

## Robert R. McLeod

### Contact Information

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### Education

1995	University of Colorado <i>Doctorate of Philosophy in Electrical Engineering</i>	Boulder, CO
1989	University of California <i>Masters of Science in Engineering Applied Science</i>	Davis, CA
1984	Montana State University <i>Bachelors of Science summa cum laude, Honors Program</i>	Bozeman, MT
1985	<i>Masters of Science in Electrical Engineering</i>	

### Professional Experience

2003- 2006-2007	University of Colorado <i>Assistant Professor</i> <i>Director, Colorado Center for Information Storage</i>	Boulder, CO
1999-2001 2001-2003	JDS Uniphase <i>Senior Manager, Passive Components</i> <i>Director, Photonic Subsystems</i>	San Jose, CA
1996-1997 1997-1999	Siros Technologies <i>Systems Engineer</i> <i>Manager of Head/Media Group</i>	San Jose, CA
1993 - 1996	Optoelectronic Data Systems <i>Vice President</i>	Boulder, CO
1986-1991	Lawrence Livermore National Lab <i>Member of Technical Staff</i>	Livermore, CA

### Honors and Awards

2008	<b>Best Student Paper Award</b> , Benjamin A. Kowalski at the IEEE/OSA/SPIE International Symposium on Optical Memory and Optical Data Storage
2007	<b>Best Student Paper Award</b> , Amy C. Sullivan at the OSA topical meeting on Controlling Light with Light: Photorefractive Effects, Photosensitivity, Fiber Gratings, Photonic Materials and More
2007	<b>Best Student Poster Award</b> , Eric Moore at the SPIE/CPIA Photonics Research in Colorado annual meeting
2007	<b>Faculty Fellowship</b> , CU College of Engineering and Applied Science

- 2004 **Best Student Poster Award**, Amy C. Sullivan at the SPIE/CPIA Photonics Research in Colorado annual meeting
- 2004 **Junior Faculty Development Award**, CU Boulder Council on Research and Creative Work
- 2002 **Award for Excellence**, JDS Uniphase
- 1992 **Defense Science and Engineering Fellow**
- 1982 **Phi Kappa Phi**

#### Selected Press Coverage (out of 85 articles)

1. "[Nanopatterning: What diffraction limit?](#)", *Nature Nanotechnology Research Highlights*, April 24, 2009, doi:10.1038/nnano.2009.115
2. "[Two-Laser Lithography Shrinks Transistors](#)," *IEEE Spectrum*, June 2009
3. "[Novel technique shrinks size of nanotechnology circuitry](#)," *ScienceWeek*, April 16, 2009
4. "[Double-laser approach makes one thin line](#)," *Science News*, April 10, 2009
5. "[3D Etch-a-Sketch for Extreme Polymer Optics](#)," *CUEngineering Magazine*, Spring 2009 edition

### Publications

#### Peer-Reviewed Journal Papers (citations)

1. M. R. Gleeson, S. Liu, R. R. McLeod, J. T. Sheridan, "Non-Local Photo-Polymerization Kinetics Including Multiple Termination Mechanisms and Dark Reactions: Part II. Experimental Validation," *JOSA B*, in peer review
2. (1) T. F. Scott, C. N. Bowman, B. A. Kowalski, A. C. Sullivan, C.N. Bowman, R. R. McLeod, "Two-Color Single-Photon Photoinitiation and Photoinhibition for Sub-diffraction Photolithography," *Science* **324**, 913-917, 2009.
3. M. R. Ayres, R. R. McLeod, "Medium consumption in holographic memories," *Applied Optics*, in press
4. R. R. McLeod, "Impact of phase aberrations on three-dimensional optical data storage in homogeneous media," *JOSA B* **26**, 308-317, 2009.
5. C. Ye, R. R. McLeod, "GRIN lens and lens array fabrication with diffusion-driven photopolymer," *Optics Letters* **33**, 2575-2577, 2008.
6. (2) E. D. Moore, R. R. McLeod, "Correction of sampling errors due to laser tuning rate fluctuations in swept-wavelength interferometry," *Optics Express* **16**, 13139-13149, 2008. **Selected for co-publication in the Virtual Journal for Biomedical Optics, vol 3 (2008)**
7. R. R. McLeod, A. J. Daiber, T. Honda, M. E. McDonald, T. L. Robertson, T. Slagle, S. L. Sochava, and L. Hesselink, "Three-dimensional optical disk data storage via the localized alteration of a format hologram," *Applied Optics* **47**, 2696-2707, 2008.
8. L. Gao, K. H. Wagner, R. R. McLeod, "All-Optical TBits/S 3R Wavelength Conversion Using Dispersion-Managed Light Bullets," *IEEE Journal of Selected Topics in Quantum Electronics* **14**, 625-634, 2008.
9. S. Kim, R. R. McLeod, M. Saffman, and K. H. Wagner, "Doppler-free, multiwavelength acousto-optic deflector for two-photon addressing arrays of

