Scientific and Academic Curriculum

Paolo Lazzaroni

Education and academic appointments

2024 – now | **Senior Technological Researcher – Level 2**
Istituto Nazionale di Fisica Nucleare, Pavia, Italy
Title: "Integration and calibration of the Si(Li) tracker of the GAPS experiment"
Coordinator: Massimo Manghisoni
Keywords: ASIC design, PCB design, FPGA design, data analysis, ASIC characterisation

2023 – 2024 | **Junior Technological Researcher – Level 1**
Istituto Nazionale di Fisica Nucleare, Pavia, Italy
Title: "Characterization of integrated circuits and modules developed for hybrid pixel readout at the CMS Inner Tracker"
Coordinator: Gianluca Traversi
Keywords: ASIC design, PCB design, FPGA design, data analysis, ASIC characterisation

2023 – 2024 | **Staff associate II**
Columbia University, New York, US
Activity: Construction and testing of the GFP, the GAPS Functional prototype, as part of the GAPS experiment.
Coordinator: Chuck Hailey
Keywords: GAPS, Si(Li) tracker, front-end electronics, dark matter search

2020 – 2024 | **Doctor of Philosophy (Ph.D.) – Engineering and Applied Sciences**
Università degli Studi di Bergamo, Bergamo, Italy
Thesis: "Design of a pixel readout processor for nano-meter resolution x-ray ptychography"
Advisor: Massimo Manghisoni, Lodovico Ratti
Field of research: Microelectronics for high energy physics
Keywords: Radiation detection, front-end electronics, low noise, x-ray ptychography
Final Grade: Excellent

2018 – 2020 | **Master of Science (M.Sc.) – Computer Engineering (Mechatronics) LM-32**
Università degli Studi di Bergamo, Bergamo, Italy
Thesis: "Characterization of a Modular System for the Realisation of the Si(Li) Tracker of GAPS experiment"
Advisor: Massimo Manghisoni, Elisa Riceputi, Mauro Sonzogni
Keywords: GAPS, Front-end Electronics, Analogue IC Design, Data Analysis
Final Grade: 110/110 cum laude

2015 – 2018 | **Bachelor of Science (B.Sc.) – Computer Engineering LM-8**
Università degli Studi di Bergamo, Bergamo, Italy
Thesis: "Analysis of Reinforcement Learning Algorithms for Control in OpenAI Gym Simulated Environment"
Advisor: Fabio Previdi, Mirko Mazzoleni
Keywords: Machine Learning, Reinforcement Learning, Control, OpenAI Gym
Final Grade: 107/110

2010 – 2015 | **Technical Certificate – Accounting & IT for Entreprise**
Istituto di Istruzione Superiore "Lorenzo Lotto", Trescore Balneario (BG), Italy
Final Grade: 100/100

Scientific activity

The scientific activity and research interest of Paolo Lazzaroni fall mainly in the design and characterisation of low-noise, low-power analogue front-end integrated circuits for semiconductor detector readout in particle tracking, photon science, and astroparticle physics application.

The research activity to date encompasses the following:

1. **Readout electronics for semiconductor detectors in photon science**

   The focus of the activity is the usage of integrated circuit technologies, mainly CMOS, for the design of high-granularity pixellated detectors for x-ray imaging applications, mainly leveraging fourth-generation synchrotron light sources.

   Paolo Lazzaroni's contribution to the topic follows:

   - Development and test of a pixel readout processor for x-ray ptychography applications, pFREYA16, in a 65 nm CMOS technology in the frame of the FALCON project, an international collaboration between Argonne National Laboratory (Chicago, US), University of Bergamo, and University of Pavia. The ASIC integrates different analog, mixed, and digital structures and it is configurable through a serial interface. The circuit targets x-ray ptychography application with rate up to 1 MHz, a noise level below $300\,e^-$ rms, and provide zero-suppression.

   He is currently working on a 110 nm CMOS technology for a new hybrid detector for photon science in collaboration with DECTRIS (Switzerland).

2. **Testing of front-end circuitry for XFELs and astrophysics**

   Paolo Lazzaroni has been investigating the operation of different systems, sensors, and chips designed to be used in the field of high-energy physics, photon science, and astrophysics.

