

Daniel Diaz

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Research Interests

My research sits at the interface of experimental particle physics and machine learning: I build the AI methods and real-time computing systems that decide which LHC collisions are worth keeping, and I use them to search for new physics that conventional triggers and reconstruction would throw away.

Particle Physics	Searches for long-lived particles and dark sectors; Higgs boson pair production; trigger and data-acquisition systems; dedicated and unconventional data streams (B-parking, Level-1 scouting); calorimetry, detector operations and upgrades for the CMS experiment.
Machine Learning	Real-time and on-detector inference on FPGAs (hls4ml); anomaly detection for model-agnostic discovery; graph and transformer architectures for tagging and reconstruction; FAIR, reproducible and reusable AI models for science.
Research Computing	AI-enabled scientific workflows at scale; Kubernetes-based national cyberinfrastructure; accessible platforms that let domain scientists and students train, deploy and share models.

Appointments

Aug. 2025 –	University of California San Diego Computational Research Scientist, San Diego Supercomputer Center	La Jolla, CA
2023 – 2024	Fermi National Accelerator Laboratory Distinguished Researcher, LHC Physics Center	Batavia, IL
2021 – 2025	University of California San Diego Postdoctoral Scholar, Department of Physics	La Jolla, CA

Collaboration Appointments

2025 – Co-Convener (L3), [CMS Machine Learning](#) Knowledge subgroup

Education

2016 – 2020	Florida State University Ph.D. in Physics · M.S. in Physics (2018) <i>Dissertation:</i> Search for Higgs Boson Decays to Long-Lived Scalar Particles in pp Interactions at $\sqrt{s} = 13$ TeV	Tallahassee, FL
2014 – 2016	California State University, Long Beach M.S. in Physics <i>Thesis:</i> Threshold Resonances in Atomic Three-Body Systems	Long Beach, CA
2010 – 2014	University of California, Riverside B.S. in Physics · B.S. in Applied Mathematics	Riverside, CA

Grants and Funding

Sep. 2026 – 2027	Co-PI , DOE Award <i>AIDA-Scout: AI for Inclusive Real-Time Anomaly Detection and Accelerated Discovery in the CMS Level-1 Scouting System</i>
2023, 2024	Awardee , LHC Physics Center Distinguished Researcher program, Fermilab; competitively awarded research and travel support

Spring 2019	Awardee , Hagopian Family Endowment, Florida State University; doctoral research support in experimental high-energy physics
Summer 2015	Awardee , Department of Physics & Astronomy Student Research Support, CSU Long Beach
Summer 2011	Awardee , CCRAA STEM Pathways Research Grant, UC Riverside

Selected Contributions

- Lead analyst on the CMS search for long-lived particles in b -hadron decays using muon-detector showers in **B-parking data** [1], building on [2, 3]; designed the analysis framework and background-estimation strategy now used by the team.
- Lead role in the CMS search for long-lived particles produced in ZH **associated production** [4]: the most sensitive result for light long-lived scalars with $c\tau \in [10, 300]$ mm, and the most sensitive Z_D interpretation at tracker lifetimes.
- Built and lead **real-time machine learning** efforts for the CMS Level-1 trigger: an FPGA long-lived-particle jet tagger and a deep-learning missing-transverse-momentum algorithm, developed on a local trigger test stand in Verilog and hls4ml [5, 6].
- Contributor to CMS searches for **boosted Higgs boson pair production** [7, 8], including a suite of new jet triggers integrated into the Run 3 high-level trigger menu.
- Helped establish **FAIR principles for AI models** in high-energy physics [9, 10, 11], co-authoring the community guide for making AI models findable, accessible, interoperable and reusable.
- **Co-Convener (L3) of the CMS Machine Learning Knowledge subgroup**, responsible for how ML practice is documented and taught across the collaboration; instructor for CMS DAS, Fermilab HATS and the National Research Platform.

Research Experience

Searches for Long-Lived Particles and Dark Sectors · CMS

- 2021 – • Lead the search for long-lived particles decaying in the CMS endcap muon detectors using the **B-parking dataset** [1]; built the analysis framework and the background-estimation strategy, and supervise the two graduate students and one undergraduate carrying out the measurement.
 - Supervise development of neural-network and BDT taggers for displaced showers in the muon system, and contributed to the first iteration of the muon-detector shower method [2, 3].
 - Contributor to CMS dark-sector and unconventional-signature programmes [12, 13], including reviews and summary reports on dedicated data streams [14, 15].
- 2017 – 2022 • Lead role in the CMS search for long-lived particles produced in association with a Z boson [4]: developed the displaced-jet tagging optimisation, and built and maintained the ntuple production and analysis framework for the full Run 2 dataset.
 - Most sensitive search for light (< 20 GeV) long-lived scalars with $c\tau \in [10, 300]$ mm; adapted the analysis to a second interpretation (long-lived Z_D produced with a Z boson), improving on the corresponding ATLAS results at tracker lifetimes and heavy Higgs masses.

