Thomas T. Perkins

JILA, Univ. of Colorado
440 UCB
Boulder, CO 80309-0440
Ph: (303) 492-5291, email: tperkins@jila.colorado.edu
ORCID: 0000-0003-4826-9490

Education:

Sept. 1991- July 1997	**Stanford University** Advisor: Prof. Steven Chu Ph.D. & M.A. in Physics, July 1997	Stanford, CA
Sept. 1985- June 1989	**Harvard University** A.B. in Physics, *Magna Cum Laude*, June, 1989	Cambridge, MA

Research Experience:

Dec. 2001– Present	**JILA, University of Colorado & NIST** Fellow, JILA (Chair, 2018–9; Associate Chair 2016–7) (Associate Fellow, Dec. 2001–Oct, 2007) Professor of Molecular, Cellular, and Developmental Biology (adjoint) (Associate Professor (adjoint), May. 2010–May, 2017) (Assistant Professor (adjoint), Dec. 2001–May, 2010) Physicist, Quantum Physics Division, NIST (2001–present) (Acting Division Chief, Quantum Physics Division, Nov. 2019–May, 2020)	Boulder, CO
Sept. 1999– Nov. 2001	**Dept. of Biological Sciences, Stanford University** Burroughs Wellcome Career Awardee. *Advisor*: Steven M. Block	Stanford, CA
Aug. 1997– Aug. 1999	**Dept. of Molecular Biology & Princeton Materials Institute, Princeton University** Princeton Materials Institute Junior Fellow. *Advisor*: Steven M. Block	Princeton, NJ
Sept. 1991– June 1997	**Dept. of Physics, Stanford University** Graduate Research Assistant. *Advisor*: Steven Chu	Stanford, CA
Sept. 1989– Aug. 1991	**Science Research Laboratories, Inc**. Research Scientist.	Somerville, MA

Awards and Fellowships:

March 1997	**Padden Award**, outstanding polymer physics thesis in 1997. Awarded by the American Physical Society.
Aug., 1997– Aug., 1999	**Princeton Materials Institute Junior Fellow,** a two-year multi-disciplinary fellowship awarded by Princeton University.
Sept. 1999– Aug. 2008	**Burroughs Wellcome Fund Career Award in the Biomedical Sciences**, $500k for post-doctoral research and initial faculty years.

April 2012 **Marinus Smith Award**, Award for significant impact on lives of CU undergraduate students. Awarded by the CU Parents' Association.

June 2014 **2013 Arthur S. Flemming Award**, Award for outstanding achievement in government service. Awarded by the George Washington University Trachtenburg School of Public Police and Public Administration.

October 2017 **2017 Governor's Award for High-Impact Research,** Awarded for new twists in the molecules of life.

October 2017 **Fellow, American Physical Society,** Awarded for innovations in precision measurement of dynamic biological systems at the smallest scales.

Sept. 2018 **Gold Medal, Dept. of Commerce,** Awarded for significantly advancing biomedical understanding of crucial proteins by creating the world's best biological atomic force microscope (Dept. of Commerce's highest award).

Sept. 2018 **Ron Brown Excellence in Innovation Award, Dept. of Commerce,** selected from Gold Medal awardees as the most innovative.

Nov. 2018 **Fellow, American Association for the Advancement of Science,** awarded for pioneering advances in high-resolution studies of single biological molecules.

May 2019 **Gears of Governance Award,** awarded for world's best atomic force microscope tailored to biological measurements by the Office of Management and Budget and General Service Administration.

Sept. 2021 **Outstanding Postdoc Mentor Award**, awarded for providing exemplary mentoring, training, and leadership to postdoctoral scholars at Univ. of Colorado.

Service:

Co-Organizer, Single Molecule Biophysics, Aspen, CO 2011–present (biennial)

Section Head for Molecular Biological Physics of the Biological Physics Faculty in F1000Prime (2020–present)

Editorial Board, *Biophysical Journal*, 2016–2021

NSF, reviewer, 2004-present

External Advisory Board, Physics of Living Cell, NSF Physics Frontier Center, UIUC, 2008- present. Chair in 2009, 2013–2020.

Panelist, HLBP 1 Workgroup, Pathogenesis and Management of Heparin-Induced Thrombocytopenia, 2018

Program Committee, Optical Trapping and Optical Manipulation, San Diego, 2008–2018

Advisory Committee, NIH NCRR "3D Fine Structure Lab", 2001–2014

Chair, Optical Trapping and Manipulation in Molecular and Cellular Biology Technical Group, Optical Society of America, 2008–2011

Panelist, Golden Triangle Meeting, President's Council of Advisors on Science and Technology (PCAST), Washington D.C., 2010

Panelist, NSF FY2008 Physics Frontier Center Reverse Site Visit

Ad. hoc. Reviewer, Nanotechnology in Biology and Medicine Study Section, NIH, 2003

Reviewer, Amgen K-12 Science Teacher of the Year, 2003-2005

Reviewer:

Science, Nature, Cell, PNAS, PRL, JACS, Nano Letters, ACS Nano, Nature Methods, Nature Chemical Biology, Nature Photonics, Science Advances, Angewandte Chemie, J. of Molecular Biology, Biochemistry, Biophysical Journal, Physical Chemistry Chemical Physics, Optics Letters, Optics Express, RNA, Applied Optics, RSI, Phys. Rev. E., Analytical Chemistry, Nucleic Acids Research, Langmuir.

