TERRENCE R. MEYER

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Career Experience and Post-Graduate Education

2015-present Professor, Mechanical Engineering, Aeronautics and Astronautics (by courtesy), Purdue University, West Lafayette, IN
- Research in combustion, energetics, and propulsion
- Development of burst-mode kHz-MHz 2D/3D imaging and spectroscopy

2010-2020 Guest Professor, Graduate School in Advanced Optical Technologies, Alexander-Friedrich University, Erlangen-Nuremberg, Germany
- High-speed imaging of combustion species using custom tunable laser sources

2006-2015 Associate Professor (2012-2015), William and Virginia Binger Assistant Professor (2011-2012), and Assistant Professor (2006-2011), Department of Mechanical Engineering, Iowa State University, Ames, IA
- Diagnostics for multiphase combustion phenomena and high-speed flows

2000-2006 Sr. Research Engineer, Innovative Scientific Solutions, Inc., Dayton, OH
- Research in combustion diagnostics for air breathing propulsion engines

2001-2004 Visiting Assistant Professor, EM2C, École Centrale Paris, France
- Particle velocimetry and CH fluorescence in multiphase counterflow flames

1994-2000 Graduate Research Assistant, Mechanical Engineering, University of Illinois, Urbana-Champaign, IL (MS earned in 1997, PhD earned in 2001)
- PhD: Turbulent molecular mixing in gaseous free shear flows
- MS: The effects of asymmetry and cylinder head deformation on diesel engine exhaust valve temperatures and stresses
- NSF Fellow, Ford Dissertation Fellow, Graduate Teaching Certificate, Co-instructor in Fluid Mechanics, and Teaching Assistant in IC Engines Lab

1993-1994 Mechanical Engineer, Cummins Engine Company, Columbus, Indiana
- Design and FEM analysis of engine fuel system and air intake components

Research

Prof. Meyer specializes in advanced multiphase and reacting flow diagnostics for propulsion, high-speed flows, and energetic systems. This includes burst-mode 3D/4D imaging, coherent Raman, fluorescence, phosphorescence, x-ray radiography, scattering techniques, and molecular tagging velocimetry, among others. Applications include measurements in flows related to gas-turbine combustors, rotating detonation engines, rocket injectors, spray-combustion phenomena, novel energetic materials, and hypersonic flows.

Awards and Leadership

- Fellow, Optica (formerly Optical Society of America), 2021
- Editor's Pick or Cover Feature for Applied Physics Letters (2022), Optics Letters (2020, 2019), Applied Optics (2019, 2009, 2003), and Applied Spectroscopy (2007)
- Chair and Vice Chair, Gordon Research Conference on Laser Diagnostics in Energy and Combustion Science (2017-2023)

- Co-Chair, International Constant Volume and Detonation Combustion Workshop, Purdue University (2019)
- Awards Chair (2021-present) and Technical Chair (2018-2019), Aerodynamic Measurement Technology (AMT) Committee, AIAA Science and Technology Forum and Exposition
- Purdue University list of Outstanding Engineering Teachers (2016, 2018, 2019, 2020)
- Fellow, American Society of Mechanical Engineers (2017)
- Awardee, NSF CAREER Award, Combustion, Fire, and Plasma Systems (2011-2017)
- Best Student Presentation, 25th Annual Institute for Liquid Atomization and Spray Systems (ILASS)-Americas Conference (2013)
- Best Paper, Conference on Lasers and Electro-Optics, Active Optical Sensing (2011)
- General Co-Chair (2010-2012), Program Co-Chair (2008-2010), Optical Society of America Topical Meeting on Laser Applications to Chemical, Security, and Environmental Analysis
- Young Researcher Award and Guest Professorship, Erlangen Graduate School in Advanced Optical Technologies (SAOT) (2010)
- Chair (2009-2010) and Vice-Chair (2008-2009), Optical Society of America Conference on Lasers and Electro-Optics, Subcommittee on Active Optical Sensing
- Cover feature, Applied Optics (2003), Applied Spectroscopy (2007), Applied Optics (2009)
- Associate Fellow, American Institute of Aeronautics and Astronautics (2006)
- AIAA Dayton-Cincinnati Section Outstanding Technical Contribution Award (2003)
- AIAA Foundation Graduate Award in Fluid Dynamics (based on PhD dissertation) (2001)
- Regents of the University of Minnesota Service Award (1992)
- Tau Beta Pi (1990)

