

# Irene Zoi, PhD

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## In essence

- Curious physicist, quick and restless learner, adaptive communicator
- Passionate and highly qualified in instrumentation development with experience in silicon detectors and physics data analysis
- Collaborative and team player, brings leading contribution to common goals and student supervision

## Professional Experience

08/2025 — now

**Application Physicist 1** • Fermilab

- Leading the testing of **strip-strip and pixel-strip modules** for the **Outer Tracker Phase-2 upgrade** during production. The modules are made of **two closely spaced silicon sensors** and **multiple ASICs** to provide **tracking information to the L1 trigger** and **on module  $p_T$  discrimination** for the **first time at a hadron collider**.
  - Supervision of students and postdocs during module, electronics and sensor testing
  - Development of the DAQ tools for testing and qualification of the modules
- Coordinating a team of various institutes working on Vector Boson Scattering in final states with at least on boson decaying to jets
  - Supervision of a grad student to develop **polarization studies in jets**
- Supporting role in the **R&D of Monolithic Active Pixels Sensor** with prospects for **future colliders**
- Coordinating searches for heavy resonances, expanding my previous efforts
- **Supervision and mentoring of students**, presenting results at international conferences
- Active member of the **CMS** collaboration at **CERN**

11/2021 — 08/2025

**Research associate** • Fermilab

- Leading contribution in testing and calibration development of **strip-strip and pixel-strip modules** for the **Outer Tracker Phase-2 upgrade**.
  - Responsible for DAQ and  $p_T$  discrimination tools for an irradiated pixel-strip module testbeam at Fermilab to verify the  $p_T$  discrimination capability
  - Leading contribution in pixel-strip module task force solving outstanding issues before the start of the module production
  - Developer modules calibrations and Q&A tools, for the production of thousands of modules
- Leading the **search for anomalous EW production of VBS WV (semi-leptonic) with dimension-8 EFT operators**
  - Supervision of a grad student to develop **polarization studies in jets**
- Supporting role in the **R&D of Monolithic Active Pixels Sensor** with prospects for **future colliders**
- Coordinating searches for heavy resonances, expanding my previous efforts
- **Supervision and mentoring of students**, presenting results at international conferences, involved in **LPC events and committees**
- Active member of the **CMS** collaboration at **CERN**

02/2017 — 10/2021

**Research assistant** • Universität Hamburg (Germany)

- Active member of the **CMS** collaboration at **CERN**
- **Contact person and main data analyst** of a search for new particles covering a large variety of di-boson (W, Z, H) all-hadronic final states and **jet-tagging techniques**
- Took part in several **test beam** campaigns at the **DESY** and **Fermilab** facilities, **collecting and analysing the data**, to characterize and select **pixel silicon sensors** for the **Phase-2 upgrade**
- Supervision of students, presenting results at international conferences

11/2016 — 01/2017

**Research assistant** • Università degli studi di Firenze (Italy)

**R&D of planar and 3D pixel sensors** for the CMS Phase-2 Upgrade

04/2016 — 10/2016

**Visiting Scientist** • Fermilab (USA)

Characterization of non-irradiated and irradiated pixel sensor properties through beam and laser tests, calibrations and analysis of the collected data.

07/2015 — 09/2015

**Summer Intern** • Fermilab (USA)

Analysis of test beam data of pixel sensor prototypes.

## Education

02/2017 — 10/2021

**PhD student** • Universität Hamburg (Germany)

*Thesis: Search for diboson resonances in the all jets final state with CMS at  $\sqrt{s} = 13$  TeV and pixel sensors development for HL-LHC* - **magna cum laude**

Supervisors: A. Hinzmann, E. Garutti

- PhD student in the PIER Helmholtz Graduate School
- Working on the CMS experiment at CERN
- Data analysis on a search for new particles decaying to Higgs or Vector Bosons
- Extensive use of jet tagging techniques and jet substructure observables
- Measurement of the spatial resolution of pixel sensors for the Phase-2 Upgrade
- Study of the radiation damage for the current and future detector

09/2014 — 10/2016

**MSc in Physics and Astrophysics** • Università degli studi di Firenze (Italy)

*Thesis: Silicon pixel detectors for the CMS Tracker upgrade at HL-LHC* - **cum laude**

