Emma Castiglia

Physics Ph.D. Candidate • Yale University • New Haven, CT
emma.castiglia@yale.edu emma-castiglia-298461105

Education

Yale University New Haven, CT

Ph.D. Physics	May 2022 (expected)
M.S. Physics	May 2019
M.Phil. Physics	May 2019

University of Chicago Chicago, IL

B.A. Physics (with Honors)	June 2016
B.A. Mathematics	June 2016

Awards: University Scholar, National Merit Scholarship, Dean's List (all years)

Graduate Fellowships and Awards

Leigh Page Award for Excellence in Graduate Student Teaching Awarded Nov 2021

Awarded annually by the Physics Department to one or two physics graduate students for excellence in teaching at the undergraduate or graduate level, and/or significant teaching contributions to scientific outreach or public education events. *Inaugural Recipient*

D. Allan Bromley Graduate Fellowship in Physics Awarded June 2020

Awarded annually to support one or more students in Physics Department ... with attention to students who exhibit a broader interest than just physics, including, but not limited to, science and public policy, engineering, and applied science...Recipients will reflect and celebrate Dr. Bromley's distinguished and honorable persona in the exceptional scope, standing, talent, and character of his distinguished personal, public, and academic life.

Leigh Page Prize Graduate Fellowship Awarded Feb 2016

Awarded by the Yale Physics Department "in recognition of [my] fine academic record as an undergraduate and for the promise [I] show for making important contributions to the field of physics."

Research Experience

Doctoral Researcher, *Yale University* Aug 2016 – present

Experiment: ATLAS Experiment at CERN
Advisor: Prof. Sarah Demers, Department of Physics

- Defined analysis in Python to optimize measurement of Higgs boson decay incorporating kinematic filters, particle identification requirements, and neural network selection
- Developed data engineering components to convert 10TB of particle physics data to pandas dataframes
- Measured lepton false positive rates in 400GB of measured data and validated with Monte Carlo
- Optimizing a Lorentz equivariant neural network to improve performance of tau lepton identification, converted data stored in ROOT files to p4 vectors in hdf5 files
- Improved tau particle energy measurement in comparison with previously trained weights using a BRT with information from multiple subdetectors working remotely with the Tau Trigger Convener

Machine Learning Research Intern, *Netflix* May 2021 - Aug 2021

Manager: Yves Raimond, Research/Engineering Director, Algorithms Engineering
Mentor: Benoit Rostykus, Senior Machine Learning Researcher, ML for Systems

- Defined, trained, and optimized PyTorch models for time-series predictions of CPU requests on Netflix cluster to allow for predictive autoscaling, decreasing both launch latency times and compute costs
- Created replay simulation to show expected reduction in latency and decrease in CPU overhead
- Queried JSON databases, cleaned and scaled raw data, converted data to pandas dataframes for training
- One of 40 interns out of 30,000+ applicants in first official intern class

Graduate Student Researcher, *Yale University* Sep 2017 – Oct 2018

Experiment: Mu2e at Fermilab
Advisor: Prof. Sarah Demers, Department of Physics

- Created a likelihood function in C++ using ROOT to optimize photon detection via clustering which achieved a signal acceptance of 80% and background rejection of 2300
- Trained and benchmarked performance of MVA algorithms (e.g. MLP and Fisher Discriminant) to efficiently select out signal events in trigger, while meeting strict timing requirements of 3ms per event
- Compared timing performance of Mu2e specific multi-variate analysis algorithms and the more generally used TMVAReader for identifying background hits in the calorimeter
- Mentored 3 students by teaching particle physics coding and reviewing presentations for weekly meetings

Graduate Student Researcher, *Yale University* Sep 2016 – Aug 2017

Experiment: ATLAS Higgs boson to ZZ_{dark} Analysis
Advisor: Prof. Keith Baker, Department of Physics

