





Anna Woodard

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EDUCATION

- MAY 2018 **PhD, Physics, University of Notre Dame**
Dissertation: “[Effective field theory interpretation for measurements of top quark pair-production in association with a W or Z boson.](#)” (Advisor: Kevin Lannon)
- 2008 **BS in Physics with Honors, Florida State University**
Honors Thesis: “[Exploratory Studies of the Photoproduced \$\pi^0\eta\$ Channel and Determination of Preliminary Total Cross Sections.](#)” (Advisor: Volker Credé)

RESEARCH EXPERIENCE

- MAY 2018 **Postdoctoral Scholar**, Computation Institute, University of Chicago, USA
- 2012-2018 **Research Assistant**, Notre Dame University, USA and CERN, Switzerland
- Collaborator on the Compact Muon Solenoid (CMS) experiment at the CERN Large Hadron Collider
 - Expert in applications of effective field theory at CMS
 - Co-lead developer and original coauthor of [Lobster](#) (userspace workflow management tool for harnessing non-dedicated resources for high-throughput workloads)
 - Feature developer, CRAB3 (grid submission tool for CMS)
 - Collaborated with the Cooperative Computing Lab in the Notre Dame Computer Science department on several reproducibility and data preservation projects
 - On-call expert and development of monitoring tools for the High Level Trigger at CMS
- 2009-2010 **Research Assistant**, TANDAR Laboratory, Argentina and Universidade Federal Fluminense, Brazil
- Analysis of inelastic scattering data from weakly bound nuclei
- 2009 **Research Assistant**, Argonne National Laboratory, USA
- Design and implementation of user control interfaces for the Helios detector
 - Hardware design, assembly and configuration
- 2006-2008 **Research Assistant**, Florida State University, USA
- Analysis of CB-ELSA photoproduction reaction data
- SUMMER 2007 **Research Assistant**, Kennedy Space Center, USA
- Atomic force microscopy of bone samples
 - Molecular simulation studies of protein aggregation

PROFESSIONAL MEMBERSHIPS, HONORS & AWARDS

- 2018 Research & Dissertation Award, Notre Dame Physics Department (\$500)
- 2015 Notre Dame Computing Research Center Award for Computational Sciences and Visualization (\$500)
- 2015 Poster Award winner (Computing activities and Computing models track) at the Computing in High Energy Physics 2015 Conference, Okinawa, Japan (~\$500)
- 2012 National Science Foundation Graduate Student Research Program Fellowship (~\$120,000)
- 2007 American Physical Society Conference Experience for Undergraduates Award (~\$1,000)
- 2004 Florida Bright Futures Scholarship (~\$40,000)
- 2004 University Freshman Scholarship (~\$10,000)
- Sigma Pi Sigma Member
- Association for Women in Science Member
- American Association for the Advancement of Science Member

PUBLICATIONS & PRESENTATIONS

Selected publications in peer reviewed journals

As a past member of the CMS collaboration, I am a coauthor on more than [300 papers](#). Selected CMS collaboration publications are those in which I had a significant analysis role, either as primary author or important contributor.

