Vita for RICK S. BLUM, Lehigh University
Robert W. Wieseman Professor of Electrical Engineering

A. BIOGRAPHICAL INFORMATION

Business Address:

Electrical and Computer Engineering Department, Lehigh University
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EDUCATION

1987 – 1991 *UNIVERSITY OF PENNSYLVANIA* *Philadelphia, Pennsylvania*
Ph.D. in Electrical Engineering Aug. 1991
Specialized in Signal Processing and Communications.
Dissertation: Distributed and Quantized Weak Signal Detection
Advisor: Dr. Saleem A. Kassam

1985 – 1987 *UNIVERSITY OF PENNSYLVANIA* *Philadelphia, Pennsylvania*
Master of Science in Electrical Engineering May 1987
Thesis: A Communication Simulation Language Translator
Advisor: Dr. Peter Hahn

1980 – 1984 *THE PENNSYLVANIA STATE UNIVERSITY* *State College, Pennsylvania*
Bachelor of Science in Electrical Engineering May 1984
GPA 3.98/4.0 Graduated first in class of Electrical Engineers.

PROFESSIONAL EXPERIENCE

8/91 – 7/97 *ASSISTANT PROFESSOR*
8/97 – 7/02 *ASSOCIATE PROFESSOR*
8/02 – current *PROFESSOR*
Lehigh University; Bethlehem, PA
Research interests are in the area of signal processing and communications with emphasis on signal detection and estimation theory. Teaching assignments include graduate and undergraduate courses on Signal Processing and Communication Systems, Circuits, Signals, and Systems.
Extensive consulting experience and collaborations with companies, Ex: Agere, AT&T, Lucent, Verizon, LSI and government agencies, Ex: NASA, Air Force, Army, Navy. Sabbaticals at AT&T, Lucent, Army, Air Force

6/84 – 8/91 *SENIOR COMMUNICATIONS AND DIGITAL SIGNAL PROCESSING SYSTEM ENGINEER*

General Electric Aerospace; Valley Forge, PA
General Electric Ph.D. Fellow at the University of Pennsylvania

Research Projects at General Electric

Communication Systems Modeling and Simulation - Research aimed at developing more accurate mathematical models for use in analysis and in computer simulations. This work is described in a textbook on communication systems simulation by Dr. M. C. Jeruchim.

VLSI Research and Development - Developed a new 1.25 micron CMOS radiation hardened DSP chip to perform fast FFTs and filtering for on-board satellite processing.

Beamforming Algorithm Research - Extensive analytical and simulation study aimed at producing jammer resistant algorithms for multibeam antennas.

Parallel Processor Research for Signal and Image Processing - Researched possible architectures for high speed processing. Developed conceptual and hardware design of an SIMD based scheme. Patent issued on the concept and design.

Communication Link Simulation Tool Research - Developed a unique tool to automatically construct simulations from brief descriptions of communication links.

8/83 – 6/84 *ELECTRICAL ENGINEERING TEACHING ASSISTANT*
The Pennsylvania State University; State College, PA
Supervised problem sessions for a communications class. Presented problem solutions and review sessions. Answered questions on problems and lectures. Supervised junior level laboratory course. Provided lectures and individual assistance to support laboratory exercises. Graded reports.

6/83 – 8/83 *AUTOMATIC TEST ENGINEER*
IBM Federal Systems; Owego, NY - Summer Preprofessional Program Member

B. PUBLICATIONS

BOOKS

1. R. S. Blum and Zheng Liu, "Multi-Sensor Image Fusion and Its Applications ", CRC Press (formally Marcel Dekker) in the *special series on Signal Processing and Communications* 2006.

CHAPTERS IN BOOKS

1. R. S. Blum and S. A. Kassam, "Optimum Distributed Detection of Weak Signals in Dependent Sensors," SPIE's Milestone Series of Selected Reprints on the subject Sensor and Data Fusion, pp. 172-185, 1996.
2. R. S. Blum and Keith McDonald, "Robust Techniques in Space-Time Adaptive Processing", for the book "The Applications of Space-Time Adaptive Processing", IEE Publishers, 2003, Editor: R. Klemm

3. R. S. Blum and Jinzhong Yang, "Image Fusion using the Expectation-Maximization Algorithm and a Gaussian Mixture Model" for the book "Advanced Video-Based Surveillance Systems", Kluwer, 2003. Editors: G.L.Foresti, C.S.Regazzoni and P.Varnshey.