- Rb atoms in a quantum information processor," *Applied Optics* **47**, 1816-1831, 2008.
10. (3) A. C. Sullivan and R. R. McLeod, "Tomographic reconstruction of weak, replicated index structures embedded in a volume," *Optics Express* **15**, 14202-14212, 2007.
  11. (13) A. C. Sullivan, M. W. Grabowski, R. R. McLeod, "Three-dimensional direct-write lithography into photopolymer," *Applied Optics* **46**, 295-301, 2007.
  12. (3) M. R. Ayres and R. R. McLeod, "Scanning transmission microscopy using a position-sensitive detector," *Applied Optics* **45**, 8410-8418, 2006.
  13. (1) R. R. McLeod and S. K. Walter, "Acousto-optic parallel read/write head for optical disk data storage," *Applied Optics* **45**, 7065-7072, 2006.
  14. R. R. McLeod and T. Honda, "Improving the spectral resolution of wedged etalons and linear variable filters with incidence angle," *Optics Letters* **30**, 2647-2649, 2005.
  15. (51) R. R. McLeod, A. J. Daiber, M. E. McDonald, T. L. Robertson, T. Slagle, S. L. Sochava, and L. Hesselink, "Microholographic multilayer optical disk data storage," *Applied Optics* **44**, 3197-3207, 2005.
  16. (6) T. Honda, A.C. Liu, J. Valera, J. Colvin, K. Sawyer, R.R. McLeod, "Diffraction-compensated free-space WDM add-drop module with thin-film filters," *IEEE Photonics Technology Letters* **15**, 69 -71, 2003.
  17. (3) R. McLeod, S. Blair, and K. Wagner, "Variational approach to orthogonally-polarized optical soliton interaction with cubic and quintic nonlinearities", *Physica Scripta* **59**, 365-373, 1999.
  18. (6) R. McLeod, K. Wu, K. Wagner, and R.T. Weverka, "Acousto-optic photonic crossbar switch, Part I: Design", *Applied Optics* **35**, 6331-6353, 1996.
  19. (20) S. Blair, K. Wagner and R. McLeod, "Material figures-of-merit for spatial soliton interactions in the presence of absorption", *Journal of the Optical Society of America B* **13**, 2141-2153, 1996.
  20. (99) R. McLeod, K. Wagner and S. Blair, "3+1 dimensional optical soliton dragging logic", *Physical Review A* **52**, 3254-3278, 1995.
  21. (27) S. Blair, K. Wagner, R. McLeod, "Asymmetric spatial soliton dragging," *Optics Letters* **19**, 1943-1945, 1994.
  22. (18) M. J. Barth, R. R. McLeod, and R.W. Ziolkowski, "A near and far-field projection algorithm for finite-difference time-domain codes," *Journal of Electromagnetic Waves and Applications* **6**, 5-18, 1992.
  23. A. Gautesen, R.W. Ziolkowski, and R.R. McLeod, "Solution to the Scattering of Electromagnetic Waves from a Dielectric Semi-Cylinder," *SIAM Journal on Applied Mathematics* **51**, p. 1556, 1991.

#### Peer-Reviewed Book Chapters (citations)

1. R. R. McLeod, "Optical Disk Data Storage, Distribution and Retrieval," in *Encyclopedia of Computer Science and Engineering*, Benjamin W. Wah (Editor), Wiley, 2008.
2. (7) T. Weverka, K. Wagner, R.R. McLeod, K. Wu, "Low-Loss Acousto-Optic Photonic Switch," in *Acousto-Optic Signal Processing*, Marcel Dekker, NY, 1994.

**Patents (citations)**

1. P. E. X. de Silveira, R. R. McLeod, USP 7,292,516, "Sensor optimized for phase detection in page-based optical data storage," November 6, 2007
2. R. R. McLeod, E. D. Moore, USP 7,212,723, "Monolithic Waveguide Arrays", May 1, 2007. **Licensed to Zenwa Incorporated.**
3. (1) J. Shen, R. R. McLeod, D. E. Crafts, B. Fondeur, Y. Ding, P-C Sun, USP 7,035,505, "Optical performance monitor," April 25, 2006
4. S. P. Weaver, R. R. McLeod, K. R. Curtis, A. J. Hill, USP 2006/0082850, "Covert surface relief hologram design, fabrication and optical reconstruction for security applications," April 20, 2006.
5. S. P. Weaver, R. McLeod, K. R. Curtis, A. J. Hill, EP1647415, "Surface relief holographic recording medium and optical system for its reading," May 19, 2006
6. (1) T. Honda, R. R. McLeod, USP 7,031,610, "Diffraction-compensated integrated WDM," April 18, 2006
7. S. P. Weaver, R. R. McLeod, K. R. Curtis, A. J. Hill, Pub. No. 2005/0248817, "Covert hologram design, fabrication and optical reconstruction for security applications," Nov 10, 2005.
8. B.L. Heffner; R. McLeod, USP 6,765,665 , "Optical bit rate detector," July 20, 2004
9. R. R. McLeod, W.H. Loh, Pub. No.2004/0096212, "Optical channel monitoring device," May 20, 2004
10. (1) L. Hesselink, R.R. McLeod, S.L. Sochava, USP 6,614,741, "Optical data storage by selective localized alteration of a format hologram in a holographic storage disk," Sept 2, 2003
11. (2) R. R. McLeod, G. Lei, L. Yang, K. Tai, Pub. No.2003/0098982, "Truncated series-based resonant cavity interferometer," May 29, 2003
12. (4) M. McDonald, R. McLeod A. Daiber, USP 6,563,779, "Tracking error signal generation using confocally filtered detection", May 13, 2003
13. (11) A. Daiber, R. McLeod, R. Snyder, USP 6,549,664, "Sparse modulation codes for holographic data storage", April 15, 2003
14. X.D. He, R. McLeod, H.W. Mao, Q. Guo, K. Tai, K.W. Chang, USP 6,545,805, "Polarization-dependent retroreflection mirror device", April 8, 2003
15. (7) M. Lipson, S. Sochava, L. Hesselink; B. Cumpston, R. McLeod, C. Claude, USP 6,512,606, "Optical storage media and method for optical data storage via local changes in reflectivity of a format grating", Jan 28, 2003
16. (3) R. McLeod, A. Cohen, USP 6,437,916, "Strain-stabilized birefringent crystal", Aug 20, 2002
17. (18) A. Daiber, R. McLeod, T. Honda, USP 6,322,933, "Volumetric track definition for data storage media used to record data by selective alteration of a format hologram", Nov 27, 2001
18. (1) M. McDonald, R. McLeod, USP 6,288,986, "Focus error signal generation using a birefringent plate with confocal detection", Sept 11, 2001

19. M. McDonald, R. McLeod, USP 6,269,057, "Focus error signal generation using a birefringent lens with confocal detection", July 31, 2001
20. (3) R. McLeod, USP 6,256,271, "Focus error signal generation using two polarizers in confocal configuration", Jul. 3, 2001
21. (9) L. Hesselink, R. McLeod, S. Sochava, W. Phillips, USP 6,212,148, "Optical data storage by selective localized alteration of a format hologram", Apr. 3, 2001
22. (14) R. McLeod, M. McDonald, USP 6,111,828, "Focus error signal generation using confocally filtered detection", Aug. 29, 2000
23. (13) R. McLeod, S. Sochava, A. Daiber, M. McDonald, L. Hesselink, I. Sander, T. Slagle, USP 6,020,985, "Multilayer reflection microhologram storage in tape media", Feb. 1, 2000

### Patents, Pending

1. R. R. McLeod, C. N. Bowman, T. F. Scott, A. C. Sullivan, "Diffraction Unlimited Photolithography," US patent filed Nov 14, 2008.
2. E. D. Moore, R. R. McLeod, "System and method for correcting sampling errors associated with radiation source tuning rate fluctuations in interferometrically triggered swept-wavelength systems," US patent filed Aug 2008,. **Licensed to dBm Optics.**
3. R. R. McLeod, "Three-Dimensional Direct Write Lithography", US patent filed June 2006.

