

Final Scientific/Technical Report	
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Name of Recipient:	Oklahoma State University
Project Title:	Theoretical & Experimental Research in Weak, Electromagnetic & Strong Interactions
Principal Investigator:	Satyanarayan Nandi
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## Overview of results and activities from previous four years

The Oklahoma State University (OSU) High Energy Physics (HEP) program has been supported by the Department of Energy for over thirty years. In this report we summarize the research accomplishments of the HEP group for the past four year (years 2013-2017). This DOE grant has supported five permanent faculty members (S. Nandi and K. S. Babu in HEP theory, and F. Rizatdinova, A. Khanov and J. Haley in HEP experiment), one theory postdoctoral fellow (Dr. K. Ghosh), and two experimental postdoctoral fellows (Dr. J. Yu, Dr. D. Jamin). Over this period of time, five theory students and two experimental students graduated with Ph.D; and one experimental student graduated with MS.

The OSU HEP group is a member of the Quarknet program, and is contributing to educational activities involving high school teachers and students. Our group has two main research tasks, Theory (Task A) and Energy Frontier Experiment (Task B) involved in analysis and hardware for the ATLAS Collaboration at the CERN LHC and physics analysis at the D0 collaboration at Fermilab.

### Task A: Theory

**Nandi:** During the four years of the grant, Nandi worked on the following topics: physics beyond the Standard Model, especially the new physics being explored at the LHC. In the energy frontier, these include the Higgs boson physics, supersymmetry and beyond, extra dimensions, Higgs physics, models of mirror quarks and leptons, models of unification of particles and forces, and new models for the dark matter. In the intensity frontier, his work includes models of neutrino masses and mixings to be explored in the upcoming LBNF and other ongoing and planned neutrino experiments. His emphasis has been to propose well-motivated new physics ideas that can be tested at the high-energy colliders such as the LHC. Nandi graduated two students with PhD degrees over this period of time. Both former graduate students stayed in the high-energy theoretical physics field. Nandi has published 23 papers and made 7 presentations at conferences (not including those that have been done by his graduate students and postdoc). The results of Nandi's research in the form of publications and presentations at various conferences are listed below.

**Babu:** Over the four years of the grant, Babu investigated a variety of well-motivated models that address some of the shortcomings of the Standard Model. His research topics can be broadly classified into four categories: (A) TeV scale new physics models for LHC Run 2, (B) Neutrino mass models, phenomenology and leptogenesis, (C) Grand unification, nucleon decay and the generation of baryon asymmetry of the universe, and (D) Supersymmetry and its dynamical breaking. Several separate projects were done under each category, with a focus on experimental tests of the new ideas at the LHC and in forthcoming neutrino facilities. Babu graduated three graduate students over this period of time. Two of his former students stayed in the high-energy theoretical physics field and one left the field. Babu has published 31 papers and made 24 presentations on conferences, workshops and seminars. Results of Babu's research in form of publications and presentations on various conferences are listed below.

### Task B: Experiment

During the previous four years, the OSU experimental group carried out several physics analyses, contributed to the development of ATLAS software and reconstruction algorithms, and performed work on hardware for the ATLAS detector upgrade. All group members are deeply integrated in the ATLAS physics and object identification groups, and work closely with their US ATLAS colleagues. As for the physics studies, the group concentrated on precision measurements in top quark physics and searches for new physics beyond the Standard Model. For software and reconstruction, our main

contribution was in the area of flavor identification and pixel detector software development and online monitoring. The group’s hardware effort resulted in: (i) delivery, installation and integration of optoboxes in the Insertable B-layer (IBL); (ii) construction, installation and integration of New Service Quarter Panels (NSQP); and (iii) completion of R&D on serial powering for the Inner Tracker (ITk). These activities are based on the group’s long-term expertise in top physics, jet flavor identification, and tracking. The details of each activity are described in the rest of the section; below is a short summary of each co-PI’s activities during the reported period.

