical edges of the detectors. Sensors with reduced inactive regions around their periphery are desirable for applications in high-energy physics, X-ray experiments, and medical imaging. A solution to reduce or eliminate this inactive area is the use of active-edge technology. However, implementing active edges has presented significant challenges in sensor fabrication. Typically, a support wafer is necessary, as a trench is etched fully through the device substrate and subsequently must be filled with polysilicon for re-planarization, in order to enable the subsequent fabrication steps. The process would be greatly simplified if the edges could be doped after all other fabrication steps. This is generally not feasible with conventional methods due to the high-temperature annealing required after doping the guard rings or active-edge structures. Microwave annealing offers a promising alternative to traditional high-temperature annealing, since dopants are activated while the bulk temperature remains below 500 °C, enabling activation after all other fabrication steps are complete. This study explores a new method of achieving active-edge detectors, in which the device edges are implanted after dicing and subsequently microwave annealed. As a feasibility test, several readily available devices underwent edge ion implantation and microwave annealing. The tested devices include both p-in-n and n-in-p devices. Results from TCAD simulations exploring the effects of fixed oxide charge and large surface recombination velocity on both device polarities will be shown. These demonstrate the expected qualitative features of I-V measurement performed before and after the edge implantation and annealing. Results of these measurements will be shown, demonstrating a reduction in leakage current after the edge is doped, indicating the successful buffering of the edge current generation by the activated dopant.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 23

Type: **WG2 - Hybrid silicon sensors**

# Intra-Pixel Weighting-Field-Driven Timing Non-Uniformity Measured with the TimePix4 Telescope

*Tuesday, 11 November 2025 11:41 (16 minutes)*

This work presents a detailed study of the timing performance and its spatial variation within the pixel of planar sensors, using the high-resolution TimePix4 beam telescope for precise, track-referenced measurements. Sensors of 200, 100, and 50  $\mu\text{m}$  thickness were coupled to the triggerless TDCpix ASIC with 100 ps timestamping, originally developed for the NA62 GigaTracker at CERN. Tests were performed at the Super Proton Synchrotron H8 beamline, where the TimePix4 telescope provided tracks with  $\sim 2$   $\mu\text{m}$  spatial resolution. Hardware-level synchronization between the telescope and TDCpix combined with large hybrid pixel pitch of 300  $\mu\text{m}$  enabled accurate pixel-level timing studies and made it easier to observe and characterise timing non-uniformity.

Dependencies of the mean matrix time resolution on bias voltage and discriminator threshold were measured for each sensor thickness. Since TDCpix is optimised for charge deposition in a 200  $\mu\text{m}$  sensor, for thinner hybrids runs with rotated devices were conducted. The rotation increases hadron path length in material which improves charge deposition and enables reasonable comparison between sensors of different thicknesses. The results show better time resolution of thinner hybrids down to  $\sim 90$  ps. Combining testbeam results with laboratory ASIC calibration allowed extraction of intrinsic sensor time resolution, reaching values below 50 ps in good agreement with theoretical expectations.

A key focus of the study was the spatial dependence of time resolution within a pixel. A dedicated space-time alignment algorithm was developed to integrate telescope tracks with TDCpix data, enabling intra-pixel maps of Time-of-Arrival and time resolution with sub-micron precision. These maps reveal non-uniform timing behavior correlated with the analytical solution for the weighting field of the pixel electrode, showing up to 100 ps variations in charge collection time and tens of ps differences in time resolution. The results highlight the significant influence of the weighting field on intra-pixel timing uniformity, particularly when the pixel pitch approaches the sensor thickness, underscoring the importance of optimized electrode design for future development of fast timing detectors.

## Type of presentation (in-person/online)

in-person presentation

## Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** SHEPELEV, Artem (University of Birmingham (GB)); SAM, Ceyhan (University of Birmingham (GB)); LAZZERONI, Cristina (University of Birmingham (GB)); KRIZKA, Karol (University of Birmingham (GB))

**Presenter:** SHEPELEV, Artem (University of Birmingham (GB))

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 24

Type: **WG7 - Interconnect**

## In-house Flip-Chip Hybridisation Updates

*Friday, 14 November 2025 09:50 (20 minutes)*

The development of hybrid pixel detectors requires reliable, flexible and cost-effective interconnect technologies that are suitable for single-die processing in R&D projects and for low-volume productions.

This presentation reports on the current status and recent progress of in-house hybridization techniques developed within the CERN EP R&D programme and the DRD3 collaboration. These include bonding methods based on Anisotropic Conductive Adhesives (ACA) and gold-stud bonding with epoxy underfill. The ACA approach replaces conventional solder bumps with conductive micro-particles embedded in an epoxy matrix—applied either as a film or a paste—and enables electro-mechanical connections through thermo-compression using a flip-chip bonder.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** SHARMA, Abhishek (CERN); Dr LALE, Ahmet; DANNHEIM, Dominik (CERN); CALDERINI, Giovanni (LPNHE-Paris, Centre National de la Recherche Scientifique (FR)); VICENTE BARRETO PINTO, Mateus (Universite de Geneve (CH)); LAUSER, Moritz (KIT - Karlsruhe Institute of Technology (DE))

**Presenter:** Dr LALE, Ahmet

**Session Classification:** WG7/WP4

Contribution ID: 25

Type: **WG6 - Wide bandgap materials**

## Improving spatial and temporal resolution of 3D diamond detectors using TPA characterisation and neural network

*Thursday, 13 November 2025 16:10 (20 minutes)*

3D diamond detectors feature conductive column arrays fabricated within Chemical Vapour Deposition (CVD) diamond using femtosecond-laser graphitization. In this work, several 3D geometries are simulated, with electric fields simulated in Sentaurus TCAD and signal responses studied via Monte Carlo simulations using Garfield++. Then a Neural Network (NN)-based algorithm is developed to analyse signal waveforms and enhance spatial and temporal resolutions by predicting the hit position and time of arrival. Detector prototypes with various electrode configurations are fabricated using a femtosecond laser system equipped with a Spatial Light Modulator (SLM). The Two-Photon Absorption (TPA) technique is employed to generate localized charge distributions inside the sensors, enabling high-resolution characterization. The prototypes are further tested with CERN SPS test beam to evaluate detector performance under realistic experimental conditions.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** LI, Huazhen (The University of Manchester (GB))

**Session Classification:** WG6/WP3 - Wide bandgap detectors

Contribution ID: 26

Type: **WG8 - Outreach and dissemination**

## MAPS Academy in KEK

*Friday, 14 November 2025 11:15 (20 minutes)*

The MAPS Academy was held at KEK, Japan, for one week in July 2025. The program aimed to enhance early career researchers' understanding of CMOS-MAPS technology and to provide a foundation for developing advanced detector systems. Supported by DRD3, the school received more than 60 applications, and 20 participants from 10 countries were selected to attend lectures and hands-on sessions on semiconductor detectors, simulation, and design. The participants actively engaged in discussions and practical exercises, leading to deeper technical understanding and stronger international connections. Based on the positive outcomes, we plan to continue the MAPS Academy as a recurring educational program to further promote collaboration and skill development in detector R&D. The next edition of the MAPS Academy is planned to be held at SLAC in 2026.

The presentation will describe the structure of the school and briefly its lectures and hands-on. The feed-back from the students of the first edition will also be reviewed.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

III. other (please specify in comment field)

**Author:** OKAZAKI, Yuta (KEK High Energy Accelerator Research Organization (JP))**Co-authors:** VERNIERI, Caterina (SLAC National Accelerator Laboratory (US)); BAUDOT, Jerome (IPHC - Strasbourg); ENARI, Yuji (KEK High Energy Accelerator Research Organization (JP))**Presenter:** OKAZAKI, Yuta (KEK High Energy Accelerator Research Organization (JP))**Session Classification:** WG8 - Dissemination & outreach

Contribution ID: 27

Type: **WG2 - Hybrid silicon sensors**

## Development of 3D silicon pixel sensors at USTC

*Tuesday, 11 November 2025 09:41 (16 minutes)*

Unlike the planar detector, the distance of electrodes and the thickness of substrate is decoupling in 3D silicon detector. According to the shapes of electrodes, 3D sensors can be divided into two types: the columnar electrodes and the trenched electrodes. Through shortening the distance between the electrodes, the sensor can provide higher position resolution and can also be more irradiation tolerant due to the decreased trapping probability of carriers. However, the electrode itself can form the inactive area when the particle vertically passes through the top of the sensor. Nowadays, the electrodes with 5  $\mu\text{m}$  or less in diameter have been fabricated. Typically, in order to withstand the fluence of  $1 \times 10^{16}$   $n_{\text{eq}}/\text{cm}^2$ , the ATLAS Inner Tracker (ITk) will use 3D sensors with 5  $\mu\text{m}$  diameter columnar electrodes and small pixel cells ( $50 \times 50 \mu\text{m}^2$  and  $25 \times 100 \mu\text{m}^2$ ) which are fabricated by the FBK (Italy), CNM (Spain) and SINTEF (Norway). In addition, the time resolution of 3D sensors has been investigated which shows great potential to realize the 4D tracking. Recently, the USTC group is concentrated on the development of very small pitch, ultra thin 3D sensors whose active thickness is 50  $\mu\text{m}$  and pixel cells is  $50 \times 50 \mu\text{m}^2$  and  $25 \times 25 \mu\text{m}^2$ . This talk will present the design, fabrication and characterization of the first batch 3D sensors at USTC.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Author:** MA, Kuo (University of Science and Technology of China (CN))**Co-authors:** Mr ZHANG, De (University of Science and Technology of China); Mr WANG, Tian'ao (University of Science and Technology of China); LIU, Yanwen (University of Science and Technology of China (CN))**Presenter:** MA, Kuo (University of Science and Technology of China (CN))**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 28

Type: **WG4 - Simulations**

## RASER simulation of 4D tracking detectors

*Thursday, 13 November 2025 09:00 (20 minutes)*

We have extended RASER (RAdiation SEMiconductoR), a Python-based simulation package for solid-state particle detectors, to enable the simulation of pixelated silicon and silicon carbide (SiC) timing sensors. The spatial and temporal resolution of these sensors is evaluated through simulations of telescope beam tests and the transient current technique (TCT). By integrating DevSim and NGSpice, a fully open-source simulation framework is established.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** FU, Chenxi (Chinese Academy of Sciences (CN)); FENG, Jian (Southwest Jiaotong University); ZHONG, Dai (Xiangtan University); CAI, Ziyin (Xiangtan University)

**Presenter:** FU, Chenxi (Chinese Academy of Sciences (CN))

**Session Classification:** WG4 Simulations

Contribution ID: 29

Type: **WG4 - Simulations**

# A TCAD Simulation Framework for DLTS-based Defect Characterisation in Solid-State Particle Detectors

*Thursday, 13 November 2025 10:00 (20 minutes)*

The increasing radiation levels expected in future high-luminosity collider experiments demand robust predictive models for the design and optimisation of semiconductor particle detectors operating under extreme fluences (above  $1 \cdot 10^{16}$   $1 \text{ MeV } n_{eq}/\text{cm}^2$ ). Although TCAD-based modelling of radiation damage has evolved over the past two decades, a general-purpose model capable of reliably simulating the macroscopic effects of deep-level defects is still lacking.

