

# Brenda Fabela Enriquez

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## Education

**Vanderbilt University**, Nashville, TN (USA)  
Ph.D., Physics. Graduation date: May 2022  
Fields: High Energy Physics/Experimental Particle Physics  
Advisor: Alfredo Gurrola Ph.D.

**Universidad Autónoma de Zacatecas (UAZ)**, Zacatecas, (Mexico)  
B. in Sc., Physics. May 2017  
Honor's thesis: "Study of background events in the search for the charged Higgs boson with the CMS experiment at the LHC".  
Advisors Alejandro Gutierrez Rodríguez Ph.D (UAZ), Maria Isabel Pedraza Morales Ph.D (BUAP)  
GPA: 9.96/10.0. *Summa Cum Laude*

## Dissertation

**"Search for Compressed Supersymmetry in Electroweak Vector Boson Fusion Topologies with 0-, 1- and 2- Low Energy Lepton Final States in Proton-Proton Collisions at  $\sqrt{s} = 13$  TeV"**

Regardless of its remarkable success, the standard model (SM) of particle physics is unable to explain experimental observations like dark matter (DM), or conceptual problems, like the hierarchy problem. Supersymmetry (SUSY) has been proposed to solve the SM hierarchy problem, and could also explain the particle nature of DM. This has motivated experimental searches for SUSY DM production at colliders, creating a connection between particle physics and cosmology. A search for electroweak SUSY production in  $pp$  collision events with two energetic jets, large momentum imbalance and one, two or zero low energy charged leptons is presented. Jets are largely separated in rapidity, consistent with the topology in electroweak vector boson fusion (VBF) processes. The data sample corresponds to an integrated luminosity of  $\mathcal{L}_{\text{int}} = 137 \text{ fb}^{-1}$  of  $pp$  collisions at  $\sqrt{s} = 13$  TeV collected during the LHC Run II by the CMS detector. Results are interpreted using the R-parity conserving minimal supersymmetric extension of the SM (MSSM), focusing on scenarios where the mass difference between the lightest supersymmetric particle (LSP) and other electroweak SUSY particles is small. In this region, the LSP has the right properties to co-annihilate with other SUSY particles and produce the observed DM relic density. The experimental features of VBF processes provide an increased sensitivity to compressed SUSY, compared to traditional searches. The observed dijet invariant mass and lepton-neutrino transverse mass distributions are used to search for the presence of new physics. The analysis with Run II data provides sensitivity which exceeds that of other searches to date in these compressed SUSY scenarios.

## Research experience

**Graduate research assistant** January 2019 – May 2022

Department of Physics, Vanderbilt University

Advisor: Alfredo Gurrola Ph.D

Activities:

- Contribution to studies of background events in the search for SUSY in VBF topologies with 0- and 1-lepton final states with data collected in 2016 with the CMS experiment.
- Tracker Detector-on-Call (DOC) shifts for the CMS experiment.

**Undergraduate research intern** Spring 2017

Facultad de Ciencias Físico Matemáticas, Benemérita Universidad Autónoma de Puebla (FCFM-BUAP) and European Organization for Nuclear Research (CERN)

Advisors: Maria Isabel Pedraza Morales Ph.D, Roumyana Mileva Hadjiiska Ph.D

Activities:

- Contribution to offline efficiency analysis of the Resistive Plate Chambers (RPC) of the CMS muon detector system.
- Participation in signal region optimization studies in the search for charged Higgs boson production in the decay channel to  $t$  and  $b$  quarks with the CMS experiment.

**Internship for Physics Majors (IPM)** Summer 2016

Fermi National Accelerator Laboratory (Fermilab)

Advisor: Corrado Gatto Ph.D.

Activities:

- Radiation studies with simulations for the detector of the REDTOP (Rare Eta Decays with a TPC for Optical Photons) experiment.
- Software development for reconstruction of  $\eta$  meson mass in different decay channels (Summer 2016 - Summer 2017).

## Teaching and mentoring experience

**Graduate student mentor** Spring 2020 - Summer 2021

Department of Physics, Vanderbilt University

Undergraduate student: Kyungmin Park (University of Seoul, South Korea)

Advisor: Alfredo Gurrola Ph.D.

Project: Data analysis: search for supersymmetry with VBF topologies and 0-leptons in the final state using Run II CMS data.

**Graduate student mentor for the REU program** Summer 2019

Department of Physics, Vanderbilt University

Undergraduate student: Lauren Kasper (Baldwin Wallace University)

Advisor: Alfredo Gurrola Ph.D.

Project: Phenomenology study to search for direct production of supersymmetric scalar tau  $\tilde{\tau}$  leptons in vector boson fusion topologies at the LHC.