4. R. S. Blum, Zhiyun Xue, and Zhong Zhang, "An Overview of Image Fusion", for the book " Multi-Sensor Image Fusion and Its Applications", CRC Press, 2006, Editor: R. Blum.

5. R. S. Blum and Jinzhong Yan, "A Statistical Signal Processing Approach to Image Fusion using Hidden Markov Models", for the book " Multi-Sensor Image Fusion and Its Applications", CRC Press, 2006, Editor: R. Blum.

6. H. Godrich, A.M Haimovich, and R.S. Blum, "Concepts And Applications of MIMO Radar System With Widely Separated Antenna" in the book MIMO Radar Signal Processing, 2009, edited by J. Li.

7. Qian He, Yang Yang, and R. S. Blum. MIMO Radar with Widely Separated Antennas: From Concepts to Designs, book Chapter for Academic Press Library in Signal Processing: Volume 2: Communications and Radar Signal Processing, edited by S. Theodoridis and R. Chellappa, Academic Press, Oct 2013. available at http://www.amazon.com/Academic-Press-Library-Signal-Processing/dp/0123965004 or http://www.safaribooksonline.com/library/view/academic-press-library/9780123965 004/xhtml/CHP013.html

REFEREED JOURNAL ARTICLES

1. R. S. Blum and S. A. Kassam, "Approximate analysis of the convergence of relative efficiency to ARE for known signal detection," *IEEE Transactions on Information Theory*, IT-37, pp. 199-206, Jan. 1991.

2. R. S. Blum and S. A. Kassam, "Asymptotically optimum quantization with time invariant breakpoints for signal detection," *IEEE Transactions on Information Theory*, IT-37, pp. 402-407, March 1991.

3. R. S. Blum and S. A. Kassam, "Optimum distributed detection of weak signals in dependent sensors," *IEEE Transactions on Information Theory*, IT-38, pp. 1066-1079, May 1992.

4. R. S. Blum, "Asymptotically robust detection for known signals in contaminated multiplicative noise," *Signal Processing*, Vol. 38, Issue 3, pp. 197-210, 1994.

5. R. S. Blum, "Asymptotically robust detection for known signals in non-additive noise," *IEEE Transactions on Information Theory*, IT-40, pp. 1612-1619, Sept. 1994.

6. R. S. Blum, "Quantization in multisensor random signal detection," *IEEE Transactions on Information Theory*, IT-41, pp. 204-215, Jan. 1995.

7. R. S. Blum and S. A. Kassam, "On the asymptotic relative efficiency of distributed detection schemes," *IEEE Transactions on Information Theory*, IT-40, pp. 523-527, March 1995.

8. R. S. Blum and S. A. Kassam, "Distributed cell-averaging CFAR detection in dependent sensors," *IEEE Transactions on Information Theory*, IT-40, pp. 513-518, March 1995.

9. R. S. Blum, "Distributed detection of narrowband signals," *IEEE Transactions on Information Theory*, IT-40, pp. 519-522, March 1995.

10. R. S. Blum and S. A. Kassam, "Optimum distributed CFAR detection of weak signals," *Journal of the Acoustical Society of America*, Vol. 98, no. 1, pp. 221-229, July 1995.

11. R. S. Blum and J. Qiao, "Threshold optimization for distributed order-statistic CFAR signal detection," *IEEE Transactions on Aerospace and Electronic Systems*, pp. 568-577, Jan. 1996.

12. R. S. Blum, "Necessary conditions for optimum distributed sensor detectors under the Neyman-Pearson criterion," *IEEE Transactions on Information Theory*, IT-42, pp. 990-994, May 1996.

13. R. S. Blum, "Locally optimum distributed detection of correlated random signals based on ranks," *IEEE Transactions on Information Theory*, IT-42, pp. 931-942, May 1996.

14. R. S. Blum, S. A. Kassam, and H. V. Poor, "Distributed detection with multiple sensors: part II - advanced topics," *Proceedings of the IEEE*, pp. 64-79, Jan. 1997 (**Invited Review Paper**).

15. R. S. Blum and M. C. Jeruchim, "A note on windowing in the simulation of continuous-time communication systems," *IEEE Transactions on Communications*. pp. 889-892, Aug. 1997.

16. M. C. Deans and R. S. Blum, "Distributed random signal detection with multiple bit sensor decisions," *IEEE Transactions on Information Theory*, pp. 516-524, March 1998.

17. R. S. Blum, "Distributed detection for diversity reception of fading signals in noise," *IEEE Transactions on Information Theory*, IT-48, pp. 158-164, Jan. 1999.