This work presents a TCAD simulation framework designed to reproduce Deep Level Transient Spectroscopy (DLTS) spectra and Arrhenius plots, enabling the extraction and refinement of trap characteristics –namely concentration, activation energy, and capture cross-section –and their direct implementation into numerical radiation damage models. In particular, the activities carried out so far include the reproduction of DLTS spectra based on current transient measurements (I-DLTS) following laser-induced charge carrier injection for  $\text{CiO}_i$  and  $\text{BiO}_i$  defects, using the developed TCAD framework. Additionally, the numerical strategies adopted to ensure convergence at cryogenic temperatures (below 250 K), as required by the operating conditions of the DLTS climate chamber, are presented. These include the tuning of mathematical parameters (e.g. number of Newton iterations, extended precision floating-point arithmetic, error criteria) and the implementation of specific workarounds, such as artificially increasing the charge carrier generation rate.

To evaluate the reliability of the proposed framework, a benchmark procedure is defined, using DLTS measurements as reference data to validate the simulated defect response. This enables a systematic assessment of the “effectiveness” of each trap in reproducing key device-level observables such as leakage current, depletion voltage, and charge collection efficiency.

By bridging the gap between microscopic defect spectroscopy and macroscopic device simulation, the framework lays the groundwork for general-purpose TCAD models applicable across semiconductor materials and fluence regimes. This approach enhances the predictive power of simulation tools and supports the development of radiation-hard detectors for future collider environments.

## Type of presentation (in-person/online)

in-person presentation

## Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** CROCI, Tommaso (INFN, Perugia Unit); FONDACCI, Alessandro (Università and INFN Perugia (IT)); GURIMSKAYA, Yana; MOLL, Michael (CERN); MOROZZI, Arianna (INFN, Perugia (IT)); MOSCATELLI, Francesco (IOM-CNR and INFN, Perugia (IT)); Prof. PASSERI, Daniele (Università)

e INFN Perugia (IT); RIZWAN, Faiza (Cern); SORGENFREI, Niels (CERN / University of Freiburg (DE))

**Presenter:** CROCI, Tommaso (INFN, Perugia Unit)

**Session Classification:** WG4 Simulations

Contribution ID: 30

Type: **WG3 Radiation Damage - Extreme Fluence**

## Study of radiation damages at extreme fluences by Infrared Spectroscopy

*Wednesday, 12 November 2025 12:35 (20 minutes)*

Study of Si detectors for radiation tolerance at extreme fluences up to  $1e18$  neq/cm<sup>2</sup> has been suffering with numerous challenges. Defects created in the crystal lattice, compensate the doping by trapping the free charge carriers, causing the depletion region to collapse. Resultantly, the electrical defect characterization tools become ineffective. This moves our attention towards the optical characterization tools such as FTIR spectroscopy. Incoming light undergoes resonance with different vibrational modes of the bonds present in the crystal structure; hence we get characteristic peaks belonging to a particular set of defects. In the present study FTIR spectrum of Si pieces irradiated to extreme neutron fluences at room and low temperatures is presented. Results from newly acquired FTIR spectrometer at CERN are also displayed and concentration of defects is calculated.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Author:** Dr RIZWAN, Faiza (CERN)**Co-authors:** TEYSSIER, Jérémie (Geneva University); MOLL, Michael (CERN)**Presenter:** Dr RIZWAN, Faiza (CERN)**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 31

Type: **WG2 - Hybrid silicon sensors**

## Radiation hardness of 24 GeV proton and mixed irradiated LGADs for ATLAS High Granularity Timing Detector

*Wednesday, 12 November 2025 10:12 (16 minutes)*

ATLAS experiment will be upgraded with High Granularity Timing Detector (HGTD) for the high luminosity runs at Large Hadron Collider after 2029. It will utilize LGAD detectors placed in very harsh radiation environment. During the R&D phase sensors with carbon enriched gain layer were designed showing sufficient radiation hardness after reactor neutron irradiations of up to  $\Phi_{eq} = 2.5 \cdot 10^{15} \text{ cm}^{-2}$ . The composition of the particles at HGTD will change with the distance from the beam pipe. Around 50% of the Non-Ionizing Energy Loss (NIEL) will come from charged hadrons at the innermost part of HGTD (12 cm) and around 10% at the outermost part (65 cm). In order to study the radiation damage of highly energetic charged hadrons, LGADs from HGTD pre-production were irradiated with 24 GeV p at CERN-PS. The acceptor removal constant of protons was found to be almost three times larger than that of the reactor neutrons at the same NIEL. After proton irradiations the sensors were irradiated also with neutrons. When accounted for the difference in acceptor removal constant the amount of removed acceptors in mixed irradiated samples scales with the sum of the delivered equivalent fluences of protons and neutrons. The impact on HGTD performance was simulated and although substantially higher removal for charged hadrons the running scenario of the HGTD is robust enough to allow efficient operation over the life time of the experiment.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** HITI, Bojan (Jozef Stefan Institute (SI)); KRAMBERGER, Gregor (Jozef Stefan Institute (SI))

**Presenter:** HITI, Bojan (Jozef Stefan Institute (SI))

**Session Classification:** Joint WG2-WG3

Contribution ID: 32

Type: WG3 Radiation Damage - Extreme Fluence

## Radiation hardness and annealing studies of double irradiated silicon diodes produced on 8-inch wafers for CMS HGICAL

*Wednesday, 12 November 2025 15:00 (20 minutes)*

To face the higher levels of radiation due to the 10-fold increase in integrated luminosity during the High Luminosity LHC, the CMS detector will replace the current endcap calorimeters (CE) with the new High Granularity Calorimeter (HGICAL). It will facilitate the use of particle flow calorimetry with its unprecedented transverse and longitudinal readout and trigger segmentation, with more than 6M readout channels. The electromagnetic section as well as the high-radiation regions of the hadronic section of the HGICAL will be equipped with silicon pad sensors, covering a total area of 620m<sup>2</sup>.

The sensors are processed on novel 8-inch p-type wafers with active thicknesses of 300µm, 200µm, and 120µm and cut into hexagonal shapes for optimal use of the wafer area and tiling. With each main sensor, several small-sized test structures are hosted on the wafers, used for quality assurance and radiation hardness tests. In order to investigate the radiation-induced bulk damage, the diode test structures of these sensors have been irradiated with neutrons at JSI (Jozef Stefan Institute, Ljubljana).

A previous annealing study has been performed on silicon diodes from neutron irradiation with fluences from 2e15neq/cm<sup>2</sup> to 1.5e16neq/cm<sup>2</sup>. In a more realistic operational scenario, the detector experience a cumulative increase of fluence during its expected life-time of ten years, with technical stops in-between allowing the silicon sensors to anneal, to finally reach expected fluences up to 1.5e16neq/cm<sup>2</sup> and doses up to 1.5 MGy.

In this new study, silicon diodes were irradiated with neutrons in a first round to fluences between 5e14neq/cm<sup>2</sup> and 4e15neq/cm<sup>2</sup>, and subsequently annealed at three different temperatures, 20°C, 40°C, and 60°C, within the expected beneficial annealing window. In the second irradiation step, the same silicon diodes were further irradiated to end-of-lifetime fluences between 2e15neq/cm<sup>2</sup> and 1.5e16neq/cm<sup>2</sup>, now consistent with the previous annealing studies. In this talk, the electrical characterisation and charge collection measurements from both irradiation rounds will be presented and compared with results from the full fluence annealing study.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** SICKING, Eva (CERN); KALFA, Ioanna (CERN); DIEHL, Leena (University of Zurich (CH)); MUEHLNIKEL, Marie Christin (CERN); ANDERSSON, Max (Uppsala University (SE))

**Presenter:** ANDERSSON, Max (Uppsala University (SE))

**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 33

Type: **WG6 - Wide bandgap materials**

## Impact of neutron irradiation on carrier dynamics in high-quality epitaxial GaN

*Thursday, 13 November 2025 17:30 (20 minutes)*

Gallium nitride (GaN) is a key semiconductor material for optoelectronic and high-power applications such as light-emitting diodes (LEDs), laser diodes, and high electron mobility transistors (HEMTs). Owing to its wide bandgap (3.4 eV), high thermal stability, and large displacement energy, GaN is also a promising candidate for ionizing radiation detection under extreme conditions. For such applications, high crystalline quality with low unintentional doping and low dislocation density is essential, which can be achieved by epitaxial growth on native GaN substrates.

In this study, GaN epitaxial layers grown on ammonothermal GaN substrates were fabricated at the Institute of High Pressure Physics, Polish Academy of Sciences (UNIPRESS), within the framework of DRD3 project "Development of radiation-hard GaN devices for MIP detection." The samples were subjected to neutron irradiation at the Ljubljana TRIGA reactor with fluences ranging from  $1 \times 10^{12}$  to  $1 \times 10^{17}$  cm<sup>-2</sup>.

To assess the effects of irradiation-induced defects, carrier recombination dynamics were investigated using contactless microwave-probed photoconductivity transients and femtosecond pump-probe techniques. Complementary photoluminescence measurements were performed to evaluate changes in optical properties. The correlation between neutron fluence, carrier lifetime, and PL response provides insight into defect generation and its impact on the optoelectronic quality of GaN.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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Contribution ID: 34

Type: **WG6 - Wide bandgap materials**

# Temperature-Dependent Electrical Characterization of GaN Homoepitaxial Schottky Diodes for Radiation Detection

*Thursday, 13 November 2025 17:10 (20 minutes)*

Wide band-gap (WBG) semiconductors such as SiC and GaN are increasingly driving advances in high-efficiency, high-power electronics. With improved substrate growth and reduced defect densities, these materials have also emerged as promising candidates for radiation detection. However, further characterization and optimisation is required before they can replace silicon for some applications.

GaN's wide band gap (3.4 eV) and strong Ga-N bond suggest excellent thermal and radiation resilience. While several studies have demonstrated GaN-based radiation detector, these typically use GaN epitaxial layers grown on Si, SiC, or sapphire. The performance of true GaN-on-GaN devices under harsh environments remains insufficiently understood. For broader adoption in high-radiation settings it will require further development and characterisation<sup>1, 2</sup>.

In this work, Schottky diodes of varying geometries were fabricated on an n-type GaN bulk wafer with an n<sup>-</sup> epilayer. Following metal rapid thermal annealing, the devices were characterized via current-voltage (I-V) and capacitance-voltage (C-V) measurements, exhibiting typical Schottky behaviour with design-dependent variations. However, they have displayed high leakage current, which is detrimental to their application as radiation detectors. To gain deeper insight into the underlying physical mechanisms driving the observed trends, temperature-dependent I-V and C-V measurements were carried out and the results are systematically analysed in the present contribution.