**Graduate teaching assistant** Spring – Fall 2018

Department of Physics, Vanderbilt University

PHYS 1601 (Spring 2018): Classical mechanics for physics majors (grading)

PHYS 1502 (Fall 2018): Introductory physics lab for non-physics majors

**High school teacher (Physics)** Fall 2017

Unidad Académica Preparatoria, Universidad Autónoma de Zacatecas (Mexico)

Introductory physics (classical mechanics) for freshmen high school students.

Physics and mathematics help desk sessions for high school sessions.

**Senior undergraduate student mentor** Fall 2016 - Summer 2017

Facultad de Ciencias Físico Matemáticas, Benemérita Universidad Autónoma de Puebla (FCFM-BUAP), Mexico.

Undergraduate students: Sofía Escobar Martínez (Universidad Nacional Autónoma de Honduras).

Advisors: Corrado Gatto Ph.D, María Isabel Pedraza Morales Ph.D

Project:

– Software development for the reconstruction of the invariant mass of the  $\eta$  meson with the REDTOP detector.

**Undergraduate teaching assistant** 2013-2015

Unidad Académica Preparatoria, Universidad Autónoma de Zacatecas (Mexico)

Help-desk sessions for high school students in physics and mathematics.

## Publications

### *Research:*

A.M. Sirunyan *et al.* [CMS], “Search for supersymmetry with a compressed mass spectrum in the vector boson fusion topology with 1-lepton and 0-lepton final states in proton-proton collisions at  $\sqrt{s} = 13$  TeV”, *JHEP* 08, 150 (2019). DOI: 10.1007/JHEP08(2019)150. e-print: [arXiv:1905.13059](https://arxiv.org/abs/1905.13059).

### *Conference proceedings:*

S. D. Escobar Martinez, B. Fabela Enriquez, M. I. Pedarza Morales, “Invariant mass reconstruction of the  $\eta$  meson in the decay channel  $\pi^+\pi^-\pi^0$  with the REDTOP experiment”, *Journal of Physics, Conference Series*. Vol. 912, No. 1, IOP Publishing, 2017

Fabela, Brenda, Maria Isabel Pedraza and Corrado Gatto, “The REDTOP project: Rare Eta Decays with a TPC for Optical Photons”. Proceedings of Science, International Conference on High Energy Physics, 2016.

B. Fabela and I. Pedraza, “Offline Data Quality Monitoring for the RPC of the CMS detector”. *Journal of Physics, Conference Series*, Vol. 761, No. 1, IOP Publishing, 2016.

## Awards and Fellowships

### *Graduate school awards:*

#### **Robert Lagemann Award 2019**

Entering or first-year graduate student for exceptional promise in physics. Vanderbilt University, Department of Physics, USA.

### *Undergraduate awards and fellowships:*

#### **State Youth Award 2017**

Award given to people native of Zacatecas between 18 and 29 years old, who have an exceptional academic and/or community service career.

Category: Academic achievement. Government of Zacatecas, Mexico

#### **Leon M. Lederman Physics Award 2016:** First place.

Fundación Hertel and Benemérita Universidad Autónoma de Puebla (BUAP). Mexico.

## Awards and Fellowships

**Leon M. Lederman Physics Award 2015:** Second place.  
Fundación Hertel and Benemérita Universidad Autónoma de Puebla. Mexico

**“Science Olympiads” scholarship (2009-2016)**  
Academia Mexicana de Ciencias, Secretaría de Educación Pública, Mexico.  
Excellence scholarship for undergraduate students who participated and have been awarded in national science Olympiads.

**“Special Talents” scholarship (2009-2016).**  
Excellence scholarship for outstanding undergraduate students with national and/or international awards.  
Consejo Zacatecano de Ciencia, Tecnología e Innovación (COZCYT),  
Government of Zacatecas, Mexico.

### *High school awards:*

**XXI National Chemistry Olympiad, 2012:** Second place.  
Category: General Chemistry. Academia Mexicana de Ciencias  
(Mexican Academy of Sciences - Federal Department of Education), Mexico.

**XXII National Physics Olympiad, 2011:** Honorific mention.  
Academia Mexicana de Ciencias, Sociedad Mexicana de Física  
(Mexican Physical Society), Mexico.

**State Chemistry Olympiad, 2011:** First place.  
Category: General chemistry. Universidad Autónoma de Zacatecas, Mexico.

**X State Basic Sciences Olympiad, 2012:** First place.  
Categories: Physics, mathematics and chemistry.  
Instituto Tecnológico de Zacatecas, Zacatecas, Mexico.

**First Basic Science contest for High School Students, 2012:** First place.  
Category: Physics and mathematics. Consejo Zacatecano de Ciencia, Tecnología e Innovación (COZCYT), Government of Zacatecas, Mexico.

