

JOHN STUPAK III

Curriculum-Vitae

Contact Information

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Education

Ph.D. Experimental Particle Physics, August 2012

Stony Brook University
Stony Brook, NY 11790

Thesis Topic: *Search for First Generation Leptoquarks with the ATLAS Detector*

Co-Advisors: Prof. Michael Rijssenbeek and Prof. Dmitri Tsybychev

B.S. Physics (Summa Cum Laude), May 2007

Fairfield University
Fairfield, CT 06824

Appointments

Post-Doctoral Research Associate (October 2012 – Present)

Purdue University Calumet
Hammond, IN 46323

Research Assistant (June 2009 – September 2012)

State University of New York - Stony Brook
Stony Brook, NY 11790

Awards and Honors

- 2016 LHC Physics Center (LPC) Distinguished Researcher (\$42.5k)
- 2015 LPC Distinguished Researcher (\$42k)
- 2014 Universities Research Association Visiting Scholar co-recipient (\$20k)
- 2011 NSF US LHC Student Support (\$15k)
- 2007 Graduation with Highest Honors
- 2007 College of Arts and Sciences Award for Distinguished Work in the Natural Sciences and Mathematics
- 2007 Inducted into Phi Beta Kappa, national Liberal Arts honor society
- 2006 Inducted into Sigma Pi Sigma, national Physics honor society
- 2006 Inducted into Pi Mu Epsilon, national Mathematics honor society
- 2006 College of Arts and Sciences Award for Outstanding Achievement in Physics

Research Experience

POST-DOCTORAL RESEARCH ASSOCIATE (October 2012 – Present)

Purdue University Calumet

Stationed at the LPC at Fermilab

Supervisor: Prof. Neeti Parashar

CMS Collaboration

Physics Analysis

- **Search for anomalous HVV couplings** (2014 –)

I am currently leading a group of postdocs and graduate students, searching for the presence of beyond the standard model, pseudoscalar couplings of the Higgs boson to weak vector bosons. This is an indirect search for the presence of new physics that couples the Higgs boson to vector bosons through higher-dimensional operators. The search is conducted in the topology of VH associated production, with the Higgs boson decaying to a pair of bottom quarks, where the sensitivity to anomalous couplings is expected to soon surpass that of similar studies in $H \rightarrow VV$ decays. This represents the first study of the tensor structure of the Higgs boson couplings in VH production at the LHC, putting me at the forefront of the emerging field of precision Higgs measurements. We also perform a combination of the VH and $H \rightarrow VV$ channels, demonstrating a significant improvement of the overall sensitivity under certain assumptions. The resulting paper based on run I data is in the final stages of collaboration review, and preparations have begun for a run II analysis, considering a variety of beyond the standard model coupling structures.

- **Searches for tb resonances** (2012 – 2015)

I contributed to a search for a W' boson decaying to a top and bottom quark pair, in the $\ell\nu bb$ final state. Such bosons are a generic feature of beyond the standard model theories with extended gauge sectors. I worked primarily on the optimization of the event selection criteria; studies of systematic uncertainties; and editing the analysis note, physics analysis summary (PAS), and paper. The resulting paper was published in *JHEP*.

Building on this experience, I led an analysis group in a search for a heavy, charged Higgs boson H^\pm , also decaying to a top and bottom quark pair. Charged Higgs bosons would be produced at the LHC predominantly in association with a top quark, with many complex final states resulting from the top quark decays. I developed an algorithm to reconstruct a charged Higgs candidate from the $5j + \ell + E_T^{miss}$ final state, and improved the event classification scheme and method for extraction of data-driven background normalizations. I also wrote the associated analysis note. This analysis was combined with searches for $H^\pm \rightarrow \tau\nu$ and $H^\pm \rightarrow tb$ in multilepton final states, and published in *JHEP*.