   Paolo Lazzaroni's main works in this field include:

   - Test and analysis of data coming from CROCv2, the final chip design for the CMS experiment at CERN, to be integrated in the upcoming years in the HL-LHC upgrade.
   - Characterisation of the DEPFET sensors and readout ASICs for the upgrade of the DSSC camera, a hybrid pixel detector for the European XFEL, in a collaboration including DESY (Hamburg, Germany), INFN, and German and Italian universities.
   - Characterisation of the Si(Li) tracker of the GAPS experiment, a balloon-borne experiment for the search of dark matter and antimatter in cosmic rays, in a big international collaboration comprising different universities and institutes across

the globe including NASA, JAXA, ASI, INFN, and American, Japanese, and Italian universities.

3. **Design and development of affordable IoT solutions**

   The activity is collateral to the main topic of Paolo Lazzaroni's research and consists in designing efficient, precise, and smart IoT infrastructures to address different needs and developing machine learning solutions both on the back-end and on the IoT node. Paolo Lazzaroni's main interest lies in the low-power radar sensing field.

   The main achievements to date coming from this activity are:

   - Design and development of an IoT system for the monitoring of domestic boilers, with the aim of improving their efficiency and reducing energy consumption. The activity resulted in the first prize in Bosch SensorTec's "Making SensorTec" challenge, together with the microlab team.
   - Design and development of data acquisition system for multi-sensor readout, with the aim of monitoring the dynamics of a bike and the environment surrounding the rider. The activity is part of the MOST, Spoke 5 project funded by the italian PNRR.
   - Design and development of a low-power radar-based board for human presence detection, vital parameters monitoring, and telemetry based on commercially available solutions.

4. **Testing of electrically conductive cotton fabric coatings**

   The activity was pursued together with "A. J. Zaninoni" textile technology laboratory at the University of Bergamo.

   The research work consists in performing high-precision, low-current measurement on different types of cotton coatings – based on carbon nanotubes and tungsten selenide – in order to check their conductivity properties against different temperature, humidity levels, and their reversibility after repeated test cycles.

Scientific publications

Paolo Lazzaroni is author or co-author of 18 scientific publications, specifically 7 papers on international scientific journals and 11 conference proceedings. More details are found in the ORCID profile at the link:

https://orcid.org/0000-0002-8443-1101

Metrics updated to the date of the document (Scopus):

- **h-index**: 2
- **Citations**: 11

The list of publications is given in the appendix.

Oral communications at scientific conferences

Paolo Lazzaroni gave oral communication at 3 international scientific conferences.

2023 | "Characterisation of the pFREYA16 ASIC for low-noise ptychography applications," *2023 IEEE Nuclear Science Symposium, Medical Imaging Conference and Room Temperature Semiconductor Detector Conference*, Vancouver (Canada), 04 – 11 November 2023

2022 | "A low-noise readout channel for x-ray ptychography applications," *2022 IEEE Nuclear Science Symposium, Medical Imaging Conference and Room Temperature Semiconductor Detector Conference*, Milano (Italy), 05 – 12 November 2022

2022 | "FALCON readout channel for x-ray ptychography applications," *2022 17th Conference on Ph.D Research in Microelectronics and Electronics (PRIME)*, Villasimius (Italy), 12 – 15 June 2022

Reviewer activity for journals and ASIC design

Paolo Lazzaroni serves as reviewer for journals and conferences in the field of microelectronics and electronics design.

- IEEE Nuclear Science Symposium (NSS)
- IEEE Transactions on Nuclear Science (TNS)
- Nuclear Science and Techniques (NST)
- International Conference on Applications in Electronics Pervading Industry, Environment, and Society (ApplePies)
- International Conference on Modern Circuits and Systems Technologies on Electronics and Communications (MOCAST)

He also served as an ASIC reviewer for Cornell University Detector Group.

Scientific international projects

Paolo Lazzaroni has been involved in different international projects together with different universities and research institutes. The list includes, but is not limited to:

CMS | (2023 – today) CMS collaboration at CERN.
Characterisation of integrated circuits and modules developed for hybrid pixel readout at the CMS inner tracker.

FALCON | (2020 – today) ANL, UniPV, and UniBG collaboration.
Design of a pixel readout processor for nano-meter resolution x-ray ptychography.

GAPS | (2020 – today) GAPS collaboration.
Testing and verification of the performance of the Si(Li) tracker of the experiment.

DSSC | (2021 – today) EuXFEL, DESY, and INFN collaboration.
Testing and verification of the performance of the DEPFET sensors and ASICs.