18. R. S. Blum and Y. Zhang, "Analysis of the adaptive matched filter algorithm for cases with mismatched clutter statistics," *IEEE Transactions on Signal Processing*. pp. 1715-1721, June 1999.

19. R. S. Blum, R. J. Kozick, and B. M. Sadler, "An adaptive spatial diversity receiver for non-Gaussian interference and noise," *IEEE Transactions on Signal Processing*, pp. 2100-2112, Aug. 1999.

20. Z. Zhang and R. S. Blum, "A categorization and study of multiscale-decomposition-based image fusion schemes", *Proceedings of the IEEE*, Aug. 1999, pp. 1315-1328.

21. X. Lin and R. S. Blum, "Robust STAP algorithms using prior knowledge for airborne radar applications," *Signal processing*, Vol. 79, pp. 273-287, 1999.

22. Y. Zhu, R. S. Blum, Z-Q. Luo, and K. M. Wong, "Unexpected properties and optimum distributed sensor detectors for dependent observation cases," *IEEE Transactions on Automatic Control*, pp. 62-72, Jan. 2000.

23. R. S. Blum and K. F. McDonald, "Analysis of STAP algorithms for cases with mismatched steering and clutter statistics," *IEEE Transactions on Signal Processing*, pp. 301-310, Feb. 2000.

24. X. Lin and R. S. Blum, "Improved space-time codes using serial concatenation," *IEEE Communication Letters*, pp. 221-223, July 2000.

25. Y. Zhang and R. S. Blum, "An adaptive receiver with an antenna array for channels with correlated nonGaussian interference and noise using the SAGE algorithm," *IEEE Transactions on Signal Processing*, pp. 2172-2175, July 2000.

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28. K. F. McDonald and R. S. Blum, "Exact performance of STAP algorithms with mismatched steering and clutter statistics," *IEEE Transactions on Signal Processing*, pp. 2750-2763, Oct. 2000.

29. J. Hu and R. S. Blum, "A gradient guided search algorithm for multiuser detection ," *IEEE Communication Letters*, pp. 340-342, Nov. 2000.

30. P. Willett, P. F. Swaszek and R. S. Blum, "The good, bad, and ugly: distributed detection of a known signal in dependent Gaussian noise," *IEEE Transactions on Signal Processing*, pp. 3266-3279, Dec 2000.

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35. Q. Yan and R. S. Blum, "Distributed signal detection under the Neyman-Pearson criterion," *IEEE Transactions on Information Theory*, pp. 1368-1377, May 2001.

36. R. S. Blum, Y. (Geoffrey) Li, J. H. Winters, and Q. Yan, "Improved Space-time coding for MIMO-OFDM Wireless Communications," *IEEE Trans. on Communications*, pp. 1873-1878, Nov. 2001.

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39. R. S. Blum and J. H. Winters, "On Optimum MIMO with Antenna Selection", *IEEE Communications Letters*, pp. 322-324, Aug. 2002.

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41. R. S. Blum, "Some analytical tools for the design of space-time convolutional codes," *IEEE Transactions on Communications*, pp. 1593-1599, Oct. 2002.

42. J. Hu and R. S. Blum, "Application of Distributed signal detection to multiuser communication systems," *IEEE Transactions on Aerospace and Electronic Systems*, pp. 1220-1229, Oct. 2002.

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48. R. S. Blum, "Maximum MIMO System Mutual Information with Antenna Selection and Interference", to appear in *European Journal on Applied Signal Processing, Special issue on MIMO*, pp. 676-684, May 2004.

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66. Eugene Perevalov, R. S. Blum, Anthony Nigara and Xun Chen, “Throughput Capacity of Ad hoc Networks with Route Discovery”, EURASIP Journal on Wireless Communications and Networking in a special issue on “Wireless Mobile Ad Hoc Networks”. Volume 2007, Issue 1, 14 pages, January 2007.

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69. Y. Chen, Z. Xue and R. S. Blum, “Theoretical Analysis of an Information-Based Quality Measure for Image Fusion”, *Information Fusion*, Vol. 9, Issue 2, pp. 161-175, April 2008.

70. Yang Yang and R. S. Blum, “Minimax Robust MIMO Radar Waveform Design,” IEEE Journal of Selected Topics in Signal Processing, Vol. 1, Issue 1, June 2007, pp. 147-155.

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183. Jiangfan Zhang and Rick S. Blum, "Asymptotically Optimal Truncated Hypothesis Test for a Large Sensor Network Described by a Multivariate Gaussian Distribution", Asilomar Conference on Signals, Systems and Computers 2013, Nov 2013.