### Invited Conference Presentations

1. Robert R. McLeod, "Advances in two-color materials for high density optical data storage," *Optical Data Storage Topical Meeting 2009*, Lake Buena Vista, FL, May 2009
2. T. F. Scott, B. A. Kowalski, A. C. Sullivan, C. N. Bowman, R. R. McLeod, "Lithography well below the diffraction limit inspired by STED microscopy," SPIE 3D and Multi-Dimensional Microscopy: Image Acquisition and Processing 2009.
3. Robert R. McLeod, Matthew S. Kirchner, Amy C. Sullivan, "3D micro-optic circuits in holographic photopolymers," OSA Frontiers in Optics 2008.
4. E. D. Moore, Amy C. Sullivan, R. R. McLeod, "Three-dimensional waveguide arrays via projection lithography into a moving photopolymer," SPIE Organic 3D Photonics Materials and Devices 2008.
5. R. R. McLeod, "Photo-induced meso-scale mass transport in polymers," Light-Controlled Liquid Crystalline Complex Adaptive Materials, Boulder CO 2008.
6. R. R. McLeod, "Applications for 3D Index Control of Diffusion-Mediated Photopolymers," *Photopolymerization Fundamentals*, Breckenridge CO, 2007.
7. Robert R. McLeod, Matthew W. Grabowski, Mark R. Ayres, Amy C. Sullivan, "Localized Recording Approaches and Phase Metrology for Holographic Storage," *Optical Data Storage Topical Meeting 2007*, Portland, OR, May 2007.
8. R. R. McLeod, "3D Etch-a-Sketch<sup>®</sup> : Building complex optical circuits in photopolymer," *IEEE Engineering the Future of Colorado - Pioneering*

- Engineering efforts in Colorado, Annual Colorado Tech Summit, Denver, CO, September 2006.*
9. R. R. McLeod, M. Wolkin, V. Morozov, K. A. Sawyer, "Packaging of micro-optics components to meet Telcordia standards," *Optical Fiber Communication Conference*, pp. 326-327, Anaheim, CA, March 2002.
  10. R. McLeod, K. Tai, G. Lei, K. Sawyer, "Micro-Optic Passive Devices: An All-Glass Fabrication Technique," *IEEE Lasers and Electro-Optics Society International Workshop on Fibers and Optical Passive Components*, Pavia, Italy June 2000.
  11. R. McLeod, "WDM Component Packaging Design Methodology", *CPMT/LEOS Workshop on Fiber-Optics, Optoelectronics, Photonics Assembly, Packaging and Manufacturing*, Vail, CO, September 1999.

### Peer-Reviewed Conference Proceedings

1. C. Ye, R.R. McLeod, "GRIN lens and GRIN lens array fabrication with diffusion driven photopolymer," *Conference on Lasers and Electro-Optics (CLEO) 2009*, paper CF13
2. M. W. Grabowski, R. R. McLeod, "Increasing Microholographic Storage Density in Photopolymer with a Secondary Unimolecular Termination Agent," *IEEE Optical Data Storage Topical Meeting*, May 2009, paper MA4
3. T. F. Scott, C. N. Bowman, B. A. Kowalski, A. C. Sullivan, R. R. McLeod, "Exceeding the diffraction limit with single-photon photopolymerization and photo-induced termination," *SPIE Organic 3D Photonics Materials and Devices*, August 2008
4. M. W. Grabowski, K. M. Vogelhuber, R. R. McLeod, "Absorption and bleaching dynamics of initiator in thick photopolymer exposed to Gaussian illumination," *SPIE Organic 3D Photonics Materials and Devices*, August 2008
5. B. A. Kowalski, R. R. McLeod, T. F. Scott, "A two-color photopolymer system for high-capacity multilayer optical data storage," *International Symposium on Optical Memory & Optical Data Storage*, July 2008, **Best Student Paper Award**
6. R. R. McLeod, "Phase aberration limits to three-dimensional optical data storage in homogeneous media," *International Symposium on Optical Memory & Optical Data Storage*, July 2008
7. M. R. Ayres, R. R. McLeod, "Intra-signal modulation in holographic memories," *International Symposium on Optical Memory & Optical Data Storage*, July 2008
8. R. R. McLeod, M. C. Cole, C. D. Anderson, M. S. Kirchner, K. Kamysiak, M. G. Gleeson, "Hybrid fiber and free space couplers for polymer integrated optical circuits," *Photonics West*, San Jose CA, January 2008.
9. R. R. McLeod, A. C. Sullivan, "Taper control of radially-symmetric gradient-index waveguides in photopolymer," *Photonics West*, San Jose CA, January 2008.
10. M. W. Grabowski, R. R. McLeod, "Low Loss Rings in Self Processing Polymer Guides," *Conference on Lasers and Electro-Optics (CLEO)* paper JTUA32, 2008.
11. Robert R. McLeod, Matthew S. Kirchner, Amy C. Sullivan, "3D micro-optic circuits in holographic photopolymers," in *Controlling Light with Light: Photorefractive Effects, Photosensitivity, Fiber Gratings, Photonic Materials and*

