

## Nhan V. Tran

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## Education

*Ph.D., Physics*

Johns Hopkins University, September 2005 - September 2011

*B.S., Physics*

Princeton University, September 2001 - June 2005

## Professional Experience

- Wilson Fellow, Fermi National Accelerator Laboratory, May 2017 - present
- Postdoctoral Research Associate, Fermi National Accelerator Laboratory, CMS Collaboration, October 2011 - May 2017
- Research Assistant, Johns Hopkins University, CMS Collaboration, 2006 - 2011  
Dissertation: "Angles and Daemons: Spin correlations at the LHC"  
Advisor: Professor Andrei Gritsan

## Selected Research Experience

Development of a particle flow-based global correlator hardware trigger concept at Level-1 at CMS for the HL-LHC Phase-2 upgrade (*Apr. 2016 - present*)

Hadronic veto development for proposed missing momentum experiment (LDMX) searching for low mass thermal dark matter with fixed-target electron beams (*Apr. 2016 - present*)

Leader of CMS searches for hidden low mass resonances decaying to quarks. (*Feb. 2016 - present*)

Co-convenor of the CMS sub-group on diboson resonances in the Beyond Second Generation (B2G) physics analysis group (*Dec. 2015 - present*)

Studies of detectors for super boosted jet substructure for future colliders (*Nov. 2015 - present*)

Searches for supersymmetry in final states with jets and missing transverse energy; studies of jet and missing transverse energy observables and correlations (*Jul. 2014 - Jul. 2016*)

Search for Higgs boson decaying to two b quarks and studies of anomalous Higgs couplings (*June 2014 - present*)

Pileup mitigation at the LHC (PUPPI) in high pileup environments; implementation in CMS studies for jets, missing energy and leptons (*Jan. 2014 - present*)

Development of the track trigger hardware in CMS and fast pattern recognition 3D associative memory chip technology (*Mar. 2013 - present*)

Development of jet substructure techniques for tagging W/Z/H/t jets; co-convenor of the CMS sub-group on algorithms and reconstruction in the jet and  $\cancel{E}_T$  physics object group (*Jul. 2012 - present*)

Co-editor for CMS Run I legacy combination of searches for high mass Standard Model-like Higgs bosons where the Higgs decays to a pair of W or Z bosons; leader of CMS analyses searching for  $X \rightarrow WW \rightarrow \ell\nu qq$  resonances (*July. 2012 - Apr. 2015*)

Co-leader of measurement of jet mass in dijet and vector boson plus jet events (*Jan. 2012 - Mar. 2013*)

Search, discovery, and determination of spin-parity for the Standard Model Higgs boson in the decay  $H \rightarrow ZZ \rightarrow 4l$  at CMS; Characterization of the spin and parity of single-produced resonances including development of the MELA (matrix element likelihood analysis) technique and Monte Carlo generator (JHU generator) (*Jul. 2008 - Dec. 2015*)

Z boson dilepton differential analyses at CMS; measurement of  $\sin^2 \theta_W$  in the Drell-Yan process via a novel analytic approach (*Mar. 2010 - Jun. 2011*)

Tracker alignment and tracking validation at CMS; commissioning of the CMS detector with cosmic ray data (*Jul. 2006 - Nov. 2009*)

## Awards & Grants

Universities Research Association (URA) Tollestrup Award for Postdoctoral Research Excellence, 2017

Fermilab Reward & Recognition Award, 2015: *for the development of PUPPI*

LHC Physics Center (LPC) Distinguished Researcher, 2014

Universities Research Association (URA) Visiting Scholars Program at Fermilab, Fall 2009

National Science Foundation (NSF) US LHC Graduate Student Support Award, 2009

## Selected Conference, Workshop and Seminar Presentations

### (Invited Conference Presentations)

"BOOST 2014: Experimental Summary", BOOST 2014 Conference, London, England, August 2014.

### (Seminars and Colloquia)

"In pursuit of new physics at the LHC and beyond", SLAC seminar, Menlo Park, CA, USA, March 2017.

"A dijet renaissance and the light dark matter connection", Texas A&M University, College Station, TX, USA; Rutgers University, New Brunswick, NJ, USA; University of Maryland, College Park, MD, USA; February/May 2017.

"Dijets for hipsters and the light dark matter connection", Northwestern University, Evanston, IL, USA, December 2016

"Dissecting Jets plus MET using  $n$ -body simplified models", Fermilab LPC Topic of the Week, Batavia, IL, USA & SLAC high energy physics seminar, Menlo Park, CA, USA, June/July 2016.