International Scientific Collaborations

Paolo Lazzaroni has collaborated with different universities and research institutes. The list includes, but is not limited to:

ANL | Argonne National Laboratory, Chicago, US

CERN | European Organization for Nuclear Research, Geneva, Switzerland

UH | University of Hawaii, Honolulu, US

UCLA | University of California, Los Angeles, US

CU | Columbia University, New York, US

DESY | Deutsches Elektronen-Synchrotron, Hamburg, Germany

DECTRIS | Baden-Daettwil, Switzerland

Awards and recognitions

2023 | Bosch SensorTec "Making SensorTec!" challenge winner
First prize awarded to the University of Bergamo microlab team for the development of an intelligent IoT infrastructure for boiler monitoring, alert managing, and data analysis. The team was invited to present the work both at Bosch SensorTec (BST) in Milan, Italy, and at the BST headquarters in Reutlingen, Germany.

2022 | PRIME 2022 Bronze Leaf Certificate
Certificate awarded to the paper "FALCON readout channel for x-ray ptychography applications" as one of the top 30% paper of the PRIME 2022 conference.

Academic activity

Teaching activity

Starting from 2021, Paolo Lazzaroni has carried out teaching assistant activities for Computer Engineering and Mechanical Engineering degrees at the University of Bergamo and Medicine and Surgery degree at the University of Milano-Bicocca. A detailed list of the aforementioned activities, with the corresponding academic year, follows:

2024 – 2025 | Teaching assistant for the course "Fundamentals of Electronics" (9 CFU).
Teaching assistant for the course "Sensors" (6 CFU).
Teaching assistant for the course "Electronics and Elaboration of Biomedical Signals" (6 CFU).
Lecturer for the course "Prosthesis and Rehabilitation in Practice" (1 CFU).

2023 – 2024 | Teaching assistant for the course "Fundamentals of Electronics" (9 CFU).
Teaching assistant for the course "Sensors" (6 CFU).
Teaching assistant for the course "Electronics and Elaboration of Biomedical Signals" (6 CFU).
Lecturer for the course "Prosthesis and Rehabilitation in Practice" (1 CFU).

2022 – 2023 | Teaching assistant for the course "Fundamentals of Electronics" (9 CFU).
Teaching assistant for the course "Sensors" (6 CFU).
Lecturer for the course "Prosthesis and Rehabilitation in Practice" (1 CFU).

2021 – 2022 | Teaching assistant for the course "Fundamentals of Electronics" (9 CFU).
Teaching assistant for the course "Electronics and Elaboration of Biomedical Signals" (6 CFU).
Teaching assistant for the course "Sensors" (6 CFU).
Lecturer for the course "Prosthesis and Rehabilitation in Practice" (1 CFU).

2020 – 2021 | Teaching assistant for the course "Fundamentals of Electronics" (9 CFU).
Teaching assistant for the course "Electronic Instrumentation" (6 CFU).

Tutoring activity

Paolo Lazzaroni has been the co-advisor for 2 M.Sc. theses and for 5 B.Sc. theses at the University of Bergamo.

He is also the tutor of a scholarship, funded by the italian PNRR and part of the MOST, Spoke 5 project, for research activities designated for young bachelors with the title "Study of radar solution for telemetry on track and dynamic vital signs monitoring."

Memberships

2020 – today | **INFN**
Istituto Nazionale di Fisica Nucleare, Pavia
INFN CSN5 group mamber as Technological Ph.D., section of Pavia.

2020 – today | **SIE**
Società Italiana di Elettronica, Bergamo
SIE member, section of Bergamo.

2020 – 2024 | **IEEE**
Institute of Electrical and Electronics Engineers, Italy
IEEE graduate student member, section of Italy.

2020 – 2024 | **IEEE NPSS**
Institute of Electrical and Electronics Engineers, Italy
Nuclear & Plasma Sciences Society member, section of Italy.

Scholarships and certificates

2020 – 2023 | **Ph.D. Scholarship**
Università degli Studi di Bergamo, Bergamo

2016 – 2019 | **TOP 10 Student Program 2015/2016, 2016/2017, 2017/2018, 2018/2019**
Università degli Studi di Bergamo, Bergamo
Fee exemption awards issued by Università degli Studi di Bergamo to best students.

2018 | **C1 Advanced (Grade B)**
Cambridge Assessment English, Cambridge

Other work experiences

03/2019 – 03/2020 | Computer Engineer at ASST Papa Giovanni XXIII, Genetics Department, Bergamo
System administrator and programmer
Winner of a scholarship given by ASST Papa Giovanni XXIII to a computer engineer for RARE (Rapid Analysis for Rapid carE) project.