- Optimized boosted decision tree algorithm and selection cuts to retain the most signal from background events and presented results as part of the Yale Physics Special Investigations Course
- Determined BDT cut value and found peaks consistent with the theorized mass of Z_{dark}

Undergraduate Researcher, *University of Chicago* June 2015 – June 2016

Experiment: ATLAS Fast TracKer (FTK)
Advisor: Prof. Young-Kee Kim, Department of Physics

- Completed BA honors thesis titled "FTK Performance" based on FTK simulation results
- Ran simulation of FTK system to analyze efficiency at identifying particle tracks selected
- Wrote VME access test and created instructions for testing the AUX board
- Collaborated with and presented weekly progress updates to team comprised of Professor Kim and Professor Shochet, three postdocs, and three graduate students

Undergraduate Researcher, *University of Chicago* May 2014 – June 2015

Experiment: ATLAS Dark Matter Search
Advisor: Prof. Young-Kee Kim, Department of Physics

- Calculated significance of optimized selection cuts to determine effectiveness of seeing the Higgs boson coupling dark matter with the Higgs boson decaying to two bottom quarks
- Generated background samples using MadGraph and Delphes with varied b-tagging efficiency
- Participated in UChicago MRSEC REU Summer 2014

Technical Skills

Programming Languages	Python, C++/ROOT, Tensorflow, PyTorch, SQL
Tools	Data Structures (Pandas), Git version control, LaTeX, Distributed Systems, Toolkit for Multi Variate Analysis
Research	Particle Physics, Machine Learning
Techniques	Machine Learning Algorithms (BDT, BRT, CNN, MLP), Clustering, Dimensionality Reduction
Computing Courses	Deep Learning Theory Applications, Unsupervised Learning for Big Data, ML for Physicists, Intro to Database Systems

Physics and Machine Learning Summer Schools

Third Computational and Data Science School for HEP (CodaS) Princeton, July 2019
Deep Learning for Science School Lawrence Berkeley National Laboratory July 2019
US ATLAS CAMPFIRE Argonne National Laboratory, June 2019
13th Hadron Collider Physics Summer School Fermilab, August 2018

Presentations

1. **MVA in V(lep)H** **invited talk* Dec 2021
   Tau and Hleptons Workshop, CERN
2. **Status of the VH Analysis** Sep 2020
   Tau and HLeptons Workshop, Virtual
3. **Energy Calibration in the ATLAS Tau Trigger** April 2020
   American Physical Society April Meeting, Virtual
4. **Improvements to the Tau Energy Scale (MVATES) at the Trigger Level** Jan 2020
   ATLAS Trigger Meeting, Remote
5. **Associated Production of a Higgs boson with a vector boson, with the Higgs boson decaying to two tau leptons** Nov 2019
   Yale Wright Laboratory Weak Interaction Discussion Group, New Haven, CT
6. **Tau Energy Scale at the ATLAS Detector** Oct 2019
   USLUA Lightning Talk, Rice University, Remote
   Lightning Round Winner: engagingly explaining research in 10 minutes to general physics audience; prize covers travel to DC to meet with members of Congress to discuss particle physics funding
7. **High Energy Photon Trigger for Mu2e** Oct 2018
   Mu2e Collaboration Meeting, Fermilab, IL
8. **Calorimeter Clustering Studies for the Mu2e Experiment** June 2018
   New Perspectives, Fermilab, IL
9. **FTK Performance (Poster)** Oct 2015
   Second Annual Undergraduate Research Symposium, UChicago
10. **Higgs Coupling Dark Matter** Aug 2014
    Research Experience for Undergraduates (MRSEC REU) Final Presentations, UChicago

Selected Publications

Full list of 80 publications available upon request.

