

# Thomas J Langford

## Curriculum Vitae

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Address: Wright Lab, Yale Center for Research Computing  
Yale University, New Haven, CT 06511 USA.  
Phone: 203.432.5194 (office) 240.271.0217 (cell)  
Email: thomas.langford@yale.edu  
WWW: <http://physics.yale.edu/people/thomas-langford>

### Education and Qualifications

- 2013 Ph.D. Physics University of Maryland, College Park  
*Measurement of the Surface and Underground Neutron Spectra with the UMD/NIST Fast Neutron Spectrometers*  
Advisor: Prof. Elizabeth J. Beise
- 2009 M.Sci. Physics University of Maryland, College Park
- 2007 B.Sci. Physics University of Maryland, College Park

### Appointments

- 2018 - present **Associate Research Scientist** - Wright Laboratory, Yale University
- 2018 - present **Computational Research Support Analyst** - Yale Center for Research Computing
- 2013 - 2018 **Postdoctoral Research Associate** - Wright Laboratory, Yale University  
*Member of the Daya Bay, PROSPECT, and FaNS Collaborations*
- 2011 - 2013 **NIST-ARRA Graduate Research Fellow** - University of Maryland
- 2007 - 2013 **Graduate Research Assistant** - University of Maryland

### Research Activities

#### Precision Measurements of Neutrinos with Daya Bay, PROSPECT, and DUNE

- Spearheading multiple aspects of PROSPECT, a Yale-lead experiment to search for sterile neutrinos and measure the  $^{235}\text{U}$  antineutrino spectrum
- Lead the technical R&D for PROSPECT's scintillator detector system, including characterization of  $^6\text{Li}$ -loaded scintillator and test detectors
- Topical Physics Coordinator for PROSPECT's  $^{235}\text{U}$  antineutrino spectrum measurement
- Co-author and co-editor of PROSPECT proposals for the DOE Intermediate Neutrino Program and Heising-Simons Foundation
- Steering the combined analysis between PROSPECT and Daya Bay to disentangle origin of the reactor antineutrino flux deficit and spectral anomaly
- Co-authored a study of *ab-initio* calculations of the reactor antineutrino spectrum, published in Physical Review Letters
- Working with scientists and engineers to prepare Wright Lab for DUNE Anode Plane Assembly construction

#### YCRC Computational Research Support

- Working to help students and faculty better utilize the Yale Center for Research Computing's High Performance Computing systems
- Developing and leading tutorials and workshops at YCRC and Wright Lab on scientific computing, including parallel programming with Python
- Acting as an interface between researchers in Wright Lab and the staff in YCRC to facilitate advancements in research computing

## Professional Activities

### Awards

- Sambamurti Memorial Lectureship, Brookhaven National Lab, 2019, [https://sambamurti.phy.bnl.gov/lecturers/2019\\_Langford.html](https://sambamurti.phy.bnl.gov/lecturers/2019_Langford.html).

### Teaching Experience

- Developed and taught *Parallel Programming with Python* tutorial, training university members on fundamentals and advanced parallel programming for data analysis - *Fall 2018, Spring 2019*
- Guest lecturer for advanced undergraduate courses at the University of Maryland - *2012-2013*

### Supervised Students

- Supervised Yale undergraduate India Bhalla-Ladd for PHYS470, *Hiyashi: Light Yield and PSD Temperature Dependence of EJ-309 for PROSPECT*.
- Supervised Yale undergraduate Arina Bykadorova during her internship at Wright Laboratory, *Development of the PROSPECT Calibration Deployment System - Summer 2016 - Spring 2018*.
- Mentored undergraduate students Connor Thompson and Robert Valdillez during their summer internships at the National Institute of Standards and Technology - *Summer 2016*.
- Mentored undergraduate Nate Stemen during his summer internships at Wright Laboratory, *Pulse Shape Discrimination with Liquid Scintillators (Summer 2014), Optimization of Light Guides for PROSPECT (Summer 2015)*.
- Supervised Yale undergraduate Karl Medina during his undergraduate thesis, *Pulse Shape Discrimination with Liquid Scintillators* at Wright Laboratory - *Spring 2014*.
- Mentored undergraduate Geoffrey Ji during his internship with the Experimental Nuclear Physics Group at UMD - *Summer 2009, Spring 2012*.
- Guided and mentored Dylan Erwin for his undergraduate thesis, *MCNP modeling of the Fast Neutron Spectrometer for Underground Science - June 2009 - June 2010*

