Vinicius Mikuni

▬ Work Experience

2021 –	**NESAP Postdoctoral Fellow**, *Lawrence Berkeley National Laboratory*.
Research	**Machine learning methods for collider physics**.

Developed new ideas incorporating deep learning into collider physics applications, overcoming the limitations from traditional approaches and improving upon state-of-the-art methods. Co-developed the first complete strategy for unsupervised detection of non-resonant anomalies that includes both signal sensitivity and a data-driven method for background estimation. Analysed jets produced in deep inelastic scattering events collected by the H1 detector using machine learning to correct for detector effects and graph neural networks to achieve high precision, resulting in one of the first science results with Perlmutter supercomputer and multidimensional unfolding using 100 GPUs simultaneously. Developed the first application of diffusion generative models in collider physics for calorimeter detector simulation, able to simulate reliably detectors with up to 50k readout channels. Led the white paper on future developments for surrogate models and differentiable programming in collider physics as part of the US Community Study on the Future of Particle Physics (Snowmass 2021).

Event Organisation and Tutorials

2022	**ATLAS ML training program**, Lawrence Berkeley National Laboratory, United Stated of America.

Tutorial given on anomaly detection for new physics searches using the CORI Supercomputer.

2021	**UZH Machine learning workshop**, University of Zurich, Switzerland.

Main organizer of the first interdisciplinary machine learning workshop at the the university of Zurich.

2021 -	**Machine Learning and Science Forum**, Berkeley Institute for Data Science, United Stated of America.

Co-organiser of the Machine Learning and Science Forum responsible for the invitation of speakers, organisation, and moderation of seminars.

Internships

Institute	CERN, Switzerland.
Supervisor	Dr. Marco Adinolfi.
Project	**The decay of $\Psi(4040)$ at the LHCb experiment**, *Summer 2015*.

Investigated decays of $\Psi(4040)$ particles into D_s^* using the reconstructed decay of D_s^* into D^0s and pions.

Institute	University of São Paulo, Brazil.
Supervisor	Prof. Luiz Nunes de Oliveira.

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Project	**Time evolution of a correlated system**, *2014*. Investigated the use of Time Dependent Density Functional Theory to describe the time and spatial development of an electron inside a one-dimensional electron gas.
Institute	University of Glasgow, United Kingdom.
Supervisor	Dr. James Ferrando.
Project	**b-jet choice for top-antitop semileptonic decay in a boosted topology with the ATLAS experiment**, *Summer 2013*. Investigated different kinematic methods to identify b-jets associated to top quark decays at boosted topologies.

Teaching Assignments

2015	**Teaching assistant of Modern Physics II**, *5 hrs/wk*, University of São Paulo.
2016	**Teaching assistant of Physics I**, *10 hrs/wk*, University of São Paulo.
2017	**Teaching assistant of Physics I lab for physicists**, *5 hrs/wk*, University of Zurich.
2018	**Teaching assistant of Physics I lab for physicists**, *10 hrs/wk*, University of Zurich.
2019-2020	**Teaching assistant of Physics I**, *20 hrs/wk*, University of Zurich.
2019-2020	**Teaching assistant of Physics II**, *20 hrs/wk*, University of Zurich.

Student Supervision

2022 -	**Jason Wong**, *Undergraduate student*, University of California Berkeley. Score-based generative models using graph neural networks for collider physics.
2022 -	**Chirag Furia**, *Undergraduate student*, Rutgers University. Calorimeter detector simulation with continuous normalising flows.
2022 -	**Haoxing Du**, *Graduate student*, University of California Berkeley. Maximum likelihood inference with neural density estimation.
2022	**Alp Altug**, *Undergraduate student*, University of California Berkeley. Resonant anomaly detection with continuous normalizing flows.
2021	**Vikas Ummadisetty**, *Undergraduate student*, University of California Berkeley. Domain adaptation strategies for collider physics.
2021	**Eduardo Ploerer**, *Master student*, University of Zurich. Jet flavor tagging with graph neural networks.

Education

2017 – 2021	**PhD in physics**, *University of Zurich*.
2015 – 2017	**Master in physics**, *University of São Paulo*.
2013	**Internship**, *University of Glasgow*.
2011 – 2015	**Bachelor in theoretical and experimental physics**, *University of São Paulo*.

PhD Thesis

Institute	University of Zurich, Switzerland.

Title	**Collider Physics Measurements in High Jet Multiplicity Final States**.
Supervisor	Prof. Florencia Canelli.
Description	Performed the first search for vector-like leptons to third generation fermion final states and the first measurement of the top quark pair production cross section with additional b jets in the all hadronic final state. Machine learning techniques were developed and used to improve the signal sensitivity. Developed the ABCNet algorithm based on graph neural networks, applied to the separation of quark-gluon jets. In addition, UCluster, an anomaly detection algorithm, and PCT, a graph neural network using the transformer architecture, were developed in the context of jet flavor tagging and searches for new physics interactions. Organised the first University of Zurich interdisciplinary ML workshop.

Master thesis

Institute	University of São Paulo, Brazil and CERN, Switzerland.
Title	**Measurement of cosmic ray electrons and positrons with the AMS-02 experiment**.
Supervisor	Prof. Manuela Vecchi.
Description	Measured the time-dependent flux of cosmic ray electrons using the data collected by the AMS-02 experiment during the first 5 years of operations. Particular attention was given to low energy cosmic rays to further characterise the impact of the solar activity on the cosmic ray spectrum.