"The LHC unleashed: diboson results from CMS", Ohio State University Physics Colloquium, Columbus, OH, USA; Florida State University Physics Colloquium, Tallahassee, FL, USA; UIUC HEP Seminar, Urbana-Champaign, IL, USA; University of Buffalo HEP Seminar, Buffalo, NY, USA, Jan./Feb. 2016.

"New Challenges in Searches For New Physics at the LHC and Beyond", Stony Brook University HEP Seminar, Stony Brook, NY, USA, November 2015.

"The Evolution of Jets at the LHC", Joint JHU-UMD HEP Seminar, Baltimore, MD, USA, January 2015.

"The Evolution of Jets at the LHC: jets, subjets, particles", Fermilab Wine and Cheese Seminar, Batavia, IL, USA, April 2014.

"The Future of Boosted Jets at the LHC: jets, subjets, particles", Rutgers University High Energy Physics Seminar, New Brunswick, NJ, USA, April 2014.

"Jet substructure at the LHC", Michigan State University High Energy Physics Seminar, Lansing, MI, USA, October 2013.

"Discovery of the Higgs boson", University of Missouri KC Physics Colloquium, Kansas City, MO, USA, April 2013.

"Jet substructure at CMS: current status and future perspectives", Northwestern University High Energy Physics Seminar. Evanston, IL, USA, April 2013.

"Discovery of the Higgs Boson (or something like it)", Missouri Science and Technology University Physics Department Colloquium. Rolla, MO, USA, October 2012.

"Spin determination of single-produced resonances at the LHC", Northwestern University High Energy Physics Seminar. Evanston, IL, USA, April 2010.

### **(Selected Workshop and Conference Presentations)**

"Boosting hidden light new physics at the LHC and beyond," Fermilab User's meeting, Batavia, IL, USA, June 2017.

"Precision in high pileup environments", Precision theory for precise measurements at the LHC and future colliders, Quy Nhon, Vietnam, September 2016.

"Detectors for super boosted jet substructure at future circular colliders", BOOST 2016 Conference, Zurich, Switzerland & ICHEP 2016 (poster), Chicago, IL, USA (July/August 2016).

"Search for light vector resonances decaying to quarks at  $\sqrt{s} = 13$  TeV", BOOST 2016 Conference, Zurich, Switzerland, July 2016.

"Performance Study of the First 2D Prototype of Vertically Integrated Pattern Recognition Associative Memory (VIPRAM)", IEEE Nuclear Science Symposium, San Diego, CA, USA, November 2015.

"Searches for diboson resonances at CMS", Brookhaven Forum 2015, Brookhaven, New York, USA, October 2015.

"ProtoVIPRAM00: performance studies", Vth INFIERI Workshop, Geneva, Switzerland, April 2015.

"Pileup Per Particle Identification", Workshop on Mitigating Pileup Effects at the LHC, Geneva, Switzerland, May 2014.

"Performance and applications of jet substructure in SUSY searches at the LHC", SUSY at the Near Energy Frontier, Batavia, IL, USA, November 2013.

" $H \rightarrow b\bar{b}$  and  $H \rightarrow VV$  in boosted topologies at CMS", BOOST 2013, Flagstaff, AZ, USA, August 2013.

"Jet structure at hadron colliders", Lepton-Photon 2013, San Francisco, CA, USA, June 2013.

"Jet Substructure and Top Tagging at CMS", Chicago 2012 Workshop on LHC Physics. Chicago, IL, USA, November 2012.

"Jet Mass in Dijet and Vector Boson Plus Jet Events at CMS", BOOST 2012 Workshop. Valencia, Spain, July 2012.

"Combined Results of Standard Model Higgs Searches at CMS", MCTP Higgs Symposium. Ann Arbor, MI, USA, April 2012.

"Higgs Properties at the LHC", MCTP Higgs Symposium. Ann Arbor, MI, USA, April 2012.

"Analysis of  $Z \rightarrow l^+l^-$  polarization at CMS", Recontres de Moriond, EW. La Thuile, Italy, March 2011.

"Model-independent spin and coupling determination of Higgs-like resonances", Higgs Hunting Workshop. Orsay, France, July 2010.

"Spin determination of single-produced resonances at the LHC", ICHEP 2010. Paris, France, July 2010.

"Spin determination of single-produced resonances at the LHC", Pheno 2010 Symposium. Madison, WI, USA, May 2010.

"CMS Tracker Alignment and Implications on Physics Performance", Physics at the LHC Conference. Split, Croatia, October 2008.

## Selected Publications

### (Outside of the CMS collaboration)

S. Chekanov, M. Beydler, *et al.*, "Initial performance studies of a general-purpose detector for multi-TeV physics at a 100 TeV pp collider", *submitted to JINST* (2017), ([arXiv:1612.07291](https://arxiv.org/abs/1612.07291) (hep-ex)).