- 2017 CMS Collaboration. Measurement of the top quark pair-production in association with a W or Z boson in pp collisions at 13 TeV. *Journal of High Energy Physics*, 2018 (8):11, Aug 2018. doi [10.1007/JHEP08\(2018\)011](https://doi.org/10.1007/JHEP08(2018)011)
- 2016 CMS Collaboration. Observation of top quark pairs produced in association with a vector boson in pp collisions at 8 TeV. *Journal of High Energy Physics*, 2016(1):96, 2016. doi [10.1007/JHEP01\(2016\)096](https://doi.org/10.1007/JHEP01(2016)096)
- 2014 CMS Collaboration. Search for the associated production of the Higgs boson with a top-quark pair. *Journal of High Energy Physics*, 2014(9):87, Sept. 2014. doi [10.1007/JHEP09\(2014\)087](https://doi.org/10.1007/JHEP09(2014)087)
- 2012 A. E. Woodard, J. M. Figueira, D. R. Otomar, J. O. Fernández Niello, J. Lubian, A. Arazi, O. a. Capurro, P. Carnelli, L. Fimiani, G. V. Martí, D. Martinez Heimann, D. S. Monteiro, a. E. Negri, a. J. Pacheco, and P. R. S. Gomes. Breakup coupling effects on near-barrier inelastic scattering of the weakly bound ^6Li projectile on a ^{144}Sm target. *Nuclear Physics A*, 873:17–27, 2012. doi [10.1016/j.nuclphysa.2011.10.003](https://doi.org/10.1016/j.nuclphysa.2011.10.003)
- 2011 C. M. Deibel, K. E. Rehm, J. M. Figueira, J. P. Greene, C. L. Jiang, B. P. Kay, H. Y. Lee, J. C. Lighthall, S. T. Marley, R. C. Pardo, N. Patel, M. Paul, C. Ugalde, A. E. Woodard, A. H. Wuosmaa, and G. Zinkann. First measurement of the $^{33}\text{Cl}(p,\alpha)^{30}\text{S}$ reaction. *Physical Review C - Nuclear Physics*, 84(4):1–6, 2011. doi [10.1103/PhysRevC.84.045802](https://doi.org/10.1103/PhysRevC.84.045802)

Selected peer-reviewed proceedings & conference presentations

- 2019 Y. Babuji, A. Woodard, Z. Li, D. S. Katz, B. Clifford, I. Foster, M. Wilde, and K. Chard. Scalable Parallel Programming in Python with Parsl. In *Proceedings of the Practice and Experience in Advanced Research Computing on Rise of the Machines (Learning)*, PEARC '19, pages 22:1–22:8, New York, NY, USA, 2019a. ACM. ISBN 978-1-4503-7227-5. doi [10.1145/3332186.3332231](https://doi.org/10.1145/3332186.3332231)
- 2019 R. Chard, L. Ward, Z. Li, Y. Babuji, A. Woodard, S. Tuecke, K. Chard, B. Blaiszik, and I. Foster. Publishing and Serving Machine Learning Models with DLHub. In *Proceedings of the Practice and Experience in Advanced Research Computing on Rise of the Machines (Learning)*, PEARC '19, pages 73:1–73:7, New York, NY, USA, 2019b. ACM. doi [10.1145/3332186.3332246](https://doi.org/10.1145/3332186.3332246)
