

Anthony E Smart

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Education:

Ph.D. (Applied Optics); D.I.C.	(1968)	Imperial College, London, England
B.Sc. (Physics); A.R.C.S.	(1965)	Imperial College, London, England
Industrial Apprenticeship	(1961-2)	Rolls-Royce, Derby, England

Employment:

1996 → **Consultant**

Space-qualified electro-optical instrumentation for study of condensed matter physics. 'On console' scientific support of Space Shuttle, Columbia, STS93 (April '97) and STS94/83R (July '97), MSL-1 microgravity missions. Design of optical probes suppressing effects of multiple scattering with innovative signal processing algorithms. Systems and optical design, and performance modeling.

1984-1996 **Technical Director, Titan Spectron, Orange County, California, USA**

Technical, general and corporate management; program management; systems configuration analysis and design; customer interfacing; supervision of definition, design, building and delivery of systems which include software and optical, mechanical, electronic and computer hardware, to opto-avionic flight and/or space-qualified standards.

1980-1984 **Director of Instrument Development, Spectron, Costa Mesa, California, USA**

Design and development of laser-based measuring instruments and systems for particle sizing, laser velocimetry, NDE, NDT, holography, including custom electronics, microprocessor control and hardening for hostile environments.

1977-1980 **Senior Scientist, Spectron, Costa Mesa, California, USA**

Wide ranging contract research and development for government and industry; instrument development, documentation and delivery.

1974-1977 **Group Leader (Advanced Research), Rolls-Royce, Derby, UK**

Pioneering of laser transit anemometry for aero-engine research and development; planning and conduction of experimental test programs; creation of hi-tech educational material in laser instrumentation, optics, and information theory and processing.

1968-1974 **Research Scientist (Advanced Research), Rolls-Royce, Derby, UK**

Research and development in advanced instrumentation and fundamental physical processes relevant to aircraft engines; general trouble shooting and diagnostics.

Other:

Publications: 77 Books, Journal Papers, Conference Proceedings; 13 Handbooks; 100 + Proposals and Reports; Joint Editor, 'Photon Correlation in Fluid Mechanics', Stanford University, (1980); 'Photon Correlation Techniques and Applications', OSA, Vol. 1. (1988); Applied Optics 'Photon Correlation and Scattering' Feature Issues 20 October 1997, 20 August 2001

Patents: 1. Surface Texture Measurement (1974); 2. Laser Transit Anemometer (1976); 3. Movement of Airborne Vehicle (1989); 4. Optical Air Data Sensor Improvements (1991); 5. Remote Pressure and Temperature Sensor (1991); 6. Laser-Diode Cooler (1992); 7. Airborne LIDAR (1995); 8. Suppression of Multiple Scattering (1999); 9. Surface Contouring (2001); 10. Dynamic Light Scattering Homodyne Probe (2002)

Memberships: Fellow, Institute of Physics and European Physical Society; Chartered Physicist; Associate Fellow, AIAA; Member, OSA

Awards: I-R 100: '5 ns Digital Correlator' (1982); TITAN: 'Technical Performer of the Year' (1986)

Chairman: PCS 4, Stanford (1980); PCS 7, Washington DC (1988); PCS Capri, Italy (1996)
PCS Topical Meeting, Whistler, Canada (2000), PCS2004 Amsterdam (2004)

Other: Distinguished Lecturer, Ohio Aerospace Institute (June, 1996);

Science Team Member, NASA STS83 and STS94 Microgravity Missions (MSL-1) (1997)

Citizenship: British Citizen; United States Permanent Resident

Special Interests:

Design: System concepts, optical, mechanical and electronic implementations.

Systems: Architecture, lasers, signal processing, microcomputer hardware and software.

Organization: Satisfied customers, successful programs, financial performance.

Journal Publications:

1. "An Investigation of Glare from White and Yellow Sources", *Lighting Research and Technology*. Vol. 1, No. 2, pp 106-109 (1969)
2. "An Investigation of Chromatic Glare with Particular Reference to Night Driving", *Lighting Research Technology*. Vol. 2, No. 1, pp 33-37 (1970)
3. "A Geometric Demonstration of Optical Phase Modulation", with R. J. Hill and C. J. Moore. *J. Phys. D: Applied Physics*. Vol. 6, pp 1421-14266 (1973)
4. "Measurement of Thin Liquid Films by a Fluorescence Technique", with R. A. J. Ford. *Wear*, No. 29, pp 41-47 (1974)
5. "Retrieval of Flow Statistics Derived from Laser Anemometry by Photon Correlation", with C. J. Moore. *J. Phys. E: Sci. Inst.* Vol. 9, pp 977-981 (Nov. 1976)
6. "Aero-Engine Applications of Laser Anemometry", with C. J. Moore. *AIAA Journal*. Vol. 14, No. 3, pp 363-70 (Mar. 1976)
7. "Applications of Laser Anemometry to High Reynolds Number Flows", with W. T. Mayo, Jr. *Physica Scripta (Stockholm)* Vol. 19, pp 426-440 (1979)
8. "A Compact Wide Aperture Image Rotator Without Aberrations", *J. Phys E: Scientific Instruments*. Vol. 13, pp 1166-9 (Jun. 1980)
9. "Optical Advances in Laser Transit Anemometry", with D. C. Wisler and W. T. Mayo, Jr. *Journal of Engineering for Power, Transactions of ASME* (May, 1980)
10. "Photon Correlation - the Undiscovered Wonder", with W. T. Mayo, Jr. *Laser Focus*, pp 68-71 (Aug. 1982)
11. "5 ns Correlator: A New Tool for Timing, Processing and Analysis", *International Research and Development* (Apr. 1982)
12. "Folk Wisdom in Optical Design", *Optics News*, Vol 13, No. 11, (Nov 1987) [Also Cover Picture]
13. "Velocity Sensor for an Airborne Optical Air Data System", *AIAA: Journal of Aircraft*. Vol. 28, No. 3. pp 163-164 (Mar. 1991)
14. "Optical velocity sensor for air data applications", *Optical Engineering*, Vol. 31 No. 1, pp 166-173 (Jan. 1992)
15. "Folk Wisdom in Optical Design" (second version), *Optics and Photonics News*, Vol 5, No. 11, (Nov 1994)
16. "Photon correlation and scattering: introduction to the feature issue", with W. V. Meyer, R. W. G. Brown and M. A. Anisimov, *Applied Optics*, Vol 36, No 30, pp 7480-92 (20 Oct. 1997)
17. "Practical Considerations in Photon Correlation Experiments", with R. W. G. Brown, *Applied Optics*, Vol 36, No 30, pp 7477-79 (20 Oct. 1997)
18. "Physics of Hard Spheres Experiment - A General Purpose Light Scattering Instrument", with C. T. Lant, D. S. Cannell, W. V. Meyer and M. P. Doherty, *Applied Optics*, Vol 36, No 30, pp 7501-7 & cover (20 Oct. 1997)
19. "Multiple scattering suppression by cross-correlation", with D. S. Cannell, W. V. Meyer, T. W. Taylor & P. Tin, *Applied Optics*, Vol 36, No 30, pp 7551-8 (20 Oct. 1997)
20. "Particle Sizing in Strongly Turbid Suspensions Using the One-Beam Cross-Correlation Light Scattering Technique", with A. J. Adjoran, J. A. Lock, T. W. Taylor, P. Tin & W. V. Meyer, *Applied Optics*, Vol 38, pp 3409-16 (20 May, 1999)
21. "Multiple Scattering Suppression in Laser Light Scattering, Sizes of particles in solutions can be determined over a wide range of concentrations", with W. V. Meyer, P. Tin, D. S. Cannell, J. A. Lock, and T. W. Taylor, *NASA Tech Briefs*, 23(11), pp 14a, 16a. (1999)
22. "Photon correlation and scattering: introduction to the feature issue", with W. V. Meyer, and R. W. G. Brown, *Applied Optics*, Vol 40, No 24, pp 3965-8 (20 Aug. 2001)
23. "Quantitative simulation of errors in correlation analysis", with R. V. Edwards and W. V. Meyer, *Applied Optics*, Vol 40, No 24, pp 4064-78 (20 Aug. 2001)

Books, Papers, Proceedings, and Lectures:

