

## **Edward S. Boyden, Ph. D.**

Leader, Synthetic Neurobiology Group  
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### **Vision**

My group invents, and applies, technologies that enable the systematic mapping and repair of the brain and other complex biological systems. Our philosophy is to try to bring the observation and fixing of such complex systems to a “ground truth” level, so that we can understand and address the fundamental mechanisms of operation of these systems. We are developing tools that enable molecular mapping of large 3-D biological systems with nanoscale precision, recording of the high-speed dynamics of brain circuits and other 3-D biological systems, and control of the activity of brain cells using new synthetic biology tools engaged by pulses of light. Ultimately we hope to create technologies that enable the correction of brain disorders and other complex diseases that affect almost everyone, directly or indirectly, and to provide insights into how the brain generates thoughts and feelings, essential to understanding the human condition.

### **Research and work activities**

**Massachusetts Institute of Technology**, Cambridge, MA (June 2014- )  
*Associate Professor with Tenure*, MIT Media Lab  
*Investigator*, MIT McGovern Institute  
*Joint Professor*, MIT Department of Biological Engineering  
*Joint Professor*, MIT Department of Brain and Cognitive Sciences  
*Associate Member*, Broad Institute  
*Leader*, Synthetic Neurobiology Group  
*Co-director*, MIT Center for Neurobiological Engineering  
Developing tools for systematic analysis and engineering of the brain.

**Massachusetts Institute of Technology**, Cambridge, MA (Jan 2011-May 2014)  
*Associate Professor*, MIT Media Lab (Benesse Career Development Professor 2011-2013, AT&T Career Development Professor, 2013-2014)  
*Investigator*, MIT McGovern Institute  
*Joint Professor*, MIT Department of Biological Engineering  
*Joint Professor*, MIT Department of Brain and Cognitive Sciences  
*Associate Member*, Broad Institute  
*Leader*, Synthetic Neurobiology Group  
*Co-director*, MIT Center for Neurobiological Engineering  
Developing tools for systematic analysis and engineering of the brain.

**Massachusetts Institute of Technology**, Cambridge, MA (Jan 2007-Jan 2011)  
*Assistant Professor*, MIT Media Lab (Benesse Career Development Professor)  
*Joint Professor*, MIT Department of Biological Engineering  
*Joint Professor*, MIT Department of Brain and Cognitive Sciences  
*Leader*, Synthetic Neurobiology Group  
Developing tools for systematic analysis and engineering of the brain.

**Massachusetts Institute of Technology**, Cambridge, MA (Nov 2006-Jan 2007)  
*Visiting Scientist*, MIT Media Lab; *Leader*, Neuroengineering and Neuromedia Group  
Developing tools for systematic analysis and engineering of the brain.

**Stanford University**, Stanford, CA (Oct 2005-Oct 2006)  
*Helen Hay Whitney fellow*, Depts. of Bioengineering, Applied Physics, Biological Sciences, with Drs. Mark Schnitzer and Karl Deisseroth  
Inventing optical methods for accelerating neuroscience progress.

**Stanford University**, Stanford, CA (Sep 1999-Oct 2005)

*Hertz predoctoral fellow, NIH NRSA predoctoral fellow*, Program in Neurosciences, Depts. of Molecular and Cellular Physiology and Neurobiology, with Drs. Jennifer Raymond and Richard Tsien.

Studied how neural circuits selectively engage plasticity to store specific memories.  
Co-developed optogenetics (an independent side collaboration, parallel to PhD work).

**Bell Labs**, Lucent Technologies, Murray Hill, NJ (1998-99)

*Research assistant*, with Drs. Sebastian Seung and Michale Fee.

Created an elementary phase-resetting model of birdsong stochasticity.

Helped implement active electrode stabilizer for neural recordings in awake animals.

**Massachusetts Institute of Technology**, MIT Media Lab, Cambridge, MA (1998-99)

*Graduate research*, with Dr. Neil Gershenfeld.

Design and fabrication of prototype nuclear magnetic resonance (NMR) quantum computer.

Engineered control software for the MIT ORCA-1 autonomous submarine.

Designed hardware for a MEMS accelerometer using electron-tunneling.

**Massachusetts Institute of Technology**, MIT Media Lab, Cambridge, MA (1996-98)

*Research assistant*, with Dr. Neil Gershenfeld.

Programmed machine-learning tools for reconstructing dynamics of a digital violin.

Created 3D, non-contact interactive design program based on electric field imaging of hands.

**Activision, Inc.**, Santa Monica, CA (1997)

*Research programmer*

Designed real-time, physics-based animation engine for video games.

**University of North Texas** Chemistry Department, Denton, TX (1994-95)

*Research assistant*, with Dr. Paul Braterman

Research on the origins of life; synthesized and analyzed layered double hydroxides with intercalated anions.

## Education

**Stanford University**, Stanford, CA (1999-2005)

GPA: 4.1/4.0

PhD, Neurosciences

Thesis title: *Task-specific neural mechanisms of memory encoding*

Advisors: Drs. Jennifer Raymond and Richard Tsien.

**Massachusetts Institute of Technology**, Cambridge, MA (1995-99)

GPA: 5.0/5.0

M.Eng., Electrical Engineering and Computer Science

B.S., Electrical Engineering and Computer Science

B.S., Physics

Thesis title: *Quantum Computation: Theory and Implementation*

Advisor: Dr. Neil Gershenfeld

**Texas Academy of Mathematics and Science**, University of North Texas, Denton, TX (1993-95)

GPA: 4.0/4.0

## Major awards and honors (since 1998)

### Major international prizes and honors

2017, American Academy of Arts and Sciences, elected member

2016, Breakthrough Prize in Life Sciences

2015, BBVA Foundation Frontiers of Knowledge Award

2015, Society for Neuroscience Young Investigator Award

2015, Carnegie Prize in Mind and Brain Sciences

2014, Schuetze Award in Neuroscience

2013, Jacob Hessel Gabbay Award

2013, Grete Lundbeck European Brain Research Prize ("The Brain Prize")

2011, Perl/UNC Neuroscience Prize

2011, A F Harvey Prize

2010, *Nature Methods* Method of the Year (Optogenetics)  
2007, Society for Neuroscience, Research Award for Innovation in Neuroscience (RAIN)  
2006, *Technology Review* TR35, World's Top 35 Innovators under Age 35

**Named lectureships and keynotes (selected; full list at end)**

2017, Breakthroughs in Biology (Hadad) lecture, Haverford College  
2017, Boston Photonics Centennial, keynote  
2017, Foundations of Nanoscience, keynote  
2016, Karen L. Wrenn Lectureship, Duke University  
2016, Optogenetics Day, Keynote, Neurex, Strasbourg, France  
2016, Litwack Lecture, North Carolina State University  
2016, Schueler Lecture, Tulane University  
2016, Hello Tomorrow Global Summit, Keynote, Paris, France  
2016, National Society of for Histotechnology Annual Symposium, Keynote Lecture  
2015, Keynote, Gulf Coast Cluster for Neuroengineering 5th Annual Symposium, Houston, TX.  
2015, NIH Director's Lecture, NIH  
2015, Milton Gordon Lecturer, University of Washington  
2015, Crill Lecturer, University of Washington  
2015, SPIE Optogenetics Conference, Keynote  
2014, "Talking Science" Lecture, Munich, Germany  
2014, Gordon Conference, Membrane Transport Proteins, Keynote  
2014, Special Lecturer, 9th FENS Forum of Neuroscience  
2014, Featured Plenary Speaker, Canadian Neuroscience Meeting  
2014, Carl P. Duncan Lecturer, Northwestern University  
2014, Edward Llewellyn-Thomas Lecturer, University of Toronto  
2014, Theodore Koppanyi Lecturer, Georgetown University  
2014, Director's Special Colloquium, Argonne National Laboratory  
2014, Brain Prize Talk, XXVIII Sandbjerg Symposium, Danish Society for Neuroscience  
2013, Herman P. Schwan Lecturer, University of Pennsylvania  
2013, Marine Biology Laboratory, Friday Evening Lecturer  
2013, Leica Scientific Forum Lecturer  
2013, Georgia Tech/Emory University "Young Innovator In Biomedical Engineering"  
2013, Brain Prize Meeting, Keynote Address  
2013, Neuroscience Day Lecturer, University of New Mexico  
2013, Society for Neuroscience, Symposium Speaker  
2012, Bagrit Lecturer, Imperial College London  
2012, 2013, 2016, World Economic Forum, Davos, Switzerland, Invited Speaker  
2012, The Brain: An Owner's Guide Lecture, UT Dallas Center for Brainhealth  
2011, Sackler Lecturer, Leiden University Medical Center  
2011, SPIE "Hot Topics" Opening Session, Plenary Lecturer  
2011, Mahoney Institute of Neurological Sciences Retreat, University of Pennsylvania, Keynote  
2011, Honors Colloquium, University of Rhode Island  
2011, 4th Conference on Artificial General Intelligence, Keynote Address  
2011, Harvard Biophysics Retreat, Keynote address  
2011, Taiwan Neuroscience Society Meeting, Keynote Address  
2011, Issekutz Memorial Lecturer, Dalhousie University  
2010, Spivack Distinguished Lecturer, Boston University  
2008, NIMH Annual Retreat, Keynote Lecture

**Honorary grant awards**

2016, Howard Hughes Medical Institute Simons Faculty Scholar  
2013, NIH Director's Pioneer Award  
2013, NIH Director's Transformative Research Award  
2013, NSF INSPIRE Award  
2012, NIH Director's Transformative Research Award  
2011, NIH EUREKA Award  
2011, New York Stem Cell Foundation-Robertson Investigator Award  
2011, NSF CAREER Award

2010, Paul Allen Distinguished Investigator Award in Neuroscience  
2008, NARSAD Young Investigator Award  
2008, Alfred P. Sloan Research Fellowship  
2007, NIH Director's New Innovator Award  
2007, Wallace H. Coulter Foundation Early Career Translational Research Award in Biomedical Engineering  
2005, McKnight Technological Innovations in Neuroscience Award, Investigator  
2005, Helen Hay Whitney Fellowship  
1999, Fannie and John Hertz Fellowship

#### **Other honors**

2017, *Nature Methods* Method to Watch (Expansion Microscopy)  
2016, TED Summit, Invited Speaker  
2016, Boston Globe, 2016 Game Changers  
2014, Academy of Achievement, Delegate  
2013, 10 Life Science Superstars 40 and Under, Genetic Engineering & Biotechnology News  
2013, World Economic Forum, Young Scientist  
2012, Wired, "Smart List 2012: 50 People Who Will Change the World"  
2011, TED, Invited Speaker  
2010, Eppendorf and Science Prize for Neurobiology, Finalist  
2008, Discover Magazine, 20 Best Scientists Under Age 40  
2007, Discovery Science Channel, Top 5 'Best Science Moments 2007'  
2006, Fannie and John Hertz Foundation, Top Ph.D. Thesis Prize  
2004, Dan David Prize Scholarship (Future Dimension, Brain Sciences)  
1998, International Autonomous Underwater Vehicle Competition, 1st place

#### **Other notable invited talks at conferences or special events (selected; full list at end)**

2017, 10th Annual Future of Genomic Medicine Conference, La Jolla, CA.  
2017, Max Planck Florida Sunposium 2017, Palm Beach, FL.  
2017, 14th Annual Advanced Imaging Methods Workshop at UC Berkeley, Berkeley, CA.  
2016, Molecular and Cellular Cognition Society, San Diego, CA.  
2016, 13th Key Symposium, New York City  
2016, Neurotechnology Center Kavli Futures Symposium, Columbia University  
2016, 2nd Proteins and Peptides International Conference, University of Geneva  
2016, Optogenetic Approaches to Understanding Neural Circuits & Behavior, Sunday River, Newry, ME  
2016, The Brain in Focus: New Approaches to Imaging Neurons and Neural Circuits, Rungstedgaard, Denmark.  
2016, Computational Neuroscience and Vision Systems, University of Massachusetts Amherst.  
2016, High-Resolution Circuit Reconstruction Conference, Janelia Farm.  
2016, Symposium, Biophysical Society 60th Annual Meeting, Los Angeles, CA.  
2015, Behavior & Neurogenetics of Nonhuman Primates, Cold Spring Harbor Laboratory.  
2015, Technology Integration Cross-Cutting Theme, 2nd Annual BRAIN Initiative Investigators Meeting, Bethesda, MD.  
2015, PopTech, Camden, ME  
2015, Science Writers 2015, Council for the Advancement of Science Writing New Horizons in Science, Cambridge, MA, Plenary Talk.  
2015, 3rd Annual Workshop on Micro- and Nanotechnologies for Medicine: Emerging Frontiers and Applications  
2015, MindEx 2015, Mind First Foundation/Harvard Personal Genome Project  
2015, 21st International Conference on DNA Computing and Molecular Programming  
2015, Albany 2015: the 19th Conversation  
2015, Photonics Media, Webinar  
2015, Dana Foundation/AAAS Capitol Hill Briefing  
2015, 2nd International Workshop on Mammalian Synthetic Biology  
2015, 3rd NIH Single Cell Meeting, NIH, Bethesda, MD  
2015, Neural Engineering and Systems Design BootCamp, DARPA  
2015, Brain Forum 2015, Lausanne, Switzerland  
2014, NIH High-Risk-High-Reward Symposium

2014, Russian-American Research Symposium, Moscow, Russia  
 2014, DFG-NSF workshop "New Perspectives of Neurotechnology and Neuroengineering,"  
 2014, Monitoring Molecules in Neuroscience, Plenary Lecture  
 2014, IEEE EMBS BRAIN Grand Challenges Conference, Washington DC  
 2014, The Scientist, Webinar  
 2014, Fourth Biennial Conference on Resting State/Brain Connectivity, MIT, Cambridge, MA.  
 2014, Congress of Neurological Surgeons Annual Meeting, Boston, MA.  
 2014, Plenary Talk, Techonomy  
 2014, 2nd Workshop, Micro- and Nanotechnologies for Medicine: Emerging Frontiers and  
 Applications, Brigham and Women's Hospital, Harvard, Cambridge, MA.  
 2014, Translational Neuroscience Center Inaugural Symposium, Children's Hospital, Harvard  
 Medical School.  
 2014, Gordon Conference on Lasers in Medicine and Biology, Holderness, NH.  
 2013, 7th World Congress of Biomechanics, Boston, MA.  
 2014, Molecular Frontiers Symposium, Royal Swedish Academy of Sciences, Stockholm,  
 Sweden  
 2014, Lester Wolfe Workshop on Laser Biomedicine, Massachusetts General Hospital,  
 Boston, MA  
 2014, Neuronal Circuits Meeting, Cold Spring Harbor  
 2013, CURE the Epilepsies: Frontiers in Research Seminar, Albert Einstein College of  
 Medicine, Bronx, NY  
 2013, Royal Swedish Academy of Sciences Symposium: Optogenetics, Stockholm, Sweden  
 2013, What is Life? Lecture, Karolinska Institute, Stockholm, Sweden  
 2013, Society for Neuroscience Symposium, "All for one and one for all: progress in single  
 cell Neurobiology", San Diego, CA  
 2013, Brain Prize Meeting, Hindsgravl Castle, Denmark.  
 2013, Brain Prize Day, Aarhus University, Denmark.  
 2013, 1st International Israeli Brain Technology Conference, Tel Aviv, Israel.  
 2013, Neuroscience Day, University of New Mexico, Albuquerque, NM.  
 2013, NIH Single Cell Meeting, Bethesda, MD.  
 2013, Harvard Mind, Brain, and Behavior Junior Symposium 2013.  
 2013, Accelerating Translational Neurotechnology: Fourth Annual Aspen Brain Forum,  
 Aspen, CO.  
 2013, New Advances in Optical Imaging of Live Cells & Organisms, Cold Spring Harbor Asia,  
 Suzhou, China.  
 2013, Association of Research in Otolaryngology, Baltimore, MD.  
 2012, 8th Kavli Futures Symposium: Tool Development for the Brain Activity Map,  
 Washington, DC.  
 2012, 7th Brain Research Conference, Optogenetics and Pharmacogenetics, Society for  
 Neuroscience Official pre-meeting, New Orleans, LA.  
 2012, IET Inspec Webinar, Online.  
 2012, Japan Neuroscience Society 35th Annual Meeting, Nagoya, Japan.  
 2012, "Cracking the Neural Code" Meeting, Aspen Brain Forum, Aspen, CO.  
 2012, David Colman Symposium, Montreal Neurological Institute/McGill University, Montreal,  
 Canada.  
 2012, Cell Press, Webinar.  
 2012, Photosensory Receptors & Signal Transduction Gordon Research Conference,  
 Galveston, TX.  
 2011, 14th Annual International Symposium on Neural Regeneration, Monterey, CA.  
 2011, 15th Annual Future of Light Symposium, Boston University Photonics Center, Boston  
 University, Boston, MA.  
 2011, Ar Seminar Series, Inaugural Lecture, Champalimaud Institute for the Unknown,  
 Lisbon, Portugal.  
 2011, Symposium on the Emerging Genetics and Neurobiology of Severe Mental Illness,  
 Broad Institute, Cambridge, MA.  
 2011, Genetic and Neural Complexity of Psychiatry, Santorini, Greece.  
 2011, New Frontiers in Neurodegeneration Symposium, UMass Medical School  
 Neurotherapeutics Institute/Biogen Idec, Cambridge, MA.  
 2011, Selected Talk, 7th NIH Director's Pioneer Award Symposium, Bethesda, MD.