Patents:

Real-time, active picometer-scale alignment, stabilization and registration in one or more dimensions, T.T. Perkins, G.M. King and A.R. Carter, *US Patent 7,928,409.* Filed October, 2006: Awarded April, 2011.

Laser guided tip approach with 3D registration to a surface, T.T. Perkins, G.M. King and A.R. Carter. *US Patent 8,387,158.* *Filed* July 2010: Awarded February, 2013

Invited Presentations, Colloquiums, Lectures, and Seminars:

156. Les Houches-TSRC Workshop on Protein Dynamics, Les Houches, France June, 2024
155. Dept. of Biomedical Engineering, UC Irvine, CA, April, 2024
154. Dept. of Physics, Auburn, CA, Feb., 2024
153. SMB Les Houches, Les Houches, France Jan.-Feb., 2024
152. Dept. of Chemistry, UT Austin, Texas, Oct. 2023.
151. Center for Biological Physics, Arizona State Univ., Sept. 2023
150. Keynote presentation at "Tang Aoqing" Doctoral Academic Forum College of Chemistry, and International Center of Future Science, Jilin University, China Nov., 2022. (virtual).
149. 22nd International Vacuum Congress, Sapporo, Japan, Sept. 2022
148. Physics Dept., Nagoya University, Japan, Sept. 2022.
147. Graduate School of Frontier Bioscience, Osaka Univ., Japan, Sept. 2022
146. AFM BioMed Conference, Nagoya-Okazaki, Japan Aug., 2022
145. Single Molecule Approaches to Biology, Castelldefels, Spain, July, 2022.
144. Protein Dynamics Workshop, Aussois, France, May, 2022.
143. Keynote Lecture, 2021 NanoScientific Forum Europe, Freiburg, Germany, Sept. 2021. (virtual)
142. NIST-AstraZeneca Innovation workshop, Feb, 2021 (virtual).
141. Precision Nanoscale Patterning and Characterization → From Cybernetic Proteins to Nanoengineered Quantum Devices, Univ. of Missouri, Aug. 2020 (virtual).

140. Honeywell Quantum Solutions, Broomfield, CO March, 2020
139. Quantitative biosciences and engineering seminar, Colorado School of Mines, Feb. 2020
138. Keynote Lecture, Single Molecule Biophysics, Les Houches, France, Feb., 2020
137. Keynote Speaker, 2019 Midwest ACS regional meeting, Wichita, Oct. 2019.
136. Plenary lecture, IFIMAC, Universidad Autonoma de Madrid, Spain, Sept., 2019
135. Stretching the boundaries of physics, one molecule at a time, LMU, Munich, Germany, Sept. 2019
134. Progress in Single Molecule Force Spectroscopy Workshop, Duke Univ., Aug-Sept, 2019
133. MechanoChemBio 2019, Montreal, Canada, July 2019
132. Protein Society, Seattle, June 2019
131. JASON Spring Meeting, McLean, VA, April, 2019
120. APS March Meeting, Boston, March, 2019.
129. Molecular Biophysics, Biophysical Society, Baltimore, March. 2019
128. Physics Colloquium, Univ. of Wisconsin Milwaukee, November, 2018
127. PhysBio2018, Gif-sur-Yvette, France, October, 2018
126. Molecular Biology Institute, UCLA, October, 2018
125. Biophysics Seminar, Princeton Univ., Sept. 2018
124. Chu70-Symposium, Stanford Univ., May 2018
123. Dept. of Biosystems Science and Engineering, ETH Zurich, Switzerland, April, 2018
122. Institute for Biophysical Dynamics, Univ. of Chicago, April, 2018
121. Molecular Biophysics, Biophysical Society, San Francisco, Feb. 2018
120. Keynote lecture, 3rd International Symposium on Mechanobiology, Singapore, Dec. 2017
119. Mechanobiology Biology Institute, Singapore, Dec. 2017
118. Department of Physiology and Biophysics, Weill Cornell Medicine, New York, Sept. 2017
117. Seminar, Mechanical Engineering and Materials Science, Duke Univ., Sept. 2017
116. Membrane Protein Folding GRC, Stonehill College, MA, June, 2017.
115. World Metrology Day Symposium, Stanford Univ., May, 2017.
114. 19th ISPM conference at Kyoto, Japan, May, 2017.
113. Nanoscale Matter – Novel Concepts Workshop, Venice International Univ., Venice, Italy, Sept. 2016
112. Seminar, Center for Nanoscience, LMU, Munich, Germany, Sept. 2016
111. SPM on SPM 2016, Changchun, China, August, 2016
110. State Key Laboratory for Supramolecular Structure and Materials, Jilin University, August 2016
109. Single Molecule Approaches to Biology, Gordon Research Conference, Hong Kong, July, 2016
108. Mini-conference in Single Molecule Biophysics, National Taiwan University, Taipei, July 2016.