- 2019 Y. Babuji, A. Woodard, Z. Li, D. S. Katz, B. Clifford, R. Kumar, L. Lacinski, R. Chard, J. M. Wozniak, I. Foster, M. Wilde, and K. Chard. Parsl: Pervasive parallel programming in python. In *Proceedings of the 28th International Symposium on High-Performance Parallel and Distributed Computing*, HPDC '19, pages 25–36, New York, NY, USA, 2019b. ACM. ISBN 978-1-4503-6670-0. doi [10.1145/3307681.3325400](https://doi.org/10.1145/3307681.3325400). nominated for best paper
- 2019 R. Chard, Z. Li, K. Chard, L. Ward, Y. Babuji, A. Woodard, S. Tuecke, B. Blaiszik, M. Franklin, and I. Foster. DLHub: Model and Data Serving for Science. In *33rd IEEE International Parallel and Distributed Processing Symposium*, May 2019a
- 2018 Y. Babuji, K. Chard, I. Foster, D. S. Katz, M. Wilde, A. E. Woodard, and J. M. Wozniak. Interactive, scalable, reproducible data analysis with containers, Jupyter, and Parsl ([abstract](#), [slides](#)). In *Computing in High Energy Physics*, Sofia, Bulgaria, 9–13 July 2018b
- 2018 S. Belforte, M. Wolf, T. T. Ivanov, M. Mascheroni, A. P.-C. Yzquierdo, J. Letts, J. Balcas, A. E. Woodard, B. P. Bockelman, D. D. Foyo, and D. Ciangottini. Improving efficiency of analysis jobs in CMS ([abstract](#), [slides](#)). In *Computing in High Energy Physics*, Sofia, Bulgaria, 9–13 July 2018
- 2018 Y. Babuji, K. Chard, I. Foster, D. S. Katz, M. Wilde, A. Woodard, and J. Wozniak. [ParSl: Scalable Parallel Scripting in Python](#). In *10th International Workshop on Science Gateways*, June 2018a
- 2017 M. Wolf, A. Woodard, P. Brenner, P. Donnelly, M. Hildreth, K. P. H. Anampa, W. Li, K. Lannon, D. Thain, B. Tovar, and A. Yannakopoulos. Opportunistic Computing with Lobster: Lessons Learned from Scaling up to 20k Cores ([abstract](#), [slides](#)). In *Computing in High Energy Physics*, San Francisco, California, 10–14 October 2016a
- 2017 M. Wolf, M. Mascheroni, A. Woodard, B. P. Bockelman, E. Vaandering, J. Hernandez, and S. Belforte. Use of DAGMan in CRAB3 to improve the splitting of CMS user jobs ([abstract](#), [slides](#)). In *Computing in High Energy Physics*, San Francisco, California, 10–14 October 2016b
- 2017 M. Wolf, A. Woodard, B. Tovar, D. Thain, K. P. H. Anampa, K. P. Lannon, M. Hildreth, P. Donnelly, and P. Brenner. Scaling Up a CMS Tier-3 Site with Campus Resources and a 100 Gb/s Network Connection: What Could Go Wrong? ([abstract](#), [poster](#)). In *Computing in High Energy Physics*, San Francisco, California, 10–14 October 2016c

