

## **CURRICULUM VITAE - SCOTT M. SPULER, Ph.D.**

### *1. EDUCATION*

- Ph.D. in Engineering Systems/Applied Optics, 2001, Colorado School of Mines
  - Thesis: "Sensitive Absorption Spectroscopy Techniques for Quantitative Detection of Species in Flames and Ambient Air"
- M.S. in Engineering Systems/Applied Optics, 1999, Colorado School of Mines
  - Thesis: "Development of a Cavity Ringdown Laser Absorption Spectrometer for Detection of Trace Levels of Mercury"
- B.S. in Civil/Environmental Engineering, 1993 Virginia Tech

### *2. WORK HISTORY*

- 2007-present: Research Engineer, National Center for Atmospheric Research, Boulder CO
- 2002-2007: Optical Engineer, National Center for Atmospheric Research, Boulder CO
- 2001-2002: R&D Optical Engineer, Zolo Technologies Inc., Boulder CO
- 1997-2001: Research Assistant, Combustion/Emissions Lab, Colorado School of Mines, Golden CO
- 1992-1996: Sr. Staff Geo-Environmental Engineer, Schnabel Engineering Associates, Bethesda MD

### *3. SCIENTIFIC /TECHNICAL ACCOMPLISHMENTS*

*Research Goal:* Design, build and utilize innovative optical and laser-based instruments which can be applied to enhance the understanding of the atmospheric earth sciences.

- Co-developed a low-cost thermodynamic profiler (combined water vapor, aerosol, and temperature DIAL)
- Co-developed low-cost, diode-laser-based HSRL profiling
- Co-developed and designed a diode-laser-based Differential Absorption Lidar (DIAL) for Water Vapor Profiling
- Co-designed and built an Er/Yb fiber amplifier for high power and low-noise performance
- Developed a fiber-based heterodyne laser remote sensor for measurement of winds from aircraft
- Co-designed and performed stray light analysis on novel multi-pass cell for enhanced trace gas detection
- Developed an in-line holographic imaging system for three-dimensional measurement of cloud particles
- Investigated eye-safe laser profiler for measurement of horizontal winds in the atmospheric boundary layer
- Designed NCAR GV-aircraft optical viewports for airborne laser remote sensing
- Investigated high spectral resolution lidar at 1550 nm for quantitative measurement of cloud/aerosols radiative properties

- Designed and built a robust Raman shifter for high-pulse energy lidar applications
- Developed high energy, eye-safe lidar system for 3D visualization of aerosols and atmospheric structure

#### 4. COMMUNITY SERVICE

- AMS Nationwide Network of Networks (NNoN) Committee (2023 - 2026)
- Technical Steering Committee member, 31st International Laser Radar Conference, Landshut, Germany (2023 - 2024)
- Technical Program Committee, European Lidar Conference 16-18 Nov Granada Spain (2021)
- UCAR Leadership Academy (2018-2019)
- PhD Committee member, Montana State University, Physics Department (2017-2019)
- General Co-chair, OSA Light Energy and the Environment Congress 6-9 Nov Boulder CO (2017)
- Local Organizing Committee Co-chair, OSA Light Energy and the Environment Congress 6-9 Nov Boulder CO (2017)
- Committee Member, Optical Instrumentation for Energy & Environmental Applications (E2) 14 - 17 November, Leipzig, Germany (2016)
- Program sub-committee member, Conference on Lasers and Electro-Optics: Applications and Technology: Laser & Photonics Applications for Energy & Environment, San Jose, CA (2014)
- Program Committee member, 26th International Laser Radar Conference, Greece (2012)
- PhD examination member, Universitat Politècnica de Catalunya, Barcelona Tech, Spain (2011)
- Program Committee member, 25th International Laser Radar Conference, Russia (2010)
- Co-chair of Program Committee, 24th International Laser Radar Conference (2007-2008)
- Site-visit team member, NSF Engineering Research Center Program (2009)
- Member of the AMS Nationwide Network of Networks Committee (NNoN) (2023-current)
- Reviewer: Appl. Opt., Appl. Phys. B, J. Atmos. Oceanic Technol., Atmos. Meas. Tech. (ongoing)
- Reviewer of NSF proposals (ongoing)
- Engineering Judge, for Colorado School of Mines EPICS design program (2013)
- Project client, for Colorado School of Mines EPICS design program (2011)
- Optical book reviewer, NCAR Library (2004-2012)
- Member, NCAR Workforce Management Subcommittee (2009)
- Co-lead, NCAR Technology Innovation Forum (2009-2012)
- Mentor, Photonics Engineering Students (Jan-Aug, 2010)
- Mentor, EOL Summer Engineering Students (2003, 2005, 2006, 2007)
- Co-chair, EOL Engineering visitor fund oversight (2008-current)
- Head of the EOL Engineering Group (2009-2012)
- Member, EOL Internal Advisory Committee (2007-2009) (2017-2022)