Other Relevant Accomplishments

- Archival works: 115 journal articles and 2 book chapters, 1 patent, and 3 invention disclosures
- Google citations: h-index 42, i10-index 97, and 4600+ citations
- Presentations: 35+ invited lectures, 325+ conference papers and presentations
- Reviewer for 20+ journals and numerous technical symposia
- Advised or advising 32 PhD, 20 MS, 70+ UG researchers, and 4 post-doctoral associates
- Career research grants of over $33.7M, with $15.3M as PI and $15.8M as Meyer's share

Journal Publications

1. N.S. Rodrigues, A.D. Brown, T.R. Meyer, and R.P. Lucht, "0.1–5 MHz ultrahigh-speed gas density distributions using digital holographic interferometry," Appl. Opt. 61(1), 28-34, 2022; doi.org/10.1364/AO.434725.
2. J.M. Fisher, M.N. Slipchenko, and T.R. Meyer, "Grid-based femtosecond laser electronic excitation tagging for single-ended 2D velocimetry at kilohertz rates," Appl. Opt. 60(34), 10714-10720, 2021; doi.org/10.1364/AO.432803.
3. D.K. Lauriola, P.S. Hsu, N. Jiang, M.N. Slipchenko, T.R. Meyer, and S. Roy, "Burst-mode 100 kHz N2 ps-CARS flame thermometry with concurrent nonresonant background referencing," Opt. Lett. 46(21), 5489-5492, 2021; doi.org/10.1364/OL.439996.
4. E.R. Westphal, A.D. Brown, E.C. Quintana, A.L. Kastengren, S.F. Son, T.R. Meyer, and K.N.G. Hoffmeister, "Temperature-dependent X-ray fluorescent response from

thermographic phosphors under X-ray excitation," Appl. Phys. Lett. 119(3), 2021; doi.org/10.1063/5.0053469.
5. V. Athmanathan, K.A. Rahman, D. Lauriola, J. Braun, G. Paniagua, M.N. Slipchenko, S. Roy, and T.R. Meyer, "Femtosecond/picosecond rotational coherent anti-Stokes Raman scattering thermometry in the exhaust of a rotating detonation combustor," Combust. Flame 231, 111504, 2021; doi.org/10.1016/j.combustflame.2021.111504.
6. E. Westphal, A. Brown, E. Quintana, A. Kastengren, S. Son, T.R. Meyer, and K. Hoffmeister, "Visible emission spectra of thermographic phosphors under x-ray excitation," Meas. Sci. Technol. 32, 094008, 2021; doi.org/10.1088/1361-6501/abf222.
7. N. Rahman, B. R. Halls, K. E. Matusik, T. R. Meyer, and A. L. Kastengren, "Evaluation of liquid-phase thermometry in impinging jet sprays using synchrotron x-ray scattering," Appl. Opt. 60(11), 2967-2973, 2021; doi.org/10.1364/AO.417796.
8. J. Saavedra, G. Paniagua, F. Lozano, J. Fisher, A. Webb, and T. Meyer, "Flow conditioning system for tri-sonic high pressure aerothermal testing," Flow Measurement and Instrumentation 79, 101910, 2021; doi.org/10.1016/j.flowmeasinst.2021.101910.
9. J. Saavedra, V. Athmanathan, G. Paniagua, T. Meyer, D. Straub, J. Black, and S. Ramesh, "Scalable Heat Transfer Characterization on Film Cooled Geometries Based on Discrete Green's Functions," J. Turbomach. 143(2), 021005, 2021; doi.org/10.1115/1.4049613.
10. D.K. Lauriola, K.A. Rahman, H.U. Stauffer, M.N. Slipchenko, T.R. Meyer, and S. Roy, "Concentration and pressure scaling of CH2O electronic-resonance-enhanced coherent anti-Stokes Raman scattering signals," Appl. Opt. 60(4), 1051-1058, 2021; doi.org/10.1364/AO.415496.
11. B.R. Halls, N. Rahman, K.E. Matusik, T.R. Meyer, and A.L. Kastengren, "Feasibility of X-ray scattering for tracer-free liquid-phase thermometry for multiphase flows," Fuel 290, 120040, 2021; doi.org/10.1016/j.fuel.2020.120040.
12. J.M. Fisher, B.C. Chynoweth, M.E. Smyser, A.M. Webb, M.N. Slipchenko, J.S. Jewell, T.R. Meyer, and S.J. Beresh, "Femtosecond laser electronic excitation tagging velocimetry in a Mach six quiet tunnel," AIAA J. 59(2), 768-772, 2021; doi.org/10.2514/1.J059879.
13. D.N. Collard, M.S. McClain, N.A. Rahman, N.H. Dorcy, T.R. Meyer, and S.F. Son , "Dynamic x-ray imaging of additively manufactured reactive components in solid propellants," J. Propul. Power 37(3), 2021; doi.org/10.2514/1.B38128.
14. R. Yokoo, K. Goto, J. Kasahara, V. Athmanathan, J. Braun, G. Paniagua, T. Meyer, A. Kawasaki, K. Matsuoka, A. Matsuo, and I. Funaki, "Experimental study of internal flow structures in cylindrical rotating detonation engines," Proc. Combust. Inst. 38(3), 3759-3768, 2021; doi.org/10.1016/j.proci.2020.08.001.
15. M.N. Slipchenko, T.R. Meyer, and S. Roy, "Advances in burst-mode laser diagnostics for reacting and nonreacting flows," Proc. Combust. Inst. 38(1), 1533-1560, 2021; doi.org/10.1016/j.proci.2020.07.024.
16. J.D. Miller, J.W. Tröger, S.R. Engel, T. Seeger, A. Leipertz, and T.R. Meyer, "CH and NO planar laser-induced fluorescence and Rayleigh-scattering in turbulent flames using multimode optical parametric oscillation," Appl. Opt. 60(1), 98-108, 2021; doi.org/10.1364/AO.406237.
17. M.E. Smyser, E.L. Braun, V. Athmanathan, M.N. Slipchenko, S. Roy, and T.R. Meyer, "Dual output fs/ps burst-mode laser for MHz-rate rotational coherent anti-Stokes Raman scattering," Opt. Lett. 45(21), 5933-5936, 2020; doi.org/10.1364/OL.404984.