Supervisors: R. D'Alessandro, G. Bolla, L. Uplegger

- Thesis work carried out at Fermilab as a continuation of the study started during my stay as Summer Intern at Fermilab in 2015
- Contributed to test beam data taking and analysis on irradiated sensors

09/2010 — 04/2014

**BSc in Physics and Astrophysics** • Università degli studi di Firenze (Italy)

*Thesis: Study of saturation effects in the new silicon detectors modules of the LHCf experiment* - **cum laude**; Supervisor: M. Bongi

## Awards

2025

**Breakthrough Prize in Fundamental Physics** •

Awarded to the authors of the ATLAS, CMS, ALICE and LHCb collaborations.

2025

**LHC Physics Center Distinguished Researcher** • Fermilab

Fellowship for 2025

2024

**SPOT award** • Fermilab

For guiding excellent VIP tours for the Italian Scientific Attache and the students

2024

**R&R** • Fermilab

Reward and recognition award for PS module testbeam in 2023

2023	<b>SPOT award</b> • Fermilab Panelist in the fSWE Collegiate Pipeline Program
2018	<b>Travel grant</b> • PIER Helmholtz Graduate School To participate in the CERN-Fermilab Hadron Collider Physics Summer School
2015	<b>Summer student scholarship</b> • INFN & Fermi National Accelerator Laboratory Two months staying at Fermilab working on R&D on pixel silicon detector. Supervisors: G. Bolla, L. Uplegger, C. Vernieri

## Leadership roles

May 2025 — Now	<b>Board of Directors</b> • Fermilab Friends for Science and Education (FFSE) 501c3 charitable organization created with the help of Fermilab Director Leon Lederman in 1983 to help the lab do educational outreach
February 2025 — June 2025	<b>EFT workshop at the LPC</b> • Fermilab Program Committee
July 2024 — Now	<b>Fermilab Society of Women Engineers (fSWE) Executive Board</b> • Fermilab Outreach Subcommittee
June 2024 — Now	<b>LPC Physics Forum chair</b> • Fermilab Organization of seminars for CMS and non CMS members.
10/2023 — 04/2024	<b>Pixel-strip modules task force</b> • CMS Collaboration Investigated and solved outstanding issues with pixel-strip modules before the start of production
2022 — 2023	<b>LPC Events Committee member</b> • Fermilab Organization of events, workshops and tutorials.
2018 — 2020	<b>DESY Language Café</b> • DESY Organized bi-weekly meeting to practice different languages with the support of DOIT (Doktoranden-Initiative in partnership of DESY, Universität Hamburg & PIER Helmholtz Graduate School), CSSB (Centre for Structural Systems Biology) and Fortbildung DESY.

# Supervision, teaching and mentoring

## Student supervision

2022 - Now

Co-supervision of several students and interns • Fermilab

- **Laser setup for the characterization of a MAPS prototype**
  - Luca Bolla, Bachelor student at EPFL (Switzerland), (Summer 2024)
  - Nelson Salvador, Master student in electronics at UTFSM (Chile), (Summer 2024)
- **Several topics related to the Outer Tracker Phase-2 Upgrade, including test-beam datataking and analysis, software development and module testing.**
  - Sweta Baradia, Graduate student at Saha Institute of Nuclear Physics (IN) and Fermilab G&V, (2024)
  - Olivia Clark, Undergraduate student at Tennessee University, Knoxville, (Summer 2025)
  - Allie Dabney, Undergraduate student at Tennessee University, Knoxville, (Summer 2025)
  - Lacey Dishman, Undergraduate student at Tennessee University, Knoxville, (Summer 2023)
  - Olivia Gzamouranis, High school student at Willowbrook High School, Villa Park, now Undergraduate student at Purdue, (2023 - now)
  - Elizabeth Hagen, Undergraduate student at Tennessee University, Knoxville, (Summer 2023)
  - Micah Hillman, Undergraduate student at Tennessee University, Knoxville (US),(Summer 2025)
  - Johnny Lawless, Graduate student at Tennessee University, Knoxville (US),(2023 - 2024)
  - Nhi Nanh Le, Undergraduate student at Gettysburg College, (Summer 2025)
  - Jack Peltier, Undergraduate student at Tennessee University, Knoxville (US),(Summer 2023)
  - Nicolò Salimbeni, Master student at University of Padova (IT), (2023 - now)
  - Iqra Sohail, Graduate student at National Centre for Physics (PK) and LPC based, (2023 - now)
  - Colby Thompson, Graduate student at Tennessee University, Knoxville (US),(Summer 2024)
  - Adam Vendrasco, Graduate student at Tennessee University, Knoxville (US), (2025 - now)
  - Sweta Baradia, Postdoc at UC Davis, California (US), (2025 - now)
- **Jet tagging (including ML) and polarization studies in VBS**
  - Hayden Hollenbeck, Graduate student at the University of Virginia, (2023 - now)
  - Raffaele Delli Gatti, Graduate student at Trieste University (IT), (Summer 2023)
  - Aimen Obaid, Undergraduate student at Smith College (US), (Summer 2025)
- **Search for heavy resonances in all-jets final states**
  - Toan Phan, Graduate student at UIC (US), (2022 - now)
  - Taozhe Yu, Postdoc at DESY (DE), (2023 - now)

