

Introduction

I am an experimental high energy particle physicist, currently working in the ATLAS Collaboration at the CERN Large Hadron Collider as a qualified author. In August of 2018, I began a tenure-track position at Southern Methodist University. My physics interests currently involve using the Higgs boson as a tool for discovery, specifically through the search for di-Higgs and top-associated Higgs production. I have a history of involvement in ATLAS electronics, and am currently turning my attention to fast-tracking upgrades of the ATLAS trigger system.

Work History

Assistant Professor at Southern Methodist University at Dallas, TX, USA **2018-Present**

I am currently a professor at Southern Methodist University, focusing on di-Higgs physics and ATLAS fast-tracking trigger upgrades. I teach one course per semester.

Post-doctoral Researcher at University of Michigan, Ann Arbor, MI, USA **2013-2018**

I worked with Dr. Tom Schwarz within the ATLAS Collaboration. My focus was on beyond Standard Model searches in Higgs and exotics, as well as top physics.

Education

Ph.D. University of Illinois at Urbana-Champaign, IL, USA **2007-2013**

I completed my doctoral studies in particle physics in May of 2013. I worked as a Research Assistant to Dr. Mark Neubauer's ATLAS high energy physics group 2009-2013, and prior to that had experience as a Teaching Assistant.

B.S. North Carolina State University, NC, USA **2003-2007**

Bachelor of Science in Physics, with a minor in Japanese language. While at the University, I participated in research with Dr. Harald Ade, and through a summer REU program at UCLA.

ATLAS Analysis History

Search for Higgs Boson Pair Production **2018-Present**

Higgs boson pair production is the primary channel for probing the Higgs boson self-coupling, which is a necessary measurement for the experimental determination of the Higgs potential field. Searches for HH look for evidence of deviation from Standard Model non-



resonant production, or evidence of resonant production through a hypothetical new particle. I am an analysis coordinator for the $b\bar{b}\tau\tau$ final state, and my team is involved in the search for a multiple lepton final state that will incorporate many small Higgs decay modes. In the 2018 HH combination, the observed limit on the non-resonant production was 7 times the Standard Model production cross section.

Measurement of Top-Associated Higgs Boson Production

2018-Present

Measurements of $t\bar{t}H$ production can provide insight into the coupling of the Higgs boson with the top quark, and into the possibility of the Higgs having a CP-admixture state. In addition, loop corrections to the $t\bar{t}H$ cross section provide sensitivity to the Higgs self-coupling. $t\bar{t}H$ production was observed in 2018, and future analyses will be able to make measurements of differential cross sections and Higgs CP properties. I was involved in the observation of $t\bar{t}H$ production in the diphoton decay mode, and am currently involved in the multiple lepton decay mode. The post-doctoral researcher in my group, Rohin Narayan, is leading this effort.

Search for Vector-Like Quarks

2015-2018

Vector-like quarks are predicted by various models (Composite Higgs, Little Higgs...) that can provide explanations for the cancellation of the divergent radiative corrections of the Higgs boson mass. I was the analysis coordinator in the search for a vector-like T quark decaying to a 1-lepton final state, specifically targeting the decay $T \rightarrow Wb$. I was then analysis coordinator for a search for vector-like T or B quarks decaying to fully-hadronic final states, which used novel boson identification techniques. In parallel, I was also involved in the combination of the fully-hadronic channel with other vector-like quark searches.

Search for Heavy Resonances in $\tau\tau$ Final States

2015-2016

Additional heavy Higgs bosons are predicted by models with extended Higgs sectors, which have been proposed to explain several remaining issues with the Standard Model. The search for a heavy resonance decaying to a $\tau\tau$ final state provides a unique window into probing the high mass, high $\tan\beta$ region of the MSSM and the alignment limit of 2HDM. I worked on the channel with one τ decaying leptonically and the other decaying hadronically. The latest results, with data of center-of-mass energy 13 TeV, significantly improve the limits on this process from run-1.

Measurements of Top Charge Asymmetry

2013-2016

The discrepancy from the SM of the Tevatron forward-backward asymmetry in top-quark pair-production motivated the search in a similar observable at the LHC. Due to the symmetric initial state, it is not possible to define a forward-backward asymmetry at the LHC, and so a forward-central 'charge asymmetry' is instead measured. I was a main analyzer in the inclusive and differential measurements of the charge asymmetry in top-quark pair events in a final state with a single lepton and jets. The charge asymmetry was measured in resolved and boosted regions, in two separate papers.



Search for a Pseudoscalar Boson Decaying to Z and h Bosons

2013-2015

In models with an extended Higgs sector, it is possible for a heavy pseudoscalar A boson to decay into a Z boson and h boson (which is understood to be the observed Higgs boson). In 2HDM, this search targets m_A below the top-quark pair mass and low $\tan\beta$. My contribution was focused on the channels where the Z boson decays leptonically and the h boson decays to two τ leptons.

