Dr Héctor de la Torre Pérez

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Education

PhD in Physics — *Madrid, Spain*
Universidad Autónoma de Madrid — *February 2016*
- Measurement of photon plus jets production and identification of boosted top quarks in pp collisions at the LHC using the ATLAS detector

MSc in Theoretical Physics — *Madrid, Spain*
Universidad Autónoma de Madrid — *January 2011*

BSc in Physics — *Madrid, Spain*
Universidad Autónoma de Madrid — *September 2008*

Fellowships and contracts

Assistant Professor — *Dekalb, USA*
Northern Illinois University — *Since April 2023*

Research associate — *East Lansing, USA*
Michigan State University — *May 2016 - February 2023*

Research fellow (4 years) and Research assistant — *Madrid, Spain*
Universidad Autónoma de Madrid — *August 2009 - April 2016*

Positions and appointments

Leadership positions

Convener	Upgrade physics group (UPPH), ATLAS Collaboration	*Since Oct. 2023*
Coordinator	TDAQ phase II - PPES group, ATLAS Collaboration	*Mar. 2023 - Oct. 2023*
Convener	HQT subgroup, ATLAS Collaboration	*2019 - 2021*
Analysis contact of ATLAS analyses (Multiple)	Exotics and SM groups, ATLAS Collaboration	*Since 2013*
Run coordinator	LAr calorimeter group, ATLAS Collaboration	*2011 - 2013*

Editor and reviewer roles

Referee	Journal of High Energy Physics	*Since 2021*
Editorial board on ATLAS physics analyses (multiple)	Exotics group, ATLAS Collaboration	*Since 2021*
PhD Thesis committee (multiple)	Madrid and Valencia Universities	*Since 2021*
Paper editor of ATLAS physics results (multiple)	Exotics and SM groups, ATLAS Collaboration	*Since 2013*

Teaching and Mentoring

Courses taught at Northern Illinois University

PHYS 684	Introduction to High Energy Physics	*Spring 2024 (Ongoing)*

Mentoring and supervision

Graduate student supervision at NIU	Two current MS students	*Since 2023*
Graduate student supervision at MSU	Three students graduated between 2020 and 2023	*2016 - 2023*
Career panel (as a recent HEP faculty appointment)	US-ATLAS Workshop (Hosted at Yale University)	*Summer 2023*
Career dinner (as a recent HEP faculty appointment)	CAMPFIRE Workshop (Hosted at ANL)	*Summer 2023*
Student mentoring	Women and Minorities in the Physical Sciences, MSU	*Summer 2021*

International conferences and seminars

US LHC Users Association annual meeting (Hosted at Fermi National Laboratory) — *Batavia, USA*
ATLAS status report — *December 2023*

Argonne National Laboratory, High Energy Physics division seminar — *Lemont, USA*
Challenges and opportunities for ATLAS at the High-Luminosity LHC — *November 2023*

US ATLAS Summer Workshop 2023 (Hosted at Yale University) — *New Haven, USA*
Upgrade Physics Projections — *July 2023*

11th Large Hadron Collider Physics Conference (LHCP 2023) — *Belgrade, Serbia*
Convener of the BSM-1 (TeV-Scale) session — *May 2023*

14th Conference on the Intersections of Particle and Nuclear Physics (CIPANP 2022) — *Lake Buena Vista, USA*
Convener of the Physics at High Energies sessions & plenary talk (Physics at High Energies) — *August 2022*

40th International Conference on High Energy Physics (ICHEP 2020) — *Virtual conference*
Search for new physics in final states with heavy-flavour quarks using the ATLAS detector — *August 2020*

US ATLAS Physics Workshop 2019 — *Amherst, USA*
Overview of the Exotics search program: present and future — *August 2019*

39th International Conference on High Energy Physics (ICHEP 2018) — *Seoul, South Korea*
Expected performance of the upgraded ATLAS experiment for HL-LHC — *July 2018*

ATLAS Overview Week 2018 — *Tokyo, Japan*
Physics studies for the HL(HE)-LHC — *June 2018*

Deep Inelastic Scattering 2017 (DIS 2017) — *Birmingham, United Kingdom*
High- E_{T} isolated-photon plus jets production in pp collisions at $\sqrt{s} = 8\,\mathrm{TeV}$ with the ATLAS detector — *April 2017*

Selected publications

On a total of 1163 research papers. Full list can be accessed through the ORCID link included in the header of this document