06/2019 – 10/2019

Supervision of a Bachelor student • Universität Hamburg (Germany)

David Leppla-Weber, "Search for excited quark states decaying to  $qW/qZ$  with the CMS experiment"

10/2018

Supervision of 3 Italian high school students for a European project of work-school exchange • Universität Hamburg (Germany)

Project on pixel sensors

## Teaching

- 2024 [Excellence in Instrumentation and Detector Technologies \(EDIT\) school](#) • Fermilab  
Exercise with Low Gain Avalanche Diode (LGAD) for time resolution measurement
- 2022 - 2025 [LPC Data Analysis School](#) • Fermilab  
Responsible for several short and long exercises

## Mentoring

- 09/2024 - Now [USCMS mentor](#) • US  
Mentoring of graduate students
- 06/2024 - Now [Mentoring@CERN mentor](#) • CERN  
Women in Technology (WIT) and LHC Early Career Mentoring programme

## Outreach

### Talks

- **Women in STEM presentation** • Willowbrook High School, Villa Park, IL (USA), April 2024
  - My journey in particle physics (so far) (**invited talk**)
- **fSWE Collegiate Pipeline Program- Panel Discussion on Engineering Career Paths at Fermilab** • Fermilab, March 2023
  - How I went from intern to postdoc at Fermilab
- **Physikerinnentagung 2019 (German conference for women physicists)** • TU Berlin, Germany, November 2019
  - Are you ready for the future? Here how the CMS pixel detector will evolve (**invited talk**)

## Various activities

- 2024 — 2025 [CU\\*IP Program Committee](#) • Fermilab  
Organization of the Conference for Undergraduate Women and Gender Minorities in Physics
- 2023 — Now [Remote Operation Center Outreach](#) • Fermilab  
Presenting the Outer Tracker work to VIP visitors of the lab or the department.
- 2022 — Now [ACT-SO Judge](#) • DuPage County  
Judge or mock judge for the Afro-Academic, Cultural, Technological, and Scientific Olympics (ACT-SO) in the Engineering category. The program targets African American High school students.
- 2022 — Now [SiDet tour guide](#) • Fermilab  
Providing tours of the Silicon Detector facility at Fermilab for students, experts of the scientific community and other guests of the laboratory.
- 08/2019 [Supervision of 2 female high school students](#) • Physik-Projekt-Tage, Universität Hamburg (Germany)  
Initiative to involve more women in pursuing a career in science, project on Silicon Photo Multipliers (SiPM)

## Skills

- Programming** Python • Jupyter • C++ •  $\text{\LaTeX}$  • ROOT • Git • Linux • Basic VHDL • Batch computing (Condor) • singularity
- Languages** Italian (Mother tongue) • English (Fluent) • German (B1)

## Publications

The CMS collaboration lists each member of the experiment as an author on all publications. Below are publications to which I contributed substantially. A full publication list can be found at <http://inspirehep.net/author/profile/Irene.Zoi.1>.

### Selected peer-reviewed publications

CMS Collaboration, "Combination of CMS searches for heavy vector boson resonances at  $\sqrt{s} = 13$  TeV", CMS-PAS-B2G-25-003, to be submitted to JHEP.

