# William Loh

**244 Wood Street, Lexington, MA 02421 • 732-850-5401 • William.loh@ll.mit.edu**

## Education

2009 – 2013 **Ph.D. Electrical Engineering**
*Massachusetts Institute of Technology, Cambridge, MA*
Thesis: "The physics of phase-noise mitigation: signal generation and filtering using microwave-photonic links"
Thesis committee: Paul W. Juodawlkis (co-advisor), Rajeev J. Ram (co-advisor), and Erich P. Ippen

2007 – 2009 **M.S. Electrical Engineering**
*Massachusetts Institute of Technology, Cambridge, MA*
Thesis: "Analysis and Characterization of Slab-Coupled Optical Waveguide Amplifiers and Lasers"
Thesis co-advisors: Paul W. Juodawlkis and Rajeev J. Ram

2003 – 2007 **B.S. Electrical Engineering** (*summa cum laude*)
*University of Michigan, Ann Arbor, MI*

## Honors and Awards

April 2021 MIT LL best Paper Award

September 2018 MIT LL Advanced Concepts Committee Best Presentation Award

2013 – 2015 NRC Postdoctoral Research Fellowship

- Rank 1 out of 135 applicants

2012 – 2013 IEEE Photonics Society Fellowship

- One of 10 awarded globally in 2012 in the area of photonics

2009 – 2010 Siebel Foundation Scholarship

- One of 5 awarded to the MIT electrical engineering and computer science department

2006 – 2007 KLA-Tencor Scholarship

2005 – 2006 Haig P. Iskenderian Engineering Scholarship

2003 – 2007 William R. Salomon Scholarship

2003 – 2007 National Merit Scholarship

## Research Experience

2016 – present **MIT Lincoln Laboratory Technical Staff**
*Quantum Information and Integrated Nanosystems (Group 89)*
Project: Develop an ultra-stable Brillouin laser system for interrogation of a Strontium optical atomic clock

- Developed a novel self-referencing technique for the stabilization of the Brillouin laser's temperature drift to ~100 nK, which brings the laser's frequency drift to the level of a Rb atom.
- Implemented a compact (3 in. X 3 in.) vacuum isolation chamber for reducing the Brillouin laser noise to < 20 Hz.
- Developed an amplitude-locking servo to further stabilize the laser's noise and long-term drift against power fluctuations.
- Translated the high quality factor optical resonator design to a silicon nitride platform for generating Brillouin lasing in a miniaturized chip resonator.

- Demonstrated 0.5 dB/m optical loss on chip which corresponds to an intrinsic resonator quality factor of 30 million.

Project: Develop an optoelectronic filter system for enabling the ability to simultaneously transmit and receive RF signals without interference

- Demonstrated the concept of a novel optoelectronic filter capable of suppressing an interferer relative to a desired signal, independent of their frequency separation.
- Demonstrated suppression ratios of > 50 dB and experimentally showed the full recovery of a QPSK modulated desired signal transmitted at the same frequency as a nearby interferer.
- Developed a new amplitude-locking scheme that stabilizes arbitrary incoming RF signals to the otherwise stringent optoelectronic filter nulling condition, which enables operation of the filter in real-world environments.
- Improved the signal suppression of the interferer to a record 71 dB as a result of the amplitude servo.

Project: Investigate the potential of various passive waveguide platforms for transporting light with low loss at visible wavelengths in order to realize a scalable quantum computer

- Characterized the loss of silicon nitride and aluminum oxide for guiding light at wavelengths relevant to Strontium ions: (i.e. ranging from 405 nm to 1092 nm).
- Demonstrated low optical loss at 674 nm in silicon nitride and also record low losses of 1.2 dB/cm at a wavelength of 405 nm for aluminum oxide.
- Characterized the efficiency of grating couplers for directing visible light to a Strontium ion and also analyzed the beam angle and focus height to ensure optimal alignment to the ion.

2013 – 2015 **NRC Postdoctoral Research Fellow**
*Time and Frequency Division, National Institute of Standards and Technology, Boulder, CO*
Project: Utilize the capabilities of extreme light confinement in microresonators to realize the potential for nonlinear optics in a chip-scale platform
Advisor: Scott A. Diddams

- Engineered high-Q (> $10^8$) microrod resonators through laser machining and pulled low-loss fiber tapers to enable the excitation of nonlinear processes in microresonators
- Investigated the formation of microresonator frequency combs which resulted in a theoretical and experimental understanding of comb phase and coherence
- Generated low-noise stimulated Brillouin lasing in a silica microresonator which demonstrated the potential for high spectral purity lasers on a chip-compatible platform
- Realized temperature tuning of the Brillouin laser frequency and used feedback locking to stabilize the Brillouin laser to 90 Hz linewidth
- Created the theoretical framework for Brillouin lasers which explains the laser's fundamental noise limits and aids in the understanding of the laser's steady-state and dynamic behavior