- **Future collider studies** (2013)

As part of the *Snowmass 2013 Community Summer Study* and *ECFA High Luminosity LHC Experiments Workshop 2014* efforts, I led studies of the sensitivity of future hadron colliders to extended Higgs sectors. For the *Snowmass* workshop, I analyzed the discovery potential of the HL-LHC and potential 33 and 100 TeV colliders for a heavy, neutral pseudoscalar (scalar) Higgs boson decaying to ZH (4ℓ) within the context of a two Higgs doublet model (2HDM). Such models typically include modifications to the couplings of

the light scalar Higgs from those predicted by the standard model, which could be probed indirectly through precision Higgs coupling measurements. I found significant complementarity between these direct and indirect approaches, and the resulting work was featured in the Higgs and New Particles working group reports. I also oversaw a graduate student as he updated these studies for the HL-LHC under various CMS phase II detector upgrade scenarios, and wrote the resulting PAS. This work was shown at the *ECFA* workshop.

I also contributed to studies of the sensitivity for top quark partners in decays to tZ , tH , and Wb . I oversaw graduate students as they adapted the code I developed for 2HDM studies and used it to determine the discovery potential for heavy vector-like top quark partners at future hadron colliders for the *Snowmass* workshop. This work was featured in the Top Quark and New Particles working group reports. I then oversaw these graduate students as they repeated similar studies, which were shown at the *ECFA* workshop.

Technical Work

- **Phase I Forward Pixel (FPIX) detector upgrade (2013 –)**

As a result of a dynamic inefficiency of the current pixel detector readout chips which becomes significant for instantaneous luminosities above $10^{34} \text{ cm}^{-2}\text{s}^{-1}$, the current pixel detector will be replaced with the “phase I” detector in the winter of 2016/2017. I am heavily involved in the effort to construct six forward pixel disks, which constitute the FPIX upgrade. I conducted extensive testing of prototype hardware, from individual components to fully-assembled pre-production modules, and trained undergraduate and graduate students to assist in this effort. I assisted in the installation of some of these modules in CMS during long shutdown I, which are currently taking data and providing valuable feedback on the new detector hardware and readout system. I contributed to the development of module qualification criteria and a database to store module data and grades. I am currently overseeing the testing and qualification of ~ 1000 production modules by shifters.

- **Jet/ E_T^{miss} Object Expert (2013 –)**

The Beyond Two Generations (B2G) group is one of nine physics analysis groups within CMS, focusing on searches for new physics that involve third-generation particles. Many of the signatures considered involve highly Lorentz-boosted hadronic decays, which necessitate the use of novel jet substructure techniques. I serve as the Jet/ E_T^{miss} Object Expert for the B2G group. In this position, I serve as the liaison between the B2G and Jet/ E_T^{miss} groups. I am tasked with keeping the B2G group up to date on the latest developments regarding jets and E_T^{miss} . Before any B2G analysis proceeds to pre-approval, I am required to review and approve the usage of jets and E_T^{miss} .

- **LPC Computing, Software, and Analysis Challenge (CSA14) Coordinator (2014)**

During long shutdown I of the LHC, CMS took the opportunity to develop and deploy an array of software improvements, including a new data tier (miniAOD), grid management tool (CRAB3), and data access strategy (AAA). To ensure scalability of these developments and readiness for 13 TeV data, the CSA14 exercise was held. I served as the LPC CSA14 Coordinator, organizing a coherent effort within the LPC. Members of the LPC community produced many large background Monte Carlo (MC) samples in miniAOD format on the grid with CRAB3. In doing so, this also stress tested the AAA data access model. We then analyzed and validated these samples, and provided feedback to the miniAOD and

CRAB3 developers. This effort revealed many bugs and weaknesses in the new software, which were remedied in time for the collection of 13 TeV data.

- **Jet software development** (2013 – 2014)

Throughout run I, many tools related to jets were developed; but these tools resided in private software repositories, involved complicated recipes, used different inputs, and produced output in various forms. I undertook the reorganization of these tools into a coherent “jet toolbox.” I standardized the input and output of all tools, consolidated the code, and merged it into the official CMSSW repository. After the development of miniAOD, I oversaw a graduate student as he generalized the code to run on this new data format, and incorporated the toolbox into the official miniAOD production recipe.