### Outreach Activities

- Poster Session Judge for the Yale Undergraduate Research Association Symposium - *September 2018*
- Developed activity station for the Yale Pathways to Science events at Wright Lab - *April 2018*
- Lead tours of Wright Lab for Alumni Reunion Weekends - *Spring 2017, 2018, 2019*
- Assisted in the organization of the Yale Parents Leadership Council visit to Wright Lab *Fall 2017*
- High school outreach at Walt Whitman High School in Bethesda, MD. Spoke to physics students about pursuing physics in graduate school and as a career - *Spring 2009, 2010, 2011*

### Departmental Activities

- Student Member of the UMD Physics Council *October 2009 - 2013*
- Student Member of the UMD Graduate Committee *March 2009 - 2013*
- Member of the UMD Physics Departmental Chair Reappointment Committee *Fall 2010*

### Conference Organization

- Member of the Local Organizing Committee for the Workshop on the Intermediate Neutrino Program at Brookhaven National Lab in January, 2015.

## Journal Referee

- Active referee for *Physical Review Letters*, *Physical Review C*, *European Journal of Physics C*, *Physical Review Applied*, and *Nuclear Instrumentation and Methods A*.

## Seminars and Invited Talks

- “Fingerprinting a Nuclear Reactor with Neutrinos,” Sambamurti Memorial Lectureship, Brookhaven National Lab, Upton NY, July 25, 2019. [https://sambamurti.phy.bnl.gov/lecturers/2019\\_Langford.html](https://sambamurti.phy.bnl.gov/lecturers/2019_Langford.html).
- “HPC & Big Data: Probing the smallest particles in the universe,” SuperComputing 2018, Dallas TX, November 14, 2018.
- “PROSPECT: The Precision Reactor Oscillation and Spectrum Experiment,” University of Maryland, College Park MD October 31, 2018.
- “PROSPECT: The Precision Reactor Oscillation and Spectrum Experiment,” NEUTRINO2018, Heidelberg, DE, June 8, 2018. <https://doi.org/10.5281/zenodo.1287000>.
- “The search for sterile neutrinos at reactors and underground laboratories,” April Meeting of the American Physical Society, Washington DC, January 30, 2017.
- “Reactor Antineutrinos: Discoveries, Anomalies, and Opportunities,” NACS Colloquium, Lawrence Livermore National Lab, Livermore CA, January 18, 2017.
- “Reactor Antineutrinos: Discoveries, Anomalies, and Opportunities,” Colorado State University, Fort Collins CO, January 12, 2017.
- “PROSPECT: A Reactor Oscillation and Spectrum Experiment at HFIR,” Neutrinos in Nuclear Physics Workshop, Knoxville TN, July 30, 2016.
- “Neutrino mixing and sterile neutrino search at Daya Bay,” XIIIth International Conference on Heavy Quarks and Leptons, Virginia Tech, Blacksburg VA, May 23, 2016.
- “PROSPECT: The Precision Oscillation and Spectrum Experiment,” Department of Physics, Applied Physics, and Astronomy Colloquium, Rensselaer Polytechnic Institute, Troy, NY, April 6, 2016.
- “Neutrons and Neutrinos: Capture-tagged Detectors for Nuclear Science,” Department of Nuclear Engineering, University of California, Berkeley, February 19, 2016.
- “PROSPECT: The Precision Oscillation and Spectrum Experiment,” Triangle University Nuclear Laboratory, Durham, NC, February 4, 2016.
- “Timing Requirements for Inverse Beta Decay Detectors,” PSEC4A Workshop, Massachusetts Institute of Technology, December 14, 2015.
- “PROSPECT: Precision Oscillation and Spectrum Experiment,” Neutrino Oscillation Workshop, Otranto, Italy, September 12, 2014.
- “The UMD/NIST Fast Neutron Spectrometers”, Yale University, New Haven, CT, February 18, 2014.
- “The UMD/NIST Fast Neutron Spectrometers”, University of Washington, Seattle, WA, June 13, 2013.
- “The UMD/NIST Fast Neutron Spectrometers”, Indiana University, Bloomington IN, April 26, 2013.
- “Fast Neutron Spectroscopy with CAEN V1720s”, CAEN Technologies, Viareggio, Italy, April 15, 2013.
- “FaNS-2: Spectroscopy of Cosmic Ray Induced Neutrons,” National Institute for Standards and Technology, Gaithersburg, MD, July 31, 2012.
- “Fast Neutron Detection Greater than 200 MeV,” National Institute for Standards and Technology, Gaithersburg, MD, November 1, 2011.

