Abstract: The grant "Taus at ATLAS" supported the group of Sarah Demers at Yale University over a period of 8.5 months, bridging the time between her Early Career Award and her inclusion on Yale's grant cycle within the Department of Energy's Office of Science. The work supported the functioning of the ATLAS Experiment at CERN's Large Hadron Collider and the analysis of ATLAS data. The work included searching for the Higgs Boson in a particular mode of its production (with a W or Z boson) and decay (to a pair of tau leptons.) This was part of a broad program of characterizing the Higgs boson as we try to understand this recently discovered particle, and whether or not it matches our expectations within the current standard model of particle physics. In addition, group members worked with simulation to understand the physics reach of planned upgrades to the ATLAS experiment.

Supported (or partially supported) group members:
Sarah Demers, Associate Professor of Physics
Lotte Thomsen, Postdoctoral Researcher
Mariel Pettee, Graduate Student

Grant Funding Period: July 15, 2016 – March 31, 2017
Funding Amount: $110,000

Summary of Work:
The Large Hadron Collider at CERN provides the world's highest energy proton-proton collisions. The ATLAS Collaboration uses this data to understand the fundamental building blocks of nature and the forces between them. Demers has been a member of the ATLAS Collaboration since 2006. Her primary interests include using tau leptons – a fundamental particle – to search for signs of physics beyond what we already know and to make measurements that test the standard model of particle physics. In addition she and her group work on the trigger for the experiment, which has the job of reducing the collisions at the LHC, which happen approximately 40,000,000 times per second, down to the rate of approximately 1,000 per second that the experiment has space and bandwidth to store.

During this granting period, Demers and her group worked on an analysis of Higgs Bosons decaying to pairs of tau leptons. This work is on-going, and is part of a broad effort to understand the behavior of the recently discovered Higgs. In addition, Demers co-led the ATLAS Trigger and Data Acquisition effort to understand the physics case for planned upgrades of the experiment. This work has culminated in a Technical Design Report for the Trigger and Data Acquisition System that was submitted for internal review within ATLAS on November 17, 2017, but was years in the making, including a significant amount of work within this grant period. This report will become public in January of 2018. The group also supported the functioning of the tau trigger. We took data quality shifts and were responsible for validation of the tau trigger as well as optimizing the selections for some of the physics channels of interest. As evidence of our leadership here, group graduate student Mariel Pettee is currently serving as the trigger contact for the ATLAS group that works on Higgs decays to tau leptons.

Associated Publications:
Published or submitted:

1)
Search for Minimal Supersymmetric Standard Model Higgs bosons H/A and for a Z' boson in the ττ final state produced in pp collisions at √s = 13 TeV with the ATLAS Detector, ATLAS Collaboration, Eur. Phys. J C 76:585 (2016)
https://link.springer.com/article/10.1140%2Fepjc%2Fs10052-016-4400-6

Demers served on the ATLAS internal editorial board for this paper, and her prior graduate student, Andrew Leister, was one of the main analyzers for the previous iteration of this result.

2)
submitted to journal on September 11, 2017, but used work done during grant period:
Measurement of tau polarization in Z/gamma -> tautau decays in proton-proton collisions at root(s) = 8 TeV with the ATLAS detector*, ATLAS Collaboration,
https://arxiv.org/abs/1709.03490

3)
submitted to journal on September 22, 2017, but used work done during grant period:
Search for additional heavy neutral Higgs and gauge bosons in the ditau final state produced in 36 fb-1 of pp collisions at root(s) = 13 TeV with the ATLAS detector
https://arxiv.org/pdf/1709.07242.pdf