

Relevant Expertise

- field deployed DCS systems with a team of other engineers [1]
- dual comb spectroscopy with ~40 FP-QCLs, provided in collab. with MIT, ETH-Zurich, Jet Propulsion Lab., and Thorlabs [1,6,13]
- dual comb spectroscopy with ICLs at 3um [2,7]
- spectroscopy in outdoor environments, both single point detection and integrated path [1]
- spectroscopy in combustive environments [3, 4]
- spectroscopy for medical purposes [9] and cavity enhanced techniques [10]
- I have developed post-processing algorithms for DCS for improving SNR and also for multi-species simultaneous detection [8, 13]

Education

Ph.D. in Electrical Engineering, Princeton University	Expected August 2023	
B.S. in Electrical Engineering, Boise State University	Graduated 2015	GPA: 3.9 (152 credits)

Employment

Electrical Engineering Ph.D. Researcher	Wysocki Pulse Princeton University	9/1/2015-current
Lab Research Assistant	Müllner Research Group at BSU	10/15/2011-8/31/2015
Web-Designer	Just1 Web Design	07/01/2011-01/30/2012
Hod Carrier	Carter Construction	08/08/2011-11/01/2011
Landscape Laborer	Boise Basin Landscaping	05/29/2011-09/01/2011

Coding Languages Used

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|---|--|--|
| <ul style="list-style-type: none"> • Matlab • C++, C • Java | <ul style="list-style-type: none"> • Python • JavaScript • HTML | <ul style="list-style-type: none"> • LabVIEW • Spice (engineering tool) • SimuLink (engineering tool) • COMSOL (engineering tool) |
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Professional Accomplishments

Awards and Special Honors

- NSF Award 2017
- Graduated at Top of Engineering Class
- Two Gold Medals from National Latin Exams
- Dean's List with highest honors at BSU
- Award of Merit in Honors college at BSU

Activities and Leadership Positions

- Soccer Tournaments around the Northwest
- National placement in team drama and band, in Fine Arts National Competition
- National placement in Teen Quiz
- First place in Public Speaking 5 years out of 6 in Regional Fine Arts District Competitions

Additional Expertise

- ferromagnetic shape memory alloy material science [5, 11, 12]
- audio amplifier design and fabrication
- neural network interface design and fabrication
- Applied Electromagnetics
 - Antenna Design Simulation
 - Fabry-Perot Interferometer Simulation
- Radio Frequency (RF) design
 - Varactor-tuned Oscillator Design
 - Phase-locked loop design

References/Publications

- [1] J. Liu, C. Teng, Y. Chen, C. Patrick, et al. "Field deployment of a multi-pass cell based mid-IR quantum cascade laser dual-comb spectrometer." CLEO: Applications and Technology. Optical Society of America, 2021.
- [2] L. Sterczewski, J. Westberg, L. Patrick, et al, *Multiheterodyne spectroscopy using interband cascade lasers*, Optical Engineering 57(1) (2017), p. 011014.
- [3] H. Zhong, C. Patrick, et al, *Kinetic study of plasma-assisted n-dodecane/O₂/N₂ pyrolysis and oxidation in a nanosecond-pulsed discharge*. Proceedings of the Combustion Institute 38.4 (2021): 6521-6531.
- [4] H. Zhao, W. Lingnan, Z. Zunhua, C. Patrick, et al, *Study of Kinetic Effect of NO_x Sensitization on the Low Temperature Oxidation of N-pentane in a Jet Stirred Reactor*, AIAA Aerospace Sciences Meeting (2018), p. 0139.
- [5] A. Hobza, C. L. Patrick, et al, *Sensing strain with Ni-Mn-Ga*. Sensors and Actuators A: Physical 269 (2018), pp. 137-144.
- [6] J. Westberg, L. Sterczewski, L. Patrick, G. Wysocki, *Broadband mid-infrared and THz chemical detection with quantum cascade laser multi-heterodyne spectrometers*, Next-Generation Spectroscopic Technologies X. Vol. 10210. International Society for Optics and Photonics (2017).
- [7] C. L. Patrick, et al. *Multi-heterodyne spectroscopy using Fabry-Perot interband cascade lasers for trace gas detection: a feasibility assessment*. Novel In-Plane Semiconductor Lasers XVI. Vol. 10123. International Society for Optics and Photonics (2017).
- [8] L. Sterczewski, J. Westberg, L. Patrick, G. Wysocki, *Computational adaptive sampling for multiheterodyne spectroscopy*. Lasers and Electro-Optics (CLEO), 2017.
- [9] L. Patrick, et al, "Time-resolved breath oxygen monitor for critical care-clinical prototype development." Applied Industrial Spectroscopy. Optical Society of America, 2020.
- [10] C.L.Patrick, J. Westberg, G. Wysocki, *Cavity attenuated phase shift Faraday rotation spectroscopy*. Analytical chemistry, 91(3), pp. 1696-1700 (2018).
- [11] N. J. Kucza, C.L. Patrick, D. C. Danand, P. Müllner, *Magnetic-field-induced bending and straining of Ni-Mn-Ga single crystal beams with high aspect ratios*, Acta Materialia (2015), pp. 284-290.
- [12] P. Lindquist, A. Hobza, C. Patrick, P. Müllner, *Efficiency of energy harvesting in Ni-Mn-Ga shape memory alloys*, Shape Memory and Superelasticity (2018).
- [13] L. Patrick, et al, *Quantum cascade laser frequency combs covering up to 80 cm-1 for dual-comb spectroscopy at 8um*. CLEO: Applications and Technology. Optical Society of America, 2022.

