Juan Montoya Sanchez

September 9, 2025

Medellín, Colombia | juan.montoya110@udea.edu.co | +57 300 366 8854 | ORCID: 0009-0006-6739-8449

linkedin.com/in/juan-montoya | github.com/JuanJ27| ScopusID: 58973544700

Areas of expertise

Physics undergraduate specializing in high-energy physics, quantum computing, machine learning, statistical data analysis, cernROOT, Geant4, MadGraph, Python, C++, PennyLane.

Technical Skills

Programming:	C++, Python, BASH, MicroPython, LaTeX, SQL
HEP Software:	ROOT, Geant4, MadGraph5, uproot
ML & Quantum:	PyTorch, TensorFlow, scikit-learn, PennyLane
Scientific:	NumPy, SciPy, Pandas, Matplotlib, Jupyter, COMSOL, OriginLab
Tools & Systems:	Git, Linux, Overleaf

Education

Universidad de Antioquia - Medellín, Colombia.   2019 – *Expected* 2026

- Bachelor's degree in Physics   GPA: 3.85/5.0

- **Relevant coursework**:

Physics:	Quantum Mechanics, Particle Physics, Statistical Mechanics, Electrodynamics
Computing:	Computational Physics, Introduction to Quantum Computing, Big Data Analysis
Mathematics:	Linear Algebra, Differential Equations, Numerical Analysis
Experimental:	Electronics, Data Acquisition Systems, Signal Processing

Research Experience

Undergraduate Research Assistant, Phenomenology and Fundamental Interactions   2024 – Present
Group (GFIF) — Universidad de Antioquia

- Developed C++ ROOT scripts to characterize geometric and energetic properties of b-jets and $\bar{b}$-jets at low p_T ($<$ 30 GeV), reading branches from `.root` files, performing necessary calculations, and generating visualization plots

- Project code available at **GitHub**

Research Intern, Condensed Matter Group — Universidad de Antioquia   2023 – 2024

- Contributed to research on quantum dots, focusing on their electronic and optical properties under external fields:

  - **Structural modifications in GaAs/AlGaAs tetrapod nanocrystals under applied pressure and temperature: Electron-impurity properties**
    Physics Letters, Section A: General, Atomic and Solid State Physics, 2025
    * **My contribution**: Performed temperature and pressure-dependent calculations for electron-impurity interactions. Analyzed structural modifications using COMSOL and developed visualization scripts for data representation. Collaborated on manuscript preparation and revision. Designed the final figures using Inkscape.

  - **Electronic and optical properties of tetrapod quantum dots under applied electric and magnetic fields**
    European Physical Journal Plus, 2024
    * **My contribution**: Ran half of the COMSOL simulations and exported both numerical and graphical data. Processed simulation outputs in OriginLab, improved figure clarity and references in Overleaf with LaTeX, and created final figures in Inkscape.

  - **Hopf-link GaAs-AlGaAs quantum ring under geometric and external field settings**
    Physica E: Low-Dimensional Systems and Nanostructures, 2024
    * **My contribution**: Verified the correct implementation of the potential model in COMSOL and Python. Adjusted the manuscript format in Overleaf to meet the journal's guidelines.

Conferences & Presentations

9th Colombian Meeting on High Energy Physics (COMHEP) — Pasto, December 2024

- Oral Presentation: *Systematic Study of the Structure of b-Jets and $\bar{b}$-Jets at Low p_T (< 30 GeV)*. Presented the results of the C++ ROOT script developed during my undergraduate research assistantship.
- One of the leaders at the CMS Masterclass activity in Pasto on December 3, 2024. I was responsible for explaining to the attendees how to classify events using graphical tools.

ICTP Physics Without Frontiers: Colombian Network for High Energy Physics School — Ibagué, December 2023

- Attended theoretical and experimental HEP lectures, covering tools such as MadGraph5, applications of neural networks for Higgs signal and background discrimination, and Compton scattering.
- Collaboratively developed a neural network for Higgs signal and background discrimination, where I was responsible for cross-validation. After the school, I attended the **8th COMHEP in 2023**.

Personal Projects

LowPt-Jet-Qml — Quantum Machine Learning for Particle Physics *GitHub link* — 2025.

- Implemented and compared Quantum Machine Learning techniques with classical ML for low-pT b-jet tagging
- Developed quantum neural networks using PennyLane with Angle Embedding for 16-qubit circuits
- Analyzed datasets from different PT ranges using uproot, evaluating models with AUC and tagging power metrics

SensorArray — Experimental Physics Course Final Project *GitHub link* — 2025.

- Designed and built a data acquisition system with multiple phototransistors for laser pattern detection
- Implemented MicroPython code for ESP32 microcontroller to collect and process sensor data
- Developed signal processing algorithms for real-time analysis of light patterns

Biospeckle-ML — *First Place Winner, Physics Experimental Fair* *GitHub link* — 2024.

- Designed and built an optical system to capture biospeckle phenomenon in blueberries.
- Developed C++ algorithms with OpenCV for image processing and statistical pattern analysis
- Using scikit-learn and PyTorch, created a neural network classifier achieving 89% accuracy in blueberry quality assessment
- Presented statistical validation of results with rigorous hypothesis testing and confidence intervals

United Nations Datathon 2024 – Sustainable Tourism Analysis, Second Place Winner in student category *GitHub link* — Medellín, November 2024

- Developed a data analysis pipeline for assessing tourism impact on Medellín's sustainable development
- Collected, cleaned and preprocessed multidimensional urban datasets using Python
- Created interactive visualizations with `GeoPandas` and `Plotly` to represent spatial patterns
- Collaborated in a multidisciplinary team to present findings to UN Development Program representatives

NASA Space Apps Challenge 2024 – Community Mapping *GitHub link* — Medellín, October 2024

- Led data acquisition and processing for a socioeconomic mapping project of Medellín
- Gathered demographic, economic, and infrastructure data from multiple government sources
- Collaborated with frontend developers to ensure seamless data visualization in the final application