1. ATLAS Collaboration, *Search for vector-boson resonances decaying into a top quark and a bottom quark using pp collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector*, JHEP **12** (2023) 073, arXiv: 2308.08521 [hep-ex]
2. ATLAS Collaboration, *Search for single vector-like B quark production and decay via B → bH($b\bar{b}$) in pp collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector*, JHEP **23** (2023) 168, arXiv: 2308.02595 [hep-ex]
3. Hector de la Torre and Trisha Farooque, *Looking beyond the Standard Model with Third Generation Quarks at the LHC*, Symmetry **14**.3 (2022), ISSN: 2073-8994, URL: https://www.mdpi.com/2073-8994/14/3/444
4. ATLAS Collaboration, *Search for heavy particles in the b-tagged dijet mass distribution with additional b-tagged jets in proton-proton collisions at $\sqrt{s}$= 13 TeV with the ATLAS experiment*, Phys. Rev. D **105**.1 (2022) 012001, arXiv: 2108.09059 [hep-ex]
5. ATLAS Collaboration, *Search for $t\bar{t}$ resonances in fully hadronic final states in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector*, JHEP **10** (2020) 061, arXiv: 2005.05138 [hep-ex]
6. ATLAS Collaboration, *Search for vector-boson resonances decaying to a top quark and bottom quark in the lepton plus jets final state in pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector*, Phys. Lett. B **788** (2019) 347, arXiv: 1807.10473 [hep-ex]
7. Xabier Cid Vidal et al., *Report from Working Group 3: Beyond the Standard Model physics at the HL-LHC and HE-LHC*, CERN Yellow Rep. Monogr. **7** (2019) 585, ed. by Andrea Dainese et al., arXiv: 1812.07831 [hep-ph]
8. ATLAS Collaboration, *Search for $W' \to tb$ decays in the hadronic final state using pp collisions at $\sqrt{s} = 13$ TeV with the ATLAS detector*, Phys. Lett. B **781** (2018) 327, arXiv: 1801.07893 [hep-ex]
9. Hector De la Torre Perez, *High-E_T isolated-photon plus jets production in pp collisions at $\sqrt{s}$ = 8 TeV with the ATLAS detector*, PoS **DIS2017** (2018) 160, ed. by Uta Klein
10. ATLAS Collaboration, *Technical Design Report for the Phase-II Upgrade of the ATLAS TDAQ System*, tech. rep. CERN-LHCC-2017-020. ATLAS-TDR-029, CERN, 2017, URL: https://cds.cern.ch/record/2285584

Outreach

Interview for the program 'En fase experimental' on particle physics (Spanish)
Youtube and other podcast platforms — *Oct. 2023*

Research experience

As assistant professor at Northern Illinois University. Since 2023

The HL-LHC upgrade programme for the ATLAS detector

- **Convener of Upgrade Physics group (Since 2023):** I manage and coordinate all performance, physics, and simulation studies related to the upgrade program of the ATLAS detector. In addition to purely upgrade efforts, I advise Physics, detector, and computing groups to ensure that today's decisions keep the upgrade objectives in mind. The studies taking place in the group shape and define the planning and execution of the detector upgrades to be installed in ATLAS in preparation for the High-Luminosity LHC (HL-LHC)
- **Continuation of studies on the Global trigger (Since 2023):** I conduct performance studies related to cluster and jet reconstruction at the trigger level with HL-LHC conditions as part of the effort to design the Global trigger. This new planned trigger system consists of a layer of incoming multiplexing nodes that feed into a layer of global event processors. This structure makes the whole event available on a single processor (one FPGA), decoupled from the LHC bunch-crossing rate. It will be able to run complex algorithms to maintain or improve the performance of the ATLAS trigger in the challenging environment of the HL-LHC.
- **Coordinator of the TDAQ Phase II Physics Performance and Event selection group (2023-2023):** I managed a dedicated group within the ATLAS trigger community dedicated to coordinating and supporting performance studies for the upgrade of the trigger system for HL-LHC.

Searches for new physics beyond the Standard Model with the ATLAS Detector

- **Heavy resonance combination (2023-):** I participate in the current effort of the statistical combination of 18 searches dedicated to heavy vector resonances. Liaison for the searches with top quarks in the final state, $W' \to tb$ and $Z' \to t\bar{t}$. Provided the relevant inputs from the $W' \to tb$ analysis, which provides the strongest sensitivity among the searches combined, to models with dominant third-generation couplings.
- $W' \to tb$ **searches with entire run 2 data (2023-2023):** I led the last iteration of the search, looking for new heavy vector resonances decaying into a top quark and a bottom quark, using the complete run-2 dataset. The search, published in August of 2023, has a better sensitivity than any previous analysis by either ATLAS or CMS and combines both the leptonic and hadronic channels into a single result. It takes advantage of the latest improvements in machine learning methods applied to jet tagging to boost the reach of the analysis and set limits on the production of heavy vector resonances with masses up to 6 TeV.
- **Monotop search (2023-2023):** As a member of the editorial board, I take part in this search for new physics in final states composed of one top quark accompanied by missing transverse energy with interpretations in dark matter and Vector-like quarks (VLQ) models. Preliminary results were published in June of 2023.
- **Right-handed neutrino search (2023-2023):**As a member of the editorial board, I participated in a search for exotic resonances in final states with multiple leptons and jets, focusing on the hunt for heavy neutrinos. The analysis was published in April of 2023.

Computation in HEP

- **Computational HEP traineeship (2023-)** I take part as a faculty mentor in the Chicagoland Computational Traineeship in High Energy Particle Physics (C-^{2}-THE-P^2, an effort between NIU and UIC to train new graduate students in computational skills aimed at improving research in high energy physics. One of my students works on the implementation and usability in physics analysis of RNtuple, the next generation of ROOT I/O subsystem.