107. Molecular Biophysics Seminar, Chemistry Dept., Univ. of Texas, April, 2016
106. Frontiers in biophysical instrument development workshop, Biophysical Society, Los Angles, Feb., 2016
105. Biophysics colloquium, NIH, Dec, 2015
104. Biophysical Dynamics, Telluride, CO, July, 2015
103. Colloquium, Physics Dept., Univ. of New Mexico, April, 2015
102. Nanoscale Biophysics subgroup, Biophysical Society Meeting, Baltimore, Feb. 2015
101. Trends in Optical Micromanipulation III, Obergurgl, Austria, Jan. 2015
100. International Conference on Scanning Probe Microscopy on Soft and Polymeric Materials, Toronto, Canada, Sept. 2014
99. 23rd Congress of the International Commission for Optics, Santiago de Compostela, Spain, Aug., 2014
98. Single Molecule Approaches to Biology, Gordon Research Conference, Il Ciocco, Italy, July, 2014
97. Biomedical Optics (OSA), Miami, April, 2014
96. Frontiers in Biophysics Symposium, UIUC, Nov. 2013
95. Tutorial talk, Optical Trapping and Optical Manipulation, SPIE meeting, San Diego, August 2013
94. Plenary talk, NanoBioEurope (NBE 2013) Toulouse, France, June, 2013
93. Seminar, Institute Curie, Paris, 2013
92. Arizona Imaging and Microanalysis Society, Mar, 2013
91. Biophysics Seminar, Physics. Dept, Univ. of Arizona, Mar. 2013
90. Physics Colloquium, UC Merced, Dec. 2012
89. 3rd Kanazawa Bio-AFM Workshop, Japan, Nov. 2012
88. Seminar, QBiC/RIKEN, Osaka, Japan, Nov. 2012
87. Seminar, Chemical & Biochemical Engineering, CSU, Oct. 2012
86. OSA Mesoscale Photonics Incubator Meeting, Washington, DC, May, 2012
85. Molecular and Cellular Biophysics Symposium, Univ. of Denver, April, 2012
84. Physics Colloquium, Univ. of Northern Colorado, Greely, April, 2012
83. Biochemistry Colloquium, Univ. of Missouri, April 2012
82. Biophysics Seminar, Univ. of Missouri, April, 2012
81. Physics Colloquium, McGill University, Montreal, Canada, March, 2012
80. Association of Biomolecular Resource Facilities Conf., Orlando, March, 2012
79. Chemistry Department, Colloquium, Wayne State, Oct, 2011
78. Biomolecular Science and Engineering, Seminar, UCSB, Sept. 2011
77. ACS Meeting, August, Denver, Aug, 2011
76. 7th International Conference on Biological Physics, La Jolla, June, 2011

75. Structure and Chemistry Affinity group seminar, The Scripps Research Institute, June, 2011
74. Biophysics Seminar, Princeton Univ. November, 2010.
73. Biochemistry and Molecular Biophysics Seminar, Washington Univ. School of Medicine, Oct. 2010
72. Physics Colloquium, University of Alberta, Oct. 2010
71. Seminar, Theoretical and Computational Biophysics Group, Univ. of Illinois, Oct, 2010
70. Single Molecule Approaches to Biology, Gordon Research Conference, Il Ciocco, Italy, June 2010
69. Conf. on Lasers and Electo-Optics (CLEO), San Jose, May, 2010
68. AFM BioMed Conference, Red Island, Croatia, May 2010
67. APS March Meeting, Portland, 2010
66. New and Notable Symposium, Biophysical Society, San Francisco, Feb. 2010.
65. COSI Seminar, CU-Boulder, November, 2009
64. Butcher Symposium on Genomics and Biotechnology, Nov. 2009.
63. APS Four Corners Meeting, Oct. 2009
62. Physical Chemistry/Chemical Physics Colloquium, CU-Boulder, Oct., 2009
61. Seminar, Mechanical Engineering, CU-Boulder, Boulder, Sept., 2009
60. Single-Molecule Imaging, Spectroscopy, Manipulation of Biological Systems, Beijing, China, July, 2009
59. Joint ECBO-CLEO/Europe session, Hot Topics: Molecules to Metabolism, Munich, Germany, June 2009
58. Single Molecule Biophysics, Aspen, January, 2009
57. Seminar, NSF Center of Physics of Living Cells, UIUC, Dec. 2008
56. Colloquium, Dept. of Physics, Univ. of Kansas, Nov. 2008
55. AFM BioMed Conference, Monterey, Oct. 2008
54. Seminar, Structure and Chemistry Seminar Series, Proteins Scripts Research Institute, Aug. 2008
53. Proteins – from chemistry to biology: Symposium Celebrating the 30th Anniversary of the Institute of Biological Chemistry of Academia Sinica, Taiwan, October, 2007
52. Colloquium, Dept. of Chemistry, National Technical University, Taiwan, October, 2007
51. Seminar, Dept. of Pharmaceutical Sciences, UCHSC, September, 2007
50. Colloquium, Dept. of Biochemistry and Molecular Biology, CSU, August, 2007
49. Spudich Symposium, Stanford University, August, 2007
48. Helicases & NTP-Driven Nucleic Acid Motors: Structure, Function, Mechanisms & Roles in Human Disease, Indian Wells, CA, June 2007\
47. Seminar, Physics Department, Goettingen University, Germany, March 2007
46. Guttenberg Lecture Symposium, Mainz, Germany, March 2007
45. Single Molecule Biophysics, Aspen, February, 2007