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201. Anand Guruswamy, Rick S. Blum, Shalinee Kishore and Mark Bordogna, Minimax Optimum Joint Frequency and Phase Recovery in IEEE 1588, 2015 IEEE China Summit and International Conference on Signal and Information Processing (ChinaSIP), Chengdu, China, 2015 (invited paper).

202. Zheng Zhou, Mugen Peng, Zhongyuan Zhao, Rick Blum, Wireless Information and Power Transfer Design with Scheduling for Cooperative Networks, 2015 IEEE China Summit and International Conference on Signal and Information Processing (ChinaSIP), Chengdu, China, 2015 (invited paper).

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208. Jianbin Hu, Qian He, Rick S. Blum and Yonggang Wu, Performance Analysis of Joint Parameter Estimation for Distributed Radar Networks under a General Model, IET Radar Conference, Oct 2015.

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214. Qian He, Jiangfan Zhang, Anand Guruswamy, Basel Alnajjab, Rick S. Blum, New Contributions to Estimation Theory with Applications in Wave Energy, IEEE 1588, Cybersecurity, MIMO Radar and the Internet of Things, *Asilomar Conference on Signals, Systems, and Computers*, Pacific Groove, CA, Nov. 2016.

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218. Yang Li, Qian He. and Rick S. Blum, Passive Radar Detection Based Illuminator of Opportunity Selection, International Conference on Acoustics, Speech, and Signal Processing, Msrch 2016.

219. Jianbin Hu, Yonggang Wu, Qian He, and Rick S. Blum, Comparison of Centralized and Distributed Estimation Using Passive Radar Networks, International Conference on Acoustics, Speech, and Signal Processing, March 2016.

220. Lawrence V. Snyder, Jiyun Yao, Parv Venkitasubramaniam, Shalinee Kishore, Rick Blum, Risk Assessment And Network Optimization For Smart Grid Cybersecurity, INFORMS Annual Meeting 2016 Nashville.

221. Basel Informs poster and Alberto paper.

222. Jiyun Yao, Parv Venkitasubramaniam, Shalinee Kishore, Lawrenc Snyder, Rick Blum, "Network Topology Risk Assessment Of Stealthy Cyber Attack On Advanced Metering Infrastructure Network," Submitted to Acoustics, Speech and Signal Processing (ICASSP), submitted to IEEE International Conference on, March 5-9, 2017, New Orleans, USA.

INVITED CONFERENCE PAPERS

1. R. S. Blum, "Robust distributed data fusion," *Invited Presentation at the Joint Conference on Information Sciences*, Pinehurst, NC, Nov. 1994.

2. R. S. Blum, "Fusing quantized observations in multisensor random signal detection," *Invited paper, Proceedings of the American Control Conference*, Seattle, WA, pp. 1703-1707, June 21-23, 1995.

3. H. Vikalo and R. S. Blum, "Distributed detection of known signals in Gaussian mixture noise which is dependent from sensor to sensor", Invited paper at International Conference on Telecommunications, pp. 599-604, Melbourne, Australia, April 1997.

4. H. Vikalo and R. S. Blum, 'Distributed detection in dependent Gaussian mixture noise" US-Australia workshop on selected areas in defense signal processing (sponsored by AFOSR), Victor Harbor, South Australia, June 1997.

5. H. Mecklai and R. S. Blum, "Distributed detection for BFSK frequency hopped systems with fading and additive Gaussian noise," *Conference on Information Sciences and Systems*, pp. 101-106, Princeton University, Princeton, NJ, March 1998.

6. R. S. Blum, "Decision and data fusion research at Lehigh University," National Symposium on Data Fusion (sponsored by AFOSR) and held at Georgia Tech. Atlanta, Georgia, March 1998.

7. X. Lin and R. S. Blum, "Numerical solutions for optimum distributed detection of known signals in dependent t distributed noise-the two sensor problem", *Asilomar Conference on Signals, Systems, and Computers*, pp. 613-617, Monterey, CA, Nov. 1998.

8. Z. Zhang and R. S. Blum, "Image fusion for a digital camera application" *Asilomar Conference on Signals, Systems, and Computers*, pp. 603-607, Monterey, CA, Nov. 1998.

9. R. S. Blum and J. Hu, "Distributed multiuser detection," *Asilomar Conference on Signals, Systems, and Computers*, pp. 1567-1571, Monterey, CA, Nov. 1999.