- **Monte Carlo production** (2013)

For the *Snowmass 2013 Community Summer Study*, an array of MC samples were needed for various physics studies of future hadron colliders with $\sqrt{s} = 14, 33, \text{ and } 100$ TeV. I was one of the main contributors to the production of these samples, for common usage by member of ATLAS, CMS, and the theory community. I contributed to the tuning of Delphes parameterized detector simulation to reproduce full simulation. I incorporated jet substructure techniques into Delphes for the first time. I developed scripts that were used on the Open Science Grid to generate billions of simulated events. The resulting MC samples are still in use today for studies performed as part of the Future Circular Collider study at CERN and the efforts at the Center for Future High Energy Physics in Beijing.

As a result of this work, when similar MC samples were needed for the *ECFA High Luminosity LHC Experiments Workshop 2014*, I was asked to serve as Open Science Grid (OSG) Production Contact within CMS. I trained a graduate student to use the tools I had developed for *Snowmass*, and oversaw him as he produced the samples needed for *ECFA*.

RESEARCH ASSISTANT (June 2009 – September 2012)

Stony Brook University

Co-Advisors: Prof. Michael Rijssenbeek and Prof. Dmitri Tsybychev

ATLAS Collaboration

Physics Analysis

- **Searches for scalar leptoquarks** (2010 – 2012)

I contributed to several searches for pair-production of scalar leptoquarks. I began by generating first- and second-generation leptoquark signal MC samples in the $lvjj$ and ℓljj final states, and performing an independent crosscheck of the cut flow in the $eejj$ channel for an analysis with 35 pb^{-1} of $\sqrt{s} = 7$ TeV data. This analysis resulted in a publication in *PRD*.

I then performed an update of the first-generation leptoquark search in the $evjj$ channel with 1 fb^{-1} of $\sqrt{s} = 7$ TeV data. In an improvement over the previous analysis, I implemented a multivariate log-likelihood ratio discriminant with enhanced background-rejection power. I developed a generic tool for the calculation of this discriminant, which was utilized by analysts in the $eejj$, $\mu\nu jj$, and $\mu\mu jj$ channels as well. These first- and

second- generation leptoquark searches were published in *PLB* and *EPJC*, respectively.

- ***W*+jets cross section measurement (2010)**

I contributed to a measurement of the *W*+jets cross section at $\sqrt{s} = 7$ TeV. I studied the systematic uncertainty associated with the signal MC modeling and lepton isolation. This measurement was published in *PLB*.

Technical Work

- **Insertable B-Layer (IBL) software development (2009 – 2011)**

In order to cope with increased pileup interactions and the associated pattern recognition challenges, ATLAS installed an additional pixel barrel layer during LHC long shutdown I. I was responsible for the modification of the ATLAS simulation and reconstruction software to include this fourth barrel layer. I then generated various MC samples with the new geometry, and assessed the tracking and b-tagging performance of the planned upgrade. This work was essential in order to prepare the IBL Technical Design Report.

- **Pixel leakage current analysis (2010-2012)**

Leakage current in silicon sensors increases due to radiation damage. I performed analysis of the leakage current in the ATLAS pixel detector recorded during periodic scans, as a means of monitoring for signs of radiation damage. I observed a modest increase in the amount of leakage current, which was most pronounced in the inner barrel layer. The increase was found to be consistent with expectations based on radiation damage simulations.

- **3D pixel sensor research and development (2009-2010)**

As a radiation-hard alternative to planar silicon sensors, pixel detectors can utilize so-called “3D” sensors. I participated in test beam campaigns to assess the performance and radiation-hardness of such sensors. These devices were shown to maintain adequate performance after exposure to large radiation doses, and were chosen for use in the forward region of the IBL. These test beam campaigns resulted in publications in *NIM*.

Teaching Experience

- **Classroom Instructor**, Science and Technology Entry Program (STEP), Stony Brook University (2008)

I taught two sections of a Research Methods class in a STEP summer program. This program seeks to prepare historically underrepresented and economically disadvantaged high school students for entry into scientific and technical fields.

