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UNIVERSITÀ
DEGLI STUDI
DI PADOVA

**PhD course of National Interest in Technologies for
Fundamental Research in Physics and Astrophysics**

Annual report

Name and surname: Arbab Imtiaz

Cycle and a.a.: 40th 2024/25

Supervisor: Prof. Alberto Aloisio

Co-supervisor: Dr. Pierluigi Casolaro

• Research activity carried out during the year 2024/25

Aim

The research activity focuses on the study and characterization of solid-state sensors and photodetectors based on

both conventional and innovative materials with Impedance Spectroscopy (IS) and low-frequency noise measurements. IS is a multidisciplinary methodology that investigates fundamental physical processes, including diffusion, charge generation and recombination, and charge transfer reactions. The analysis of light-sensitive devices, such as photodiodes, is complemented by measurements of quantum efficiency, responsivity, and sensitivity. The developed characterization methodologies are also employed to evaluate the effects of radiation on the performance of a broad class of devices, including diodes, silicon photodiodes, metal-oxide-semiconductor (MOS) transistor-based systems, and other advanced components to be used in High-Energy Physics (HEP) experiments.

In summary, the aims of the research activity:

- To study and characterize solid-state sensors with IS and low-noise analysis techniques
- To use such techniques to study how radiation affects the electrical properties of these devices
- To improve sensor performance through in-depth electrical characterization.

RESEARCH ACTIVITIES

1. Characterization of sensors and photodetectors with Impedance Spectroscopy (IS) and low-frequency noise measurements
2. Analysis of light-sensitive devices, such as photodiodes, by measurements of quantum efficiency, responsivity, and sensitivity
3. Studying effects of radiation on the performance of a broad class of devices, including diodes, photodiodes, metal-oxide-semiconductor (MOS)-based transistors, and other advanced components of interest for High-Energy Physics (HEP) experiments.



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- **List of attended courses and passed exams**

1. *Cabling and Shielding for Low Noise Application* (1.25 CFU)
Lecturer: Prof. Alberto Aloisio
(Exam passed)
2. *Cosmic Radiation and Radiation Hardness Assurance* (2 CFU)
Lecturer: Dr. Pierluigi Casolaro
(Exam passed)
3. *Electronic System in High Energy Physics* (4 CFU)
Lecturer: Prof. Adriano Lai
(Exam passed)
4. *Solid State Detector* (2 CFU)
Lecturer: Prof. Donato Creanza
(Lectures completed, exam to do)
5. *Radiation Matter Interaction* (2 CFU)
Lecturer: Prof. Raffaella Radogna
(Course not yet started)
6. *Italian language Course-intensive and communicative*
Delivered by CLA Univ. of Padua
(Start in October 2025)
7. *Cyber Security-Basic*
Mandatory course delivered by INFN for IT security

- **List of attended conferences, workshops and schools, with mention of the presented talks**

CONFERENCES

1. **Arbab Imtiaz**, Vincenzo Izzo, Riccardo Vari, Antonio Vanzanella, Claudio Principe, Pierluigi Casolaro, Alberto Aloisio, "*Investigating Total Ionizing Dose Effects on LVDS Receivers with Impedance Spectroscopy*". RAD 13th Conference 2025. **(Poster presentation by A. Imtiaz)**
2. Pierluigi Casolaro, Vincenzo Izzo, Riccardo Vari, Antonio Vanzanella, Claudio Principe, **Arbab Imtiaz**, Alberto Aloisio, "*Frequency-domain analysis of ⁶⁰Co radiation effects on silicon pn and pin photodiodes*". **(Accepted as horal presentation to 2025 IEEE NSS MIC RTSD)**
3. Pierluigi Casolaro , Vincenzo Izzo, Riccardo Vari, Claudio Principe, Antonio Vanzanella, Paolo, Di Meo, Antonio Anastasio, **Arbab Imtiaz**, and Alberto Aloisio", *Analysis of radiation effects in trigger front-end electronics with impedance spectroscopy*". **(Submitted to TIPP2026)**



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4. P. Casolaro, V. Izzo, R. Vari, A. Vanzanella, C. Principe, **A. Imtiaz** and A Aloisio, *TID reliability of voltage translators for the ATLAS muon trigger system* (**Accepted as poster presentation by TWEPP**)
5. Pierluigi Casolaro, Vincenzo Izzo, Riccardo Vari, Mila D'Angelantonio, Antonio Vanzanella, Claudio Principe, **Arbab Imtiaz**, Alberto Aloisio, *Investigating radiation effects on LSF0102 level shifters* (**Oral presentation at ANIMMA 2025**)

SCHOOLS

1. Participated remotely and presented my project during the online PhD meeting at Gran Sasso Laboratories, School

FUTURE EVENTS

1. First Bulletin: International Workshop on Photon-Detectors, 3–5 Dec, Bologna, Italy
2. Bi-National Conference on Detectors R&D 18-20 Nov 2025, LPNHE Paris

• **List of published papers/proceedings**

At present, no papers have been published; the following paper has been submitted for evaluation by Radiation Physics and Chemistry is currently under review:

1. Pierluigi Casolaro, Vincenzo Izzo, Riccardo Vari, Mila D'Angelantonio, Antonio Vanzanella, Claudio Principe, **Arbab Imtiaz**, Alberto Aloisio, *60 Co gamma irradiation effects on Low- Voltage Differential Signaling (LVDS) receivers: analysis with impedance spectroscopy* (Under review by Radiation Physics and Chemistry)

• **Thesis title (temporary)**

Characterization of sensors with Impedance Spectroscopy (IS) techniques and noise analysis

Date, 17/09/2025

Signature...

Seen, the supervisors

Pierluigi Casolaro
Alberto Aloisio