2011, 7th NIH Inter-Institute Workshop on Optical Diagnostic and Biophotonic Methods from Bench to Bedside, NIH, Bethesda, MD.

2011, 15th Annual Conference on Cognitive and Neural Systems, Boston University, Boston, MA.

2011, Boehringer Ingelheim Fonds 103rd International Titisee Conference, Genetic analysis of neural circuits, Titisee, Germany.

2011, Association for Research in Otolaryngology MidWinter Meeting, Baltimore, MD.

2010, Minisymposium: Toward the Second Generation of Optogenetic Tools, Society for Neuroscience, San Diego, CA.

2010, Allen Institute for Brain Science Symposium, Open Questions in Neuroscience, Seattle, WA.

2010, Aspen Brain Forum: Building Better Brains: Neural Prosthetics and Beyond, Aspen, Colorado.

2010, 14th International Conference on Retinal Proteins, Santa Cruz, CA.

2010, INCF Neuroinformatics Congress, Kobe, Japan.

2010, Gordon Research Conference on Lasers in Medicine and Biology, Holderness, New Hampshire.

2010, Multi-modal Neural Training Program Symposium, Carnegie Mellon University and University of Pittsburgh, Pittsburgh, PA.

2010, Translational Research and Vision, National Eye Institute 40th Anniversary Symposium, NIH, Bethesda, MD.

2010, 27th Symposium of the Center for Visual Science, University of Rochester, Rochester, NY.

2010, 16th German-American Frontiers of Science Symposium, Potsdam, Germany.

2010, Neurotechnology Industry Organization Neurotech Investing and Partnering Conference, Boston, MA.

2010, Cambridge Science Festival, Cambridge, MA

2010, BrainForum 2010: The Brain Revolution, in honor of Rita Levi Montalcini's 101st birthday, Rome, Italy.

2010, Lester Wolfe Workshop in Laser Biomedicine, Boston, MA

2009, Sloan-Swartz Annual Meeting on Computational Neuroscience.

2009, Fifth Annual NIH Director's Pioneer Award Symposium, National Institutes of Health, Bethesda, MD.

2009, No Barriers Festival, Miami, FL

2009, Tufts Neuroscience Symposium, Tufts University, Cambridge, MA.

2009, NextGens Technologies Symposium, TTI/Vanguard, Salt Lake City, UT.

2008, Carolina Biophysics Symposium, Chapel Hill, NC.

2008, '10, '14, '16 Genetic Manipulation of Neuronal Activity, Janelia Farm, Ashburn, VA.

2008, O'Reilly ETech (Emerging Technology) Conference, San Diego, CA.

2008, Integrative Approaches to Brain Complexity Conference, Cold Spring Harbor/Wellcome Trust, Wellcome Trust Conference Center, Hinxton, UK.

2008, Integrative Brain Research Symposium, Sapporo, Japan.

2008, Neuroscience Spring Symposium, University of Michigan.

**Other training**

**Cold Spring Harbor Laboratories**, Cold Spring Harbor, NY (2001)  
 Biology of Memory: From Molecules to Behavior, Summer Course  
 Directors: Drs. Kelsey Martin, Jack Byrne, Howard Eichenbaum, Larry Squire

**Marine Biological Laboratory**, Woods Hole, MA (2000)  
 Neural Systems and Behavior, Summer Course  
 Directors: Drs. Catherine Carr and Rick Levine

**Classes Taught**

**Applications of Neuroengineering**, MAS.882/9.433, MIT (Spring 2008, Spring 2009)  
 Project-focused course in which students take top-down approach to developing technologies that address critical clinical and basic-science problems of human brain function. Focus is on application of engineering principles to development of systematically powerful tools. Problem domains include neurological/psychiatric disorders, consciousness, and human cognitive augmentation. Students work in teams to apply cross-disciplinary (e.g., molecular, physical, nanotechnological) building blocks to design new tools for the analysis and engineering of the brain.

**Bioinstrumentation Project Lab**, 20.345, MIT (Spring 2011, Spring 2012, Spring 2013, Spring 2014, Spring 2015, Spring 2016)

In-depth examination of instrumentation design, principles and techniques for studying biological systems, from single molecules to entire organisms. Lectures cover optics, advanced microscopy techniques, electronics for biological measurement, magnetic resonance imaging, computed tomography, MEMs, microfluidic devices, and limits of detection. Students select two lab exercises during the first half of the semester and complete a final design project in the second half. Lab emphasizes design process and skillful realization of a robust system. (Taught in collaboration with M. F. Yanik, S. Nagle, P. So, S. Wasserman, M. Jonas, E. Frank, and others.)

**Biological Instrumentation and Measurement**, 20.309, MIT (Spring 2009, Spring 2010, Spring 2014, Spring 2015, Spring 2016, Spring 2017)

Sensing and measurement aimed at quantitative molecular/cell/tissue analysis in terms of genetic, biochemical, and biophysical properties. Methods include light and fluorescence microscopies, and electro-mechanical probes (atomic force microscopy, optical traps, MEMS devices). Application of statistics, probability, signal and noise analysis, and Fourier techniques to experimental data. Preferences given to juniors and seniors. (Taught in collaboration with M. F. Yanik, S. Nagle, P. So, S. Wasserman, M. Jonas, E. Frank, and others.)

**Neurotechnology Ventures**, MAS.883/9.455/20.454/15.128 (MAS.961/9.912J/HST.588 in Spring 2007; MAS.883/9.455/20.454/15.128/HST.588 Fall 2008-Fall 2009), MIT (Spring 2007, Fall 2008, Fall 2009, Fall 2010, Fall 2011, Fall 2012, Fall 2013, Fall 2014)

A special seminar focused on the challenges of envisioning, planning and building startups; commercializing innovations from neuroscience; and the blossoming domain of neuroengineering. (Taught in collaboration with J. Bonsen and R. Ellis-Behnke.)

**Principles of Neuroengineering**, MAS.881/20.452/9.422, MIT (Fall 2007, Fall 2008, Fall 2009, Fall 2010, Fall 2011, Fall 2012, Fall 2013, Fall 2014, Fall 2015)

Covers principles underlying current and future technologies for brain analysis and engineering, for neurology, psychiatry, and neuroscience. Focuses on using biophysical, biochemical, and anatomical models to understand technology design constraints governing ability to observe and alter brain function. Topics include functional magnetic resonance imaging, electromagnetic recording/stimulation, neuropharmacology, optical cellular imaging, and gene/stem-cell therapy. Design projects by student teams.

**Revolutionary Ventures**, MAS.883/9.455/20.454/15.128, MIT (Fall 2015)

Seminar on envisioning and building ideas and organizations to accelerate engineering revolutions. Focuses on emerging technology domains, such as neurotechnology, imaging, cryotechnology, gerontechnology, and bio-and-nano fabrication. Draws on historical examples as well as live case studies of existing or emerging organizations, including labs, institutes, startups, and companies. Goals range from accelerating basic science to developing transformative products or therapeutics. Each class is devoted to a specific area, often with invited speakers, exploring issues from the deeply technical through the strategic. Individually or in small groups, students prototype new ventures aimed at inventing and deploying revolutionary technologies. (Taught in collaboration with J. Bonsen, D. Dudley, J. Jacobson, and A. Marblestone.)

## **Social and professional activities**

### **Advisory roles**

2014, The Brain Challenge, Advisor  
2013-present, University of Pennsylvania Gene Therapy Center, steering committee  
2012, confidential foundation, advisory committee  
2012-present, Tufts Center for Neuroscience Research, Science Advisor  
2011-present, Faculty of 1000 (F1000), Member  
2011-present, Brain Sciences Foundation, steering committee  
2010-2016, Technology Review TR35 Young Innovators Under 35, Judge  
2010-present, Cognitive Rhythms Collaborative (Boston-wide network working on brain dynamics), executive committee

2010-present, Aspen Brain Forum, Scientific Advisory Board  
2009-present, Lifeboat Foundation, Advisory Board  
2007-present, Fannie and John Hertz Foundation, Fellowship Interviewer

### **Invited workshops, panels, and events**

2017, Panel, AI Frontiers - Straight from the Labs, MIT Club of Northern California Spotlight Conference, Redwood City, CA.  
2017, Human Cell Atlas Meeting, Chan Zuckerberg Science, Stanford, CA, invited participant  
2016, Breakthrough Prize Panel, Theory of Everything, Berkeley, CA  
2016, Enhancing Humans: How Far Can We Go?, Panel, Hello Tomorrow Global Summit, Paris, France  
2016, "Convergence: The Future of Health," MIT Washington Office, Science Advisor  
2016, Reddit AskScience "Ask Me Anything"  
2016, NIMH Convergent Neuroscience Virtual Workshop  
2015, Breakthrough Prize Panel, Why is the Universe Understandable?, Berkeley, CA  
2015, Kavli Futures Symposium, Is it time for national BRAIN observatories?, Argonne National Laboratory  
2015, Epilepsy Innovation Meeting, Epilepsy Foundation, Cambridge MA  
2015, Kavli Workshop on Cortical Computation, Cambridge MA  
2015, Frontiers in Neurophotonics Summer School, Quebec City, Canada  
2015, NIH Workshop on Defining Cellular Phenotypes, invited participant  
2015, Dialog Retreat, invited participant  
2015, Neural Engineering and Systems Design BootCamp, DARPA, invited participant  
2014, Simons Foundation Autism Research Initiative, Circuit Dynamics Workshop  
2014, Jackson Hole Science Media Awards, Panelist, Idea Salon: The Brain  
2014, Allen Institute for Brain Science, Human Cell Types Advisory Council Meeting  
2014, 9<sup>th</sup> FENS Forum on Neuroscience, Big Questions in Neuroscience, invited panelist  
2014, NSF Panel, Surprising Reasons Why We Need Biodiversity, invited panelist  
2013, 1<sup>st</sup> International Workshop on Mammalian Synthetic Biology, discussion leader  
2013, NSF Workshop on Mapping and Engineering the Brain, Arlington, VA, invited participant  
2013, NIH Advisory Committee to the Director, Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Working Group Meeting, Invited Participant  
2013, Physical and Mathematical Principles of Brain Structure and Function, Workshop Sponsored by NSF & Kavli Foundation  
2012, 8th Kavli Futures Symposium: Tool Development for the Brain Activity Map, invited participant  
2012, Dahlem Conference, Optogenetics, Invited Participant  
2012, '13, '16, World Economic Forum, Davos, Switzerland, Discussion Leader  
2011, Milken Institute, Accelerating Innovation in the Bioscience Revolution, Invited Participant and Panelist  
2011, Allen Institute for Brain Science, Neural Coding Meeting, Invited Participant  
2011, Arnold and Mabel Beckman Initiative for Macular Research, National Academies of Sciences, Arnold and Mabel Beckman Center, Irvine, CA, invited participant  
2010, Science Magazine, advisory workshop  
2010, XPrize Workshop, "Brain-Computer Interfaces: Igniting a Revolution", featured advisor  
2010, European Commission, Medical Devices Expert Group, invited panelist  
2008, National Academies Keck Futures Initiative 2008: Complex Systems, Arnold and Mabel Beckman Center, Irvine, CA, invited participant  
2008, NIH Blueprint for Neuroscience Research, Pain Grand Challenges/Transformative R01 Workshop, invited participant  
2007, NIH Blueprint for Neuroscience Research, Neuroplasticity Workshop, invited participant  
2006, '07, '10, '12, '15 Science Foo (SciFoo) camp, Nature / Google / O'Reilly, invited participant  
2006, United Kingdom Office of Horizon Scanning, Institute for the Future, Palo Alto, CA, invited workshop participant

### **Teaching outside of MIT**



2016, Research Update in Neuroscience for Neurosurgeons Course, Marine Biology Laboratory, Woods Hole, MA.  
2014, Marine Biology Laboratory, Brains Minds and Machines Course, Visiting Faculty  
2013, Society for Neuroscience Short Course, "The Science of Large Data Sets: Spikes, Fields, and Voxels," lecturer  
2013, Cold Spring Harbor Ion Channels and Synaptic Transmission Course, Visiting Faculty  
2012, Marine Biology Laboratory, Neurobiology Course, Visiting Faculty  
2011, FENS-IBRO-SFN Summer School, Causal Neuroscience, Bertinoro, Italy, Faculty  
2011, '13, Marine Biology Laboratory, Neural Systems and Behavior Course, Visiting Faculty  
2009, Society for Neuroscience Short Course, "Rhythms of the Neocortex: Where Do They Come From and What Are They Good For?," lecturer

### **Conference organizing**

2017, 17th Congress of the European Light Microscopy Initiative, scientific advisory board  
2016, Expansion Microscopy Workshop, Janelia Research Campus, co-organizer  
2016, Optogenetics in Neuroscience, Symposium Chair, Biophysical Society 60th Annual Meeting, Los Angeles, CA.  
2015, NYSCF Immunoengineering Workshop, Co-Chair  
2014, IEEE EMBS BRAIN Grand Challenges Conference, International Program Committee  
2014-2017, Minnesota Neuromodulation Symposium, Program Committee  
2013, Cognitive Rhythms Collaborative "Rhythmic Dynamics and Cognition" Conference, Organizing Committee  
2013, "Optogenetics and optical control of biological processes", Symposium co-chair, CLEO conference, San Jose, CA  
2013, European Conferences on Biomedical Optics (ECBO), Neurophotonics program committee  
2012, SPIE BiOS 2012 Meeting, Neurons and Photons Conference, San Jose, CA, Program Committee  
2010, Computational and Systems Neuroscience (CoSyNe) Meeting, reviewer  
2010, Society for Neuroscience Meeting, Mini-Symposium Co-Chair, Towards the Second Generation of Optogenetic Tools, San Diego, CA  
2010-2015, Society for Neuroscience, Newsworthy Items Reviewer  
2010, Program Committee, First Augmented Human International Conference, '10, Megeve, France.  
2009, SPIE BiOS 2009 Meeting, Neurons and Photons Conference, San Jose, CA, Program Committee  
2008, Computational and Systems Neuroscience (CoSyNe) Meeting, Workshop Organizer, How to solve systems neuroscience problems with molecular tools, Snow Bird, Utah  
2007, BodyNets 2007 Conference, Florence, Italy, Technical Program Committee member

### **Editing and writing**

2016-present, Network Neuroscience, Editorial Board  
2014-present, Neural Computation, Editorial Board  
2014-present, Bioelectronic Medicines, Editorial Board  
2013-present, Journal of Neural Engineering, Editorial Board  
2012-2013, Optogenetics, Editorial Board  
2012, Neural Systems & Circuits, Editorial Board  
2012, Progress In Brain Research, invited co-editor of vol. 196, "Optogenetics"  
2011, *The Scientist*, invited writer (cover story, July 2011 issue)  
2011, Dana Foundation, invited writer ("Cerebrum" magazine, November/December 2011)  
2010, SPIE Newsroom, invited writer  
2000, NINDS Conference on Computational and Theoretical Neuroscience: From Synapse to Circuitry, writer

### **Other events**

2014, White House, BRAIN Initiative Conference, Invited Participant  
2013, White House/Pres. Obama BRAIN Initiative Launch, Invited Participant

### **Reviewing**

2017, NIH New Innovator Award, Final Review Committee

2016-on, Breakthrough Prize in Life Sciences, Selection Committee  
2016, Special Emphasis Panel ZRG1 IFCN-J(02)  
2016, 2016/05 ZRG1 MOSS-C (56) R RFA RM13-007: New Innovator Award  
2015, NIH 2016/01 BVS - Biology of the Visual System Study Section  
2015, NIH 2015/10 NSD-C, Neurological Sciences and Disorders C  
2015, NIH 2015/05 ZRG1 MOSS-C (56) R - RFA RM13-007: New Innovator Award  
2014, IEEE EMBS BRAIN Young Investigator Competition, Judge  
2014, NEI 2015/01 ZEY1 VSN (03) 2 - NEI K Training Grant Applications  
2014, NIH 2014/05 ZRG1 ETTN-H (53) R - Center for Scientific Review Special Emphasis Panel  
2013, 2014/01 RRDS R Rehabilitation Research and Development SPiRE Review Group, US Veterans Administration  
2012, Knut and Alice Wallenberg Foundation  
2012, National Institutes of Health Study Section ZRG1 ETTN-H (50) R  
2012, National Institutes of Health Study Section, ZRG1 BCMB-A (51) R, Transformative R01 Reviewing  
2012, 2013, confidential evaluator, two awarding foundations  
2011, CIMIT  
2011, Michael J. Fox Foundation  
2010-2014, National Institutes of Health Molecular Neurogenetics (MNG), Study Section Member  
2010, Vienna Science and Technology Fund  
2010, European Commission  
2010, U. S. Veterans Administration  
2010, 2012, 2014, Human Frontiers Science Program  
2010, Israeli Science Foundation  
2010 February, 2010 June, National Institutes of Health Study Section, Molecular Neurogenetics  
2010, Duke Institute for Brain Sciences  
2009, Wellcome Trust  
2009, NIH Challenge Grants  
2008, Alberta Ingenuity Fund (Ingenuity Centres Program)  
2008, National Institutes of Health Study Section ZRG1 MDCN-B(90), Tools to Investigate Neural Circuit Development  
2007, National Institutes of Health Study Section ZRG1 MDCN-P(02), Neurodegeneration and Disease Mechanisms  
2006-present, National Science Foundation