Full list of publications

- Hayden, J., Westberg, J., Patrick, C.L., Lendl, B., Wysocki, G., 2018a. Frequency-locked cavity ring-down Faraday rotation spectroscopy. *Opt. Lett.*, OL 43, 5046–5049. <https://doi.org/10.1364/OL.43.005046>
- Hayden, J., Westberg, J., Patrick, L., Lendl, B., Wysocki, G., 2018b. Line-locked cavity ring-down Faraday rotation spectroscopy with high repetition rate, in: Conference on Lasers and Electro-Optics (2018), Paper STu3N.2. Presented at the CLEO: Science and Innovations, Optical Society of America, p. STu3N.2. https://doi.org/10.1364/CLEO_SI.2018.STu3N.2
- Hobza, A., Patrick, C.L., Ullakko, K., Rafla, N., Lindquist, P., Müllner, P., 2018. Sensing strain with Ni-Mn-Ga. *Sensors and Actuators A: Physical* 269, 137–144. <https://doi.org/10.1016/j.sna.2017.11.002>
- Kosan, N., Patrick, L., Liu, J., Wysocki, G., 2022. Quantum Cascade Laser Dual-Comb Spectrometer Intensity Noise Comparison: Symmetric vs. Asymmetric Configuration, in: Conference on Lasers and Electro-Optics (2022), Paper JW3A.62. Presented at the CLEO: Science and Innovations, Optica Publishing Group, p. JW3A.62. https://doi.org/10.1364/CLEO_AT.2022.JW3A.62
- Kosan, N., Patrick, L., Wysocki, G., 2021. Relative Intensity Noise Characterization of a Quantum Cascade Laser Frequency-Comb Symmetric Dual-Comb Spectrometer, in: OSA Optical Sensors and Sensing Congress 2021 (AIS, FTS, HISE, SENSORS, ES) (2021), Paper JTU5A.13. Presented at the Optical Sensors, Optica Publishing Group, p. JTU5A.13. <https://doi.org/10.1364/AIS.2021.JTU5A.13>
- Kuczka, N.J., Patrick, C.L., Dunand, D.C., Müllner, P., 2015. Magnetic-field-induced bending and straining of Ni–Mn–Ga single crystal beams with high aspect ratios. *Acta Materialia* 95, 284–290. <https://doi.org/10.1016/j.actamat.2015.05.030>
- Lindquist, P., Hobza, T., Patrick, C., Müllner, P., 2018. Efficiency of Energy Harvesting in Ni–Mn–Ga Shape Memory Alloys. *Shap. Mem. Superelasticity* 4, 93–101. <https://doi.org/10.1007/s40830-018-0158-z>
- Liu, J., Teng, C.C., Chen, Y., Patrick, C.L., Westberg, J., Wysocki, G., 2021a. A reconfigurable mid-infrared dual-comb spectrometer for point and remote chemical sensing, in: OSA Optical Sensors and Sensing Congress 2021 (AIS, FTS, HISE, SENSORS, ES) (2021), Paper JTU6E.4. Presented at the Hyperspectral Imaging and Sounding of the Environment, Optica Publishing Group, p. JTU6E.4. <https://doi.org/10.1364/AIS.2021.JTU6E.4>
- Liu, J., Teng, C.C., Chen, Y., Patrick, C.L., Westberg, J., Wysocki, G., 2021b. Field deployment of a multi-pass cell based mid-IR quantum cascade laser dual-comb spectrometer, in: Conference on Lasers and Electro-Optics (2021), Paper AW2S.1. Presented at the CLEO: Applications and Technology, Optica Publishing Group, p. AW2S.1. https://doi.org/10.1364/CLEO_AT.2021.AW2S.1
- Patrick, C., Westberg, J., Wysocki, G., 2020. System and Method for Mainstream Exhaled Oxygen Sensor. https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2020227394&_cid=P10-LH991J-81313-1
- Patrick, C.L., Sterczewski, L.A., Westberg, J., Bewley, W.W., Merritt, C.D., Canedy, C.L., Kim, C.S., Kim, M., Vurgaftman, I., Meyer, J.R., Wysocki, G., 2017. Multi-heterodyne spectroscopy using Fabry-Perot interband cascade lasers for trace gas detection: a feasibility assessment, in: Novel In-Plane Semiconductor Lasers XVI. Presented at the Novel In-Plane Semiconductor Lasers XVI, International Society for Optics and Photonics, p. 101231L. <https://doi.org/10.1117/12.2252253>
- Patrick, C.L., Westberg, J., Wysocki, G., 2019. Cavity Attenuated Phase Shift Faraday Rotation Spectroscopy. *Anal. Chem.* 91, 1696–1700. <https://doi.org/10.1021/acs.analchem.8b04359>