1. "An Investigation and Analysis of Visual Sensitivity Under Conditions of Glare", **Ph.D. Thesis**, University of London (1968)
2. "A Laser Anemometer and Turbulence Analyser for use in High Speed High Turbulence Combustion Systems", Microwave and Laser Instrumentation Conference, September 1970, Sheffield University.
3. "Laser Anemometry", Design Electronics Monographs. I.P.C. Business Press (1971)
4. "**Aero-Engine Applications of Laser Anemometry**", Seminar Text and Notes. RR Library (Jan. 1974)
5. "**Information Theory Seminar**", with several co-authors. RR Library (Sep. 1975)
6. "Measurements of Unsteady Parameters in a Rig Designed to Study Reheat Combustion Instabilities", with B. Jones and N. T. Jewel. AIAA Paper #76-141, AIAA 14th Aerospace Sciences Meeting, Washington, DC (Jan. 26-28, 1976)
7. "Transit Anemometer Trials at the Cambridge Whittle Laboratory", First International Meeting on Photon Correlation Techniques in Fluid Mechanics, Churchill College, Cambridge, England (Apr. 6-7, 1977)
8. "Special Problems of Laser Anemometry in Difficult Applications", **AGARD LS-90** (August 1977)
9. "Applications of Digital Correlation to the Measurement of Velocity by Light Scattering", CLEOS, San Diego (Feb. 9, 1978)
10. "Data Retrieval in Laser Anemometry by Digital Correlation", in Laser Velocimetry and Particle Sizing. Thompson & Stevenson (eds.) Hemisphere Publishing Corp. (1979)
11. "Limitations of LTA Technology at Mach 8: Theory and Practice", with W. T. Mayo, Jr., Presented at ISL, France (Sep. 1980)
12. "Feasibility study of transit photon correlation anemometer for Ames Research Center unitary wind tunnel plan", with W. T. Mayo Jr., **NASA-CR-152238** (Feb. 1979)
13. "Comparison of data from the transit time velocimeter with other systems now in use for velocity measurements (near a wall in the boundary layer)", with W. T. Mayo Jr. **AEDC-TR-79-32** (May 1979)
14. "Feasibility of utilizing laser Doppler velocimeter techniques in very clean wind tunnels (for velocity measurement)", with J. D. Trolinger and V. A. Cline, **AFFDL-TR-79-3084** (Aug. 1979)
15. "Laser Anemometry Close to Walls", Proceedings of the Dynamic Flow Conference 1978 on Dynamic Measurements in Unsteady Flows. Published by DFC, PO Box 121, DK-2740, Skovlunde, Denmark (1979)
16. "Laser Transit Anemometer with Microcomputer and Special Digital Electronics: Measurements in Supersonic Flows", with W. T. Mayo, Jr. and T. E. Hunt. **ICIASF RECORD**, pp 146-53 (Sep. 24-6, 1979)
17. "Photon Correlation Techniques in Fluid Mechanics" 4th International Conference. Proceedings published by Stanford University. Mayo and Smart (eds.) (August 24-27, 1980)
18. "Tutorial: Digital Correlation Data Processing", with W. T. Mayo, Jr. *ibid.*
19. "Tutorial: Laser Transit Anemometry", with W. T. Mayo, Jr. *ibid.*
20. "Photon Processing Requirements and Technology for Laser Transit Anemometry", with W. T. Mayo, Jr. Paper #10, *ibid.*
21. "CORRELEX: A Multiplexed Correlation Processor", with W. T. Mayo, Jr., R. P. Woodward, and A. Boland. Paper #17, *ibid.*
22. "Experimental and Analytical Development of the Application of a Transit Laser Velocimeter", with W. T. Mayo, Jr. **AEDC-TR-80-28** (Nov. 1980)
23. "Flow velocity and angularity measurements in the FDL trisonic gasdynamic facility and self adaptive wall wind tunnels with a laser transit anemometer", with W. T. Mayo Jr., R. J. Hermes and J. D. Trolinger **AFWL-TR-81-3081** (Aug. 1981)
24. "Laser Transit Anemometer Measurements with Unseeded Backscatter", with W. T. Mayo, Jr. and R. J. Hermes. **ICIASF RECORD**, pp 46-52 (Sep. 1981)
25. "Photon Correlation: A Fast New Digital Processor for Optical Measurements", with W. T. Mayo, Jr. CLEO '82, Phoenix, AZ (Apr. 1982)
26. "Techniques for the Measurement of Turbulence and High Speed Flow with a Laser Transit Anemometer: Vol I Technical, Vol. II Appendices" with W. T. Mayo, Jr. **AEDC-TR-84-13** (May 1984)
27. "Short Course on Holography and Laser Applications" Spectron Development Laboratories (1983)
28. "Research study of droplet sizing technology leading to the development of an advanced droplet sizing system", with C. F. Hess and V. E. Espinosa, **NASA-CR-174839** (Jan. 1985)
29. "Folk Wisdom in Optical Design", OSA Conference, Seattle, Washington (Oct. 1986)
30. "Laser Transit Anemometry Developments", **ICIASF RECORD**, pp 239-44 (June 22-5, 1987)
31. "Discrimination Techniques for a Highly Accurate Laser-Sheet Anemometer", with J. B. Abbiss. 7th International Conference. OSA Proceedings on Photon Correlation Techniques and Applications published. Abbiss and Smart (eds) Vol I. Optical Society of America (May 31 - Jun. 2, 1988)
32. "Trends in Optical Sensors for Hostile Environments", SPIE Conference, Dearborn, Michigan (Jun. 28-9, 1988)
33. "F-16 Flight Test Results from Spectron/Titan Optical Air Data Velocity Sensor", Aeronautical Flight Measurements and Techniques (AFMAT) Working Group, Ontario CA (May 21, 1990)
34. "Flight Test Experience with an Optical Air Data Sensor System", Aeronautical Flight Measurements and Techniques (AFMAT) Working Group, Seattle WA (June 18, 1990)
35. "Trends in Opto-Electronic Devices for Sensors and Instrumentation", Institute of Physics, Nottingham, England (Sep. 17-20, 1990)
36. "Optical Velocity Sensor for Air Data Applications", Paper 1480-04, Proceedings of SPIE's OE/Aerospace Sensing, Orlando, Florida (April 1991)