**Reviewer for journals:**

Biophysical Journal  
Cell  
Cell Reports  
Current Biology  
Drug Discovery Today  
IEEE Journals  
Journal of Neural Engineering  
Journal of Neurophysiology  
Journal of Neuroscience  
Journal of Neuroscience Methods  
Journal of Selected Topics in Quantum Electronics  
Lasers in Surgery and Medicine  
mBio  
Nature  
Nature Biotechnology  
Nature Chemical Biology  
Nature Methods  
Nature Neuroscience  
Nature Protocols  
Neuron  
PLoS ONE

PLoS Biology  
Proceedings of the National Academy of Sciences  
Science  
Scientific Reports

### **Memberships**

2000-present, Society for Neuroscience, member

### **MIT**

2016, MIT Research and Development Conference, lecturer  
2016, MIT President's Convocation for Incoming Freshman, speaker  
2016, MIT Freshman Pre-Orientation Program, Discover Brain and Cognitive Sciences, Lecturer  
2016-present, MIT PRIMES (Program for Research in Mathematics, Engineering and Science for High School Students) program, faculty mentor  
2016, MIT Media Lab Artificial Intelligence and Governance Meeting, Participant  
2016, MIT Sidney Pacific Presidential Fellows Distinguished Lecture Series, "Reverse Engineering, and Repairing, the Brain and Mind," with Alan Jasanoff  
2015, visit to MIT by U.S. Secretary of Defense, presenter  
2015, CBMM Retreat, Entrepreneurship tutorial lecturer  
2015, CBMM Summer Workshop for Teachers about the Brain, lecturer  
2015, The Accenture and MIT Alliance on Business Analytics, Spring Meeting, Keynote  
2014, 2015, MIT Neurotech Symposium, co-chair  
2014, MIT Laureates and Leaders Program, lecturer  
2014, MIT Science and Engineering Program for Teachers, lecturer  
2014, MIT CEO Advisory Board, presenter  
2014-present, MIT Center for Environmental Health Sciences, faculty member  
2014, 2015, Center for Brains, Minds, and Machines Summer School, lecturer  
2014, MIT Cardinal and Gray Academy (50<sup>th</sup> reunion) Alumni Event Presentation, "Center for Neurobiological Engineering"  
2014, MIT Class of 1974 40<sup>th</sup> Reunion, dinner speaker  
2013, MIT Tech Day featured speaker, "Unraveling the Workings of the Brain"  
2013-present, Broad Institute, Associate Member  
2013, MIT Simons Center for the Social Brain, Workshop "The Social Brain — New Opportunities for Discovery and Technology Development" Panelist  
2012-present, MIT-MGH Initiative, member  
2008, '11, MIT Knight Science Journalism Program lecturer  
2013-present, MIT Center for Neurobiological Engineering, co-director  
2013-2014, AT&T Career Development Professor  
2012-present, SkTech faculty search committee  
2012-present, SkTech curriculum committee  
2007-2013, Benesse Career Development Professor  
2010-present, Investigator, MIT McGovern Institute  
2009-present, MIT Interdepartmental Graduate Program in Biophysics, faculty member  
2009-present, MIT Molecular and Cellular Neuroscience Track, faculty member  
2009-present, MIT Microsystems Technology Laboratories, affiliate member  
2009-present, *Technology Review*, invited columnist  
2008-present, MIT Department of Brain and Cognitive Sciences, joint professor  
2007-present, *Technology Review*, official blogger/writer  
2007-present, MIT Department of Biological Engineering, joint professor  
2007-2010, MIT McGovern Institute for Brain Research, Associate Faculty  
2007-2013, MIT Picower Center for Learning and Memory, Affiliate Faculty  
2007, MIT Department of Biological Engineering, Affiliate Faculty  
2007-on, MIT Neurotechnology Seminar Series (informal), host  
2006-present, MIT Computational and Systems Biology Initiative, Faculty Member

### **Departmental, MIT Media Lab**

2013-2014, MIT Media Lab Media Arts and Sciences Faculty Search Committee  
2012, MIT Media Lab Inside/Out Symposium, co-organizer

2009-present, MIT Media Lab Media Arts and Sciences, Environmental Health and Safety Officer  
2008-2009, MIT Media Lab Media Arts and Sciences Faculty Search Committee  
2007-2008, MIT Media Lab Media Arts and Sciences Steering Committee (aka MASCOM; academic committee)  
2007, MIT Media Lab DCGS (Department Committee on Graduate Studies)  
2006-present, MIT Media Lab IPCOM (Intellectual Property Committee)

#### **Departmental, MIT Biological Engineering**

2007-present, MIT Biological Engineering Undergraduate Advising  
2007-2009, MIT Biological Engineering Undergraduate Programs Committee

#### **Departmental, MIT McGovern Institute/Picower/BCS**

2013, MIT Brains on Brains Event, Neurotechnology Panel and Panel Chair  
2013-present, MIT Brain and Cognitive Sciences Undergraduate Advising  
2011-present, MIT BCS Multiphoton Microscope Core Committee  
2010, MIT McGovern Institute Symposium: Cells, Circuits, and Behavior, co-organizer

#### **Major Publications**

##### **Papers (peer-reviewed)**

1. Maguire, Y., Boyden, E. S., Gershenfeld, N. (2000) Toward a table-top quantum computer, *IBM Systems Journal* 39:3&4, p.823.
2. Boyden, E. S., Raymond, J. L. (2003) Active reversal of motor memories reveals rules governing memory encoding, *Neuron* 39(6):1031-42.
3. Boyden, E. S.\*, Katoh, A.\*, Raymond, J. L. (2004) Cerebellum-dependent learning: The role of multiple plasticity mechanisms, *Annual Review of Neuroscience* 27:581-609. (\* co-first authors)
4. Kimpo, R. R.\*, Boyden, E. S.\*, Katoh, A., Ke, M. C., Raymond, J. L. (2005) Distinct patterns of stimulus generalization of increases and decreases in VOR gain, *Journal of Neurophysiology* 94(5):3092-3100. (\* equal contribution)
5. Boyden, E. S., Zhang, F., Bamberg, E., Nagel, G., Deisseroth, K. (2005) Millisecond-timescale, genetically-targeted optical control of neural activity, *Nature Neuroscience* 8(9):1263-1268.
6. Boyden, E. S., Katoh, A., Pyle, J. L., Chatila, T. A., Tsien, R. W., Raymond, J. L. (2006) Selective engagement of plasticity mechanisms for motor memory storage, *Neuron* 51(6):823-834.
7. Zhang, F., Wang, L.-P., Boyden, E. S., Deisseroth, K. (2006) Channelrhodopsin-2 and optical control of excitable cells, *Nature Methods* 3(10):785-92.
8. Han, X. and Boyden, E. S. (2007) Multiple-color optical activation, silencing, and desynchronization of neural activity, with single-spike temporal resolution, *PLoS ONE* 2(3): p. e299.
9. Wang, H., Peca, J., Matsusaki, M., Matsusaki, K., Noguchi, J., Qiu, L., Wang, D., Zhang, F., Boyden, E. S., Deisseroth, K., Kasai, H., Hall, W. C., Feng, G., Augustine, G. J. (2007) High-speed mapping of synaptic connectivity using photostimulation in channelrhodopsin-2 transgenic mice, *Proceedings of the National Academy of Sciences* 104(19):8143-848.
10. Liao, Y. J., Safa, P., Chen, Y.-R., Sobel, R. A., Boyden, E. S., Tsien, R. W. (2008) Anti-Ca<sup>2+</sup> channel antibody attenuates Ca<sup>2+</sup> currents and mimics cerebellar ataxia *in vivo*, *Proceedings of the National Academy of Sciences* 105(7):2705-2710.
11. Han, X.\*, Qian, X., Bernstein, J.G., Zhou, H.-H., Talei Franzesi, G., Stern, P., Bronson, R.T., Graybiel, A.M., Desimone, R., and Boyden, E.S.\* (2009) Millisecond-Timescale Optical

Control of Neural Dynamics in the Nonhuman Primate Brain, *Neuron* 62(2):191-198. (\* co-corresponding authors)

12. Han X., Qian X., Stern P., Chuong A. and Boyden E.S. (2009) Informational Lesions: Optical Perturbation of Spike Timing and Neural Synchrony Via Microbial Opsin Gene Fusions, *Frontiers in Molecular Neuroscience* 2:12.

13. Chow, B. Y.\*, Han, X.\*, Dobry, A. S., Qian, X., Chuong, A. S., Li, M., Henninger, M. A., Belfort, G. M., Lin, Y., Monahan, P. E., Boyden, E. S. (2010) High-performance genetically targetable optical neural silencing by light-driven proton pumps, *Nature* 463:98-102. (\* co-first authors)

14. Chan, S. Y., Bernstein, J. G., Boyden, E. S. (2010) Scalable Fluidic Injector Arrays for Viral Targeting of Intact 3-D Brain Circuits, *Journal of Visualized Experiments* 35:1489.

15. Knopfel, T., Lin, M. Z., Levskaya, A., Tian, L., Lin, J. Y., Boyden, E. S. (2010) Toward the Second Generation of Optogenetic Tools, *Journal of Neuroscience* 30(45):14998-15004.

16. Zorzos, A. N., Boyden, E. S.\*, and Fonstad, C. G. (2010) Multiwaveguide implantable probe for light delivery to sets of distributed brain targets, *Optics Letters* 35(24):4133-5. (\* corresponding author)

17. Desai M., Kahn I., Knoblich U., Bernstein J., Atallah H., Yang A., Kopell, N., Buckner R.L., Graybiel A. M., Moore C. I.\*, and Boyden E. S.\* (2011) Mapping Brain Networks in Awake Mice Using Combined Optical Neural Control and fMRI, *Journal of Neurophysiology* 105(3):1393-405. (\* co-corresponding authors)

18. Han, X.\*, Chow, B. Y.\*, Zhou, H., Klapoetke, N. C., Chuong, A., Rajimehr, R., Yang, A., Baratta, M. V., Winkle, J., Desimone, R., Boyden, E. S. (2011) A high-light sensitivity optical neural silencer: development and application to optogenetic control of non-human primate cortex, *Frontiers in Systems Neuroscience* 5:18. (\* co-first authors)

19. Doroudchi, M. M., Greenberg, K. P., Liu, J., Silka, K. A., Boyden, E. S., Lockridge, J. A., Arman, A. C., Janani, R., Boye, S. E., Boye, S. L., Gordon, G. M., Matteo, B. C., Sampath, A. P., Hauswirth, W. W., Horsager, A. (2011) Virally delivered Channelrhodopsin-2 Safely and Effectively Restores Visual Function in Multiple Mouse Models of Blindness, *Molecular Therapy* 19(7):1220-9.

20. Boyden, E.S. (2011) A history of optogenetics: the development of tools for controlling brain circuits with light, *F1000 Biology Reports* 3:11.

21. Chow, B. Y.\*, Chuong, A. S. \*, Klapoetke, N. C. \*, Boyden, E. S. (2011) Synthetic Physiology: Strategies for Adapting Tools from Nature for Genetically-Targeted Control of Fast Biological Processes, *Methods in Enzymology* 497:425-43. (\* co-first authors)

22. Wentz, C. T., Bernstein, J. G., Monahan, P., Guerra, A., Rodriguez, A., Boyden, E. S. (2011) A Wirelessly Powered and Controlled Device for Optical Neural Control of Freely-Behaving Animals, *Journal of Neural Engineering* 8(4):046021.

23. Chow, B. Y. and Boyden, E. S. (2011) Synthetic Physiology, *Science* 332(6037):1508-1509.

24. Tsunematsu, T., Kilduff, T., Boyden, E. S., Takahashi, S., Tominaga, M., Yamanaka, A. (2011) Acute optogenetic silencing of orexin/hypocretin neurons induces slow wave sleep in mice, *Journal of Neuroscience* 31(29): 10529-10539.

25. Joo, J., Chow, B. Y., Prakash, M., Boyden, E. S., Jacobson, J. M. (2011) Face-selective electrostatic control of hydrothermal zinc oxide nanowire synthesis, *Nature Materials* 10(8):596-601.

26. McCarthy, M. M., Moore-Kochlacs, C., Xuan Gu, T., Boyden, E. S., Han, X., Kopell, N. J. (2011) Striatal origin of the pathologic beta oscillations in Parkinson's disease, *Proceedings of the National Academy of Sciences* 108(28):11620-5.
27. Bernstein, J. G., Garrity, P. A.\* , Boyden, E. S.\* (2012) Optogenetics and thermogenetics: technologies for controlling the activity of targeted cells within intact neural circuits, *Current Opinion in Neurobiology* 22(1):61-71. (\* co-corresponding authors)
28. Chow B.Y., Han, X., Boyden, E. S. (2012) Genetically encoded molecular tools for light-driven silencing of targeted neurons, *Progress in Brain Research* 196:49-61.
29. Bernstein, J. G., Boyden, E. S. (2011) Optogenetic tools for analyzing the neural circuits of behavior, *Trends in Cognitive Sciences* 15(12):592-600.
30. Kahn, I. \* Desai, M., Knoblich, U., Bernstein, J., Henninger, M., Graybiel, A. M., Boyden, E. S.\* , Buckner, R. L. \* , Moore, C. I. \* (2011) Characterization of the Functional MRI Response Temporal Linearity via Optical Control of Neocortical Pyramidal Neurons, *Journal of Neuroscience* 31(42):15086-15091. (\* co-corresponding authors)
31. Kleinlogel, S., Terpitz, U., Legrum, B., Gokbuget, D., Boyden, E. S., Bamann, C., Wood, P. G., Bamberg, E. (2011) A gene-fusion strategy for stoichiometric and co-localized expression of light-gated membrane proteins, *Nature Methods* 8(12):1083-1088.
32. Börgers C., Talei Franzesi G., LeBeau F. E., Boyden E. S., Kopell N.J. (2012) Minimal Size of Cell Assemblies Coordinated by Gamma Oscillations, *PLoS Computational Biology* 8(2):e1002362.
33. Knopfel, T., Boyden, E. S. (2012) Tools for observing and controlling specific molecular or physiological pathways in intact cells and tissues. Preface, *Progress in Brain Research* 196:vii–viii.
34. Madisen, L., Mao, T., Koch, H., Zhuo, J.-m., Berenyi, A., Fujisawa, S., Hsu, Y.-W., Garcia, A. J., Gu, X., Zanella, S., Kidney, J., Gu, H., Mao, Y., Hooks, B. M., Boyden, E. S., Buzsáki, G., Ramirez, J. M., Jones, A. R., Svoboda, K., Han, X., Turner, E. E., Zeng, H. (2012) A toolbox of Cre-dependent optogenetic transgenic mice for light-induced activation and silencing, *Nature Neuroscience* 15(5):793-802.
35. Kodandaramaiah, S., Talei Franzesi, G., Chow, B., Boyden, E. S.\* , Forest, C.\* (2012) Automated whole-cell patch clamp electrophysiology of neurons in vivo, *Nature Methods* 9:585–587. (\* co-corresponding authors)
36. Kim K.M., Baratta M.V., Yang A., Lee D., Boyden E.S.\* , Fiorillo C.D.\* (2012) Optogenetic mimicry of the transient activation of dopamine neurons by natural reward is sufficient for operant reinforcement, *PLoS One* 7(4):e33612. (\* co-corresponding authors)
37. Karayiorgou M., Flint J., Gogos J.A., Malenka R.C.; the Genetic and Neural Complexity in Psychiatry 2011 Working Group (Bargmann C.I., Boyden E.S., Bullmore E.T., Chan A.W., Davis M., Deisseroth K., Dolmetch R.E., Eggan K., Fears S.C., Freimer N.B., Geschwind D.H., Gordon J., Nickerson D.A., Vanderhaeghen P., Axel R., Zuker C.S., Fischbach G.) (2012) The best of times, the worst of times for psychiatric disease, *Nature Neuroscience* 15(6):811-812.
38. Lee, S.-H., Kwan, A. C., Zhang, S., Phoumthippavong, V., Flannery, J. G., Masmanidis, S. C., Taniguchi, H., Huang, Z. J., Zhang, F., Boyden, E. S., Deisseroth, K., Dan, Y. (2012) Activation of specific interneurons improves V1 feature selectivity and visual perception, *Nature* 488(7411):379-8.
39. Gerits, A., Farivar, R., Rosen, B. R., Wald, L. L., Boyden, E. S., Vanduffel, W. (2012) Optogenetically Induced Behavioral and Functional Network Changes in Primates, *Current Biology*, 22(18):1722-1726.