**Rizatdinova** has been the OSU experimental group leader since she founded the group in 2005. During the reported period, she performed a search for a heavy charged Higgs boson decaying into top-bottom quark pairs at 8 TeV (published) and contributed to the  $t\bar{t}$  cross-section measurement in  $\ell$ +jets at 8 TeV (published). In 2016, she started a new analysis (search for gluino pair production in multilepton final states in 13 TeV data). Under Rizatdinova’s supervision, postdoc J. Cantero (who joined the group in 2016) was working on analyses involving direct photon production. Rizatdinova was heavily involved in the ATLAS tracker upgrade hardware development together with OSU engineer Welch. The group delivered optoboxes for the IBL and Welch played a key role in the NSQP project. Rizatdinova and Welch performed R&D on serial powering for the pixel detector upgrade. As a result, the OSU group got the responsibility for serial powering (a US ATLAS core deliverable to the experiment). During the last four years, Rizatdinova made three conference presentations on behalf of ATLAS. She graduated one PhD student (Hegab, 2014). Papers and conference note to which Rizatdinova contributed during this grant are listed below.

**Khanov** performed the  $t\bar{t}$  cross-section measurement in  $\ell$ +jets at 8 TeV (published) and  $t\bar{t}$ +heavy flavor at 8 TeV (published). In 2016, he started a new analysis searching for  $W' \rightarrow t\bar{b}$  in 13 TeV data. In the ATLAS flavor tagging group, Khanov led the effort on the mistag rate calibration (the paper on ATLAS  $b$ -tagging performance has been recently published). He has also been an upgrade co-ordinator of the ATLAS flavor tagging group and ATLAS upgrade physics contact on flavor tagging since 2013. Khanov contributed to ATLAS Phase-II Scoping document. During the last four years, Khanov made three conference presentations and one poster on behalf of ATLAS. He graduated one PhD student (Sidorov, 2015) and one MS student (Klimov, 2014). Papers and conference note to which Khanov contributed during this grant are listed below.

**Haley** became a co-PI in the last year of the grant, April 2016 to March 2017. His group had multiple undergraduate students, one graduate student, and one postdoc, Dr. David Jamin. His research was mainly focused on searching for vector-like quarks (VLQs), new particles predicted by many extensions to the Standard Model, such as the Left-Right Mirror Model developed by Prof. Nandi’s group here at OSU. In the spring of 2016 Haley became co-convenor of the “Heavy Quarks, Tops, and Composite Higgs” (HQT) Exotics subgroup. In this position, he help coordinate and oversee ATLAS searches for exotic heavy quarks, composite Higgs, and final states with top quarks. In 2016, the HQT subgroup completed eight conference notes based on LHC Run 2 data, one based on Run 1 data, and one performance study for the future High Luminosity LHC. Haley’s group directly worked on two searches for pair-production of VLQs. The first was in final states with at a leptonically decaying  $W$  boson and a bottom quark, which produced preliminary results using 14.7/fb for the TOP2016 conference and then a publicaion using the full 2015+2016 data set. In the fall of 2016, he started working on a search for VLQs that decay to fully hadronic final states. Haley was also on the ATLAS editorial board of the analysis searching for events containing a single VLQ that decays to a  $W$  boson and a bottom quark.

Haley aslo contributed to the studies aimed at identifying highly boosted objects that decay to jets. He supervised an undergraduate student who investigated the use of multivariate classifiers to

improve the efficiency for identifying boosted  $W$  bosons. He then shifted focus to identifying jets from top quark using a new theory-inspired method called shower deconstruction. He worked with Prof. Rizatdinova's postdoc, J Cantero, and an undergraduate student to study how to improve the signal efficiency for the shower deconstruction method. Papers and conference note to which Haley contributed during this grant are listed below.