44. Colloquium, Dept of Structural and Chemical Biology, Mt. Sinai Medical School, January 2007
43. Condensed matter seminar, NYU, January, 2007
42. Lecture, Boulder Condensed Matter Summer School, CU Boulder, July, 2006
41. Colorado Initiative in Molecular Biotechnology, CU Boulder, June, 2006
40. APS March Meeting, Baltimore, March 2006
39. France-US NanoBiotechnology Workshop, March 2006
38. Seminar, Dept. of Applied Physics, Caltech, September, 2005
37. Colloquium, Dept. of Biochemistry and Molecular Biophysics, Washington University in St. Louis School of Medicine, September, 2004
36. Colloquium, Center for Advanced Research in Biotechnology, Maryland, April 2005
35. Single Molecule Biophysics, Aspen, January, 2005
34. CU-NIST Forum, January, 2005
33. Butcher Symposium on Biotechnology and Genomics, November 2004
32. Nanotechnology and Regenerative Medicine, Canadian Institute of Health Research, Canada, February, 2004
31. Colloquium, Dept. of Physics, Purdue, February, 2004
30. Seminar, NIST-Boulder, March 2004
29. Joint Central and Western Section Meeting of the American Mathematical Society, October, 2003
28. Single Molecule Biophysics, January, 2003
27. 50th Midwest Solid State Conference, Urbana-Champaign, October, 2002
26 Seminar, NIST-Gaithersburg, October, 2002
25. Colloquium, University of Colorado, Physics Dept, December, 2001
24. APS New Laser Scientist Conference, Long Beach, October 2001
23. Biophysics Society Meeting, Boston, February 2001
22. Single Molecule Biophysics, Aspen, January 2001
21. Colloquium, Dept. of Biology, MIT, January 2001
20. Colloquium, Dept. of Biophysics, University of Michigan, January, 2001
19. Colloquium, JILA, January 2001
18. Colloquium, Institute for Molecular Biology, University of Oregon, January 2000
17. Colloquium, Dept. of Chemistry, Harvard, November 2000
16. Colloquium, Dept. of Molecular Biology, Princeton University, October 1999
15. Optical Society of America, Santa Clara, September 1999
14. Colloquium, Dept. of Chemistry, Harvard University, May 1999
13. Seminar, Niels Bohr Institute, Copenhagen, February 1998
12. Biophysics Society Meeting, Baltimore, February 1998

11. Colloquium, JILA, University of Colorado at Boulder, October 1998
10. Symposium for the Nobel Prize in Physics, Stockholm, Sweden, December 1997
9. Center for Studies in Physics and Biology, Rockefeller University, October 1997
8. Bell Laboratories, October 1997
7. MRS Meeting, Boston, December. 1996
6. APS March Meeting, St. Louis, March 1996
5. Gordon Research Conf., Ventura, CA, February 1996
4. Colloquium, Chemistry Dept., Univ. of Washington, March 1995
3. Colloquium, James Frank Institute, University of Chicago, November1994
2. Frontiers in Physics of DNA, La Jolla, CA, July 1994
1. Conf. on Lasers and Electo-optics (CLEO), Baltimore, May 1991

Publications:

69. D.R. Jacobson, & **T.T. Perkins**, Quantifying a light-induced energetic change in bacteriorhodopsin by force spectroscopy, *PNAS*, **121**, e2313818121 (2024).

68. A.M.K. Taylor, S.R. Okoniewski, L. Uyetake, & **T.T. Perkins**, Force-activated DNA substrates for in-situ generation of ssDNA and designed ssDNA/dsDNA structures in an optical-trapping assay, *Methods in Molecular Biology,* **2478**. 273-312 (2022).

67. M.-A. LeBlanc, M.R. Fink, **T.T. Perkins,*** & M.C. Sousa*, Type III secretion system effector proteins are mechanically labile, *PNAS* **118**, e2019566118 (2021). *Co-corresponding authors

66. D.R. Jacobson, & **T.T. Perkins**, Free-energy changes of bacteriorhodopsin point mutants measured by single-molecule force spectroscopy, *PNAS,* **118**, e2020083118 (2021).

65. D.T. Edwards, M.-A. LeBlanc, & **T.T. Perkins**, Modulation of a protein-folding landscape revealed by AFM-based force spectroscopy notwithstanding instrumental limitations, *PNAS,* **118**, e2015728118 (2021).

64. D.R. Jacobson & **T.T. Perkins**, Correcting molecular transition rates measured by single-molecule force spectroscopy for limited temporal resolution, *Physical Review E,* **102**, 022402 (2020).

63. H. Yu, D.R. Jacobson, H. Luo, & **T.T. Perkins**, Quantifying the native energetics stabilizing bacteriorhodopsin by single-molecule force spectroscopy, *Physical Review Letters,* **125**, 068102 (2020).

62. P.R. Heenan, X. Wang, A.R. Gooding, T.R. Cech, & **T.T. Perkins**, Bending and looping of long DNA by Polycomb repressive complex 2 revealed by AFM imaging in liquid, *Nucleic Acid Research*, **48**, 2969–2981 (2020).