10. R. S. Blum, "New analytical tools for designing space-time convolutional codes," Invited paper at *Conference on Information Sciences and Systems*, Princeton University, pp. WP3-1 to WP3-6, Princeton, NJ, March 2000.

CONFERENCE PAPERS WITH SELECTION BASED ON ABSTRACT

1. R. Theodore, D. Hoeschele, R. Blum, E. Faller, C. Bianchi, and C. Hayes, "Reconfigurable 1.25 micron CMOS signal processor for spacecraft applications," *Proceedings of Computers in Aerospace V Conference*, Long Beach, CA, Oct. 21-23, 1985.

2. H. K. Mecklai and R. S. Blum, "Diversity techniques for wireless communications on the shop floor," *Proceedings of the Information Resources in Manufacturing, 9th Conference with Industry,* Lehigh University, Bethlehem, PA, May 23-24, 1995.

3. R. S. Blum, "Data fusion for manufacturing," *Proceedings of the Information Resources in Manufacturing, 9th Conference with Industry,* Lehigh University, Bethlehem, PA, May 23-24, 1995.

4. M. C. Deans and R. S. Blum, "An adaptive algorithm for distributed signal detection system design," *Proceedings of the Sensor Fusion and Networked Robotics VII Conference, SPIE Photonics East Symposium,* Phila., pp. 172-181, PA. Oct. 1995.

5. Z. Zhang and R. S. Blum, "Multisensor image fusion using a region-based wavelet transform approach", *Proc. of the DARPA IUW*, pp. 1447-1451, 1997.

6. Z. Zhang and R. S. Blum, "A hybrid image registration technique for a digital camera image fusion application", SPIE AeroSense, Conference on Battlefield Digitization and Network Centric Warfare (4396-39), Orlando, FL, April 2001.

NON-REFEREED PUBLICATIONS

1. Several Final and Interim Reports for projects I worked on while employed by General Electric.

2. R. S. Blum, "An Analysis of Adaptive DPCA," *Final Report for the AFOSR Summer Faculty Research Program*, Aug. 1995.

3. R. S. Blum, Increasing Secondary Data or Enhanced ADPCA Approaches: A Necessity for Improved Detection, Air Force Research Lab., *Final Report for AFOSR Grant*, 1998.

4. R. S. Blum, "Robust Diversity Combining," *Final Report for Army Research Laboratory Grant*, 1999.

5. R. S. Blum, "Space-Time Processing with Limited Reference Data," *Final Report for AFOSR Grant*, 2000.

6. R. S. Blum, "Models for Man-made Interference in Electromagnetic Environments," *Final Report for Army Research Laboratory Grant*, 2000.

7. R. S. Blum, "A Theory for Distributed Detection and Data fusion," *Final Report for ONR Young Investigator Award Research Program*, 2000.

C. HONORS AND AWARDS

h-index of 49 by gooogle scholar, will soon pass 50, 2016.
3 papers over 1000 cites, another 1 > 800, another 2 ≈ 500, another 6 near 300.
Graduated 20th PhD Student, impressive since worked closely with each one, 2016.
Lehigh lead on $12.5 million Department of Energy Cybersecurity center, 2015
Recruited, hired and mentored large group of impressive faculty in Sig Proc in ECE (ex: S. Kishore), now full professors or close, 2015
Mentored INE Cluster faculty to impressive accomplishments, many now full professors or close, 2015
Energy Systems Engineering Director 2015
Integrated Networks for Electricity Cluster Director 2012
Named IEEE Signal Processing Society Distinguished Lecturer 2011
Named IEEE Fellow for scientific contributions to detection, data fusion and signal processing with multiple sensors 2005
Start up Company formed based on one of my inventions 2004
IEEE Third Millennium Medal 2000
Class of 1961 Professorship from Lehigh University 1998
Signal Proc. for Communication Tech Com Member, IEEE Signal Proc. Soc. 1998
Office of Naval Research Young Investigator Award 1997
Invited Presenter at AFOSR-DSTO Workshop on Signal Processing 1997
Paper selected for SPIE's Milestone Reprints on Sensor and Data Fusion 1996
Asked to write review paper for spec. issue of Proc. of the IEEE (on data fusion)
Chosen as panel member for NSF working group on Array Processing 1995
Elected full member of *Sigma Xi* 1994
Listed in Who's Who in Science and Engineering 1994, 1995,...
National Science Foundation Research Initiation Award 1992
Awarded U. S. Patent No. 4,972,495 "Feature Extraction (parallel) Processor," with J. J. Blike, M. S. Horwedel, and J. L. Rimlinger (GE) 1990
Outstanding College Students of America (Penn) 1988
General Electric Ph.D. Fellowship Program (Penn) 1987
GE Advanced Course in Engineering Graduate (GE) 1985
Top GPA of 1984 PSU EE Graduates 1984
Eta Kappa Nu Outstanding Young Engineer (PSU) 1983
Evan Pugh Scholar (PSU) 1983,1984
National Dean's List (PSU) 1982, 1983, 1984
Awarded Scholarships (PSU) 1982, 1983, 1984
President's Freshman Award (PSU) 1982