## Contributed Talks

- “Probing Nuclear Data with the PROSPECT Reactor Experiment,” Fall Meeting of the APS Division of Nuclear Physics, 2019.
- “PROSPECT: The Precision Reactor Oscillation and Spectrum Experiment,” Fall Meeting of the APS Division of Nuclear Physics, 2016.
- “PROSPECT: The Precision Reactor Oscillation and Spectrum Experiment,” Fall Meeting of the APS Division of Nuclear Physics, 2015.
- “PROSPECT Background Studies and Operation of Li-Loaded Liquid Scintillator Detectors at a Research Reactor,” April Meeting of the American Physical Society, 2015. BAPS.2015.APR.E7.2.
- “Background Characterization for PROSPECT: a US Short-baseline Neutrino Oscillation Experiment,” April Meeting of the American Physical Society, 2014. BAPS.2014.APR.K12.2.
- “Neutron Capture-gated Spectroscopy with FaNS,” T.J. Langford, E.J. Beise, H. Breuer, C.R. Heimbach, J.S. Nico, AARM Workshop, Chicago, IL, March 20, 2014.
- “A Fast Neutron Spectrometer for Underground Science,” T.J. Langford, E.J. Beise, H. Breuer, C.R. Heimbach, J.S. Nico, Low Radioactivity Techniques Workshop, Assergi, Italy, April 10, 2013.
- “The UMD-NIST Fast Neutron Spectrometer,” T. Langford, E. Beise, H. Breuer, C. Heimbach, J. Nico. Cosmogenic Activity and Backgrounds Workshop, Berkeley, CA, April 13, 2011.
- “Development of a segmented fast neutron spectrometer based on  $^6\text{Li}$ -loaded liquid scintillator for measuring neutron background,” C. Bass, T. Langford, E. Beise, H. Breuer, D. Erwin, C. Heimbach, J. Nico. April Meeting of the American Physical Society, 2010. BAPS.2010.APR.Y10.1.
- “A fast neutron spectrometer for underground science,” T. Langford, E. Beise, H. Breuer, D. Erwin, C. Bass, C. Heimbach, J. Nico. April Meeting of the American Physical Society, 2010. BAPS.2010.APR.Y10.2.

## Publications

### Selected publications

1. Ashenfelter, J. et al. (2019c). Measurement of the Antineutrino Spectrum from  $^{235}\text{U}$  Fission at HFIR with PROSPECT. *Phys. Rev. Lett.* **122**(25), 251801. arXiv: 1812.10877 [nucl-ex].
2. Ashenfelter, J. et al. (2018a). First search for short-baseline neutrino oscillations at HFIR with PROSPECT. *Phys. Rev. Lett.* **121**(25), 251802. arXiv: 1806.02784 [hep-ex].
3. An, F. P. et al. (2016e). Measurement of the Reactor Antineutrino Flux and Spectrum at Daya Bay. *Phys. Rev. Lett.* **116**, 061801. arXiv: 1508.04233 [hep-ex].
4. Dwyer, D. and T. J. Langford (2015). Spectral Structure of Electron Antineutrinos from Nuclear Reactors. *Phys.Rev.Lett.* **114**(1), 012502. arXiv: 1407.1281 [nucl-ex].

### PhD thesis

1. Langford, T. J. (2013). "Measurement of the Surface and Underground Neutron Spectra with the UMD/NIST Fast Neutron Spectrometers". PhD thesis. UNIVERSITY OF MARYLAND, COLLEGE PARK.