2007 – 2013 **Graduate Research Assistant**
*Electrooptical Materials and Devices Group, MIT Lincoln Laboratory, Lexington, MA*
*Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, MA*
Project: Combine the advantages of photonics and electronics to realize low-noise hybrid optoelectronic systems with enhanced functionality
Advisors: Paul W. Juodawlkis and Rajeev J. Ram

- Characterized the noise performance of Watt-class single-mode 1550 nm semiconductor optical amplifiers and obtained an ultra-low noise figure of 4.5 dB in a packaged fiber-coupled configuration
- Designed and characterized a 370 mW single-mode semiconductor external-cavity laser operating at 1550 nm with 35-kHz linewidth and low relative-intensity noise
- Combined these low-noise semiconductor components with 1.5 km of passive fiber delay to demonstrate a low phase-noise optoelectronic oscillator which exhibited 20 dB lower noise compared to the highest performance free-running RF oscillators
- Developed and experimentally verified (to within 1 dB) a unified theory of phase noise that explains the noise operation of both photonic and electronic oscillators

- Analyzed and showed the unique saturation properties of the microwave-photonic gain which enables single-mode optoelectronic oscillation at kilometer delay lengths
- Conceived and experimentally demonstrated the concept of a nonlinear optoelectronic filter that exploits the properties of microwave-photonic gain to selectively filter out one RF signal among the rest.
- Fabricated high-power low-noise 1550-nm distributed feedback lasers for the potential realization of optoelectronic systems on chip

2005 – 2007 **Undergraduate Research Assistant,** 2005-2007
*Professor Kevin Pipe Research Group, University of Michigan, Ann Arbor, MI*
Advisor: Kevin P. Pipe

- Assisted graduate student Kwang H. An in integrating an organic light-emitting diode onto a scanning-probe cantilever to enable capabilities in near-field imaging
- Designed a transimpedance amplifier which allowed the detection and processing of light emission from ultra-low power organic light-emitting diodes

## Grants

2024 **Rare-Earth Doped Optical Waveguides on Chip**
**TO Seedling**
*Principal Investigator*

2023 – present **Robust Optical Clock Network (ROCkN)**
**DARPA**
*Principal Investigator*

2022 – present **An Integrated Visible Light Platform for Compact Ultranarrow Linewidth Lasers**
**ACC**
*Principal Investigator*

2022 – present **Advanced Components for Optical Systems**
**AFRL**
*Principal Investigator*

2021 – present **Ultra-narrow Linewidth Lasers for Deployed Quantum Timing Applications**
**NASA**
*Principal Investigator*

2020 – 2022 **SBS Lasers for Quantum Timing**
**AFRL**
*Principal Investigator*

2019 – 2020 **Robust Integrated High-Extinction Optical Switches**
**MIT LL ACC**
*Co-Principal Investigator*

October 2017 – September 2018 **Compact Optical Trapped-Ion Array Clock (COTIAC)**
**MIT LL Line**
*Co-Principal Investigator*

May 2017 – January 2018 **Compact ultra-narrow linewidth Brillouin lasers for space-based lidar, optical atomic clocks, and quantum processing systems**
**MIT LL ACC**
*Principal Investigator*

## Teaching Experience and Mentoring

2013 – 2015 **Mentor for Graduate Student: Adam Green, Undergraduate Student: Joe Becker, and Visiting Scientist: Yi-Chen Chuang**
*National Institute of Standards and Technology, Boulder, CO*

- Worked together to stabilize a Brillouin laser to a microresonator reference cavity which resulted in a laser linewidth of 90 Hz
  - The results are published in *Optica*
- Demonstrated SBS lasing in a single high-Q microrod resonator to achieve linewidths of 240 Hz
  - The results are published in *New Journal of Physics*
- Developed skills of critical thinking and problem solving by encouraging open communication of questions and establishing intuition for difficult concepts

Spring 2013 **Graduate Teaching Assistant**
*Massachusetts Institute of Technology, Cambridge, MA*
6.731 – Semiconductor Optoelectronics: Theory and Design (Graduate Course)

- Delivered several lectures on noise in semiconductor optical amplifiers and lasers
- Assisted in the design of homework problems and also in the construction of homework solutions

Fall 2005 **Undergraduate Tutor for EECS 215 – Introduction to Circuits**
*University of Michigan, Ann Arbor, MI*

- Met with students on a weekly basis to provide tutoring for the introductory circuits course at the University of Michigan
- Provided help on homework assignments and on understanding course concepts

## Professional Leadership and Activities

2023 – present **Reviewer,** *Journal Lightwave Technology*

2022 – present **Reviewer,** *APL Photonics*

2020 – present **Reviewer,** *Nature Communications*

2017 – present **Reviewer,** *IEEE Journal of Selected Topics in Quantum Electronics*