- Member, EOL Development Advisory Committee (2005-2012)

## 5. HONORS AND AWARDS

- 1997, Colorado Fellowship recipient
- 1999, Center for Combustion and Environmental Research E. J. Mallet Student Seminar Award recipient
- 2006, a co-author on best poster award, 23rd International Laser Radar Conference, Nara, Japan.
- 2012, co-author best scientific contribution award, 26th International Laser Radar Conference, Porto Heli, Greece
- 2015, EOL/NCAR Outstanding Publication Nomination
- 2018, NCAR Scientific and Technical Achievement Award

## 6. RESEARCH GRANTS

- Co-PI: “Development of a Three-Dimensional Laser Air Motion Sensor,” (2010) NCAR/EOL with Co-PI Mike Spowart NCAR/EOL and Co-I’s Dirk Richter NCAR/EOL and Don Lenschow NCAR/MMM
- Co-PI: “Development and Evaluation of an Ultra-Compact Wireless Network Enabled CO<sub>2</sub> Diode Laser Spectrometer,” (2010) NCAR/EOL with Co-PI Dirk Richter NCAR/EOL
- Co-PI: “Further Development of the HOLODEC 2 (Holographic Detector for Clouds 2) Instrument,” (2011) DOE/ARM Climate Research Facility with Co-PI Raymond Shaw at Michigan Technological University
- PI: “Phase II Development: Water Vapor Diode-Laser-Based Micro-pulse Differential Absorption Lidar (DIAL),” (2013) NCAR/EOL
- Co-PI: “HSRL for Aerosols Winds and Clouds using the Optical Auto-covariance Wind Lidar (HAWC-OAWL) Instrument Incubator Program,” (2014) NASA with Co-PI Sara Tucker at Ball Aerospace
- PI “Water Vapor DIAL Development: Phase C” (2015) NCAR/EOL
- PI “Diode-laser-based High Spectral Resolution Lidar Demonstration” (2016) NCAR/EOL
- Co-PI: “Development of a micro-pulse DIAL (MPD) testbed for sensing lower-tropospheric water vapor profiles” (2016) NSF Major Research Instrumentation, with Co-PI Kevin Repasky at Montana State University
- PI: “Water Vapor DIAL LAPE” (2016) DOE/PNNL
- Co-I: “MPD (MicroPulse Differential absorption lidar) Network Demonstration” (2019) DOE/ARM Climate Research Facility Field Campaign, with PI Tammy Weckwerth NCAR/EOL and Co-I David Turner NOAA/ESRL
- Co-PI: “Diode-Laser-Based Remote Sensing for Thermodynamic Profiling of the Lower Troposphere” (2019) NOAA Office of Weather and Air Quality, Next Generation of Mesoscale Weather Observing Platforms, with Co-PI Kevin Repasky at Montana State University

## 7. PUBLICATION LIST

## 7.1 THESIS

1. M.S. Thesis: Development of a Cavity Ringdown Laser Absorption Spectrometer for Detection of Trace Levels of Mercury, 1999, Colorado School of Mines
2. Ph.D. Thesis: Sensitive Absorption Spectroscopy Techniques for Quantitative Detection of Species in Flames and Ambient Air, 2001, Colorado School of Mines.