D. FUNDING

COMPETITIVELY AWARDED RESEARCH GRANTS FUNDED

1. R. S. Blum, Lehigh lead PI, Multiuniversity DoE Center on Cybersecurity, 12.5 Million. Lehigh part about 3.2 million (9 Lehigh faculty), An Interdisciplinary approach to Integratable, Composable and Evolvable Cybersecurity in Energy Delivery Systems, 2015-2020, Univ. of Ark is lead school but Lehigh has more faculty and funding than they do.

2. R. S. Blum, PI, Impacts and Mitigation of Attacks on Sensor Networks, Army Research Office, $376.784, 2014-2017.

3. R. S. Blum, PI, Robust Sensor Systems for Estimation with Army Surveillance Applications, Army Research Office, $100,000, 2014-2017.

4. R. S. Blum, PI, Performance Limits of Networked Passive Radar Systems, National Science Foundation (ECCS-1405579), $233,573, 2014-2017.

5. Lawrence V. Snyder, Rick S. Blum, Kathleen Edwards, Shalinee Kishore, GOALI: Optimizing the Design of Ocean Wave Energy Farms, National Science Foundation (CMMI-1400164), $400,000, 2014-2017.

6. Shalinee Kishore, Rick S. Blum, Alberto Lamadrid, Arindam Banerjee, Lawrence V. Snyder, CyberSEES: Type 2: Ocean Wave Energy and the Power Grid: Optimization and Integration, National Science Foundation (CCF-1442858), $900,000, 2014-2017.

7. Rick S. Blum and Shalinee Kishore, "PITA XVII: Filtering Packet Delay Variations in Wireless Backhaul Networks for Precise time Distribution (Phase 3)", State of PA, $16,350.00, 2015-16.

8. Rick S. Blum and Shalinee Kishore, "2014 University Research Program LSI: Algorithm for filtering packet delay variations in access networks for precise time distribution", LSI (now Intel) corporation, $20,000, 20013-2014.

9. Rick S. Blum and Shalinee Kishore, "PITA XVI: Filtering Packet delay Variations in Wireless Backhaul Networks for Presise Time Distribution (Phase II)", State of PA, $31,350.00, 20013-2014.

10. Shalinee Kishore and Rick S. Blum, "Development of a PDV Cancelation Algorithm for Accurate Time Distribution", LSI corporation, $20,000, 20012-2013 (only student support, no support for Kishore or Blum).

11. Shalinee Kishore and Rick S. Blum, "PITA XV: Filtering Packet delay Variations in Wireless Backhaul Networks for Presise Time Distribution", State of PA, $25,674, 20012-2013 (only student support, no support for Kishore or Blum).

12. R. S. Blum, PI, Smart Grid Security and Failure Detection, State of PA, $50,000, 20011-2012.

13. R. S. Blum, PI, Distributed Coordination for Signal Detection in Sensor Networks, National Science Foundation, $270,000, 2008-2013.

14. R. S. Blum, PI, Energy Efficient Signal Detection for Army Applications Based on Ordering, Army Research Office, $280,429, 2008-2011.

15. R. S. Blum, PI, MIMO Radar Practical Issues Missile Defense Agency STTR, $240,000, 2008-2011.

16. R. S. Blum, PI, Networking Sensors for Information Dominance: Joint Signal Processing and Communication Design, Air Force Office of Scientific Research, $326,563, 2008-2011.

17. R. S. Blum, PI, Signal Processing For Improved Artery Identification Using Infrared Imaging Systems PITA, $26,180, 2008-2009.

18. R. S. Blum, PI, Performance Limits and Design of MIMO for Sensor and Ad Hoc Wireless Networks, Air Force Office of Scientific Research, $271,911, 2005-2008.

19. R. S. Blum, co-PI, Space-Time Inhomogeneity and Performance of Large Scale Ad Hoc Networks, National Science Foundation, $200,000, 2005-2008.

20. R. S. Blum, Sensor Networking Research, *Darpa Funding via Army Research Lab*, (funding obtained independent of COT), 2006-2007, $50,000.