Previous research experience in the ATLAS Collaboration

As a research associate at Michigan State University and graduate student at Universidad Autónoma de Madrid, 2009-2023

Simulation and processing of simulated samples for physics groups

- **Derivation production for the exotics group (2021-2023):** I was responsible for the group's derivation framework. This framework is used to process the common Monte Carlo simulation ATLAS format into simplified formats, with less content and/or events, that are easier to work with for specific analyses. I also process and submit to the grid production system the derivation requests from the different teams in the group.
- **Monte Carlo sample production for the exotics group (2018-2019) :** I was in charge of collecting, validating, and processing the Monte Carlo requests of the different analysis teams of the group.

ATLAS Upgrade programme

- **Studies on the Global trigger (2017-2023):** I participated in performance studies on cluster and jet reconstruction for the Global trigger in the context of the HL-LHC ATLAS upgrade program. Coordinated the design of a dedicated software framework for global trigger performance studies.
- **Monte Carlo sample production for HL(HE)-LHC studies (2017-2019):** I designed and executed a sample simulation strategy for physics and performance studies used for the six Technical Design Reports (TDR) published by ATLAS in 2017. These TDRs compiled the plans for the HL-LHC upgrade of the ATLAS detector. The same set of samples was used to perform studies included in the Yellow report on the physics potential of the HL(HE)-LHC, a fundamental input for the update of the European strategy for particle physics finalized in 2020. Coordinated with relevant experts and analyzers to ensure the samples were created according to specifications and took care of producing the samples with the ATLAS grid production system.
- **Performance studies for Trigger and Data Acquisition TDR (2016-2017):** I led calorimeter performance studies for the global trigger and provided inputs for other team members using a custom-built analysis framework.

Searches for new physics beyond the Standard Model

- $b\bar{b}Z' \to b\bar{b}b\bar{b}$ **search (2019-2022):** I was responsible for the definition and study of new signal samples using Madgraph and performed the truth-level analyses needed to determine the analysis strategy. This novel analysis published in 2022 was focused on vector-like resonances that couple exclusively to third-generation quarks. This is especially relevant in models incorporating lepton flavor universality violation.
- $W' \to tb$ **searches (2016-2021):** I led the publication of preliminary results with the entire run 2 dataset on the $W' \to tb \to qqbb$ channel published in 2021 as a first step of the full publication that would be completed in 2023. I supervised two students, who graduated in 2021 and 2022, respectively. I was the main analyzer of the first 13 TeV iteration of $W' \to tb \to qqbb$ search, published in 2018. I led on statistical analysis, framework development, and strategy design. I was responsible for sample generation, truth-level studies for the exact search, and another on the complementary channel, $W' \to tb \to l\nu bb$. A combination of both searches was published in 2019.
- **Convener of Heavy Quarks, Top and composite Higgs (HQT) subgroup (2019-2021):** I managed the search subgroup, part of the exotics group, focused on physics beyond the SM with final states of third generation quarks. I coordinated 20 analyses with approximately 200 analyzers under my care, dealing with many resonance searches and the complete ATLAS program of VLQ analyses. I reviewed relevant talks, internal notes, and papers.
- $VLB \to bh(bb)$ **search (2019-2021):** I participated as HQT convener in the full run-2 version of the analysis, with preliminary results published in 2021. I supervised the main analyzer, a student who graduated the same year and I was integral in the design of the background estimation method. The analysis took advantage of an innovative background estimation method to improve the sensitivity with respect to previous VLB searches in a challenging all-hadronic final state. After a delay necessary to understand signal modelling, the full version of the analysis was published in 2023.
- $Z' \to t\bar{t}$ **search (2019-2020):** I participated as HQT convener in the all-hadronic, full run-2 version of the analysis, published in 2020. Worked closely with the team to validate the background estimation process based on a functional form. It was the first analysis to introduce deep neural network top-taggers in ATLAS.

Physics measurements of standard model processes

- **Photon + jet differential cross section measurement (2013-2017** I led a new physics analysis effort in the Standard Model group for the photon + jets analysis at 8 TeV, published in 2017. The analysis contained differential cross-section measurements as a function of 15 different observables in events with one photon and up to three additional jets. It constituted the first test of color coherence effects in photon + jets events in ATLAS.

Liquid argon (LAr) calorimeter operations

- **LAr run coordinator (2011-2013):** I led the LAr operations team, managing a team of around 15 experts and shifters. The team ensured the smooth operation of LAr within the ATLAS detector during the 8 TeV data-taking period. I was the point of contact between the LAr operations team and ATLAS management.
- **LAr software on-call (2011-2013):** I was available 24 hours a day to investigate and repair issues related to the LAr online software and back-end electronics
- **LAr online software developer (2011-2013):** I developed two tools running on the ATLAS online framework during data taking. One tool to investigate single event upsets in LAr front-end boards and a monitoring tool to check the LAr configuration at the beginning of each run.