

Gage DeZoort

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Education

Princeton University

Doctoral Student in the Physics Department
Center for Statistics and Machine Learning Certificate

Princeton, NJ

2018-Present

University of Virginia

Bachelor of Science in Physics and Engineering Science
With Highest Distinction

Charlottesville, VA

2014-2018

Publications

Graph Neural Networks for Charged Particle Tracking on FPGAs

A. Elabd, V. Razavimaleki, et al., *arXiv:2012.01563*

Submitted to Frontiers in Big Data, section Big Data and AI in High Energy Physics.

Charged Particle Tracking via Edge-Classifying Interaction Networks

G. DeZoort, et al. *Comput Softw Big Sci* **5**, 26 (2021).

<https://doi.org/10.1007/s41781-021-00073-z>

Physics and Computing Performance of the Exa.TrkX TrackML Pipeline

X. Ju, D. Murnane, et al., *arXiv:2103.06995* (2021).

Accelerated Charged Particle Tracking with Graph Neural Networks on FPGAs

A. Heintz, V. Razavimaleki, et al., *arXiv:2012.01563v1* (2020).

Instance Segmentation GNNs for One-Shot Conformal Tracking at the LHC

S. Thais and G. DeZoort, *arXiv:2103.06509* (2020).

Search for black holes and sphalerons in high-multiplicity final states in proton-proton collisions at $\sqrt{s} = 13$ TeV

A.M. Sirunyan, et al. [CMS Collaboration]. *J. High Energ. Phys.* (2018).

[https://doi.org/10.1007/JHEP11\(2018\)042](https://doi.org/10.1007/JHEP11(2018)042)

Performance of Wavelength-Shifting Fibers for the Mu2e Cosmic Ray Veto Detector

G. DeZoort, E.C. Dukes, R.C. Group, et al., *arXiv:1511.06225* (2015).

Research Experience

Displaced Hadronic Tau Reconstruction and Identification

Fall 2020 - Present

- Exploring calorimeter and tracker signatures towards graph-based representations of displaced hadronic tau decays.
- Designing graph neural network (GNNs) to reconstruct displaced hadronic taus from RECO-level hits and identify displaced hadronic taus based on their particle-flow constituents.

Graph Neural Networks (GNNs) for High-Pileup Tracking

Fall 2019 - Present

- Implementing GNN architectures such as the Interaction Network in PyTorch Geometric and training them to reconstruct tracks in the high-pileup TrackML simulated dataset.
- Accelerating graph construction algorithms and GNN inference via heterogeneous computing resources, in particular FPGAs.
- Developing instance segmentation strategies for one-shot tracking, in which tracks are identified as

objects in different coordinate spaces and used to predict track parameters in a single forward-pass.

- Exploring the use of graph equivariances for GNN parameter-sharing schemes in order to reduce the computational resource usage of GNN-based tracking algorithms.

Associated Higgs Production with $ll\tau\tau$ Final States

Spring 2019 - Present

$ZH \rightarrow ll\tau\tau$ SM Analysis (ZH) and $A \rightarrow Zh \rightarrow ll\tau\tau$ BSM Analysis (AZh)

- Writing a Coffea-based AZh pre-selection framework from scratch; developing subsequent plotting and statistical analysis stages with Python-based analysis tools including Awkward Array, Boost Histogram, and SciPy.
- Comparing $\tau\tau$ mass reconstruction strategies including FastMTT, SVFit, and constrained kinematic fits; re-implementing FastMTT in Python accelerated by Numba.
- Rewriting the Princeton University Analysis CMSSW-based software package to accommodate $ll\tau\tau$ final states; contributing to the development of a NanoAOD-based Python framework for the ZH analysis.

Muon Lifetime Measurement Device

Spring 2019 - Fall 2019

- Built a 'desktop' cosmic ray muon detector out of a 1 gallon paint pail, liquid scintillator, and a photodetector made of a silicon photomultiplier (SiPM) array and a transimpedance amplifier board; constructed an electronic trigger circuit to capture muon decay events.
- Developed a set of Python scripts to process detector data and perform a muon lifetime measurement using Scipy and iMinuit implementations of χ^2 and $-\log \mathcal{L}$ minimizations.

Search for Black Holes and Sphalerons in High-Multiplicity Final States

Summer 2017

- Used the CMS Combine tool to calculate model-independent and model-dependent limits in a search for microscopic black holes and other new physics in high-multiplicity final states.
- Fit black hole mass spectra and examined their anomalous features via sideband subtraction.

Shashlik Calorimeter Research and Design

Summer 2016 - Spring 2017

- Took beam shifts to collect data with a Shashlik detector module, a compact electromagnetic calorimeter composed of alternating layers of scintillator and absorber material with optical fiber readouts.
- Contributed to waveform analysis software and studied detector hits resulting from beamshift data.

Mu2e Cosmic Ray Veto R&D

Summer 2015 - Spring 2016

- Tested long-range and short-range light transmission in optical readout fibers; wrote software to analyze the resulting transmission data.
- Aided in the design and construction of CRV test modules and production equipment.

CERN Collaborative Activities

CMS Machine Learning Knowledge Subgroup

Spring 2021 - Present

- Writing PyTorch and PyTorch Geometric inference and optimization tutorials for the new CMS ML documentation website.

Tau DQM Developer

Spring 2020 - Spring 2021

- Restructuring the tau DQM file structure to accommodate MiniAOD-level validation sequences.