Real-Time Machine Learning and the CMS Level-1 Trigger

- 2021 – • Established and run a local Level-1 trigger test stand at UCSD; test algorithms on FPGA boards, evaluate resource utilisation, and develop in Verilog and hls4ml [5, 6].
 - Supervise students building an ML-based long-lived-particle jet tagger and a deep-learning missing-transverse-momentum algorithm for Level-1.
 - Privately generated the large signal Monte Carlo samples used to train the ML jet taggers, where no central production existed.

Higgs Boson Pair Production

- 2021 – 2025 • Contributor to CMS searches for non-resonant di-Higgs production in the highly boosted topology: $hh \rightarrow bbbb$ [7] and $hh \rightarrow bbVV$ across Run 2 and Run 3; developed the top control-region background study.
 - Designed a suite of new jet triggers adopted into the Run 3 high-level trigger menu, extending acceptance for boosted hadronic final states.
 - Co-author of the community HHH whitepaper [8].
- 2021 – 2022 • Supervised undergraduate students on the Snowmass study of di-Higgs sensitivity at the FCC-hh [16], comparing ML-based jet taggers for identifying boosted di-Higgs events.

FAIR AI and Research Computing Infrastructure

- 2025 – • Computational research scientist at SDSC: support and extend Kubernetes-based national cyberinfrastructure for AI and data-intensive science, and develop the tutorials and user-facing tooling that get domain scientists and students onto it.
- 2021 – 2023 • FAIR4HEP: developed frameworks and a community guide for findable, accessible, interoperable and reusable AI models in high-energy physics [9, 10, 11]; co-maintained the project site and coordinated group meetings.

Detector Operations and Upgrades · CMS HCAL

- 2018 – 2020 • HCAL detector-on-call expert; participated in readout-module installation and megatile connection at CMS Point 5.
 - Commissioned a new HCAL calibration laser and helped write the WinCC software integrating laser controls into central HCAL monitoring.
- 2018 – 2019 • Phase-I HB upgrade: built the readout-module test stand at CERN B28 and ran quality control on SiPM control cards, mounting boards and mezzanines, qualifying components for installation; participated in readout-box burn-in at CERN B904.
- 2017 – 2018 • Phase-II Scintillator Endcap: studied radiation hardness of candidate UV LEDs at the FSU John D. Fox laboratory; built the dark-box setup, wrote firmware for the rastering device, and measured luminosity and IV characteristics before and after irradiation.

Earlier Research

- 2015 – 2016 • CSU Long Beach: led calculations of resonant states in the e -Ps and e -H three-body systems [17]; contributed Fortran code solving the Faddeev–Merkuriev integral equations and found evidence for broad-width (“threshold”) resonances.
- 2014 • Muon Ionization Cooling Experiment (MICE), UC Riverside: contributed to an early iteration of the MAUS software package and trigger software; ran Geant4 event simulations.
- 2011 – 2014 • COSMOS survey, UC Riverside: classified galaxies from Hubble and Subaru imaging and analysed the color–magnitude relations used for classification.

Publications

As a member of the CMS Collaboration I am a co-author of 583 publications with 28,016 citations and an h-index of 85 (InspireHEP, September 2026). Listed below are works to which I made a direct and substantial contribution; the full list is available on InspireHEP.

