

Gregory L. Holst

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EDUCATION

Ph.D. – Bioengineering Aug 2011 - Aug 2016, **Georgia Institute of Technology**

- Advisor: Dr. Craig R. Forest, Precision Biosystems Laboratory
- Committee: Dr. Edward S. Boyden (MIT), Dr. Hongkui Zeng (Allen Institute for Brain Science), Dr. Garrett B. Stanley (Georgia Tech), Dr. Todd D. Sulcheck (Georgia Tech), Dr. Suhasa B. Kodandaramaiah (MIT)
- Thesis Title: “High-throughput, fully-automated, sequential, whole-cell patch clamp neural recordings *in vivo*”
- Awarded a Stem Cell Biomanufacturing Integrative Graduate Education and Research Traineeship
- Awarded a Georgia Institute of Technology Presidential Fellowship
- Co-authored 4 journal articles in top tier journals including Nature Protocols, Biomicrofluidics, Biosensors and Bioelectronics, and IEEE Transactions on Communications,
- Presented work at 6 professional societies including Society for Neuroscience (SFN), American Society of Precision Engineers (ASPE), and Biomedical Engineering Society (BMES)
- Co-authored 15 other conference proceedings
- Co-wrote and received a \$40,000 Translational Research Institute for Biomedical Engineering & Science grant

M.S. – Mechanical Engineering Aug 2009 - June 2011, **Brigham Young University**

- Advisor: Dr. Brian D. Jensen, Compliant Mechanisms Research Laboratory
- Committee: Dr. Larry L. Howell (BYU), Dr. Matthew R. Jones (BYU)
- Thesis Title: “Modeling, design, and testing of an underwater microactuation system using a standard MEMS foundry process”
- Published 1 journal article in the Journal of Mechanical Design
- Published and presented 2 peer reviewed conference articles at IMECE and DETC
- GPA 3.85 (GRE 770 Quantitative, 540 Verbal, 4.5 Analytical)

B.S. – Mechanical Engineering Jan 2004 - Aug 2009, **Brigham Young University**

- GPA 3.89 (Cum Laude)
- Awarded academic merit full tuition scholarships 04-09

PUBLICATIONS

Publications in refereed journals

1. M. A. Stockslager*, C. M. Capocasale*, **G. L. Holst**, M. D. Simon, D. J. M., Yuanda Li, E. B. Rousseau, W. A. Stoy, C. R. Forest, and T. Sulchek, "Optical method for automated measurement of glass micropipette tip geometry," *Precision Engineering*, (under review). **equal contribution*
2. S. B. Kodandaramaiah, **G. L. Holst**, I. R. Wickersham, A. C. Singer, G. Talei-Franzesi, C. R. Forest, E. S. Boyden, Autopatching: assembling and using a robot for automated intracellular neural recording in live

mammalian brain, *Nature Protocols* (accepted)

3. C. R. Phaneuf, N. Pak, D. C. Saunders, **G. L. Holst**, J. Birjiniuk, N. Nagpal, S. Culpepper, E. Popler, A. L. Shane, R. Jerris, C. R. Forest, "Thermally multiplexed polymerase chain reaction", *Biomicrofluidics*, vol. 9, no. 4, 2015. (**Selected as one of the Editor's Picks, 2015**)
4. B. Krishnaswamy, C. M. Austing, J. P. Bardill, D. Russakow, **G. L. Holst**, B. K. Hammer, C. R. Forest, R. Sivakumar, "Time-Elapse Communication: Bacterial Communication on a Microfluidic Chip", *IEEE Transactions on Communications*, Vol. 61, No. 12, Dec 2013
5. D.C. Saunders, **G.L. Holst**, C.R. Phaneuf, N. Pak, M. Marchese, N. Sondej, M. McKinnon, C.R. Forest, "Rapid, quantitative, reverse transcription PCR in a polymer microfluidic chip", *Biosensors and Bioelectronics*, Vol. 44, 2013
6. **G. L. Holst**, G. H. Teichert, B. D. Jensen, "Modeling and Experiments of Buckling Modes and Deflection of Fixed-Guided Beams in Compliant Mechanisms." *Journal of Mechanical Design* (ASME) vol. 133, no. 5. 2011