40. Zamft, B. M.\* , Marblestone, A. H.\* , Kording, K., Schmidt, D., Martin-Alarcon, D., Tyo, K., Boyden, E. S., Church, G. (2012) Measuring Cation Dependent DNA Polymerase Fidelity Landscapes by Deep Sequencing, *PLoS ONE* 7(8): e43876. (\* co-first authors)
41. Zorzos, A. N., Scholvin, J., Boyden, E. S.\* , Fonstad, C. G. (2012) Three-dimensional multiwaveguide probe array for light delivery to distributed brain circuits, *Optics Letters* 37(23):4841-4843. (\* corresponding author)
42. Boyden, E. S. (2013) Interview with Edward S. Boyden, *Trends in Neurosciences* 36(1):1-2.
43. Gurkan, U. A., Fan, Y., Xu, F., Erkmen, B., Urkac, E. S., Parlakgul, G., Bernstein, J., Xing, W.\* , Boyden, E. S.\* , Demirci, U.\* (2013) Simple precision creation of digitally specified, spatially heterogeneous, engineered tissue architectures, *Advanced Materials* 25(8):1192-1198. (\* co-corresponding authors)
44. Cavanaugh, J., Monosov, I. E., McAlonan, K., Berman, R. A., Smith, M. K., Cao, V., Wang, K. H., Boyden, E. S., Wurtz, R. H. (2012) Optogenetic Inactivation Modifies Monkey Visuomotor Behavior, *Neuron* 76:901–907.
45. Chow, B. Y.\* and Boyden, E. S.\* (2013) Optogenetics and Translational Medicine, *Science Translational Medicine* 5(177):177ps5. (\* co-corresponding authors)
46. Alivisatos, A., Andrews, A., Boyden, E. S., Chun, M., Church, G., Deisseroth, K., Donoghue, J., Fraser, S., Lippincott-Schwartz, J., Looger, L., Masmanidis, S., McEuen, P., Nurmikko, A., Park, H., Peterka, D., Reid, C., Roukes, M., Scherer, A., Schnitzer, M., Sejnowski, T., Shepard, K., Tsao, D., Turrigiano, G., Weiss, P., Xu, C., Yuste, R., Zhuang, X. (2013) Nanotools for Neuroscience and Brain Activity Mapping, *ACS Nano* 7(3):1850-66.
47. Kahn, I., Knoblich, U., Desai, M., Bernstein, J., Graybiel, A.M., Boyden, E.S., Buckner, R.L., Moore C.I. (2013) Optogenetic drive of neocortical pyramidal neurons generates fMRI signals that are correlated with spiking activity, *Brain Research* 1511:33-45.
48. Famm, K., Litt, B., Tracey, K.J., Boyden, E.S., Slaoui, M. (2013) Drug discovery: a jump-start for electroceuticals, *Nature* 496(7444):159-61.
49. Tsunematsu T., Tabuchi S., Tanaka K.F., Boyden E.S., Tominaga M., Yamanaka A. (2013) Long-lasting silencing of orexin/hypocretin neurons using archaerhodopsin induces slow-wave sleep in mice, *Behavioural Brain Research*, 255:64-74.
50. Kodandaramaiah, S. B., Boyden, E. S.\* , Forest, C. F.\* (2013) In vivo robotics: the automation of neuroscience and other intact-system biological fields, *Annals of the New York Academy of Sciences*, 1305(1):63-71. (\* co-corresponding authors)
51. Glaser J.I.\*\* , Zamft B.M.\* , Marblestone A.H.\* , Moffitt J.R., Tyo K., Boyden E.S., Church G., Kording K.P. (2013) Statistical analysis of molecular signal recording, *PLoS Computational Biology* 9(7):e1003145. (\*\* corresponding author, \* equal contribution)
52. Marblestone, A. H.\*\*+, Zamft, B. M.+ , Maguire, Y. G., Shapiro, M. G., Cybulski, T. R., Glaser, J. I., Amodei, D., Stranges, P. B., Kalhor, R., Dalrymple, D. A., Seo, D., Alon, E., Maharbiz, M. M., Carmena, J. M., Rabaey, J. M., Boyden, E. S.\* , Church, G. M.\* , Kording, K. P.\* (2013) Physical Principles for Scalable Neural Recording, *Frontiers in Computational Neuroscience*, 7:137. (\*\* corresponding author, + equal contribution, \* equal contribution)
53. Schmidt, D., Tillberg, P. W.\* , Chen, F.\* , Boyden, E. S. (2014) A fully genetically-encoded protein architecture for optical control of peptide ligand concentration, *Nature Communications*, 5:3019. (\* equal contribution)

54. Klapoetke, N. C., Murata, Y., Kim S. S., Pulver, S. R., Birdsey-Benson, A., Cho, Y. K., Morimoto, T. K., Chuong, A. S., Carpenter, E. J., Tian, Z., Wang, J., Xie, Y., Yan, Z., Zhang, Y., Chow, B.Y., Surek, B., Melkonian, M., Jayaraman, V., Constantine-Paton, M., Wong, G. K.\* , Boyden, E. S.\* (2014) Independent Optical Excitation of Distinct Neural Populations, *Nature Methods* 11:338–346. (\* co-corresponding authors)
55. Perea, G., Yang, A., Boyden, E. S., Sur, M. (2014) Optogenetic astrocyte activation modulates response selectivity of visual cortex neurons in vivo, *Nature Communications* 5:3262.
56. Prevedel, R.\*\* , Yoon, Y.-G.\*\* , Hoffman, M., Pak, N., Wetzstein, G., Kato, S., Schrodell, T., Raskar, R., Zimmer, M., Boyden, E. S.\* , Vaziri, A. \* (2014) Simultaneous whole-animal 3D imaging of neuronal activity using light-field microscopy, *Nature Methods* 11:727-730. (\*\* equal contribution, \* co-corresponding authors)
57. Hochbaum, D.R.\* , Zhao, Y.\* , Farhi, S.L., Klapoetke, N.C., Werley, C.A., Kapoor, V., Zou, P., Kralj, J.M., Maclaurin, D., Smedemark-Margulies, N., Saulnier, J., Boulting, G.L., Straub, C., Cho, Y., Melkonian, M., Wong, G.K.-S., Harrison, D. J., Murthy, V.N., Sabatini, B., Boyden, E.S.\*\* , Campbell, R.E.\*\* , Cohen, A.E. (2014) All-optical electrophysiology in mammalian neurons using engineered microbial rhodopsins, *Nature Methods*, 11(8):825-33. (\* equal contribution, \*\* jointly directed work)
58. Chuong, A. S., Miri, M. L.\* , Busskamp, V.\* , Matthews, G.A.C.\* , Acker, L.C.\* , Soresnsen, A.T., Young, A., Klapoetke, N. C., Henninger, M.A., Kodandaramaiah, S.B., Ogawa, M., Ramanlal, S. B., Bandler, R. C., Allen, B. D., Forest, C.R., Chow, B.Y., Han, X., Lin, Y., Tye, K.M., Roska, B., Cardin, J.A., Boyden, E. S. (2014) Noninvasive optical inhibition with a red-shifted microbial rhodopsin, *Nature Neuroscience* 17:1123-1129. (\* equal contribution)
59. Fukunaga I., Herb J.T., Kollo M., Boyden E.S., Schaefer A.T. (2014) Independent control of gamma and theta activity by distinct interneuron networks in the olfactory bulb, *Nature Neuroscience* 17(9):1208-16.
60. Marblestone, A.H., Boyden, E.S. (2014) Designing Tools for Assumption-Proof Brain Mapping, *Neuron* 83(6):1239-1241.
61. Boyden ES. (2011) Optogenetics: using light to control the brain, *Cerebrum* 2011:16.
62. Danilo Boada M., Martin T.J., Peters C.M., Hayashida K., Harris M.H., Houle T.T., Boyden E.S., Eisenach J.C., Ririe D.G. (2014) Fast Conducting Mechanoreceptors Contribute to Withdrawal Behavior in Normal and Nerve Injured Rats, *Pain* 155(12):2646-2655.
63. Johansen J.P., Diaz-Mataix L., Hamanaka H., Ozawa T., Ycu E., Koivumaa J., Kumar A., Hou M., Deisseroth K., Boyden E.S., LeDoux J.E. (2014) Hebbian and neuromodulatory mechanisms interact to trigger associative memory formation, *Proceedings of the National Academy of Sciences* 111(51):E5584–E5592.
64. Harrison R.R., Kolb I., Kodandaramaiah S.B., Chubykin A.A., Yang A., Bear M.F., Boyden E.S.\* , Forest C.\* (2014) Microchip amplifier for in vitro, in vivo, and automated whole-cell patch-clamp recording, *Journal of Neurophysiology* 113(4):1275-82. (\* equal contribution)
65. Darrow KN, Slama MC, Kozin E, Owoc M, Hancock K, Kempfle J, Edge A, Lacour S, Boyden E, Polley D, Brown MC, Lee DJ (2014) Optogenetic stimulation of the cochlear nucleus using channelrhodopsin-2 evokes activity in the central auditory pathway, *Brain Research* 1599:44-56.
66. Chen, F.\* , Tillberg, P.W.\* , Boyden, E.S. (2015) Expansion Microscopy, *Science* 347(6221):543-548. (\* equal contribution)



67. Cybulski TR, Glaser JI, Marblestone AH, Zamft BM, Boyden ES, Church GM, Kording KP (2015) Spatial information in large-scale neural recordings, *Frontiers in Computational Neuroscience* 8:172.
68. Madisen, L., Garner, A.R., Shimaoka, D., Chuong, A.S., Klapoetke, N.C., Li, L., van der Bourg, A., Niino, Y., Egolf, L., Monetti, C., Gu, H., Mills, M., Cheng, A., Tasic, B., Nguyen, T.N., Sunkin, S.M., Benucci, A., Nagy, A., Miyawaki, A., Helmchen, F., Empson, R.M., Knöpfel, T., Boyden, E.S., Reid, R.C., Carandini, M., Zeng, H. (2015) Transgenic Mice for Intersectional Targeting of Neural Sensors and Effectors with High Specificity and Performance, *Neuron* 85(5):889-892.
69. Edward Hight A, Kozin ED, Darrow K, Lehmann A, Boyden E, Brown MC, Lee DJ (2015) Superior Temporal Resolution of Chronos versus Channelrhodopsin-2 in an Optogenetic Model of the Auditory Brainstem Implant, *Hearing Research* 322:235-241.
70. Allen, B.D.\*, Singer, A.C.\*, Boyden, E.S. (2015) Principles of designing interpretable optogenetic behavior experiments, *Learning and Memory* 22:232-238. (\* equal contribution)
71. Scholvin, J., Kinney, J. P., Bernstein, J. G., Moore-Kochlacs, C., Kopell, N., Fonstad, C.G., Boyden, E. S. (2016) Close-Packed Silicon Microelectrodes for Scalable Spatially Oversampled Neural Recording, *IEEE Transactions on Biomedical Engineering* 63(1):120-30.
72. Li P, Rial D, Canas PM, Yoo JH, Li W, Zhou X, Wang Y, van Westen GJ, Payen MP, Augusto E, Gonçalves N, Tomé AR, Li Z, Wu Z, Hou X, Zhou Y, PIJzerman A, Boyden ES, Cunha RA, Qu J, Chen JF (2015) Optogenetic activation of intracellular adenosine A2A receptor signaling in the hippocampus is sufficient to trigger CREB phosphorylation and impair memory, *Molecular Psychiatry* 20:1339–1349.
73. Pak N, Siegle JH\*, Kinney JP\*, Denman DJ, Blanche TJ, Boyden ES (2015) Closed-loop, ultraprecise, automated craniotomies, *Journal of Neurophysiology* 113(10):3943-53. (\* equal contribution)
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### **Patents and Patent Applications**

Total: >275 patents or patents pending. Selected patents related to academic research, below, updated September 2016:

<b>Patent #</b>	<b>Title</b>
9,498,293	Automated cell patch clamping method and apparatus
9,278,159	Light-activated cation channel and uses thereof
9,187,745	System for optical stimulation of target cells
9,163,094	Light-activated fusion proteins and uses therefor
9,101,690	Light-activated cation channel and uses thereof
8,957,028	Red-shifted opsin molecules and uses thereof
8,939,774	Methods and apparatus for three-dimensional microfabricated arrays
8,910,638	Methods and apparatus for high-throughput neural screening
8,906,360	Light-activated cation channel and uses thereof
8,864,805	System for optical stimulation of target cells
8,708,965	Scalable parallel gene therapy injector array
8,545,543	Methods and apparatus for microstructure lightguides
8,398,692	System for optical stimulation of target cells

### **Application # Title**

20160252524 LIGHT-ACTIVATED CATION CHANNEL AND USES THEREOF  
20160238593 Pumilio Domain-based Modular Protein Architecture for RNA Binding  
20160194624 SYSTEM FOR OPTICAL STIMULATION OF TARGET CELLS  
20160176933 MUTANT CHANNELRHODOPSINS WITH ALTERED ION SELECTIVITY  
20160116384 EXPANSION MICROSCOPY  
20160096036 LIGHT-ACTIVATED CATION CHANNEL AND USES THEREOF  
20160091705 Methods and apparatus for stretched light field microscope  
20160039902 CHANNELRHODOPSIN VARIANTS AND USES THEREOF  
20160000590 Intravascular Device  
20150259670 SYSTEM FOR OPTICAL STIMULATION OF TARGET CELLS  
20150225741 VECTORS FOR DELIVERY OF LIGHT SENSITIVE PROTEINS AND METHODS OF USE  
20150223679 BLUE LIGHT-ACTIVATED ION CHANNEL MOLECULES AND USES THEREOF  
20150192567 RED-SHIFTED OPSIN MOLECULES AND USES THEREOF  
20150165227 Light-Activated Cation Channel and Uses Thereof  
20140324138 Wirelessly-powered illumination of biological tissue  
20140324134 CHANNELRHODOPSINS FOR OPTICAL CONTROL OF CELLS  
20140309705 System for Optical Stimulation of Target Cells  
20140228857 Automated Cell Patch Clamping Method and Apparatus  
20130295635 System for Optical Stimulation of Target Cells  
20130225963 Automated Cell Patch Clamping Method and Apparatus  
20130225664 METHODS AND COMPOSITIONS FOR DECREASING CHRONIC PAIN  
20130184817 Light-Activated Cation Channel and Uses Thereof  
20130157498 Methods and apparatus for three-dimensional microfabricated arrays  
20130116165 LIGHT-ACTIVATED FUSION PROTEINS AND USES THEREFOR  
20120214188 LIGHT-ACTIVATED ION CHANNEL MOLECULES AND USES THEREOF  
20120123508 Methods and apparatus for wireless control of biological tissue  
20120121542 RED-SHIFTED OPSIN MOLECULES AND USES THEREOF  
20120089205 Methods and Apparatus for High-Throughput Neural Screening  
20110165681 Light-Activated Proton Pumps and Applications Thereof  
20110087311 Methods and Apparatus for Microstructure Lightguides  
20110087126 Light-Proof Electrodes  
20100234273 LIGHT-ACTIVATED CATION CHANNEL AND USES THEREOF  
20100152662 Scalable Parallel Gene Therapy Injector Array  
20100145418 SYSTEM FOR OPTICAL STIMULATION OF TARGET CELLS  
20090018384 Portable, Modular Transcranial Magnetic Stimulation Device  
20080319505 Integrated Transcranial Current Stimulation and Electroencephalography Device  
20080306576 Optical Cell Control Prosthetics  
20070261127 LIGHT-ACTIVATED CATION CHANNEL AND USES THEREOF  
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**Invited talks  
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talks**