2015 – present **Reviewer,** *Optica*

2015 – present **Reviewer,** *IEEE Transactions on Microwave Theory and Techniques*

2015 – present **Reviewer,** *Laser & Photonics Reviews*

2014 – present **Reviewer,** *Optics Express*

2012 – present **Reviewer,** *IEEE Photonics Journal*

2011 – present **Reviewer,** *IEEE Photonics Technology Letters*

October 2018 **Presider,** IPC 2018 – Session: Microwave Photonics Devices and Comb Generations

October 2017 **Presider,** IPC 2017 – Session: Photonic Filters and Combs for Wideband Applications

October 2016 **Presider,** IPC 2016 – Session: Frequency Agile Techniques

2018 – 2019 **Committee Member, LAOP** Laser Science and Technology

2017 – 2019 **Committee Member, IEEE IPC** Microwave Photonics

2019 – 2021 **Committee Chair, IEEE IPC** Optical Micro/Nano Resonators and Devices

2016 – 2019 **Committee Member, IEEE IPC** Optical Micro/Nano Resonators and Devices

2016 – present **Member,** Optical Society of America (OSA)

2012 – present **Member**, IEEE Photonics Society

2010 – present **Senior Member,** Institute of Electrical and Electronic Engineers (IEEE)

| | |
|---|---|
| 2006 – 2007 | **Officer,** Industry Relations Chair, University of Michigan, IEEE student chapter |

## Invited Seminars

| | |
|---|---|
| January 2025 | **Invited Seminar,** SPIE Photonics West 2025 |
| September 2024 | **Panelist,** Quantum World Congress 2024 |
| January 2024 | **Invited Seminar,** SPIE Photonics West 2024 |
| May 2023 | **Invited Seminar,** IEEE Frequency Control Symposium 2023 |
| March 2023 | **Invited Seminar,** Optica Optical Fiber Communication Conference 2023 |
| July 2022 | **Invited Seminar,** Optica Applied Industrial Optics 2022 |
| May 2018 | **Tutorial,** Conference on Lasers and Electro-Optics 2018 |
| October 2017 | **Invited Seminar,** IEEE Photonics Conference 2017 |
| May 2016 | **Invited Seminar,** Raytheon BBN Technologies |
| November 2015 | **Workshop,** Optical Frequency Combs for Space Applications |
| March 2015 | **Invited Seminar,** Boston IEEE Photonics Society |
| March 2015 | **Invited Seminar,** Harvard University |
| February 2015 | **Invited Seminar,** Pennsylvania State University |
| May 2013 | **Poster and Presentation,** MIT Advanced Research and Technology Symposium (ARTS) |
| May 2010 | **Poster,** MIT Center for Integrated Photonic Systems (CIPS) Annual Meeting |
| May 2009 | **Poster,** MIT Center for Integrated Photonic Systems (CIPS) Annual Meeting |

## Book Chapters

1. J. P. Donnelly, P. W. Juodawlkis, R. K. Huang, J. J. Plant, G. M. Smith, L. J. Missaggia, **W. Loh**, S. M. Redmond, B. Chann, M. K. Connors, R. B. Swint, and G. W. Turner, "High-Power Slab-Coupled Optical Waveguide Lasers and Amplifiers" in *Advances in Semiconductor Lasers*, vol. 86, *Semiconductors and Semimetals*, J. J. Coleman, A. C. Bryce, and C. Jagdish, Eds.: Elsevier, 2012.

## Patents

1. **W. Loh**, S. Yegnanarayanan, R. J. Ram, and P. W. Juodawlkis, "Optoelectronic Filter," Patent WO2015017653 A1.

2. **W. Loh**, S. Yegnanarayanan, and P. W. Juodawlkis, "Narrow-Linewidth Microcavity Brillouin Laser with Suppressed Temperature Fluctuations," Provisional Patent.

## Journal Publications

1. **W. Loh**, D. Reens, D. Kharas, A. Sumant, C. Belanger, R. T. Maxson, A. Medeiros, W. Setzer, D. Gray, K. DeBry, C. D. Bruzewicz, J. Plant, J. Liddell, G. N. West, S. Doshi, M. Roychowdhury, M. E. Kim, D. Braje, P. W. Juodawlkis, J. Chiaverini, and R. McConnell, "Optical Atomic Clock Interrogation Via an Integrated Spiral Cavity Laser," Nature Photonics, 2025.

2. **W. Loh**, D. Gray, R. Irion, O. May, C. Belanger, J. J. Plant, P. W. Juodawlkis, and S. Yegnanarayanan, "Ultralow noise microwave synthesis via difference frequency division of a Brillouin resonator," Optica vol. 11, 4, 2024.