Conference Publications

1. **G. L. Holst**, W. Stoy, I. Kolb, L. Li, U. Knoblich, S. B. Kodandaramaiah, S. Sorensen, H. Gill, T. Jarsky, J. Waters, A. Singer, B. Yang, G. T. Franzesi, E. S. Boyden, C. R. Forest, "Progress towards high throughput, in vivo cell-type identification using coupled electrophysiological and morphological properties", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2015), Chicago, IL, October 17-21, 2015.
2. F.J. Flores*, S.B. Kodandaramaiah*, I.R. Wickersham, **G. L. Holst**, G. Talei-Franzesi, A.S. Singer, N. Kopell, C. Borgers, C. Forest, Emery N. Brown, Edward S. Boyden, "Effects of general anesthetics on somatosensory cortical neurons", *Proceedings of the 22nd Annual meeting of the Cognitive Neuroscience Society* (CNS 2015), San Francisco, CA, Mar 28-31, 2015.
3. **G. L. Holst**, S. B. Kodandaramaiah, I. Kolb, W. Stoy, I. Wickersham, A. Singer, L. Li, E. S. Boyden, H. Zeng, C. R. Forest, "High-throughput fully-automated patch clamp robot for in vivo electrophysiology and morphology", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2014), Washington DC, November 15-19, 2014.
4. A. A. Chubykin, I. Kolb, B. M. Callahan, **G. L. Holst**, W. Stoy, C. R. Forest, E. S. Boyden, M. F. Bear, "Automated image-guided whole-cell patch clamp technology for mapping functional neuronal circuitry", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2014), Washington DC, November 15-19, 2014.
5. S. B. Kodandaramaiah, F. J. Flores, G. Talei Franzesi, A. C. Singer, **G. L. Holst**, I. R. Wickersham, C. Borgers, N. J. Kopell, C. R. Forest, E. N. Brown, E. S. Boyden, "Automated multiple-cell patch clamp assessment of multineuron subthreshold dynamics in waking and anesthetized states", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2014), Washington DC, November 15-19, 2014.
6. G. Talei Franzesi, A. Singer, I. Kolb, S. Sharma, S. Kodandaramaiah, M. Tsitsiklis, I. Wickersham, **G. L. Holst**, D. Bozic, S. Batir, C. Forest, C. Borgers, N. Kopell, E. S. Boyden, "Automated exploration of

intracellular mechanisms of in vivo neural computation", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2014), Washington DC, November 15-19, 2014.

