

Matthew Harris

RESEARCH ASSISTANT · UNIVERSITY OF MASSACHUSETTS, AMHERST

1130 Lederle Graduate Research Tower, Amherst, MA 01002

☎ (+1) 413-992-7715 | ✉ matthewharri@umass.edu | 📱 matthewharri | 🐙 maharris

Summary

Physics Ph.D. candidate at the University of Massachusetts, Amherst, conducting research on the ATLAS experiment at CERN, with expected graduation in Fall 2025. Interested in studying complex datasets and applying machine learning techniques to extract meaningful insights.

Experienced in large-scale data analysis and the application of machine learning techniques in high-energy physics. Strong theoretical foundation in machine learning with hands-on experience using libraries such as **Tensorflow**, **PyTorch**, and **scikit-learn**. Skilled in software development and CI/CD workflows, and proficient in Linux, Python and C++, with a focus on writing clean, maintainable code and following best practices.

Education

University of Massachusetts, Amherst

Amherst, Massachusetts

PH.D. PHYSICS

Aug. 2020 - Fall 2025

- Thesis: *Measurement of the Higgs boson production cross section in association with a vector boson and decaying into WW^* with the ATLAS detector at $\sqrt{s} = 13.6$ TeV*

Training to Advance Computational High Energy Physics in the Exascale Era (TAC-HEP)

TRAINEE

Jan. 2023 - Jan. 2025

- Participated in Department of Energy-funded traineeship program aimed at preparing the next generation of software and computing experts for the high-energy physics community.
- Curriculum included coursework in software engineering, GPU and FPGA programming, machine learning, systems for data science, and data analysis.
- Collaborated with experts from national laboratories, including Brookhaven National Laboratory, Fermi National Accelerator Laboratory, and Argonne National Laboratory

University of Massachusetts, Amherst

Amherst, Massachusetts

B.S. PHYSICS

Aug. 2016 - May. 2020

- Additional mathematics major with a pure math concentration

Skills

Programming Languages

Python, C, C++, CUDA, Shell Scripting

Tools & Technologies

TensorFlow, PyTorch, scikit-learn, Keras, ONNX, pandas, numpy, matplotlib, seaborn, ROOT, HTCondor, PanDA, Git, GitLab CI/CD, GitHub Actions, CMake, Conda, Jupyter Notebooks, VS Code, Linux

Work Experience

University of Massachusetts, Amherst

Amherst, Massachusetts

RESEARCH ASSISTANT - DATA ANALYSIS AND MACHINE LEARNING

Jan. 2021 - Present

- Lead analyst for a high-energy physics analysis using data from the ATLAS detector at CERN, focused on measuring a rare Higgs boson process.
- Processed hundreds of terabytes of real and simulated data into compact datasets (~2 TB) using distributed computing and the **PanDA** workload management system.
- Built an efficient data analysis framework in Python using ROOT's **RDataFrame** to perform columnar analysis.
- Developed machine learning pipelines using **TensorFlow** and **scikit-learn**, incorporating data normalization, feature scaling, and one-hot encoding. Addressed class imbalance by scaling signal and background samples to have equal total weight. Trained four multi-class classifiers and a regression model to predict a non-reconstructable quantity.
- Prototyped a graph neural network using **PyTorch** to explore alternative architectures.
- Implemented model validation with 5-fold cross-validation and hyperparameter tuning using **keras-tuner**; Evaluated model performance using ROC curves and confusion matrices.
- Built a data-driven background estimation method to model processes not well captured by simulation. Derived weights from control samples and propagated uncertainties through the analysis.
- Performed statistical modeling including likelihood fitting and uncertainty estimation to extract physical parameters.
- Maintained analysis code and documentation in GitLab; authored internal technical reports detailing methodology and results.

- Developed a detector geometry for the ATLAS Muon Spectrometer using a C++20-based high-energy physics library, maintaining up-to-date design implementations.
- Created a geometry navigation algorithm using frustum and octree techniques to enable efficient traversal of complex detector structures.
- Implemented a material description system for passive and support structures within the ATLAS software framework.
- Simulated particle interactions and validated geometry performance by comparing reconstructed vs. truth data.
- Implemented initial calibration algorithms for the upgraded muon system in the ATLAS software framework.

University of Massachusetts, Amherst

Amherst, Massachusetts

TEACHING ASSISTANT

Aug. 2020 - Dec. 2022

- Independently taught undergraduate physics laboratory courses for life science majors and engineering students, managing all aspects including instruction, grading lab reports, and holding office hours.
- Assisted in a team-based learning course for first-year physics students, emphasizing collaborative problem-solving and conceptual understanding.
- Supported students in developing a solid grasp of fundamental physics principles and practical experimental skills, allowing them to draw conclusions from their observations.

Other Projects

TAC-HEP

TRAINING PROJECTS

- **GPU Training Project:**
 - Developed a CUDA kernel to perform a stencil operation using the default stream, with supporting utility functions for error checking. Profiled the application using **nsys** to measure time spent in CUDA API calls, on the host, and on the device. Optimized performance by leveraging non-default CUDA streams and shared memory. Rewrote the application using the Alpaka portability library to enable cross-platform execution.
- **FPGA Training Project:**
 - Implemented a sliding-window clustering algorithm using Vivado HLS to emulate FPGA-based data processing in high-energy physics experiments.