- **Laboratory Instructor**, Stony Brook University (2007-2009)

For four semesters, I led two sections of an introductory Classical Physics lab for physical-science and engineering majors. This lab was designed to familiarize students with basic concepts in classical mechanics and electricity & magnetism.

- **Tutor**, Fairfield, CT (2005-2007)

I tutored fellow undergraduate students taking introductory physics classes, assisting with homework, lab assignments, and test preparation. I also tutored area high school students in various math and physics courses.

Selected Publications

- 387 international peer-reviewed publications (2010 –)
See SPIRES listing for John Stupak: <https://inspirehep.net/author/profile/J.Stupak.1>

Primary Authorship or Significant Contribution

- “Search for a charged Higgs boson in pp collisions at $\sqrt{s} = 8$ TeV,” CMS Collaboration, accepted by JHEP, [arXiv:1508.07774](https://arxiv.org/abs/1508.07774) [hep-ex].
- “Search for W' to tb decays in the lepton + jets final state in pp collisions at $\sqrt{s} = 8$ TeV,” CMS Collaboration, JHEP 05 (2014) 108, [arXiv:1402.2176](https://arxiv.org/abs/1402.2176) [hep-ex].
- “Search for Second Generation Scalar Leptoquarks in pp Collisions at $\sqrt{s}=7$ TeV with the ATLAS Detector,” ATLAS Collaboration, EPJ C72 (2012), [arXiv:1203.3172v1](https://arxiv.org/abs/1203.3172v1) [hep-ex].
- “Search for First Generation Scalar Leptoquarks in pp Collisions at $\sqrt{s}=7$ TeV with the ATLAS Detector,” ATLAS Collaboration, Phys. Lett. B709 (2012), [arXiv:1112.4828v5](https://arxiv.org/abs/1112.4828v5) [hep-ex].
- “Test Beam Results of 3D Silicon Pixel Sensors for the ATLAS Upgrade,” Grenier, P. *et al.*, Nucl. Instrum. Meth. A638 (2011), [arXiv:1101.4203v1](https://arxiv.org/abs/1101.4203v1) [physics.ins-det].
- “Search for Pair Production of First and Second Generation Leptoquarks in Proton-Proton Collisions at $\sqrt{s}=7$ TeV with the ATLAS Detector at the LHC,” ATLAS Collaboration, Phys. Rev. D83, 112006 (2011), [arXiv:1104.4481v2](https://arxiv.org/abs/1104.4481v2) [hep-ex].
- “3D Silicon Pixel Sensors: Recent Test Beam Results,” Hansson, P. *et al.*, Nucl. Instrum. Meth. A628 (2011), [DOI:10.1016/j.nima.2010.06.321](https://doi.org/10.1016/j.nima.2010.06.321).
- “Measurement of the production cross section for W-bosons in association with jets in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector,” ATLAS Collaboration, Phys. Lett. B698 (2011), [arXiv:1012.5382v2](https://arxiv.org/abs/1012.5382v2) [hep-ex].

Additional Public Notes

- “Sensitivity study of the prospects for searching for heavy vector-like charge 2/3 quarks at $\sqrt{s}=14$ TeV with the upgraded CMS detector,” CMS PAS: [FTR-13-026](https://arxiv.org/abs/1307.6545)
- “Performance studies on the search for 2HDM neutral Higgs bosons with CMS Phase-II detector upgrades,” CMS PAS: [FTR-13-024](https://arxiv.org/abs/1307.6545)

Conference Proceedings

- “ATLAS+CMS: Boosted topologies (run 1 results, run 2 potential),” John Stupak III, Proceedings of the 50th Rencontres de Moriond.
- “Search for Heavy Resonances in Leptonic Final States with CMS,” John Stupak III, EPJ Web of Conferences 60 (2013), [DOI:10.1051/epjconf/20136017013](https://doi.org/10.1051/epjconf/20136017013)
- “Snowmass 2013 Top quark working group report,” Top Quark Working Group, [arXiv:1311.2028](https://arxiv.org/abs/1311.2028)