- [1] CMS Collaboration, “Search for b-hadron decays to long-lived particles in the CMS endcap muon detectors”, *Phys. Rev. D* **113** (2026), no. 1, 012009, doi:10.1103/71dn-snzn, arXiv:2508.06363.
- [2] CMS Collaboration, “Search for Long-Lived Particles Decaying in the CMS End Cap Muon Detectors in Proton-Proton Collisions at $\sqrt{s}=13$ TeV”, *Phys. Rev. Lett.* **127** (2021), no. 26, 261804, doi:10.1103/PhysRevLett.127.261804, arXiv:2107.04838.
- [3] CMS Collaboration, “Search for long-lived particles decaying in the CMS muon detectors in proton-proton collisions at $\sqrt{s}=13$ TeV”, *Phys. Rev. D* **110** (2024), no. 3, 032007, doi:10.1103/PhysRevD.110.032007, arXiv:2402.01898.
- [4] CMS Collaboration, “Search for long-lived particles produced in association with a Z boson in proton-proton collisions at $\sqrt{s}=13$ TeV”, *JHEP* **03** (2022) 160, doi:10.1007/JHEP03(2022)160, arXiv:2110.13218.
- [5] J.-F. Schulte et al., “hls4ml: A Flexible, Open-Source Platform for Deep Learning Acceleration on Reconfigurable Hardware”, arXiv:2512.01463.
- [6] T. Baldi et al., “Reliable edge machine learning hardware for scientific applications”, arXiv:2406.19522.
- [7] CMS Collaboration, “Search for Nonresonant Pair Production of Highly Energetic Higgs Bosons Decaying to Bottom Quarks”, *Phys. Rev. Lett.* **131** (2023), no. 4, 041803, doi:10.1103/PhysRevLett.131.041803, arXiv:2205.06667.
- [8] H. Abouabid et al., “HHH whitepaper”, *Eur. Phys. J. C* **84** (2024), no. 11, 1183, doi:10.1140/epjc/s10052-024-13376-3, arXiv:2407.03015.
- [9] Y. Chen et al., “A FAIR and AI-ready Higgs boson decay dataset”, doi:10.1038/s41597-021-01109-0, arXiv:2108.02214.
- [10] J. Duarte et al., “FAIR AI models in high energy physics”, *Mach. Learn. Sci. Tech.* **4** (2023), no. 4, 045062, doi:10.1088/2632-2153/ad12e3, arXiv:2212.05081.
- [11] E. A. Huerta et al., “FAIR for AI: An interdisciplinary and international community building perspective”, doi:10.1038/s41597-023-02298-6, arXiv:2210.08973.
- [12] CMS Collaboration, “Dark sector searches with the CMS experiment”, *Phys. Rept.* **1115** (2025) 448–569, doi:10.1016/j.physrep.2024.09.013, arXiv:2405.13778.

- [13] CMS Collaboration, "Search for long-lived particles using out-of-time trackless jets in proton-proton collisions at $\sqrt{s} = 13$ TeV", *JHEP* **07** (2023) 210, doi:[10.1007/JHEP07\(2023\)210](https://doi.org/10.1007/JHEP07(2023)210), arXiv:[2212.06695](https://arxiv.org/abs/2212.06695).
- [14] CMS Collaboration, "Probing new physics with dedicated data streams at CMS", technical report, CERN, Geneva, 2024.
- [15] CMS Collaboration, D. C. Diaz, "Search for new physics with long-lived and unconventional signatures in CMS", in *31st International Symposium on Lepton Photon Interactions at High Energies*. 2023. doi:[10.5281/zenodo.8373133](https://doi.org/10.5281/zenodo.8373133).
- [16] A. Apresyan et al., "Improving Di-Higgs Sensitivity at Future Colliders in Hadronic Final States with Machine Learning", in *Snowmass 2021*. 3, 2022. arXiv:[2203.07353](https://arxiv.org/abs/2203.07353).
- [17] D. Diaz, Z. Papp, and C.-Y. Hu, "Series of broad resonances in atomic three-body systems", *Atoms* **4** (2016), no. 2, doi:[10.3390/atoms4020017](https://doi.org/10.3390/atoms4020017).

Honors and Awards

2025	Breakthrough Prize in Fundamental Physics , awarded to the ALICE, ATLAS, CMS and LHCb collaborations for results published 2015–2024; shared as a CMS collaborator
2023, 2024	LHC Physics Center Distinguished Researcher , Fermilab, for long-lived particle searches and real-time ML for the CMS Level-1 trigger
Spring 2019	Hagopian Family Endowment, Florida State University
Fall 2016	Dean's Doctoral Scholarship, Florida State University
Spring 2016	Physics Department Graduate Student Honors, CSU Long Beach
Spring 2016	CSULB Student Research Competition, 3rd Place
Summer 2015	Department of Physics & Astronomy Student Research Support, CSU Long Beach
Summer 2011	CCRAA STEM Pathways Research Grant, UC Riverside