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2. (2005) Causal roles of neurons and neural circuits in learning and behavior. Hertz Foundation Scholars 2005 Retreat, Pt. Reyes, CA.
3. (2006) Solving the brain systematically: tools for the analysis and engineering of neural circuits. Google Tech Talk series, Google, Mountain View, CA.
4. (2006) Cutting-edge technologies for the systematic analysis of neural circuit dynamics. UCSF, Program in Bioengineering Seminar Series, San Francisco, CA.
5. (2006) Resolving the computational role of specific neural circuit elements. McGovern Institute, MIT, Cambridge, MA.
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7. (2006) Enabling technologies for controlling neural circuit functions. Brain Science Program, Brown University, Providence, RI.
8. (2006) Technologies for the systematic analysis of neural circuit function. Center for Brain Science, Harvard University, Cambridge, MA.
9. (2006) Neural Circuit Technology: Towards New Brain Interfaces and Biological Tools. MIT Media Laboratory, MIT, Cambridge, MA.
10. (2006) Engineering tools for engineering the brain. Division of Engineering, Brown University, Providence, RI.
11. (2006) Ultraprecise biological interfaces: Controlling life with light. Opening night talk, Science Foo (SciFoo) Camp, Google, Mountain View, CA.
12. (2006) Launching the Open Brain Stimulator Project. Session leader, Foo Camp, O'Reilly Media, Sebastopol, CA.
13. (2006) The future of neural devices. Stanford Biodesign Program, Stanford, CA.
14. (2006) Systematic approaches for understanding neural circuit function. Center for Basic Neuroscience, UT Southwestern Medical School, Dallas, TX.
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19. (2007) Engineering the Brain. Department of Psychiatry, Harvard/MGH, Boston, MA.
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45. (2008) Optical Neural Control: Analyzing and Engineering Normal and Pathological Neuronal Circuit Dynamics. Neuroimaging Groups presentation, Marine Biology Laboratory, Woods Hole, MA.
46. (2008) What should we really be doing, to understand neural systems?. Grass Lab Tuesday night talk, Marine Biology Laboratory, Woods Hole, MA.
47. (2008) Optical Brain Control: Analyzing and Engineering Normal and Pathological Neural Circuit Dynamics. Integrative Brain Research Symposium, Sapporo, Japan.
48. (2008) Optical Brain Control: Analyzing and Engineering Normal and Pathological Neural Circuit Dynamics. Keynote, NIMH Intramural Retreat, Gettysburg, PA.
49. (2008) Optical Neuron Control: Towards Principles of Controlling Neural Circuits. Integrative Approaches to Brain Complexity Conference, Cold Spring Harbor/Wellcome Trust, Wellcome Trust Conference Center, Hinxton, UK.
50. (2008) Optical methods for controlling and correcting neural circuit functions. In Vivo Imaging in Recovery After Neural Injury: From Microimaging in Animal Models to Functional Imaging in Man. Satellite Symposium to the American Congress of Rehabilitation Medicine (ACRM) and the American Society of Neurologic Rehabilitation (ASNR) Joint Educational Conference, Toronto, Canada.
51. Barry, B., Boyden, E., Lang, E. (2008) Software Technologies in the Delivery of Intelligent Language Hypnosis Engines. Procedural Hypnosis: From Bench Top to Bedside (Symposium), 59th Annual Scientific Program, October 24-26, 2008 Hypnosis 2008: Foundations & Frontiers, Society for Clinical and Experimental Hypnosis.
52. (2008) High-Precision Genetically-Targeted Optical Control of Normal and Pathological Neural Computations. HHMI Conference on Genetic Manipulation of Neuronal Activity, Janelia Farm, Ashburn, VA.
53. (2008) Optical Brain Control: Analyzing and Engineering Normal and Pathological Neural Circuit Dynamics. Carolina Biophysics Symposium, Chapel Hill, NC.
54. (2008) Optical Brain Control: Analyzing and Engineering Normal and Pathological Neural Circuit Dynamics. MIT Synthetic Biology Working Group, Cambridge, MA.
55. (2009) Novel Tools for Precisely Controlling Brain Functions. Brain Research Center and Student Biotechnology Network, University of British Columbia, Vancouver, Canada.
56. (2009) Optical Brain Control: Analyzing and Engineering Normal and Pathological Neural Circuit Dynamics. CIMIT Forum, Boston, MA.
57. (2009) Optical Brain Control: Analyzing and Engineering Normal and Pathological Neural Circuit Dynamics. Dept. of Bioengineering, University of Pennsylvania, Philadelphia, PA.

58. (2009) Optical Control Of Normal and Pathological Neural Circuit Computations. McGovern Symposium, Tsinghua University, Beijing, China.
59. (2009) Optical Neural Control: Towards Systematic Parsing of the Role of Cell Types in Normal and Abnormal Neural Computation. MGH-HST Martinos Center Brainmap Series, Cambridge, MA.
60. (2009) Optical Brain Control: Towards New Therapies for Brain Disorders. Optical Society of America (New England Section Meeting), Cambridge, MA.
61. (2009) Optical Neural Control: Analyzing and Engineering Normal and Pathological Neural Circuit Dynamics. Tufts Neuroscience Symposium, Tufts University, Cambridge, MA.
62. (2009) Towards Understanding The Circuits of Cognition: Engineering Tools for Analyzing Primate Brain Dynamics. Along with Xue Han, New England Primate Research Center (NEPRC), Harvard Medical School, Southborough, MA.
63. (2009) Optical Activation of Neurons. Challenges for 21st Century Photonics, CIPS, MIT, Cambridge, MA.
64. (2009) Optical Brain Control: Towards New Insights and Therapies. Psychiatric Genetics and Translational Research Seminar, Massachusetts General Hospital, Boston, MA.
65. (2009) Enabling Systematic Neuroscience with Novel Optical Neural Control Strategies. Cold Spring Harbor Laboratories, NY.
66. (2009) Optical Neural Control Prosthetics. No Barriers Festival, Miami, FL.
67. (2009) Optical Cell-Specific Neuromodulation: Towards Engineering the Brain for Therapeutic Purposes. Medtronic, Minneapolis, MN.
68. (2009) Optical control of the brain: Understanding thought, engineering cures. HST Summer Institute Biomedical Optics Lecture Series, Massachusetts General Hospital, Boston, MA.
69. (2009) Technologies for controlling neural circuit dynamics. Sloan-Swartz 2009 Annual Meeting on Computational Neuroscience.
70. (2009) Enabling Systematic Neuroscience with Novel Optical Neural Control Strategies. Indiana University, Bloomington, IN.
71. (2009) Systematic Optical Control of Neural Circuits. Fifth Annual NIH Director's Pioneer Award Symposium, National Institutes of Health, Bethesda, MD.
72. (2009) Synthetic Neurobiology: Optically Engineering the Brain to Augment Its Function. Singularity Summit, New York City, NY.
73. (2009) Enabling Systematic Neuroscience with Novel Optical Neural Control Strategies, Salk Institute, San Diego, CA.
74. (2009) Enabling Systematic Neuroscience with Novel Optical Neural Control Strategies, Caltech, Pasadena, CA.
75. (2009) Enabling Systematic Neuroscience with Novel Optical Neural Control Strategies, NIH, Bethesda, MD.
76. (2009) Enabling Systematic Neuroscience with Novel Optical Neural Control Strategies. University of Texas at Austin, Austin, TX.

77. (2009) Enabling Systematic Neuroscience with Novel Optical Neural Control Strategies, UNC, Chapel Hill, NC.
78. (2009) Enabling Systematic Neuroscience with Novel Optical Neural Control Strategies, USC, Los Angeles, CA.
79. (2009) Engineering the Brain, NextGens Technologies Symposium, TTI/Vanguard, Salt Lake City, UT.
80. (2010) Entering Information Into the Brain to Shape Emotion, Thought, and Action, XPrize Workshop "Brain-Computer Interfaces: Igniting a Revolution", MIT, Cambridge, MA.
81. (2010) Novel Optical Biological Control Tools: Towards Enabling Integrative Analysis of Neural Systems, Spivack Distinguished Lecture, Boston University, Boston, MA.
82. (2010) Novel Optical Biological Control Tools: Enabling Integrative Analysis and Engineering of Neural Systems, Center for Brain Science, Harvard University, Cambridge, MA.
83. (2010) Novel Optical Biological Control Tools: Towards Enabling Integrative Analysis of Neural Systems, A Meeting of the Minds in Monaco, 1st International Congress on Alzheimer's Disease and Advanced Neurotechnologies, Monaco.
84. (2010) Novel Optical Biological Control Tools: Enabling Integrative Analysis and Engineering of Neural Systems, University of Illinois Urbana-Champaign, Champaign, Illinois.
85. (2010) Novel Optical Biological Control Tools: Enabling Integrative Analysis and Engineering of Neural Systems, Wake Forest University, Winston-Salem, NC.
86. (2010) Novel Optical Biological Control Tools: Enabling Integrative Analysis and Engineering of Neural Systems, Lincoln Labs, MA.
87. (2010) Novel Optical Biological Control Tools: Enabling Integrative Analysis and Engineering of Neural Systems, University of Massachusetts, Amherst.
88. (2010) Optical Neuron Control: Discovery and Engineering of A Second Generation of Tools, Baylor College of Medicine, Houston, TX.
89. (2010) Enabling Systematic Neuroscience with Novel Optical Neural Control Strategies, Yale, New Haven, CT.
90. (2010) Controlling Brain Circuits with Light, Lester Wolfe Workshop in Laser Biomedicine: Optogenetics - Probing the Brain with Light, George R. Harrison Spectroscopy Laboratory/MGH Wellman Center for Photomedicine/Harvard—MIT Division of Health Sciences and Technology/CIMIT, Boston, MA
91. (2010) Controlling the Brain with Light, BrainForum 2010: The Brain Revolution, in honor of Rita Levi Montalcini's 101st birthday, Rome, Italy.
92. (2010) Brain Co-Processors for Analyzing and Augmenting the Mind, Big Ideas for Busy People, Cambridge Science Festival, Cambridge, MA
93. (2010) Optical Neural Control: A Platform for Cell-Specific Neuromodulation Therapy, Neurotechnology Industry Organization Neurotech Investing and Partnering Conference, Boston, MA.
94. (2010) Controlling Brain Circuits with Light, Academia Sinica Symposium, Picower Institute for Learning and Memory, MIT, Cambridge, MA.

95. Boyden, E. S., (2010) Controlling Brain Circuits with Light, Max Planck Institute for Biological Cybernetics, Tübingen, Germany.
96. (2010) Controlling Brain Circuits with Light, European Commission, Forum on Implantable Medical Technologies, Medical Devices Expert Group, Working Group on New & Emerging Technologies, Brussels, Belgium.
97. (2010) In Vivo Imaging and Control of Neural Networks: Watching the Brain in Action, Introductory talk, 16th German-American Frontiers of Science Symposium, Potsdam, Germany.
98. (2010) Controlling Brain Circuits with Light: Enabling Integrative Analysis and Engineering of Neural Systems, 27th Symposium of the Center for Visual Science, University of Rochester, Rochester, NY.
99. (2010) Controlling Brain Circuits with Light, H+ Summit, Harvard University, Cambridge, MA.
100. (2010) Controlling Brain Circuits with Light: Enabling Integrative Analysis and Engineering of Neural Systems, Translational Research and Vision, National Eye Institute 40th Anniversary Symposium, NIH, Bethesda, MD.
101. (2010) Controlling Brain Computations with Light. Multi-modal Neural Training Program Symposium, Carnegie Mellon University and University of Pittsburgh, Pittsburgh, PA.
102. (2010) Optogenetics: Targeted Control of Brain Circuits With Light, Gordon Research Conference on Lasers in Medicine and Biology, Holderness, New Hampshire.
103. (2010) Brain Co-Processors. Science Foo (SciFoo) Camp, Google, Mountain View, CA. (Selected as highlighted talk for presentation in final session.)
104. (2010) Optical Control of Biological and Neural Functions Using Retinal Proteins, 14th International Conference on Retinal Proteins, Santa Cruz, CA.
105. (2010) New Optical Reagents and Strategies for Controlling Neural Circuit Dynamics, Gordon Conference on Mechanisms Of Epilepsy & Neuronal Synchronization, Waterville, ME.
106. (2010) Enabling Systematic Neuroscience with Novel Optical Neural Control Strategies, INCF Neuroinformatics Congress, Kobe, Japan.
107. (2010) Controlling the Brain with Light: From Genomic Mining of Molecular Tools, to Neural Circuit Solving, UNC-Wilmington.
108. (2010) Controlling Brain Circuits With Light, EmTech@MIT, Cambridge, MA.
109. (2010) Controlling Brain Circuits With Light, Aspen Brain Forum: Building Better Brains: Neural Prosthetics and Beyond, Aspen, Colorado.
110. (2010) Controlling Brain Computations: Towards New Brain Insights and Brain Therapies, Allen Institute for Brain Science Symposium, Open Questions in Neuroscience, Seattle, WA.
111. (2010) Controlling brain circuits with light: Harnessing ecological diversity and molecular optimization to make new neuroscience tools, Genetic Manipulation of Neuronal Activity II, Janelia Farm, VA.
112. (2010) Novel optical neural control tools: towards enabling integrative analysis of neural systems, Minisymposium: Toward the Second Generation of Optogenetic Tools (Minisymposium co-chair), Society for Neuroscience, San Diego, CA.

113. (2010) Controlling Brain Circuits with Light: Towards the Next Generation of Tools. Harvard Neurobiology and Children's Hospital, Boston, MA.
114. (2010) Controlling Brain Circuits with Light, Purdue University, West Lafayette, IL.
115. (2010) Controlling Brain Circuits with Light, Medical University of South Carolina, Charleston, SC.
116. (2011) Inventing Tools for Controlling Brain Circuits With Light, Harvard School of Engineering and Applied Sciences, Cambridge, MA.
117. (2011) Optogenetics. Alfred Mann Foundation, Valencia, CA.
118. (2011) Controlling the Brain With Light. Plenary Lecture, Hot Topics Opening Session, SPIE, Moscone Center, San Francisco, CA.
119. (2011) Controlling Brain Circuits with Light: Enabling Integrative Analysis and Engineering of Neural Systems, Issekutz Memorial Lecture, Dalhousie University, Halifax, Canada.
120. (2011) Controlling Brain Circuits with Light: Optogenetics, Association for Research in Otolaryngology MidWinter Meeting, Baltimore, MD.
121. (2011) Controlling Brain Circuits With Light (published on TED.com as "A light switch for neurons"), TED (Technology, Entertainment, and Design Conference), Long Beach, CA.
122. (2011) Optogenetics: Molecular Tools & Hardware for Controlling the Brain with Light, UT Health Sciences, Houston, TX.
123. (2011) Optogenetics: Controlling Brain Circuits with Light, University of Chicago, Chicago, IL.
124. (2011) Optical reagents and strategies for controlling neural circuit dynamics, Boehringer Ingelheim Fonds 103rd International Titisee Conference, Genetic analysis of neural circuits, Titisee, Germany.
125. (2011) Controlling Brain Circuits With Light, University of Freiburg, Freiburg, Germany.
126. (2011) Optogenetics: Tools for Controlling Brain Circuits with Light, Cornell Weill Medical College, New York, NY.
127. (2011) Controlling Brain Circuits with Light, Keynote Talk, University of Pennsylvania Mahoney Institute of Neurological Sciences, 27th Annual Retreat, Philadelphia, PA.
128. (2011) Controlling The Brain With Light: New Molecular Tools and Devices for Optogenetics, Molecular and Cellular Neuroscience Seminar Series, MIT, Cambridge, MA.
129. (2011) Controlling brain circuits with light: New tools for analyzing neural systems. 15th Annual Conference on Cognitive and Neural Systems, Boston University, Boston, MA.
130. (2011) Optogenetics and Neurodegeneration. New Frontiers in Neurodegeneration Symposium, UMass Medical School Neurotherapeutics Institute/Biogen Idec, Cambridge, MA.
131. (2011) Optogenetics: Controlling Brain Circuits With Light, Dept of Pharmacology, Oxford University, Oxford, UK.
132. (2011) Towards Understanding the Brain as a Computational Circuit, Dept of Physiology, Oxford University, Oxford, UK.