01/2017 -– 08/2018 | Apprentice Computer Engineer at ASST Papa Giovanni XXIII, Genetics Department, Bergamo
System administrator and programmer
Administrator of 2 Linux-based servers (Ubuntu, Redhat). Software development on Linux and Windows (mainly Python, Java, bash scripting).

Languages

Italian:	Mother tongue	Japanese:	Beginner (A2)
English:	Fluent (C1)	Spanish:	Beginner (A2)
French:	Intermediate (B2)	German:	Beginner (A1)
Russian:	Intermediate (B2)		

Interests and activities

Technology, Electronics, Space, Nuclear Physics.
Music, Books, Travels.

Complete list of publications

Journal articles

[J1] V. Trovato, R. Konar, E. Teblum, P. Lazzaroni, V. Re, G. Rosace, and G. D. Nessim, "Humidity- and Temperature-Sensing Properties of 2D-Layered Tungsten Di-Selenide (2H-WSe2) Electroconductive Coatings for Cotton-Based Smart Textiles," *Polymers (Basel)*, vol. 17, no. 6, p. 752, Mar. 12, 2025, ISSN: 2073-4360. DOI: 10.3390/polym17060752.

[J2] P. Lazzaroni, M. Hammer, M. Manghisoni, A. Miceli, L. Ratti, V. Re, H. Shi, and G. Torilla, "Experimental results of the pFREYA16 ASIC for x-ray ptychography in continuous wave light sources," *J. Inst.*, vol. 19, no. 12, pp. 1–6, Dec. 2024, ISSN: 1748-0221. DOI: 10.1088/1748-0221/19/12/C12001.

[J3] L. Ghislotti, M. Boezio, L. Fabris, P. Lazzaroni, M. Manghisoni, L. Ratti, V. Re, E. Riceputi, and G. Zampa, "Energy threshold calibration of the GAPS experiment Si(Li) tracker readout electronics," *Il Nuovo Cimento C*, vol. 47, no. 3, pp. 121–125, Apr. 3, 2024, ISSN: 2037-4909. DOI: 10.1393/ncc/i2024-24121-1.

[J4] S. Botticini, E. Comini, S. Dello Iacono, A. Flammini, L. Gaioni, A. Galliani, L. Ghislotti, P. Lazzaroni, V. Re, E. Sisinni, M. Verzeroli, and D. Zappa, "Index Air Quality Monitoring for Light and Active Mobility," *Sensors*, vol. 24, no. 10, pp. 1–27, Jan. 2024, ISSN: 1424-8220. DOI: 10.3390/s24103170.

[J5] M. Manghisoni, L. Ghislotti, P. Lazzaroni, V. Re, E. Riceputi, L. Ratti, L. Fabris, M. Boezio, and G. Zampa, "A 32-Channel Readout ASIC for X-Ray Spectrometry and Tracking in the GAPS Experiment," *IEEE Transactions on Nuclear Science*, vol. 71, no. 1, pp. 96–105, Jan. 2024, ISSN: 0018-9499. DOI: 10.1109/TNS.2023.3336192.

[J6] M. Verzeroli, L. Gaioni, A. Galliani, L. Ghislotti, P. Lazzaroni, and V. Re, "Advancing Sustainable Mobility: A Data Acquisition System for Light Vehicles and Active Mobility," *Electronics*, vol. 13, no. 21, pp. 1–19, Jan. 2024, ISSN: 2079-9292. DOI: 10.3390/electronics13214249.

[J7] V. Re, L. Ghislotti, P. Lazzaroni, M. Manghisoni, E. Riceputi, L. Ratti, M. Boezio, G. Zampa, and L. Fabris, "A mixed-signal processor for X-ray spectrometry and tracking in the GAPS experiment," *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, vol. 1045, pp. 1–4, Jan. 1, 2023, ISSN: 0168-9002. DOI: 10.1016/j.nima.2022.167617.

Conference proceedings

[C1] S. N. Feldman and on behalf of the GAPS Collaboration, "The GAPS Time-of-Flight Detector," in *Proceedings of 38th International Cosmic Ray Conference — PoS(ICRC2023)*, vol. 444, SISSA Medialab, Sep. 27, 2024, pp. 1–6. DOI: 10.22323/1.444.0120.