18. J.M. Fisher, A.D. Brown, D.K. Lauriola, M.N. Slipchenko, and T.R. Meyer, "Femtosecond laser activation and sensing of hydroxyl for velocimetry in reacting flows," Appl. Opt. 59(34), 10853-10861, 2020; doi.org/10.1364/AO.404788.
19. P.S. Hsu, M.N. Slipchenko, N. Jiang, C.A. Fugger, A.M. Webb, V. Athmanathan, T.R. Meyer, and S. Roy, "Megahertz-rate OH planar laser-induced fluorescence imaging in a rotating detonation combustor," Opt. Lett. 45(20), 5776-5779, 2020; doi.org/10.1364/OL.403199.
20. J. Felver, M.N. Slipchenko, E.L. Braun, T.R.Meyer, and Sukesh Roy, "High-energy laser pulses for extended duration MHz-rate flow diagnostics," Opt. Lett. 45(16), 4583-4586, 2020; doi.org/10.1364/OL.400831.
21. J.M. Fisher, J. Braun, T. R. Meyer, and G. Paniagua, "Application of femtosecond laser electronic excitation tagging (FLEET) velocimetry in a bladeless turbine," Meas. Sci. Technol. 31(6), 064005, 2020; doi.org/10.1088/1361-6501/ab7062.
22. K.A. Rahman, E.L. Braun, M.N. Slipchenko, S. Roy, and T.R. Meyer "Flexible chirp-free probe pulse amplification for kHz fs/ps rotational CARS," Opt. Lett. 45(2), 503-506, 2020; doi.org/10.1364/OL.382033 (Editor's Pick).
23. J. M. Fisher, M.E. Smyser, M.N. Slipchenko, S. Roy, and T.R. Meyer, "Burst-mode femtosecond laser electronic excitation tagging (FLEET) for kHz–MHz seedless velocimetry," Opt. Lett. 45(2), 335-338, 2020; doi.org/10.1364/OL.380109.
24. M.E. Smyser, M.N. Slipchenko, T.R. Meyer, A.W. Caswell, and S. Roy, "Burst-mode laser architecture for generation of high-peak-power MHz-rate femtosecond pulses," OSA Continuum 2(12), 3490-3498, 2019; doi.org/10.1364/OSAC.2.003490.
25. B.R. Halls, N. Rahman, M.N. Slipchenko, J.W. James, A. McMaster, M.D.A. Lightfoot, J.R. Gord, and T.R. Meyer, "4D spatiotemporal evolution of liquid spray using kilohertz-rate x-ray computed tomography," Opt. Lett. 44(20), 5013-5016, 2019; doi.org/10.1364/OL.44.005013.
26. J.A. Tiarks, C.E. Dedic, T.R. Meyer, R.C. Brown, J.B. Michael, "Visualization of physicochemical phenomena during biomass pyrolysis in an optically accessible reactor," Journal of Analytical and Applied Pyrolysis 143, 104667, 2019; doi.org/10.1016/j.jaap.2019.104667.
27. K.A. Rahman, V. Athmanathan, M.N. Slipchenko, T.R. Meyer, and S. Roy, "Pressure-scaling characteristics of femtosecond, two-photon laser-induced fluorescence of carbon monoxide," Appl. Opt. 58(27), 7458-7465, 2019; doi.org/10.1364/AO.58.007458.
28. A.D. Casey, Z.A. Roberts, A. Satija, R.P. Lucht, T.R. Meyer, and S.F. Son, "Dynamic imaging of the temperature field within an energetic composite using phosphor thermography," Appl. Opt. 58(16), 4320-4325, 2019; doi.org/10.1364/AO.58.004320 (Editor's Pick).
29. A. Douglawi, A. McMaster, M.E. Paciaroni, J.B. Michael, B.R. Halls, J.R. Gord, and T.R. Meyer, "Tracer-free liquid-vapor imaging using lifetime-filtered planar laser-induced fluorescence," Opt. Lett. 44(8), 2101-2104, 2019; doi.org/10.1364/OL.44.002101.
30. A. Douglawi, V. Athmanathan, M.N. Slipchenko, J.R. Gord, and T.R. Meyer, "Lifetime-filtered laser-induced exciplex fluorescence for crosstalk-free liquid-vapor imaging," Opt. Lett. 44(6), 1399-1402, 2019; doi.org/10.1364/OL.44.001399 (Editor's Pick).
31. K. Arafat Rahman, V. Athmanathan, M.N. Slipchenko, S. Roy, J.R. Gord, Z. Zhang, and T.R. Meyer, "Quantitative femtosecond, two-photon laser-induced fluorescence of atomic

