

# Alejandro Gomez Espinosa Ph.D.

## Carnegie Mellon University

Postdoctoral Research Associate – Mellon College of Science - Department of Physics

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### Education

#### Rutgers, The State University of New Jersey

Ph.D., Experimental High Energy Physics

New Brunswick - USA

May 2018

Thesis topic: Search for pair-produced diquark resonances in proton-proton collisions with the CMS detector at  $\sqrt{s} = 13$  TeV

Advisor: Prof. Eva Halkiadakis

#### Escuela Politecnica Nacional

B.Sc. Physics

Quito - Ecuador

August 2012

Research Project: Search for Heavy Scalar Bosons decaying into Four Tops at the LHC.

Advisors: Prof. Edgar Carrera (USF-Q), Prof. Francisco Yumiceva (Florida Tech).

### Significant publications and public results

A full list of publications can be found in the following [INSPIRE link](#).

#### Primary author

- CMS Collaboration. *Search for high transverse momentum  $H \rightarrow b\bar{b}$  produced in association with semileptonic  $t\bar{t}$  at  $\sqrt{s} = 13$  TeV.* (Co-supervisor) Ph.D. thesis [CMS internal link \(AN/2021-015\)](#).
- CMS Collaboration. *Search for pair-produced resonances decaying to quark pairs in proton-proton collisions at  $\sqrt{s} = 13$  TeV.* [Phys.Rev.D 98, 112014. 2018.](#) ([Public twiki](#))
- CMS Collaboration. *Search for low-mass pair-produced dijet resonances using jet substructure techniques in proton-proton collisions at  $\sqrt{s} = 13$  TeV.* CMS Physics Analysis Summary [CMS-PAS-EXO-16-029](#), 2016. ([Public twiki](#))

#### Contributing author

- CMS Collaboration. *Performance of heavy-flavour jet identification in boosted topologies in proton-proton collisions at 13 TeV* [CMS-PAS-BTV-22-001](#) Contribution: Calibration and scale factor derivation using  $\mu$ -tagged method.
- CMS Collaboration. *Measurement of jet substructure observables in high transverse momentum dijet,  $W$  boson and top quark jet environments at  $\sqrt{s} = 13$  TeV. Ongoing and unpublished.* [Internal CMS link: SMP-22-003.](#)
- CMS Collaboration. *Measurement of the  $t\bar{t}H$  and  $tH$  production rates in the  $H \rightarrow b\bar{b}$  decay channel with 138 /fb in proton-proton collision data at  $\sqrt{s} = 13$  TeV.* [CMS-PAS-HIG-19-001](#) Contribution: Studies related to one of the discriminant variables used to distinguished signal processes, and high transverse momentum studies.
- CMS Collaboration. *Inclusive search for the standard model Higgs boson produced in pp collisions at  $\sqrt{s} = 13$  TeV using  $H \rightarrow b\bar{b}$  decays.* [Phys. Rev. Lett. 120, 071802. 2018.](#) ([Public twiki](#)). Contribution: optimization and efficiency measurements of triggers.
- CMS Collaboration. *Search for light vector resonances decaying to a quark pair produced in association with a jet in proton-proton collisions at  $\sqrt{s} = 13$  TeV.* [JHEP 01 097. 2018.](#) ([Public twiki](#)). Contribution: optimization and efficiency measurements of the triggers.
- CMS Collaboration. *Search for low mass vector resonances decaying to quark-antiquark pairs in proton-proton collisions at  $\sqrt{s} = 13$  TeV.* [Phys. Rev. Lett. 119, 111802. 2017.](#) ([Public twiki](#)). Contribution: optimization and efficiency measurements of the triggers.

## Professional service

### Employment positions

#### Postdoctoral Research Associate

*Department of Physics, Carnegie Mellon University*

*Oct 2023 – present*

Studying the self-interaction of the Higgs boson in the di-Higgs production channel. Research focuses on the four b-quark decay channel and is expanding to improve current studies in the bbWW channel. Additionally, working on workflow orchestration tools and analysis reproducibility. Advocating for the adoption of modern programming practices, including continuous integration (CI), extensive use of unit tests, and regular result replication using Snakemake and REANA.

#### Visitor Researcher

*IPA, ETH Zurich*

*Oct 2022 – Sep 2023*

Continued measurements of jet substructure observables and algorithms. Worked towards automatization of processes in the CMS collaboration.

#### Postdoctoral researcher

*IPA, ETH Zurich*

*April 2018 - Sept 2022*

Leading the measurements for the ttH production in the H(bb) channel using Run II data from CMS, particularly in the *boosted regime*. Additionally leading the measurements of *jet substructure observables* in different high transverse momentum jet environments. Moreover, I have significant contributions in commissioning and calibration of boosted taggers for heavy resonances and pileup mitigation techniques at high trigger level for Run III.