[C2] R. Munini, A. Lenni, and on behalf of the GAPS Collaboration, "The identification of the cosmic-ray light nuclei with the GAPS experiment," in *Proceedings of 38th International Cosmic Ray Conference — PoS(ICRC2023)*, vol. 444, SISSA Medialab, Sep. 27, 2024, pp. 1–6. DOI: 10.22323/1.444.0179.

[C3] R. Munini and on behalf of the GAPS Collaboration, "Integration and Calibration of the GAPS Antarctic Balloon Payload," in *Proceedings of 38th International Cosmic Ray Conference — PoS(ICRC2023)*, vol. 444, SISSA Medialab, Sep. 27, 2024, p. 180. DOI: 10.22323/1.444.0180.

[C4] A. Stoessl and on behalf of the GAPS Collaboration, "The GAPS experiment - a search for light cosmic ray antinuclei," in *Proceedings of 38th International Cosmic Ray Conference — PoS(ICRC2023)*, vol. 444, SISSA Medialab, Sep. 27, 2024, pp. 1–8. DOI: 10.22323/1.444.1440.

[C5] L. Ghislotti, P. Lazzaroni, M. Manghisoni, and E. Riceputi, "Low-Noise Wide Dynamic Range Charge Sensitive Amplifier in 65 nm CMOS Technology for the Second Flight of the GAPS Experiment," in *2024 19th Conference on Ph.D Research in Microelectronics and Electronics (PRIME)*, Jun. 2024, pp. 1–4, ISBN: 979-8-3503-8630-1. DOI: 10.1109/PRIME61930.2024.10559720.

[C6] M. Verzeroli, A. Galliani, L. Ghislotti, L. Gaioni, P. Lazzaroni, and V. Re, "Empowering Smart Mobility with a Component-based Data Acquisition System for Multi-sensor Readout," in *2024 19th Conference on Ph.D Research in Microelectronics and Electronics (PRIME)*, Jun. 2024, pp. 1–4, ISBN: 979-8-3503-8630-1. DOI: 10.1109/PRIME61930.2024.10559671.

[C7] E. Riceputi, M. Boezio, L. Fabris, L. Ghislotti, P. Lazzaroni, M. Manghisoni, L. Ratti, V. Re, and G. Zampa, "The 32 Analog Channels Readout for the Long-Flight GAPS Balloon Experiment Tracking System," in *Proceedings of SIE 2022*, G. Cocorullo, F. Crupi, and E. Limiti, Eds., vol. 1005, Cham: Springer Nature Switzerland, 2023, pp. 27–32, ISBN: 978-3-031-26066-7. DOI: 10.1007/978-3-031-26066-7_5.

[C8] P. Lazzaroni, M. P. Hammer, M. Manghisoni, A. Miceli, L. Ratti, V. Re, and G. Torilla, "Characterisation of the pFREYA16 ASIC for low-noise ptychography applications," in *2023 IEEE Nuclear Science Symposium, Medical Imaging Conference and International Symposium on Room-Temperature Semiconductor Detectors (NSS MIC RTSD)*, Nov. 2023, pp. 1–1. DOI: 10.1109/NSSMICRTSD49126.2023.10338652.

[C9] E. Riceputi, M. Manghisoni, V. Re, L. Ghislotti, P. Lazzaroni, L. Ratti, L. Fabris, M. Boezio, G. Zampa, M. Xiao, E. Cavazzuti, and V. Vagelli, "Experimental results from the characterization of a 32-channels mixed-signal processor for the GAPS experiment," in *2023 IEEE Nuclear Science Symposium, Medical Imaging Conference and International Symposium on Room-Temperature Semiconductor Detectors (NSS MIC RTSD)*, Nov. 2023, pp. 1–1. DOI: 10.1109/NSSMICRTSD49126.2023.10338321.

[C10] P. Lazzaroni, M. Hammer, M. Manghisoni, A. Miceli, L. Ratti, V. Re, and G. Torilla, "A Low-Noise Readout Channel for X-Ray Ptychography Applications," in *2022 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC)*, Nov. 2022, pp. 1–6, ISBN: 978-1-66548-872-3. DOI: 10.1109/NSS/MIC44845.2022.10399156.

[C11] P. Lazzaroni, M. Hammer, M. Manghisoni, A. Miceli, L. Ratti, and V. Re, "FALCON readout channel for X-ray ptychography applications," in *2022 17th Conference on Ph.D Research in Microelectronics and Electronics (PRIME)*, Jun. 2022, pp. 193–196, ISBN: 978-1-66546-700-1. DOI: 10.1109/PRIME55000.2022.9816837.