oxygen in high-pressure flames," Appl. Opt. 58(8), 1984-1990, 2019; doi.org/10.1364/AO.58.001984.
32. G. Paniagua, D. Cuadrado, J. Saavedra, V. Andreoli, T. Meyer, J.P. Solano, R. Herrero, S. Meyer, and D. Lawrence, "Design of the Purdue experimental turbine aerothermal laboratory for optical and surface aero-thermal measurements," J. Eng. Gas Turbines Power 141(1), 012601, 2018; doi.org/10.1115/1.4040683.
33. B.R. Halls, J.R. Gord, L.E. Schultz, W.C. Slowman, M.D.A. Lightfoot, S. Roy, and T.R. Meyer, "Quantitative 10-50 kHz X-ray Radiography of Liquid Spray Distributions Using a Rotating-Anode Tube Source," Int. J. Multiphas. Flow 109, 123-130, 2018; doi.org/10.1016/j.ijmultiphaseflow.2018.07.014.
34. H.U. Stauffer, K.A. Rahman, M.N. Slipchenko, S. Roy, J.R. Gord, and T.R. Meyer, "Interference-free hybrid fs/ps vibrational CARS thermometry in high-pressure flames," Opt. Lett. 43(20), 4911-4914, 2018; doi.org/10.1364/OL.43.004911.
35. K.A. Rahman, K.S. Patel, M.N. Slipchenko, T.R. Meyer, Z. Zhang, Y. Wu, J.R. Gord, S. Roy "Femtosecond, two-photon, laser-induced fluorescence (TP-LIF) measurement of CO in high-pressure flames," Appl. Opt. 57(20), 5666-5671, 2018; doi.org/10.1364/AO.57.005666.
36. U. Retzer, R. Pan, T. Werblinski, F.T.J. Huber, M.N. Slipchenko, T.R. Meyer, L. Zigan, S. Will, "Burst-mode OH/CH2O planar laser-induced fluorescence imaging of the heat release zone in an unsteady flame," Opt. Express 26(14), 18105-18114, 2018; doi.org/10.1364/OE.26.018105.
37. R. Halls, P. S. Hsu, S. Roy, T. R. Meyer, and J. R. Gord, "Two-color volumetric laser-induced fluorescence of OH and temperature in turbulent reacting flows," Opt. Lett. 43(12), 2961-2964, 2018; doi.org/10.1364/OL.43.002961.
38. R. Pan, U. Retzer, T. Werblinski, M. Slipchenko, T.R. Meyer, L. Zigan, and S. Will, "Generation of high-energy, kHz-rate narrowband tunable ultraviolet pulses using a burst-mode dye laser system," Opt. Lett. 43(5), 1191-1194, 2018; doi.org/10.1364/OL.43.001191.
39. M.E. Smyser, K.A. Rahman, M.N. Slipchenko, S. Roy, and T.R. Meyer, "Compact burst-mode Nd:YAG laser for kHz–MHz bandwidth velocity and species measurements," Opt. Lett. 43(4), 735-738, 2018; doi.org/10.1364/OL.43.000735.
40. C.D. Radke, P. McManamen, A.L. Kastengren, A.B. Swantek, and T.R. Meyer, "Synchrotron x-ray interrogation of turbulent gas-liquid mixing in cryogenic rocket sprays," AIAA J. 55(12), 4306-4313, 2017; doi.org/10.2514/1.J055938.
41. B.R. Halls, P. Hsu, N. Jiang, E.S. Legge, J.J. Felver, M.N. Slipchenko, S. Roy, T.R. Meyer, and J.R. Gord, "kHz-rate four-dimensional fluorescence tomography using an ultraviolet-tunable narrowband burst-mode optical parametric oscillator," Optica 4(8), 897-902, 2017; doi.org/10.1364/OPTICA.4.000897.
42. B.R. Halls, N. Jiang, T.R. Meyer, S. Roy, M.N. Slipchenko, J.R. Gord, "4D spatio-temporal evolution of combustion intermediates in turbulent flames using burst-mode volumetric laser-induced fluorescence," Opt. Lett. 42(14), 2830-2833, 2017; doi.org/10.1364/OL.42.002830.
43. C.E. Dedic, T.R. Meyer, and J.B. Michael, "Single-shot ultrafast coherent anti-Stokes Raman scattering of vibrational/rotational nonequilibrium," Optica 4(5), 563-570, 2017; doi.org/10.1364/OPTICA.4.000563.
44. B.R. Halls, J.R. Gord, T.R. Meyer, D.J. Thul, M.N. Slipchenko, and S. Roy, "20-kHz-rate three-dimensional tomographic imaging of the concentration field in a turbulent jet," Proceedings of the Combustion Institute 36(3), 4611-4618, 2017; doi.org/10.1016/j.proci.2016.07.007.