3. **W. Loh**, R. T. Maxson, A. P. Medeiros, G. N. West, P. W. Juodawlkis, and R. McConnell "Optical Frequency Averaging of Light," Opt. Express vol. 31, 16, 2023.

4. **W. Loh**, D. Kharas, R. Maxson, G. N. West, A. Medeiros, D. Braje, P. W. Juodawlkis, and R. McConnell, "Cooling of an integrated Brillouin laser below the thermal limit," Opt. Express vol. 30, 13, 2022.

5. P. W. Juodawlkis, **W. Loh**, and C. Sorace-Agaskar, "Photonic circuit integrated platforms," *JPhys Photonics,* 2021.

6. **W. Loh**, J. Stuart, D. Reens, C. D. Bruzewicz, D. Braje, J. Chiaverini, P. W. Juodawlkis, J. M. Sage, and R. McConnell, "A Brillouin laser optical atomic clock," *Nature*, vol. 588, pp. 244–249, 2020.

7. D. Kharas, J. J. Plant, **W. Loh**, R. B. Swint, S. Bramhavar, C. Heidelberger, S. Yegnanarayanan, and P. W. Juodawlkis, "High-power (>300 mW) on-chip laser with passively aligned silicon-nitride waveguide DBR cavity" *IEEE Photon. J.*, vol. 12, 2020.

8. G. N. West, **W. Loh**, D. Kharas, and R. J. Ram, "Impact of laser frequency noise on high-extinction optical modulation," Opt. Express, vol. 28, pp. 39606–39617, 2020.

9. R. J. Niffenegger, J. Stuart, C. Sorace-Agaskar, D. Kharas, S. Bramhavar, C. D. Bruzewicz, **W. Loh**, R. T. Maxson, R. McConnell, D. Reens, G. N. West, J. M. Sage, and J. Chiaverini, "Integrated multi-wavelength control of an ion qubit," *Nature*, vol. 586, pp. 538–542, 2020.

10. **W. Loh**, S. Yegnanarayanan, R. Maxson, K. E. Kolodziej, B. perry, and P. W. Juodawlkis, "An amplitude stabilization technique for nonlinear optoelectronic filtering," *IEEE Photon. Technol. Lett.*, vol 32, pp. 875–878, 2020.

11. C. Sorace-Agaskar, D. Kharas, S. Yegnanarayanan, R. T. Maxson, G. N. West, **W. Loh**, S. Bramhavar, R. J. Ram, J. Chiaverini, J. Sage, and P. Juodawlkis, "Versatile silicon nitride and alumina integrated photonic platforms for the ultraviolet to short-wave infrared," *IEEE J. Sel. Top. Quantum Electron.*, 2019.

12. G. N. West, **W. Loh**, D. Kharas, C. Sorace-Agaskar, K. K. Mehta, J. Sage, J. Chiaverini, and R. J. Ram, "Low-loss integrated photonics for the blue and ultraviolet regime," *APL Photonics*, vol. 4, 026101, 2019.

13. **W. Loh**, S. Yegnanarayanan, F. O'Donnell, and P. W. Juodawlkis, "Ultra-narrow linewidth Brillouin laser with nanokelvin temperature self-referencing," *Optica*, vol. 6, pp. 152–159, 2019.

14. J. A. Sedlacek, J. Stuart, **W. Loh**, R. McConnell, C. d. Bruzewicz, J. M. Sage, and J. Chiaverini, "Method for determination of technical noise contributions to ion motional heating," *J. Appl. Phys.*, vol. 123, 214904, 2018.

15. **W. Loh**, S. Yegnanarayanan, K. E. Kolodziej, and P. W. Juodawlkis, "Optical unmasking of spectrally overlapping RF signals," *Opt. Express.*, vol. 25, pp. 26581–26590, 2017.

16. **W. Loh**, M. T. Hummon, H. F. Leopardi, T. M. Fortier, F. Quinlan, J. Kitching, S. B. Papp, and S. A. Diddams, "Microresonator Brillouin laser stabilization using a microfabricated rubidium cell," *Opt. Express.*, vol. 24, pp. 14513–14524, 2016.

17. **W. Loh**, J. Becker, D. C. Cole, A. Coillet, F. N. Baynes, S. B. Papp, and S. A. Diddams, "A microrod-resonator Brillouin laser with 240 Hz absolute linewidth," *New J. Phys*., vol. 18, 045001, 2016.

18. **W. Loh**, S. B. Papp, and S. A. Diddams, "Noise and dynamics of stimulated Brillouin scattering microresonator lasers," *Phys. Rev. A.*, vol. 91, 053843, 2015.

19. **W. Loh**, A. A. S. Green, F. N. Baynes, D. C. Cole, F. J. Quinlan, H. Lee, K. J. Vahala, S. B. Papp, and S. A. Diddams, "Dual-microcavity narrow-linewidth Brillouin laser," *Optica*, vol. 2, pp. 225–232, 2015.