### List of publications: Nandi

1. S. Jana and S. Nandi, "New Physics Scale from Higgs Observables with Effective Dimension-6 Operators," arXiv:1710.00619 [hep-ph].
2. K. Das, T. Li, S. Nandi and S. K. Rai, "New signals for vector-like down-type quark in  $U(1)$  of  $E_6$ ," arXiv:1708.00328 [hep-ph].
3. K. Ghosh, S. Jana and S. Nandi, "Neutrino Mass Generation at TeV Scale and New Physics Signatures from Charged Higgs at the LHC for Photon Initiated Processes," arXiv:1705.01121 [hep-ph].
4. S. Bhattacharya, S. Jana and S. Nandi, "Neutrino Masses and Scalar Singlet Dark Matter," Phys. Rev. D **95**, no. 5, 055003 (2017)  
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5. S. Chakdar, K. Ghosh, V. Hoang, P. Q. Hung and S. Nandi, "The search for electroweak-scale right-handed neutrinos and mirror charged leptons through like-sign dilepton signals," Phys. Rev. D **95**, no. 1, 015014 (2017)  
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6. K. Ghosh, S. Jana and S. Nandi, "Neutrino Mass Generation and 750 GeV Diphoton excess via photon-photon fusion at the Large Hadron Collider," arXiv:1607.01910 [hep-ph].
7. K. Das, T. Li, S. Nandi and S. K. Rai, "A new proposal for diphoton resonance from  $E_6$  motivated extra  $U(1)$ ," arXiv:1607.00810 [hep-ph].
8. S. Chakdar, K. Ghosh, V. Hoang, P. Q. Hung and S. Nandi, "Search for mirror quarks at the LHC," Phys. Rev. D **93**, no. 3, 035007 (2016)  
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9. K. Das, T. Li, S. Nandi and S. K. Rai, "Diboson excesses in an anomaly free leptophobic left-right model," Phys. Rev. D **93**, no. 1, 016006 (2016)  
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10. S. Chakdar, K. Ghosh and S. Nandi, "Superworld without Supersymmetry," Phys. Lett. B **754**, 162 (2016)  
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11. S. Chakdar, K. Ghosh and S. Nandi, "Dark Matter, Parallel Universe and Multiple Higgs Signals at the ILC," arXiv:1410.7331 [hep-ph].
12. D. Karabacak, S. Nandi and S. K. Rai, "New signal for singlet Higgs and vector-like quarks at the LHC," Phys. Lett. B **737**, 341 (2014)  
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13. S. Chakdar, K. Ghosh and S. Nandi, “A predictive model of Dirac Neutrinos,” *Phys. Lett. B* **734**, 64 (2014)  
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14. K. Ghosh, D. Karabacak and S. Nandi, “Constraining Bosonic Supersymmetry from Higgs results and 8 TeV ATLAS multi-jets plus missing energy data,” *JHEP* **1409**, 076 (2014)  
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15. U. Maitra, B. Mukhopadhyaya, S. Nandi, S. K. Rai and A. Shivaji, “Searching for an elusive charged Higgs boson at the Large Hadron Collider,” *Phys. Rev. D* **89**, no. 5, 055024 (2014)  
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18. S. Chakdar, K. Ghosh and S. Nandi, “A model for Dirac neutrino mass matrix with only four parameters,” arXiv:1405.2328 [hep-ph].
19. D. Karabacak, S. Nandi and S. K. Rai, “New signal for singlet Higgs and vector-like quarks at the LHC,” *Phys. Lett. B* **737**, 341 (2014)  
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21. S. Chakdar, K. Ghosh, S. Nandi and S. K. Rai, “Collider signatures of mirror fermions in the framework of a left-right mirror model,” *Phys. Rev. D* **88**, no. 9, 095005 (2013)  
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23. D. A. Dicus, D. Karabacak, S. Nandi and S. K. Rai, “Search for spin-3/2 quarks at the Large Hadron Collider,” *Phys. Rev. D* **87**, no. 1, 015023 (2013)  
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### List of publications: Babu