1. Capan I. Wide-Bandgap Semiconductors for Radiation Detection: A Review. *Materials*. 17 (5). 2024.
2. Vaitkus J, et al. Semi-insulating GaN and its evaluation for  $\alpha$  particle detection. *Nucl. Instrum. Methods Phys. Res. Section A*. 509 (1-3). 2003.

## Type of presentation (in-person/online)

in-person presentation

## Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** NICKSON, Jack (IMB-CNM)

**Session Classification:** WG6/WP3 - Wide bandgap detectors

Contribution ID: 35

Type: **WG2 - Hybrid silicon sensors**

## Investigation of Spatial Patterns of Elevated Cell Leakage Currents in HGAL Silicon Sensors

*Tuesday, 11 November 2025 11:23 (16 minutes)*

The High-Granularity Calorimeter (HGAL) of the CMS experiment at CERN uses radiation-hard, fast-response silicon sensors to maintain stable and precise operation during HL-LHC conditions. The sensors are fabricated on 8-inch p-type wafers with three different thicknesses (120  $\mu\text{m}$ , 200  $\mu\text{m}$ , and 300  $\mu\text{m}$ ), two main granularities ( $\sim 0.5 \text{ cm}^2$  and  $\sim 1 \text{ cm}^2$  for standard cells), as well as so-called full-sensor and multi-geometry-sensor masks.

During the main production phase from February 2023 to May 2025, the manufacturer Hamamatsu performed quality control tests on all  $\sim 25000$  wafers, including per-cell current-voltage (IV) and capacitance-voltage (CV) measurements, as part of the vendor qualification process before delivery to CERN.

The presented data analysis is based on these IV measurements, focusing on cells and regions with elevated but moderate leakage currents (e.g., a few nA for cells of  $\sim 1 \text{ cm}^2$ ), which are hereafter referred to as “hot” cells. A volume normalization is applied to account for differences in cell geometry and type.

Distinct spatial patterns of hot cells were identified across certain wafer regions and delivery times, differing between sensor variants. Although a direct impact on the detector performance has not been established, these observations provided valuable feedback to the production process at the time and supported subsequent improvements in sensor quality.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** SIMSEK, Ebru (Yildiz Technical University (TR)); SICKING, Eva (CERN); TOK, Ufuk Guney (Cukurova University (TR))

**Presenter:** SIMSEK, Ebru (Yildiz Technical University (TR))

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 36

Type: WG3 Radiation Damage - Extreme Fluence

## Annealing effects on highly n-doped layers in Resistive AC-coupled Silicon Detectors (RSD/AC-LGAD)

*Wednesday, 12 November 2025 16:30 (20 minutes)*

Resistive AC-coupled Silicon Detectors (RSD/AC-LGAD) are novel silicon sensors that provide both precise spatial and temporal resolution, making them a key technology for the next generation of collider experiments (HL-LHC, FCC, CEPC). Like all silicon devices, these sensors suffer from irradiation damage which create additional states in the silicon band gap that lead to macroscopic changes, such as increased leakage current or changes in effective donor concentration. Annealing studies of irradiated sensors allow for detailed analysis of the defects created inside of silicon during irradiation. Traditionally, annealing studies focus on studying the sensor bulk with detailed IV, CV, and Charge Collection measurements. However, this study focuses on the resistive n+ layer, which is a thin, highly n-doped layer crucial for the charge spread (spatial reconstruction) in RSDs/AC-LGADs. The donor doping is monitored with sheet resistivity measurements via dedicated test structures. As the structures are irradiated, the sheet resistance increases due to donor removal. This study focuses on understanding the mechanism of donor removal by observing how the sheet resistance changes with annealing at low and high temperatures. It is important to assess how irradiation and annealing accumulated during a technical stop at a collider experiment, affect the sheet resistance and the charge sharing mechanism in these devices. The results of this study also demonstrate that simple sheet resistance measurements are a powerful tool for defect analysis in thin, highly n-doped silicon layers.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenters:** LOSANA, Aurora (università di Torino); REGNERY, Brendan (KIT - Karlsruhe Institute of Technology (DE))

**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 37

Type: **WG1 - Monolithic Sensors**

## First results of COFFEE3, a small prototype for 55nm HVCMOS validation

*Monday, 10 November 2025 14:15 (20 minutes)*

The HVCMOS technology is promising technology for tracking detectors at future experiments such as LHCb upgrade and Higgs factories, for its radiation hardness, fast charge collection and hence good spatial and timing resolution. Development of HVCMOS in smaller feature size will allow more functionalities in the same pixel area, and a reduced power consumption. We proposed a project to develop HVCMOS sensor prototypes using 55nm CMOS process based on initial validation of the process. A small prototype sensor chip, COFFEE3, was submitted in January 2025 which features two pixel arrays with completely different readout architectures. Both are designed aiming at 10 micron spatial resolution and a few nanosecond timing resolution, with moderate power consumption. This talk will report the first test results of the COFFEE3 chips, validating the basic functionalities. Future development plan will also be briefly discussed.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** XU, Zijun (Chinese Academy of Sciences (CN))

**Session Classification:** WG/WP1 - CMOS technologies

Contribution ID: 38

Type: **WG3 Radiation Damage - Extreme Fluence**

## Investigation of point defects in silicon supercells using density functional theory

*Wednesday, 12 November 2025 14:20 (20 minutes)*

Neutral and charged point defects in silicon supercells containing vacancies and/or extrinsic impurities (B, P, C, O) are investigated using density functional theory (DFT) calculations. We consider a number of defects and determine the formation energies and the transitions between the charged states. The electronic structure is analyzed in detail, the focus being on defects that can explain the acceptor removal process (ARP).

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** NEMNES, George Alexandru (Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering)

**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 39

Type: **WG3 Radiation Damage - Extreme Fluence**

## Donor removal and Global Gain Quenching (GGQ) in nLGAD detectors

*Wednesday, 12 November 2025 14:40 (20 minutes)*

nLGAD detectors are specifically designed for detecting shallow-penetrating radiation. In our previous work, we tested these devices using low-wavelength lasers and achieved reasonable detectability down to 200 nm. In this work, we explore the potential of nLGADs for the detection of shallow-penetrating ions, aiming to evaluate their gain and response to induced damage. Using Ion Beam Induced Charge (IBIC) technique, the nLGAD detector was probed with 1.285 MeV gallium ions, showing clear gain suppression. Additionally, local damage was induced with the same ion type at a low fluence of  $4 \times 10^9$  ions/cm<sup>2</sup>, revealing two effects: first, the donor removal mechanism occurs much faster than the acceptor removal, making nLGADs more prone to damage; and second, the local damage affected the gain across the entire device. This effect was termed Global Gain Quenching (GGQ). Finally, we present the first attempt to microscopically evaluate the donor removal mechanism using Thermally Stimulated Current (TSC) measurements and hypothesize the defect mechanism responsible for such pronounced vulnerability.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 40

Type: **WG1 - Monolithic Sensors**

## Porting the MALTA chip to the 65 nm TPSCo node: Conceptual Design Overview

*Monday, 10 November 2025 17:45 (20 minutes)*

The existing MALTA design is employing low capacitance of the collection electrode together with full depletion of the sensitive volume and is fabricated in Tower 180 nm technology. Currently, further development of the MALTA chip is shifting towards substantially better timing performance (timing resolution <500 picoseconds) as well as improved integration capabilities of the sensor in larger (>2×2 cm<sup>2</sup>) matrices while maintaining the radiation hardness at the 2×10<sup>15</sup> neq/cm<sup>2</sup> NIEL achieved with the MALTA2 chip. The underlying objective is the improvement of radiation resilience which indicates the need for a deep submicron CMOS processes. For the MALTA chip technology scaling will dictate a move to the TPSCo 65 nm CMOS process.

In this presentation, we will provide a conceptual design overview that will allow the porting of the current MALTA design to the 65 nm technology node. By systematically combining advanced CMOS circuit, architecture, and process level radiation hardening techniques with optimized circuit design methodologies, we can significantly enhance the analog and mixed-signal performance of event-based silicon pixel sensors without affecting its radiation tolerance.

A first focus area will be the Analog-Front-End where we will exploit the increased capabilities provided by the 65 nm technology node to: improve signal-to-noise ratio thus enhancing sensitivity to particle signals while enabling lower operation voltage; offer increased robustness of the sensor against the degrading effects of radiation exposure; and implement a calibration and functional monitoring strategy. A second focus area will be on the optimization of the digital periphery for higher data throughput, improved integration capabilities, and radiation resilience. To push towards sub-nanosecond timing resolution, we envision the implementation of a simple memory synchronization scheme in an otherwise asynchronous, event-based operation mode. To mitigate risk and overcome potential design bottlenecks, we will follow an incremental approach where the most challenging design aspects will first be implemented in smaller, standalone test chips still in the 65 nm technology node.

We will present in some detail the above ideas while justifying the move to the 65nm technology node. Where possible, experience gained from previous applications will be included. To ensure robust performance, we will outline a comprehensive verification and testing strategy to be employed while acknowledging potential challenges.

### **Type of presentation (in-person/online)**

in-person presentation

### **Type of presentation (I. scientific results or II. project proposal)**

I. Presentation on scientific results

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**Presenters:** SOLANS SANCHEZ, Carlos (CERN); KOFFAS, Thomas (Carleton University (CA))

**Session Classification:** WG/WP1 - CMOS technologies

Contribution ID: 41

Type: **WG3 Radiation Damage - Extreme Fluence**

## **Defect investigation on n-type Schottky diodes based on 4H-SiC before and after irradiation with 6 MeV electrons**

*Wednesday, 12 November 2025 17:10 (20 minutes)*

We present the results of DLTS investigation of as-grown and radiation-induced defects in **n-type 4H-SiC Schottky diodes** irradiated with different fluences of **6 MeV electrons**. The only variable between the samples has been the irradiation fluence, varying from unirradiated state up to fluences as high as  $6E14$  e/cm<sup>2</sup>. The DLTS spectra were analyzed and simulated to extract the defect parameters. The study also examined the annealing **behavior of defects up to 750 K** (~477°C).

The results are correlated with current literature and discussed in terms of **defect evolution, thermal stability and possible chemical identification**.

### **Type of presentation (in-person/online)**

online presentation (zoom)

### **Type of presentation (I. scientific results or II. project proposal)**

I. Presentation on scientific results

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**Presenter:** BONI, Andra-Georgia (National Institute of Materials Physics –Romania)

**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 42

Type: **WG2 - Hybrid silicon sensors**

## Technological development and performance of Low Gain Avalanche Detectors with and without carbon co-doping at IMB-CNM

*Wednesday, 12 November 2025 09:54 (16 minutes)*

IMB-CNM has been a main actor in the development of Low Gain Avalanche Detectors since the initial device conception, more than a decade ago.