**XXX Regional Contest “Francisco Mirabal García” 2012**  
Category: High school physics: Second place.  
Category: High school mathematics: Third place.  
Universidad Autónoma de San Luis Potosí, Mexico.

**XXV State Mathematics Olympiad, 2010:** Second place.  
Universidad Autónoma de Zacatecas, Mexico.

**XXIX Regional Contest “Carlos Ernesto Angulo Aguila” 2011**  
Category: High school physics: Ninth place.  
Category: High school mathematics: Tenth place.  
Universidad Autónoma de San Luis Potosí, Mexico.

**Eighth National Astronomy Olympiad, 2012:** Finalist.  
Instituto Nacional de Astronomía, Óptica y Electrónica (INAOE), Mexico.

Presentations **Brenda Fabela Enriquez, Alfredo Gurrola on behalf of the CMS collaboration.** “*Search for supersymmetry with a compressed mass spectrum in the vector boson fusion topology with 1-lepton and 0-lepton final states*”. Poster and elevator speech presented at the Dark Matter at the LHC workshop, Summer 2019.

Lauren Kasper, Brenda Fabela Enriquez, Alfredo Gurrola. “*Search for direct stau production in proton-proton collisions at  $\sqrt{s} = 13$  TeV with vector boson fusion topologies*”. Poster and talk presented at the Vanderbilt Physics & Astronomy REU Symposium, Summer 2019.

Sofía Escobar Martínez, Brenda Fabela Enriquez, María Isabel Pedraza Morales on behalf of the REDTOP collaboration, “*Invariant mass reconstruction of the  $\eta$  meson in the decay channel  $\pi^+\pi^-\pi^0$  with the REDTOP experiment*”. Poster presented at the XXXI Annual Meeting of the Division of Particles and Fields of the Mexican Physical Society, Spring 2017.

Dario Gonzalez Herrera, Diana León Silverio, Brenda Fabela Enriquez, María Isabel Pedraza Morales on behalf of the REDTOP collaboration. “*Detecting physics beyond the Standard Model with the REDTOP experiment*”. Poster presented at the XXXI Annual Meeting of the Division of Particles and Fields of the Mexican Physical Society, Spring 2017.

Brenda Fabela Enriquez, María Isabel Pedraza Morales and Corrado Gatto on behalf of the REDTOP experiment. “*The REDTOP experiment: Rare Eta Decays with a TPC for Optical Photons*”. Poster presented at the XVII Mexican School of Particles and Fields 2016. Division of Particles and Fields of the Mexican Physical Society, Fall 2016. **Award to the best poster.**

Brenda Fabela Enriquez, Juan Pablo Fernández Guzmán and María Isabel Pedraza Morales. “*Estimación de la contribución de procesos ZZ a los eventos de fondo en la búsqueda de Higgses cargados en el CMS del LHC*” (Background estimation of ZZ processes in the search for charged Higgs with the CMS experiment at the LHC). Poster presented at the VII Encuentro Nacional de Ciencia “*Luis Rivera Terrazas*” and the LIX Mexican Congress in Physics, Fall 2016.

Brenda Fabela Enriquez, Corrado Gatto, María Isabel Pedraza Morales, *et.al*, “*The REDTOP project: Rare Eta Decays with a TPC for Optical Photons*”. Poster and elevator speech presented at the 38th International Conference on High Energy Physics (ICHEP), Summer 2016.

Brenda Fabela Enriquez, María Isabel Pedraza Morales on behalf of the CMS collaboration, “*Offline Data Quality Monitoring for the RPCs of the CMS detector*”. Talk presented at the XXX Annual Meeting of the Division of Particles and Fields of the Mexican Physical Society, Spring 2016.

Brenda Fabela Enriquez, María Isabel Pedraza Morales, Ángel Bello Muñoz, “*Análisis de la producción del bosón Z en el canal de decaimiento a dos electrones en el experimento CMS del LHC del CERN*” (Analysis of Z boson production in the two-electrons decay channel with the CMS experiment at the LHC using CMS Open Data). Poster presented at the LVIII Mexican Congress in Physics, Fall 2015.

## Outreach *Experience:*

**Support staff at Summer Science Camps for Kids** 2012-2016  
Community service at the Adventure Science Museum “Zig Zag”.  
COZCYT. Zacatecas, Mexico.

**Exhibit attendant/demonstrator, science communicator** 2010-2011  
Adventure Science Museum “Zig Zag” - COZCYT. Zacatecas, Mexico.

### *Publications:*

Brenda Fabela Enriquez, “El Gran Colisionador de Hadrones: la importancia de los aceleradores de partículas” (The Large Hadron Collider: the importance of particle accelerators), *EEK'*, Volume 6, Number 3, June/July 2017. ISSN: 2007-4565 (COZCYT).