- More on CD-ROM (The Optical Society of America, Washington, DC, 2007), TuC2. Best Student Paper Award.*
12. R. R. McLeod, M. W. Grabowski, M.C. Cole, "Impact of inhibitor diffusion in holographic photopolymers," *Proceedings of SPIE: Volume 6657 Organic 3D Photonics Materials and Devices V*, San Diego, CA, 7 pages, August 2007
  13. R. R. McLeod, M. S. Kirchner, K. Kamysiak, A. C. Sullivan, M.C. Cole, "3D waveguides with fiber couplers and 90 degree bends in holographic photopolymer," *Proceedings of SPIE: Volume 6657 Organic 3D Photonics Materials and Devices V*, San Diego, CA, 6 pages, September 2007
  14. Amy C. Sullivan, Robert R. McLeod, "3D Tapered Waveguides in Volume Photopolymers," in *Integrated Photonics Research and Applications/Nanophotonics 2007 Technical Digest*, 3 pages (Optical Society of America, Washington, DC, 2007)
  15. M. Grabowski, A.C. Sullivan, R.R. McLeod, "Large scale diffusion timescale measurement in diffusion limited photopolymer systems", *American Physical Society March Meeting*, Denver CO (2007)
  16. A. C. Sullivan, M. R. Ayres, R. R. McLeod, "Phase and absorption metrology for thick photopolymer devices," *Proceedings of SPIE Volume: 6335, Organic Holographic Materials and Applications IV*, San Diego, CA, 12 pages, September 2006.
  17. A. C. Sullivan, M. W. Grabowski, R. R. McLeod, "Impact of initiation species on index distribution in diffusion photopolymers," *Proceedings of SPIE Volume: 6335, Organic Holographic Materials and Applications IV*, San Diego, CA, 66350F (9 pages), September 2006.
  18. M.R. Ayres, R.R. McLeod, "Volumetric Phase Metrology for Optical Data Storage," *Optical Data Storage Topical Meeting 2006*, 132- 134, Montreal, CA, April 2006.
  19. C. D. Anderson, R. R. McLeod, M. W. Grabowski, A. C. Sullivan, "Photopolymer Waveguide to Fiber Coupling via 3D Direct-Write Lithography," in *Integrated Photonics Research and Applications/Nanophotonics 2006 Technical Digest*, 3 pages (Optical Society of America, Washington, DC, 2006), ITuD4
  20. M. W. Grabowski, A. C. Sullivan, R. R. McLeod, "3D Direct-Write Waveguides in Diffusion Photopolymers," in *Integrated Photonics Research and Applications/Nanophotonics 2006 Technical Digest*, 3 pages (Optical Society of America, Washington, DC, 2006), ITuD5
  21. R. R. McLeod, A.J. Daiber, M.E. McDonald, S. L. Sochava, T. Honda, T.L. Robertson, T. Slagle, L. Hesselink, "Holographic storage without holography: Optical data storage by localized alteration of a format hologram ," *International Symposium on Optical Memory and Optical Data Storage*, Honolulu, HI, Paper MB1, 2005.
  22. S. Kim, L. Gao, and K. H. Wagner, R. T. Weverka, and R. McLeod, "Acousto-Optic Tunable Filter Using Phased-Array Transducer with Linearized RF to Optical Frequency Mapping," *Proc. SPIE Vol. 5953, 59530M, Acousto-optics and Photoacoustics*, September 2005.

23. R. R. McLeod, A.J. Daiber, M.E. McDonald, S. L. Sochava, T.L. Robertson, T. Slagle, L. Hesselink, "Micro-holographic multi-layer optical disk data storage," *International Symposium on Optical Memory and Optical Data Storage*, Paper MB3, Honolulu, HI, July 2005.
24. R. R. McLeod, S. K. Walter, "Acousto-optic parallel read/write head for optical disk data storage," *International Symposium on Optical Memory and Optical Data Storage*, Paper WB3, Honolulu, HI, July 2005.
25. L. Gao, K. H. Wagner, R. McLeod, "Dispersion-Managed Light Bullets and Their Interactions," *OSA Nonlinear Guided Waves and Their Applications Technical Digest*, Dresden, Germany, Sept 2005.
26. A. C. Sullivan, M. W. Grabowski, R. R. McLeod, "Tomographic Reconstruction of 3D Index Structures in Photopolymer," *Integrated Photonics Research and Applications Technical Digest*, San Diego, CA, April 2005.
27. Lu Gao, Robert McLeod, Kelvin H. Wagner, "Ultrafast all-optical wavelength conversion based on (3+1)-D optical soliton dragging interaction", *Proc. SPIE Vol. 5556*, p. 57-67, *Photonic Devices and Algorithms for Computing VI*, Denver, CO, August 2004
28. Robert R. McLeod, Amy C. Sullivan, Matthew Grabowski, "Direct-write waveguides in volume photopolymers," *Integrated Photonics Research and Applications*, Paper JWB24, San Francisco, CA, June 2004.
29. Robert R. McLeod, Amy C. Sullivan, Matthew W. Grabowski, Timothy F. Scott, "Hybrid integrated optics in volume holographic photopolymer", *Proc. SPIE Vol. 5521*, 55-62, *Organic Holographic Materials and Applications II*, Denver, CO, October 2004
30. T. Honda, A.C. Liu, J. Valera, J. Colvin, R. R. McLeod, K. Sawyer, "Diffraction-compensated free-space wavelength add/drop module with thin-film filters," in *Optical Fiber Communications Conference*, A. Sawchuk, ed., Vol. 70 of OSA Trends in Optics and Photonics, 323- 324 (Optical Society of America, 2002), paper WS5
31. X. Li, F. Dimov, W. Phillips, L. Hesselink, and R. McLeod, "Parallel Associative Search by Use of a Volume Holographic Memory", *Proceedings of 29th Applied Imagery Pattern Recognition Workshop*, pp.78-83, Washington, DC, October 2000.
32. J. Gamo-Aranda, R. R. McLeod, P. R. Horche, K. H. Wagner, "Rapid reconfiguration in an acousto-optic crossbar interconnection network," *Proc. SPIE Vol. 3805*, *Photonic Devices and Algorithms for Computing*, p. 11-18, October 1999.
33. J. Gamo, P. R. Horche, R. McLeod, K. Wagner, "Dynamic switching of an acousto-optic photonic crossbar," *Proceedings of Advances in Acousto-Optics AAO'99*, 27-28, Florence, Italy, June 1999.
34. S. Blair and K. Wagner and R. McLeod, "(2+1)-D spatio-temporal solitary-wave dragging," *OSA topical meeting on Nonlinear Optics: Materials, Fundamentals, and Applications*, 482-484, Maui HI, July 1996.
35. R. McLeod, K. Wagner, and S. Blair, "Robust light bullet dragging logic," *1995 OSA topical meeting on Optical Computing*, Salt Lake City UT, March 1995.