## 7.2 PATENTS

3. Huang P. and S. Spuler. 2004. Apparatus and Method for producing a flat-topped filter response for (de)multiplexer having a diffraction grating with variable line spacing. [US 6,754,412](#) filed 31 Jul 2002, granted 22 Jun 2004.
4. Mayor S. and S. Spuler. High Pulse-Energy, Eye-safe lidar system. [US 7,583,364](#) filed 19 May 2004, granted 1 Sep 2009.
5. Spuler S. 2011. Raman cell for high power applications. [US 7,869,469](#), filed 27 May 2005, granted 11 Jan 2011.
6. Spuler S. and S. Mayor. 2010. Lidar system for remote determination of calibrated, absolute aerosol backscatter coefficients. [US 7,656,526](#) filed 21 Jul 2006, granted 2 Feb 2010.
7. Mayor S. and S. Spuler. 2009. Polarization Lidar for the Remote Detection of Aerosol Particle Shape. [US 7,580,127](#) filed 21 Jul 2006, granted 25 Aug 2009.
8. Abari F. C. F, and S. Spuler. A system and method to measure an atmospheric thermodynamic profile with a compact, all-fiber and eye-safe lidar, [US 10,295,672](#) filed 13 Nov 2015, granted 21 May 2019.
9. Cooper W., S. Spuler, M. Spowart, D. Richter. Calibration of aircraft instruments using a laser sensor. [US 10,352,813](#) filed 24 Sep 2014, granted 16 Jul 2019.
10. Hayman M. and S. Spuler. Analog Photon Counting, [US 10,473,521](#) filed 05 Apr 2017, granted 12 Nov 2019.
11. Spuler S., K. Repasky, A. Nehrir. Micropulse Differential Absorption Lidar. [US 10,605,900](#) filed 27 Apr 2016, granted 31 Mar 2020.
12. Spuler, S., M. Hayman, B. Morley, and E. Eloranta. Diode Laser Based High Spectral Resolution Lidar. US Patent US 10,794,998, filed 4 Apr 2016, granted 6 Oct 2020.
13. Spuler S. M., Telescope, [US 11,143,748](#) filed 27 Apr 2016, granted 12 Nov 2021.
14. Spuler S. M., K. Repasky, A. Nehrir, Optical Filter, [US 11,243,295](#) filed 27 Apr 2016, granted 8 Feb 2022.

### 7.2.1 PATENTS PENDING

15. Stillwell R., S. Spuler, M. Hayman and K. Repasky. Differential Absorption Lidar for Profiling Temperature. US Patent App. PCT/US18/63360, filed 30 Nov 2018, published 30 Dec 2021 (US 2021/0405207 A1).

## 7.3 REFEREED JOURNAL ARTICLES

16. Spuler S., M. Linne, A. Sappey, S. Snyder, 2000: Development of a cavity ringdown laser absorption spectrometer for detection of trace levels of mercury. *Appl. Optics*, 39, 2480-2486.\*
17. Dreyer C.B, S. M. Spuler, and M. Linne, 2001: Calibration of Laser Induced Fluorescence of the OH radical by Cavity Ringdown Spectroscopy in Premixed Atmospheric Flames. *Combust. Sci. Technol.*, 171, 163-190.\*
18. Spuler S. and M. Linne, 2002: Numerical analysis of beam propagation in pulsed cavity ringdown spectroscopy. *Appl. Optics*, 41, 2858-2868.\*
19. Mayor S. and S. M. Spuler, 2004: Raman-shifted Eye-safe Aerosol Lidar. *Appl. Optics*, 43, 3915-3924.
20. Spuler S. M. and S. Mayor, 2005: Scanning eye-safe elastic backscatter lidar at 1.54 microns. *J. Atmos. Oceanic Technol.*, 22, 696-703
21. Huang X. P, S. M. Spuler and A. D Sappey, 2007: Varied Line-space grating for flat spectral response of coupling to single mode fiber. *Appl. Optics*, 46, 147-153
22. Mayor S. D., S. M. Spuler, B. Morley, E. Loew, 2007: Polarization lidar at 1.54 um and observations of plumes from aerosol generators. *Opt. Eng.*, 46, 096201-11
23. Refaat, T. F., S. Ismail, T. L. Mack, M. N. Abedin, S. D. Mayor, S. M. Spuler, 2007: Infrared Phototransistor Validation for Atmospheric Remote Sensing Application using the Raman-Shifted Eye-Safe Aerosol Lidar (REAL). *Opt. Eng.*, 46, 086001-8.
24. Spuler S. M. and S. D. Mayor, 2007: Raman shifter optimized for lidar at 1.5 microns. *Appl. Optics*, 46, 2990-2995.
25. Warner T., P. Benda, S. Swerdlin, J. Knievel, E. Argenta, B. Aronian, B. Balsey, J. Bowers, R. Carter, K. Clawson, J. Copeland, A. Crook, R. Frehlich, M. Jensen, Y. Liu, S. Mayor, Y. Meillier, B. Morley, R. Sharman, S. Spuler, D. Storwold, J. Sun, J. Weil, M. Xu, A. Yates, Y. Zhang, 2007: The Pentagon Shield Field Program – Toward Critical Infrastructure Protection. *Bull. Amer. Meteor. Soc.*, 88, 167-176
26. Refaat, T. F., S. Ismail, M. N. Abedin, S. M. Spuler, S. D. Mayor, U. N. Singh, 2008: Lidar backscatter signal recovery from phototransistor systematic effect by deconvolution. *Appl. Optics*, 47, 5281-5295
27. Spuler, S. M., J. Fugal, 2011: Design of an in-line, digital holographic imaging system for airborne measurement of clouds. *Appl. Optics*, 50, 1405-1412.
28. Spuler, S. M., D. Richter, M. P. Spowart, and K. Rieken, 2011: Optical fiber-based laser remote sensor for airborne measurement of wind velocity and turbulence. *Appl. Optics*, 50, 842-851.
29. Lewander, M., A. Fried, P. Weibring, D. Richter, S. Spuler, and L. Rippe, 2011: Fast and sensitive time multiplexed gas sensing of multiple lines using a miniature telecom diode laser between 1529 nm and 1565 nm. *Appl. Phys. B*, 104(3), 715-723.
30. Patton, E, T. Horst, P. Sullivan, D. Lenschow, S. Oncley, W. Brown, S. Burns, A. Guenther, A. Held, T. Karl, S. Mayor, L. Rizzo, S. Spuler, J. Sun, A. Turnipseed, E. Allwine, S. Edburg, B. Lamb, R. Avissar, R. Calhoun, J. Kleissl, W. Massman, K. Paw, J. Weil, 2011: The Canopy Horizontal Array Turbulence Study. *Bull. Amer. Meteor. Soc.*, 92, 593-611.