Selected Talks and Tutorials

Physics

Jun. 2025	<i>Muon-detector showers with the CMS B-parking dataset</i> Long-Lived Particles Workshop, Valencia, Spain · <i>Invited</i>
Mar. 2025	<i>Illuminating the dark sector</i> Colloquium, California State University, Long Beach · <i>Invited</i>
Feb. 2025	<i>Exploring the dark sector: long-lived particle searches and machine learning at the LHC</i> Colloquium, University of Notre Dame · <i>Invited</i>
Jul. 2024	<i>Probing new physics with dedicated data streams at CMS</i> ICHEP, Prague, Czechia
Jul. 2023	<i>Searches for new physics with long-lived and unconventional signatures in CMS</i> Lepton Photon 2023, Melbourne, Australia
Jun. 2022	<i>Higgs boson decays to long-lived scalar particles produced with a Z boson</i> USCMS Annual Meeting, Madison, WI · <i>Invited</i>
Apr. 2022	<i>Hunting for long-lived particles</i> Colloquium, California State University, Long Beach · <i>Invited</i>
Apr. 2022	<i>Experiences with the APS Bridge Program</i> APS April Meeting, New York, NY · <i>Invited</i>
Nov. 2021	<i>Level-1 Trigger (FPGA) and on-detector readout (ASIC)</i> A3D3 Kick-off Meeting, virtual
Nov. 2020	<i>Search for Higgs boson decays to long-lived scalar particles in pp interactions at $\sqrt{s} = 13$ TeV</i> Doctoral dissertation defense, Florida State University
Oct. 2019	<i>Decays to long-lived displaced jets (tracker-based analyses)</i> CMS Exotica Workshop, RWTH Aachen, Germany
Oct. 2018	<i>Search for Higgs boson decays to long-lived scalar particles in pp interactions at $\sqrt{s} = 13$ TeV</i>

- CMS Exotica Workshop, University of Athens, Greece
- Sep. 2018 *Search for Higgs boson decays to long-lived scalar particles in pp interactions at $\sqrt{s} = 13$ TeV*
Prospectus defense, HEP Seminar, Florida State University
- Aug. 2016 *Threshold resonances in atomic three-body systems*
Master's thesis defense, California State University, Long Beach
- Oct. 2015 *Structure of resonances in atomic three-body systems*
APS Far West Meeting
- Sep. 2015 *Structure of resonances in atomic three-body systems*
Student Research Symposium, California State University, Long Beach · *Poster*
- May 2015 *Structure of resonances in atomic three-body systems*
California State University Research Competition

AI and Research Computing

- Sep. 2026 *AI agents and large language models for scientific discovery*
CLARIPHY AI Collaboration Meeting, UW–Madison; three-hour tutorial with A. Novak · *Tutorial*
- Sep. 2026 *The National Research Platform*
CLARIPHY AI Collaboration Meeting, UW–Madison; plenary session · *Invited*
- Sep. 2026 *AIDA-Scout: AI for inclusive real-time anomaly detection and accelerated discovery in the CMS Level-1 scouting system*
CLARIPHY AI Collaboration Meeting, UW–Madison; co-author, presented by a collaborator · *Poster*
- Aug. 2026 *NRP's hosted LLM service: open-weight frontier models, on hardware the community owns*
REN Makerspace Call · *Invited*
- Aug. 2026 *Prototype National Research Platform Classroom*
NAIRR AI Education Webinar Series, Computing Research Association · *Webinar*
- Aug. 2026 *NRP as a resource for LLMs*
Hands-On Advanced Tutorial Sessions (HATS), Fermilab LPC; four-hour tutorial with A. R. Das · *Tutorial*
- Aug. 2026 *NRP as a resource for USCMS*
Hands-On Advanced Tutorial Sessions (HATS), Fermilab LPC; three-hour tutorial · *Tutorial*
- Jul. 2026 *Kubernetes for AI-enabled scientific research computing and education*
PEARC26; full-day tutorial with M. F. Sada · *Tutorial*
- Jun. 2026 *Capacity and community for research emerging institutions with large computing programs*
NAIRR Pilot Classroom Expansion Conference; two-hour workshop with M. F. Sada · *Tutorial*
- Jun. 2026 *Hands-on AI on NRP: managed LLMs, RAG and agentic coding*
RCSI; one-hour session with M. F. Sada · *Tutorial*

Teaching

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- 2025 – **The National Research Platform** Various, USA
Tutorial developer and instructor. Teach students, staff and faculty to use the NRP's Kubernetes-based platform for data analysis, machine learning, high-performance computing and coursework, including hosted large language models, retrieval-augmented generation and AI agents for scientific workflows. Built and maintain the NRP training site (training.nrp-nautilus.io); seven hands-on trainings and webinars in 2026, listed under Selected Talks and Tutorials.
- 2023 – **Fermi National Accelerator Laboratory** Batavia, IL
Hands-On Advanced Tutorial (HATS) instructor. Three-hour lecture and interactive sessions for students across CMS institutions on trigger studies, machine learning, Kubernetes-based HEP workflows and jet substructure; developed a new session on outreach and advocacy (2023).
- Jan. 2023 **Fermi National Accelerator Laboratory** Batavia, IL
CMS Data Analysis School instructor. Week-long bootcamp introducing graduate students across CMS to HEP data analysis.