### Leadership positions

#### Workflow Orchestration and Analysis Preservation Group Convener

*CMS Experiment, Common Analysis Tools Group*

*Sept 2024 – present*

Leading the CMS Experiment efforts on workflow orchestration tools and analysis reproducibility. The group *develops, maintains and supports* the use of modern programming practices, including continuous integration (CI), extensive use of unit tests, and regular result replication using Snakemake and REANA.

#### JetMET Algorithms and Reconstructions (JMAR) Group Convener

*CMS Experiment, JetMET Group*

*Sept 2019 - Sept 2021*

Leaded the CMS Experiment efforts on jet algorithms, substructure, tagging tools and pileup mitigation studies. The group *organizes, plans and reviews the work of ten or more different teams*. It also coordinates the overall CMS implementation and validation of jet and MET tools.

#### JetMET-HIG contact

*CMS Experiment, Higgs Group*

*July 2018 - April 2021*

Liaison between JetMET objects and Higgs physics groups. *Review* the application of jetMET objects in *all the Higgs analyses in CMS*. Additionally, *report* issues among the groups and *advise* analysts with jetMET object challenges.

#### B2G-Trigger contact

*CMS Experiment, Beyond Two Generations (B2G) Group*

*Sept 2016 - Sept 2017*

Liaison between trigger and B2G physics groups. *Studied* efficiency and performances of triggers used by *all the B2G analyses in CMS*. Additionally, *assisted* analysts developing and studying triggers, and *reviewed* trigger studies for all the analyses in the group.

#### BRIL-DQM contact

*CMS Experiment. BRIL Group*

*April 2015 - April 2017*

Liaison between Data Quality Monitoring systems (DQM) and, Beam, Radiation, Instrumentation and Luminosity (BRIL) group. *Developed* a new framework to monitor the luminometers used in CMS in CMS-DQM system.

### Awards and Honors

#### American Physics Society (APS) - Division of Particles and Fields (DPF)

*Student Travel Award*

*April 2016*

Awarded travel funds to present my contributions to the search for paired dijet resonances in the boosted regime at the APS DPF Meeting 2017.

#### CERN Summer Student

*CERN Summer Students Programme*

*June 2012 - August 2012*

Studied improvements in selection for the search for Higgs decaying to WW in the leptonic channel. Project supervised by Prof. Lawrence Sulak (Boston University).

#### Visitor Undergraduate Scientist

*LHC Physics Center at Fermilab*

*November 2011 - May 2012*

Main contributor on the search for heavy scalar bosons decaying in four top quarks, as part of my undergraduate thesis project supervised by Prof. Francisco Yumiceva (Florida Tech).

## Teaching experiences

### Facilitator

*CMS Data Analysis School (CMSDAS)*

*January/July 2024, January 2021, September 2020*

Main contributor and instructor for the jet exercise in CMS for the CMS Data Analysis School. CMS School for newcomers at graduate level.

### Teaching Assistant

*ETH Zürich*

*September 2018 - Septembre 2022*

General physics lab instructor for science-related undergraduates. Statistical methods in particle physics for master in physics program.

### Graduate Research Assistant

*Rutgers, The State University of New Jersey*

*June 2013 - March 2018*

Supervision of undergraduates, Research Experience for Undergraduates (REU) students, and a high school student working in Prof. Halkiadakis' group.

### Teaching Assistant

*Rutgers, The State University of New Jersey*

*September 2012 - May 2013*

General physics lab instructor.

### High School Teacher

*San Gabriel High School. Quito - Ecuador*

*January 2011 - March 2012*

Substitute teacher of physics and maths for senior high school students.

## Supervision of students

- *Pamela Llerena* (EPN-Quito) Partially supervised *undergraduate project*. Study of the four top signature with the  $\mu$ +jets channel using CMS Open Data. (2023)
- *Andres Chicaiza* (EPN-Quito) Partially supervised *undergraduate project*. Study of the four top signature with the  $e$ +jets channel using CMS Open Data. (2023)
- *Matteo Marchegiani* (ETH Zurich) Partially supervised *PhD thesis*. Search for high transverse momentum  $H \rightarrow b\bar{b}$  produced in association with dileptonic  $t\bar{t}$  at  $\sqrt{s} = 13$  TeV. (2020-2022)
- *Kaustuv Datta* (ETH Zurich) *PhD thesis*. Measurement of jet substructure observables in different high transverse momentum jet topologies at  $\sqrt{s} = 13$  TeV. (2019-2022)
- *Daniele Ruini* (ETH Zurich) *PhD thesis*. Search for high transverse momentum  $H \rightarrow b\bar{b}$  produced in association with semileptonic  $t\bar{t}$  at  $\sqrt{s} = 13$  TeV. (2019-2021)
- *Kaustuv Datta* (ETH Zurich) *Master thesis*. Novel jet observables for the identification and calibration of boosted hadronic W decays. (2019)
- *Geliang Liu* (ETH Zurich) *Master project*. Unfolding of jet substructure variables in a dijet-enriched environment using 2016 data from the CMS Experiment (2020)
- *Diego Coloma* (USFQ-Quito) *Undergraduate project*. Implementation of pileup mitigation techniques in the High Level Trigger of the CMS Experiment. (2020)
- *Jean Somalwar* (Rutgers University) *Undergraduate project*. Background estimation studies for pair-dijet searches with boosted jets. (2015-2017)
- *Alan Kahn* (Rutgers University) *Undergraduate project*. Efficiency studies for substructure triggers. (2014-2016)
- *Margaret Morris* (Rutgers University) *Undergraduate project*. Optimization studies for pair-dijet searches with resolved jets. (2014-2016)