20. P. Del'Haye, A. Coillet, **W. Loh**, K. Beha, S. B. Papp, and S. A. Diddams, "Phase steps and resonator detuning measurements in microresonator frequency combs," *Nat. Commun*., vol. 6, 5668, 2015.

21. **W. Loh**, P. Del'Haye, S. B. Papp, and S. A. Diddams, "Phase and coherence of optical microresonator frequency combs," *Phys. Rev. A*, vol. 89, 053810, 2014.

22. **W. Loh**, S. Yegnanarayanan, R. J. Ram, and P. W. Juodawlkis, "A nonlinear optoelectronic filter for electronic signal processing," *Sci. Rep.*, vol. 4, 3613, 2014.

23. **W. Loh**, S. Yegnanarayanan, R. J. Ram, and P. W. Juodawlkis, "Unified theory of oscillator phase noise II: flicker noise," *IEEE Trans. Microw. Theory Tech.*, vol. 61, pp. 4130–4144, 2013.

24. **W. Loh**, S. Yegnanarayanan, R. J. Ram, and P. W. Juodawlkis, "Unified theory of oscillator phase noise I: white noise," *IEEE Trans. Microw. Theory Tech.*, vol. 61, pp. 2371–2381, 2013.

25. **W. Loh**, S. Yegnanarayanan, J. Klamkin, S. M. Madison, J. J. Plant, F. J. O'Donnell, and P. W. Juodawlkis, "Amplifier-free slab-coupled optical waveguide optoelectronic oscillator systems," *Opt. Express*, vol. 20, pp. 19589–19598, 2012.

26. **W. Loh**, S. Yegnanarayanan, J. J. Plant, F. J. O'Donnell, M. W. Grein, J. Klamkin, S. M. Madison, and P. W. Juodawlkis, "Low-noise RF-amplifier-free slab-coupled optical waveguide coupled optoelectronic oscillators: physics and operation," *Opt. Express*, vol. 20, pp. 19420–19430, 2012.

27. **W. Loh**, S. Yegnanarayanan, R. J. Ram, and P. W. Juodawlkis, "Super-homogeneous saturation of microwave-photonic gain in optoelectronic oscillator systems," *IEEE Photon. J.*, vol. 4, pp. 1256–1266, 2012.

28. P. W. Juodawlkis, J. J. Plant, **W. Loh**, L. J. Missaggia, F. J. O'Donnell, D. C. Oakley, A. Napoleone, J. Klamkin, J. T. Gopinath, D. J. Ripin, S. Gee, P. J. Delfyett, and J. P. Donnelly, "High-power, low-noise 1.5-μm slab-coupled optical waveguide (SCOW) emitters: physics, devices, and applications," *IEEE J. Sel. Top. Quantum Electron.*, vol. 17, pp. 1698–1714, 2011.

29. **W. Loh**, F. J. O'Donnell, J. J. Plant, M. A. Brattain, L. J. Missaggia, and P. W. Juodawlkis, "Packaged, high-power, narrow-linewidth slab-coupled optical waveguide external-cavity laser (SCOWECL)," *IEEE Photon. Technol. Lett.*, vol. 23, pp. 974–976, 2011.

30. **W. Loh**, J. J. Plant, J. Klamkin, J. P. Donnelly, F. J. O'Donnell, R. J. Ram, and P. W. Juodawlkis, "Noise figure of Watt-class ultralow-confinement semiconductor optical amplifiers," *IEEE J. Quantum Electron.*, vol. 47, pp. 66–75, 2011.

31. J. Klamkin, R. K. Huang, J. J. Plant, M. K. Connors, L. J. Missaggia, **W. Loh**, G. M. Smith, K. G. Ray, F. J. O'Donnell, J. P. Donnelly, and P. W. Juodawlkis, "Directly modulated narrowband slab-coupled optical waveguide laser," *Electron. Lett.*, vol. 46, pp. 522–523, 2010.

32. P. W. Juodawlkis, J. J. Plant, **W. Loh**, L. J. Missaggia, K. E. Jensen, and F. J. O'Donnell, "Packaged 1.5-μm quantum-well SOA with 0.8-W output power and 5.5-dB noise figure," *IEEE Photon. Technol. Lett.*, vol. 21, pp. 1208–1210, 2009.

## Conference Presentations / Proceedings

1. **W. Loh**, D. Gray, R. Irion, O. May, C. Belanger, J. J. Plant, and S. Yegnanarayanan, "Frequency Division of a Brillouin laser for robust ultralow-noise signal generation," in proc. IEEE CLEO, 2024.

2. **W. Loh**, D. Kharas, R. Maxson, G. N. West, A. Medeiros, D. Braje, P. W. Juodawlkis, and R. McConnell, "Thermal stabilization of a Brillouin laser," in proc. IEEE IPC, 2022.