- 2016 – 2017 **Florida State University** *Tallahassee, FL*
Lecture grader and laboratory instructor. Graded weekly problem sets and held office hours for *Physics Problem Solving*; led introductory physics laboratory sections.
- 2014 – 2016 **California State University, Long Beach** *Long Beach, CA*
Physics laboratory instructor. Led weekly introductory physics laboratory sections, held office hours, graded reports and quizzes.

Research Mentorship

Direct research supervision of 5 graduate, 9 undergraduate and postbaccalaureate, and 4 high-school students.

Graduate Students

- 2021 – **Anthony Aportela** UC San Diego
 CMS muon-system LLP search with B-parking data; Level-1 LLP jet tagger; ML methods for offline LLP tagging.
- 2022 – **Russell Marroquin** UC San Diego
 CMS Level-1 LLP jet tagger.
- 2023 – 2025 **Aram Hayrapetyan** Yerevan Physics Institute
 CMS muon-system LLP search (B-parking); Level-1 LLP jet tagger.
- 2024 – 2025 **Daniel Primosch** UC San Diego
 CMS Level-1 Deep MET trigger.
- 2017 – 2018 **Suho Kim** Florida State University
 CMS search for long-lived particles produced with a Z boson.

Undergraduate and Postbaccalaureate Students

- 2024 – 2025 **Trevin Lee** UC San Diego
 Dense graph convolutional network for tagging long-lived particles.
- Summer 2024 **Juan D. Guadalupe-Rosado** USCMS PURSUE intern
 BDT tagger for the offline long-lived particle analysis.
- 2023 – 2025 **Shuyang Zhang** UC San Diego
 CMS muon-system LLP search with B-parking data.
- Summer 2023 **Michael Miranda** USCMS PURSUE intern
 CMS Level-1 trigger sensitivity and rate studies.
- 2021 – 2024 **Simon Poon** UC San Diego
 CMS Level-1 Deep MET trigger.
- 2022 – 2023 **Brian Sheldon** UC San Diego
 FCC di-Higgs sensitivity, Snowmass study.
- Summer 2022 **Qiudi (Autumbia) Ge** UC San Diego
 FCC di-Higgs sensitivity, Snowmass study.
- Spring 2022 **Haifeng Ding** UC San Diego
 FCC di-Higgs sensitivity, Snowmass study.
- 2022 **John Chen** UC San Diego
 CMS Level-1 trigger long-lived particle jet tagging.

High School Students

- 2022 **Parsa Pourghasem and Oliver Young**
 Peltier-cooled cloud chamber.
- 2022 **Serena Zhang and Nitika Tatineni**
 Desktop muon detector.

Service and Outreach

- Sep. 2026 Co-convenor, Computing Infrastructure session, CLARIPHY AI Collaboration Meeting, UW–Madison

- 2025 – Co-Convener (L3), [CMS Machine Learning](#) Knowledge subgroup
- 2025 – [USCMS](#) In-house Activities Committee
- 2024 – [A3D3](#) Equity and Career Committee
- 2023 – USCMS Mentor
- 2023 – 2025 Chair, [USCMS Mentorship Committee](#)
- 2024 – 2025 [LHC Physics Forum](#) Committee
- 2023 – 2025 [A3D3](#) Seminar Committee
- 2023 Organizer, [LHC Physics Center Journal Club](#)
- 2022 – 2023 [A3D3](#) Mentor
- Spring 2023 Planning committee, [A3D3](#) High-Throughput Workshop
- Fall 2022 Planning committee, [FAIR4HEP](#) Workshop
- Jul. 2022 Co-organizer, [h1s4m1](#) tutorial at the Snowmass Summer Meeting, Seattle
- Jul. 2022 Organizer, UCSD local "Higgs@10" celebration
- Sep. 2019 Volunteer, CERN Open Days