61. D.R. Jacobson, L. Uyetake, & **T.T. Perkins**, Membrane-protein unfolding intermediates detected with enhanced precision using a zigzag force ramp, *Biophysical Journal*, **118**, 667–675 (2020).

60. P.R. Heenan, & **T.T. Perkins**, Imaging DNA equilibrated onto mica in liquid using biochemically relevant deposition conditions, *ACS Nano*, **13**, 4220–4229 (2019).

59. H. Yu, P.R. Heenan, D.T. Edwards, L Uyetake, & **T.T. Perkins**, Quantifying the initial unfolding of bacteriorhodopsin reveals retinal stabilization, *Angewandte Chemie Int. Ed*. **58**, 1710 –1713 (2019).

58. R. Walder, W.J. Van Patten, D.B. Ritchie, R.K. Montange. T.W. Miller, M.T. Woodside, & **T.T. Perkins**, High-precision single-molecule characterization of the folding of an HIV RNA hairpin by atomic force microscopy, *Nano Letters*, **18**, 6318–6325 (2018).

57. P.R. Heenan, & **T.T. Perkins**. FEATHER: Automated analysis of force spectroscopy unbinding/unfolding data via a Bayesian algorithm, *Biophysical Journal*, **115**, 757–762 (2018).

56. P. R. Heenan, H. Yu, M.G.W. Siewny, & **T.T. Perkins,** Improved free-energy landscape reconstruction of bacteriorhodopsin highlights local variations in unfolding energy, *Journal of Chemical Physics*, **148**, 123313 (2018).

55. R. Walder, W.J. Van Patten, A. Adhikari, & **T.T. Perkins**, Going vertical to improve accuracy in AFM-based single-molecule force spectroscopy, *ACS Nano*, **12**, 198–207 (2018)

54. W.J. Van Patten, R. Walder, A. Adhikari, S.R. Okoniewski, R. Ravichandran, C.E. Tinberg, D. Baker & **T.T. Perkins**, Improved free-energy landscape quantification illustrated with a computationally designed protein-ligand interaction, *ChemPhysChem*, **19**, 19–23 (2018). [Cover Article]

53. D.T. Edwards, J.K. Faulk, M.-A. LeBlanc, & **T.T. Perkins**, Force spectroscopy with 9-μs resolution and sub-pN stability by tailoring AFM cantilever geometry, *Biophysical Journal*, **113**, 2595–2600 (2017).

52. S.R. Okoniewski, L.Uyetake, & **T.T. Perkins**, Force-activated DNA substrates for probing individual proteins interacting with single-stranded DNA, *Nucleic Acid Research*, **45**, 10775–10782 (2017).

51. R. Walder, M.-A. LeBlanc, W.J. Van Patten, D.T. Edwards, J.A. Greenberg, A. Adhikari, S. R. Okoniewski, R. M. A. Sullan, D. Rabuka, M. C. Sousa,* & **T.T. Perkins***, Rapid characterization of a mechanically labile α-helical protein enabled by efficient site-specific bioconjugation, *Journal of American Chemical Society*, **139**, 9867–9875 (2017). *Co-corresponding authors

50.. H. Yu, M.G.W. Siewny, D. T. Edwards, A.W. Sanders, & **T.T. Perkins.** Hidden dynamics in the unfolding of individual bacteriorhodopsin proteins, *Science*, **355**, 945–950 (2017).

49. J.K. Faulk, D.T. Edwards, M.S Bull, & **T.T. Perkins,** Improved force spectroscopy using focused-ion-beam modified cantilevers, *Methods in Enzymology*, Single-Molecule Enzymology: Nanomechanical Manipulation and Hybrid Methods, Maria Spies, Yann R. Chemla (Eds), Academic Press (Cambridge), **582**, 321–351 (2017)

48. D.T. Edwards & **T.T. Perkins**, Optimizing force spectroscopy by modifying commercial cantilevers: improved stability, precision, and temporal resolution, *Journal of Structural Biology*, **197**, 13–25 (2017). (*invited*)

47. S.R. Okoniewski, A.R. Carter, & **T.T. Perkins**, A surface-coupled optical trap with 1-bp precision via active stabilization, *Methods in Molecular Biology*, Optical tweezers**,** Arne Gennerich (Ed.) Humana Press (New York), **1486**, 77–107 (2017).

46. A.R. Carter, M.H. Seaberg, H.-F. Fan, G. Sun, C.J. Wilds, H.-W. Li, & **T.T. Perkins**, Sequence-dependent nanometer-scale conformational dynamics of individual RecBCD-DNA complexes, *Nucleic Acids Research*, **44**, 5489–590 (2016).

45. D.T. Edwards, J.K. Faulk, A.W. Sanders, M.S Bull, R. Walder, M.-A. LeBlanc, M.C. Sousa, & **T.T. Perkins**, Optimizing 1-μs-resolution single-molecule force spectroscopy on a commercial AFM, *Nano Letters*, **15**, 7091–7098 (2015).

44. R. Walder, D.H. Paik, M.S. Bull, C. Sauer, & **T.T. Perkins**, An ultrastable measurement platform: sub-nm drift over hours in 3D at room temperature, *Optics Express*, **23** 16554–16564 (2015).