O. Gutsche, M. Cremonesi, *et al.*, "Big Data' in HEP: A comprehensive use case study", ([arXiv:1703.04171](https://arxiv.org/abs/1703.04171) (cs)), March 2017.

O. Colegrove, B. Echenard *et al.*, "Light Dark Matter eXperiment (LDMX): Preliminary Design Studies", *document in preparation*, December 2016.

Timothy Cohen, Matthew J. Dolan, Sonia El Hedri, James Hirschauer, Nhan Tran, Andrew Whitbeck. "Dissecting Jets and Missing Energy Searches Using  $n$ -body Extended Simplified Models", JHEP 08 (2016) 038 ([arXiv:1602.04305](https://arxiv.org/abs/1602.04305) (hep-ph)).

James Dolen, Philip Harris, Simone Marzani, Salvatore Rappoccio, Nhan Tran. "Thinking outside the ROCs: Designing Decorrelated Taggers (DDT) for jet substructure". JHEP 05 (2016) 156 ([arXiv:1504.00679](https://arxiv.org/abs/1504.00679) (hep-ph)).

Dawei Li, Siddhartha Joshi, Seda Ogrenci-Memik, James Hoff, Sergo Jindariani, Tiehui Liu, Jamieson Olsen and Nhan Tran, "A methodology for power characterization of associative memories," 33rd IEEE International Conference on Computer Design, ICCD 2015, New York City, NY, USA, pp.491-498, 18-21 Oct. 2015.

D. Adams, A. Arce, L. Asquith, M. Backovic, T. Barillari, P. Berta, D. Bertolini and A. Buckley *et al.*, "Towards an Understanding of the Correlations in Jet Substructure," Eur. Phys. J. C 75, 409 (2015) ([arXiv:1603.00027](https://arxiv.org/abs/1603.00027) (hep-ph)).

T. Liu, G. Deptuch, J. Hoff, S. Jindariani, S. Joshi, J. Olsen, N. Tran and M. Trimpl, "Design and testing of the first 2D Prototype Vertically Integrated Pattern Recognition Associative Memory," JINST 10, 02, C02029 (2015).

D. Bertolini, M. Low, P. Harris, N. Tran, "Pileup Per Particle Identification", JHEP 10 (2014) 059 ([arXiv:1407.6013](https://arxiv.org/abs/1407.6013) (hep-ph)).

I. Anderson *et al.*, "Constraining anomalous HVV interactions at proton and lepton colliders", Phys. Rev. D 89, 035007 (2014) ([arXiv:1309.4819](https://arxiv.org/abs/1309.4819) (hep-ph)).

A. Altheimer, A. Arce, L. Asquith, J. Backus Mayes, E. Bergeaas Kuutmann, J. Berger, D. Bjergaard and L. Bryngemark *et al.*, "Boosted objects and jet substructure at the LHC. Report of BOOST2012,

held at IFIC Valencia, 23rd-27th of July 2012,” Eur. Phys. J. C 74, 2792 (2014) ([arXiv:1311.2708](#) (hep-ex)).

Y. Chen, N. Tran and R. Vega-Morales, “Scrutinizing the Higgs Signal and Background in the  $2e2\mu$  Golden Channel,” JHEP 01 (2013) 182 ([arXiv:1211.1959](#) (hep-ph)).

S. Bolognesi et al., “On the spin and parity of a single-produced resonance at the LHC,” Phys. Rev. D 86, 095031 (2012) ([arXiv:1208.4018](#) (hep-ph)).

Y. Gao et al., “Spin determination of single-produced resonances at hadron colliders,” Phys. Rev. D. 81, 075022 (2010) ([arXiv:1001.3396](#) (hep-ph)).

#### **(Within the CMS collaboration)**

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”, CMS HIG-17-010 (2017).

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”, CMS EXO-17-001 (2017).

CMS Collaboration, “Search for low mass vector resonances decaying to quark-antiquark pairs in proton-proton collisions at  $\sqrt{s} = 13$  TeV”, *submitted to PRL* (2016), ([arXiv:1705.10532](#) (hep-ph)).

CMS Collaboration, “Search for a narrow resonance decaying to  $WW \rightarrow \ell\nu qq$  in the mass range from 600-1000 GeV”, CMS B2G-16-004 (2016).

CMS Collaboration, “Search for supersymmetry in the multijet and missing transverse momentum final state in pp collisions at 13 TeV”, Phys. Lett. B 758 (2016) 152 ([arXiv:1602.06581](#) (hep-ex)).

CMS Collaboration, “Combined search for anomalous pseudoscalar HVV couplings in VH production and H to VV decay”, Phys. Lett. B 759 (2016) 672 ([arXiv:1602.04305](#) (hep-ex)).