- “New Particles Working Group Report of the Snowmass 2013 Community Summer Study,” New Particles Working Group, [arXiv:1311.2028](https://arxiv.org/abs/1311.2028)
- “Higgs Working Group Report of the Snowmass 2013 Community Planning Study ,” Higgs Working Group, [arXiv:1310.8361](https://arxiv.org/abs/1310.8361)
- “Snowmass Energy Frontier Simulations,” Anderson *et al.*, Snowmass 2013 Electronic Proceedings: SNOW13-00138, [arXiv:1309.1057](https://arxiv.org/abs/1309.1057)
- “Methods and Results for Standard Model Event Generation at $\sqrt{s} = 14$ TeV, 33 TeV and 100 TeV Proton Colliders,” Avetisyan *et al.*, Snowmass 2013 Electronic Proceedings: SNOW13-00167, [arXiv:1308.1636](https://arxiv.org/abs/1308.1636)
- “Snowmass Energy Frontier Simulations using the Open Science Grid,” Avetisyan *et al.*, Snowmass 2013 Electronic Proceedings: SNOW13-00168, [arXiv:1308.0843](https://arxiv.org/abs/1308.0843)
- “Prospects for a Heavy Vector-Like Charge 2/3 Quark T search at the LHC with $\sqrt{s} = 14$ TeV and 33 TeV,” Bhattacharya *et al.*, Snowmass 2013 Electronic Proceedings: SNOW13-00166, [arXiv:1309.0026](https://arxiv.org/abs/1309.0026)
- “Heavy Higgs Scalars at Future Hadron Colliders,” Brownson *et al.*, Snowmass 2013 Electronic Proceedings: SNOW13-00183, [arXiv:1308.6334](https://arxiv.org/abs/1308.6334)
- “Search for 1st-Generation Leptoquarks Using the ATLAS Detector,” John Stupak III, EPJ Web of Conferences 28 (2012), [DOI:10.1051/epjconf/20122812012](https://doi.org/10.1051/epjconf/20122812012)

Invited Talks at International Conferences

June 2015	“Qualification of pixel modules for the CMS FPIX detector upgrade” Vertex 2015, Santa Fe, NM
March 2015	“ATLAS+CMS: Boosted topologies (run 1 results, run 2 potential)” Rencontres de Moriond EW 2015, La Thuile, Italy
Sept. 2014	“ATLAS + CMS: Top quark cross sections” Physics in Collision 2014, Bloomington, IN
Aug. 2013	“2HDM @ Hadron Colliders” Snowmass 2013 Community Summer Study, Minneapolis, MN
May 2013	“Search for Heavy Resonances in Leptonic Final States in CMS” Large Hadron Collider Physics Conference, Barcelona, Spain
Nov. 2011	“Search for 1st-Generation Leptoquarks Using the ATLAS Detector” Hadron Collider Physics Symposium, Paris, France
Oct. 2011	“Recent Results from BSM Searches at ATLAS (Including SUSY)” Brookhaven Forum 2011: A First Glimpse of the Tera Scale, Upton, NY

Presentations and Seminars

Oct. 2015	“FPIX phase I upgrade” LPC Coffee Hour
Feb. 2015	“Status of FPIX for Phase 1” LPC Physics Forum
June 2014	“CSA14 Preparation” LPC Physics Forum
May 2014	“Search for Anomalous Couplings in $VH(\rightarrow bb)$ ” DOE LPC site visit
Jan. 2014	“Prospects for 2HDM studies using 100 TeV” LPC meeting on a future 100 TeV proton collider
Jan. 2014	“Two Higgs Doublet Model studies at the LHC and beyond” LPC Physics Forum
Sept. 2013	“Top Partner Projections” LPC Workshop on Exotic Top Partners, Fermilab, Batavia, IL
May 2013	“Snowmass @ LPC” DOE LPC site visit
April 2013	“Delphes Fast MC for Snowmass” Snowmass Energy Frontier Workshop, Brookhaven, Upton, NY
March 2013	“Preliminary Simulation Studies for Snowmass” LPC Physics Forum, Fermilab, Batavia, IL
March 2013	“Search for Narrow $t+b$ Resonances in the Leptonic Final State” USCMS Meeting