One of the challenges for LGAD is the deterioration of the gain and timing resolution after radiation damage due to the acceptor removal mechanism.

A well-established solution to increase radiation tolerance is carbon co-doping in the gain layer. Also, the IMB-CNM's Radiation Detectors Group has revisited its strategy regarding the technological design.

This contribution aims at summarizing the development and performance of the new LGAD technology with and without carbon co-doping at IMB-CNM.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** DOUGADOS, Florent (Consejo Superior de Investigaciones Cientificas (CSIC) (ES))

**Session Classification:** Joint WG2-WG3

Contribution ID: 43

Type: **WG5 - Characterization techniques - facilities**

## Response of diamond radiation detectors operated at high electric fields

*Thursday, 13 November 2025 16:50 (20 minutes)*

Due to their inherent properties, Chemical Vapor Deposition (CVD) diamond detectors are often highly appealing solutions in the field of nuclear technology, in applications where radiation sensors are expected to provide reliable response in harsh conditions and under high fluences in mixed radiation environments. Moreover, today's technological challenges require the development of particle detectors with increased detection sensitivity to low ionization density radiation.

On the contrary, the radiation damage in diamond detectors is manifested primarily in the deterioration of the signal pulse height. Similarly, studies of diamonds response in low temperatures have revealed a significant reduction of their signal below 120 K, due to the formation of excitons. As such, the diamond detectors performance in the aforementioned challenges is often limited.

Even though diamond single crystal can withstand extremely high electric fields, investigations of the charge transport properties of such detectors under high electric field are scarce. In the present contribution we report on recent results of charge transport on scCVD diamond detectors, operated in electric fields, from 10 V/um up to several hundreds of V/um. Examples showing the enhancement of diamonds signal after radiation damage as well as in cryogenic temperatures, when operated in high fields, will be presented. In addition, charge multiplication and avalanche processes observed in the higher operation fields will be highlighted.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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Contribution ID: 44

Type: **WG2 - Hybrid silicon sensors**

## Performance of irradiated TI-LGADs at 120 GeV SPS pion beams

*Tuesday, 11 November 2025 14:32 (16 minutes)*

Trench-isolated LGADs (TI-LGADs), developed at FBK, are devices in which pixelated LGAD pads are separated by physical trenches etched into the silicon substrate and filled with a dielectric material. Designed as an alternative to implant-based inter-pad isolation techniques (such as JTEs), this technology offers a significant reduction in dead regions, thereby mitigating fill-factor limitations inherent to small-pixel LGAD matrices.

In this study, we present results from a 120 GeV pion test beam campaign at CERN SPS using carbon-infused single-trench TI-LGADs with varying trench widths. Investigated samples were irradiated with neutrons up to a fluence of  $2.5 \times 10^{15}$  neq/cm<sup>2</sup>. Tracking information provided by a MIMOSA26-based beam telescope and time information from a reference LGAD detector are used to evaluate the TI-LGAD efficiency, spatially resolved time resolution and inter-pixel performance. Preliminary results from April and October 2025 campaigns will be shown.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 45

Type: **WG3 Radiation Damage - Extreme Fluence**

## TI-LGADs for PPS2 Timing Detector Upgrade

*Wednesday, 12 November 2025 09:36 (16 minutes)*

The PPS sub-detector of CMS, in operation since 2016, has shown exceptional performance, operating tracking and timing detectors in the challenging high radiation environment a few millimetres from the LHC beam. During Long Shutdown 3 the PPS detector will be upgraded with additional stations and a new timing detector based on LGAD+ETROC. The high and non-uniform irradiation requires dedicated techniques for radiation damage mitigation and a custom pixel geometry to meet operational requirements. FBK has been contracted to produce a custom TI-LGAD Pre-Production for PPS2, implementing the custom pixel geometry. Additional geometry variations, for optimising PPS2 physics acceptance have been implemented.

Standard LGADs, from the UFSD4 production, have been exposed to non-uniform irradiation gradients mimicking the extreme conditions expected in PPS2 with peak fluences up to  $1E16$  p/cm<sup>2</sup>. Post irradiation, the IV characteristics of these sensors have been measured, compatible with community data from uniform irradiation. Work is ongoing on characterising these non-uniform irradiated sensors using test beam data.

Once delivered, the PPS2 TI-LGAD Pre-Production devices will be characterised before irradiation and after uniform and non-uniform irradiation, using the same procedures established with the standard UFSD4 LGADs. In preparation for these activities, a suite of multi-channel systems are being developed, with a test beam setup supporting up to 96 channels operating the sensors down to -30 C and a pogo-pin based test setup for multichannel IV measurements. The multichannel system is essential for evaluating the non-uniform irradiated devices across the irradiation gradient.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** BEIRAO DA CRUZ E SILVA, Cristovao (Laboratory of Instrumentation and Experimental Particle Physics (PT))

**Session Classification:** Joint WG2-WG3

Contribution ID: 46

Type: **WG3 Radiation Damage - Extreme Fluence**

## Study of Irradiation-Induced Defects in EPI silicon PINs and LGADs by c/iDLTS

*Wednesday, 12 November 2025 11:55 (20 minutes)*

Low Gain Avalanche Detectors (LGADs) exhibit excellent properties, including ultra-fast time resolution and a high signal-to-noise ratio. They are widely used in high-energy physics experiments for precise particle detection and time-of-flight measurements. However, irradiation introduces deep-level defects and causes detector performance degradation. Therefore, improving the radiation hardness of LGADs is essential. In this work, capacitance-transient deep-level transient spectroscopy (c-DLTS) and current-transient deep-level transient spectroscopy (i-DLTS) were employed to investigate PINs and LGADs after various proton irradiation fluences up to  $8 \times 10^{14}$  Neq/cm<sup>2</sup>. The defects of LGAD was observed by c/iDLTS method which has different defects energy level compared with PIN. We will show the tested defects of PIN and LGAD after  $1 \times 10^{13}$  Neq/cm<sup>2</sup> proton irradiation. And we will also show the defects of LGAD with different carbon dose after  $8 \times 10^{14}$  proton irradiation.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** Dr FAN, Yunyun (Chinese Academy of Sciences (CN))

**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 47

Type: **WG5 - Characterization techniques - facilities**

## Advancements and future expansions of the Caribou DAQ system

*Thursday, 13 November 2025 12:30 (20 minutes)*

Caribou is a versatile data acquisition (DAQ) system developed within several collaborative frameworks (CERN EP R&D, DRD3, AIDAInnova, and Tangerine) to support laboratory and test-beam characterization of novel silicon pixel detectors. It combines a custom Control and Readout (CaR) board with a Xilinx Zynq System-on-Chip (SoC) running project-wide shared firmware and software stacks. The system architecture emphasizes reusability, flexibility, and ease of integration. The CaR board provides essential interfaces such as programmable power supplies, voltage and current references, high-speed ADCs, and configurable I/O lines for detector control and readout. The SoC runs an embedded Linux distribution built with PetaLinux and integrates two main components: Peary, a C++ embedded DAQ application providing hardware abstraction, configuration management, logging, and multi-device control through Command Line (CLI) and Python interfaces; and Boreal, a common Caribou FPGA firmware framework offering reusable modules and automated build workflows for user-specific bit files.

The next major milestone in Caribou's evolution is the transition to version 2.0, based on a Zynq UltraScale+ System-on-Module (SoM) architecture. Compatibility with UltraScale+ MPSoC evaluation platforms such as the AMD ZCU102 and the Enclustra Mercury+ ST1/XU1 has already been demonstrated, paving the way for the integration of the SoC directly onto the CaR board and the removal of external evaluation platforms.

Recent progress in the Caribou project includes the development of a test bench for CaR board v1.5 validation and first results from a dedicated test board that was developed to validate components for the future CaR board v2.0. In parallel, the Peary embedded application architecture is being revised to support multiple boards and platforms, and some of the Boreal FPGA firmware modules are being migrated to the UltraScale+ platform. This presentation will provide an overview of the current status, recent progress and future prospects of the project.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Author:** OTARID, Younes (CERN)**Co-authors:** YOU, Changbum (Carleton University (CA)); DANNHEIM, Dominik (CERN); BUSCHMANN, Eric (Brookhaven National Laboratory (US)); CHEN, Hucheng (Brookhaven National Laboratory (US)); KAMOISIS, Ilias (CERN and Aristotle University of Thessaloniki (GR)); BENOIT, Mathieu (Oak Ridge National Laboratory (ORNL)); ST-JEAN, Ryan (Carleton University (CA)); TANG, Shaochun (Brookhaven National Laboratory (US)); SPANNAGEL, Simon (Deutsches Elektronen-Synchrotron (DE)); KOFFAS, Thomas (Carleton University (CA)); VANAT, Tomas (Deutsches Elektronen-Synchrotron (DE))

**Presenter:** OTARID, Younes (CERN)

**Session Classification:** WG5 - Characterization techniques, facilities

Contribution ID: 48

Type: **WG1 - Monolithic Sensors**

# The OCTOPUS project: optimizing monolithic active pixel sensors for the next generation of lepton collider experiments

*Monday, 10 November 2025 17:05 (20 minutes)*

The OCTOPUS (Optimized CMOS Technology for Precision in Ultra-thin Silicon) project, part of the DRD3 collaboration, aims to develop Monolithic Active Pixel Sensors (MAPS) based on the TPSCo 65 nm CMOS process, designed to meet the key requirements of vertex detectors operating in the next generation of lepton colliders.

The sensor development is planned in two stages. The first large-area prototype will be a 50  $\mu\text{m}$ -thick beam telescope demonstrator, targeting a spatial resolution of 3  $\mu\text{m}$ , a hit rate capability of approximately 100 MHz/cm<sup>2</sup>, a time resolution of 100 ns, and an average power consumption below 500 mW/cm<sup>2</sup>. The final chip —a 50  $\mu\text{m}$ -thick, full-reticle vertex detector demonstrator —aims to achieve a time resolution of 5 ns and an average power consumption below 50 mW/cm<sup>2</sup>, while maintaining the 3  $\mu\text{m}$  spatial resolution.

The project brings together 13 European institutes involved in a broad range of R&D activities, including sensor layout design and optimization using TCAD modeling and Monte Carlo simulations, ASIC design and verification, DAQ development for prototype testing, and sensor characterization to validate performance against project requirements.

This contribution presents an overview of the project, with a focus on the modeling and design of the readout architecture concepts for the first pixel sensor prototype.