133. (2011) Optogenetics: New Toolsets for Controlling Brain Circuits with Light, Karolinska Institute, Stockholm, Sweden.
134. (2011) Controlling Brain Circuits With Light: Analyzing and Engineering Neural Circuit Dynamics, Genetic and Neural Complexity of Psychiatry, Santorini, Greece.
135. (2011) Optogenetics: Tools for Controlling Brain Circuits With Light, National Institute for Drug Abuse, Baltimore, MD.
136. (2011) Optogenetics: Controlling Brain Circuits With Light, University of Washington, Seattle, WA.
137. (2011) Massively-Parallel Recording of Neural Activity: System Prototypes, Allen Distinguished Investigators Symposium, Seattle, WA.
138. (2011) New Technologies for Analyzing and Engineering the Brain: How 21st Century Tools are Opening up New Fronts on Thought, Emotion, and Disease, Kavli Science Journalism Workshop 'Brain Science,' Knight Science Journalism Fellowships Program, MIT, Cambridge, MA.
139. (2011) Controlling Brain Circuits with Light: Molecules, Hardware, Strategies, and Applications, Causal Neuroscience: interacting with neural circuits, FENS-IBRO-SFN School, Bertinoro, Italy.
140. (2011) Optogenetics: Tools for Controlling Brain Circuits With Light, BioMethods Boston Conference, Boston, MA.
141. (2011) Optogenetics: New Tools for Controlling Brain Circuits with Light, University of Louisville, Kentucky.
142. (2011) Technologies for the Systematic Analysis of How Brain Circuits Perform Computations, Keynote, 4th Conference on Artificial General Intelligence, Google, Mountain View, CA.
143. (2011) Optogenetics: Controlling the Brain with Light, MIT Club of Northern California.
144. (2011) Optogenetics and Other Neural Circuit Analysis Tools, Halcyon Molecular, Redwood City, CA.
145. (2011) Optogenetics and Other Neural Circuit Analysis Tools, UC Berkeley.
146. (2011) Optogenetics and Other Neural Circuit Analysis Tools, Erasmus MC, Rotterdam, The Netherlands.
147. (2011) Optogenetics: Controlling Neural Circuits with Light, 7th NIH Inter-Institute Workshop on Optical Diagnostic and Biophotonic Methods from Bench to Bedside, NIH, Bethesda, MD.
148. (2011) Optogenetics: Controlling Brain Circuits With Light, Selected Talk, 7th NIH Director's Pioneer Award Symposium, Bethesda, MD.
149. (2011) Optogenetics and Other Neural Circuit Analysis Tools, Keynote, Harvard Biophysics Retreat.
150. (2011) Neural Networks for Solving Neural Networks, Networks Solving Networks Meeting, MIT Media Lab, Cambridge, MA.
151. (2011) Optogenetics: Controlling Brain Circuits With Light, Keynote, Taiwan Neuroscience Society Meeting, Taipei, Taiwan.

152. (2011) Optogenetics and Other Neural Circuit Analysis Tools, Adrian Seminar, University of Cambridge, Cambridge, UK.
153. (2011) Controlling brain circuits with light: Towards systematic analysis of neural circuit functions. Symposium on the Emerging Genetics and Neurobiology of Severe Mental Illness, Broad Institute, Cambridge, MA.
154. (2011) Optogenetics and Other Neural Circuit Analysis Tools, Champalimaud Institute for the Unknown, Lisbon, Portugal.
155. (2011) Engineering the Mind, Ar Seminar Series for the Public, Inaugural Lecture, Champalimaud Institute for the Unknown, Lisbon, Portugal.
156. (2011) Enhancing the Brain - Past, Present and Future, Honors Colloquium, University of Rhode Island.
157. (2011) Technologies for Analyzing the Computations of the Brain, invited talk, IBM Watson Research Center, Yorktown Heights, NY.
158. (2011) Optogenetics and Other Neural Circuit Analysis Tools, 15th Annual Future of Light Symposium, Boston University Photonics Center, Boston University, Boston, MA.
159. (2011) Optogenetics and Other Neural Circuit Analysis Tools, Albert Einstein College of Medicine, Bronx, NY.
160. (2011) Optogenetics and Other Neural Circuit Analysis Tools, University of Connecticut.
161. (2011) Optogenetics: Tools for Controlling the Brain With Light, 14th Annual International Symposium on Neural Regeneration, Monterey, CA.
162. (2011) Optogenetics and Other Neural Circuit Analysis Tools, Sackler Lecture, Leiden University Medical Center, Leiden, The Netherlands.
163. (2012) Optogenetics, Robotic Neurophysiology, and Other Neural Circuit Analysis Tools, UCLA, Los Angeles, CA.
164. (2012) Optogenetics, Robotic Neurophysiology, and Other Neural Circuit Analysis Tools, USC, Los Angeles, CA.
165. (2012) Optogenetics: Tools for Controlling Brain Circuits With Light, Invited Talk, Photosensory Receptors & Signal Transduction Gordon Research Conference, Galveston, TX.
166. (2012) Engineering Creativity (“Interactive Dinner”), Discussion Leader, World Economic Forum Annual Meeting, Davos, Switzerland.
167. (2012) Leading Under Pressure (“WorkStudio”), Discussion Leader, World Economic Forum Annual Meeting, Davos, Switzerland.
168. (2012) Controlling neurons with light: Illuminating the path to fixing brain disorders, Speaker, Future Science with *Nature* Magazine (“IdeasLab”), World Economic Forum Annual Meeting, Davos, Switzerland.
169. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuit Tools, Vollum Institute, Oregon Health Science University, Portland, OR.
170. (2012) Engineering the Brain, MIT Techfair, MIT, Cambridge, MA.



171. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuit Tools, Brainmap Seminar, MGH Charlestown.
172. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuit Tools, Tufts, Medford, MA.
173. (2012) Controlling the Brain With Light: New Technologies for Repairing Neural Circuits, The Brain: An Owner's Guide Lecture Series, UT Dallas BrainHealth Center, Dallas, TX.
174. (2012) Optogenetics. Optogenetics in neurons and beyond, Cell Press Webinar, March 15, 2012, Online.
175. (2012) Optogenetics and Other Tools For Analyzing and Engineering Neural Circuits, Case Western Reserve University, Cleveland, OH.
176. (2012) Optogenetics, In Vivo Robotics, and Other Neural Circuit Technologies, University of Oregon, Eugene, OR.
177. Bensen, J. P., (2012) Curating Innovation: Creative Inventing for Solving Big Problems, Workshop, Media Lab Inside/Out Symposium, MIT, Cambridge, MA.
178. (2012) Adapting Tools From Nature To Engineer The Brain, Media Lab Inside/Out Symposium, MIT, Cambridge, MA.
179. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuit Tools, Yale, New Haven, CT.
180. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuit Tools, Lincoln Labs, Lexington, MA.
181. (2012) Optogenetics and other tools for analyzing neural circuits, Bagrit Lecture, Imperial College London.
182. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuit Tools, David Colman Symposium, Montreal Neurological Institute/McGill University, Montreal, Canada.
183. (2012) Optogenetics, In Vivo Robotics And Other Tools for Brain Understanding, IEEE/IET Hosted Talk, Cambridge, MA.
184. (2012) Technologies for Understanding How the Brain Computes, Analog Devices, Wilmington, MA.
185. (2012) Technologies for Understanding and Fixing the Brain, NOVA ScienceNow ScienceCafe, Cambridge, MA.
186. (2012) Technologies for Analyzing and Engineering Brain Computations, "Cracking the Neural Code" Meeting, Aspen Brain Forum, Aspen, CO.
187. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuit Tools, Max Planck Institute for Dynamics and Self-Organization, Gottingen, Germany.
188. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuit Tools, Max Planck Institute for Brain Research, Frankfurt, Germany.
189. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuit Tools, University of Tokyo, Tokyo, Japan.
190. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuit Tools, Nagoya University, Nagoya, Japan.

191. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuit Tools, Japan Neuroscience Society 35<sup>th</sup> Annual Meeting, Nagoya, Japan.
192. (2012) Optogenetics: Controlling the Brain With Light, Perl/UNC Prize Lecture, UNC, Chapel Hill, NC.
193. (2012) Engineering the Brain & Transforming World Health, IET Inspec Webinar, Online.
194. (2012) Optogenetics: Molecules and Devices Enabling Precision Control of Neural Circuits with Light. 7<sup>th</sup> Brain Research Conference, Optogenetics and Pharmacogenetics, Society for Neuroscience Official pre-meeting, New Orleans, LA.
195. (2012) Optogenetics. Harvey Prize Lecture. Cambridge, MA.
196. (2012) Some ideas for how to do scalable neural circuit voltage imaging, Janelia Voltage Imaging Workshop, Janelia Farm, Ashburn, VA.
197. (2012) Some technologies for the brain activity map, 8th Kavli Futures Symposium: Tool Development for the Brain Activity Map, Washington, DC.
198. (2012) Synthetic Neurobiology, MIT Smart Customization Seminar, MIT, Cambridge, MA.
199. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuits Tools, Biological Imaging Lecture Series, University of Wisconsin Madison.
200. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuits Tools, Biochemistry, University of Wisconsin Madison.
201. (2012) Optogenetics, Robotic Electrophysiology, and Other Neural Circuits Tools, Psychiatry Grand Rounds, UT Southwestern.
202. (2013) Tools for Integrative Neuroscience: Optogenetics, Scalable Neural Recording, Molecular Brain Mapping, and 3-D Brain Building, Allen Institute for Brain Science, Seattle, WA.
203. (2013) Synthetic Intelligence, MIT Media Lab @ Tokyo 2013, Tokyo, Japan.
204. (2013) Science: The Next Revolution (“Interactive Dinner”), Discussion Leader, World Economic Forum Annual Meeting, Davos, Switzerland.
205. Boyden, E. S (2013) Nanorobots that repair the brain, Science Uncovered with Nature Magazine (“IdeasLab”), World Economic Forum Annual Meeting, Davos, Switzerland.
206. (2013) X Factors: Preparing for the Unknown (“Interactive Session”), World Economic Forum Annual Meeting, Davos, Switzerland.
207. (2013) Optogenetics, Invited Session Speaker, Association of Research in Otolaryngology, Baltimore, MD.
208. (2013) Optogenetics, In Vivo Robotics, 3-D Neural Interfacing, & Brain Building, Young Innovator In Biomedical Engineering Series, Georgia Tech, Atlanta, GA.
209. (2013) Engineering the Brain, Hertz Foundation Board Dinner, San Mateo, CA.
210. Boyden, E. S (2013) Optogenetics, In Vivo Robotics, 3-D Neural Interfacing, & Brain Building, Neuroscience Day, University of New Mexico, Albuquerque, NM.
211. (2013) Technologies for Integrative Analysis of Cell Types, NIH Single Cell Meeting, Bethesda, MD.

212. Boyden, E. S (2013) Optogenetics, In Vivo Robotics, 3-D Neural Interfacing, & Brain Building, Lundbeck, Copenhagen, Denmark.
213. (2013) Optogenetics. MIT Opto 2013 Conference, MIT, Cambridge, MA.
214. (2013) Technologies for Mapping Brain Computations. BU Medical School, Boston, MA.
215. (2013) Engineering the Brain, MIT Tech Day Kresge Symposium.
216. (2013) Engineering the Brain, DARPA Invited Presentation, Defense Science Office, Arlington, VA.
217. (2013) Tools for Analyzing and Engineering the Brain, Global Future 2045 (GF2045) Congress, Alice Tully Hall, Lincoln Center, New York, NY.
218. (2013) Optogenetics, In Vivo Robotics, 3-D Brain Building: Tools for Analyzing and Engineering the Brain, Leica Scientific Forum Lecture, Bernstein Center for Computational Neuroscience Berlin, Berlin, Germany.
219. (2013) Optogenetics, In Vivo Robotics, 3-D Brain Building: Tools for Analyzing and Engineering the Brain, Leica Scientific Forum Lecture, Max-Planck-Institute Heidelberg, Heidelberg, Germany.
220. (2013) Optogenetics, In Vivo Robotics, 3-D Brain Building: Tools for Analyzing and Engineering the Brain, Leica Scientific Forum Lecture, Max Planck Institute of Neurobiology, Munich, Germany.
221. (2013) Invited Presentation, Large-Scale Recording Technologies and Structural Neurobiology, National Institutes of Health Advisory Committee to the Director Brain Research through Advancing Innovative Neurotechnologies(BRAIN) Working Group, Rockefeller University, New York City, NY.
222. (2013) Engineering The Brain, Friday Evening Lecture, Marine Biology Laboratory, Woods Hole, MA.
223. (2013) Optogenetics and novel methods for imaging neural activity, NSF Workshop on Mapping and Engineering the Brain, Arlington, VA.
224. (2013) Optogenetics. New Advances in Optical Imaging of Live Cells & Organisms, Cold Spring Harbor Asia, Suzhou, China.
225. (2013) Tools for Mapping Brain Computations, MIT/MGH Initiative Symposium in Neuroscience, MIT, Cambridge, MA.
226. (2013) Tools for Mapping Brain Computations, Herman P. Schwan Distinguished Lecture, University of Pennsylvania.
227. (2013) Optogenetics and Other Tools for Controlling and Analyzing Neural Circuits, Accelerating Translational Neurotechnology: Fourth Annual Aspen Brain Forum, Aspen, CO.
228. (2013) Optogenetics. Harvard Mind, Brain, and Behavior Junior Symposium 2013: New Methods in Brain Science: Optogenetics, the Connectome, and Functional Imaging 2.0, Harvard University, Cambridge, MA.
229. (2013) Optogenetics. Inaugural MIT Institute for Medical Engineering and Science Symposium, MIT.
230. (2013) Engineering the Brain, EmTech 2013 Conference, MIT Technology Review, MIT, Cambridge, MA.

231. (2013) Optogenetics. Gabbay Award Lecture, Brandeis University.
232. (2013) Tools for Mapping Brain Computations, Industry-Academy Symposium in CNS, Tel Aviv University.
233. (2013) Optogenetics. Israeli BRAIN Prize Competition Talk, 1<sup>st</sup> International Israeli Brain Technology Conference, Tel Aviv, Israel.
234. (2013) Optogenetics. Invited presentation, Brain Prize Day, Aarhus University, Denmark.
235. (2013) Optogenetics: Tools for Controlling Brain Circuits with Light, Brain Prize Meeting, Hindsgavl Castle, Denmark.
236. (2013) Towards the Brainome: Tools for Understanding Molecules, Connectivity, Activity, and Behavior, Society for Neuroscience Short Course, "The Science of Large Data Sets: Spikes, Fields, and Voxels," lecturer.
237. (2013) Optical, Molecular, and Robotic Tools for Integrative Single Cell Analysis, Society for Neuroscience Symposium "All for one and one for all: progress in single cell Neurobiology", San Diego, CA.
238. (2013) Technologies for Mapping and Engineering the Brain, What is Life? Lecture, Karolinska Institute, Stockholm, Sweden.
239. (2013) Optogenetics: Tools for Analyzing and Controlling Brain Circuits with Light, Royal Swedish Academy of Sciences Symposium: Optogenetics, Stockholm, Sweden.
240. (2013) Optogenetics: Tools for Mapping and Controlling Brain Dynamics, CURE the Epilepsies: Frontiers in Research Seminar Series, Albert Einstein College of Medicine, Bronx, NY.
241. (2014) Tools for Mapping and Engineering Brain Computations, Yale University.
242. (2014) Tools for Mapping and Engineering Brain Computations, Honors Program, NYU.
243. (2014) Tools for Mapping and Engineering Brain Computations, Bioconference Live.
244. (2014) Tools for Mapping Brain Computations, Distinguished Seminar Series, Institute for Computational Medicine, Johns Hopkins University.
245. (2014) Tools for recording and controlling neural activity, Neuronal Circuits Meeting, Cold Spring Harbor.
246. (2014) Optical Tools for Mapping and Engineering the Brain, Lester Wolfe Workshop on Laser Biomedicine, Massachusetts General Hospital, Boston, MA.
247. (2014) Tools for Mapping Brain Computations, Carl P. Duncan Lecture, Northwestern University.
248. (2014) Tools for Mapping Brain Computations, XXVIII Sandbjerg Symposium, Danish Society for Neuroscience.
249. (2014) Tools for mapping and engineering brain circuits, Genetic Manipulation of Neuronal Activity III, Janelia Farm, Ashburn, VA.
250. (2014) New tools to study and engineer brain circuits, The Brain: Achievements and challenges, Molecular Frontiers Symposium, Royal Swedish Academy of Sciences, Stockholm, Sweden.

251. (2014) Tools for mapping brain computations, Featured Plenary Speaker, Canadian Neuroscience Meeting, Montreal, Canada.
252. (2014) Tools for mapping brain computations, Schuetze Award Lecture, Columbia University.
253. (2014) Optogenetics, Special Lecture, 9<sup>th</sup> FENS Forum for Neuroscience, Milan, Italy.
254. (2014) Optogenetics. 7<sup>th</sup> World Congress of Biomechanics, Boston, MA.
255. (2014) Optical Tools for Mapping Brain Computations, Gordon Conference on Lasers in Medicine and Biology, Holderness, NH.
256. (2014) Optogenetics: Membrane Transport Proteins as Tools for Mapping the Brain, Keynote, Gordon Conference on Membrane Transport Proteins, West Dover, VT.
257. (2014) Tools for Mapping and Engineering the Brain, 2nd Workshop, Micro- and Nanotechnologies for Medicine: Emerging Frontiers and Applications, Brigham and Women's Hospital, Harvard, Cambridge, MA.
258. (2014) Tools for Mapping and Engineering the Brain, MIT Club of Northern California, Palo Alto, CA.
259. (2014) Tools for Mapping and Engineering the Brain, Canary Center, Stanford University, Palo Alto, CA.
260. (2014) Tools for Mapping and Engineering the Brain, Rambus, Sunnyvale, CA.
261. (2014) Tools for Mapping and Engineering the Brain, Singularity University, NASA Ames, Mountain View, CA.
262. (2014) Tools for Mapping, Recording, and Controlling Neural Circuits, Monitoring Molecules in Neuroscience, Plenary Lecture, Los Angeles, CA.
263. (2014) Tools for Mapping and Engineering the Brain, Draper Executive Seminar on Neurotechnology, Draper Lab, Cambridge, MA.
264. (2014) Tools for Mapping and Engineering Brain Computations, Director's Special Colloquium, Argonne National Laboratory, Argonne, IL.
265. (2014) Tools for Mapping and Engineering Brain Computations, Biophysics Colloquium, Cornell University, Ithaca, NY.
266. (2014) Tools for Mapping Brain Computations, Fourth Biennial Conference on Resting State/Brain Connectivity, MIT, Cambridge, MA.
267. (2014) Tools for Mapping and Engineering Brain Computations, Applied Physics Colloquium, Harvard University.
268. (2014) Robots that can Drill Ultraprecise Craniotomies and Automatically Record Neurons, SYM02: Neuro-Vation, Congress of Neurological Surgeons Annual Meeting, Boston, MA.
269. (2014) Molecular Tools for Mapping and Controlling Neural Circuits, SYM02: Neuro-Vation, Congress of Neurological Surgeons Annual Meeting, Boston, MA.
270. (2014) Tools for Mapping and Engineering the Brain, The Scientist Webinar, New Models and Tools for Studying Synaptic Development and Function.