36. R. McLeod, K. Wagner, and S. Blair, "Collisions of stable spatio-temporal solitons," *1995 OSA topical meeting on nonlinear optical guided waves*, Dana Point, CA, February 1995.
37. S. Blair, K. Wagner, and R. McLeod, Orthogonally polarized soliton interactions for all optical logic, *1995 OSA topical meeting on nonlinear optical guided waves*, Dana Point, CA, February 1995.
38. Robert McLeod, Steve Blair, and Kelvin Wagner, "Asymmetric light bullet dragging logic," *Optical Computing 1994*, Edinburgh Scotland, August 1994.
39. K. -Y. Wu, R. McLeod, S. Kwiatkowski, R. T. Weverka, K. Wagner, and A. Mickelson, "Integrated AO space-division optical crossbar," in Conference on Optical Fiber Communication, Vol. 4 of 1994 OSA Technical Digest Series (Optical Society of America, 1994), paper WL9.
40. K. Wagner and B. McLeod, "Spatial Soliton Dragging Gates and Light Bullets," *OSA Topical Mtg. on Optical Computing*, Palm Springs CA, March 1993.
41. B. McLeod, R.T. Weverka, K.Y. Wu, K. Wagner, A. Mickelson, R. Roth, "Acoustooptic Crossbar Photonic Switch," *OSA Topical Mtg. on Photonics in Switching*, Palm Springs CA, March 1993.
42. R. R. McLeod, R. J. Hawkins, "Using the Finite Difference Time Domain Method as a Design Tool," *Integrated Photonics Research, OSA Technical Digest Series Vol. 10*, 38-39, paper MB17, New Orleans, LA, April 1992.
43. R. J. Hawkins, R. R. McLeod, J.S. Kallman, R.P. Ratowsky, M.D. Feit, J. A. Fleck, Jr., "New Directions in Photonics Simulations: Lanczos Recursion and Finite-Difference Time-Domain," *Seventh IMACS International Conference on Computer Methods for Partial Differential Equations*, New Brunswick, New Jersey, June 1992.
44. R. J. Hawkins and R. McLeod, "Finite-difference time-domain simulations of linear integrated photonic devices," *IEEE Antennas Propagation Society International Symposium Digest*, vol. 1, 261., New York, July 1992,
45. R. McLeod, R.J. Hawkins, J.S. Kallman, "Simulation of planar integrated photonics devices with the LLNL time-domain finite-difference code suite," *Integrated Photonic Research/Gradient Index Optic System (IPR/GIOS) Workshop*, Monterey, CA, April 1991.
46. Barth, Marvin; Pennock, Steve; Ziolkowski, Richard; McLeod, R., "Modeling pulse driven antenna systems with finite differences," *6th Annual Review of Progress in Applied Computational Electromagnetics*, Monterey, CA, March 1990.
47. B. K. Cabral, G. W. Laguna, R. R. McLeod, S. L. Ray, S. T. Pennock, R. L. Berger, and M. F. Bland. Interactive pre and post-processing tools for finite-difference time-domain codes," *IEEE Antennas and Propagation Society International Symposium*, 1098-1099, San Jose, CA, June 1989.
48. J.F. DeFord, G.D. Craig, R. McLeod, "The AMOS (Azimuthal Mode Simulator) Code," *Proceedings of the 1989 IEEE Particle Accelerator Conference*, 1181-1183, Chicago, IL, March 1989.
49. S. T. Pennock, R. R. McLeod, and H. G. Hudson, "Finite-difference time-domain modeling of electromagnetic radiation from an electron beam," *5th Annual*

- Review of Progress in Applied Computational Electromagnetics*, volume 1, 360-372, Monterey, CA, March 1989.
50. R. R. McLeod, S. T. Pennock, and M. J. Barth, "Time domain analysis of waveguide fed antennas," in *Proceedings of the 1989 URSI Radio Science Meeting.*, p. 269, June 1989.
  51. McLeod, R. R.; Berger, R. L.; Bacon, L. D. "Time domain modeling of electromagnetic coupling," *4th National Conference on High Power Microwave (HPM) Technology for Defense Applications*, Monterey, CA, May 1988.
  52. McLeod, R. R.; Hudson, H. G.; King, R. J., "Magnitude and phase calibration of microwave sensors," *National Radio Science Meeting*, Boulder, CO, January 1986.
  53. B.R. McLeod, R.R. McLeod, "Experimental Measurements on a large-scale Helmholtz Coil – Broken Bone Model," *5<sup>th</sup> Annual BRAGS*, Boston, Massachusetts, October 1985

#### **Peer-Reviewed Conference Proceedings (in press)**

#### **Peer-Reviewed Conference Proceedings (in review)**

#### **Seminars and Tutorials**

1. Robert R. McLeod, Susanna Orlic, "Microholographic recording", *Optical Data Storage Topical Meeting 2009*, Lake Buena Vista, FL, May 2009
2. R. R. McLeod, "Two color lithography beyond the diffraction limit," CU IEEE Student Chapter, Boulder CO, May 2009
3. R. R. McLeod, C. Anderson, E. Moore, M. W. Grabowski, A. C. Sullivan, "Hybrid Integrated Photonics," on-site seminar, Lockheed Martin, Louisville, CO, May 2006.
4. R. R. McLeod, E. Moore, A. C. Sullivan, M. Grabowski, C. Anderson, "Hybrid Integrated Photonics in 3D Photopolymers: Integrating nanophotonics into complex systems," NIST Nanoscience and Applications Conference, Boulder, CO October 2005.
5. R. R. McLeod, "Hybrid Integrated Photonics in 3D Photopolymer," on-site seminar, Lawrence Livermore National Laboratory, Livermore, CA August 2005.
6. R. R. McLeod, "Hybrid Integrated Photonics in 3D Photopolymer," on-site seminar, Intel Corporation, San Jose, CA August 2005.
7. R. R. McLeod, "Hybrid Integrated Photonics," on-site seminar, JDS Uniphase, San Jose, CA, June 2004.
8. R. R. McLeod, "Hybrid Integrated Photonics Development at CU," on-site seminar, Coherent Technologies, Louisville, CO, October 2003.
9. "CDMA Search of holographic digital data storage," on-site seminar, StorageTek, Louisville, CO, October 2003.
10. R. R. McLeod, "Optical Data Storage and Communications Devices in 3D Photopolymers," Optical Sciences and Engineering Program Seminar, Boulder, CO, September 2003.
11. R. R. McLeod, "Next Generation Telecom Components", Stanford Center for Novel Opto-Electronic Materials Annual Meeting, Stanford, CA, September 2000.