43. C. He, C. Hu, X. Hu, X. Hu, A. Xiao, **T.T. Perkins**, & H. Li, Directly observing the reversible two-state unfolding and refolding of an α/β protein by single-molecule atomic force microscopy, *Angewandte Chemie Int. Ed*., **54**, 9921–9925 (2015).

42. A.B. Churnside, & **T.T. Perkins**, Ultrastable atomic force microscopy: improved force and positional stability, *FEBS Letters*, **588**, 3621-3630 (2014). (*invited*)

41. **T.T. Perkins**, Ångstrom-precision optical traps and applications, *Annual Review of Biophysics*, **43**, 279–302 (2014).

40. M.S. Bull, R.M.A. Sullan, H. Li, & **T.T. Perkins,** Improved single-molecule force spectroscopy using micromachined cantilevers, *ACS Nano*, **8**, 4984–4995 (2014).

39. S. Berweger, D.M. Nguyen, E.A. Muller, H.A. Bechtel, **T.T. Perkins**, and M.B. Raschke, Nano-chemical infrared imaging of membrane proteins in lipid bilayers, *Journal of the American Chemical Society,* **135**, 18292−18295 (2013).

38. D.H. Paik, V.A. Roskins, & **T.T. Perkins**, Torsionally constrained DNA for single-molecule assays: an efficient, ligation-free method, *Nucleic Acids Research*, **41**, e179 (2013).

37. R.M.A. Sullan, A.B. Churnside, D.M. Nguyen, & **T.T. Perkins**, Atomic force microscopy with sub-picoNewton force stability for biological applications, *Methods*, **60**, 131–141(2013). (*invited*)

36. R.K. Montange, M.S. Bull, E.R. Shanblatt, **T.T. Perkins**, Optimizing bead size reduces errors in force measurements in optical traps, *Optics Express*, **21**, 39–48 (2013).

35. D.H. Paik, & **T.T. Perkins**, Force spectroscopy of DNA: there is still a lot to learn, *Proc. of SPIE*, **8458**, 845817 (2012). (*invited*)

34. A.B. Churnside, R.M.A. Sullan, D. M. Nguyen, S.O. Case, M.S. Bull, G.M. King, & **T.T. Perkins**, Routine and timely sub-picoNewton force stability and precision for biological applications of atomic force microscopy, *Nano Letters*, **12**, 3557–3561 (2012).

33. D.H. Paik, & **T.T. Perkins**, Dynamics and multiple stable binding modes of DNA intercalators revealed by single molecule force spectroscopy, *Angewandte Chemie Int. Ed.* 51, 18110-5 (2012) [Cover article]

32. D.H. Paik, & **T.T. Perkins**, Single-molecule optical-trapping measurements with DNA anchored to an array of gold nanoposts, *Methods in Molecular Biology*, Spectroscopic Methods of Analysis, Wlodek M. Bujalowski (Ed.) Humana Press (New York), **875**, 335–356 (2012). (*invited*)

31. G. M. King, A.B. Churnside, & **T.T. Perkins**, Laser-guided atomic force microscopy: precision photonics meets Nanotechnology, *Microscopy and Imaging*, **4**, (2011). (*invited*)

30. D.H. Paik, and **T.T. Perkins**, Ovestretching DNA at 65 pN does not require peeling from free ends or nicks, *Journal of the American Chemical Society*,133, 3219–3221 (2011) [Cover Article].

29. A.B. Churnside, G.M. King, & **T.T. Perkins**, Label-free optical imaging of membrane patches for atomic force microscopy, *Optics Express*, **18**, 23924–23932 (2010)**.**

28. **T.T. Perkins**, C.V. Malley, M. Dubson, & K. K. Perkins, An interactive optical tweezers simulation for science education, *Proc. of SPIE*, Vol. 7762, 776215 (2010).

27. G.M. King, A.B. Churnside, & **T.T. Perkins**, Optical trapping meets atomic force microscopy: A precision force microscope for biophysics, *Proc. of SPIE*, Vol. 7762, 77620D (2010). (*invited*)

26. **T.T. Perkins** & H.-W. Li, Single molecule studies of RecBCD, *Methods in Molecular Biology*, Helicases, Abdelhaleem, Mohamed M. (Ed.) Humana Press (New York) **587**, 155–172 (2009). (*invited*)

25. A.B. Churnside, G.M. King, & **T.T. Perkins**, Independent measurement of force and position in atomic force microscopy, *Proc. of SPIE*, 7405, 7405OH (2009).

24. D.H. Paik, Y. Seol, W.A. Halsey, & **T.T. Perkins**, Integrating a high-force optical trap with gold nanoposts and a robust gold-DNA bond, *Nano Letters*, ***9***, 2978–2983 (2009).

23. G.M. King, A.R. Carter, A.B. Churnside, L.S. Eberle & **T.T. Perkins**, Ultrastable atomic force microscopy: atomic-scale stability and registration in ambient conditions, *Nano Letters*, **9**, 1451–1456 (2009)

22. A.R. Carter, Seol, Y. & **T.T. Perkins**, Precision surface-coupled optical-trapping assay with 1 base-pair resolution, *Biophysical Journal*, 96, 2926–34 (2009).