## Analysis Review Committee

- CMS Experiment, "Search for Higgs boson decay to a charm quark-antiquark pair in proton-proton collisions at 13 TeV", *Phys. Rev. Lett.* **131**, 061801.
- CMS Experiment, "Inclusive search for a boosted Higgs boson decaying to charm quark pairs in proton-proton collisions at 13 TeV", *Phys. Rev. Lett.* **131**, 041801.

## Workshop organizer

- *EPIC-III* Scientific Computing School. August 2023. (In Spanish) Quito-Ecuador. Main organizer and contributor for the particle physics exercise.
- *EPIC-I* Scientific Computing School. October 2021. (In Spanish) Quito-Ecuador. Main organizer and contributor for the particle physics exercise.

## Committees

- USCMS Diversity, Equity and Inclusion (DEI), Committee Member. 2024–present.

## Conferences and talks

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### Selected Talks

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- SILAE 2022. *Measurements of Higgs boson decaying into heavy flavored quarks in CMS*. Quito. Ecuador. November 2022.
- Semivisible Jets Workshop 2022. *Jet in CMS*. Invited talk. July 2022.
- BOOST 2021. *Jet substructure measurements in CMS*. Plenary talk on behalf of CMS. August 2021.
- SM@LHC 2021. *Jet substructure at the LHC*. Plenary talk on behalf of ATLAS, CMS and LHCb. April 2021.
- ML4Jets 2020. *Jet substructure tagging and pileup mitigation at CMS*. New York. USA. January 2020.
- 31st Rencontres de Blois. *Searches for boosted objects at ATLAS and CMS*. Blois. France. June 2019.
- XIIth International Workshop on the Interconnection between Particle Physics and Cosmology. *Exotic searches at the LHC*. Plenary talk. Zurich. Switzerland. August 2018.
- SUSY 2018. *Searches for R-parity violating supersymmetry with CMS*. Barcelona. Spain. July 2018.
- APS DPF Meeting 2017. *Search for paired dijet resonances in the boosted regime with the CMS detector at 13 TeV*. Fermilab. Batavia, USA. August 2017.
- APS April Meeting 2016. *CMS Run-2 Instrumentation for beam radiation and luminosity measurement using novel detector technologies*. Utah, USA. April 2016.

### Seminars

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- What are we doing at the LHC and what is the Ecuadorian contribution. School of Physics and Nanotechnology. Yachay Tech. Urcuqui, Ecuador. Jun 2023.
- El Gran Collisionador de Hadrones, la Inteligencia Artificial y la experiencia Ecuatoriana. Department of Physics Seminar. EPN. Quito, Ecuador. February 2023.

### Posters

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- BOOST Conference 2017. *Search for paired dijet resonances in the boosted regime with the CMS detector at 13 TeV*. Buffalo, USA. July 2017.
- LHCC 2017 Winter Conference. *Search for paired dijet resonances in the boosted regime with the CMS detector at 13 TeV*. Geneva, Switzerland. February 2017.

## Continuous training

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[Deep Learning Specialization](#), *Deep Learning.AI - Coursera*.

2021

Online specialization in deep learning techniques: deep neural networks, hyperparameter optimization, convolutional neural networks, sequence models.

[Google Data Analytics Professional Certificate](#), *Google - Coursera*.

2022

Online specialization in data analytics, data cleaning and visualizations.

## Outreach

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[Latitud Cero Group](#)

January 2020-present

Founding member. Outreach projects and talks for Ecuadorian physics undergraduates. (In Spanish)

[CERN Spanish High School Teachers Program](#)

July 2019/2020

Lecturer. Introduction to Experimental Particle Physics. (In Spanish)

[International Masterclasses](#)

March 2023

Organizer. CERN-Fermilab video conferences for Ecuadorian High School Students.

[International Masterclasses](#)

March 2016/2017/2019/2020/2021/2022

Moderator. CERN video conferences with high school students from all over the world to answer questions, encouraging them to pursue a scientific career.

[CMS Voices](#)

June 2016

In charge of managing the CMS Voices twitter account for a month. Share my life as scientist, answer questions, engage the general public into the physics world.

## Extra activities

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**Peregrino:** A 800 km walk along the Camino de Santiago. Spain - Sept 2022.