**Unclassified Government Reports**

1. R. J. Hawkins, R.R. McLeod, J.S. Kallman, R.P. Ratowsky, M.D. Feit, J.A. Fleck Jr. "New directions in photonics simulation: Lanczos recursion and finite-difference time-domain," 1992.
2. R. R. McLeod, "Temporal scattering and reflection software users manual, version 2.3" Report UCRL-MA--104861-Ver.2-3, Lawrence Livermore National Laboratories, Livermore, CA, 1992.
3. J.F. Deford, G. D. Craig, R.R. McLeod, "The AMOS (Azimuthal MOde Simulator) wakefield code," Report UCRL-102731;CONF-900163—4, 1990.
4. R. R. McLeod, "Temporal scattering and reflection software, Users Manual," Report UCID-21637, Lawrence Livermore National Laboratories, Livermore, CA, 1989.
5. B.K. Cabral, G.W. Laguna, R.R. McLeod, S.L. Ray, S. T. Pennock, R.L. Berger, M.F. Bland, "Interactive pre- and post-processing tools for finite-difference time-domain codes," Report UCRL-100237; CONF-890660—11, 1989.
6. R.R. McLeod, R.L. Berger, L.D. Bacon, "Time domain modeling of electromagnetic coupling," Report UCRL-97831;CONF-8805132-14, 1989.
7. R.J. King, H.G. Hudson, R.R. McLeod, "EM laboratories for linear coupling," Report UCID-20954, 8 pages, Lawrence Livermore National Lab, Livermore, CA, 1987.
8. R.R. McLeod, H.G. Hudson, H.S. Cabayan, R.J. King, "Experiments in high power microwave susceptibility simulation issues," Report UCID-20851, 16 pages, Lawrence Livermore National Lab, Livermore, CA, 1986.
9. R.R. McLeod, H.G. Hudson, R.J. King, "Magnitude and phase calibration of microwave sensors," Report UCRL-95475;CONF-860198-1, 1986.

**Research Grants and Contracts (University of Colorado only)****Research Equipment and Facilities Grants Awarded, all as PI except #1**

1. CU Provost and College of Engineering, "Augmentation of Shared Nano-Scale Characterization Facility for Advanced Materials and Biological Systems", Total: \$80,000, Award Date: November, 2006, *Co-PI with Rafael Piestun*
2. CU Provost and College of Engineering, "Recirculated Chilled Water for Lasers in ECE and Optics Research and Teaching," \$260,000, Award Date: November 2006
3. Engineering Excellence Fund, "Undergraduate Optics Lab Computer and Remote Instrumentation," Total \$25,750, February 2006
4. CU College of Engineering: "Photopolymer Testing and Packaging," Total: \$15,000, Award date: March 2005.
5. ILX Lightwave University Donation Program: "Optical Circuits Lab Instrumentation," Total \$10,000, Award date: August 2005.
6. InPhase Technologies: "Optical data storage equipment donation", Total: \$53,000, Award date: January 2005
7. JDS Uniphase: "Integrated Optics Research Facility," Total: \$871,612, Award date: August 2003.

**Total Equipment and Facilities Grants (McLeod portion only):** **\$1,275,362**

**Research Grants and Contracts Awarded, *all as PI***

1. Air Force Office of Scientific Research MURI, "Polymeric Optical Sensor Meshes and Composite Meta-Materials," \$750,000, Duration: June 2009 – May 2014
2. National Science Foundation, "3D Lithography of Thick Photopolymers for Imaging and Photonic Crystal Waveguides," Phase II Total: \$250,000, matched with \$20,000 gift from prime contractor. Duration: July 2008 – Aug 2010
3. National Science Foundation, "3D Lithography of Thick Photopolymers for Imaging and Photonic Crystal Waveguides," Phase IB Total: \$25,000, matched with \$50,000 gift from prime contractor. Duration: January 2008 – June 2008
4. National Science Foundation, "Hybrid integrated optoelectronic systems," Phase II Total: \$250,000, matched with \$38,217 of CU funds. Duration: January 2008 – Dec 2009.
5. CU Innovative Seed Grant Program, "Diffraction Unlimited Photolithography," \$49,926, Duration: July 2007 – July 2008.
6. CU Tech Transfer Office, "Tape casting of high performance polymer optical imaging arrays," \$24,964, Duration: June 2007 – November 2007.
7. National Science Foundation, "Hybrid integrated optoelectronic systems," Phase IB Total: \$25,000, Duration: January 2007 – June 2007.
8. National Science Foundation, "3D Lithography of Thick Photopolymers for Imaging and Photonic Crystal Waveguides," Phase I Total: \$89,921. Duration: January 2007 – December 2007
9. National Science Foundation, "Hybrid RF/Optical ICs for High-Bandwidth Spread-Spectrum Communications," Total: \$499,996, Co-PIs Z. Popovic and D. Anderson, McLeod portion: \$432,808, Duration: January 2007 – December 2010.
10. Intel Corporation, "Plastic PHY Interconnect Technology," Total: \$231,000, Duration: August 2006 – July 2009
11. dBm Optics, "Design of system and development of algorithms for interferometric measurement of chromatic dispersion and polarization mode dispersion," Total: \$25,000, May 2006 – December 2007
12. National Science Foundation, "Hybrid integrated optoelectronic systems," Phase I Total: \$50,000, Duration: January 2006 – December 2006.
13. Science Applications International Corporation, "Parallel Polymer Waveguide Array Development," Total: \$50,000, Duration: July 2005 – December 2006.
14. Engineering Excellence Fund, "Optical Circuits Lab Instrumentation," Total: \$15,000, Duration: July 2005 – July 2007
15. CU Council on Research and Creative Work, "Imaging via Flexible Polymer Fiber Arrays," Total: \$7,000, Duration: May 2005 – May 2006
16. US Army Medical Research and Materiel Command, "Innovative portable human computer interface system for performance monitoring prediction and eye movement robotic control," Phase I Total: \$39,899, Duration: January 2005 – October 2005