31. Hayman, M., S. Spuler, B. Morley, and J. VanAndel, 2012: Polarization lidar operation for measuring backscatter phase matrices of oriented scatterers. *Opt. Express*, 20, 29553-67.
32. Repasky K.S., D. Moen, S. Spuler, A. R. Nehrir, J. Carlsten, 2013: Progress towards an Autonomous field deployable diode-laser-based differential absorption lidar (DIAL) for profiling water vapor in the lower troposphere. *Remote Sens.*, 5, 6241-6259.
33. Hayman, M., S. Spuler, and B. Morley, 2014: Polarization lidar observations of backscatter phase matrices from oriented ice crystals and rain. *Opt. Express*, 22, 16976-90.
34. Cooper W. A., S. Spuler, M. Spowart, D. H. Lenschow, and R. B. Friesen, 2014: Calibrating airborne measurements of airspeed, pressure and temperature using a Doppler laser air-motion sensor. *Atmos. Meas. Tech.*, 7, 3215-3231.
35. Richter, D., P. Weibring, J. G. Walega, A. Fried, S. M. Spuler, and M. S. Taubman, 2015: Compact Highly Sensitive Multi-species Airborne Mid-IR Spectrometer. *Appl. Phys. B.*, 1-13. (doi:10.1007/s00340-015-6038-8)
36. Spuler, S. M., Repasky K.S., D. Moen, B. Morley, M. Hayman, A. R. Nehrir, 2015: Field deployable diode-laser-based differential absorption lidar (DIAL) for profiling water vapor. *Atmos. Meas. Tech.*, 8, 1073-1087. (doi:10.5194/amt-8-1073-2015)
37. Beals, M.J., J. P. Fugal, R. A. Shaw, J. Lu, S. M. Spuler, J. L. Stith, 2015: Holographic measurements of inhomogeneous cloud mixing at the centimeter scale. *Science*, 350 (6256), 87-90 (doi: 10.1126/science.aab075)
38. Mayor, S. P. Derian, C. Mauzey, S. Spuler, P. Ponsardin, J. Pruitt, D.I Ramsey, and Scott Higdon, 2016: Comparison of an analog direct detection and a micropulse aerosol lidar at 1.5 $\mu$ m wavelength for wind field observations – with first results over the ocean. *JARS*, 10, 016031-1-16. (doi: 10.1117/1.JRS.10.016031)
39. Weckwerth, T. M., K. Weber, D. D. Turner, S. M. Spuler, 2016: Validation of a Water Vapor Micropulse Differential Absorption Lidar (DIAL). *J. Atmospheric and Oceanic Technology* (33) 2353-2372 (doi: 10.1175/JTECH-D-16-0119.1)
40. Hayman, M., and S. Spuler, 2017: Demonstration of a diode-laser-based high spectral resolution lidar (HSRL) for quantitative profiling of clouds and aerosols. *Optics Express*, 25(24) A1096 (doi: 10.1364/OE.25.0A1096)
41. Bunn C., K. Repasky, M. Hayman, R. Stillwell and S. Spuler, 2018: Perturbative solution to the two component atmosphere DIAL equation for improving the accuracy of the retrieved absorption coefficient, *Appl. Opt.* 57(16), 4440-4450. (doi: 10.1364/AO.57.004440)
42. Fernando, H., J. Mann, J. Palma, J. Lundquist, R. Barthelmie, M. BeloPereira, W. Brown, F. Chow, T. Gerz, C. Hocut, P. Klein, L. Leo, J. Matos, S. Oncley, S. Pryor, L. Bariteau, T. Bell, N. Bodini, M. Carney, M. Courtney, E. Creegan, R. Dimitrova, S. Gomes, M. Hagen, J. Hyde, S. Kigle, R. Krishnamurthy, J. Lopes, L. Mazzaro, J. Neher, R. Menke, P. Murphy, L. Oswald, S. Otarola-Bustos, A. Pattantyus, C. Rodrigues, A. Schady, N. Sirin, S. Spuler, E. Svensson, J. Tomaszewski, D. Turner, L. van Veen, N. Vasiljevic, D. Vassallo, S. Voss, N. Wildmann, and Y. Wang, 2018: The Perdigão: Peering into