271. (2014) Tools for Mapping and Fixing the Brain, Translational Neuroscience Center Inaugural Symposium, Children's Hospital, Harvard Medical School.
272. (2014) From Here to Where? Following the Brain Map, Plenary Talk, Techonomy.
273. (2014) Mapping the brain at scale: collecting the data necessary to infer the computations carried out by neural circuits, Google, Mt. View, CA.
274. (2014) Towards a Comprehensive Atlas of the Mechanisms of Brain Computation, IEEE EMBS BRAIN Grand Challenges Conference, Washington, DC.
275. (2014) Optical Tools for Mapping and Engineering the Brain, DFG-NSF workshop "New Perspectives of Neurotechnology and Neuroengineering," NSF, Washington, DC.
276. (2014) Tools for Mapping and Repairing the Brain, Thirty Third Annual Seminar Series, The Human Brain: Research, Progress, and Policy, MIT Club of Washington DC.
277. (2014) Tools for Mapping and Repairing the Brain, Lincoln Lab ARTS Conference, MIT.
278. (2014) Tools for Multiscale Analysis of Biological Systems, Biochemistry Lecture, Massachusetts General Hospital, Boston, MA.
279. (2014) Understanding Brains and Minds, Russian-American Research Symposium, Moscow, Russia.
280. (2014) Super-resolution microscopy across arbitrary scales, NIH High-Risk High-Reward Symposium, Bethesda, MD.
281. (2014) Tools for Mapping, Recording, and Fixing Brains, "Talking Science" Lecture, Munich, Germany.
282. (2015) Tools for Understanding and Fixing Complex Biological Systems, MGH BioMEMS Resource Center Seminar, Harvard University, MGH Charlestown.
283. (2015) Tools for Understanding and Fixing Complex Biological Systems, Feinstein Institute, NY.
284. (2015) Tools for Understanding and Fixing Complex Biological Systems, Northeastern University, Boston, MA.
285. (2015) Tools for Mapping and Fixing the Brain, NIDA, Baltimore, MD.
286. (2015) Tools for Mapping and Fixing the Brain, Army Research Laboratory, Aberdeen Proving Ground, MD.
287. (2015) Tools for Mapping and Fixing the Brain, World CNS Summit 2015, Boston, MA.
288. (2015) Expansion Microscopy, NYSCF Webinar.
289. (2015) Optical Tools for Mapping and Engineering the Brain, SPIE Optogenetics Conference, Keynote.
290. (2015) Tools for Brain-Wide Mapping of the Computations of Intelligence, Center for Brains, Minds, and Machines Seminar, Harvard.
291. (2015) Tools for Mapping and Fixing the Brain, Brain Forum 2015, Lausanne, Switzerland.
292. (2015) Tools for Mapping and Fixing the Brain, Carnegie Prize Lecture, Carnegie Mellon University.

293. (2015) Tools for Understanding and Fixing the Brain, Massachusetts Neurological Association, Waltham, MA.
294. (2015) Tools for Mapping and Fixing the Brain, Neural Engineering and Systems Design BootCamp, DARPA.
295. (2015) Expansion Microscopy, Plenary Talk, 3rd NIH Single Cell Meeting, NIH, Bethesda, MD.
296. (2015) Towards Imaging DNA, RNA, and Proteins With Nanoscale Precision Throughout Entire Neurons and Neural Networks, NIH Workshop on Defining Cellular Phenotypes, NIH, Bethesda, MD.
297. (2015) Expansion Microscopy, Janelia Zebrafish Workshop, Janelia Farm.
298. (2015) Tools for Mapping and Controlling Complex Biological Systems, 2nd International Workshop on Mammalian Synthetic Biology, MIT.
299. (2015) Tools for Mapping and Fixing Complex Biological Systems, Wayne Crill Lecture, University of Washington.
300. (2015) Tools for Mapping and Fixing Complex Biological Systems, Institute for Disease Modeling, Bellevue, WA.
301. (2015) Tools for Mapping and Fixing Complex Biological Systems, Milton Gordon Lecture, University of Washington.
302. (2015) Precision tools for optically mapping and repairing the brain, Frontiers in Neurophotonics Summer School, Quebec City, Canada.
303. (2015) Tools for Mapping and Repairing the Brain, Dana Foundation/AAAS Capitol Hill Briefing, Washington, DC.
304. (2015) Tools for Mapping and Fixing the Brain, Albany 2015: the 19th Conversation, SUNY Albany, Albany, NY.
305. (2015) Mapping the Control Knobs of Autoimmune Attack, NYSCF Immunoengineering Working Group Meeting, New York, NY.
306. (2015) Tools for Mapping and Fixing Complex Biological Systems, Xerox PARC, Palo Alto, CA.
307. (2015) Expansion Microscopy, Science Foo (SciFoo) Camp, Google, Mountain View, CA.
308. (2015) Why is understanding the brain so difficult? The Future of the Brain segment, Science Foo (SciFoo) Camp, Google, Mountain View, CA.
309. (2015) Tools for Mapping and Fixing Complex Biological Systems, "Dinner and Ideas," 3scan, San Francisco, CA.
310. (2015) Tools for Mapping and Fixing Complex Biological Systems, webinar, Photonics Media.
311. (2015) Tools for mapping and repairing complex biological systems, 3rd Annual Workshop on Micro- and Nanotechnologies for Medicine: Emerging Frontiers and Applications, Cambridge, MA.

312. (2015) Tools for Mapping Brain Computations, Program on Challenges in Computational Neuroscience (CCNS) Workshop, Statistical and Applied Mathematical Sciences Institute, Research Triangle Park, NC.
313. (2015) Tools for mapping and repairing the brain, Beyond Monoamines: Towards New Conceptualizations and Treatments for Major Depression Workshop, Radcliffe Institute, Cambridge, MA.
314. (2015) Expansion Microscopy, 21st International Conference on DNA Computing and Molecular Programming, Wyss Institute for Biologically Inspired Engineering, Harvard University, Cambridge, MA.
315. (2015) Tools for analyzing and repairing complex biological systems, NIH Director's Lecture, NIH, Bethesda, MD.
316. (2015) Tools for analyzing and repairing the brain, MindEx 2015, Mind First Foundation/Harvard Personal Genome Project, Cambridge, MA
317. (2015) Tools for analyzing and repairing complex biological systems, Novartis Venture Fund annual retreat.
318. (2015) Tools for analyzing and repairing complex biological systems, Epilepsy Innovation Meeting, Epilepsy Foundation, Cambridge MA
319. (2015) Tools for analyzing and repairing the brain, Kavli Workshop on Cortical Computation, Cambridge MA
320. (2015) Tools for analyzing and repairing the brain, L'Universite Paris Descartes, Paris, France.
321. (2015) Tools for analyzing and repairing complex biological systems, Keynote Address, Gulf Coast Cluster for Neuroengineering 5<sup>th</sup> Annual NeuroEngineering Symposium (Rice, Baylor, UT Houston, UT Galveston, MD Anderson), Houston, TX.
322. (2015) Lighting up Biology, Science Writers 2015, Council for the Advancement of Science Writing New Horizons in Science, Cambridge, MA, Plenary Talk.
323. (2015) Tools for analyzing and repairing the brain, McLean Hospital, Belmont, MA.
324. (2015). Seeing very small things, PopTech 2015, Camden, ME.
325. (2015) Tools for mapping and repairing the brain, Wellesley College, Wellesley, MA.
326. (2015) Tools for understanding and repairing the brain, MIT Neurotech 2015, MIT, Cambridge, MA.
327. (2015) Tools for analyzing and modulating brain circuits, Behavior & Neurogenetics of Nonhuman Primates, Cold Spring Harbor Laboratory, 2015.
328. (2015) Tools for Understanding and Fixing Complex Biological Systems, Stanley Seminar, Cold Spring Harbor Laboratory, 2015.
329. (2015) Tools for Analyzing and Repairing Complex Biological Systems, Huck Institutes Distinguished Lecture Series, Penn State, State College, PA.
330. (2015) Vascular Interfaces for Brain Imaging and Stimulation, Research Highlight Talks, 2nd Annual BRAIN Initiative Investigators Meeting, Bethesda, MD.



331. (2015), with Ian Wickersham: Identifying and Accessing Cells and Circuits, Technology Integration Cross-Cutting Theme, 2nd Annual BRAIN Initiative Investigators Meeting, Bethesda, MD.
332. (2015) Thinking backwards from the goal of really simple data analysis, BICCC Break Out Session: Cell Type Histology & Morphology, 2nd Annual BRAIN Initiative Investigators Meeting, Bethesda, MD.
333. (2015) Tools for Mapping and Repairing Complex Biological Systems, Biochemistry, UCSF, San Francisco, CA.
334. (2016) Tools for analyzing brain circuits implementing intelligence, The Science and Engineering of Intelligence: A bridge across Vassar Street, MIT, Cambridge, MA.
335. (2016) (2016) Engineering Revolutions (“BetaZone”), World Economic Forum Annual Meeting, Davos, Switzerland. Delivered lecture twice.
336. (2016) Will Science Save Us?, Discussion Leader, Nature Publishing Group, World Economic Forum Annual Meeting, Davos, Switzerland.
337. (2016) Tools for Mapping and Repairing Complex Biological Systems, Longitudinal Seminar for the Master’s Program in Clinical and Translational Investigation (MPCTI) and the Program in Clinical and Translational Science (PCaTS ) at Harvard Medical School
338. (2016) Expansion microscopy: toward large-volume, 3D, nanoscale, multiplexed molecular mapping, 4th Annual Klarman Cell Observatory Retreat, Broad Institute, Cambridge, MA.
339. (2016) Tools for Analyzing and Repairing Brains and Other Complex Biological Systems, Schueler Lecture, Tulane University, New Orleans, LA.
340. (2016) Reverse Engineering, and Repairing, the Brain and Mind, MIT Sidney Pacific Presidential Fellows Distinguished Lecture Series.
341. (2016) Tools for Analyzing and Repairing Complex Biological Systems, Optogenetics in Neuroscience, Symposium, Biophysical Society 60th Annual Meeting, Los Angeles, CA.
342. (2016) Mapping, Observing, and Controlling the Brain Using Light, Mind Control: Past, Present, and Future, Mind Brain Behavior Initiative, Harvard University.
343. (2016) Tools for Mapping and Controlling Complex Biological Systems, 2016 Gene Circuits LabLinks, Broad Institute.
344. (2016) Tools for Mapping and Controlling Complex Biological Systems, Harvard Medical School, Division of Immunology Trainee Forum.
345. (2016) Tools for Analyzing and Repairing the Brain, Neuroscience Graduate Program, USC.
346. (2016) Optical Tools for Analyzing and Repairing Complex Biological Systems, Biology, Caltech.
347. (2016) Tools for Mapping and Repairing Complex Biological Systems, Cell Circuits and Epigenomics Seminar Series, Broad Institute.
348. (2016) Expansion Microscopy, High-Resolution Circuit Reconstruction Conference, Janelia Farm.
349. (2016) Tools for Analyzing and Repairing the Brain, Stanford Neuroscience Institute Seminar Series, Stanford.

350. (2016) Tools for Comprehensive Analysis of Brain Circuitry, The Brain in Focus: New Approaches to Imaging Neurons and Neural Circuits, Rungstedgaard, Denmark.
351. (2016) Tools for Analyzing and Repairing Brains and Other Biological Systems, Institute for Biophysical Dynamics, U Chicago.
352. (2016) Optical Tools for Analyzing and Repairing Complex Biological Systems, Salk Institute Thursday Seminar Series, Salk Institute.
353. (2016) Tools for Ground-Truth Analysis and Control of Neural Circuits, Computational Neuroscience and Vision Systems, University of Massachusetts Amherst.
354. (2016) Expansion Microscopy (published on TED.com as “Baby diapers inspired this new way to study the brain”), TED (Technology, Entertainment, and Design) Summit Conference, Banff, Canada.
355. (2016) Tools for Mapping and Controlling Neural Circuitry, Optogenetic Approaches to Understanding Neural Circuits & Behavior, Sunday River, Newry, ME.
356. (2016) New tools for mapping and engineering the brain: optogenetics and expansion microscopy, 2nd Proteins and Peptides International Conference, University of Geneva, Switzerland.
357. (2016) Ground-Truthing Medicine, Effective Altruism Global, Berkeley, CA.
358. (2016) Introduction to Expansion Microscopy, Expansion Microscopy Workshop, Janelia Research Campus.
359. (2016) Tools for Analyzing and Controlling Biological Systems, Litwack Lecture, North Carolina State University.
360. (2016) Tools for Mapping and Controlling the Brain, Neurotechnology Center Kavli Futures Symposium, Columbia University.
361. (2016) Tools for Analyzing and Repairing Complex Biological Systems, Wellman Center for Photomedicine, MGH.
362. (2016) Technologies for Mapping and Repairing the Brain, Reading Your Mind: Understanding your brain through physical responses, MDG Forum, Regis College.
363. (2016) Expansion Microscopy, Keynote, National Society of for Histotechnology Annual Symposium, Long Beach, CA.
364. (2016) Optical Tools for Analyzing and Repairing Complex Biological Systems, 13th Key Symposium 2016: Bioelectronic Medicine - Technology Targeting Molecular Mechanisms, New York Academy of Sciences, New York, NY.
365. (2016) Perspectives on Optogenetics, Optogenetics Day, Neurex, Strasbourg, France.
366. (2016) Optogenetics and Expansion Microscopy: Molecular Tools for Mapping and Controlling Complex Biological Systems, Institut de Science et d'Ingénierie Supramoléculaires, U. Strasbourg.
367. (2016) Ground-truthing Medicine, Hello Tomorrow Summit, Keynote, Paris, France.
368. (2016) Towards ground-truth analysis of neural circuit computations, Genetic Manipulation of Neuronal Activity IV, Janelia Research Campus, Ashburn, VA.

369. (2016) Technologies for Mapping and Repairing the Brain at a Fundamental Level, Center for BrainHealth, UT Dallas, Dallas, TX.
370. (2016) Optical Tools for Analyzing and Repairing the Brain, Karen L. Wrenn Lectureship, Duke University.
371. (2016) Tools for Understanding and Repairing the Brain, Research Update in Neuroscience for Neurosurgeons Course, Marine Biology Laboratory, Woods Hole, MA.
372. (2016) Tools for Systematically Analyzing Neural Circuits, Molecular and Cellular Cognition Society, San Diego, CA.
373. (2016) Expansion Microscopy and Expansion Sequencing: Towards Comprehensive Molecular Interrogation of Complex Biological Systems, Illumina Science & Technology Seminar Series, San Francisco, CA.
374. (2016) Expansion Microscopy: Towards Nanoscale Multiplexed Mapping of Biological Systems, Oncology Seminar Series, Koch Institute, MIT, Cambridge MA.
375. (2016) Lecture on Expansion Microscopy, Precision Medicine and Emerging Methods of Bioimaging panel, Association of Academic Health Centers 2016 Research Meeting, Washington, DC.
376. (2017) Expansion Microscopy and Optogenetics, 14th Annual Advanced Imaging Methods Workshop at UC Berkeley, Berkeley, CA.
377. (2017) Expansion Microscopy, AAAS/Science Webinar, Washington, DC.
378. (2017) Towards Comprehensive Biological Analysis of Intact Cells and Tissues: Expansion Microscopy, Optogenetics, and Other Tools, Brigham and Womens Pathology Grand Rounds, Brigham and Womens Hospital, Boston, MA.
379. (2017) Optical Tools for Analyzing and Repairing Brain Circuits, Max Planck Florida Sunposium 2017, Palm Beach, FL.
380. (2017) Optical Tools for Analyzing and Repairing Complex Biological Systems, Friday Lecture Series, Rockefeller University.
381. (2016) Ultra-Multiplexed Nanoscale in Situ Proteomics for Understanding Synapse Types, Brain Initiative Cell Census Consortium 3rd Annual BRAIN Initiative Investigators Pre-Meeting, Rockville, MD.
382. (2017) Nanoscale Resolution, Multiplexed, 3-D Molecular Imaging Across Large Volumes: Expansion Microscopy, Human Cell Atlas Meeting, Chan Zuckerberg Science, Stanford University.
383. (2017) Optogenetics and Expansion Microscopy: New Ways of Using Light to Understand Biological Systems, Keynote, Boston Photonics Centennial Conference, Harvard University.
384. (2017) Towards 3-D Multiplexed, Multimodal Imaging of Biomolecules Throughout Cells and Tissues, BRAIN Initiative Technology Integration Webinar.
385. (2017) Optical Tools for Mapping and Repairing the Brain: Expansion Microscopy and Optogenetics, 10th Annual Future of Genomic Medicine Conference, La Jolla, CA.
386. (2017) Tools for Analyzing and Repairing the Brain, Breakthroughs in Biology (Hadad) lecture, Haverford College.