37. "Technology, Design and Flight Tests of an Optical Air Data Velocity Sensor" and "High Performance Information Processing for Optical Air Data Velocity Sensors", Spaceborne Photonics: Aerospace Applications of Lasers and Electro-Optics Conference, Newport Beach (July 22-24, 1991)
38. "A New Remote Optical Measurement Technique for Aerosol Sizing from an Airborne Platform", with J. B. Abbiss, CRDEC Conference of Obscuration and Aerosol Research Aberdeen, MD (June 22-3, 1992)
39. "Folk Wisdom and High Technology in Optical Sensor Systems", Invited Lecture, Optical Society of San Diego (September 17, 1992)
40. "Design and Flight Testing of an Airborne Coherent Doppler Anemometer", with J. B. Abbiss and P. D. Kenefick, Seventh Conference on Coherent Laser Radar, Paris, France (July 19-23 1993)
41. "Affordable Low Observable Air Data System", Integrated Product Team, WPAFB, (March 5, 1995)
42. "Light Scattering in Space, NASA Lewis Challenges in Extending the Frontiers of Condensed Matter Physics", Invited Lecture, Ohio Aerospace Institute (June 21, 1996)
43. "A Single Wavelength Cross-Correlation Technique Which Suppresses Multiple Scattering," with W. V. Meyer, J. A. Lock, D. S. Cannell, T. W. Taylor, P. Tin, J. X. Zhu, H. M. Cheung, and J. A. Mann, Jr., in Photon Correlation & Scattering. Capri, Italy: Optical Society of America (1996)
44. "Comparative Optical Measurements of Airspeed and Aerosols on a DC-8 Aircraft", with Rodney Bogue, Rick McGann, Thomas Wagener and John Abbiss, ICIASF WPAFB, Dayton OH, (July 18-21, 1995) and NASA Technical Memorandum 113083 (July 1997)
45. "Applying Photon Correlation Spectroscopy in Space", in 'Light Scattering and Photon Correlation Spectroscopy', E. R. Pike, ed. pp 373-386 (Kluwer Academic Publishers, Dordrecht, 1997)
46. "Suppression of Multiple Scattering using a Single Beam Cross-Correlation Method", with W. V. Meyer, D.S. Cannell, T. W. Taylor and P. Tin, in 'Light Scattering and Photon Correlation Spectroscopy', E. R. Pike, ed. pp 39-50 (Kluwer Academic Publishers, Dordrecht, 1997).
47. "Feature Issue on Photon Correlation and Scattering", Applied Optics: Lasers, Photonic and Environmental Optics, Special Feature Editor with W. V. Meyer, R. G. W. Brown, and M. A. Anisimov, Applied Optics, Vol 36, No 30 (20 Oct. 1997)
48. "Ultra High Resolution Telescopes: Imaging with Lens Arrays", Invited Lecture to Boeing (Nov. 12, 1997)
49. "Laser Light Scattering: Multiple Scattering Suppression with Cross Correlation, and Flare Rejection with Fiber Optic Homodyning", with W. V. Meyer, D. S. Cannell, R. G. W. Brown, J. A. Lock, and T. W. Taylor. Paper AIAA 99-0962, 37th AIAA Aerospace Science Meeting and Exhibit, Reno, NV (January 11-14, 1999)
50. "Laser Light Scattering - Multiple Scattering Suppression with Cross-Correlation and a Preview of Flare Rejection Techniques Possible with Fiber Optic Homodyning", with W. V. Meyer, D. S. Cannell, R. G. W. Brown, J. A. Lock, and T. W. Taylor. in Cleveland ACS May Meeting (1999)
51. "Quantitative simulation of errors in correlation analysis", with R. V. Edwards, and W. V. Meyer, Photon Correlation and Scattering 2000. Whistler, British Columbia, Canada, Optical Society of America (August 2000).
52. "Feature Issue on Photon Correlation and Scattering", Applied Optics: Lasers, Photonic and Environmental Optics, Special Feature Editor with W. V. Meyer, and R. G. W. Brown, **Applied Optics**, Vol 40, No 24 (20 Aug. 2001)
53. "Microdiagnostics Using Integrated Optics", with C. M. Fitzpatrick and M. Abid, SPIE Conference, San Diego (July 11, 2001)
54. "Optical Diagnostics in Hostile Environments, from Ocean to Space", Invited Lecture, Rank Prize Funds, Grasmere (August 12-14, 2002)
55. "Leveraging Company Capabilities", Invited Lecture, ITT Industries Tech, Fair (October 26-29, 2003)
56. "The Art of Practical Optoelectronics Systems", Chapter 5 in 'Handbook of Optoelectronics', Institute of Physics, (to be published, April, 2004)