CMS Collaboration, "Vector boson scattering and anomalous quartic couplings in final states with  $\ell\nu qq$  or  $\ell\ell qq$  plus jets using proton-proton collisions at  $\sqrt{s} = 13$  TeV", CMS-PAS-SMP-22-011, [arXiv:2510.00118](https://arxiv.org/abs/2510.00118), submitted to JHEP.

CMS Collaboration, "Search for new heavy resonances decaying to  $WW$ ,  $WZ$ ,  $ZZ$ ,  $WH$ , or  $ZH$  boson pairs in the all-jets final state in proton-proton collisions at  $\sqrt{s} = 13$  TeV", CMS-B2G-20-009, [arXiv:2210.00043](https://arxiv.org/abs/2210.00043), [10.1016/j.physletb.2023.137813](https://doi.org/10.1016/j.physletb.2023.137813).

I. Zoi et al., "Position resolution with 25  $\mu\text{m}$  pitch pixel sensors before and after irradiation", *NIM A* 1021 (2021) 165933

A. Ebrahimi et al., "Position reconstruction for segmented detectors", *NIM A* 1014 (2021) 165744

M. Boscardin et al., "Performance of new radiation-tolerant thin planar and 3D columnar  $n$  on  $p$  silicon pixel sensors up to a maximum fluence of  $\sim 5 \times 10^{15} n_{eq}/\text{cm}^2$ ", *NIM A* 953 (2020) 163222

CMS Collaboration, "The Phase-2 Upgrade of the CMS Tracker", Technical Design Report, CERN-LHCC-2017-009, CMS-TDR-17-001

C. Vernieri et al., "Pixel sensors with slim edges and small pitches for the CMS upgrades for HL-LHC", *NIM A* 845 (2017) 189

CMS Collaboration, "Model-agnostic search for dijet resonances with anomalous jet substructure in proton-proton collisions at  $\sqrt{s} = 13$  TeV", CMS-PAS-EXO-22-026, *Rep. Prog. Phys.* 88 067802

CMS Collaboration, "Searches for Higgs boson production through decays of heavy resonances", CMS-B2G-23-002, *Physics Reports* 1115 (2025) 368-447

### Selected technical and conference notes

Irene Zoi on behalf of the CMS Collaboration, "Design and construction of the Outer Tracker for the Phase-2 Upgrade", 2025 JINST 20 C06030.

Irene Zoi on behalf of the CMS Collaboration, "Design and construction of the Outer Tracker for the Phase-2 Upgrade", *NIM A* 1078 (2025) 170599.

Irene Zoi on behalf of the CMS Collaboration, "Design and construction of the Outer Tracker for the Phase-2 Upgrade", CMS-CR-2023-298, *PoS(VERTEX2023)021*.

CMS Collaboration, "Pixel Charge Profiles in Run-2 Data and Simulation", CMS-DP-2020-026

CMS Collaboration, "Tracker Performance in 2017 Legacy processing", CMS-DP-2019-027

F. Feindt for the CMS Tracker Group, "Beam test measurements on planar pixel sensors for the CMS phase 2 upgrade", CMS-CR-2019-298

I. Zoi et al., "Beam Test Results of Thin  $n$ -in- $p$  3D and Planar Pixel Sensors for the High Luminosity LHC Tracker Upgrade at CMS", *PoS(EPS-HEP2017)809*

## Conference contributions

### Most relevant international conferences

- **Lepton-Photon 2025** • Madison, WI (US), 25 - 29 August 2025

- Vector Boson Scattering measurements at CMS
- **VCI 2025 - Vienna Conference on Instrumentation** • Vienna (Austria), 17 - 21 February 2025
  - Design and construction of the CMS Outer Tracker for the Phase-2 Upgrade (plenary)
- **Pixel 2024 - 11th International Workshop on Semiconductor Pixel Detectors for Particles and Imaging** • Strasbourg (France), 18-22 November 2024
  - Design and construction of the CMS Outer Tracker for the Phase-2 Upgrade (poster)
- **Vertex 2023 - 32nd International Workshop on Vertex detectors** • Sestri Levante (Italy), 16-20 October 2023
  - Design and construction of the CMS Outer Tracker for the Phase-2 Upgrade (plenary)
- **Deep Inelastic Scattering (DIS)** • Michigan State University (US), 27-31 March 2023
  - Vector Boson Scattering results in CMS
- **The Tenth Annual Large Hadron Collider Physics (LHCP2022) conference** • Taipei, Taiwan (online), 16-20 May 2022
  - ATLAS+CMS Searches for Di-/Tri-boson resonances
- **Phenomenology 2022 Symposium: From Virtual to Real** • University of Pittsburgh, USA, 9-11 May 2022
  - Searches for heavy resonances in diboson final states at CMS
  - Chair of Higgs II parallel session
- **European Physical Society Conference on High Energy Physics** • Venice (Italy), July 2017
  - Beam Test Results of Thin n-in-p 3D and Planar Pixel Sensors for the High Luminosity LHC Tracker Upgrade at CMS (poster)