## Type of presentation (in-person/online)

in-person presentation

## Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** RUSSO, Roberto (Austrian Academy of Sciences (AT))

**Session Classification:** WG/WP1 - CMOS technologies

Contribution ID: 49

Type: **WG2 - Hybrid silicon sensors**

## Study of Ti-LGAD for low penetrating radiation

*Tuesday, 11 November 2025 12:35 (16 minutes)*

This study investigates the inter-pixel distance (IPD) of 250  $\mu\text{m}$ -thick Trench-isolated Low Gain Avalanche Detectors (Ti-LGADs) fabricated by Micron Semiconductor Ltd. Single Photon Absorption (SPA) and Two Photon Absorption (TPA) Transient Current Technique (TCT) scans were performed at the Extreme Light Infrastructure (ELI ERIC) to study the dependence of the effective IPD on interaction depth. The results show that the apparent IPD increases when the interaction occurs near the detector backside and decreases when close to the front-side gain layer. The best IPD measured was around 6 microns. A larger backside IPD corresponds to a lower fill factor, which could limit performance for low-penetrating particles. Ti-LGADs are being investigated as potential imaging sensors coupled to the Timepix3/4 family of ASICs for low-penetrating radiation detection, such as soft X-rays, where small pixel sizes are essential.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** REZAEI MIANROODI, Parisa

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 50

Type: **WG4 - Simulations**

## Simulations of the Monolithic Active Pixel Sensors for the OCTOPUS Project

*Thursday, 13 November 2025 10:20 (20 minutes)*

The OCTOPUS (Optimised CMOS Technology for Precision in Ultra-thin Silicon) project, part of the DRD3 collaboration, aims to simulate, develop, and characterise fine-pitch monolithic sensors using the 65 nm TPSCo CMOS process. The project targets a spatial resolution of 3  $\mu\text{m}$ , a temporal resolution below 5 ns, a material budget of 50  $\mu\text{m}$  of silicon equivalent, and an average power consumption below 50  $\text{mW}/\text{cm}^2$  to meet the requirements of vertex detectors in future lepton collider experiments.

OCTOPUS places significant emphasis on the extensive simulation effort, which aims to improve sensor layouts. This includes simulations of standard process sensor designs with different readout options and moderate pitches of  $\sim 20 \mu\text{m}$ , and a new n-Opt (Optimised) design, which benefits from both increased depletion volume and charge sharing mechanism.

The sensor simulation strategy combines TCAD static simulations using generic doping profiles, transient simulations and high-statistics Monte Carlo simulations, both of which are essential for guiding sensor design and performance optimisation.

To better link OCTOPUS R&D with the development of future lepton collider detectors, a connection between the sensor simulation and Key4hep full simulation will be established using lookup tables of propagated charges for the different sensor layouts designed within the OCTOPUS project.

This contribution presents simulation results for sensors with various pixel pitch configurations, including both standard and n-Opt layouts.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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Contribution ID: 51

Type: **WG2 - Hybrid silicon sensors**

## ML processing and compression of signal shared AC-LGADs

*Tuesday, 11 November 2025 15:26 (16 minutes)*

Resistive Silicon Devices (RSDs), particularly AC-coupled Low Gain Avalanche Diodes (AC-LGADs), open the path of pico-second level space and time (4D) tracking in high-energy physics (HEP) experiments such as those at the Large Hadron Collider (LHC), Electron-Ion Collider (EIC), and future (lepton) colliders facilities. These sensors combine the fine spatial resolution of segmented detectors with the excellent timing performance of LGADs, achieving nearly 100% fill factor. Unlike conventional detectors, typically structured as linear strip arrays (1D) or pixel matrices (2D), RSDs offer a highly flexible geometry for readout pads, allowing for optimization based on experimental demands.

When ionizing radiation interacts with these sensors, the generated charge spreads beyond adjacent pixels. This broad charge sharing, while beneficial for interpolation-based resolution enhancement, is complicated by reduced signal amplitudes and Landau fluctuations on pixels farther from the true hit location. To address these challenges, we study pixelated AC-LGADs fabricated at Brookhaven National Laboratory with different pad geometries, including square and triangular configurations with a  $500\ \mu\text{m} \times 500\ \mu\text{m}$  pitch, and analyze their impact on spatial resolution.

In contrast to previous studies, we leverage full-waveform information from each readout channel and utilize Recurrent Neural Networks (RNNs) to infer the full waveforms of the readout pads, given the hit's position and AC-LGAD structure, thereby reconstructing the hit position. The higher precision achieved by the classical charge-imbalance and geometry-based matrix inversion methods is leveraged by the amount of information processed by the networks, such as identifying optimal trade-offs between spatial granularity and data volume. Initial studies on Transient Current Techniques are used as inputs to further refine the algorithms with particle beams, where Landau fluctuations challenge the readout.

To support real-time applications and reduce computational load, we evaluate waveform rasterization techniques for compressing temporal signal data while preserving critical spatial information. These techniques are essential for future implementation on Field Programmable Gate Arrays (FPGAs) and other low-latency hardware platforms. Additionally, we conduct comparative studies of alternative geometric pad arrangements, assessing how shape and connectivity influence charge collection and algorithmic performance. These combined studies demonstrate the feasibility and scalability of using RSDs with flexible geometries, optimized readout configurations, and machine learning-enhanced reconstruction to meet the stringent resolution and speed requirements of next-generation high-energy physics (HEP) detectors.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** WONG, Don Ching-Long; BARONE, Gaetano (Brown University); TANG, Jessica (Brown University (US))

**Presenters:** WONG, Don Ching-Long; BARONE, Gaetano (Brown University); TANG, Jessica (Brown University (US))

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 52

Type: **WG2 - Hybrid silicon sensors**

## Stress Tests on Low Gain Avalanche Diodes and AC-coupled Low Gain Avalanche Diodes

*Tuesday, 11 November 2025 15:08 (16 minutes)*

Devices with internal gain, such as Low Gain Avalanche Diodes (LGADs), demonstrate O(30) ps timing resolution, and they play a crucial role in High Energy Physics (HEP) experiments, among other applications. Similarly, resistive silicon devices, such as AC-coupled Low Gain Avalanche Diodes (AC-LGADs) sensors, achieve a fine spatial resolution while maintaining the LGAD's timing resolution. However, their performance is strongly affected by environmental factors such as temperature, humidity, and storage conditions. The challenging operating conditions in space impose challenging constraints on the operational performance, against temperature fluctuations, for example. Therefore, devices with different depletion layers and implantation characteristics are tested. A systematic evaluation of the response of these sensors as a function of these environmental parameters is therefore of essential importance when accounting for any application. The precise characterization of resistive silicon devices is experimentally challenging because of the capacitively coupled correlated degrees of freedom involved in the readout. (AC-)LGAD sensors fabricated at the Brookhaven National Laboratory (BNL, US) are characterized at the Silicon Laboratories at BNL, at Brown University, and the RD50/DRD3 facilities at CERN. They are stress-tested against various operating conditions. Previous studies have focused primarily on the electrical characterization of LGAD; now, we focus on the environmental resilience of AC-LGADs and on the signal characterization when ionizing radiation hits those devices.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** BARONE, Gaetano (Brown University); SHEN, Xiaohe (Brown University (US))**Presenters:** BARONE, Gaetano (Brown University); SHEN, Xiaohe (Brown University (US))**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 53

Type: **WG1 - Monolithic Sensors**

## DRD3 Community Shared Submission in LF15A Technology

*Monday, 10 November 2025 14:35 (20 minutes)*

We are organising a DRD3 community shared submission in the 150 nm High Voltage CMOS process (LF15A) from LFoundry. This joint submission will include several chips designed by the DRD3 community to further advance the R&D of High Voltage CMOS sensors for future detector applications in physics experiments. By sharing the wafer among several chips with compatible requirements, this collaborative submission offers a cost-effective route for sensor R&D. The chip design work is currently ongoing and the tape-out is tentatively planned for spring 2026.

The presentation will outline the submission details (such as reticle area, substrate resistivity and available metal layers), show the preliminary reticle floorplan, and provide an overview of the individual chips and their current design status.

### **Type of presentation (in-person/online)**

online presentation (zoom)

### **Type of presentation (I. scientific results or II. project proposal)**

II. Presentation on project proposal

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**Presenter:** VILELLA FIGUERAS, Eva (University of Liverpool (GB))

**Session Classification:** WG/WP1 - CMOS technologies

Contribution ID: 54

Type: **WG2 - Hybrid silicon sensors**

## IV, CV, Fast Timing and Top TCT Measurement Results of the RD50 Common Project Double-Sided 3D Sensors

*Tuesday, 11 November 2025 09:23 (16 minutes)*

Sensors with fast timing capabilities are a critical component for all future tracking detectors to disentangle high multiplicity events. Double-sided silicon 3D sensors utilize columns etched orthogonal to the sensor substrate as their readout electrodes, in contrast to regular, planar detector technologies, where the electrodes are only found on the sensor surface. 3D sensors display, in addition to their excellent time resolution, a high radiation tolerance, making them ideal candidates for use in HEP tracking detectors.

In the course of a common RD50 project, double-sided 3D sensors with two different column layouts, hexagonal and rectangular, and different column counts were designed and produced by CNM.

In this presentation, updated IV and CV characteristics of these 3D sensors, as well as recent fast timing and top TCT measurement results of a small number of samples, will be presented.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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**Presenter:** SIBOLD, Yannik (University of Freiburg (DE))

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 55

Type: **WG1 - Monolithic Sensors**

## Testbeam results of the MiniCactus V2 timing demonstrator

*Monday, 10 November 2025 14:55 (20 minutes)*

MiniCactus V2 is a demonstrator intended to study the timing performance that can be obtained from non amplified large electrode CMOS sensors developed with the 150 nm LFoundry HV CMOS LF15A technology.

MiniCactus V2 is the most recent iteration of a line of timing oriented sensors, with improved performance over its predecessors. It features pixels of different sizes, from 1mm x 1mm to 0.5 mm x 0.5mm. The pixels are equipped with different types of analog individual front-end and discriminators, with bias parameters and thresholds programmable via an integrated slow control.

MiniCactus V2 has been tested during two testbeam periods in 2025. The first period was in July 2025 using high energy muons, in parasitic mode during a DRD1 testbeam campaign. The second period was beginning of October 2025, as part of a DRD3 testbeam period. In both cases, the beamline was equipped with timing detectors allowing a precise and reliable measurement of the time resolution of the individual pixels of the MiniCactus V2 chip. For the DRD3 beam period, the beamline was also equipped with a silicon tracker allowing precise extrapolation of the tracks to the sensor.