21. R. S. Blum, Image fusion for night vision applications IV, *Army Research Lab*, 2006-2007, $90,000.

22. R. S. Blum, Signal Processing for Nanotechnology sensors, *NASA*, 2006-2007, $56,634.

23. R. S. Blum, Cooperative MIMO for Ad hoc, PITA - State of PA, 2005-2007, $30,000.

24. R. S. Blum, "Performance of Image Fusion Algorithms for Night Vision III," Army Research Laboratory, 2005-2006, $90,000.

25. R. S. Blum, co-pi, SBIR: MIMO Radar, DoD, 2006-2007.

26. R. S. Blum, co-pi, SBIR: Image Fusion, Darpa, 2006-2007.

27. R. S. Blum, Wireless Networking, *PITA - State of PA*, 2005-2006, $30,000.

28. R. S. Blum, "Fusion for Night Vision II," *Army Night Vision Laboratory (CACI)*, 2004-2005, $25,000.

29. R. S. Blum, PI, Third Research Experience for Undergraduates (REU) addition to ITR Grant, *National Science Foundation*, $10,000, 2004-2007.

30. R. S. Blum, "Performance of Image Fusion Algorithms for Night Vision," *Army Research Laboratory*, 2004-2005, $87,000.

31. R. S. Blum, "Fusion for Night Vision," *Army Night Vision Laboratory*, 2004-2005, $25,000.

32. R. S. Blum, PI, AASERT with extended PhD student funding for Investigations of Image Fusion, *Army Research Office*, $30,000, 2003-2005.

33. R. S. Blum, PI, MIMO for wireless and sensor networks, *Air Force Office of Scientific Research*, $238,663, 2003-2007.

34. R. S. Blum, PI, Information Technology Research Grant: MIMO Processing and Space-time Coding with Interference, *National Science Foundation*, $282,627, 2001-2007.

35. R. S. Blum, PI, Second Research Experience for Undergraduates (REU) addition to ITR Grant, *National Science Foundation*, $15,000, 2003-2007.

36. R. S. Blum, PI, Research Experience for Undergraduates (REU) addition to ITR Grant, *National Science Foundation*, $15,000, 2001-2007.

37. R. S. Blum, PI, Investigations of Image Fusion, *Army Research Office*, $277,868, 2000-2004.

38. R. S. Blum, "Image Fusion for Night Vision," *Army Research Laboratory*, 2003-2004, $87,000.

39. R. S. Blum, "Registration for Night Vision," *Army Night Vision Laboratory*, 2003-2004, $20,000.

40. R. S. Blum, PI, Phase II of MIMO Techniques for 802.11, PITA Program, *State of Pennsylvania*, $30,000, 2003-2005.

41. R. S. Blum, PI, Wireless extensions to Optics, *State of Pennsylvania*, $37,500, 2002-2004.

42. R. S. Blum, PI, Coding for Optics, *State of Pennsylvania*, $37,500, 2003-2004.

43. R. S. Blum, PI, MIMO Techniques for 802.11, *PITA Program, State of Pennsylvania*, $62,106, 2003-2005.

44. R. S. Blum, PI, Data Fusion with Communication Applications, *Air Force Office of Scientific Research*, $237,322, 2001-2003.

45. R. S. Blum, PI, ONR Young Investigator Award: A Theory for Distributed Detection and Data Fusion, *Office of Naval Research*, $300,000, 1997-2000.

46. R. S. Blum, PI, Towards a Fundamental Understanding of Distributed Signal Detection with an Acoustic System Emphasis, *National Science Foundation*, $162,000, 1997-2002.

47. R. S. Blum, PI, Research Experience for Undergraduates, *National Science Foundation supplement to Regular NSF Grant*, $10,000, 1997-2002.

48. R. S. Blum, PI, Space-Time Processing with Limited Reference Data (AASERT), *Air Force Office of Scientific Research*, $109,278, 1997-2000.

49. R. S. Blum, "Models for Man-made Interference in Electromagnetic Environments," *Army Research Laboratory* , 1997-2000, $25,000.

50. R. S. Blum, Increasing Secondary Data or Enhanced ADPCA Approaches: A Necessity for Improved Detection, *Air Force Research Lab.*, $100,000, 1997-1998.

51. R. S. Blum, "Robust Diversity Combining," *Army Research Laboratory* , 1996-1999, $25,000.

52. R. S. Blum, PI, "An Analysis of the Adaptive Displaced Phase Centered Antenna Space-Time Processing Algorithm," *Air Force Office of Scientific Research*, 1995-1996, $25,000.