### Refereed research papers

1. Adey, D. et al. (2019a). A high precision calibration of the nonlinear energy response at Daya Bay. *Nucl. Instrum. Meth.* **A940**, 230–242. arXiv: 1902.08241 [physics.ins-det].
2. Adey, D. et al. (2019b). Extraction of the  $^{235}\text{U}$  and  $^{239}\text{Pu}$  Antineutrino Spectra at Daya Bay. *Phys. Rev. Lett.* **123**(11), 111801. arXiv: 1904.07812 [hep-ex].
3. Ashenfelter, J. et al. (2019a). A Low Mass Optical Grid for the PROSPECT Reactor Antineutrino Detector. *JINST* **14**(04), P04014. arXiv: 1902.06430 [physics.ins-det].
4. Ashenfelter, J. et al. (2019b). Lithium-loaded Liquid Scintillator Production for the PROSPECT experiment. *JINST* **14**(03), P03026. arXiv: 1901.05569 [physics.ins-det].
5. Ashenfelter, J. et al. (2019c). Measurement of the Antineutrino Spectrum from  $^{235}\text{U}$  Fission at HFIR with PROSPECT. *Phys. Rev. Lett.* **122**(25), 251801. arXiv: 1812.10877 [nucl-ex].
6. Ashenfelter, J. et al. (2019d). The Radioactive Source Calibration System of the PROSPECT Reactor Antineutrino Detector. *Nucl. Instrum. Meth.* **A944**, 2019. arXiv: 1906.07244 [physics.ins-det].
7. Adey, D. et al. (2018a). Improved Measurement of the Reactor Antineutrino Flux at Daya Bay. arXiv: 1808.10836 [hep-ex].
8. Adey, D. et al. (2018b). Measurement of the Electron Antineutrino Oscillation with 1958 Days of Operation at Daya Bay. *Phys. Rev. Lett.* **121**(24), 241805. arXiv: 1809.02261 [hep-ex].
9. Adey, D. et al. (2018c). Search for a time-varying electron antineutrino signal at Daya Bay. *Phys. Rev.* **D98**(9), 092013. arXiv: 1809.04660 [hep-ex].
10. An, F. P. et al. (2018a). Seasonal Variation of the Underground Cosmic Muon Flux Observed at Daya Bay. *JCAP* **1801**(01), 001. arXiv: 1708.01265 [physics.ins-det].
11. An, F. P. et al. (2018b). Cosmogenic neutron production at Daya Bay. *Phys. Rev.* **D97**(5), 052009. arXiv: 1711.00588 [hep-ex].
12. Ashenfelter, J. et al. (2018a). First search for short-baseline neutrino oscillations at HFIR with PROSPECT. *Phys. Rev. Lett.* **121**(25), 251802. arXiv: 1806.02784 [hep-ex].
13. Ashenfelter, J. et al. (2018b). Performance of a segmented  $^6\text{Li}$ -loaded liquid scintillator detector for the PROSPECT experiment. *JINST* **13**(06), P06023. arXiv: 1805.09245 [physics.ins-det].
14. An, F. P. et al. (2017a). Evolution of the Reactor Antineutrino Flux and Spectrum at Daya Bay. *Submitted to: Phys. Rev. Lett.* arXiv: 1704.01082 [hep-ex].