CMS Collaboration, “Search for a Higgs Boson in the Mass Range from 145 to 1000 GeV Decaying to a Pair of W or Z Bosons”, JHEP 10 (2015) 144 ([arXiv:1504.00936](#) (hep-ex)).

CMS Collaboration, “Identification techniques for highly boosted W bosons that decay into hadrons”, JHEP 12 (2014) 017 ([arXiv:1410.4227](#) (hep-ex)).

CMS Collaboration, “Study of Pileup Removal Algorithms for Jets”, [CMS PAS JME-14-001](#) (2014).

CMS Collaboration, “Search for massive resonances decaying into pairs of boosted bosons in semi-leptonic final states at  $\sqrt{s} = 8$  TeV”, JHEP 08 (2014) 174 ([arXiv:1405.3447](#) (hep-ex)).

CMS Collaboration, “Study of jet mass in dijet and W/Z + jet events,” JHEP 05 (2013) 090 ([arXiv:1303.4811](#) (hep-ex)).

CMS Collaboration, “Study of the mass and spin-parity of the Higgs boson candidate via its decays to Z boson pairs,” Phys. Rev. Lett. 110 (2013) 081803 ([arXiv:1212.6639](#) (hep-ex)).

CMS Collaboration, “Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC”, Phys. Lett. B 716 (2012) 30 ([arXiv:1207.7235](#) (hep-ex)).

CMS Collaboration, “Search for the Standard Model Higgs Boson in the Decay Channel  $H \rightarrow ZZ \rightarrow 4\ell$  in  $pp$  Collisions at  $\sqrt{s} = 7$  TeV”, Phys. Rev. Lett. 108, 111804 (2012) ([arXiv:1202.1997](#) (hep-ex)).

CMS Collaboration, “Measurement of the weak mixing angle with the Drell-Yan process in proton-proton collisions at the LHC”, Phys. Rev. D 84, 112002 (2011) ([arXiv:1110.2682](#) (hep-ex)).

CMS Collaboration, “Alignment of the CMS silicon tracker during commissioning with cosmic rays”, 2010 JINST 5 T03009 ([arXiv:0910.2505](#) (hep-ex)).

CMS Collaboration, "Performance of CMS muon reconstruction in cosmic-ray events", 2010 JINST 5 T03022 ([arXiv:0911.4994](https://arxiv.org/abs/0911.4994) (hep-ex)).

W. Adam et al., "CMS Tracker Alignment at the Integration Facility", JINST 4 T07001, 2009 ([arXiv:0904.1220](https://arxiv.org/abs/0904.1220) (hep-ex)).

## Teaching & Mentoring Experience

"HATS (Hands-on Advanced Tutorial Session) @ LPC: Jet Substructure", Fermilab, Batavia, IL, USA, May 2013 and June 2014.

"CMS Data Analysis School: Tracking; Jets and Dijet resonance searches; Pileup mitigation", Fermilab, Batavia, IL, USA, January 2013/2014/2015/2016.

Teaching Assistant: General Physics I/II, Johns Hopkins University, Fall 2005/Spring 2006.

## Committees & Services

Organizing Committee, New Physics Interpretations at the LHC (Argonne), May 2016/2017.

Local Organizing Committee, BOOST 2015 Conference, Chicago, IL, USA

Journal Referee: Int. J. Mod. Phys. A. (IJMPA), Eur. Phys. J. (EPJC), Physical Review D (PRD), Physical Review Letters (PRL)

CMS Analysis Review Committee (ARC), 12 analyses beginning in 2013 (3 chairs).

LHC Physics Center (LPC) physics forum organizer, 2015 - 2016

LHC Physics Center (LPC) Topic of the Week committee, 2012 - 2014

Vice President, JHU Physics and Astronomy Graduate Students (PAGS), 2006 - 2007

## Education & Outreach

Doctoral dissertation defense committee, external member, Rutgers University, May 2017.

"After Higgs", Nokia Technology Leadership Council Seminar, Warrenville, IL, USA, Sept. 2016.

Guide for "Saturday Morning Physics", Fermilab, Batavia, IL, USA, 2013 - present

"USCMS Got a Minute: Finding the best collisions", Fermilab Today, July 22, 2014.

"New boson's mirror image looks like the Higgs", CERN Courier, Jan/Feb 2013.

"Weinberg's Angle", Fermilab Today, November 11, 2011.

"The Science of the Large Hadron Collider", USA Science and Engineering Festival, Washington D.C., USA, October 2010.

"Particle Physics, The Mysteries of the Universe, and the LHC", Central Bucks West High School, Doylestown, PA, USA, December 2009.

Johns Hopkins Physics Fair, Baltimore, MD, USA, April 2006 and April 2007.

June 23, 2017