7. A. C. Singer, G. Talei Franzesi, S. B. Kodandaramaiah, M. Tsitsiklis, S. Sharma, D. Bozic, S. Batir, I. R. Wickersham, **G. L. Holst**, C. R. Forest, C. Borgers, N. J. Kopell, E. S. Boyden, "Time course of subthreshold activity preceding spike generation in awake behaving mouse hippocampus", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2014), Washington DC, November 15-19, 2014.
8. **G. L. Holst***, I. Kolb*, S. B. Kodandaramaiah, W. Stoy, E.S. Boyden, C.R. Forest. "Linear micro-actuation system for patch-clamp recording", *Proceedings of the 29th Annual Meeting of the American Society for Precision Engineering*. Boston, MA. 2014 *Contributed equally. (**Student Travel Award**)
9. W. Stoy, **G. L. Holst**, N. Pak, C.R. Forest, "Mobile tools for automated scoring and analysis at Capstone Expos" *Proceedings of the Capstone Design Conference 2014*, Columbus, OH, May 30-Jun 1, 2014.
10. **G. L. Holst**, J. Go, C. Lu, S. B. Kodandaramaiah, C. R. Phaneuf, W. Stoy, I. Kolb, I. R. Wickersham, E. S. Boyden, C. R. Forest, "Pipette Replacement Robot to fully automate sequential patch clamp recordings in vivo", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2013), San Diego, CA, November, 2013.
11. **G. L. Holst**, S. B. Kodandaramaiah, C. R. Phaneuf, W. Stoy, I. Kolb, I. R. Wickersham, N. Killian, E. A. Buffalo, E. S. Boyden, C. R. Forest, "Miniaturized actuation system for automated, in vivo, patch clamp recording", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2013), San Diego, CA, November, 2013.
12. S. B. Kodandaramaiah, F. J. Flores, I. R. Wickersham, **G. L. Holst**, E. N. Brown, C. R. Forest, E. S. Boyden, "The Multipatcher: A robot for high-density measurement of intracellular dynamics in vivo", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2013), San Diego, CA, November, 2013.
13. A. C. Singer, G. T. Franzesi, S. B. Kodandaramaiah, I. R. Wickersham, S. Sharma, S. Batir, N. Pak, **G. L. Holst**, C. R. Forest, J. J. Kopell, E. S. Boyden, "Awake Autopatching: automatic whole cell patch clamp hippocampal neurons in awake behaving animals", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2013), San Diego, CA, November, 2013.
14. W. Stoy, C. Shepard, I. Kolb, **G. L. Holst**, S. Kodandaramaiah, D. Ollerenshaw, D. Millard, E. S. Boyden, G. Stanley, C. R. Forest, "Multiple, In vivo patch clamp recordings along the mouse vibrissae pathway", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2013), San Diego, CA, November, 2013.
15. J. Go, A. Fan, C. Lu, S.B. Kodandaramaiah, **G.L. Holst**, W. Stoy, I. Kolb, E.S. Boyden, C.R. Forest, "Fully-automated, in vivo, single cell electrophysiology", *Proceedings of the 28th Annual Meeting of the American Society for Precision Engineering*, Saint Paul, MN, Oct 20-25, 2013.
16. I. Kolb, **G.L. Holst**, B. Goldstein, S.B. Kodandaramaiah, E.S. Boyden, E. Culurciello, C.R. Forest, "Automated, in vivo, whole-cell electrophysiology using an integrated patch-clamp amplifier", *Proceedings of the 22nd Annual Computational Neuroscience Meeting* (CNS 2013), Paris, France, July 13-18, 2013.
17. B. Krishnaswamy, C.M. Henegar, J.P. Bardill, D. Russakow, **G.L. Holst**, B.K. Hammer, C.R. Forest, R. Sivakumar, When Bacteria Talk: Time elapse communication for super-slow networks, *Proceedings of the Institute of Electrical and Electronics Engineers (IEEE) International Conference on Communications* (ICC)

2013 - Wireless Networking Symposium (ICC'13 WN), Budapest, Hungary, June 2013.

18. S.B. Kodandaramaiah, I. Wickersham, S.R. Bates, A.S. Chuong, M. Ogawa, M.V. Baratta, N. Klapoetke, **G. L. Holst**, L.C. Acker, F. Yoshida, P.E. Monahan, C.R. Forest, E.S. Boyden, "Autopatcher application to single cell RNA analysis and optogenetic cell type identification", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2012), New Orleans, LA, October 13-17, 2012.
19. S.B. Kodandaramaiah, **G. L. Holst**, G.T. Franzesi, A. Singer, I. Wickersham, X. Han, E.S. Boyden, C.R. Forest, "The Multipatcher: a robot for automated, simultaneous whole-cell patch-clamping of multiple neurons in vivo", *Proceedings of the Annual Meeting of the Society for Neuroscience* (Neuroscience 2012), New Orleans, LA, October 13-17, 2012.
20. **G. L. Holst**, D. C. Saunders, N. Pak, C. R. Phaneuf, and C. R. Forest, "Open-loop, rapid, laser PCR system using transient thermal analysis, optimization, and environmental control", *Proceedings of the Biomedical Engineering Society (BMES) 2012 Annual Meeting*, Atlanta, GA, October 24-27, 2012.
21. N. Pak, **G. L. Holst**, C.R. Phaneuf, C. Saunders, C.R. Forest, "Control schemes for microfluidic viral DNA/RNA amplification," *Proceedings of the 27th Annual Meeting of the American Society for Precision Engineering*, San Diego, CA, October 21-26, 2012.
22. **G. L. Holst**, B. D. Jensen, "A Silicon Thermomechanical In-Plane Microactuation System for Large Displacements in Aqueous Environments," *2011 International Mechanical Engineering Congress & Exposition (IMECE2011-64268)*, Denver, Colorado, USA.
23. **G. L. Holst**, G. H. Teichert, B. D. Jensen, "An Exploration of Buckling Modes and Deflection of a Fixed-Guided Beam," *Proceedings of the ASME 2010 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference (DETC2010-29076)*, Montreal, Canada.