15. An, F. P. et al. (2017b). Measurement of electron antineutrino oscillation based on 1230 days of operation of the Daya Bay experiment. *Phys. Rev.* **D95**(7), 072006. arXiv: 1610.04802 [hep-ex].
16. Adamson, P. et al. (2016). Limits on Active to Sterile Neutrino Oscillations from Disappearance Searches in the MINOS, Daya Bay, and Bugey-3 Experiments. *Phys. Rev. Lett.* **117**(15), 151801. arXiv: 1607.01177 [hep-ex].
17. An, F. P. et al. (2016a). New measurement of  $\theta_{13}$  via neutron capture on hydrogen at Daya Bay. *Phys. Rev.* **D93**(7), 072011. arXiv: 1603.03549 [hep-ex].
18. An, F. P. et al. (2016b). The Detector System of The Daya Bay Reactor Neutrino Experiment. *Nucl. Instrum. Meth.* **A811**, 133–161. arXiv: 1508.03943 [physics.ins-det].
19. An, F. P. et al. (2016c). Improved Measurement of the Reactor Antineutrino Flux and Spectrum at Daya Bay. *Chin. Phys.* **C2017**, 41. arXiv: 1607.05378 [hep-ex].
20. An, F. P. et al. (2016d). Improved Search for a Light Sterile Neutrino with the Full Configuration of the Daya Bay Experiment. *Phys. Rev. Lett.* **117**(15), 151802. arXiv: 1607.01174 [hep-ex].
21. An, F. P. et al. (2016e). Measurement of the Reactor Antineutrino Flux and Spectrum at Daya Bay. *Phys. Rev. Lett.* **116**, 061801. arXiv: 1508.04233 [hep-ex].
22. Ashenfelter, J. et al. (2016a). Background Radiation Measurements at High Power Research Reactors. *Nucl. Instrum. Meth* **A806**, 401–419. arXiv: 1506.03547 [physics.ins-det].
23. Ashenfelter, J. et al. (2016b). The PROSPECT Physics Program. *J. Phys.* **G43**(11), 113001. arXiv: 1512.02202 [physics.ins-det].
24. Langford, T. J., E. J. Beise, H. Breuer, C. R. Heimbach, G. Ji, and J. S. Nico (2016). Development and Characterization of a High Sensitivity Segmented Fast Neutron Spectrometer (FaNS-2). *Jour. of Inst.* **11**(01), P01006. arXiv: 1510.07607 [physics.ins-det].
25. An, F. P. et al. (2015). New Measurement of Antineutrino Oscillation with the Full Detector Configuration at Daya Bay. *Phys. Rev. Lett.* **115**(11), 111802. arXiv: 1505.03456 [hep-ex].
26. Ashenfelter, J. et al. (2015). Light Collection and Pulse-Shape Discrimination in Elongated Scintillator Cells for the PROSPECT Reactor Antineutrino Experiment. *Jour. of Inst.* **10**(11), P11004. arXiv: 1508.06575 [physics.ins-det].
27. Dwyer, D. and T. J. Langford (2015). Spectral Structure of Electron Antineutrinos from Nuclear Reactors. *Phys.Rev.Lett.* **114**(1), 012502. arXiv: 1407.1281 [nucl-ex].
28. Langford, T. J., C. D. Bass, E. J. Beise, H. Breuer, D. K. Erwin, et al. (2015). Fast Neutron Detection with a Segmented Spectrometer. *Nucl.Instrum.Meth.* **A771**, 78–87. arXiv: 1407.6601 [physics.ins-det].
29. Ashenfelter, J. et al. (2013). PROSPECT - A Precision Reactor Oscillation and Spectrum Experiment at Short Baselines. arXiv: 1309.7647 [physics.ins-det].
30. Bass, C. D., E. J. Beise, H. Breuer, C. R. Heimbach, T. J. Langford, et al. (2013). Characterization of a Li-6 loaded liquid organic scintillator for fast neutron spectrometry and thermal neutron detection. *Appl. Radiat. Isot.* **77**, 130–138. arXiv: 1206.4036 [physics.ins-det].
31. Langford, T. J., C. D. Bass, E. J. Beise, H. Breuer, D. K. Erwin, et al. (2013). Event Identification in  $^3\text{He}$  Proportional Counters Using Risetime Discrimination. *Nucl.Instrum.Meth.* **A717**, 51–57. arXiv: 1212.4724 [physics.ins-det].
32. Dobi, A., C. G. Davis, C. Hall, T. J. Langford, S. Slutsky, et al. (2011). Detection of krypton in xenon for dark matter applications. *Nucl. Instrum. Meth.* **A665**, 1–6. arXiv: 1103.2714 [astro-ph.IM].
33. Dobi, A., D. Leonard, C. Hall, L. Kaufman, T. J. Langford, et al. (2010). Study of a zirconium getter for purification of xenon gas. *Nucl. Instrum. Meth.* **A620**, 594–598. arXiv: 1002.2791 [physics.ins-det].
34. Leonard, D., A. Dobi, C. Hall, L. Kaufman, T. J. Langford, et al. (2010). A simple high-sensitivity technique for purity analysis of xenon gas. *Nucl. Instrum. Meth.* **A621**, 678–684. arXiv: 1002.2742 [physics.ins-det].

35. Slutsky, S., Y.-R. Yen, H. Breuer, A. Dobi, C. Hall, et al. (2009). A Xenon Condenser with a Remote Liquid Storage Vessel. *Nucl. Instrum. Meth.* **A610**, 669–676. arXiv: 0907.2172 [physics.ins-det].

### Conference proceedings

1. Langford, T. J. (June 2018). *PROSPECT: The Precision Reactor Oscillation and Spectrum Experiment*. <https://doi.org/10.5281/zenodo.1287000>.
2. Adams, C., J. Alonso, A. Ankowski, J. Asaadi, J. Ashenfelter, et al. (2015). The Intermediate Neutrino Program. arXiv: 1503.06637 [hep-ex].
3. Langford, T. J. (2014). PROSPECT - A precision oscillation and spectrum experiment. arXiv: 1501.00194 [physics.ins-det].
4. Kishek, R., G. Bai, B. Beaudoin, S. Bernal, D. Feldman, et al. (2007). The University of Maryland Electron Ring (UMER) enters a new regime of high-tune-shift rings. *Conf.Proc.* **C070625**, 820.

## References

### **Prof. Elizabeth J. Beise**

Professor of Physics  
Associate Provost of Academic Planning and Programs  
University of Maryland, College Park  
beise@umd.edu  
301-405-6836

### **Prof. Karsten M. Heeger**

Professor of Physics  
Director of Wright Laboratory  
Yale University  
karsten.heeger@yale.edu  
203-432-3378

### **Prof. Jim Napolitano**

Professor of Physics  
Department Chair  
Temple University  
napolj@temple.edu  
215-204-7827

### **Dr. Jeffrey S. Nico**

Physicist  
Physical Measurement Laboratory  
National Institute of Standards and Technology, Gaithersburg  
jeffrey.nico@nist.gov  
301-975-4663