Gabriel Rabanal Bolaños

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EDUCATION

Harvard University   Cambridge, MA
Ph.D. in Physics   2023
M.A. in Physics   2020
Advisor: Melissa Franklin

National University of Engineering   Lima, Peru
Bachelor of Science in Physics   2016
Advisor: Orlando Pereyra

RESEARCH EXPERIENCE

Harvard University ATLAS Experiment Group   Cambridge, MA / Geneva, Switzerland
Graduate researcher

Measurement of Triboson Production   2021 — 2023
Based at Harvard University and at CERN

- **Thesis:** served as the main analyzer for the four-lepton decay channel in the measurement of the production of three massive vector bosons (VVZ, where $V = W, Z$) in proton-proton collisions

- Optimized Deep Neural Networks and Boosted Decision Trees models on the kinematic properties of leptons from particle collision simulations. These optimizations were critical for accurately targeting signal processes, significantly boosting the measurement's sensitivity and precision

- Developed a comprehensive system to evaluate the performance of machine learning models on Monte Carlo events. This included pruning redundant variables and resolving issues with Neural Network training, ensuring robust and reliable model performance

- Optimized signal region selections to improve the rejection of non-prompt leptons by leveraging new lepton quality and isolation working points

- Created control regions to validate the Monte Carlo background predictions against real data to ensure the accuracy of background estimations and the overall reliability of the analysis

- Conducted detailed statistical analyses using the TRExFitter framework, incorporating the treatment of systematic uncertainties into the data fitting process

- Trained and mentored undergraduate and high school researchers, integrating them into the Harvard ATLAS research group. Provided guidance on research methodologies, data analysis techniques, and the use of advanced machine learning models in high-energy physics

New Small Wheel Upgrade   2019 — 2021
Based at CERN

- Commissioned the first Micromegas chambers (gaseous particle detectors) for the New Small Wheel, an upgrade to the ATLAS forward end-cap muon spectrometers

- Worked at the cosmic ray test stand based in building BB5 at CERN

- Collaborated in C++ software development for Micromegas detectors by implementing the full detector geometry of each Micromegas chamber

- Collected data from cosmic muon hits in order to measure the response of the detector (hits) which were used to fit tracks
- Measured the spatial resolution (directly related to momentum resolution) and tracking efficiency of the first-ever complete Micromegas chambers
- Analyzed the performance of different spatial sectors of each detector under different high voltage conditions after the voltages needed to be lowered in order to stop high spark rates
- Characterized the electronic noise (which produced spurious readings reconstructed as hits) as a function of the electronic baseline with noise runs
- Debugged readout timing issues where the recorded data was not associated to the proper triggers
- Mentored other graduate students in the use of the analysis software

Measurement of $WWW \to \ell\nu\ell\nu\ell\nu$ 2018
Based at CERN

- Implemented detailed cutflow analyses to systematically reduce background noise
- Evaluated the efficiency of various lepton selection criteria and trigger algorithms in signal regions
- Enhanced expertise in data analysis tools and techniques specific to high-energy physics, including ROOT and Python

Yale University   New Haven, CT
Undergraduate researcher   2016

- Participated in research and development for the PROSPECT reactor antineutrino experiment
- Conducted comprehensive data analysis on prototypes of liquid scintillator cells using Python
- Developed and executed simulations of a Compton scattering test setup using C++ and GEANT4

Peruvian Institute of Nuclear Energy   Lima, Peru
Undergraduate researcher   2015

- Conducted calibration of high-purity germanium detectors using a variety of radioactive sources
- Measured neutron flux density in the RP-10 reactor core using neutron activation analysis, including sample preparation, irradiation, identification of activation products, and gamma spectrum analysis to calculate neutron flux
- Gained hands-on experience with nuclear instrumentation and radiation detection techniques

PUBLICATIONS

- ATLAS Collaboration. *Measurement of VVV production in pp collisions at $\sqrt{s} = 13$ TeV* (forthcoming)
- Rabanal Bolaños, G. on behalf of the ATLAS Collaboration. *Cosmic results with the final Micromegas sectors for the ATLAS Muon upgrade.* In *Proceedings of 40th International Conference on High Energy Physics* — PoS(ICHEP2020), volume 390 (pp. 773-778)
- ATLAS Collaboration. *Evidence for the production of three massive vector bosons with the ATLAS detector*. Phys. Lett. B 798 (2019) 134913. arXiv:1903.10415 [hep-ex]