Brenda Fabela Enriquez, “Biografía: Jocelyn Bell” (Biography: Jocelyn Bell), *EEK'*, Volume 6, Number 1, February/March 2017. ISSN: 2007-4565 (COZCYT).

Brenda Fabela Enriquez, “Microscopía de fluorescencia de super resolución” (Super resolution fluorescence microscopy), *EEK'*, Volume 4, Number 4, August/September 2015. ISSN: 2007-4565 (COZCYT).

Brenda Fabela Enriquez, “Biografía: Dorothy Crowfoot Hodgkin” (Biography: Dorothy Crowfoot Hodgkin), *EEK'*, Volume 3, Number 1, February/March 2014. ISSN: 2007-4565 (COZCYT).

Brenda Fabela Enriquez, “Biografía: Lise Meitner” (Biography: Lise Meitner), *EEK'*, Volume 2, Number 4, August/September 2013. ISSN: 2007-4565 (COZCYT).

### *Presentations:*

Moderator of the panel “Life in graduate school: motivation, mental health and more careers in academia”, [Conference for Undergraduate Women in Physics 2022 in Mexico \(CUWiP-2022\)](#). (virtual event). March 26, 2022.

“Letting go of comparison and cultivating creativity”, guidepost from the book *The Gifts of Imperfection* by Dr. Brené Brown. Invited participation at the PHYS 1502 Speaker series, Spring 2022 (Introduction to Physics for the Life Sciences, Vanderbilt University, February 18, 2022).

“Seeing with particles: understanding the Universe with High Energy Physics”, Undergraduate physics [colloquium](#) at Washington and Jefferson College. November 4, 2021.

“Six useful insights from a Ph.D. in High Energy Physics for everyone”, Invited talk at the Senior Physics Seminar class at Washington and Jefferson College. November 4, 2021.

“El Universo y su origen” (The Universe and its origin). Invited virtual talk at the Spring 2022 Introduction to Biophysics class, Unidad Académica de Física, UAZ. March 1, 2022.

“My life experience as a physics graduate student and what I learned”, PHYS 1501 Speaker series Fall 2021 (Introduction to Physics for the Life Sciences), Vanderbilt University. October 28, 2021.

## Outreach

“El Universo y su origen” (The Universe and its origin). Invited virtual talk at the Fall 2021 Introduction to Biophysics class, Unidad Académica de Física, UAZ. October 6, 2021.

“El experimento Muon g-2, ¿nueva física?” (Muon g-2 experiment, new physics?), Livestream at [5 Alautuns](#) Facebook page from Unidad Académica de Física, UAZ. April 9, 2021.

“El Universo y su origen” (The Universe and its origin). Invited virtual talk at the Spring 2021 Introduction to Biophysics class, Unidad Académica de Física, UAZ. March 2, 2021.

“Soy mujer, soy científica” (I am female, I am a scientist), Livestream at [5 Alautuns](#) Facebook page from Unidad Académica de Física, UAZ. February 11, 2021.

“A personal journey to the physics energy frontier”, PHYS 1501 Speaker series Fall 2020 (Introduction to Physics for the Life Sciences), Vanderbilt University. September 4, 2020.

“An introduction to High Energy Physics”, QuarkNet workshop at Vanderbilt University. June 23, 2020.

“Simetrías en la naturaleza” (Symmetries in nature), Physics colloquium at Unidad Académica de Física, UAZ. May 9, 2019.

“An introduction to High Energy Physics”, QuarkNet workshop at Vanderbilt University. June 23, 2020.

“Simetrías en la naturaleza” (Symmetries in nature), Physics colloquium at Unidad Académica de Física, UAZ. May 9, 2019.

“El camino de la Mujer en la Física” (The path of women in Physics), Discussion panel at Unidad Académica de Física, UAZ. March 8, 2018.

“Física en la frontera de la energía: cómo producirla y cómo detectarla” (Physics in the energy frontier: how to produce it and how to detect it), Physics undergraduate colloquium at Unidad Académica de Física, UAZ. May 7, 2017.

“The REDTOP experiment at Fermilab: Rare Eta Decays with a TPC for Optical Photons”, Physics undergraduate colloquium at Benemérita Universidad Autónoma de Puebla (FCFM-BUAP). October 18, 2016.

## Languages

Spanish (native proficiency), English (professional proficiency).

## Computing skills

**Programming:** C/C++, Python, Mathematica,  $\text{\LaTeX}$ , Fortran 90/95.  
**Data analysis and simulations (high energy physics):** ROOT, Madgraph5@NLO, MadAnalysis, Pythia, Delphes.  
**MS Office:** Excel, Word, PowerPoint, Outlook  
**Operating systems:** Unix/Linux, Ubuntu, Windows.  
**High-throughput computer software:** HTCondor, SLURM  
**Other skills:** [Github](#), [GitLab](#) ([CERN](#))