Sensors thinned down to 150, 175, and 200  $\mu$  have been tested. The data analysis shows that a time resolution of about 50 ps can be obtained on 0.5 x 0.5 mm pixels.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** HANLON, Archie William (University of Liverpool); VILELLA FIGUERAS, Eva (University of Liverpool (GB)); GUILLOUX, Fabrice (Université Paris-Saclay (FR)); Dr PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES)); HAMMERICH, Jan (University of Liverpool); MEYER, Jean-Pierre (Université Paris-Saclay (FR)); PINOL BEL, Joaquim (IFAE); FERNANDEZ-MARTINEZ, Pablo (IMB-CNM, CSIC); Prof. SCHWEMLING, Philippe (Université Paris-Saclay (FR)); CASANOVA MOHR, Raimon (IFAE - Barcelona (ES)); GRINSTEIN, Sebastian (IFAE - Barcelona (ES)); TERZO, Stefano (IFAE Barcelona (ES)); DEGERLI, Yavuz (CEA Saclay)

**Presenter:** PINOL BEL, Joaquim (IFAE)

**Session Classification:** WG/WP1 - CMOS technologies

Contribution ID: 56

Type: **WG1 - Monolithic Sensors**

## Development of sensors with intrinsic gain in LFoundry 150 nm technology

Monday, 10 November 2025 15:15 (20 minutes)

One of the limitations of monolithic sensors is their signal over noise ratio, which constrains strongly the downstream front-end electronics, especially for timing oriented sensors, and leads to architectures that are quite power hungry. Present monolithic designs have been shown to reach a 50 ps time resolution for MIPs, with a power consumption of several hundreds of mW per  $cm^2$ .

A possible way to improve further the time resolution, and also to reduce the power required to operate the fast front-end needed for good timing performance, is to implement directly inside the sensor a charge multiplying layer in the form of a PN junction (DJ-LGAD concept). Given sufficient polarization, a large electric field develops in this PN junction, leading to avalanche multiplication of collected charge carriers.

Six different test structures, with slightly different architectures of the gain layer, have been produced in 2024 using the LFoundry 150 nm LF15A process. Two epi wafers and two HR wafers have been produced, with two different sets of doping parameters for the gain layer. The doping parameters of the gain layer and its geometry have been optimized beforehand using TCAD simulations.

IV measurements, and first test results obtained with IR light and Strontium beta particles will be presented, showing that a gain of about 10 can be obtained.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** HANLON, Archie William (University of Liverpool); VILELLA FIGUERAS, Eva (University of Liverpool (GB)); GUILLOUX, Fabrice (Université Paris-Saclay (FR)); Dr PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES)); HAMMERICH, Jan (University of Liverpool); MEYER, Jean-Pierre (Université Paris-Saclay (FR)); PINOL BEL, Joaquim (IFAE); FERNANDEZ-MARTINEZ, Pablo (IMB-CNM, CSIC); Prof. SCHWEMLING, Philippe (Université Paris-Saclay (FR)); CASANOVA MOHR, Raimon (IFAE - Barcelona (ES)); GRINSTEIN, Sebastian (IFAE - Barcelona (ES)); TERZO, Stefano (IFAE Barcelona (ES)); DEGERLI, Yavuz (CEA Saclay)

**Presenter:** Prof. SCHWEMLING, Philippe (Université Paris-Saclay (FR))

**Session Classification:** WG/WP1 - CMOS technologies

Contribution ID: 57

Type: **WG2 - Hybrid silicon sensors**

## Gain suppression studies on IMB-CNM LGAD detectors

*Wednesday, 12 November 2025 09:00 (16 minutes)*

Low Gain Avalanche Detectors (LGADs) have recently emerged as key sensors for precise timing measurements, enabling accurate tracking of charged particles and photons in High Energy Physics (HEP) experiments and beyond. The time resolution is closely linked to the detector's gain, with a direct correlation between gain stability and timing precision. In turn, the gain of LGADs depends on the nature of the particle being detected, since both the ionization density and the depth at which the charge is generated within the active volume influence the multiplication process, a phenomenon known as gain suppression. This contribution presents gain suppression studies performed on LGAD detectors fabricated at IMB-CNM, employing Ion Beam Induced Current (IBIC) measurements with a focused 2.3 MeV proton microbeam at different incidence angles. The analysis provides direct insight into the spatial dependence of charge multiplication and highlights the sensitivity of LGAD performance to different ionization density profiles.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Author:** VILLEGAS DOMINGUEZ, Jairo Antonio (Consejo Superior de Investigaciones Cientificas (CSIC) (ES))

**Co-authors:** Ms TORRES, Carmen (Centro Nacional de Aceleradores (CNA)); GARCIA LOPEZ, FRANCISCO JAVIER; Mr DOUGADOS, Florent (Instituto de Microelectrónica de Barcelona (IMB-CNM)); Dr JIMENEZ RAMOS, Maria Del Carmen (Universidad de Sevilla (ES)); Mr RODRIGUEZ-RAMOS, Mauricio (Centro Nacional de Aceleradores (CNA)); FERNANDEZ-MARTINEZ, Pablo (IMB-CNM, CSIC); Dr HIDALGO, Salvador (Instituto de Microelectronica de Barcelona (IMB-CNM-CSIC))

**Presenter:** VILLEGAS DOMINGUEZ, Jairo Antonio (Consejo Superior de Investigaciones Cientificas (CSIC) (ES))

**Session Classification:** Joint WG2-WG3

Contribution ID: 58

Type: **WG1 - Monolithic Sensors**

## Status of the MANTA project

*Monday, 10 November 2025 17:25 (20 minutes)*

Developing such advanced MAPS technology may exceed the individual capacities of smaller experimental collaborations. The MANTA project addresses this challenge through a joint R&D initiative aimed at creating a versatile, configurable sensor platform. The sensor will be designed to adapt to various experimental environments via slow control mechanisms, enabling a wide range of use cases within a unified technological framework.

This contribution will introduce the MANTA project, outline its scientific and technological objectives, present the current organizational status, and highlight ongoing activities toward a first chip submission.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

II. Presentation on project proposal

**Author:** DEVEAUX, Michael (GSI - Helmholtzzentrum für Schwerionenforschung GmbH (DE))

**Presenter:** DEVEAUX, Michael (GSI - Helmholtzzentrum für Schwerionenforschung GmbH (DE))

**Session Classification:** WG/WP1 - CMOS technologies

Contribution ID: 59

Type: **WG5 - Characterization techniques - facilities**

## Determination of the Relative Defect Density in Semiconductors Using SPA-TCT and TPA-TCT Method

*Thursday, 13 November 2025 11:30 (20 minutes)*

This study investigates the sensitivity of the Single-Photon Absorption Transient Current Technique (SPA-TCT) and the Two-Photon Absorption Transient Current Technique (TPA-TCT) to variations in defect density within semiconductor materials. Controlled ion implantation was performed on silicon pin detectors using four ion species (1H, 14N, 16O and 28Si), at different energies to create well-defined traces of structural defects at different depths. Among them, silicon ions were used to reproduce the displacement of atoms originally located at lattice sites, simulating the effect of a neutral particle interaction.

The implantations were carried out at the microprobe line of the 3 MV Tandem accelerator at the National Accelerator Center (CNA, Seville). Using a pulsed beam system and our nuclear microprobe line, for each ionic species 9 different micrometric regions were irradiated in a single device, varying the number of ions between 1 and 10e5 to create damaged regions with very different defect densities.

SPA-TCT and TPA-TCT measurements were subsequently performed at the Solid-State Detectors (SSD) laboratory at CERN. Preliminary results show that both techniques can resolve spatial variations in defect density only above certain fluence levels, while low-fluence regions remain below the detection threshold. TPA-TCT exhibits enhanced depth discrimination and higher sensitivity at low defect densities, whereas SPA-TCT becomes more sensitive for regions with higher damage levels. These results highlight the complementarity of both techniques for the characterization of radiation-induced defects in semiconductor detectors.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** TORRES MUNOZ, Carmen (Universidad de Sevilla (ES)); FERNANDEZ GARCIA, Marcos (Universidad de Cantabria and CSIC (ES)); Dr JIMENEZ RAMOS, Maria Del Carmen (Universidad de Sevilla (ES)); GARCIA LOPEZ, FRANCISCO JAVIER; MOLL, Michael (CERN); Mr VILLEGAS DOMINGUEZ, Jairo Antonio; RODRIGUEZ RAMOS, MAURICIO (Centro Nacional de Aceleradores (CNA). University of Seville.); MUEHLNIKEL, Marie Christin (CERN)

**Presenter:** TORRES MUNOZ, Carmen (Universidad de Sevilla (ES))

**Session Classification:** WG5 - Characterization techniques, facilities

Contribution ID: 60

Type: WG3 Radiation Damage - Extreme Fluence

## Studies of surface radiation damage with CMS HGICAL test diodes

*Wednesday, 12 November 2025 15:50 (20 minutes)*

Studies of the silicon dioxide (SiO<sub>2</sub>) passivation layer in HGICAL's n-on-p sensors are important for qualifying their performance at the High-Luminosity LHC and for optimising the operation of future high-energy physics experiments. This work presents a novel method to evaluate the impact of the surface radiation damage on the inter-pad isolation in HGICAL sensors, by measuring the threshold voltage for inter-electrode isolation ( $V_{th,iso}$ ). For this study, diode test structures were irradiated with X-rays, and their characteristics were measured at -20 °C. Three measurement techniques: CV, IV, and inter-strip like measurements, were employed to extract the  $V_{th,iso}$ . The results show an unexpected dependence of  $V_{th,iso}$  on the ionising dose, as well as correlation between the surface properties after irradiation and the bulk properties before irradiation. Such behavior has not been observed previously. Possible explanations are being investigated with the help of TCAD simulations.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** FIALOVA, Eva (CERN); DEFRANCHIS, Matteo (CERN)**Presenter:** FIALOVA, Eva (CERN)**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 61

Type: **WG2 - Hybrid silicon sensors**

## Status of USTC pixel and strip AC-LGAD sensors

*Tuesday, 11 November 2025 14:50 (16 minutes)*

The development of next-generation particle detectors capable of precise 4D tracking is crucial for future high-energy physics experiments. AC-LGAD have emerged as a leading technology to achieve excellent spatial and temporal resolution simultaneously. This report details the development and characterization of a new batch of AC-LGAD detectors fabricated by the University of Science and Technology of China (USTC). We present a comprehensive performance evaluation of these devices, focusing on key metrics such as spatial resolution, time resolution, and signal uniformity. Furthermore, the report provides a critical analysis of how different fabrication parameters and design choices—including electrode layout, doping profiles—directly influence the detector's electrical and functional characteristics.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Author:** LI, Han (University of Science and Technology of China (CN))**Presenter:** LI, Han (University of Science and Technology of China (CN))**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 62

Type: **WG3 Radiation Damage - Extreme Fluence**

## Annealing of radiation defects in 8" silicon sensors for CMS HGICAL

To withstand the much higher radiation levels resulting from a tenfold rise in integrated luminosity at the High-Luminosity LHC, the CMS experiment will upgrade its existing endcap calorimeters (CE) with the new High Granularity Calorimeter (HGICAL). This detector will enable particle-flow calorimetry through its exceptionally fine transverse and longitudinal segmentation for both read-out and triggering, providing over six million readout channels. The electromagnetic compartment and the high-radiation zones of the hadronic section will employ silicon pad sensors, collectively covering a surface area of 620 square meters. The system is designed to endure particle fluences up to  $1.5 \times 10^{16}$  neq/cm<sup>2</sup> and radiation doses reaching 1.5 MGy.