Other Reports: *(Some with restricted availability.)*

1. "A High-Speed Photographic Study of Leader Spark Ignition", with R. J. Hill and D. T. Brassington. **RR(OH)248** (Jun. 1966)
2. "Determination of Molochite Particle Impact Velocities Relevant to the Manufacture of Investment Casting Moulds", **RR(OH)376** (Feb. 1969)
3. "Observations on the Initial Breakdown of High Energy Igniters", **RR(OH)389** (May 1969)
4. "Proposed Centrifuge", with A. E. Forest, **RR(OH)M210** (Jun. 1969)
5. "A Laser Wand for Distance or Vibration Measurement", **RR(OH)M224** (Oct. 1969)
6. "The Measurement of Velocity Spectra by Laser Doppler Techniques", **RR(OH)420** (Dec. 1969)
7. "Energy Distribution and Beam Widths in Laser Machining Beams Focused with Various Lenses", **RR(OH)M231** (Jan. 1970)
8. "Theoretical Feasibility of Measurement of Localized Smoke Density in Turbulent Flow", **RR(OH)M249** (Feb. 1970)
9. "Evaluation of Information Processing Methods for Laser Doppler Velocimetry", **RR(OH)450** (May 1970)
10. "Speckle Pattern Analysis Applied to the Detection of Incipient Fatigue", with I. C. G. Bruce. **RR(OH)462** (Jul. 1970)
11. "Measurement of Bending Behavior in Hyfil and Titanium Alloy Blades by Photogrammetry", **RR(OH)467** (Aug. 1970)
12. "Feasibility Study of Measurement of Localized Smoke Density in Turbulent Flow", **RR(OH)468** (Aug. 1970)
13. "Research in High Energy Ignition for Gas Turbines - A Review and Bibliography", with R. J. Hill, R. B. Price and H. Priestner. **RR(OH)473** (Sep. 1970)
14. "Feasibility of Measurement of Gas Flow Velocity in a Rotating Detonation Rig", **RR(OH)M279** (Oct. 1970)
15. "Considerations of Window Design for Harsh Environments", with N. T. Jewel. **RR(OH)496** (Jan. 1971)
16. "High Accuracy Torque Measurements in Engine Shafts", with B. S. Hockley and C. J. Moore. **RR(OH)498** (Jan. 1971)