387. (2017) Tools for Mapping and Controlling Complex Biological Systems, Department of Genetics, Washington University in St. Louis.
388. (2017) Expansion Microscopy and Optogenetics: Tools for Deconstructing Neural Circuits, OneChemistry Symposium, Chemistry's Role in the Brain Initiative, Johns Hopkins University.
389. (2017) Expansion microscopy, Frontiers in Imaging Science, Janelia Research Campus.
390. (2017) Expansion microscopy, Whitehead Institute Symposium on Frontiers in Biological Microscopy Technologies, Whitehead Institute, Cambridge, MA.
391. (2017) Expansion microscopy, keynote lecture, Foundations of Nanoscience, Snowbird, UT.
392. (2017) Optical tools for analyzing and repairing complex biological systems, Science and Technology Speaker Series, Sandia National Laboratory.

#### **Other non-peer-reviewed talks and conference papers**

1. Schoner, B., Cooper, C., Douglas, C., Boyden, E. S., Gershenfeld, N. (1998) Cluster Weighted Modeling for Time Series (How to Build a Digital Strad). Workshop on Nonlinear Dynamics and Statistics, Issac Newton Institute, Cambridge.
2. Chen, G., Foletti, D. L., Boyden, E. S., Holz, R. W., Scheller, R. H., Tsien, R. W. (2000) Differential functions of Rab3A in regulating excitatory and inhibitory transmission in hippocampal neurons. Society for Neuroscience, Online.
3. Boyden, E. S., Raymond, J. L. (2002) Induction, timecourse, and persistence of mouse vestibulo-ocular reflex adaptation. Society for Neuroscience, Online.
4. Boyden, E. S., Chatila, T. A., Raymond, J. L. (2003) Motor memories in the vestibulo-ocular reflex of CaMKIV knockout mice. Society for Neuroscience, Online.
5. Mong, C., Cao, Y. Q., Boyden, E. S., Abbott, L. C., Tsien, R. W. (2003) Properties of cortical spreading depression across visual cortex in mice with spontaneous mutations in P/Q-type Ca<sup>2+</sup> channels. Society for Neuroscience, Online.
6. Liao, Y. J., Boyden, E. S., Tsien, R. W. (2003) Anti-calcium channel antibody affects cerebellar synaptic transmission in a model of acquired channelopathy. Society for Neuroscience, Online.
7. Liao, Y. J., Safa, P., Boyden, E. S., Tsien, R. W. (2004) Antibody-mediated altered cerebellar transmission. Channels, Receptors, and Synapses Meeting, Cold Spring Harbor, NY, April 2004.
8. Kimpo, R. R., Katoh, A., Boyden, E. S., Raymond, J. L. (2004) Patterns of generalization constrain encoding of learned opposite changes in the vestibulo-ocular reflex. Society for Neuroscience, Online.
9. Liao, Y. J., Safa, P., Boyden, E. S., Tsien, R. W. (2004) Antibody-mediated channelopathy in a model of paraneoplastic cerebellar ataxia. Society for Neuroscience, Online.
10. Boyden, E. S., Content-selective neural mechanisms of memory encoding. (2005) Catalyzing the Future, Fannie and John Hertz Foundation Symposium.
11. Boyden, E. S., Zhang, F., Bamberg, E., Nagel, G., and Deisseroth, K. (2005) Millisecond-timescale optical control of neural computation via channelrhodopsin-2. Talk, at Society For Neuroscience, Online.

12. Zhang, F., Boyden, E. S., Deisseroth, K. (2005) Genetic and optical strategies for using channelrhodopsin-2 to control diverse neural functions. Society for Neuroscience, Online.
13. Boyden, E. S., Safa, P., Pyle, J. L., Neogi, M., Raymond, J. L., Tsien, R. W. (2005) Gene expression patterns in the medial vestibular nucleus indicate the direction of motor learning in the vestibulo-ocular reflex. Talk, at Society for Neuroscience, Online.
14. Wang H., Peca J., Qiu L., Wang D., Zhang F., Boyden E. S., Deisseroth K., Feng G., Augustine G. J., Hall W. C. (2006) Circuit analysis using optical stimulation in ChR2 transgenic mice. Society for Neuroscience, Online.
15. Peca, J., Wang, H., Arenkiel, B. R., Matsusaki, M., Davison, I. G., Matsusaki, K., Noguchi, J., Qiu, L., Wang, D., Zhang, F., Zhao, S., Berglund, K., Feliciano, C., Boyden, E. S., Kasai, H., Hall, W. C., Deisseroth, K., Ehlers, M. D., Augustin, G. J., Feng, G. (2007) A transgenic tool for controlling neuronal activity with light, Society for Neuroscience, Online.
16. Han, X., and Boyden, E. S. (2007) Two-Color, Bi-Directional Optical Voltage Control of Genetically-Targeted Neurons, Spotlight Presentation, Computational and Systems Neuroscience (CoSyNe), Salt Lake City, UT, Feb 22-25, 2007.
17. (Henninger, M. A.), Bernstein, J., Ko, E., Strelzoff, A., Chan, S. C. Y., Gidwaney, V., Stickgold, E., Tentori, A. M., McConnell, J., Rodriguez, A., Monahan, P., Talei Franzesi, G., Han, X., Qian, X., Boyden, E. S. (2008) A scalable toolbox for systematic, cell-specific optical control of entire 3-D neural circuits in the intact mammalian brain. Society for Neuroscience, Online. (M. A. Henninger sponsored the abstract submission, but J. Bernstein performed the key work.)
18. Han, X., Qian, X., Bernstein, J., Zhou, H., Graybiel, A., Desimone, R., Boyden, E. S. (2008) Millisecond-timescale optical control of specific genetically-targeted neurons and neural circuits in primate cerebral cortex. Society for Neuroscience, Online.
19. Han, X., Qian, X., Talei Franzesi G., Stern, P., Boyden, E. S. (2008) Molecular toolboxes for quantitatively precise, genetically-targeted optical control of normal and pathological neural network dynamics. Society for Neuroscience, Online.
20. Horsager, A., Liu, J.-W., Boyden, E. S., Arman, A. C., Matteo, B. C., Sampath, A. P., Hauswirth, W.W. (2009) Restoring visual function in adult rd1 mice using virally-delivered channelrhodopsin. Association for Research in Vision and Ophthalmology, Online.
21. Liu, J.-W., Horsager, A., Ding, M., Mani, S., Chiodo, V.A., Boyden, E.S., Hauswirth, W.W. (2009) AAV-mediated ON Bipolar Cell Targeting In The rd1 Mouse Lacking Photoreceptors. Association for Research in Vision and Ophthalmology, Online.
22. Tsien, R. W., Barrett, C. F., Safa, P., Chen, Y.-R., Boyden, E. S., Liao, Y. J. (2008) Genetic and Acquired Neural Diseases Involving Voltage-gated Calcium Channels. Abstract, Sixty-Second Annual Meeting of the Society of General Physiologists, Woods Hole, MA.
23. Boyden, E. (2009) Optical neural control: towards treating neurological and psychiatric disorders. Talk at Photons and Neurons, Conference 7180, BiOS 2009, Photonics West 2009, SPIE, January 2009.
24. Han, X., Qian, X., Bernstein, J., Zhou, H., Graybiel, A., Desimone, R., Boyden, E.S. (2009) Safety and efficacy of genetically-targeted optical neuromodulation in non-human primates. Talk at Photons and Neurons, Conference 7180, BiOS 2009, Photonics West 2009, SPIE, January 2009.
25. Han, X., Qian, X., Bernstein, J., Zhou, H., Graybiel, A., Desimone, R., Boyden, E.S. (2009) Excitatory-inhibitory network interactions during cell-specific optical cortical control. Talk at Photons and Neurons, Conference 7180, BiOS 2009, Photonics West 2009, SPIE, January 2009.

26. Lang, E. V., Diamond, S. G., Flory, N., Barry, B., (Boyden, E. S.) (2008) Hypnosis and Empathic Communication in Medical Practice -- A Report. American Psychological Association Convention, Session 1264.
27. Bernstein, J. G., Baratta, M. V., Ko, E. Y., Henninger, M. A. Li, M., Goosens, K., Boyden, E. S. (2009) Modulation of fear behavior via optical fiber arrays targeted to bilateral prefrontal cortex. Society for Neuroscience, Online.
28. Talei Franzesi, G., Borgers, C., Qian, X., Li, M., Han, X., Kopell, N., LeBeau, F., Whittington, M., Boyden, E. S. (2009) Dynamical properties of gamma-frequency cell assemblies in the hippocampus probed with optical neural control and computational modeling. Society for Neuroscience, Online.
29. McCarthy, M., Han, X., Boyden, E. S., Kopell, N. (2009) Striatum as a possible source of exaggerated beta oscillations in Parkinson's Disease: insights from computational models. Society for Neuroscience, Online.
30. Zorzos, A. N., Bernstein, J. G., Boyden, E.S., Fonstad, C. G. (2009) Integrated microstructure lightguides for ultradense optical neural control of 3-dimensional neural circuits. Society for Neuroscience, Online.
31. Zorzos, A. N., Dietrich, A., Talei Franzesi, G., Chow, B., Han, X., Fonstad, C. G., Boyden, E.S. (2009) Light-proof neural recording electrodes. Society for Neuroscience, Online.
32. Desai, M., Bernstein, J., Atallah, H., Kahn, I., Moore, C. I., Kopell, N., Graybiel, A., Boyden, E. S. (2009) Integration of optical neural control and high-field fMRI: Towards systematic exploration of functional neural dynamics with 'Opto-fMRI'. Society for Neuroscience, Online.
33. Horsager, A., Liu, J.-W., Boyden, E.S., Arman, A.C., Matteo, B.C., Sampath, A.P., Hauswirth, W.W. (2009) Circuit-specific expression of channelrhodopsin restores visual function in blind rd1, rd16, and rho -/- mice. Society for Neuroscience, Online.
34. Shin, S.-L., Boyden, E. S., Katoh, A., Zhao, G. Q., Raymond, J.L. (2009) Adaptive timing is impaired in mice deficient in presynaptic LTP. Society for Neuroscience, Online.
35. Chow, B.Y., Han, X., Qian, X., Li, M., Chuong, A. S., Monahan, P.E., Dobry, A.S., Boyden, E.S. (2009) High-efficacy, temporally-precise, in vivo neural silencing via light-driven proton pumping. Society for Neuroscience, Online.
36. Chow, B.Y., Han, X., Qian, X., Li, M., Chuong, A. S., Monahan, P.E., Dobry, A.S., Boyden, E.S. (2009) Multiple-color optical silencing of distinct neural populations using novel classes of light-driven ion pumps. Society for Neuroscience, Online.
37. Cao, R., Cardin, J., Higashikobo, B., Knoblich, U., Brumberg, J. C., Boyden, E. S., Moore, C. I. (2009) Testing the hemoneural hypothesis: Specific control of blood flow and functional two photon imaging. Society for Neuroscience, Online.
38. Boyden, E. S. (2009) Optical Neural Control: Engineering Therapeutic Circuit Dynamics: Application to Post-Traumatic Stress Disorder, Talk 7-9, Poster P31-11, PTSD Treatment, Military Health Research Forum, Kansas City, MO.
39. Chow, B. Y., Han, X., Klapoetke, N. C., Dobry, A. S., Desimone, R., Boyden, E. S. (2010) NOVEL CLASSES OF OPTICAL NEURAL CONTROL TOOLS REVEALED VIA SCREENING OF PHYLOGENETIC DIVERSITY, Cold Spring Harbor Meeting on Neural Circuits, Cold Spring Harbor, NY.
40. Bernstein, J. G., Zorzos, A. N., Baratta, M. V., Ko, E. Y., Yang, A., Li, M., Talei Franzesi, G., Goosens, K. A., Fonstad, C. G., Boyden, E. S. (2010) Hardware for Optical Perturbation

of 3-D Neural Circuits: Towards High-Throughput Screening of Neural Circuit Targets, Cold Spring Harbor Meeting on Neural Circuits, Cold Spring Harbor, NY.

41. Zimmerman, C., Wasserman, S., Boyden, E. (2010) Classroom NMR System, Institute of Biological Engineering Annual Conference, Cambridge, MA.

42. Talei Franzesi, G., Borgers, C., Qian, X., Li, M., Han, X., Kopell, N. J., Le Beau, F., Whittington, M.A., Boyden, E.S. (2010) Dynamical properties of gamma-frequency cell assemblies in the hippocampus probed with optical neural control and computational modeling. Collaborative Research in Computational Neuroscience (CRCNS) Meeting, Johns Hopkins University, Baltimore, Maryland.

43. Kim, K., Baratta, M. V., Yang, A., Lee, D., Boyden, E. S., Fiorillo, C. D. (2010) Optical activation of dopamine neurons for 200 milliseconds is sufficient for operant reinforcement. Society for Neuroscience, Online.

44. Chuong, A. S., Klapoetke, N. C., Chow, B. Y., Dobry, A. S., Han, X., Boyden, E. S. (2010) Development of next-generation optical neural silencers through directed combinatorial optimization. Society for Neuroscience, Online.

45. Klapoetke, N., Chuong, A., Chow, B., Morimoto, T., Han, X., Boyden, E. S. (2010) Novel classes of optogenetic reagent derived from screening genomic and ecological diversity. Society for Neuroscience, Online.

46. Han, X., Chow, B. Y., (Li, M.), Yang, A., Zhou, H., Rajimehr, R., Klapoetke, N., Chuong, A., Desimone, R., Boyden, E. S. (2010) Temporally precise optical neural silencing in the nonhuman primate brain. Society for Neuroscience, Online.

47. Allen, B. D., Bernstein, J., Guerra, A., Talei Franzesi, G., Yang, A., Wang, V., Sternberg, J., Boyden, E. S. (2010) Strategies for practical use of multi-site optical neural control hardware in vivo. Society for Neuroscience, Online.

48. Wentz, C., Bernstein, J., Guerra, A., Monahan, P., Simon, J., Farrell, M., Liu, Y., Boyden, E. S. (2010) Wireless Optical Control of Neural Circuits in Freely-Moving Animals. Society for Neuroscience, Online.

49. Desai, M., Kahn, I., Bernstein, J., Atallah, H., Kopell, N., Buckner, R. L., Moore, C.I., Graybiel, A.M., Boyden, E.S. (2010) Opto-fMRI: Ultra-High Resolution Causal Circuit Mapping, and Application to Analysis of Network Dynamics. Society for Neuroscience. Online.

50. Kahn, I., Knoblich, U., Desai, M., Bernstein, J., Graybiel, A.M., Boyden, E.S., Buckner, R.L., Moore, C.I. (2010) Opto-fMRI: Blood oxygenation level-dependent (BOLD) response is correlated with optically-driven pyramidal spiking activity. Society for Neuroscience. Online.

51. Kodandaramaiah, S. B., Malik, S., Dergance, M. J., Forest, C. R., and Boyden, E. S. (2010) Design and Performance of Telescoping Micropipette Arrays for High Throughput in Vivo Patch Clamping, Proceedings of the 25th Annual Meeting of the American Society for Precision Engineering 2010, V. 50, p. 246-249, Atlanta, GA, October 31-November 4, 2010.

52. Becerra, L., Brenner, G., Bishop, J., Chang, P.-C., Shin, H.-S., Boyden, E. Borsook, D. (2011) Opto-fMRI in awake rodents: Activation and deactivation BOLD signal induced by excitation and inhibition of neurons, 2011 Annual Meeting of the International Society for Magnetic Resonance in Medicine, Montreal, Quebec, Canada.

53. Ririe, DG, Boada DM, Martin TJ, Boyden E, Eisenach JC (2011) Optical inhibition of neurons in whole rat dorsal root ganglion after in vivo intrathecal viral vector induced expression of the optically active proton pump Arch-T, American Society of Anesthesiologists.

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