The sensors are fabricated on 8-inch p-type silicon wafers with active thicknesses of 300  $\mu\text{m}$ , 200  $\mu\text{m}$  (both float zone), and 120  $\mu\text{m}$  (epitaxial). They are diced into hexagonal geometries to optimize wafer area utilization and facilitate efficient tiling. To study radiation-induced bulk damage as well as inter-cell effects on the wafer-scale sensors, full sensors –from prototypes to production rounds –were irradiated with neutrons at the Rhode Island Nuclear Science Center (RINSC) up to fluence levels of  $1.4 \times 10^{16}$  neq/cm<sup>2</sup>.

This talk focusses on the electrical characterization (IV+CV) of production sensors of all three thicknesses exposed to  $2 \times 10^{15}$  neq/cm<sup>2</sup>. The study investigates for the first time the isothermal annealing behaviour at 60°C after annealing durations ranging from 10 to 5000 minutes. Hamburg model parameters extracted from the full-sensor data will be compared to single-diode results. The post-irradiation behaviour of sensors with hot regions in the pre-irradiation IV measurements as well as epitaxial sensors with stacking faults in individual cells are investigated.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Author:** DINCER, Gizem Gul (KIT - Karlsruhe Institute of Technology (DE))

**Co-authors:** SICKING, Eva (CERN); DIEHL, Leena (University of Zurich (CH))

**Presenter:** DINCER, Gizem Gul (KIT - Karlsruhe Institute of Technology (DE))

**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 63

Type: **WG6 - Wide bandgap materials**

## Edge Transient-Current Technique Investigation of Single-crystalline CVD Diamond

*Thursday, 13 November 2025 16:30 (20 minutes)*

The development of future high-energy colliders, such as the Future Circular Collider (FCC), requires detectors, particularly tracking systems, capable of operating in extremely high radiation environments. To meet this challenge, new radiation-tolerant materials are crucial. Owing to its wide band gap (5.47 eV) and considerable displacement energy (42 eV/atom), diamond is a promising candidate for the next-generation tracking detectors under such demanding conditions.

To gain a deeper insight into the charge transport properties of diamond, we have implemented the multi-photon absorption edge transient-current technique (MPA edge-TCT). Using an 800 nm femto-second laser, electron-hole pairs are generated at specific locations within the diamond bulk. And then after amplification and digitization, the induced transient current allows the detailed characterization of charge collection, electric field distribution, and carrier mobility. To further explore the influence of defects on charge transport, LED illumination and temperature-dependent studies are carried out on both irradiated and non-irradiated single-crystalline CVD (sCVD) diamonds. LED measurements employing a range of wavelengths (from red to UV) probe the behavior of defect-related depletion regions under optical stimulation, while temperature-dependent measurements up to 200 °C examine how the depletion region and charge transport evolve with temperature.

The results of this study will enhance the understanding of charge transport and defect-induced effects in diamond, thereby contributing to the optimization of radiation-hard diamond sensors for the FCC and other future high-luminosity experiments.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Author:** XIE, Chen (ETH Zurich (CH))**Presenter:** XIE, Chen (ETH Zurich (CH))**Session Classification:** WG6/WP3 - Wide bandgap detectors

Contribution ID: 64

Type: **WG2 - Hybrid silicon sensors**

## **The first results from Three Photon Absorption (3PA) and Two Photon Absorption (2PA) TCT on irradiated 3D CNM devices from 3D RD50 production**

*Tuesday, 11 November 2025 09:05 (16 minutes)*

We report the first results on irradiated 3D Double Side Double Column devices using Three-Photon and Two-Photon Absorption Transient Current Technique. Devices are fabricated at the CNM in Barcelona (3D Rd50 Project) and irradiated at the Josef Stefan Institute at two fluences:  $10^{15}$  and  $10^{17}$  neq/cm<sup>2</sup>. Multicell 3D Hex structure was studied. Additionally, we show the results from the Single Photon Absorption - TCT where several wavelengths were exploited. This study is performed on the same sample on which 2PA and 3PA- TCT were performed. For comparison and as reference data, we show also results from SPA, 2PA and 3PA on non-irradiated 3D Hex structure.

### **Type of presentation (in-person/online)**

in-person presentation

### **Type of presentation (I. scientific results or II. project proposal)**

I. Presentation on scientific results

**Authors:** LASTOVICKA-MEDIN, Gordana (University of Montenegro (ME)); MRKIC, Danijela (University of Montenegro); BALETIC, Vuk (University of Montenegro); KRAMBERGER, Gregor (Jozef Stefan Institute); VELKOVSKA, Iskra (Jozef Stefan Institute); Dr REBARZ, Mateusz (ELI Beamlines, ELI ERIC)

**Presenter:** LASTOVICKA-MEDIN, Gordana (University of Montenegro (ME))

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 65

Type: **WG2 - Hybrid silicon sensors**

## Novel silicon 3D-trench pixel detectors based on 8-inch CMOS process (IME) studied with 2PA and 3PA using laser beam at ELI ERIC

*Tuesday, 11 November 2025 10:17 (16 minutes)*

We report the first results from our study on the non-irradiated novel silicon 3D-trench pixel detector based on 8-inch CMOS process (IME) originated from the first batch production. A novel 3D-Trench pixel sensor with an enclosed deep trench surrounding the central columnar cathode, has stronger isolation with neighbouring pixels and sharper electric field around the cathode. The first batch of 3D-Trench pixel sensors are being fabricated at the Institute of Microelectronics of the Chinese Academy of Sciences (IMECAS). To reduce the dead area in the 3D sensor, the Bosch Deep Reactive Ion Etching (DRIE) technology is being developed to achieve an aspect ratio of more than 100:1. The second batch is being designed, expected to be fabricated in 2026.

Bias scan and device depth scan (exploiting several 2PA depths (0, 7, 15, 20 and 30 um) with both 2PA and 3PA are performed by utilizing the laser beam at the ELI ERIC, ELI Beamlines Facility. The gain at around 50 V bias is clearly demonstrated. The following parameters: Rising Time (RT), Time of Arrival (ToA) and Charge (Q), spatially resolved were studied. This way the spatial response of each point in the sensor volumeter is carefully examined. Results will be compared also to those obtained on 3D CNM Double Side Double Column devices with almost 9 times larger active depth and accordingly, 10x larger diameter.

In future we plan to extend study on other multicell structures (with different number of cells), exploring different cell dimension and including the irradiated samples as well.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** LASTOVICKA MEDIN, Gordana (University of Montenegro (ME)); BALETIC, Vuk (University of Montenegro); MRKIC, Danijela (University of Montenegro); KRAMBERGER, Gregor (Jozef Stefan Institute); VELKOVSKA, Iskra (Jozef Stefan Institute); LIU, Manwen (Key Laboratory of Fabrication Technologies for Integrated Circuits of Chinese Academy of Sciences and the Institute of Microelectronics of Chinese Academy of Sciences); REBARZ, Mateusz (E)

**Presenter:** LASTOVICKA MEDIN, Gordana (University of Montenegro (ME))

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 66

Type: **WG1 - Monolithic Sensors**

## Recent measurements on the CASSIA1 sensors

*Monday, 10 November 2025 16:25 (20 minutes)*

The CASSIA (CMOS Active SenSor with Internal Amplification) project is focused on developing monolithic active pixel sensors (MAPS) with internal signal gain in the Tower 180nm CMOS process. The advantages of internal amplification include a higher input signal enabling simplification of in-pixel electronics, an improved signal-to-noise ratio for radiation hardness, and superior timing resolution for future 4D tracking applications. The presentation will focus on recent measurements of the first prototype sensors (CASSIA1) which were fabricated to demonstrate the feasibility of implementing a gain layer in the Tower Semiconductor 180 nm CIS process. Current developments towards full efficiency proceed with the design of a new sensor prototype (CASSIA2), which implements the sensor structures with gain alongside in-pixel electronics to operate the sensors either in low-gain (LGAD) or high-gain (SPAD) mode.

The presentation will give an overview of the latest measurement results on CASSIA1, including measurements of sensor response to DC and pulsed laser sources. We have studied four different gain layer implant configuration which vary in n+ electrode and p+ gain layer depth and doping. In our tests we studied the performance of different design in terms of LGAD and SPAD response, break down voltage and dark-count rate. First measurements with ionising sources and a recent beam test at CERN SPS further explore the performance of the sensors.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Author:** KOTSOKECHAGIA, Anastasia (CERN)**Co-author:** PERNEGGER, Heinz (CERN)**Presenter:** KOTSOKECHAGIA, Anastasia (CERN)**Session Classification:** WG/WP1 - CMOS technologies

Contribution ID: 67

Type: **WG4 - Simulations**

## Multiscale Simulation of Irradiation-Induced Defect Evolution in EPI silicon LGADs

*Thursday, 13 November 2025 09:20 (20 minutes)*

Carbon doping in Low Gain Avalanche Diodes (LGADs) has been experimentally proven to effectively mitigate irradiation-induced acceptor removal effects. In this work, a comprehensive multiscale simulation framework was developed, combining Monte Carlo simulations (primary collision), molecular dynamics (collision cascade), kinetic Monte Carlo (long-term evolution), and TCAD simulations to model the entire process of displacement damage defect formation and evolution in irradiated LGADs, as well as their impact on the gain layer performance. The mechanism of irradiation-induced acceptor removal and the role of carbon in suppressing it were elucidated from the atomic scale. The Monte Carlo results show that the number of Frenkel pairs generated per unit length per 1 MeV neutron in silicon is 59.047 /cm, which is about 12.5% higher than the SIMS experimental value (52.5 /cm), indicating reasonable agreement within the typical uncertainty range. Molecular dynamics simulations show that the generation rate of Bi defects after the collision cascade is approximately  $g_{\text{Bi}} = 0.899$  /cm, while experiments observe  $g_{\text{BiOi}} \approx 0.1$  /cm. This discrepancy may be due to the subsequent long-term evolution, during which some Bi defects combine with Oi to form BiOi, while others recombine and annihilate. A more accurate calibration of  $g_{\text{BiOi}}$  requires further KMC simulations, which are currently in progress.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** HE, Chaohui; LI, Wei (Institute of High Energy Physics); Dr FAN, Yunyun (Chinese Academy of Sciences (CN))

**Presenter:** LI, Wei (Institute of High Energy Physics)

**Session Classification:** WG4 Simulations

Contribution ID: 68

Type: **WG2 - Hybrid silicon sensors**

## Gain Suppression Study in LGADs with Different Gain Layers

*Wednesday, 12 November 2025 09:18 (16 minutes)*

It was observed in several research groups that the gain of Low Gain Avalanche Diodes (LGADs) is significantly dependent on the amount of deposited charge and the angle of incidence of the interacting particle. In case of laser illumination, higher deposited charge results in lower gain values. Additionally, the focus of the laser is responsible for a decrease in the measured gain. The physical mechanism behind this gain suppression is a screening effect of the charge carriers on the gain layer space charge, as a result of their high concentration.