17. "Laser Anemometry in Flames and Airflows", **RR(OH)512** (Apr. 1971)
18. "Improvement of Photographs by Spatial Filtering", with B. S. Hockley. **RR(OH)517** (Jul. 1971)
19. "Image Degradation by Intervening Turbulence" **RR(OH)M299** (Oct. 1971)
20. "Optical Frequency Analysis", **RR(OH)526** (Feb. 1972)
21. "Measurements of LINAC Radiographs", **RR(OH)529** (Mar. 1972)
22. "Laser Anemometry", **RR(OH)543** (Jul. 1972)
23. "Turbulence Measurements at the Blade Inlet Plane of 7A Blade Cooling Rig", with M. C. Terrell. **EIR00434** (Jul. 1972)
24. "Measurement of Turbulence in the RT14 Turbine Noise Rig by Laser Anemometry", **RR(OH)545** (Jul. 1972)
25. "Early Turbulence Measurements in the Isolated Aerofoil Test Facility", **RR(OH)552** (Sep. 1972)
26. "Measurement of Instantaneous Velocities in Hot Flows using Laser Anemometry", Rolls-Royce **4A11 2D**
27. "Measurement of Oil Film Thickness by Fluorescence", with R. A. J. Ford. **RR(OH)556** (Jan. 1973)
28. "Laser Anemometry Behind a Combustion Annulus at B.E.D." **RR(OH)560** (May 1973)
29. "Photon Correlation for Laser Anemometry", **RR(OH)561** (May 1973)
30. "Some Design Considerations for Laser Anemometry", **RR(OH)562** (June 1973)
31. "Laser Anemometry in a Radiation Rig at NGTE, Pyestock", **RR(OH)564** (Jun. 1973)
32. "Measurement of Turbulence in the Olympus 593 at Aston Down", **RR(OH)568** (Oct. 1973)
33. "Laser Anemometry Survey Across the Exhaust of the RB211-22 (Quiet Engine Demonstrator)", **RR(OH)576** (Feb. 1974)
34. "Turbulence Measurements in Viper Noise Rig", **RR(OH)579** (Apr. 1974)
35. "Laser Anemometry for Aero-Engine Applications", **ARC 35208**, COMB 137 (Apr. 1974)
36. "Information Retrieval from Engine Radiographs", RR Library (May 1974)
37. "Photon Correlation Technique for Laser Anemometry", **RR(OH)569** (Jun. 1974)
38. "Effect of Noise Field on Measurements by Laser Anemometry", **RR(OH)570** (Nov. 1973)
39. "Measurement of Viper Exhaust at Aston Down", **RR(OH)582** (Oct. 1974)
40. "Measurements of Turbulence in a Piston Tunnel at Oxford", **RR(OH)595** (Feb. 1975)
41. "Laser Anemometry Feasibility in a Water Filled Perspex Model", **RR(OH)596** (Mar. 1975)
42. "Determination of Velocity Probability Functions from Laser Anemometry of Photon Correlograms", with C. J. Moore. **RR(OH)601** (May 1975)
43. "Visual Alignment of the Axes of Small Holes", **RR(OH)604** (Jun. 1975)
44. "Measurement of Turbulence in the Isolated Aerofoil Test Rig RC50 by Laser Anemometry", **RR(OH)606** (Jul. 1975)
45. "Measurement of Flow Profiles in Circular Section Glass and Perspex Tubes at RR & A", **RR(OH)608** (Aug. 1975)
46. "Measurement of Velocity and Turbulence Profiles at the Exit of an Olympus 593 Fitted with a Triple Tail Pipe", **RR(OH)609** (Sep. 1975)
47. "Note on Surface Coatings to Reduce Scattered Light", **RR(OH)622** (Feb. 1976)
48. "Transit Anemometry", **RR(OH)632** (Sep. 1976)
49. "Applications of Laser Anemometry at Rolls-Royce (1971) Ltd.", Report to ARC Aerodynamics Committee (Mar. 1976)
50. "Preliminary Laser Anemometry Tests of Research Compressor SF4" **RR(OH)637** (Sep. 1976)
51. "An Elementary Analysis of the Measurement Geometry of the RR Transit Anemometer", **RR(OH)638** (Oct. 1976)
52. "Transit Anemometer Trails at the Cambridge Whittle Laboratory", **RR(OH)647** (Feb. 1977)
53. "Feasibility of Transit Anemometry on the ADOUR", **RR(OH)659** (Jul. 1977)
54. "Special Problems of Laser Anemometry in Difficult Applications", **RR(OH)660** (Jul. 1977)
55. "Some Observations of Dirt Accretion on RB211 Fan Blades", **RR(OH)662** (Aug. 1977)
56. "Experimental Comparison of Hot Wire and Different Information Retrieval Methods in Laser Anemometry for the Measurement of Mean Flow and Turbulence", **RR(OH)666** (Sep. 1977)
57. "Collected Notes and Ideas in Laser Anemometry", **RR(OH)668** (Oct. 1977)
58. "Development and Application of a Laser Spectroscopy System for FBC Gas Species Measurement - Task 1: System Concept Evaluation", Argonne National Laboratory, Contract #31-109-38-4107 SDL 78-6310 (Apr. 1978)
59. "Survey of Laser Measurement Techniques for MHD Emissions", MERDE, Butte, Montana. **SDL 78-6367** Contract #8-9057-F-072 (Sep. 1978)
60. "Development and Application of a Laser Spectroscopy System for FBC Gas Species Measurement - Task 2: Systems Analysis", Argonne National Laboratory, Contract #31-109-38-4107 (Oct. 1978)
61. "Automatic System to Measure the Diameters of Large Numbers of Glass Fibers", **SDL 80-6565** (Apr. 1980)
62. "Laser Transit Anemometer Software", **NASI-17783** (Oct. 1985)
63. "Key Technology and Packaging Approaches for a Production OADS Design", **SDL 86-2502-02/S** (Aug. 1986)

64. "F-16B 2 Flight Testing of the SPECTRON/TITAN Optical Air Data Sensor [OADS] System", **SDL 90-1903-01** (1990)
65. "Airborne Doppler Homodyne Optical Air Data Sensor: Theory, Design and Performance Prediction", with J. B. Abbiss **SDL 90-2877-01** (1990)
66. "Doppler Homodyne Optical Air Data Sensor Demonstrator: Preliminary Performance Prediction", **SDL 90-2883-13** (1990)
67. "Multiple Scattering Concerns in Dynamic Light Scattering. An elegant solution to an old problem", with W. V. Meyer, M. B. Meyer, P. Tin, R. B. Rogers, J. C. Walton, S. M. Grasson, J. A. Lock, NASA Lewis Research Center (1996)
68. "Numerical Modeling of a Multi-cylinder Positive-displacement Water Pump", Undisclosed Client (July, 1996)
69. "Design Optimization of the Optics for a Timing Light", Undisclosed Client (March, 1996)
70. Design for an Optical Machine Guard, Undisclosed Client (June, 1998)
71. Coherent Laser RADAR Risk Analysis, Undisclosed Client (May, 1999)
72. Interface and Software Design and Specification for Laser- based Environmental Monitoring, Undisclosed Client (September, 1999)