ECAL Trigger Team (ETT)

Summer 2016, Summer 2017

- Studied anomalous signal reduction in the ECAL L1 trigger via software emulations.
- Completed Prompt Feedback Group (PFG) and ETT expert on-call shifts.

Talks and Posters

Charged Particle Tracking via Edge-Classifying Interaction Networks

Poster presented at the Princeton Physics Dicke Fellows Symposium (September 10th)

“Unconference” talk delivered at the Oxford School of ML (August 8th, 2021).

Poster presented at the London School of Geometry and ML (July 12th, 2021).

Plenary talk given at vCHEP, the Conference on Computing in High-Energy and Nuclear Physics (May 21st, 2021).

Instance Segmentation GNNs for One-Shot Conformal Tracking

Poster presented at the NeurIPS Machine Learning and the Physical Sciences workshop (Dec. 11th, 2020).

Particle Tracking with Graph Neural Networks Accelerated on FPGAs

Talk presented at the Accelerated Artificial Intelligence for Big-Data Experiments conference (Oct. 19th, 2020).

Desktop Cosmic Particle Detector

Poster and physical display featuring a cosmic ray muon lifetime measurement device, presented at Princeton's Annual Research Day (May 9th, 2019).

The CMS Electron and Photon Trigger for the LHC Run 2

Poster presentation delivered on behalf of CERN's ECAL Trigger Team at the APS April Meeting 2017 in Washington, DC.

Anomalous Signal Reduction in the CMS Detector's ECAL Trigger

Talk delivered at the Southeastern Section of the APS Annual Conference in Charlottesville, VA. (Nov 10th, 2016);

Poster presented at the Society of Physics Students Quadrennial Physics Congress in San Francisco, CA (Nov. 2-5, 2016) where it won an “Outstanding Poster Presentation” award in the general physics category.

Leadership and Extracurricular Activity

Princeton Physics Graduate Committee Representative

Fall 2021 - Spring 2022

Fourth-Year Representative (2021-2022); working with the Director of Graduate Studies to address the comments and concerns of the fourth-year physics graduate student cohort.

Princeton Physics Graduate Recruitment Ambassadors

Summer 2020 - Present

President (2021-2022), Program Founder (2020-2021); leading a group of physics graduate students to support undergraduates interested in applying to graduate school with a specific focus on supporting underrepresented minorities.

Princeton Physics Equity, Diversity, and Inclusion

Summer 2020 - Present

Graduate Recruitment Committee (2020-2022); compiling graduate admissions information, organizing recruitment-focused initiatives and events.

McGraw Center for Teaching and Learning

Summer 2020 - Present

Graduate Teaching Fellow (2020-2022); leading teaching orientation for students with new assistantships in instruction.

CERN Young Scientists Committee

Fall 2019 - Present

Committee Member (2019-2020), Notebook Repo Organizer (2020-2021); organizing mentor/mentee pairings, hosting talks by early-career CERN scientists, hosting a centralized notebook repository.

Princeton Graduate Student Government

Fall 2019 - Spring 2020

Physics Department Representative (2019-2020): attended and voted at general body meetings, help organize events during Mental Health Month.

Distinctions

Princeton Physics Equity, Diversity, and Inclusion (EDI) Award

Spring 2021

Awarded for significant contributions to Princeton Physics EDI work.

Princeton Physics Departmental Teaching Award

Spring 2020

Awarded for excellence in instruction in Phy. 529: High Energy Physics.

Mitchell Scholarship

Summers 2016 & 2017

Awarded by the U.Va. Physics Department to fund summer research at CERN in Meyrin, Switzerland.

Rodman Scholarship

August 2014 - May 2018

U.Va. School of Engineering and Applied Science (SEAS) honors program, admitting the top 5% of SEAS applicants and including a specialized design-thinking course sequence.

Jefferson Scholarship

August 2014 - May 2018

Awarded a full scholarship to U.Va. on the basis of leadership, citizenship, and scholarship.

Teaching

Phys. 529: High Energy Physics (Princeton)

Spring 2020

- Teaching Assistant: led office hours, graded homeworks and exams, and prepared study review guides.

Phys. 115: Physics For Future Leaders (Princeton)

Fall 2019

- Teaching Assistant: led the laboratory component of the course, answer student exit questions, and grade lab notebooks.

Phys. 2660: Introduction to Scientific Computing (U.Va.)

Spring 2017, Spring 2018

- Teaching Assistant: led lab sections, held office hours, and graded course assignments.

Phys. 1010: The Physical Universe (U.Va.)

Fall 2017

- Teaching Assistant: led tutorial session office hours and graded assignments.

Phys. 1910: Introduction to Physics Research (U.Va.)

Fall 2017

- Course co-Instructor: organized a 1-credit course featuring different U.Va. physics professors speaking about research and available opportunities.

Training

CERN-Fermilab Hadron Collider Physics Summer School

August 23 - September 4, 2021

Oxford ML School

August 9-20, 2021

Machine Learning in High Energy Physics Summer School

July 15-30, 2021

London Geometry and Machine Learning Summer School

July 12-16, 2021

CMS Data Analysis School (CMSDAS)

January, 2019

Computational and Data Science in HEP (CoDaS-HEP)

July, 2018

CMS Data Analysis School (CMSDAS)

January, 2017

Graduate Coursework

ORF 543: Deep Learning Theory

Fall 2021

SML/AST 505: Modern Statistics

Spring 2021

ELE 535: Machine Learning and Pattern Recognition

Fall 2020

PHY 509: Quantum Field Theory I

Fall 2019

PHY 529: High Energy Physics

Spring 2019

PHY 524: Biophysics

Spring 2019