1. K. S. Babu, A. Friedland, P. A. N. Machado and I. Mocioiu, “Flavor Gauge Models Below the Fermi Scale,” arXiv:1705.01822 [hep-ph].
2. K. S. Babu and S. Jana, “Probing Doubly Charged Higgs Bosons at the LHC through Photon Initiated Processes,” *Phys. Rev. D* **95**, no. 5, 055020 (2017)  
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3. K. S. Babu, A. Khanov and S. Saad, “Anarchy with Hierarchy: A Probabilistic Appraisal,” *Phys. Rev. D* **95**, no. 5, 055014 (2017)  
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4. K. S. Babu, I. Gogoladze and S. Khan, “Radiative Electroweak Symmetry Breaking in Standard Model Extensions,” *Phys. Rev. D* **95**, no. 9, 095013 (2017)  
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5. K. S. Babu, B. Bajc and S. Saad, “Yukawa Sector of Minimal  $SO(10)$  Unification,” *JHEP* **1702**, 136 (2017)  
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7. K. S. Babu, D. W. McKay, I. Mocioiu and S. Pakvasa, “Light sterile neutrinos, lepton number violating interactions and short baseline neutrino experiments,” *AIP Conf. Proc.* **1743**, 030007 (2016).
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9. D. G. Phillips, II *et al.*, “Neutron-Antineutron Oscillations: Theoretical Status and Experimental Prospects,” *Phys. Rept.* **612**, 1 (2016)  
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11. K. S. Babu and S. Khan, “Minimal nonsupersymmetric  $SO(10)$  model: Gauge coupling unification, proton decay, and fermion masses,” *Phys. Rev. D* **92**, no. 7, 075018 (2015)  
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14. K. S. Babu, B. Bajc and V. Susi, “A minimal supersymmetric  $E_6$  unified theory,” *JHEP* **1505**, 108 (2015)  
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15. K. S. Babu, S. Chakdar and R. N. Mohapatra, “Warm Dark Matter in Two Higgs Doublet Models,” *Phys. Rev. D* **91**, no. 7, 075020 (2015)  
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16. K. S. Babu and R. N. Mohapatra, “Determining Majorana Nature of Neutrino from Nucleon Decays and  $n - \bar{n}$  oscillations,” *Phys. Rev. D* **91**, no. 1, 013008 (2015)  
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17. K. S. Babu and J. Julio, “Renormalization of a two-loop neutrino mass model,” *AIP Conf. Proc.* **1604**, 134 (2014)  
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18. C. Adams *et al.*, “The Intermediate Neutrino Program,” arXiv:1503.06637 [hep-ex].
19. J. L. Hewett *et al.*, “Planning the Future of U.S. Particle Physics (Snowmass 2013): Chapter 2: Intensity Frontier,” arXiv:1401.6077 [hep-ex].
20. K. S. Babu and R. N. Mohapatra, “7 keV Scalar Dark Matter and the Anomalous Galactic X-ray Spectrum,” *Phys. Rev. D* **89**, 115011 (2014)  
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21. K. S. Babu, I. Gogoladze, S. Raza and Q. Shafi, “Flavor Symmetry Based MSSM (sMSSM): Theoretical Models and Phenomenological Analysis,” *Phys. Rev. D* **90**, no. 5, 056001 (2014)  
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22. K. S. Babu, I. Gogoladze, Q. Shafi and C. S. n, “Muon g-2, 125 GeV Higgs boson, and neutralino dark matter in a flavor symmetry-based MSSM,” *Phys. Rev. D* **90**, no. 11, 116002 (2014)  
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24. K. Babu *et al.*, “Neutron-Antineutron Oscillations: A Snowmass 2013 White Paper,” arXiv:1310.8593 [hep-ex].
25. M. Dine, K. Babu, C. Csaki, S. Dawson, L. Dixon, S. Gottlieb, J. Harvey and D. Whiteson, “Planning the Future of U.S. Particle Physics (Snowmass 2013): Chapter 5: Theory,” arXiv:1310.6111 [hep-ph].
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27. E. C. F. S. Fortes, K. S. Babu and R. N. Mohapatra, “Flavor Physics Constraints on TeV Scale Color Sextet Scalars,” arXiv:1311.4101 [hep-ph].
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29. A. Albaid and K. S. Babu, “Higgs boson of mass 125 GeV in GMSB models with messenger-matter mixing,” *Phys. Rev. D* **88**, 055007 (2013)  
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#### List of publications: Rizatdinova