17. CU Council on Research and Creative Work, "Hybrid Integrated Photonics," Total: \$5,000, Duration: July 2004 – July 2005
18. Colorado Center for Information Storage, "Parallel Track and Layer Read/Write Head for Optical Disks," Total: \$64,963, Duration: July 2004 – July 2005
19. StorageTek, Inc, "CDMA Search of Holographic Databases," Total: \$40,867, Duration: January 2004 – January 2005
20. Philip Anthony Charitable Trust, "Hybrid Integrated Photonics," Total: \$50,000, Duration: January 2004 – January 2005

**Total Grants and Contracts Awarded (R. McLeod share only):** **\$2,584,565**

**Total Equipment, Facilities, Grants and Contracts:** **\$3,859,927**

### **Graduate student advising**

#### **Graduated students**

1. Amy C. Sullivan, Doctor of Philosophy in Physics, Dissertation Title: *Tomographic Characterization of Volume Photopolymers for Integrated Optics*, University of Colorado, May 2008. Now employed as Assistant Professor of Physics, Agnes Scott College, Decatur Georgia.
2. Mark R. Ayres, Doctor of Philosophy in Electrical and Computer Engineering, Dissertation Title: *Signal Modulation for Holographic Memories*, University of Colorado, Dec 2007. Now employed at InPhase Technologies, Longmont Colorado.
3. Charles D. Anderson, Master of Science in Electrical and Computer Engineering, Thesis Title: *Photopolymer waveguide to fiber coupling via 3D direct-write lithography*, University of Colorado, August 2006. Now employed at InPhase Technologies, Longmont Colorado.
4. Sarah K. Walter, Master of Science in Electrical and Computer Engineering, Thesis Title: *Parallel read/write system for optical data storage*, University of Colorado, May 2005. Now employed at CDM Optics, Boulder Colorado.

#### **Postdoctoral students**

1. Timothy Scott (co-advised with Dr. Christopher Bowman). 6/07 – 7/08, Topic: *Diffraction unlimited photolithography*. Now an Assistant Research Professor of Mechanical Engineering, University of Colorado.
2. Martha Elizabeth Baylor, 8/1/08 –

#### **Current graduate students**

1. Matthew W. Grabowski, Doctor of Philosophy in Physics, Research area: *3D and time dependent modeling of photopolymer development*. Expected graduation date Fall 2008.
2. Eric D. Moore, Doctor of Philosophy in Electrical and Computer Engineering, Research area: *3D lithography of photopolymer, discrete diffraction in 2D waveguide arrays*.

3. Keith Kamysiak, Doctor of Philosophy in Electrical and Computer Engineering, Research area: *Polymer optical backplanes*.
4. Chunfang Ye, Doctor of Philosophy in Electrical and Computer Engineering, Research area: *Hybrid RF Optical Signal Processing*
5. Benjamin Kowalski, Doctor of Philosophy in Electrical and Computer Engineering, Research area: *Photolithography beyond the diffraction limit*
6. Adam Urness, Ph. D. Electrical Engineering, Topic: *3D optical lithography of liquid polymer systems*.
7. Anna Linnenberger, Ph.D. Electrical Engineering
8. John Willets, Ph.D. Electrical Engineering, co-advised with Steve Cundiff (Physics).
9. Matt Hayman, Ph.D. Electrical Engineering, co-advised with Jeff Thayer (Aerospace).
10. Matthew Titus, Ph.D. Electrical Engineering

**Ph.D. student research rotations hosted (outcome)**

1. Libby Heeb, Ph.D. Chemistry, Topic: *Thiol-ene polymers for volume phase lithography*, Fall 2004
2. Eric Moore, Ph.D. ECE, Topic: *3D parallel waveguide arrays in photopolymer*, Fall 2004. **(Two conference presentations including one Best Poster award, one patent)**
3. David Goldstein, Ph.D. Chemistry, Topic: *Measurement of Polymerization Kinetics of thiol-ene photopolymers* Spring 2005
4. Laura Haynes, Ph.D. Chemistry, Topic: *2D and 3D waveguide arrays in photopolymer*, Fall 2005
5. Kimberly Kester, Ph.D. Chemistry, Topic: *Termination kinetics for optimization of thiol-ene polymerization*, Fall 2005
6. Matthew Kirchner, Ph.D. Physics, Topic: *Parallel-write waveguide to fiber coupling in volume photopolymers*, Fall 2006 **(Three conference presentations including one Best Paper award)**.
7. Kristen Vogelhuber, Ph.D. Chemistry, Topic: *Holographic metrology of epoxy-based volume photopolymers*, Spring 2007
8. Greg Berman, Ph.D. ECE, Topic: *Diffraction Unlimited Lithography*, Spring 2007
9. Michael Gleeson, Ph.D. EE University College Dublin, Topic: *Photopolymer waveguide integration with thin film filters*, Fall 2007. **(One conference presentation & JOSA journal submission)**
10. April Kloxin, Ph.D. Chemical and Biological Engineering, Topic: *3D patterning of hydrogel tissue scaffolds*, Fall 2007. **(Science publication: DOI: 10.1126/science.1169494)**
11. Seyitirza Tigrek, Ph. D. Mechanical Engineering, Topic: *Tape casting of photopolymer waveguide arrays*, Summer 2007
12. Adam Urness, Ph. D. ECE, Topic: *Microstereolithography of photopolymer index structures*, Fall 2007 – Summer 2008.
13. Matthew Titus, Ph.D. ECE Topic: *Tape casting of photopolymer waveguide arrays*, Fall 2007

14. Ginni Sharma, Ph.D. ECE, Topic: *Antiresonant optical waveguides in 3D photopolymer*, Spring/Summer 2008.
15. Eric Dudley, Ph.D. ECE, Topic: *Solid Immersion Optics for lithography*, Fall 2008.
16. Betsy Hall, Ph.D. ECE, Topic: *Optical Diffraction Tomography and Photopolymer Materials Optimization*, Fall 2008.
17. Qing Chao, Ph.D. ECE, Topic: *3D Polymer Hybrid Circuits*, Fall 2008.
18. Sebastian Köber, Ph.D in Physical Chemistry, University of Cologne, Topic: *Photorefractive Polymers*, Fall 2008-Spring 2009.
19. Kevin Zekis, Ph.D ECE, Topic: *Photo-initiation/photo-termination for 3D index polymer distributions in a host matrix*. Fall 2009.
20. Farhad Majdeteimouri, M.S. ECE, Topic: *Polymer waveguide Bragg grating sensor arrays*. Summer 2009