3. C. Sorace-Agaskar, B. Aull, D. Braje, C. Bruzewicz, P. T. Callahan, J. Chiaverini, J. Ciampi, M. Collins, K. Donlon, B. Felton, P. W. Juodawlkis, D. Kharas, **W. Loh**, R. McConnell, R. Morgan, R. Niffenegger, M. Purcell-Schuldt, D. Reens, K. Ryu, J. Sage, J. Stuart, and G. N West, "Integrated photonic circuits and platform development for trapped-ion quantum computing and sensing," in Proc. OSA IPRSN, 2021.

4. R. McConnell, B. Aull, D. Braje, C. Bruzewicz, P. Callahan, J. Chiaverini, M. Collins, K. Donlon, B. Felton, P. Juodawlkis, D. Kharas, **W. Loh**, R. Niffenegger, D. Reens, K. Ryu, J. Sage, C. Sorace-Agaskar, J. Stuart, and G. West, "Integrated Technologies for Portable Optical Clocks," in Proc. OSA Sensors, 2021.

5. **W. Loh**, J. M. Stuart, D. Reens, C. D. Bruzewicz, D. Braje, J. Chiaverini, P. W. Juodawlkis, J. M. Sage, and R. McConnell, "Brillouin laser stabilization to a single ion," in Proc. CLEO, 2021.

6. R. J. Niffenegger, J. Stuart, D. Reens, C. Sorace-Agaskar, D. Kharas, S. Bramhavar, **W. Loh**, G. N. West, R. T. Maxson, A. Medeiros, C. D. Bruzewicz, R. McConnell, J. M. Sage, and J. Chiaverini, "Integrated multi-wavelength control of an ion qubit," in *Proc. Bulletin of the American Physical Society*, 2021.

7. R. McConnell, **W. Loh**, J. Stuart, D. Reens, C. D. Bruzewicz, D. Braje, J. Chiaverini, P. W. Juodawlkis, and J. M. Sage, "A Brillouin laser optical atomic clock" in *Proc. SPIE, Optical and Quantum Sensing and Precision Metrology*, 2021.

8. T. Feigenson, K. Johnsen, D. Kharas, W. Shin, R. Maxson, K. Bagnall, A. Libson, A. Benedick, **W. Loh**, C. Sorace-Agaskar, D. Braje, R. McConnell, and K-H. Hong, "Supercontinuum generation in dispersion-engineered PECVD SiN waveguides for a Yb-fiber laser frequency comb" in *Proc. Conference on Lasers and Electro-Optics (CLEO)*, 2020.

9. G. N. West, **W. Loh**, D. Kharas, and R. J. Ram, "The impact of laser frequency noise on high-extinction optical modulators" in *Proc. Conference on Lasers and Electro-Optics (CLEO)*, 2020.

10. D. Kharas, J. Plant, S. Bramhavar, **W. Loh**, R. Swint, C. Sorace-Agaskar, C. Heidelberger, and P. Juodawlkis, "High power (> 300 mW) 1550 nm on-chip laser realized using passively aligned hybrid integration" in *Proc. Conference on Lasers and Electro-Optics (CLEO)*, 2020.

11. R. McConnell, K. Bagnall, A. J. Benedick, D. A. Braje, J. Chiaverini, K, Hong, K. Johnsen, A. Libson, R. T. Maxson, **W. Loh**, and J. Sage, "On-chip addressing of trapped-ion arrays for a compact optical atomic clock" in *Proc. SPIE, Optical, Opto-Atomic, and Entanglement-Enhanced Precision Metrology*, 2019.

12. J. Stuart, **W. Loh**, C. Bruzewicz, R. McConnell, R. Niffenegger, G. West, G. Simon, J. Sage, and J. Chiaverini, "Quantum Control of a Trapped Ion using a Stimulated Brillouin Scattering Laser" in *Proc. Bulletin of the American Physical Society*, 2019.

13. S. Bramhavar, C. Sorace-Agaskar, D. Kharas, **W. Loh**, P. Juodawlkis, J. Chiaverini, and J. Sage, "A multi-layer visible-light integrated photonic platform for atomic systems" in *Proc. SPIE, Integrated Optics: Devices, Materials, and Technologies XXIII*, 2019.

14. **W. Loh**, S. Yegnanarayanan, F. O'Donnell, and P. W. Juodawlkis, "Hertz-class Brillouin lasing with nanokelvin thermal sensing" in *Proc. IEEE Photonics Conference (IPC)*, 2018.

15. C. Sorace-Agaskar, S. Bramhavar, D. Kharas, **W. Loh**, P. W. Juodawlkis, J. Chiaverini, and, J. M. Sage, "Electronic-photonic integration for government applications" in *Proc. SPIE, Frontiers in Biological Detection: From Nanosensors to Systems X*, 2018.