Leadership Positions Held

2013 – Present	Beyond Two Generations (B2G) Jet/E_T^{miss} Object Expert
2014	LPC Computing, Software, and Analysis Challenge (CSA14) Coordinator
2013	Open Science Grid (OSG) Production Contact

HEP Service and Organization

Jan. 2014 – Present	Member of LPC Topic of the Week Speakers Committee. Responsible for the recruitment of speakers and organization of seminars.
Nov. 2015 – Present	Member of Analysis Review Committee for B2G-15-007.
June 2015	Co-Convener - Hands-on Advanced Tutorial Session (HATS @ LPC), Fermilab. Organized, developed, and led tutorial on the usage of jets in CMS.
March 2015	Representative of FNAL User’s Organization on annual lobbying trip to Washington, DC. Met with members of Congress and their staff to encourage support of funding for high-energy physics.

Jan. 2015	Facilitator - CMS Data Analysis School (DAS), Fermilab. Led exercises on jet algorithms and a search for $H \rightarrow bb$.
Nov. 2014	Chair - BSM Higgs @ LPC workshop, Fermilab. Organized workshop attended by ~ 100 participants on the use of the Higgs boson as a probe of new physics.
Feb. 2014	Co-Convener - Hands-on Advanced Tutorial Session (HATS @ LPC), Fermilab. Organized, developed, and led tutorial on the usage of Delphes parameterized detector simulation in CMS.
Jan. 2014	Facilitator - CMS Data Analysis School (DAS), Fermilab. Led exercises on jet algorithms and a search for a dijet resonance in W+jets events.
Nov. 2013	Facilitator - CMS Data Analysis School (DAS), Saha Institute of Nuclear Physics, Kolkata, India. Led exercises on jet algorithms and a search for a dijet resonance in W+jets events.

Education Activities

Oct. 2015 – Present	External Research Advisor to Purdue University Calumet undergraduate Mohammad Alhousseini. Supervised Mohammad in the testing of CMS phase I pre-production modules and related software development. This work constituted his senior research project.
Aug. 2014 – Present	External Research Advisor to Purdue University Calumet undergraduate Xuan Chen. Supervised Xuan in the testing of CMS phase I pre-production sensors and ASICs, including a detailed characterization of sensor I-V properties. This work constituted her senior research project.

Outreach Presentations

July 2015	“The Standard Model and Particle Detection with CMS” QuarkNet Teacher Workshop, Purdue University Calumet
July 2015	“Cosmic Rays” QuarkNet Teacher Workshop, Purdue University Calumet
March 2015	“CMS Particle Identification” QuarkNet Master Class, Purdue University Calumet
Aug. 2014	“Pixel detectors” - USCMS “Got a Minute?” video: https://youtu.be/JOmdNySmRmE
July 2014	“Which Higgs did we find?” - USCMS “Got a Minute?” video: https://youtu.be/EfCaZGi1feQ

Outreach Organization

- June 2014 – Present Purdue University Calumet QuarkNet Center Co-Coordinator. Responsible for organizing and preparing Master Class, teacher workshops, and other activities.
- March 2015 Purdue University Calumet QuarkNet Master Class Coordinator. Prepared activities for teachers to conduct with students in advance of the Master Class, as well as organizing all presentations and activities constituting the Master Class. Students were given a series of presentations on high-energy physics, the LHC, and CMS; then analyzed CMS collision data and presented their results to a panel of expert moderators, as well as fellow students from other schools.
- March 2015 QuarkNet Master Class Moderator. Videoconferenced with students from Palaiseau, Notre Dame, and Rossville high schools as they presented the results of their analysis of CMS collision data.
- June 2014 – Aug. 2014 QuarkNet Mentor to high school teachers Adam Erler and Larry Hautzinger. Supervised training at Fermilab to contribute to the testing of CMS phase I pixel detector pre-production modules and components.

References

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