

# Gabriel Rabanal Bolaños

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 [gabrielrabanal.github.io](https://github.com/gabrielrabanal) ♦  [gabrielrabanal](https://github.com/gabrielrabanal) ♦  ♦ 

## EDUCATION

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### 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

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### 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 $WWW \rightarrow \ell\nu\ell\nu\ell\nu$

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

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- 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 \[hep-ex\]](https://arxiv.org/abs/1903.10415)

## PUBLIC TALKS

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- **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

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- **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

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**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

• **Mathematical Methods for Physicists**

2015

- Assisted in reviewing quizzes and answering questions
- Helped students develop problem-solving strategies

## DIGITAL HUMANITIES CONTRIBUTIONS

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

2022 — present

## AWARDS

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**National University of Engineering**

Lima, Peru

- Valedictorian (physics) and Salutatorian (all majors)
- “Manuel Pardo y Lavalle Award” for academic excellence
- First place in the national entrance exam for the physics major

2015

2013

2010

## OUTREACH EXPERIENCE

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- **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 International 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

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### 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