16. **W. Loh**, S. Yegnanarayanan, K. E. Kolodziej, and P. W. Juodawlkis, "Recovery of spectrally overlapping QPSK signals using a nonlinear optoelectronic filters" in *Proc. IEEE Photonics Conference (IPC)*, 2017.

17. P. W. Juodawlkis, S. Bramhavar, J. Chiaverini, D. Kharas, **W. Loh**, R. Maxson, S. Mouser, J. J. Plant, J. M. Sage, C. Sorace-Agaskar, R. B. Swint, and S. Yegnanarayanan, "Electronic-photonic integration for government applications" in *Proc. IEEE Avionics and Vehicle Fiber-Optics and Photonics Conference*, 2017.

18. D. Kharas, C. Sorace-Agaskar, S. Bramhavar, **W. Loh**, J. Sage, P. W. Juodawlkis, and J. Chiaverini, "Multi-level photonics for trapped-ion quantum computing" in *Proc. IEEE Photonics Society Summer Topical Meeting*, 2017

19. R. McConnell, S. Bramhavar, C. Bruzewicz, D. Kharas, **W. Loh**, K. Mehta, J. Plant, J. Sedlacek, C. Sorace-Agaskar, J. Stuart, J. Chiaverini, R. Ram, J. Sage, "Integrated technologies for chip-scale trapped-ion quantum control" n *Proc. Bulletin of the American Physical Society*, 2017.

20. **W. Loh**, M. T. Hummon, H. F. Leopardi, T. M. Fortier, F. Quinlan, J. Kitching, S. B. Papp, and S. A. Diddams, "A stimulated Brillouin microresonator laser referenced to Rubidium" in *Proc. IEEE Photonics Conference (IPC)*, 2016.

21. **W. Loh**, J. Becker, F. Baynes, A. A. S. Green, D. Cole, F. J. Quinlan, H. Lee, K. J. Vahala, S. B. Papp, and S. A. Diddams, "Low-noise stimulated Brillouin lasing in a microrod resonator" in *Proc. Conference on Lasers and Electro-Optics (CLEO)*, 2015.

22. J. Becker, **W. Loh**, F. Baynes, D. Cole, F. J. Quinlan, H. Lee, K. J. Vahala, S. B. Papp, and S. A. Diddams, "Toward chip integrated ultra-low-noise lasing using a microrod resonator" in *Proc. IEEE International Frequency Control Symposium (IFCS)*, 2015.

23. **W. Loh**, A. A. S. Green, F. N. Baynes, D. C. Cole, F. J. Quinlan, H. Lee, K. J. Vahala, S. B. Papp, and S. A. Diddams, "A tunable low-noise microcavity laser based on stimulated Brillouin gain" in *Proc. OSA Frontiers in Optics (FIO) Postdeadline*, 2014.

24. A. Coillet, P. Del'Haye, **W. Loh**, K. Beha, S. B. Papp, and S. A. Diddams, "Measuring optical phases of Kerr frequency combs" in *Proc. OSA Frontiers in Optics (FIO)*, 2014.

25. **W. Loh**, S. B. Papp, and S. A. Diddams, "Noise and dynamics of stimulated Brillouin scattering microresonator laser oscillators" in *Proc. IEEE Photonics Conference (IPC)*, 2014.

26. P. Del'Haye, **W. Loh**, K. Beha, S. B. Papp, and S. A. Diddams, "Phase measurements and phase-locking in microresonator-based optical frequency combs" in *Proc. Conference on Lasers and Electro-Optics (CLEO)*, 2014.

27. P. W. Juodawlkis, J. J. Plant, M. A. Hollis, D. C. Oakley, A. Napoleone, **W. Loh**, J. Klamkin, F. J. O'Donnell, and S. Yegnanarayanan, "Slab-coupled optical waveguide (SCOW) devices and photonic integrated circuits (PICS)" in *Proc. IEEE Photonics Conference (IPC)*, 2013.

28. **W. Loh**, S. Yegnanarayanan, R. J. Ram, and P. W. Juodawlkis, "Unified theory of oscillator phase noise with application to optoelectronic oscillators" in *Proc. Conference on Lasers and Electro-Optics (CLEO)*, 2013.

29. P. W. Juodawlkis, J. J. Plant, **W. Loh**, and S. Yegnanarayanan, "High-power, compact slab-coupled optical waveguide (SCOW) emitters and their applications" in *Proc. IEEE Avionics, Fiber-Optics and Photonics Conference (AVFOP)*, 2012.

30. S. Yegnanarayanan, L. M. Johnson, J. J. Plant, **W. Loh**, and P. W. Juodawlkis, "High dynamic range suppressed-bias microwave photonic links using unamplified semiconductor laser source" in *Proc. IEEE Avionics, Fiber Optics and Photonics Conference* (AVFOP), 2012.