I was a member of the Tau Trigger Group in 2019 and 2020 and worked on the tau energy scale. The energy of taus needs to be calibrated in order to account for energy lost before reaching the calorimeters, out-of-cone effects, and pileup. I trained a boosted regression tree on 1- and 3-prong taus to create weights to calibrate taus based on their measured transverse momentum. I also incorporated trigger-level track information into the BRT to show that the energy scale could be calculated during the ATLAS trigger process and allow for more informed decisions on whether to save those taus. The following ATLAS results rely on the tau energy scale and tau trigger to select their final state hadronic taus.

6. G. Aad et al. Measurement of the energy response of the ATLAS calorimeter to charged pions from $W^{\pm} \to \tau^{\pm}(\to \pi^{\pm}\nu_{\tau})\nu_{\tau}$ events in Run 2 data. 8 2021

5. G. Aad et al. Search for new phenomena in pp collisions in final states with tau leptons, b-jets, and missing transverse momentum with the ATLAS detector. 8 2021

4. G. Aad et al. Operation of the ATLAS trigger system in Run 2. *JINST*, 15(10):P10004, 2020

I ran simulations, created a board testing procedure, and wrote VME access tests for initial FTK boards.

3. G. Aad et al. The ATLAS Fast TracKer system. *JINST*, 16:P07006, 2021.

Using Run-1 data, I did a significance study for Higgs boson coupling with dark matter, with the Higgs boson decaying to b-quarks. I optimized selection cuts to separate that signal from background.

2. G. Aad et al. Search for dark matter produced in association with a Standard Model Higgs boson decaying into b-quarks using the full Run 2 dataset from the ATLAS detector. 8 2021.

Under Preparation
I am an analysis contact for this paper which is the focus of my Ph.D. work.

1. G. Aad et al. Search for the Standard Model Higgs boson produced in association with a vector boson decaying to a tau pair with the ATLAS detector in Run 2. Expected 2022.

Service and Outreach

Yale Physics Professional Development Organization New Haven, CT
Seminar Organizer June 2020 – June 2021

- Coordinated and hosted monthly seminars and panels to prepare graduate students and postdocs for both the academic and non-academic job search
- Served as liasion between the Yale Office of Career Services and physics graduate students
- Managed full year of virtual events including: "Female Alumnae in Academia and Industry", "The Academic Job Search and Application", Coffee Chats with Facebook AI Researcher, Sarah Lawrence Physics Chair, Science Policy Fellows, Postdoctoral Fellows, and US Air Force Quantum Information Scientist

US Large Hadron Collider Users Association and Fermilab UEC High Energy Physics DC Trip
Volunteer Jan 2019 – April 2020

- Met in person with 11 Congressional and Senate offices over 3 days to discuss the importance of funding high energy physics research in March 2019
- Contacted 5 offices virtually in March 2020 to encourage continued particle physics funding

Yale Physics Olympics, Yale University 2018 & 2019
Volunteer: Coordinated and judged one of the physics challenges, https://ypo.yale.edu

Girls Science Investigation, Yale University 2016 – 2019
Volunteer: Group Leader, Activity Lead, Room Assistant, https://gsi.yale.edu

Leadership

Equity in the Job Search Symposium Yale University
Co-Chair Aug 2018 – July 2021

- Oversaw board of 10 graduate students and postdocs to plan three annual day-long symposia to prepare Ph.D. students in both the academic and non-academic job search, with an emphasis on increasing gender equity in STEM careers
- Led fundraising efforts and raised ∼$7000 towards each of the 2019 and 2020 symposiums
- Converted the 2020 symposium to be virtual in just 2 weeks and organized keynote speaker in 2021
- Maintained website for event: https://equityinthejobsearch.sites.yale.edu/
- Moderated and coordinated Women's Welcome Panel for incoming women graduate students at Yale (2019)

Women in Physics^{+} Yale University
Chair Feb 2018 – June 2021

- Ran board of 5 graduate students to secure funding, plan all social and diversity focused events, and mentor undergraduates with our new Family Tree program
- Hosted monthly events for the faculty, postdocs, graduate, and undergraduate women in physics
- Established Allies to Women in Physics group and led discussions on ally-ship, creating more diverse speaker lists for conferences, and intersectionality in physics
- Advocated for diversity initiatives within department: improved course requirements and qualifying exam, ensuring student input with Department Chair selection and Open House organization