Handbooks:

1. "Laser Transit Anemometer Systems: Volume 1. Optical Head", **SDL #81-53006** (Mar. 1981)
2. "Laser Transit Anemometer Systems: Volume 2. Correlex Operators Manual", **SDL No. 82-53010D5** (Oct. 1982)
3. "Fluorescent Penetrant Inspection of Drum Rotors, Operating Manual **SDL No. 83-53013** (January 1983)
4. "Laser Transit Anemometer Systems: Volume 3. MSCLTA Software User's Manual, Version 1.1", (Feb. 1983)
5. "Droplet Sizing Interferometer System", Model 3004/C (May 1983)
6. "Advanced Droplet Sizing System. Model V-I/IMAX", **SDL #84-51036** (Nov. 1984)
7. "Split Field Microscope Manual" **SDL 84-53023/S** (1984)
8. "Spectron/Rolls-Royce Advanced Optical Anemometer: Description, Operating Manual and Handbook", **SDL #53024/S** (Jan. 1986)
9. "Velocity Information Retrieval System [VIRS] and Correlator for Optical Air Data Sensor [OADS] System", **SDL #86-51039** (Jun. 1986)
10. "Laser Transit Anemometer Systems: Volume 3. MSCLTA Software User's Manual, Version 2.0", (Sep. 1986)
11. "Optical Air Data System Source Document, Rev.D", **SDL DO 3123 049** (Dec. 1988)
12. "Optical Air Data System Handbook", **SDL DO3123 040** (1989)
13. "Optical Air Data System Handbook", Second Edition", (Dec. 1993)
14. "Technical Design, Operation and Maintenance Handbook, NASA PHASE", **NAS3-26562**, (Jan. 1996)

Proposals: Many competitive proposals (not generally available, 1970 - Present)

Patents:

1. Optical Method and Apparatus for Examining Surfaces, with R. J. Hill. UK Patent **#1,431,902** (1974)
2. Apparatus for Laser Anemometry, UK Patent **#1,542,420** (1976), US Patent **#4,125,778** (1976)
3. Movement of an Airborne Vehicle, US Patent **#4,887,213**, (1989)
4. Improvement to Optical Air Data Sensor, US Patent **#5,046,840** (1991)
5. Remote Pressure and Temperature Sensor, US Patent **#5,055,692** (1991)
6. Laser Cooling Structure, US Patent **#5,099,487** (1992).
7. System for Measurement of Airborne Vehicle Speed, US Patent **#5,313,263** (1995)
8. Multiple Scattering Suppression, US Patent **#5,956,139** (1999)
9. Optical Device for Measuring a Surface Characteristic of an Object by Multi-Color Interferometry, US Patent **#6,181,430** (2001)
10. Dynamic Light Scattering Homodyne Probe, US Patent **#6,469,787** (2002)

Current and Former Customers

Organization	Location	Technical Activity	Date
LaSen, Inc	New Mexico	Global Reconnaissance Airborne Chemical Inspection	2004-
ITT Industries	Washington DC	Invited talk, "Leveraging Company Capabilities"	20031029
ITT Sanitaire, Royce.	Louisiana	Turbidity Sensor Concept and Design	2003-
Rank Prize Funds	UK	Optical Diagnostics in Hostile Environments Presentation	20020814
Institute of Physics Pubs.	UK	Chapter 5 for 'Handbook of Optoelectronics'	2002
Starsys Research	Colorado	Design of Control Architecture for Satellite Docking	2001
NASA Glenn RC	Ohio	Gradient Driven Fluctuations Experiment [FOTON 3]	2000-
NASA Glenn RC	Ohio	Support for Microgravity Initiative (Contact Physics)	2000-2001
NASA Glenn RC	Ohio	Advanced Technology Development Program	1999-2000
LaSen, Inc	New Mexico	Airborne Sensor Systems Architecture	1999
Mission Research Corp.	California	Laser Re-packaging Consulting	1999
Namco Controls	Ohio	Optical System and Lens Design	1998
Dynacs Engineering Co.y	Ohio	Microgravity Mission and Planning Support	1998
Michigan Technical Univ.	Michigan	Optical Sensor Design for Thin Liquid Films	1998-
NASA Lewis RC	Ohio	STS-83 & STS94 Space Shuttle Mission Support	1997
Knox Company	California	Thermal Sensing Instrumentation	1997
Rice Systems	California	Miniaturized Integrated Velocity Sensor, Other Projects	1997-Present
NYMA, Inc.	Ohio	Space-qualified Equipment Design and Support	1996-1997
Aquatec Water Systems	California	Water Pump Analysis and Modeling	1996
Innova Electronics Corp.	California	Timing Light Optical Design	1996
Ohio Space Institute	Ohio	Light Scattering in Space: NASA Extending the Frontiers	19960621
Titan Corporation	New Mexico	Optical Instrumentation Design	1996
NASA Lewis RC	Ohio	'PHASE' LSI Space-Qualified System	1994-1996
Physical Optics Corp.	California	Optical Signal Calculations	1994
NASA Dryden	California	Optical Anemometry (SR-71 Flight Tests)	1993
NASA Langley	Virginia	LITE Space-Qualified Laser	1992
Northrop	California	Doppler Anemometry, (Saberliner Flight Tests)	1991-1994
NASA Dryden	California	Optical Anemometry, (F-104 Flight Tests)	1991, 1992
DARPA	Washington DC	Optical Air Data Sensor (OADS) System	1991
NADC	Maryland	Optical Air Data Sensor System Development	1989-1994
Crouzet	France	Optical Air Data Sensor Systems Evaluation	1988
DARPA	Washington DC	Submarine Wake Measurement Technologies	1987
General Dynamics	Texas	OADS System (F-16B Flight Tests)	1986-1990
MCC	Texas	Split-Field Microscope (Tape-Automated Bonding)	1986
NASA Langley	Virginia	Transit Anemometry Software	1985-1987
DNA	New Mexico	Particle Anemometry for Explosion Measurement	1985
Uresco Ardrex	California	Turbine Blade Inspection and Handling System	1985
Lockheed	California	Correlator and L1011 Flight Test Support	1984-1988