PUBLIC TALKS

- **Records from Ancient Iraq: Deciphering Sumerian Cuneiform Tablets at Kenyon College**
  Kenyon College, April 2, 2024

- **Search for production of Standard Model VVZ in proton-proton collisions at $\sqrt{s} =$ 13 TeV with the ATLAS detector**
  Elementary Particle Experiment (EPE) Seminar, University of Washington (virtual), May 4, 2023

- **Search for the production of three massive vector bosons in proton-proton collisions using data at $\sqrt{s} =$ 13 TeV recorded with the ATLAS detector at the Large Hadron Collider**
  Laboratory for Particle Physics and Cosmology Student Seminar, Harvard University, August 25, 2022

- **Cosmic results with the final Micromegas sectors for the ATLAS Muon upgrade**
  40th International Conference on High Energy Physics (ICHEP), Prague (virtual), July 28, 2020

ADDITIONAL TRAINING

- **US ATLAS Machine Learning Training Event** — Remote
  Lawrence Berkeley National Laboratory (LBNL) — 2022

- **Signals in Particle Detectors** — Geneva, Switzerland
  CERN Academic Training Lectures — 2019

- **US ATLAS CAMPFIRE** — Lemont, IL, USA
  Argonne National Laboratory — 2019

- **First Peruvian School on High-Energy Physics and Cosmology** — Lima, Peru
  National University of Engineering — 2015

- **Nuclear Energy and Radiological Protection** — Lima, Peru
  Peruvian Institute of Nuclear Energy — 2015

TEACHING EXPERIENCE

Harvard University — Cambridge, MA
Teaching assistant in the Department of Physics

- **Introductory Mechanics and Relativity** — 2023
  - Conducted theory sections, worked through examples, reviewed lecture topics
  - Held office hours to provide one-on-one support to students

- **Electromagnetism, Circuits, Waves, Optics, and Imaging** — 2019
  - Led laboratory sections, taught Python and Arduino kits
  - Assisted students in troubleshooting and debugging code

- **Electromagnetism** — 2018
  - Led laboratory sections, taught Python for data analysis
  - Provided feedback on lab reports to improve scientific writing

National University of Engineering — Lima, Peru
Teaching assistant in the Department of Science

- **Mathematical Methods for Physicists** — 2015
  - Assisted in reviewing quizzes and answering questions
  - Helped students develop problem-solving strategies

DIGITAL HUMANITIES CONTRIBUTIONS

- Revisions to the Database of Neo-Sumerian Texts (BDTNS): — 2022 — present
  #158712, #007382, #007218, #007535, #007534, #007274

AWARDS

National University of Engineering — Lima, Peru

- Valedictorian (physics) and Salutatorian (all majors) — 2015
- "Manuel Pardo y Lavalle Award" for academic excellence — 2013
- First place in the national entrance exam for the physics major — 2010

OUTREACH EXPERIENCE

- **Panelist on EducationUSA Peru's Webinar on Higher Education in the USA** — 2020
  Invited by the US Embassy in Lima to offer expert advice to Peruvian students
  seeking to study in the USA
- **Volunteer during Astronomy Day in Lima, Peru** — 2018
  Assisted in organizing and conducting educational activities to promote
  astronomy and science among the public
- **Host for underprivileged Peruvian students researching at Harvard** — 2017 — 2018
  Provided lodging and support for underprivileged Peruvian students
  conducting research at Harvard

SKILLS

Programming

- Languages: Python and C++/ROOT (Proficient), Julia (Prior experience)
- Tools: Tensorflow, Keras, XGBoost, Pandas, NumPy, SciPy, Seaborn, Scikit-learn, Jupyter
- Techniques: Machine learning algorithms (DNN, BDT, etc.), data visualization, statistical modeling

Natural Languages

- Fluent: English, Spanish (native)
- Advanced: French, Akkadian, Sumerian
- Basic: Quechua, Mandarin, German