Search for a Charged Higgs Boson Decaying to a $\tau\nu$ Final State

2009-2014

Charged Higgs bosons are predicted in models with extended Higgs sectors, and are a particularly powerful probe of the MSSM with a charged Higgs boson mass less than that of the top quark. In this case, charged Higgs bosons are produced from top decays, which are plentiful at the LHC. I have been a main analyzer in the search for a charged Higgs boson in τ +lepton and τ +jets final states, and the results from run-1 have allowed the near-total exclusion of all available MSSM benchmark scenarios with $m_{H^\pm} < m_{\text{top}}$.

ATLAS Hardware History

FTK Upgrade

2009-2012, 2018-2019

This upgrade is designed to use massively parallel pattern recognition to provide online tracking at offline quality, while also freeing up CPU time for more complex tasks. I am currently working on the firmware of the HitWarrior FPGA of the Second Stage Board, which performs duplicate track removal of 12-layer tracks. In the past, I have also studied the impact of the FastTrackKer (FTK) upgrade on tracking for online τ identification in the trigger system.

Muon Subsystem Upgrade Work

2013-2018

I led the simulation effort for determining the router design for the new small wheel. My subsequent upgrade work involved programming an FPGA in VHDL to test an early version of CERN's GBTx chipset for use in a custom multiplexer board for an electronics upgrade of the ATLAS muon spectrometer. I programmed an FPGA that is designed to establish the presence or absence of multiple mezzanine cards connected to new ATLAS electronics, designed to be backwards compatible to older versions of mezzanine card.

Muon Expert

2013-2016

I took shifts as an on-call expert for the Monitored Drift Tube (MDT) and Cathode Strip Chamber (CSC) muon subsystems. I also tested the electronics of backup components, such as mezzanine cards, and took muon desk shifts.



Awards/Leadership

Higgs to Fermions Domain Contact

2016-Present

I am a liaison to facilitate communication between analyses hosted within differing ATLAS working groups, who are searching for Higgs to fermionic final states.

ATLAS Beyond Standard Model Higgs Subgroup Convener

2015-2016

I co-directed the ATLAS program for searches including beyond Standard Model Higgs bosons. The Beyond Standard Model Higgs (HBSM) Subgroup covers a wide variety of searches that require expertise in many areas. The group also coordinates Higgs-related signal interpretations to be used in searches that are primarily hosted in other groups or subgroups (such as the Exotics Working Group).

LHC Higgs Cross Section Working Group MSSM Neutral Higgs Contact

2014-2017

I worked with theorists as well as experimentalists from CMS to produce cross sections, branching ratios and uncertainties for various MSSM benchmark scenarios, which were then used in ATLAS and CMS analyses.

Top Working Group W+jets Coordinator

2014-2016

I produced tools and organized the effort to understanding the W+jets background in top analyses.

Giulio Ascoli Award

2012

An award from the University of Illinois, which supports outstanding work in experimental high energy particle physics by a graduate student.

Teaching Excellence Award Spring

2008

Ranked as an excellent teacher by students.

Mentoring

Daniel Marley (Former Graduate Student): Vector-like quark searches, charge asymmetry measurements, and boosted jet identification.

Hao Liu (Former Graduate Student): Background identification techniques in analyses involving τ final states. Searches for $A \rightarrow Zh$, $A/H/Z' \rightarrow \tau\tau$ and $hh \rightarrow bb\tau\tau$.

Rachel Hyneman (Graduate Student): Signal modeling for $Z' \rightarrow \tau\tau$, work on signal and



background parameterization in $h \rightarrow \gamma\gamma$.

Garrett Merz (Graduate Student): Leptoquark interpretations of $hh \rightarrow bb\tau\tau$, work on signal and background parameterization in $h \rightarrow \gamma\gamma$.

Julia Pakela (Former Undergraduate Student): Background estimation techniques ('matrix method').

Bennett Magy (Former Undergraduate Student): Neutrino momentum reconstruction techniques.

Selected Talks

Search for Vector-Like Quarks with the ATLAS Detector	ICHEP 2018
Search for Pair-Produced VLQs in All-Hadronic Final States	US-ATLAS Workshop 2017
Rare and Exotic Higgs Decay Prospects at the HL-LHC	Exotic Higgs Decay Workshop 2016
Extended Scalar Searches at ATLAS and CMS	Moriond 2016
ATLAS Results in the Search for a CP-odd Higgs Boson Decaying to Zh , in Final States with Two τ 's and Two e or μ	DPF 2015
ATLAS Results in the Search for a Charged Higgs Boson	DPF 2015
Data-driven background estimations in H^\pm analyses in ATLAS	Charged 2014
Searches for Higgs Beyond the SM	ATLAS Week: Marrakech 2013
MSSM $H^\pm \rightarrow \tau\nu$ & $H^\pm \rightarrow cs$: prospects and plans	LBNL Higgs Jamboree 2012
Search for Rare or BSM Top Quark Decays at the LHC	Top 2011
Study of Tau Leptons from Top Quark Pairs in ATLAS	DPF 2011

Gave seminars at the following institutions during November-December 2016: Yale University, University of Pennsylvania, University of Notre Dame, University of Virginia at Charlottesville, University of Illinois at Urbana-Champaign, University of Columbia, and at the following institutions during January-March 2018: University of Indiana, Northeastern University, Oklahoma State University, Carnegie Mellon University, Southern Methodist University.