RAE, Farnborough	UK	5m Wind Tunnel Instrumentation Design	1984
SCUAR	Egypt	Particle Sizing System	1984
SAI	California	Traversing System (1m ³)	1984
Pratt & Whitney Aircraft	Connecticut	Compressor Drum Inspection System	1983
TSI	Minnesota	Laser Transit Anemometer and 5 ns Correlator	1983
NASA Langley	Virginia	5 ns Correlator and Wind Tunnel Testing	1982-1986
AFWAL	Ohio	Wind Tunnel Instrumentation	1982
US Air Force	New Mexico	Laser Beam Analyzer	1982
US Army OMEW	New Mexico	Optical Test Bench (CSCMI)	1982
Gas Research Council	Illinois	Gas-pipe Flow Metering Instrumentation	1981-1987
Owens Corning Fiberglas	Ohio	Glass Fiber Diameter Measurement	1980
NASA Ames	California	Wind Tunnel Instrumentation, (DC8 Flight Test)	1979, 1994
General Electric	Ohio	Compressor and Combustion Research	1979
Pratt & Whitney Aircraft	Florida	Combustion Research Instrumentation	1979
AEDC	Tennessee	Wind Tunnel Instrumentation	1978
Argonne National Lab.	Ohio	Spectroscopy for Gas Energy Meter	1978
MERDI	Montana	Magneto-hydrodynamic Measurement Study	1978
USGS	Virginia	River Flow Measurement System	1978
Whittle Laboratory	UK	Wind Tunnel Instrumentation	1973
Rolls-Royce	UK	Compressor and Combustion Instrumentation	1962-1986
Svenska Flygmotor	Sweden	Technical Exchange Program	1964

Fields of Capability and Experience

Optical Sources

CW and pulsed solid state, ion and diode lasers. Conventional light sources
Diode laser drivers, controls and monitoring, built-in-test (BIT).

Optical Sensors

Avalanche photodiode control, monitoring, signal amplification and conditioning.
Analog operation and single photon quantum discrimination, also photomultipliers.

Optical Fibers

Single-mode, polarization-maintenance, short wavelength behavior, coherence.
High power transmission, losses, damage, ruggedization, space qualification.

Hostile Environments

Under-water, ground based, airborne, space-based optical measurements.
Severe thermal, shock, vibration and EMI environments, flight and space qualification.
Equipment deployed on L1011, F-16, F-104, Sabreliner, DC-8, SR-71, Space Shuttle, and ISS.

Optical Atmospheric Measurements

Coherent homodyne and incoherent ranging techniques.
Long-range velocity, signal strength, signature measurements.
Short range 3D velocity measurements Mach 3+, 70 kft+.
Scattered intensity, particle scattering characteristics.

Space

Design of space-qualified instruments for Microgravity Research.
Member of Science Team for Space Shuttle Columbia STS83 and STS94/83R MSL-1.

System and Instrument Design

Architectures, optical/mechanical/electrical packaging, computing hardware/software.

Design Verification

Feasibility, performance quantification, cost prediction.

System Capabilities

Concept, design and implementation of optical, electronic, and mechanical systems.
Signal processing techniques, hardware and software.

Numerical Modeling of Physical Systems

Physics and phenomenology, system modeling and performance prediction.
Active and passive sensor signal and SNR prediction.
Atmospheric, condensed matter physics, and isolated particle scattering modeling.

Rapid Response

Design studies, analyses, and comprehensive reports based on 43 years of experience.