Presentations at International Conferences

2022	**NeurIPS 2022**, *Invited speaker in the Machine Learning and the Physical Sciences Workshop*, New Orleans, USA, Click here to access the website. Collider Physics Innovations Powered by Machine Learning.
2022	**ML4Jets 2022**, Rutgers University, USA, Click here to access the website. Score-based Generative Models for Calorimeter Shower Simulation and Multi-differential Jet Substructure Measurement in High Q^2 Deep-Inelastic Scattering with the H1 Detector.
2022	**DIS2022**, Santiago de Compostela, Spain, Click here to access the presentation. Multi-differential Jet Substructure Measurement in High Q2 Deep-Inelastic Scattering with the H1 Detector.
2022	**Learning to Discover**, Orsay, France, Click here to access the presentation. Online-compatible unsupervised nonresonant anomaly detection.
2020	**QCD20**, Montpellier, France, Click here to access the presentation. Highlights on top quark measurements from CMS.
2020	**ML4jets 2020**, New York University, USA, Click here to access the presentation. Quark-gluon discrimination with point clouds.
2019	**CMS TOP workshop**, DESY, Germany, Click here to access the presentation. b-tagging: status, ways to improve uncertainty, expectation from UL.
2019	**3rd CMS Machine Learning Workshop**, CERN, Switzerland, Click here to access the website. Deep neural networks for point cloud segmentation applied to low-p_T τ lepton reconstruction and Using Classification Without Labels (CWoLa) for multijet background rejection.

2019 **LHCP 2019**, BUAP, Mexico, Click here to access the presentation.
Latest CMS measurements of inclusive and differential top quark pair production.

Honours and Awards

2021 **Praemierung hervorragender wissenschftlicher Arbeiten**, *awarded by University of Zurich - Switzerland.*
Ph.D. thesis award for outstanding scientific work.

2020 **Forschungskredit Candoc**, *awarded by University of Zurich - Switzerland.*
Award funding from the Physik Institut to carry independent research for 1 year at the University of Zurich.

2019 **GRC Short Grant: Interdisciplinary Workshop on Machine Learning at UZH**, *awarded by University of Zurich - Switzerland.*
Graduate Campus Short Grants funds for junior researchers, to organise events at the University of Zurich.

2016 **Bolsa Estágio de Pesquisa no Exterior (BEPE)**, *awarded by FAPESP (São Paulo Research Foundation) - Brazil.*
Scholarship granted to masters students to carry out part of their research at any international institution for 6 months.

2015 **Masters research scholarship**, *awarded by FAPESP.*
Scholarship awarded to master students with excellent research achievements and academic records.

2015 **Masters research scholarship**, *Declined*, awarded by CNPq (National Council of Technological and Scientific Development) - Brazil.
Competitive scholarship awarded to master students. Declined in favour of the FAPESP scholarship.

2015 **Ilumina tu mundo competition**, *Declined*, awarded by Lund University - Sweden.
Third place in the competition sponsored by Lund University, opened to all students in Latin America. The prize granted full tuition fees for a Masters course at Lund University.

2015 **Summer student program at CERN**, *awarded by CERN - Switzerland.*
Selected student from the summer program at CERN.

2014 **Research scholarship for undergraduate students**, *awarded by CNPq.*
Scholarship given in a competitive basis to undergraduate students to carry out a research project.

2013 **Science without borders**, *awarded by CNPq .*
Highly competitive scholarship sponsored by the Brazilian government covering tuition and living fees for 1 academic year to undergraduate students in any partner university around the world.

Selected publications

2022 V. Mikuni, B. Nachman, **Score-based generative models for calorimeter shower simulation**, Phys. Rev. D 106 (2022), 092009

2022 H1 Collaboration, **Multi-differential Jet Substructure Measurement in High Q^2 DIS Events with HERA-II Data**, H1prelim-22-034.

2022 V. Mikuni, et. al, **New directions for surrogate models and differentiable programming for High Energy Physics detector simulation**, 2022 Snowmass Summer Study Contribution.

2022 V. Mikuni, B. Nachman, D. Shih, **Online-compatible unsupervised nonresonant anomaly detection**, Phys. Rev. D 105 (2022), 055006, *Selected for the Editors' Suggestion.*

2022   CMS Collaboration, **Search for pair-produced vector-like leptons in $\geq$3b + Nτ final states**, CMS-PAS-B2G-21-004, *Submitted to Phys. Rev. Lett.*

2021   V. Mikuni and F. Canelli, **Unsupervised clustering for collider physics**, Phys. Rev. D 103, 092007.

2021   Kasieczka, Gregor and others, **The LHC Olympics 2020 a community challenge for anomaly detection in high energy physics**, Rept. Prog. Phys. 84, 124201

2020   V. Mikuni and F. Canelli, **ABCNet: an attention-based method for particle tagging**, Eur. Phys. J. Plus 135 (2020).

2019   CMS Collaboration, **Measurement of the $t\bar{t}b\bar{b}$ production cross section in the all-jet final state in pp collisions at $\sqrt{s} =$ 13 TeV**, Phys. Lett. B (803) 2020 135285.

2018   AMS Collaboration, **Observation of complex time structures in the cosmic-ray electron and positron fluxes with the Alpha Magnetic Spectrometer on the international space station**, Phys. Rev. Lett. 121, 051102.