- Patrick, L., Dikmelik, Y., Lascola, K., Wysocki, G., 2022. Quantum cascade laser frequency combs covering up to 80 cm-1 for dual-comb spectroscopy at 8 μ m, in: Conference on Lasers and Electro-Optics (2022), Paper JM4E.2. Presented at the CLEO: Science and Innovations, Optica Publishing Group, p. JM4E.2. https://doi.org/10.1364/CLEO_AT.2022.JM4E.2
- Patrick, L., Westberg, J., Wysocki, G., 2021. A compact spectroscopic laser sensor for time-resolved breath oxygen monitoring towards clinical use, in: Conference on Lasers and Electro-Optics (2021), Paper AW3T.2. Presented at the CLEO: Applications and Technology, Optica Publishing Group, p. AW3T.2. https://doi.org/10.1364/CLEO_AT.2021.AW3T.2
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- Patrick, L., Westberg, J., Wysocki, G., 2018a. Comparison of Cavity Enhanced Faraday Rotation Spectroscopy Techniques. Presented at the 73rd International Symposium on Molecular Spectroscopy. <https://doi.org/10.15278/isms.2018.T104>
- Patrick, L., Westberg, J., Wysocki, G., 2018b. Comparison of cavity enhanced Faraday rotation techniques for oxygen detection, in: Conference on Lasers and Electro-Optics (2018), Paper AW3R.2. Presented at the CLEO: Applications and Technology, Optical Society of America, p. AW3R.2. https://doi.org/10.1364/CLEO_AT.2018.AW3R.2
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- Shashaty, K., Patrick, L., Wysocki, G., 2023. Balanced wavelength modulated Zeeman spectroscopy for oxygen detection. *Opt. Express*, OE 31, 7226–7236. <https://doi.org/10.1364/OE.483807>
- Shashaty, K., Patrick, L., Wysocki, G., 2022. Optimization of the output polarization state in multi-pass cell enhanced Faraday rotation spectrometers, in: Optical Sensors and Sensing Congress 2022 (AIS, LACSEA, Sensors, ES) (2022), Paper SW4E.1. Presented at the Optical Sensors, Optica Publishing Group, p. SW4E.1. <https://doi.org/10.1364/SENSORS.2022.SW4E.1>
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- Soskind, M.G., Li, N.P., Moore, D.P., Patrick, C.L., Chen, Y., Wendt, L., McSpirtt, J., Zondlo, M., Wysocki, G., 2021. Remote Methane Sensing System with Retroreflecting Target Tracking, in: Conference on Lasers and Electro-Optics (2021), Paper AM3Q.2. Presented at the CLEO: Applications and Technology, Optica Publishing Group, p. AM3Q.2. https://doi.org/10.1364/CLEO_AT.2021.AM3Q.2
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- Westberg, J., Teng, C.C., Chen, Y., Liu, J., Patrick, L., Soskind, M., Shen, L., Wysocki, G., 2020. Field deployment of a mid-IR dual-comb spectrometer based on quantum cascade lasers, in: Optical Sensors and Sensing Congress (2020), Paper EM1C.3. Presented at the Optics and Photonics for Sensing the Environment, Optica Publishing Group, p. EM1C.3. <https://doi.org/10.1364/ES.2020.EM1C.3>
- Wysocki, G., Liu, J., Teng, C., Chen, Y., Patrick, L., Westberg, J., Soskind, M., Shen, L., 2021. Dual-comb spectroscopy of trace chemicals using mid-infrared quantum cascade laser frequency combs: recent advances and field applications, in: Optical and Quantum Sensing and Precision Metrology. Presented at the Optical and Quantum Sensing and Precision Metrology, SPIE, p. 1170036. <https://doi.org/10.1117/12.2587217>
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In prep

- Wysocki, G., Liu, J., Teng, C., Chen, Y., Patrick, L., Westberg, J., Soskind, M., Shen, L., Urban open-air chemical sensing using a mobile quantum cascade laser dual-comb spectrometer (2023), in prep.
- Patrick, L., and Wysocki, G., Faraday Enhanced Dual comb spectroscopy with quantum cascade lasers (2023), in prep.