- Microscale Details of Mountain Winds. *Bull. Amer. Meteor. Soc.* (doi: 10.1175/BAMS-D-17-0227.1)
43. Hayman M, R. Stillwell, and S. Spuler, 2019: Fast computation of absorption spectra for lidar data processing using principal component analysis. *Opt. Lett.* 44, 1900-1903 (doi: 10.1364/OL.44.001900)
  44. Repasky, K. S., C. E. Bunn, M. Hayman, R. A. Stillwell, and S. M. Spuler, 2019: Modeling the Performance of a Diode Laser-Based (DLB) Micro-Pulse Differential absorption Lidar (MPD) for Temperature Profiling in the Lower Troposphere. *Opt. Express*, 27(23), 33543-33563 (doi: 10.1364/OE.27.033543)
  45. Stillwell R. A., S. M. Spuler, M. Hayman, K. S. Repasky and C. E. Bunn, 2020: Demonstration of a Combined Differential Absorption and High Spectral Resolution Lidar for Profiling Atmospheric Temperature. *Opt. Express*, 28(1), 71–93 (doi: 10.1364/OE.379804)
  46. Hayman, M., R. Stillwell, and S. Spuler, 2020: Optimization of linear signal processing in photon counting lidar using Poisson thinning. *Optics Letters*, 45(18), 5213-5216 (doi: 10.1364/OL.396498)
  47. Spuler, S. M., M. Hayman, R. A. Stillwell, J. Carnes, T. Bernatsky, and Repasky, K. S., 2021: MicroPulse DIAL (MPD) – a diode-laser-based lidar architecture for quantitative atmospheric profiling. *Atmos. Meas. Tech.*, 14(6), 4593–4616. (doi: 10.5194/amt-14-4593-2021)
  48. Spuler S., M. Hayman, T. M. Weckwerth, 2021: Water Vapor Differential Absorption Lidar, *In: Foken T (ed.), Handbook of Atmospheric Measurements. Springer Nature, Switzerland, 741-757.* [doi: 10.1007/978-3-030-52171-4\\_26](https://doi.org/10.1007/978-3-030-52171-4_26)
  49. Hayman, M. R. Stillwell, A. Karboski, W. Marais, and S. Spuler, "Global estimation of range resolved thermodynamic profiles from micropulse differential absorption lidar," *Opt. Express* 32, 14442-14460 (2024). [doi: 10.1364/OE.521178](https://doi.org/10.1364/OE.521178)
  50. Hayman, M., R. A. Stillwell, J. Carnes, G. J. Kirchhoff, S. M. Spuler, and J. P. Thayer, 2023: 2D Signal Estimation for Sparse Distributed Target Photon Counting Data. *Scientific Reports*, 14 10325 (2024). [doi: 10.1038/s41598-024-60464-1](https://doi.org/10.1038/s41598-024-60464-1)
  51. Cruikshank, O., L. Colbert, K. Repasky, R. A. Stillwell, and S. M. Spuler, 2024: Advancement and Demonstration of a Perturbative Retrieval Technique for Temperature Profiling in the lower Troposphere Using Differential Absorption light detection and ranging. *J. Appl. Remote Sens.* 18(3), 034514 (2024), doi: 10.1117/1.JRS.18.034514

#### 7.4 JOURNAL ARTICLES IN PREPARATION OR SUBMITTED

52. Tong, C., S. D. Mayor, S.P Oncley, C. Roden, W. Brown, S. M. Spuler, M. Hayman, B. M. Morley, J. Witte, P. Dérian, and S. F. J. De Wekker, 2024: Multipoint Monin-Obukhov Similarity Theory Horizontal Array Turbulence Study (M<sup>2</sup>HATS), in preparation