Symposia

1. **G. L. Holst**, S. B. Kodandaramaiah, W. Stoy, E. S. Boyden, C. R. Forest, Automated, high-throughput recording of neuron electrical activity in the living brain. *Georgia Tech Research and Innovation Conference (gtRIC)*, Atlanta, GA, Feb 13, 2013.
2. C.R. Forest, C.M. Henegar, J.P. Bardill, C. Phaneuf, **G.L. Holst**, B.K. Hammer, "Empirical measurement of molecular communication between bacteria on a microfluidic chip", 1st *International Summer School on Nanocommunications*, Tampere University of Technology, Tampere, Finland, May 21-23, 2013. **(Invited)**

WORK EXPERIENCE

Graduate Research Assistant

Aug 2011 – Present, **Georgia Institute of Technology**

- Co-authored 4 journal articles (Nature Protocols, Biosensors and Bioelectronics, Biomicrofluidics, IEEE Transactions on Communications) and 21 conference presentations.
- Designed, fabricated, and programmed a fully automated *in vivo* neural recording system comprised of precision pneumatic controllers, precision positioning stages, and precision signal amplifiers using embedded digital control and optical and capacitive metrology.
- Sourced and installed the equipment for the new neuroscience core of the lab.

- Designed, built, and programmed a visual prosthetic system using a BeagleBoard embedded computer and the Microsoft Kinect sensor. Designed and built PCBs, software, control system, etc.
- Designed and tested a high-speed, open-loop IR laser thermocycling system using thermal finite element analysis (FEA) and optimization techniques.
- Programmed automation software for a microscope stage and camera for data acquisition for week-long autonomous experiments.

Mechanical Engineering Consultant

Feb 2015 – Present, **Intan Technologies, LLC**

- Worked with the company CEO to identify and scope projects and determine needs.
- Designed a custom electrical enclosure for an extremely sensitive scientific amplifier (pA noise maximums).
- Identified vendors for CNC fabrication, anodizing, engraving, and epoxy filling.
- Provided designs and recommendations for in-house fabrication tools and assembly jigs.

Engineering Consultant/Founding Member

May 2012 – Present, **Neuromatic Devices, Inc.**

- Designed the sole product for the startup company, a scientific instrument used to study the brain. It has been sold to 18 scientific labs around the world and was accepted as part of a publication in Nature Protocols.
- Designed the data acquisition system, PCBs, electromechanical components, signal processing algorithms, and software used in the electronic, pneumatic, and mechanical control systems. Worked with customers to install, test, and troubleshoot the system in several labs in the US and internationally.

Visiting Researcher

May – Dec 2014, **Allen Institute for Brain Science**

- Performed patch clamp recordings *in vivo* with simultaneous visual stimulation and morphology reconstruction to study cell types in the visual cortex of mice.
- Developed robots for automating serial, *in vivo*, patch clamp neural recordings.

Operations Project Engineer

Feb – July 2011, **L-3 Communications**

- Developed software in Matlab to perform automated robust design analysis on finite element satellite antenna models for military communication devices.
- Managed a team of 2 engineers to develop the software and train users.
- Identified internal customers for the software to reduce failure rates in hardware production.

Graduate Research Assistant

Aug 2009 – May 2011, **Brigham Young University**

- Presented 2 articles at ASME DETC 2010 and ASME IMECHE 2011.
- Published an article in the Journal of Mechanical Design 2011.
- Designed, analyzed, and tested thermal underwater microactuators using continuum and thermal FEA and elliptic integrals for a MEMS DNA injector.
- Designed and built current amplifiers and computer controlled switches for actuators and DNA injection process.