A batch of LGADs was produced by Fondazione Bruno Kessler featuring multiple gain layer designs and thicknesses to study the feasibility of having this technology in space-borne observatories for timing applications.

Together with the established study of the gain and timing resolution of the detectors, a measurement campaign employing Single Photon Absorption Transient Current Technique (SPA-TCT) and Two Photons Absorption TCT (TPA-TCT) was conducted on a set of detectors with thickness  $100\ \mu\text{m}$  and  $150\ \mu\text{m}$ .

While the SPA-TCT allows to verify the presence of gain suppression in the samples, TPA-TCT offers the advantage of a three dimensional resolution and much more concentrated charge carriers generation.

These make TPA-TCT an excellent tool for investigating gain suppression in a more fundamental and systematic way.

The objective of the campaign was to probe the differences in gain suppression induced by the gain layer depth, the gain layer dose, and by the thickness of the detector, with the ambitious goal of identifying a suitable gain layer solution based on the density of the deposited charge in the specific application.

The first results of the investigation will be presented.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** BISHT, Ashish (Fondazione Bruno Kessler (FBK)); Mr FICORELLA, Francesco (Fondazione Bruno Kessler); PATERNOSTER, Giovanni (Fondazione Bruno Kessler); CAVAZZINI, Leo; FERNANDEZ GARCIA, Marcos (Universidad de Cantabria and CSIC (ES)); CENTIS VIGNALI, Matteo (FBK); BOSCARDIN, Maurizio (FBK Trento); MOLL, Michael (CERN); HAMMAD ALI, Omar; KRAUS, Veronika (Vienna University of Technology (AT))

**Presenter:** CAVAZZINI, Leo

**Session Classification:** Joint WG2-WG3

Contribution ID: 69

Type: **WG6 - Wide bandgap materials**

## SiC LGAD Edge Termination via Controlled Ion-Implantation Damage

*Thursday, 13 November 2025 15:00 (20 minutes)*

We investigate a novel approach for edge termination in SiC Low-Gain Avalanche Diodes (LGADs), based on controlled ion-implantation-induced damage in mesa-etched structures. TCAD simulations and preliminary experimental results indicate that this method provides efficient high-voltage termination through helium implantation performed near the mesa edge, without consequent thermal annealing. The implantation locally reduces the effective doping concentration in the gain layer by excess carrier removal, thereby relaxing the edge-enhanced electric field. This significantly improves the breakdown voltage and enables operation at higher gain and depletion depth, leading to enhanced detector performance, as verified by UV transient-current measurements. The process utilizes standard silicon implantation tools and processes, while also relaxing bevel-angle constraints typically encountered in high-voltage mesa structures, offering simplified and more robust fabrication of SiC LGADs.

### Type of presentation (in-person/online)

online presentation (zoom)

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Author:** SEKELY, Ben (North Carolina State University)**Presenter:** SEKELY, Ben (North Carolina State University)**Session Classification:** WG6/WP3 - Wide bandgap detectors

Contribution ID: 70

Type: **not specified**

## Introduction

*Tuesday, 11 November 2025 09:00 (5 minutes)*

**Presenters:** TRICOLI, Alessandro (Brookhaven National Laboratory (US)); MACCHIOLO, Anna (University of Zurich (CH)); VAN BEUZEKOM, Martin (Nikhef National institute for subatomic physics (NL))

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 71

Type: **WG7 - Interconnect**

## Evaluating Thermal Conductivity Enhancement: A Comparative Study of Nanowire-Based Interconnection Materials

*Friday, 14 November 2025 10:40 (20 minutes)*

Increasing power density in modern detector front-end electronics and readout ASICs require advanced thermal management techniques that can handle heat dissipation more effectively. This challenge is particularly critical in high-energy physics experiments where spatial constraints and reliability requirements demand efficient thermal interfaces. This study presents a comprehensive comparative analysis of heat dissipation characteristics in nanowire-enhanced interconnection techniques compared to conventional bonding materials used in the detector community.

Five material systems are investigated: conductive epoxy, Araldite, thermal paste, sintered copper nanowires, and a nanowire-Araldite hybrid composite. This selection represents the spectrum from purely mechanical adhesives to advanced nanomaterial-based thermal interfaces, enabling direct comparison between established detector assembly techniques and emerging bonding technologies. Thermal conductivity and bonding strength are measured for each material system under conditions representative of detector-module operation.

The experimental setup utilises silicon wafer samples (300  $\mu\text{m}$  thickness) with aluminium metallisation tracks of 5  $\mu\text{m}$  thickness serving as controlled heating elements, bonded to oxygen-free copper heat sinks using each interconnection material. Thermal conductance measurements are performed using calibrated Pt1000 resistance temperature detectors (RTDs) positioned on the front surface of the wafer and in the heat sink in close proximity to the bonding region. This configuration enables direct measurement of temperature gradients across the critical thermal path from chip to cooling system. Heat loads up to 10  $\text{W}/\text{cm}^2$  simulate typical power dissipation levels in readout electronics.

Mechanical characterisation includes bonding strength measurements using a pull test machine to compare the adhesive performance across material systems.

This work aims to establish whether nanowire-enhanced interconnection techniques offer measurable thermal and mechanical advantages over conventional materials for particle physics detector applications.

### Type of presentation (in-person/online)

in-person presentation

### Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

**Authors:** GORANE, Atul (University of Freiburg (DE)); MILLAR-BRAVO, Vicente (CERN and Universidad Andres Bello, Chile); WEICK, Julian (CERN); COSTANZI, Ruddy (CERN); SHARMA, Abhishek (CERN); DANNHEIM, Dominik (CERN)

**Presenter:** GORANE, Atul (University of Freiburg (DE))

**Session Classification:** WG7/WP4

Contribution ID: 72

Type: **not specified**

## **Project: MPW Production of LGADs at BNL**

*Tuesday, 11 November 2025 15:54 (10 minutes)*

**Presenter:** GIACOMINI, Gabriele (Brookhaven National Laboratory (US))

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 73

Type: **not specified**

## **Project: Technology stabilization and yield optimization in IMB-CNM LGADs**

*Tuesday, 11 November 2025 15:44 (10 minutes)*

**Presenter:** FERNANDEZ-MARTINEZ, Pablo (IMB-CNM, CSIC)

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: 74

Type: **WG1 - Monolithic Sensors**

## **Status on access and submission preparation for MAPS technologies within DRD7.6a**

*Monday, 10 November 2025 15:35 (20 minutes)*

Report on the activity within DRD7.6a project to prepare submissions in the TPSCo 65 nm technology. Status of the possible IP sharing and run schedule will be discussed.

### **Type of presentation (in-person/online)**

in-person presentation

### **Type of presentation (I. scientific results or II. project proposal)**

III. other (please specify in comment field)

**Authors:** SEDGWICK, Iain (Science and Technology Facilities Council STFC (GB)); BARBERO, Marlon B. (CPPM, Aix-Marseille Université, CNRS/IN2P3 (FR)); SNOEYS, Walter (CERN)

**Presenter:** SNOEYS, Walter (CERN)

**Session Classification:** WG/WP1 - CMOS technologies

Contribution ID: 75

Type: **WG4 - Simulations**

## **WG4 - Updates and Discussion & Recording of the Simulation Session**

*Thursday, 13 November 2025 10:40 (20 minutes)*

**Type of presentation (I. scientific results or II. project proposal)**

**Type of presentation (in-person/online)**

**Authors:** WENNLÖF, Håkan (Nikhef National institute for subatomic physics (NL)); MANDURRINO, Marco (Universita e INFN Torino (IT))

**Presenters:** WENNLÖF, Håkan (Nikhef National institute for subatomic physics (NL)); MANDURRINO, Marco (Universita e INFN Torino (IT))

**Session Classification:** WG4 Simulations

Contribution ID: 76

Type: **not specified**

## **WG3 - Updates and Discussion**

*Wednesday, 12 November 2025 17:30 (30 minutes)*

**Presenters:** PINTILIE, Ioana (National Inst. of Materials Physics (RO)); Dr SCHWANDT, Joern (Hamburg University (DE))

**Session Classification:** WG3/WP3 - Extreme fluence and radiation damage characterization

Contribution ID: 77

Type: **not specified**

## Introduction

*Friday, 14 November 2025 09:00 (10 minutes)*

**Presenters:** DANNHEIM, Dominik (CERN); HUEGGING, Fabian (University of Bonn (DE)); CALDERINI, Giovanni (LPNHE-Paris, Centre National de la Recherche Scientifique (FR))

**Session Classification:** WG7/WP4

Contribution ID: 78

Type: **not specified**

## Update on wafer-to-wafer bonding project

*Friday, 14 November 2025 11:00 (15 minutes)*

**Presenter:** HUEGGING, Fabian (University of Bonn (DE))

**Session Classification:** WG7/WP4

Contribution ID: 79

Type: **WG5 - Characterization techniques - facilities**

## Summary of WG5 irradiation activities

*Thursday, 13 November 2025 13:50 (15 minutes)*

**Presenter:** HITI, Bojan (Jozef Stefan Institute (SI))

**Session Classification:** WG5 - Characterization techniques, facilities

Contribution ID: **80**

Type: **WG5 - Characterization techniques - facilities**

## **Summary of WG5 testbeam activities**

*Thursday, 13 November 2025 14:05 (15 minutes)*

**Presenter:** FERNANDEZ GARCIA, Marcos (Universidad de Cantabria and CSIC (ES))

**Session Classification:** WG5 - Characterization techniques, facilities

Contribution ID: **81**

Type: **WG5 - Characterization techniques - facilities**

## Summary of WG5 laser activities

*Thursday, 13 November 2025 14:20 (15 minutes)*

**Presenter:** Prof. VILA ALVAREZ, Ivan (Instituto de Física de Cantabria (CSIC-UC))

**Session Classification:** WG5 - Characterization techniques, facilities

Contribution ID: 82

Type: **not specified**

**Robert Klanner's talk on the history of silicon vertex  
detectors:  
<https://indico.cern.ch/event/1480892/timetable/>**

*Tuesday, 11 November 2025 14:00 (30 minutes)*

**Session Classification:** WG2 - Hybrid silicon technologies

Contribution ID: **83**

Type: **not specified**

## **Report from the WG8 conveners**

*Friday, 14 November 2025 11:35 (45 minutes)*

**Presenter:** PARZEFALL, Ulrich (University of Freiburg (DE))

**Session Classification:** WG8 - Dissemination & outreach

Contribution ID: **84**

Type: **not specified**

## **21st TREDI announcement**

*Tuesday, 11 November 2025 18:02 (5 minutes)*

**Presenters:** BOSCARDIN, Maurizio (Fondazione Bruno Kessler (IT)); BOSCARDIN, Maurizio (FBK Trento)

**Session Classification:** WG2 - Hybrid silicon technologies