

Sarah Demers SC0006399/E00142 Final Report Number DOE-YALE-06399

Professor Sarah Demers, at Yale University, received a Department of Energy grant from the Office of Science to support her and her group's work on the ATLAS Experiment at CERN's Large Hadron Collider. The grant, titled "Taus and the Trigger for Discovery at ATLAS" enabled the group to

- contribute to developing the tau trigger (real time selection of data that includes the signature of the tau lepton, a fundamental particle)
- contribute to the discovery of the Higgs Boson (in the channel where the Higgs decays to a tau of pairs, the first observation of the Higgs to fermions)
- develop a new measurement technique, tau polarization, first done at a hadron collider by our group, which allows for taus to be used to characterize the particles that decay to them.

Two postdoctoral researchers were supported during this grant as well as four graduate students. The four students receiving Yale Physics PhDs supervised by Demers were:

- Susie Bedikian: graduated in May, 2013, with thesis, "Search for the charged Higgs in ttbar using tau Polarization"
- Andrew Leister: graduated in May, 2015, with thesis, "Search for Z' decays to tau pairs in the lepton-hadron channel"
- Jane Cummings: graduated in May, 2016, with thesis, "Tau Polarization at Hadron Colliders (Measurement of tau polarization in W->taunu and Z-> tau tau)"
- Emma Ideal: graduated in December, 2015, with thesis, "Search for VH, H-> $\tau\tau$ in the hadron-hadron channel"

These four students have all gone on to jobs in data science or consulting, using their training from their physics PhD programs to contribute technical expertise to industry and business.

The papers that were published with participation from our group include:

1. **Reconstruction of hadronic decay products of tau leptons with the ATLAS experiment**, ATLAS Collaboration, Eur. Phys. J C 76(5), 1-26 (2016)
<http://arxiv.org/abs/1512.05955>

2. **Search for the Standard Model Higgs boson produced in association with a vector boson and decaying into a tau pair in pp collisions at $\sqrt{s} = 8$ TeV with the ATLAS detector**, ATLAS Collaboration, Phys. Rev. D 93, 092005 (2016)
<http://arxiv.org/abs/1511.08352>

3. **A search for high-mass resonances decaying to $\tau^+\tau^-$ in pp collisions at $\sqrt{s}=8$ TeV with the ATLAS detector**, ATLAS Collaboration, JHEP 07 (2015) 157, [arXiv:1502.07177](https://arxiv.org/abs/1502.07177)

4. **Evidence for the Higgs-boson Yukawa coupling to tau leptons with the ATLAS detector**, ATLAS Collaboration, JHEP 04 (2015) 117, [arXiv:1501.04943](https://arxiv.org/abs/1501.04943)

5. **Identification and energy calibration of hadronically decaying tau leptons with the ATLAS experiment in pp collisions at $\sqrt{s}=8$ TeV**, ATLAS Collaboration, Eur. Phys. J. C75 (2015) 303, <http://arxiv.org/abs/1412.7086>

6. **A Particle Consistent with the Higgs Boson Observed with the ATLAS Detector at the Large Hadron Collider**, ATLAS Collaboration, Science, Vol. 338, Issue 6114, pp. 1576-1582
<http://science.sciencemag.org/content/338/6114/1576>

7. **Search for the Standard Model Higgs boson in the H to $\tau^+\tau^-$ decay mode in $\sqrt{s}=7$ TeV pp collisions with ATLAS**
ATLAS Collaboration, JHEP (2012) 070, <http://arxiv.org/abs/1206.5971>

8. **Measurement of tau polarization in $W \rightarrow \tau \nu$ decays with the ATLAS detector in pp collisions at $\sqrt{s}=7$ TeV**

9. **Measurement of the W to $\tau \nu$ Cross Section in pp Collisions at $\sqrt{s}=7$ TeV with the ATLAS experiment**
The ATLAS Collaboration (*Aad, G, et al.*), Phys.Lett.B 706, 276-294 (2012)
[arXiv:1108.4101v2](https://arxiv.org/abs/1108.4101v2)