1. G. Aad *et al.* [ATLAS Collaboration], “Search for charged Higgs bosons in the  $H^\pm \rightarrow tb$  decay channel in  $pp$  collisions at  $\sqrt{s} = 8$  TeV using the ATLAS detector,” *JHEP* **1603**, 127 (2016).
2. G. Aad *et al.* [ATLAS Collaboration], “Measurements of fiducial cross-sections for  $t\bar{t}$  production with one or two additional b-jets in  $pp$  collisions at  $\sqrt{s} = 8$  TeV using the ATLAS detector,” *Eur. Phys. J. C* **76**, no. 1, 11 (2016).
3. G. Aad *et al.* [ATLAS Collaboration], “Measurement of the top pair production cross section in 8 TeV proton-proton collisions using kinematic information in the lepton+jets final state with ATLAS,” *Phys. Rev. D* **91**, no. 11, 112013 (2015).
4. M. Guzzi, A. Geiser and F. Rizatdinova, “DIS2015 Heavy Flavours Working Group Summary,” arXiv:1509.04582 [hep-ph].
5. K. Agashe *et al.* [Top Quark Working Group Collaboration], “Snowmass 2013 Top quark working group report,” arXiv:1311.2028 [hep-ph].

#### List of publications: Khanov

1. The ATLAS Collaboration, “Technical Design Report for the ATLAS Inner Tracker Strip Detector,” CERN-LHCC-2017-005; ATLAS-TDR-025.
2. G. Aad *et al.* [ATLAS Collaboration], “Performance of  $b$ -Jet Identification in the ATLAS Experiment,” *JINST* **11**, no. 04, P04008 (2016).
3. The ATLAS Collaboration, “ATLAS Phase-II Upgrade Scoping Document,” CERN-LHCC-2015-020; LHCC-G-166.
4. V. M. Abazov *et al.* [D0 Collaboration], “Improved  $b$  quark jet identification at the D0 experiment,” *Nucl. Instrum. Meth. A* **763**, 290 (2014).
5. J. Adelman, B. Alvarez Gonzalez, Y. Bai, M. Baumgart, R. K. Ellis, A. Khanov, A. Loginov and M. Vos, “Top Couplings: pre-Snowmass Energy Frontier 2013 Overview,” arXiv:1309.1947 [hep-ex].

#### List of publications: Haley

1. “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 Collaboration, ATLAS-CONF-2016-102 (2016).  
[http://cds.cern.ch/record/2219436]
2. “Search for single production of vector-like quarks decaying into  $Wb$  in  $pp$  collisions at  $\sqrt{s} = 13$  TeV with the ATLAS detector,” ATLAS Collaboration, ATLAS-CONF-2016-072 (2016).  
[http://cds.cern.ch/record/2206226]

3. “Search for single production of vector-like quarks decaying into  $Wb$  in  $pp$  collisions at  $\sqrt{s} = 8$  TeV with the ATLAS detector,” ATLAS Collaboration, Eur. Phys. J. C **76**, no. 8, 442 (2016)  
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4. “Identification of boosted, hadronically decaying  $W$  bosons and comparisons with ATLAS data taken at  $\sqrt{s} = 8$  TeV,” ATLAS Collaboration, Eur. Phys. J. C **76**, no. 3, 154 (2016)  
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5. “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 Collaboration, JHEP **10**, 141 (2017)  
doi:10.1007/JHEP10(2017)141 [arXiv:1707.03347 [hep-ex]].