Graduate Teaching Assistantship

Aug 2009 – Aug 2010, **Brigham Young University**

- Instructed students in numerical methods, C++ programming, and kinematics (Dr. Brian Jensen, Mechanical

Engineering).

Transportation Risk Assessment Eng. Intern

May – Aug 2010, **Idaho National Laboratory**

- Modeled the risk of transporting hazardous materials using LS-DYNA coupled with a Monte Carlo Simulation using Isight and Adobe Flex.

Teaching Assistant Manager

Aug – Dec 2008, **Brigham Young University**

- Managed 5 undergraduate teaching assistants for the Introduction to Material Science class (Dr. Anton Bowden and Dr. David Fullwood).

Teaching Assistant

2005 – 2008, **Brigham Young University**

- Tutored students in multivariable calculus and linear algebra (Dr. Tiancheng Ouyang, Mathematics Department) and introductory material science (Dr. Brent Adams, Dr. Anton Bowden, Dr. David Fullwood, Mechanical Engineering Department).

AWARDS

1st Place Student Team Competition American Society of Precision Engineers 2014

Student Scholarship Award American Society of Precision Engineers 2014

Integrative Graduate Education and Research Traineeship Stem Cell Biomanufacturing, Georgia Institute of Technology 2011

Presidential Fellowship, Georgia Institute of Technology 2011

1st Place – ASME Micro/Nano Systems Photo Contest, ASME IDETC/CIE 2011

2nd Place – ASME Micro/Nano Systems Photo Contest, ASME IDETC/CIE 2010

Convocation Student Body Speaker for Ira A. Fulton College of Engineering and Technology BYU 2009

Full Tuition Academic Merit Scholarships, Brigham Young University 2004-09

PROFESSIONAL SOCIETY INVOLVEMENT

American Society of Mechanical Engineers

American Society of Precision Engineers

Society for Neuroscience

Biomedical Engineering Society

Tau Beta Pi Honor Society

Phi Kappa Phi Honor Society

ADVISING, MENTORSHIP, AND TRAINING

- Trained 1 postdoctoral researcher and 2 graduate students to perform *in vivo* automated patch clamping and *in vivo* surgery (Bo Yang, William Stoy, Ilya Kolb)
- Directly supervised 2 undergraduate capstone design teams resulting in 3 conference presentations and 1 journal article submission. (Jamison Go, Aaron Fan, Coby Lu “Fully-automated, in-vivo, single cell

electrophysiology”) (Christopher Capocasale, Max Stockslager, Dusting McGruder, Yuanda Li, Michael Simon, “*Optical method for automated measurement of glass micropipette tip geometry*”)

- Directly supervised 8 undergraduate research assistants. Several of them received undergraduate research awards, continued on to graduate school at Georgia Tech and MIT, and one received the NSF GFRP. (Jamison Go, Matthew Marchese, Christopher Harless, Cam Phillips, Andy Lustig, Christopher Capocasale, Max Stockslager, Sage Duddleston)

OTHER

International Experience

- Lived for 3 years in Tuxpan, Veracruz, Mexico (2001-03)
- Served as a full-time church missionary for 2 years in Argentina (2005-07)
- Studied abroad in Nanjing, China for 6 weeks and toured companies and historical sites in Beijing, Suzhou, Huangshan, and Shanghai. Companies included HP, Autodesk, GM, Celanese, Quanta Computers (May – June 2008).

Languages

- Fluent Spanish, some Mandarin

Software

- MS Office, MATLAB, Adobe Flex, Actionscript, XML, CSS, jQuery, SQL, ProE, Solidworks, NX, NXopen, ANSYS, ADPL, Fluent, LS-DYNA, HyperWorks, Isight, Gambit, Adina, C/C++, Qt, OpenGL, OpenCV, OpenKinect, LabVIEW, DAQmx, Cadsoft Eagle, Linux OS, Atmel MCUs, BeagleBone, TI MSP432, Raspberry Pi, Mbed.