Selected Publications

As I am an ATLAS author, a full publication list would include the 700+ ATLAS publications since 2009 in which I am listed as an author. Those publications are listed at: <https://twiki.cern.ch/twiki/bin/view/AtlasPublic/Publications>. My "Selected Publications" list, for those in which I have made a significant contribution, includes the following:

- Combination of the searches for pair-produced vector-like partners of the third-generation quarks at $\sqrt{s}=13$ TeV with the ATLAS detector** Phys. Rev. Lett. 121, 211801 (2018)
- Search for pair production of heavy vector-like quarks decaying into hadronic final states in pp collisions at $\sqrt{s}=13$ TeV with the ATLAS detector** Phys. Rev. D 98, 092005 (2018)
- A search for resonant and non-resonant Higgs boson pair production in the $b\bar{b}\tau\tau$ decay channel in pp collisions at $\sqrt{s}=13$ TeV with the ATLAS detector** Phys. Rev. Lett. 121, 191801 (2018)
- Observation of Higgs boson production in association with a top quark pair at the LHC with the ATLAS Detector** Phys. Lett. B 784 (2018) 173
- Search for additional heavy neutral Higgs and gauge bosons in the ditau final state produced in 36.1 fb^{-1} of pp collisions at $\sqrt{s}=13$ TeV with the ATLAS detector** JHEP 01 (2018) 055
- Search for pair production of heavy vector-like quarks decaying to high- p_T W bosons and b quarks in the lepton-plus-jets final state in pp collisions at $\sqrt{s}=13$ TeV with the ATLAS detector** JHEP 10 (2017), 141
- Search for Minimal Supersymmetric Standard Model Higgs bosons H/A and for a Z' boson in the $\tau\tau$ final state produced in pp collisions at $\sqrt{s}=13$ TeV with the ATLAS detector** Eur. Phys. J. C76 (2016) 585
- Handbook of LHC Higgs Cross Sections: 4. Deciphering the Nature of the Higgs Sector** CERN--2017--002-M
- Measurement of the charge asymmetry in highly boosted top-quark pair production in $\sqrt{s}=8$ TeV pp collision data collected by the ATLAS experiment** Physics Letters B 756 (2016), 52-71
- Measurement of the charge asymmetry in top-quark pair production in the lepton-plus-jets final state in pp collision data at $\sqrt{s}=8$ TeV with the ATLAS detector** Eur. Phys. J. C76 (2016), 87
- Search for a CP-odd Higgs boson decaying to Zh in pp collisions at $\sqrt{s}=8$ TeV with the ATLAS detector** Physics Letters B 744 (2015), 163-183
- Search for charged Higgs bosons decaying via $H^\pm \rightarrow \tau^\pm \nu$ in fully hadronic final states using pp collision data at $\sqrt{s}=8$ TeV with the ATLAS detector** JHEP 03 (2015), 088
- Search for charged Higgs bosons through the violation of lepton universality in $t\bar{t}$ events using pp collision data at $\sqrt{s}=7$ TeV with the ATLAS experiment** JHEP 03 (2013), 076



Search for charged Higgs bosons decaying via $H^\pm \rightarrow \tau^\pm \nu$ in top quark pair events using pp collision data at $\sqrt{s}=7$ TeV with the ATLAS detector JHEP 06 (2012), 039

The Fast Tracker Real Time Processor and its Impact on Muon Isolation, Tau and b-jet Online Selections at ATLAS IEEE Trans. Nucl. Sci. 59, 348 (2012)

Selected Public Notes & Proceedings

Extended Scalar Searches at 13 TeV in ATLAS and CMS Moriond 2016 Proceedings

Measurements of Higgs boson properties in the diphoton decay channel using 80 fb^{-1} of pp collision data at $\sqrt{s}=13$ TeV with the ATLAS detector ATLAS-CONF-2018-028

Search for pair production of heavy vector-like quarks decaying to high p_T W bosons and b quarks in the lepton-plus-jets final state in pp collisions at $\sqrt{s}=13$ TeV with the ATLAS detector ATLAS-CONF-2016-102

Search for Minimal Supersymmetric Standard Model Higgs bosons H/A in the $\tau\tau$ final state in up to 13.3 fb^{-1} of pp collision data at $\sqrt{s}=13$ TeV with the ATLAS detector ATLAS-CONF-2016-085

Benchmark Scenarios for low $\tan\beta$ in the MSSM LHCHXSWG-2015-002

Beyond-the-Standard-Model Higgs boson searches at a High-Luminosity LHC with ATLAS ATL-PHYS-PUB-2013-016

Study of Tau Leptons from Top Quark Pairs in ATLAS DPF 2011 Proceedings

Languages

English (Native)

French (Intermediate)

Japanese (Intermediate)

Italian (Beginner)