### List of presentations: Nandi

1. “Supersymmetry versus extra dimensions at the LHC,” invited talk presented at ICHEP 2016, International Conference on High Energy Physics, August 3-10, Chicago, IL.
2. “Superworld without supersymmetry,” Talk presented at Phenomenology 2016 Symposium, May 9-11, 2016 at the University of Pittsburg, Pittsburg, PA.
3. “Supersymmetry versus extra dimensions at the LHC,” Talk presented at the Division of Particles and Fields Meeting of the American Physical Society, Ann Arbor, Michigan, August 3-8, 2015.
4. “Supersymmetry versus extra dimensions at the LHC,” Talk presented at Phenomenology 2015 Symposium at the University of Pittsburg, Pittsburg, PA, May 4-6, 2015.
5. “New physics at the LHC,” invited talk presented at the Large Hadron Collider Physics (LHCP) Conference, Columbia University, New York, June 2-7, 2014.
6. “Dark Matter in the Parallel Universe,” Talk presented at PHENO 2015 Symposium at the University of Pittsburg, Pittsburg, PA, May 5-7, 2014.
7. “Left-right symmetric mirror model at the LHC,” invited plenary talk presented at Miami 2013: A Topical Conference in Elementary Particles, Astrophysics and Cosmology, Ft. Lauderdale, FL, December 12-18, 2013.

### List of presentations: Babu

1. “Neutrinos for flavor and GUTs,” Invited talk at SLAC Workshop on Precision Investigation of the Neutrino Sector (PINS 2017), SLAC, March 2017.
2. “Probing flavor dynamics at the LHC,” Invited Plenary talk at the PLANCK Symposium, Valencia, Spain, May 2016.
3. “Radiative neutrino masses and leptogenesis,” Invited talk at the Baryogenesis Program, MIAPP, Munich, June 2016.
4. “Radiative electroweak symmetry breaking in Standard Model extensions,” Talk presented at the PHENO 2016 Symposium, University of Pittsburgh, May 2016.

5. “Trinication at the TeV scale,” Invited talk at the CETUP\* Workshop on Neutrino Physics and Astrophysics, June 2016.
6. “ $B - L$  violating nucleon decay and baryogenesis,” Invited plenary talk at the Unification Day Workshop, Stony Brook University, October 2015.
7. “BSM physics at neutrino detectors,” Invited lecture at SLAC Summer Institute, SLAC, Stanford University, Menlo Park, CA, August 2015.
8. “Leptogenesis in radiative neutrino mass models,” Invited talk at the CETUP\* NeutrinoWorkshop, Lead, SD, July 2015.
9. “Proton decay in SUSY and non-SUSY GUTs,” Invited talk at the Arnowitt Symposium and Mitchell Workshop on Collider Physics and Dark Matter, Texas A&M University, May 2015.
10. “Flavor symmetry based MSSM: Model building and phenomenology,” Talk presented at PHENO 2015, Pittsburgh, PA, May 2015.
11. “Neutrinoless double beta decay,” Discussion at the Intermediate Neutrino Program Workshop, Brookhaven National Lab, Upton, NY, February 2015.
12. “Neutrino mass models,” Talk presented at the KITP Neutrino Program, UCSB, Santa Barbara, CA, October 2014.
13. “Higgs bosons in left-right supersymmetric models,” Talk presented at the SummerWorkshop LHC after the Higgs, Santa Fe, NM, June 2014.
14. “Neutrino theory overview,” Invited plenary talk at the International Conference on Interconnection between Particle Physics and Cosmology, PPC 2014, Leon, Guanajuato, Mexico, June 2014.
15. “Neutrino mass generation,” Invited plenary talk presented at the International Conference on Neutrino Physics and Astrophysics, Neutrino 2014, Boston University, June 2014.
16. “Theory and phenomenology of Higgs boson in left-right supersymmetric models,” Invited talk presented at the Symposium on Unification and Cosmology, UNICOS 2014, Chandigarh, India, May 2014.
17. “Higgs bosons in left-right supersymmetric models,” Invited talk presented at the Santa Fe Summer workshop LHC after the Higgs, June 2014.
18. “The Next Scale in High Energy Physics: A neutrino mass perspective,” Invited talk presented at the Workshop on the Next Scale in High Energy Physics, University of Pittsburgh, November 2014.
19. “Progress in Radiative Neutrino Mass Models,” Invited Talk at the Workshop Neutrinos: From Majorana to LHC, ICTP, Trieste, Italy, October 2013.
20. “Baryon Number Violation,” Invited Grand Plenary Talk, Community Planning Study, Minneapolis, August 2013.
21. “Charged Lepton Flavor Physics,” Invited plenary talk at Energy Frontier Workshop, University of Washington, Seattle, July 2013.