45. B.R. Halls, C.D. Radke, B.J. Reuter, A.L. Kastengren, J.R. Gord, and T.R. Meyer, "High-speed, two-dimensional synchrotron white-beam x-ray radiography of spray breakup and atomization," Opt. Express 25(2), 1605-1617, 2017; doi.org/10.1364/OE.25.001605.
46. T.R. Meyer, B.R. Halls, N. Jiang, M.N. Slipchenko, S. Roy, and J.R. Gord, "High-speed, three-dimensional tomographic laser-induced incandescence imaging of soot volume fraction in turbulent flames," Opt. Express 24(26), 29547-29555, 2016; doi.org/10.1364/OE.24.029547.
47. J.D. Miller, N. Jiang, M.N. Slipchenko, J.G. Mance, T.R. Meyer, S. Roy, and J.R. Gord, "Spatiotemporal analysis of turbulent jets enabled by 100-kHz, 100-ms burst-mode particle image velocimetry," Exp. Fluids 57, 192(1-17), 2016; doi.org/10.1007/s00348-016-2279-5.
48. B.R. Halls, S. Roy, J.R. Gord, A.L. Kastengren, and T.R. Meyer, "Quantitative imaging of single-shot liquid distributions in sprays using broadband flash x-ray radiography," Int. J. Multiphas. Flow 87, 241-249, 2016; doi.org/10.1016/j.ijmultiphaseflow.2016.09.007.
49. B.R. Halls, D.J. Thul, D. Michaelis, S. Roy, T.R. Meyer, J.R. Gord, "Single-shot, volumetrically illuminated, three-dimensional, tomographic laser-induced-fluorescence imaging in a gaseous free jet," Opt. Express 24(9), 10040-10049, 2016; doi.org/10.1364/OE.24.010040.
50. Münsterjohann, F.J.T. Huber, T.C. Klima, S. Holfelder, S.R. Engel, J.D. Miller, T.R. Meyer, and S. Will, "Potential of two-line atomic fluorescence for temperature imaging in turbulent indium-oxide-producing flames," J. Nanopart. Res. 17, 459(1-10), 2015; doi.org/10.1007/s11051-015-3263-3.
51. J.D. Miller, C.E. Dedic, and T.R. Meyer, "Vibrational femtosecond/picosecond coherent anti-Stokes Raman scattering with enhanced temperature sensitivity for flame thermometry from 300–2400 K," J. Raman Spectrosc. 46(8), 702-707, 2015; doi.org/10.1002/jrs.4725.
52. C.D. Radke, J.P. McManamen, A.L. Kastengren, B.R. Halls, and T.R. Meyer, "Quantitative time-averaged gas and liquid distributions using x-ray fluorescence and radiography in atomizing sprays," Opt. Lett. 40(9), 2029-2032, 2015; doi.org/10.1364/OL.40.002029 (featured in Advanced Photon Source Science Highlights 12.10.2015).
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57. M.N. Slipchenko, J.D. Miller, S. Roy, T.R. Meyer, J.G. Mance, and J.R. Gord, "100 kHz, 100 ms, 400 J burst-mode laser with dual-wavelength diode-pumped amplifiers," Opt. Lett. 39(16), 4735–4738, 2014; doi.org/10.1364/OL.39.004735.
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59. H.U. Stauffer, J.D. Miller, M.N. Slipchenko, T.R. Meyer, B.D. Prince, S. Roy, and J.R. Gord, "Time- and frequency-dependent model of time-resolved coherent anti-Stokes Raman scattering (CARS) with a picosecond-duration probe pulse," J. Chem. Phys. 140(2), 024316, 2014; doi.org/10.1063/1.4860475.
60. B.R. Halls, T.J. Heindel, A.L. Kastengren, and T.R. Meyer, "Evaluation of X-ray sources for quantitative two- and three-dimensional imaging of liquid mass distribution in atomizing sprays," Int. J. Multiphas. Flow 59, 113-120, 2014; doi.org/10.1016/j.ijmultiphaseflow.2013.10.017.
61. J.D. Miller, J.B. Michael, M.N. Slipchenko, S. Roy, T.R. Meyer, and J.R. Gord, "Simultaneous high-speed planar imaging of mixture fraction and velocity using a burst-mode laser," Appl. Phys. B, 113, 93-97, 2013; doi.org/10.1007/s00340-013-5665-1.
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66. M.N. Slipchenko, C.E. Moody, J.D. Miller, S. Roy, J.R. Gord, and T.R. Meyer, "Micro-Optical Initiation of Nanoenergetic Materials Using a Temporally Tailored Variable-Pulse-Width Laser," ASME Journal of Nanotechnology in Engineering and Medicine, Special Issue on Micro/Nano-Scale Transport Phenomena 3, 031007(1-6), 2012; doi.org/10.1115/1.4007887.
67. N. Jiang, J. Bruzzese, R. Patton , J. Sutton, R. Yentsch, D.V. Gaitonde, W.R. Lempert, J.D. Miller, T.R. Meyer, R. Parker, T. Wadham, M. Holden, and P.M. Danehy, "NO PLIF imaging in the CUBRC 48-inch shock tunnel," Exp. Fluids 53, 1637-1646, 2012; doi.org/10.1007/s00348-012-1381-6.
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Book Chapters