21. **T.T. Perkins**, Optical traps for single molecule biophysics: a primer, *Laser & Photonics Reviews*, **3**, 203–220 (2009).

20. A.B. Churnside, G.M. King, A.R. Carter, & **T.T. Perkins**, Improved performance of an ultrastable measurement platform using a field-programmable gate array for real-time deterministic control, *Proc. of SPIE*, 7042, 704205 (2008).

19. A.R. Carter, G.M. King, & **T.T. Perkins**, Back-scattered detection provides atomic-scale localization precision, stability, and registration in 3D, *Optics Express*, **15**, 13434–45 (2007).

18. Y. Seol, J. Li, P.C. Nelson, **T.T. Perkins**[*], & M.D. Betterton[*], Elasticity of short DNA molecules: theory and experiment for contour lengths of 0.6–7 μm, *Biophysical Journal*, **93**, 4360–4373 (2007).

*Co-corresponding authors.

17. A.R. Hieb, W.A. Halsey, M.D. Betterton, **T.T. Perkins**, J.F. Kugel, & J.A. Goodrich, TFIIA changes the conformation of the DNA in TBP/TATA complexes and increases their kinetic stability, *Journal of Molecular Biology*, **372**, 619–632 (2007).

16. A. R. Carter, G.M King, T.A. Sheard, W. Halsey, D. Alchenberger & **T.T. Perkins**, Stabilization of an optical microscope to 0.1 nm in 3D, *Applied Optics* **46**, 421–7(2007).

15. Y. Seol, A.E. Carpenter, & **T.T. Perkins**, Gold nanoparticles: enhanced optical trapping and sensitivity coupled with significant heating, *Optics Letters* **31**, 2429–31 (2006).

14. L. Nugent-Glandorf & **T.T. Perkins,** Measuring 0.1-nm motion in 1 ms in an optical microscope with differential back focal plan detection, *Optics Letters* **29**, 2611–13 (2004).

13. **T.T. Perkins***, H.-W. Li, R.V. Dalal, J. Gelles, & S.M. Block, Forward and Reverse Motion of Single RecBCD Molecules on DNA, *Biophysical Journal* **86**, 1640–1648 (2004). *Corresponding author

12. **T.T. Perkins***, R.V. Dalal, P.M. Mitsis, & S.M. Block, Sequence Dependent Pausing of Single Lambda Exonuclease Molecules, *Science* **301**,1914–1918 (2003). *Corresponding author

11. **T.T. Perkins**, D.E. Smith, & S. Chu, Single Polymer in Elongational Flows: dynamic, steady-state, and population averaged properties, Flexible Polymer Chains in Elongational Flow: Theories and Experiments, Eds. T.Q. Nguyen, H. H. Kausch, (Springer-Verlag) (1999).

10. R.G. Larson, **T.T. Perkins**, D.E. Smith, & S. Chu, Hydrodynamics of Flow Past a DNA Molecule, Flexible Polymer Chains in Elongational Flow: Theories and Experiments, Eds. T.Q. Nguyen, H. H. Kausch, (Springer- Verlag) (1999).

9. **T.T. Perkins**, D.E. Smith, & S. Chu, Single Polymer Dynamics in an Elongational Flow, Science **276**, 2016–21 (1997).

8. R.G. Larson, **T.T. Perkins**, D. E. Smith, & S. Chu, Hydrodynamics of DNA Molecule in a Flow Field, *Physical Review E*. ***55*** *1794* (1997*).*

7. D.E. Smith, **T.T. Perkins**, & S. Chu, Dynamical Scaling of DNA Diffusion Coefficients, *Macromolecules* **29**, 1372–73 (1996).

6. D.E. Smith, **T.T. Perkins**, & S. Chu, *Self Diffusion of an Entangled DNA Molecule by Reptation*, *Physical Review Lett*ers, 4146–49 (1995).

5. **T.T. Perkins**, D.E. Smith, & R.G. Larson, S. Chu, Stretching of a single tethered polymer in a uniform flow, *Science* **268**, 83–87 (1995).

4. **T.T. Perkins**, D.E. Smith, & S. Chu, Optical manipulation of single DNA molecules, Physics in 1994 (AIP)

3. **T.T. Perkins**, S.R. Quake, D.E. Smith, & S. Chu, Relaxation of a single DNA molecule observed by optical microscopy, *Science* **264** 822–826 (1994).

2. **T.T. Perkins**, D.E. Smith, & S. Chu, Direct observation of tube-like motion of a single polymer chain, *Science* **264**, 819–822 (1994). [Cover Article]

1. **T.T. Perkins**, Steady-state gain and saturation flux measurements in a high efficiency, electron-beam-pumped, Ar-Xe laser, *J. Appl. Phys.* **74**, 4860–66 (1993).

Research Support.