- 2016 H. Meng, D. Thain, A. Vyushkov, M. Wolf, and A. Woodard. Conducting reproducible research with umbrella: Tracking, creating, and preserving execution environments. In *12th IEEE International Conference on e-Science*, pages 91–100, Baltimore, MD, USA, October 23–27 2016. doi [10.1109/eScience.2016.7870889](https://doi.org/10.1109/eScience.2016.7870889). Recognized as “Best of the Conference”
- 2015 A. Woodard, M. Wolf, C. Mueller, N. Valls, B. Tovar, P. Donnelly, P. Ivie, K. H. Anampa, P. Brenner, D. Thain, K. Lannon, and M. Hildreth. Scaling data intensive physics applications to 10k cores on non-dedicated clusters with lobster. In *2015 IEEE International Conference on Cluster Computing, CLUSTER 2015, Chicago, IL, USA, September 8-11, 2015*, pages 322–331, 2015b. doi [10.1109/CLUSTER.2015.53](https://doi.org/10.1109/CLUSTER.2015.53). acceptance rate: 24%
- 2015 A. Woodard, M. Wolf, C. Mueller, B. Tovar, P. Donnelly, K. H. Anampa, P. Brenner, K. Lannon, M. Hildreth, and D. Thain. Exploiting volatile opportunistic computing resources with Lobster. *Journal of Physics: Conference Series*, 664(3):032035, 2015a. doi [10.1088/1742-6596/664/3/032035](https://doi.org/10.1088/1742-6596/664/3/032035). Poster award winner for track 5
- 2015 H. Meng, M. Wolf, P. Ivie, A. Woodard, M. Hildreth, and D. Thain. A case study in preserving a high energy physics application with parrot. *Journal of Physics: Conference Series*, 664(3):032022, 2015. doi [10.1088/1742-6596/664/3/032022](https://doi.org/10.1088/1742-6596/664/3/032022)
- 2015 M. Mascheroni, J. Balcas, S. Belforte, B. P. Bockelman, J. M. Hernandez, D. Ciangottini, P. B. Konstantinov, J. M. D. Silva, M. A. B. M. Ali, A. M. Melo, H. Riahi, A. J. Tanasijczuk, M. N. B. Yusli, M. Wolf, A. E. Woodard, and E. Vaandering. CMS distributed data analysis with CRAB3. *Journal of Physics: Conference Series*, 664(6):062038, 2015. doi [10.1088/1742-6596/664/6/062038](https://doi.org/10.1088/1742-6596/664/6/062038)
- 2014 A. Woodard for the CMS Collaboration. Search for the standard model Higgs boson produced in association with top quarks in multilepton final states. In *Large Hadron Collider Physics Conference*, Columbia University, New York, New York, USA, 2014
- 2014 D. Skeehan, P. Brenner, B. Tovar, D. Thain, N. Valls, A. Woodard, M. Wolf, T. Pearson, S. Lynch, and K. Lannon. Opportunistic High Energy Physics Computing in User Space with Parrot. In *IEEE Symposium on Cluster, Cloud, and Grid Computing (CC-Grid)*, 2014
- 2010 HELIOS Collaboration. [HELIOS: A new concept for studies of light-ion reactions with radioactive beams](#). In *Proceedings of the DAE Symposium on Nuclear Physics*, volume 55, Pilani, India, 20–24 December 2010
- 2009 HELIOS Collaboration. HELIOS and the Radioactive Beam Program at Argonne. In *25th Winter Workshop on Nuclear Dynamics*, Big Sky, Montana, USA, 2009
- 2009 C. Deibel, C. Jiang, B. Kay, H. Lee, R. Pardo, K. Rehm, C. Ugalde, A. Woodard, J. Figueira, S. Marley, N. Patel, M. Paul, and A. Wuosmaa. [A Study of the \$^{30}\text{S}\(\alpha, p\)^{33}\text{Cl}\$ Reaction Rate](#). In *Third Joint Meeting of the APS Division of Nuclear Physics and the Physical Society of Japan*, Waikoloa, Hawaii, 13–17 October 2009
- 2009 N. Antler, B. B. Back, S. Baker, C. R. Hoffman, J. A. Clark, C. M. Deibel, B. J. DiGiovine, S. J. Freeman, N. J. Goodman, Z. Grelewicz, S. Heimsath, B. P. Kay, H. Y. Lee, C. J. Lister, S. T. Marley, P. Mueller, R. Pardo, K. E. Rehm, J. Rohrer, J. P. Schiffer, J. Snyder, M. Syrion, J. C. Lighthall, A. Vann, J. R. Winkelbauer, A. Woodard, D. Shetty, and A. H. Wuosmaa. The HELIOS Spectrometer and the Radioactive Beam Program at Argonne. *International Journal of Modern Physics E*, 19(05n06):825–836, 2010.