22. “Renormalization of a two-loop neutrino mass model,” Invited talk presented at the CETUP\* Workshop on Neutrino Physics and Astrophysics, Lead, South Dakota, July 2013.
23. “Theoretical models of  $n - \bar{n}$  oscillations,” Invited talk presented at Snowmass on the Mississippi, Community Summer Study, Minneapolis, August 2013.
24. “ $B - L$  Violating Nucleon Decay,” Invited talk at the Intensity Frontier Workshop, Argonne National Lab, Chicago, April 2013.

**List of presentations: Rizatdinova**

1. “High Energy Physics at the Large Hadron Collider and the ATLAS Experiment,” Seminar at University of Nebraska (October 2015), Lincoln, NE.
2. “Standard Model and Top physics at ATLAS,” 7th High-Energy Physics International Conference (September 2015), Antananarivo, Madagascar.
3. “Physics prospects with the upgraded ATLAS detector,” XXIII International Workshop on Deep-Inelastic Scattering and Related Subjects (April 2015), Dallas, TX.
4. “Top quark pair production measurements with ATLAS detector,” Seminar at Stockholm University (September 2014), Stockholm, Sweden.
5. “Readiness of the ATLAS and CMS experiments for the run-2 data taking including object reconstruction and H+/Higgs search prospects,” Charged-2014 (September 2014), Uppsala, Sweden.

**List of presentations: Khanov**

1. “ATLAS physics prospects with the High-Luminosity LHC” (poster), ICHEP (August 2016), Chicago IL.
2. “Measurements of  $t\bar{t}+X$  using the ATLAS detector,” DIS (April 2016), DESY Hamburg, Germany, published: PoS DIS2016 (2016) 156.
3. “Top quark pair charge asymmetry using the ATLAS detector at the LHC,” QCD@LHC (August 2014), Suzdal, Russia.
4. “Beyond-the-Standard Model Higgs Physics using the ATLAS Experiment,” International Conference on New Frontiers in Physics (September 2013), Kolymbari, Crete, Greece, published: EPJ Web Conf. **71**, 00067 (2014).
5. “Top quark couplings:  $t\bar{t}+\text{jets}$ ,” Snowmass Energy Frontier Workshop (April 2013), Brookhaven National Laboratory.
6. “ $t\bar{t}+\text{jets}$  studies,” ttH Workshop (May 2013), Austin, Texas, USA.

**List of presentations: Haley**

1. “Searches for Exotic phenomena,” XXXV Physics in Collision (September 2015), University of Warwick, Coventry, UK.
2. “Searches for Exotic physics beyond the Standard Model with the ATLAS detector,” 4th International Conference on New Frontiers in Physics (August 2015), Kolymbari, Crete, Greece.

### **List of presentations: Yu**

1. “Top pair inclusive and differential cross sections at LHC,” Top at Twenty (April 2015), Fermi National Laboratory.
2. “Top cross section measurements in ATLAS,” US ATLAS Physics Workshop (August 2014), Seattle, WA.
3. “Charged Higgs to  $t\bar{b}$  at the s-channel,” ATLAS Higgs Workshop (April 2014), Roma, Italy.
4. “Top Quark Physics at ATLAS,” Shanghai Particle Physics and Cosmology Symposium (June 2013), Shanghai, China.
5. “Light-jet (mis-tag) Calibrations,” Flavour Tagging Workshop (August 2013), Stockholm, Sweden.
6. “Longer-term upgrade studies,” Flavour Tagging Workshop (August 2013), Stockholm, Sweden.

### **List of presentations: Sidorov**

1. “ $b$ -tagging performance and calibration with the ATLAS detector” (poster), LHCP (June 2014), New York, NY.
2. “Beyond-the-Standard Model Higgs Physics using the ATLAS Experiment,” DIS (April 2014), Warsaw, Poland.
3. “Calibration of  $b$ -tagging algorithms” (poster), US ATLAS Physics Workshop (July 2013), Argonne National Laboratory.