31. **W. Loh**, S. Yegnanarayanan, R. J. Ram, and P. W. Juodawlkis, "Super-homogeneous microwave-photonic gain and its impact on optoelectronic oscillators" in *Proc. IEEE International Frequency Control Symposium (IFCS)*, 2012.

32. **W. Loh**, S. Yegnanarayanan, J. J. Plant, F. J. O'Donnell, M. E. Grein, J. Klamkin, S. M. Madison, R. J. Ram, and P. W. Juodawlkis, "RF-amplifier-free coupled optoelectronic oscillator (COEO)" in *Proc. Conference on Lasers and Electro-Optics (CLEO)*, 2012.

33. **W. Loh**, S. Yegnanarayanan, J. J. Plant, J. Klamkin, S. M. Madison, F. J. O'Donnell, R. J. Ram, and P. W. Juodawlkis, "Slab-coupled optical waveguide (SCOW) optoelectronic oscillator (OEO) systems" in *Proc. Precise Time and Time Interval (PTTI)*, 2012.

34. J. J. Plant, J. Klamkin, **W. Loh**, M. E. Grein, S. Yegnanarayanan, S. M. Madison, and P. W. Juodawlkis, "Compact external-cavity semiconductor mode-locked laser with quantum-well-intermixed modulator and saturable absorber," in *Proc. IEEE Photonics Conference (IPC)*, 2011.

35. **W. Loh**, J. Klamkin, S. M. Madison, F. J. O'Donnell, J. J. Plant, S. Yegnanarayanan, R. J. Ram, and P. W. Juodawlkis, "Slab-coupled optical waveguide (SCOW) based optoelectronic oscillator (OEO)," in *Proc. IEEE Photonics Conference (IPC)*, 2011.

36. P. W. Juodawlkis, J. J. Plant, **W. Loh**, L. J. Missaggia, F. J. O'Donnell, D. C. Oakley, A. Napoleone, J. Klamkin, and J. P. Donnelly, "High-power, low-noise slab-coupled optical waveguide (SCOW) amplifiers and lasers," in *Proc. Conference on Optical Fiber Communications (OFC)*, 2011.

37. J. Klamkin, J. J. Plant, M. Sheehan, **W. Loh**, S. M. Madison, and P. W. Juodawlkis, "High-output saturation power variable-confinement slab-coupled optical waveguide amplifier," in *Proc. Conference on Optical Fiber Communications (OFC)*, 2011.

38. P. W. Juodawlkis, J. J. Plant, S. M. Madison, **W. Loh**, D. C. Oakley, and A. Napoleone, "Microwave photonic applications of slab-coupled optical waveguide devices," in *Proc. IEEE Photonics Society Annual Meeting*, 2010.

39. P. W. Juodawlkis, **W. Loh**, F. J. O'Donnell, M. A. Brattain, and J. J. Plant, "High-power, ultralow-noise semiconductor external cavity lasers based on low-confinement optical waveguide gain media," in *Proc. SPIE Novel In-Plane Semiconductor Lasers IX*, vol. 7616, 2010.

40. **W. Loh**, J. J. Plant, J. Klamkin, J. P. Donnelly, F. J. O'Donnell, R. J. Ram, and P. W. Juodawlkis, "Limitations of noise figure in InGaAsP quantum-well semiconductor optical amplifiers," in *Proc. Conference on Lasers and Electro-Optics (CLEO)*, 2010.

41. J. Klamkin, R. K. Huang, J. J. Plant, M. K. Connors, L. J. Missaggia, **W. Loh**, G. M. Smith, K. G. Ray, F. J. O'Donnell, J. P. Donnelly, and P. W. Juodawlkis, "Direct modulation and wavelength stabilization of high-power slab-coupled optical waveguide lasers," in *Proc. Conference on Lasers and Electro-Optics (CLEO)*, 2010.

42. P. W. Juodawlkis, **W. Loh**, F. J. O'Donnell, M. A. Brattain, and J. J. Plant, "Ultralow-noise packaged 1.55-μm semiconductor external-cavity laser with 0.37-W output power," in *Proc. Conference on Lasers and Electro-Optics (CLEO)*, Post-Deadline Paper CPDA3, 2009.

43. **W. Loh**, J. J. Plant, F. J. O'Donnell, and P. W. Juodawlkis, "Noise figure of a packaged, high-power slab-coupled optical waveguide amplifier (SCOWA)," in *Proc. IEEE LEOS Annual Meeting*, 2008.

44. K. Hyup An, B. O'Connor, Y. Zhao, **W. Loh**, K. P. Pipe, and M. Stein, "Cantilevers with integrated organic LEDs for scanning probe microscopy," in *Proc. SPIE Organic Photonic Materials and Devices IX*, vol. 6470, 2007.