doi [10.1142/S021830131001528X](https://doi.org/10.1142/S021830131001528X)

- 2008 Anna Woodard for the CB-ELSA Collaboration. Determination of the photoproduced η and η' cross sections. In *ACC Meeting of the Minds Undergraduate Research Conference*, Tallahassee, Florida, USA, 23–24 April 2008
- 2007 Anna Woodard for the CB-ELSA Collaboration. Pseudoscalar Meson Photoproduction off Protons at CB-ELSA. In *American Physical Society Division of Nuclear Physics Fall Conference*, Newport News, Virginia, USA, October 10–13 2007

Invited talks

- APRIL 2017 “Searching for new particles and forces in events with top quark pairs and bosons at the Large Hadron Collider,” Indiana University South Bend
- DECEMBER 2014 “Searching for Higgs produced with top quark pairs in multilepton events at the Large Hadron Collider,” Society of Physics Students, Florida State University, Tallahassee, Florida

Software tutorials

- 2014 Led the Hands-on Advanced Tutorial Session at the LHC Physics Center (HATS@LPC) on CRAB3 grid computing software, Fermilab, Batavia, Illinois ([materials](#))

Technical reports & public collaboration notes

- 2014 “[Overview of the LHC data model.](#)” Peter Ivie, Anna Woodard, Matthias Wolf, Douglas Thain, Kevin Lannon, Michael Hildreth, and Rob Gardner, *Data and Software Preservation for Open Science Technical Report #1*.
- 2014 “[A Case Study in Preserving a High Energy Physics Application.](#)” Haiyan Meng, Matthias Wolf, Peter Ivie, Anna Woodard, Michael Hildreth, and Douglas Thain, *Data and Software Preservation for Open Science Technical Report #2*.
- 2013 CMS Collaboration. Search for the standard model Higgs boson produced in association with top quarks in multilepton final states. [CMS-PAS-HIG-13-020](#), September 2013b
- 2013 CMS Collaboration. Search for Higgs Boson Production in Association with a Top-Quark Pair and Decaying to Bottom Quarks or Tau. [CMS-PAS-HIG-13-019](#), July 2013a

SKILLS

Programming & markup

EXPERT	Python
PROFICIENT	C++, SQL, bash, awk, sed, HTML, \LaTeX , Markdown
NOVICE	Perl, JavaScript, PHP, CSS

Libraries, schedulers & scientific software

EXPERT	Lobster, Parsl
PROFICIENT	HTCondor, Slurm, PBS, ROOT C++ framework, SciPy, CMSSW framework, grid computing (personally used 20 million+ CPU hours), high throughput computing, high performance computing, Hadoop, CRAB3, Toolkit for Multivariate Analysis (TMVA), Mathematica
NOVICE	OpenStack, scikit-learn

Version control, documentation, & continuous integration

PROFICIENT	git, SVN, CVS, Sphinx python documentation generator, Travis CI
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Simulation software

PROFICIENT	MADGRAPH
INTERMEDIATE	PYTHIA particle physics event generators, GEANT Monte Carlo simulation toolkit, SRIM ion stopping simulator, KINPC and SUPERKIN kinematic simulator, Towhee and Rasmol molecular modeling software

Experiment

Analysis and visualization of large (400+ TB) datasets
Custom software design
Statistical methods
Experiment planning and design
Selection, assembly, testing and calibration of particle detectors
Selection, setup and configuration of data acquisition electronics

Languages

NATIVE	English
PROFICIENT	Spanish
NOVICE	French

TEACHING EXPERIENCE

MENTORING	Anthony Lefeld, Patrick Moran, Dillon Skeeahan, Kevin McDermott, Anna Yannakopoulos, Connor Pigg, Samarth Madduru, Juan David Garrido, Ted Summer, Michael Suna, Chaofeng Wu, Ruobing Wang, Kathryn Leung Worked with student researchers, providing hands-on instruction, feedback and problem solving help
INSTRUCTING	Professor of record, Westville Education Initiative, Westville Prison (2015) Taught the laboratory section of PHYS 10222 Physics of Civilization

TUTORING	Teaching Assistant, Westville Education Initiative, Westville Prison (2013-2015) Provided one-on-one and group tutoring in physics and math to non-traditional undergraduate students
PHYSICS DEMOS TUTORIALS	Teaching Assistant, Notre Dame, General Physics I (Spring 2011) Worked with professors to choose, improve, and assemble lecture demonstrations Teaching Assistant, Notre Dame, General Physics I (Spring 2010), General Physics II (Fall 2010, Fall 2011) Led classroom review discussions and group activities, reinforced problem solving skills by working in-class examples
HELP SESSIONS	Teaching Assistant, Notre Dame, Principles of Physics (Fall 2010), General Physics I (Spring 2011) Provided one-on-one and group tutoring

OUTREACH & COMMUNITY INVOLVEMENT

I take pleasure in sharing my enthusiasm for physics and computing with a wider audience, and have been active in a variety of outreach programs throughout my career. This activity has included regular service as an [International Masterclass](#) mentor and moderator, and as a science fair judge across the district; working with the local [QuarkNet](#) group to plan and present physics demonstrations at public events, including the annual [Science Alive!](#) and [ETHOS](#) Science Spectacular events; mentoring in the [I2D2 \(Imagination, Innovation, Discovery, and Design\)](#) engineering program; and participation in civic hackathon events.

Last updated: August 5, 2019