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Patents, Applications, and Invention Disclosures

1. "Quasi-continuous Burst-mode Laser," Air Force Research Laboratory Case Number AFD 1364, Invention Disclosure Filed April 9, 2013 (with J.R. Gord, M.N. Slipchenko, S. Roy, and T.R. Meyer).
2. "A System and Method for Utilizing Pyrolysis Oil in Oil Burners," Invention Disclosure Filed April 23, 2010, Patent Application Number 13092463, Filed April 22, 2011 (with D.L. Wissmiller, T.R. Meyer, and R.C. Brown).
3. "Stereoscopic Planar Laser-Induced Fluorescence Imaging for Time-Resolved 3D Movies in Hypersonic Flow," NASA Case Number LAR 17979-1, Invention Disclosure Filed December 9, 2010 (with P.M. Danehy, N. Jiang, T.L. Medford, S.B. Jones, B.F. Bathel, J.A. Inman, M. Webster, W.R. Lempert, J.D. Miller, and T.R. Meyer).
4. "Triple-Pump Coherent Anti-Stokes Raman Scattering System," U.S. Patent No. 7,106,436, Issued September 12, 2006 (with J.R. Gord, S. Roy, T.R. Meyer, M.S. Brown, G.J. Fiechtner, and R.P. Lucht).