## Other international conferences and workshops

- **2024 Annual Review - Tracker** • CERN, 29 April 2024
  - OT: modules - kick off batch results
- **PS module workshop** • Fermilab, 10-12 October 2023
  - PS testing
- **Deep Dive: QCD backgrounds** • CERN, 30 May 2023
  - Multidimensional fits
- **CMS Physics Days: Review of Run 2 interesting excesses** • CERN, 14-15 September 2022
  - B2G: Diboson and resonance searches
- **CMS Week** • CERN (online), 24-28 January 2022
  - Multi-dimensional search for new heavy resonances decaying to boosted WW, WZ, ZZ, WH or ZH boson pairs in hadronic final states
- **10th LHC students poster session at 141st LHCC Meeting** • CERN, 19 February 2020
  - Precision single hit resolution measurements for the CMS Inner Tracker Phase-2 upgrade (poster)
- **Remote B2G Spring Workshop 2020** • 18-20 May 2020 (online)
  - Diboson all-hadronic resonance search using a 3D fit
- **2019 CMS B2G Spring Workshop** • Naples, Italy, April 2019
  - Search for VBF produced diboson resonances in the all-jets final state: overview & first look at 2018 data
- **CMS Physics and Upgrade Week** • Budapest, Hungary, October 2018
  - Search for VBF produced diboson resonances in the all-jets final state at  $\sqrt{s} = 13$  TeV (poster)
- **B2G Spring Workshop** • Hamburg, Germany, May 2018
  - Search for VBF produced diboson resonances in the all-jets final state at  $\sqrt{s} = 13$  TeV with the CMS experiment

## Seminars

- **Purdue University** • 4 February 2025
  - Building a new Outer Tracker for the CMS Phase-2 upgrade
- **UChicago** • 4 November 2024
  - Building a new Outer Tracker for the CMS Phase-2 upgrade

## National conferences and workshops

- **2022 US CMS Annual Collaboration Meeting** • Jun 8 – 10, 2022 UW-Madison, Madison, WI, USA
  - The Outer Tracker module testing at Fermilab
- **DPG Spring Meeting 2021** • [March 15-19, 2021 \(online\)](#)
  - A multi-dimensional search for new heavy resonances decaying to boosted WW, WZ, ZZ, WH or ZH boson pairs in the all-jets final state at 13 TeV
  - Position resolution with 25  $\mu\text{m}$  pitch pixel sensors
- **FSP CMS Workshop 2020** • [September 23-25, 2020 \(online\)](#)
  - Diboson all-hadronic resonance search using a 3D fit
  - Pixel status and radiation effects in the Phase-1 pixel detector
- **D-CMS Workshop 2019** • KIT, Karlsruhe, Germany, September 2019
  - Extension of VV all-hadronic with 3D fit to VH and VBF
- **DPG Spring Meeting 2019** • [Aachen, Germany, March 2019](#)
  - Spatial resolution measurements with planar pixel sensors for the CMS Phase-2 Upgrade
- **FSP CMS Workshop** • [Hamburg, Germany, September 2018](#)
  - Search for VBF produced diboson resonances in the all-jets final state at  $\sqrt{s} = 13$  TeV
- **DPG Spring Meeting 2018** • [Würzburg, Germany, March 2018](#)
  - Search for VBF produced diboson resonances in the all-jets final state at  $\sqrt{s} = 13$  TeV with CMS
- **FSP CMS Workshop** • [RWTH Aachen University, Germany, October 2017](#)
  - The Phase-II Tracker Upgrade and Jet Substructure Performance