NSF Becker and Rey (PI) 9/01/2023-08/31/2029
JILA-PFC: Comprehension and Control of Emerging Complexity at the Quantum Frontier
Amount: $25,200,000 ($300k for the Perkins lab): Role: I

NSF MCB- 2139572 Perkins (PI) 1/1/2022-12/31/2025
Nanomechanics of tubulin extraction from microtubules and adhesin catch-bond rupture
Amount: $ 1,149,515. Role: PI

NIH 2 R01 HL117138 Leinwand, Perkins, & Spudich (Multi-PI) 2/15/2018-1/31/2023
Molecular characterization of cardiomyopathy mutations in human cardiac myosin
Amount: $2,355,327 ($715k for the Perkins lab). Role: PI

NSF MCB-1716033 Perkins (PI) 7/1/2017-6/30/2022
Folding and mechanical response of single proteins probed at high spatio-temporal precision
Amount: $794394. Role: PI

AHA 18TPA34170194 Leinwand (PI) & Perkins (co-PI) 7/1/2018-6/30/2022
Mutant Myosin Misfolding as a Novel Mechanism of Hypertrophic Cardiomyopathy
Amount: $300,000 ($150k for the Perkins lab). Role: co-PI

NSF Phy-1734006 Cornell (PI) 9/01/2017–08/31/2023
JILA PFC: Measurement, Manipulation, and Meaning at the Quantum Frontier
Developing advanced cantilevers and laser based methods to study biological molecules.
Amount: $16.1M, $50k/yr for Perkins Lab. Role: I

NSF MRI-1531996 Raschke (PI), Perkins, Shaheen, Nagpal, Cundiff 9/1/2015-8/31/2019
MRI: Development of an infrared scanning near-field optical microscope (IR s-SNOM) for broadband nano-imaging and -spectroscopy
Amount: $715,000 (including 30% cost match by CU), Role: co-PI

NSF DBI-1353987 Perkins (PI), 7/1/2014 -6/30/2018
An ultraprecise and ultrastable atomic force microscope for multimodal characterization of biological molecules and materials.
Amount: $665,000. Role: PI

University of Colorado, Butcher Award, Perkins & Garcea (PI) 4/1/2014-3/31/2016
Single-molecule physical probing of glycan recognition by viral capsid proteins Amount: $70,000. $35k for the Perkins lab. Role: co-PI;.

NSF Phys-1125844, Cornell (PI), Jin, Greene, & Leinberger 8/15/2011-7/31/2017
JILA PFC: Bridging the gap from few-Body to Many Body through Quantum Control
Developing advanced laser based methods to study biological molecules.
Amount: $20,045,000, $50k/yr for Perkins Lab. Role: I

NIST-BioFrontiers Seed Grant, Perkins (PI) & Anseth 3/1/2013-12/31/2013
Photo-initiated site-specific labeling for single-molecule studies
Amount: $60k, $40k for the Perkins Lab. Role: PI

NSF DBI-0923544 MRI, Perkins (PI), Stowell & Falke 8/15/2009-8/14/2013
Development of an Atomic Force Microscope with Atomic Scale Stability for Biological Studies in Water.
Amount: $854,833 (including 30% cost match by CU). Role: PI

University of Colorado, Innovative Seed Grant, Perkins (PI) 7/01/2009-6/30/2010

Efficient mechanical unfolding of individual riboswitches
Amount: $41,250. Role: PI

University of Colorado, Butcher Award, Hoenger and Perkins (PI) 7/01/2008-11/11/2011
Imaging microtubules with an ultra-stable atomic force microscope
Amount: $100,000. Role: PI

NSF PHY-0551010 Cornell, Jin, & Leinberger (PI) 8/01/2006-7/31/2011
JILA Center for Atomic, Molecular, and Optical Physics
Developing advanced laser based methods to study biological molecules.
Amount: $16,295,323: $50k/yr for Perkins Lab. Role: I

NSF PHY-0404286 Perkins (PI), Betterton, and Goodrich 8/1/2004-7/31/2009
Watching proteins bend DNA with sub-nanometer resolution
Amount: $1.5 M. $900K for the Perkins Lab. Role; PI,

University of Colorado, Technology Transfer Award Perkins (PI) 7/01/2008-9/31/2008
Towards a Nano-Scale Milling Machine: Registered SPM Tip Exchange
Amount: $10k (+ $10k NIST match). Role: PI

National Academies Keck *Futures Initiative* Grant, Perkins (PI) 5/2/2005-6/30/2007
A Widely Applicable, Highly Sensitive RNA-Based Biosensor
Amount: $75k + 37.5k CU matching funds. $65K for the Perkins Lab Role. PI.

W. M. Keck Foundation, Yarus (PI) 1/1/2004-12/31/2005
Initiative in RNA Science
Amount: $1.5 M; $340k for Perkins Lab. Role: co-PI

NSF PHY-0096822 Cornell, Lineberger, & Weiman (PI) 3/01/2002-2/28/2006
Group Research in Atomic, Molecular and Optical Physics at JILA
Developing laser based methods to measures sub-nanometer motions of enzymes.
Amount: $15M : $30k/yr for Perkins Lab. Role: I

University of Colorado, *Butcher Award*, Betterton, Goodrich & Perkins (PI) 7/1/2003-6/30/2004
Single-molecule studies of transcription factors
Amount: $100k: $60k/yr for Perkins Lab. Role: PI

BWF, *Career Award in the Biomedical Scinces,* Perkins (PI) 9/1/1999-8/31/2008
Measurements of single DNA-based molecular motors. Amount: $500k Role: PI