53. R. S. Blum, PI, "Research Initiation Award: Distributed Signal Detection in Uncertain Environments," *National Science Foundation*, 1992-1996, $90,000.

54. R. S. Blum, PI, "Research Experiences for Undergraduates," *National Science Foundation supplement to Regular NSF Grant*, 1995-1996, $10,000.

55. R. S. Blum, PI, "Research Experiences for Undergraduates," *National Science Foundation supplement to Regular NSF Grant*, 1993-1994, $4,980.

56. PI: Terrance Boult, "Autonomous Vision Sensor Systems for Manufacturing," *DoD URI managed by Office of Naval Research*, 1995-1998 $4,138,085 ($6,998,856 with added 2-year option). R. S. Blum, is one 1 of 5 other faculty collaborating in this research (essentially co-PIs) and his portion of the award amounts to one month summer and support for one graduate student for each year.

INDUSTRY SUPPORTED RESEARCH GRANTS FUNDED (not competitively awarded, but proposal written in each case and work funded on the basis of the proposal)

1. R. S. Blum, PI, Signal Processing for High Speed Communications, AANETCOM and State of PA, $70,000, 2000-2001.

2. R. S. Blum, PI, Modeling Twisted Pair for High Speed Communications, Bell Atlantic (Prof. Hwang and Prof. Fritchman helped carry out the project) $119,400, 1998-1999.

COMPETITIVELY AWARDED EQUIPMENT GRANT SUPPORT

1. E. Santos and R. S. Blum, co-PIs, CISE Research Instrumentation Grant, NSF, (when Eunice left Lehigh she subcontracted my portion back to Lehigh) $107,997, 2000-2003.

2. PI: Terrance Boult, "Acquisition of a Giga-Op Simulation Computation Environment," *National Science Foundation*, 1994-1997 $780,313. R. S. Blum is 1 of 10 faculty collaborating on this proposal (essentially co-PIs). The PI and the collaborators are using the equipment purchased under this award.

EQUIPMENT GRANT SUPPORT FROM COMPANIES AND RESEARCH LABS

1. R. S. Blum, PI, Wireless Communication Testbed and Simulation Facility, AT&T, $25,000, 1997-2000.

2. R. S. Blum, PI, "Signal Processing Laboratory," *Analog Devices*, 1994, $5,470.

COMBINED RESEARCH AND EDUCATION SUPPORT

1. R. Blum, Wireless Communication and Networking Center, AT&T Foundation, $200K, 2001-2003.

OTHER RESEARCH SUPPORT

1. R. S. Blum, AT&T Labs-Research, Red Bank and Middletown, NJ, May 2000 through Aug. 2001.

2. R. S. Blum, "AFOSR Summer Faculty Research Program: Space-Time Processing and Data Fusion," *AFOSR*, 1995, $13,000 (Research performed at Rome Laboratory, Rome, NY).

RESEARCH PROPOSALS PENDING

1. several

E. EDITORS/EDITORIAL REVIEW BOARD MEMBERSHIP

Guest Editor for Special Issue of IEEE Journal of Selected Topics in Signal Processing on MIMO Radar, 2008-2009.

Guest Editor for Special issue of IEEE Journal of Selected Areas of Communication on COOPERATIVE COMMUNICATIONS AND NETWORKING (IEEE Communications Society), 2005-2006.

Lead Editor for Special issue of IEEE Transactions on Signal Processing on MIMO (IEEE Signal Processing Society), 2002-2004.

Associate Editor for IEEE Transactions on Signal Processing (IEEE SP Soc), 1998-2004.

Associate Editor for IEEE Communications Letters (IEEE Comm Soc), 1998-2008.

On editorial board for **Journal of Advances in Information Fusion (JAIF)** of the International Society of Information Fusion, Dec. 2002-current.

Member of Statistical Array and Multidimensional Signal Processing Technical Committee for the IEEE Signal Processing Society, - These committees are very important in the IEEE Signal Processing Society. They make all decisions for this research area. They run conferences and workshops, review papers, set directions. All members must be experts in this area and are chosen by a vote from other experts in this area, 2007-current.

Member of Signal Processing for Communications Technical Committee for the IEEE Signal Processing Society, - These committees are very important in the IEEE Signal Processing Society. They make all decisions for this research area. They run conferences and workshops, review papers, set directions. All members must be experts in this area and are chosen by a vote from other experts in this area, 1998-2002.

Member of Communication Theory Technical Committee of IEEE Communications Society