Society of Women in Physics University of Chicago Spring 2013 – Fall 2015
Vice President (2015), Secretary (2014)

- Planned quarterly events such as the annual Pizza with Professors and Hot Chocolate Night to create community within the department and connect students to potential research advisors

Teaching Experience

Teaching Fellow Yale University Spring 2021
Physics 526, Introduction to Elementary Particle Physics

- Graded all problem sets & paper reading assignments and attended all lectures
- Advised students on questions to explore in their final posters and presentations

Teaching Fellow Yale University Fall 2017, Spring 2018, Fall 2020
Physics 165/166, Instructional Physics Labs for Non-Majors

- *Lead Teaching Fellow* for 19 TFs (Fall 2020): created all physics introductory material, advised all TFs on how to run each virtual lab, and managed slack channel to answer questions from other TFs
- Virtually taught weekly physics experiments that incorporated data analysis of videos and physical set-ups made from kits sent to each student (2020)

- Guided 8-10 pairs of students through each lab after giving a mini physics lecture to the section
- Graded weekly lab reports, bi-weekly at home explorations, a midterm, and final lab experiment

Teaching Fellow Yale University Summer 2020
Physics S165 and S166, Instructional Physics Labs for Non-Majors

- Helped to take the Instructional Lab fully virtual in Summer 2020. Conceptualized the Do It Yourself and What's the Flaw? activities in order to encourage scientific exploration at home
- Ran bi-weekly zoom sessions to walk 6-7 students through virtual labs and graded bi-weekly lab reports and weekly at-home activities

Teaching Fellow Yale University Spring 2020
Physics 118/ENAS 220/MUSI 187, Physics of Music and Instrument Design

- Assisted in running of 3 labs in the Center for Engineering Innovation & Design to create musical instruments and one virtual lab where students made circuits to produce music
- Graded all problem sets and laboratory explorations

Teaching Fellow Yale University Fall 2018, Spring 2019, Fall 2020
Physics 200/201, Fundamentals of Physics

- Directly instructed students by creating and running review sessions for exams
- Worked one-on-one with students in office hours and in small groups during weekly study halls
- Graded all problem sets, midterms, and finals, and wrote up pedagogical solutions

Teaching Fellow Yale University Fall 2016, Spring 2017
Physics 206, Physics laboratory course for physics majors

- Simultaneously instructed small groups of undergraduate physics majors in various classic physics experiments such as measuring fundamental constants, Millikan oil drop, and x-ray diffraction
- Graded their weekly lab reports and gave advice on how to structure formal reports of physics analyses

Undergraduate Mentorship

- **Mentoring in Research**
  - Mentored 3 undergraduates during the summer on Mu2e in 2018 by teaching coding for particle physics research and helping to prepare presentations on their work for weekly update meetings with the larger Mu2e experimental group
  - Mentored 2 undergraduates on ATLAS in 2020-2021 by setting them up on the CERN Computing Grid and ATLAS external servers, giving advice for completing coding tutorials, and supporting their continued work on tuning the mass calculators and calculating theory systematics
- **Women in Science at Yale** 2016 – 2020
  - One-on-one mentor to undergraduate women in STEM
  - Had greatest impact on a freshman in Timothy Dwight in 2018-2019 year (continued mentoring after our assigned year), helped her decide on a major and apply for summer research programs
- **Graduate Affiliate for Pierson College** 2016 – present
  - Serve as a resource for all students in the college and planned finals week study breaks and a Mardi Gras celebration
  - Mentored graduating physics student on Mellon Forum presentation (2017), advised her on her graduate school applications and gap year doing research, still in contact as she completes her Ph.D. at Columbia