**Undergraduate research associates 2003-present:** Mrnal Shukla (DLA), Devin Mayer, Wei-Chu Liao (DLA), Wei-Shen Liao (DLA), Ben Mauser, Matanya Horowitz, John Chen, Dominic Boiko, David Jorgensen (DLA), Filip Maksimovic

**Pre-college research associates:** John Chen (SURE program)

## Teaching

### Courses taught

1. ECEN 2250, *Circuits I*  
Fall 08
2. ECEN 4616/5616, *Optoelectronic System Design*  
Fall 03, Spring 05, Fall 06, Fall 07  
271 page text online at <http://ece.colorado.edu/~mcleod/teaching/oesd.html>
3. **Developed:** ECEN 4606, *Undergraduate Optics Lab*  
Spring 07, Fall 09  
96 page text online at <http://ece.colorado.edu/~mcleod/teaching/ugol.html>
4. ECEN 5606, *Optical Lab*  
Spring 2004  
106 page text online at <http://ece.colorado.edu/~mcleod/teaching/aol.html>
5. **Developed:** ECEN 6006, *Numerical Methods in Photonics*  
Fall 2004, Spring 07, Spring 09  
307 page text online at <http://ece.colorado.edu/~mcleod/teaching/nmip.html>
6. ECEN 3400, *Electromagnetic Fields and Waves*  
Fall 2005
7. ECEN 4606/5166, *Guided Wave Optics*  
Spring 2006  
184 page text online at <http://ece.colorado.edu/~mcleod/teaching/gwo.html>

**Faculty Course Questionnaire Results (all out of 6.0)**

Term	ECEN	Title	Students	Course	Instructor	
2003	Fall	5616	OE System Design	14	5.4	5.9
2004	Spring	5606	Optics Lab	28	5.1	4.9
	Fall	6006	Numerical Methods	11	5.7	5.9
2005	Spring	5616	OE System Design	8	5.6	5.8
	Fall	3400	EM fields & waves	56	5.5	5.9
2006	Spring	4006	Guided wave optics	2	6	6
		5166		4	5.4	6
	Fall	5616	OE System Design	27	5.3	5.6
2007	Spring	4606	UG Optics Lab	22	5.4	5.8
		6006	Numerical Methods	8	5.1	5.6
	Fall	5616	OE System Design	17	5.7	5.7
2008	Spring	Faculty Fellowship				
	Fall	2250	Circuits/Electronics 1	97	4.6	5.1
2009	Spring	6006	Numerical Methods	12	5.7	5.9
	Fall	4606	UG Optics Lab			
				<b>Undergrad weighted average</b>	<b>5.0</b>	<b>5.5</b>
				<b>Graduate weighted average</b>	<b>5.5</b>	<b>5.8</b>

**Notes:**

- Upper division undergrad course and instructor ratings are **0.9** and **1.1** standard deviations above the mean for tenure track professors in the College of Engineering
- Graduate course and instructor ratings are **0.8** and **0.9** standard deviations above the mean for tenure track professors in the College of Engineering
- ECEN 5606 in Spring 04 co-taught with three other professors and no individual scores were collected. This course is not included in the weighted averages.

**Professional Service****External**

1. **General Co-Chair** (with In-Ho Choi, LG Electronics), IEEE/OSA/SPIE Optical Data Storage Conference, 2010.
2. **Program Committee Co-Chair** (with In-Ho Choi, LG Electronics), IEEE/OSA/SPIE Optical Data Storage Conference, 2009.
3. **Technical Program Committee Member and Session Chair**, IEEE/OSA/SPIE Optical Data Storage Conference, 2005-2008.
4. **General Co-chair** (with Susanna Orlic, Technische Universitaet Berlin), SPIE Organic Holographic Materials and Applications Conference, 2007-2009
5. **Technical Program Committee Member and Session Chair**, SPIE Organic Holographic Materials and Applications Conference, 2004-present
6. **Panel Member**, NSF Proposal Review, ECCS, 2005, 2009

7. **Resource Volunteer** to science teachers in Colorado disadvantaged schools through the NSF/OSA/SPIE/MESA Hands On Optics program, 2005-2008
8. **Board of Directors Member**, Colorado Photonics Industry Association, 2004-present
9. **General Chair**, SPIE/CPIA Photonics Research in Colorado Annual Meeting, 2004-present
10. **Technical Program Committee Member**, IEEE LEOS Workshop on Fiber Optic Passive Components, 2002
11. **Reviewer** for: Applied Optics, Journal of Quantum Electronics, Optics Communications, Optics Letters, Optics Express, Journal of Applied Physics A, Journal of Communications

### Internal

1. **Chair**, Optics prelim exam, 2009.
2. **Member**, Search Committee for three junior optics faculty, 2008/2009
3. **Chair**, graduate recruiting for optics, 2008
4. **Member**, Search Committee for junior nano/optics faculty, 2007/2008
5. **Member**, Search Committee for college grants administrator, 2007
6. **Member**, Search Committee for two junior materials faculty, 2007/2008
7. **Director**, Colorado Center for Information Storage, 2006-2007
8. **Member**, Search Committee for senior optics faculty, 2006
9. **Chair**, Campus-wide Optics Initiative Strategy Committee, 2006
10. **Member**, College Nano Characterization Facility advisory board, 2006-2007
11. **Member**, ECE Executive Committee, 2005-2007
12. **Member**, NSF I/UCRC Photopolymerization Center, 2004-present
13. **Member**, Executive Committee for Hybrid Signal Electronics GAANN fellowship program, 2004-2008
14. **Co-chair** of Optics, Materials, Devices and Solid State prelim exam (2003, 2005)
15. **Member**, Optical Sciences and Engineering Program, 2003-2008
16. **Member or Chair** of 24 graduate student committees in Elec. E (18), Mech. E (1), Chem. E (1), and Physics (3), EE Dublin Ireland (1), 2003-present.